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Towards Evidence-based Reform of European Universities

Frederick van der Ploeg* and Reinhilde Veugelers†

Abstract

After the Bologna agreement and the Lisbon Agenda, reform of European university systems has been higher on the political agenda. This is necessary, since most European universities have been suffering from stifling blankets of government regulation, having to make do with much less funds than their North-American counterparts and do not appear high on the various rankings of top universities in the world. Furthermore, the booming economies of China and India will nurture and boost world-class universities in the coming decades. Also, universities are essential in their links to business and society to make the European economy more innovative and competitive, especially as European industries approach the world technology frontier. We argue on the basis of the stylized facts that foremost European universities need more autonomy to select students, reward staff, design new programmes, attract more funds and compete better in an increasingly tough environment. Although the general principles of the policy reform agenda are clear, the details are not. The link between governance, funding and performance is not obvious and needs still further data and research. We conclude that reform of European universities should much more be based on the best available empirical analysis. (JEL code: I23)

Keywords: University reform, governance, autonomy, funding, competition.

1 Introduction

Universities are among the key actors in constructing a knowledge-based society. Through their teaching, they disseminate knowledge and improve the stock of human capital; through the research they perform, universities extend the horizons of knowledge; and by their other activities, they transfer knowledge to the rest of society, work with established industry and create new companies. And the contribution of universities to society goes beyond economic and technical advancement, since they maintain a culture that fosters an environment for well-rounded graduates.

As Europe approaches the world technology possibility frontier and leaves the era of catching up behind, innovation and highly educated people have become crucial drivers of its growth potential. If forces are indeed to be mobilized in Europe to create the most competitive economy and knowledge-based society of the 21st century, European universities

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have to play a central role. But most European universities do not seem currently to be in a position to achieve their potential in a number of important ways. In a still too fragmented European higher education and research area, universities are hampered by a combination of excessive public control, bad governance coupled with insufficient funding opportunities. As a result, compared with their counterparts in the US, Australia and other countries (perhaps also China), are behind or falling behind in the increased international competition for talented academics and students, and miss out on fast-changing research agendas, innovative opportunities and teaching curricula.

Modernization of Europe's universities, involving their interlinked roles of education, research and innovation, has therefore rightly been acknowledged as a core condition for the success of a move towards an increasingly global and knowledge-based economy. Various policy communications have identified the main items for change, at the level of the EU and also in many European countries.[1] Spurred by the Bologna process, many countries have started designing a process of reforms. However, few countries make them national priority. Yet these changes are crucial to regenerate Europe's growth capacity. Perhaps, national governments rightly give priority to giving funds to primary and secondary education rather than to university education. But reform of the university system is not only a question of pumping more public money into the system. With a carefully designed social loans system of the type implemented in Australia, it may well be possible to raise private funds from higher tuition fees without sacrificing accessibility to higher education.

We give a brief review of the stylized statistical facts and the academic literature (both theoretical and empirical) that is available on the contribution of universities to economic growth and competitiveness (section 2) and the evidence on the performance of universities with respect to education, research and knowledge transfer (section 3). Having established the importance of universities for growth and the problems of European universities to deliver, it then goes on to examine two important drivers of university performance: governance and funding (section 4). With only limited evidence available on how governance and funding are linked to performance (section 5), the implications for the policy agenda reforming European universities have to remain tentative (section 6). Perhaps the most important conclusion for policy making at this stage is to invest more in data and analysis.

[1] For example "Mobilising the Brainpower of Europe: Enabling Universities to Make their Full Contribution to the Lisbon Strategy", COM (2005) 152 of 20 April 2005 and Council Resolution of 15 November 2005.

The main contribution of this special issue is to contribute to a more evidence-based reform process by providing empirical analysis on various dimensions of university performance. Section 7 provides an overview of these contributions. We hope that the contributions in this special issue will incite further research in this area.

2 Importance of universities for economic development

It is well recognized that European universities have several missions which are centerpiece contributions in a knowledge-based society: teaching, research and the transfer and exchange of knowledge with other parts of society. While education, basic research and transfer of knowledge are heavily interconnected within the university as institute, the academic literature, the statistics and the policy discussion mostly focus on one of these areas only. They thus ignore most of the time the multi-tasking challenge of universities having to balance the various activities which can be sometimes substitutes and other times complements. In the reminder of this contribution which reviews the literature and statistics, we will therefore also often have to resort to a focused discussion of each of the activities of the university separately.

2.1 Some evidence linking university education and research to global competitiveness

At regular intervals, the publication of various international rankings creates "frenzy" in the public opinion on how well European countries are doing on higher education, innovation and growth. Although these rankings are controversial, they nevertheless are very influential in the policy debate. In the *2006–2007 Global Competitiveness Index* compiled by the World Economic Forum (WEF), higher education is considered as one of the main pillars enabling national economies to achieve sustained economic growth and long-term prosperity. It ranks countries on their score on *Higher Education and Training*, measured by secondary and tertiary enrollment rates as well as the quality of education as assessed by the business community, and the importance of vocational and on-the-job training. It also ranks countries according to *Innovation*, measured by expenditures on R&D, especially from the private sector, high-quality scientific research institutes, collaboration between universities and industries and protection of intellectual property. The WEF exercise also enables one to link these scores to the countries' performance on their overall *Global Competitiveness*, a composite index for measuring national competitiveness which takes into account a whole set of drivers deemed critical for determining the level and growth of productivity and income.

The 2007 WEF report [Sala-i-Martin (2007)] stresses that the quality of higher education and training is especially important for economies that want to move up the value chain beyond simple production processes and products. This is akin to the arguments put forward by Aghion (2006) that the return on higher education increases as the economy moves towards the world efficiency frontier. This is why in the 2006–07 exercise, the weight of the pillar of *Higher Education and Training* increases in the ranking for those countries that have moved beyond a simple factor-driven growth stage.

The WEF evidence, by and large, confirms a positive relationship between higher education, growth and global competitiveness: all of the top 15 countries in the overall Global Competitiveness Ranking also have a high score on *Higher Education and Training* and a high score on *Innovation*,[2] reminiscent of the importance of higher education for innovation and growth, particularly for countries at the top. The US is high on the list on all three rankings, which explains why so many commentators on EU higher education reform point to the US as an example. But the top three countries leading the world on *Higher Education and Training* are Finland, Denmark and Sweden; three Nordic EU countries which are also considered as the innovation leaders in Europe [EIS 2007)] and, together with the UK and Germany, are the highest scoring EU countries in the Global Competitiveness Ranking.

Nevertheless, Table 1 also reveals the outliers in the average positive relationship. The overall competitiveness score of Hong Kong is clearly focusing on other efficiency enhancers beyond innovation, which accords with its lower score on higher education. Japan and Germany are also interesting outliers. The relatively low score of Japan and Germany on quality of higher education and training is surprising for these two innovation-driven countries. But for these countries, innovation performance is based more on their private-sector innovation performance and less to the performance of its public sector higher education and research. Surprisingly, UK, being the second ranked country on WEF Global Competitiveness Ranking, performs only moderately on the WEF *Higher Education and Training* ranking and also relatively poorly on *Innovation*. This contrasts with the UK's performance on other rankings (cf. section 3).

The WEF ranking information is crude and may be criticized for many shortcomings. Nevertheless, it suggests a positive link between higher

[2] Innovation includes the subcomponent *Knowledge Transfer between Universities and Industry*. The Top 10 countries in this subcomponent (in order) were Finland, USA, Austria, Israel, Iceland, Singapore, Germany (Bavaria), Switzerland, Sweden and Canada (*Source*: WEF 2006).

Table 1 WEF ranking on global competitiveness, higher education and innovation

Global competitiveness rank	Country	Higher education and training		Innovation	
		Score	Rank	Score	Rank
1	US	5.8	4	5.82	1
2	UK	5.56	11	4.78	12
3	DK	6.00	2	4.95	10
4	SUI	5.63	7	5.54	3
5	JP	5.39	19	5.8	2
6	FIN	6.12	1	5.47	4
7	GER	5.36	20	5.37	7
8	SIN	5.46	17	4.99	9
9	SWE	5.9	3	5.27	8
10	HK	4.96	26	4.28	22
11	NL	5.58	9	4.73	15
12	CA	5.53	13	4.77	13
13	TAI	5.74	5	5.37	6
14	ISR	5.48	15	5.39	5
15	FRA	5.55	12	4.8	11

Source: WEF 2007.

Note: Countries are ranked according to their overall score of Global Competitiveness; besides hard data from leading international sources, indicators include the results of an *Executive Opinion Survey* carried out by the World Economic Forum WEF annually.

education, innovation and growth, but at the same time also suggests that the macro-link between universities and growth is multi-faceted and country-specific. We still need to understand much better the links driving these relationships and to explain the heterogeneity among countries. The next two sections take a closer look at the economic literature trying to explain the contribution of universities to economic development, through education (section 2.2) and research (section 2.3).

2.2 The contribution of university teaching to economic development

There is a large amount of empirical evidence on the private and social returns to higher education to the individual in the form of a higher probability of finding better-paid jobs and increases in lifetime earnings (e.g. Jacobs and van der Ploeg 2006).

Economists have long argued that the benefits of human capital accumulation may not be restricted to the direct recipient but might also spill over to others. The idea of positive educational externalities is well

established. Channels for such types of externalities leading to social returns exceeding private returns include the possibility that educated workers may raise the productivity of their less educated co-workers, that there may be spill-over effects from technical progress or knowledge accumulation which in turn arise from investments in human capital, or that an environment with a higher average level of human capital may entail a higher incidence of learning from others.

The existence of positive economy-wide educational spill-over effects is an important economic justification for the public support of education and is often assumed *a priori*, although the difficulties of actually verifying their size and thus calculating true social returns are substantial.

Macro studies are especially relevant to assess the empirical importance of educational externalities. The two main macro approaches are the augmented Solow neo-classical approach [as first proposed by Mankiw, Romer and Weil (1992)] and the ''new growth theories''. The augmented neo-classical model simply extends the basic production function framework to allow human capital to enter as an extra input in the production function. Since this is estimated at the economy-wide level, it does take into account of human capital externalities that increase the *level* of output. The endogenous growth approach argues that there should be an additional effect of human capital over and above the static effect on the level of output. Based on the notion that economies richer in human capital have a higher rate of innovation, increasing the level of human capital is expected to have an effect on the *growth* rate of productivity. Some of the new growth theories have distinguished themselves from the traditional neo-classical approach by explicitly proposing a role for education externalities in economic growth (Aghion and Howitt 1998).

Taking the empirical studies as a whole, there is compelling evidence that human capital increases productivity, suggesting that education really is productivity-enhancing rather than just a device that individuals use to signal their level of ability to the employer [see Sianesi and van Reenen (2003) for an overview]. The empirical literature is largely divided over whether the stock of education affects the long-run *level* (augmented neo-classical approach) or long-run *growth* rate (new growth theories) of the economy. Increasing average education in the population by 1 year would raise the level of output per capita by between 3 and 6 percent according to the former approach, while it would lead to an over one percentage point faster growth according to the latter. Education is found to yield additional indirect benefits to growth, in particular, by stimulating physical capital investments and technological development and adoption. Nevertheless, this is an extraordinarily large effect, which needs to be taken with a lot of caution in view of the many methodological problems there still are to get the new growth channels correctly assessed. The most

pressing methodological problems are the measurement of human capital and reverse causality. More research is also needed to analyze further the systematic differences in the coefficient of education across countries (e.g. Sianesi and van Reenen 2003).

The macro-evidence also seems to indicate that type, quality and efficiency of education matters for growth. The impact of increases at different levels of education appears to depend on the level of a country's development. For developed countries, tertiary/higher education seems to be the most important education driver of economic growth. This is related to the argument that innovation and higher education become more growth enhancing for countries closer to the technology frontier (Aghion 2006). Empirical evidence, both across countries and across US States, suggests that the closer an economy is to the frontier productivity, the more growth-enhancing it is to invest in higher (in particular post-graduate) education (Aghion et al. 2005). In economies that are further below the frontier, growth is primarily enhanced by investments in primary, secondary and undergraduate education. With Europe having successfully caught up with the US during the '70s, '80s and first part of the '90s, this implies that, being located closer to the technology frontier, higher education has become increasingly more critical for EU's growth prospects.

2.3 The contribution of university research and technology transfer to economic development

A multitude of economic studies has shown the importance of *basic research* for innovation and economic growth (e.g. Adams 1990; Griliches 1998; Henderson Jaffe and Trajtenberg 1998; Mansfield 1995; Rosenberg and Nelson 1994). However, a coherent body of theory and insight into the multifaceted nature of the links between science and growth is still lacking (Stephan 1996). There are some industries where the link between science and innovation is explicit and direct. Industries such as biotechnology, pharmaceuticals, organic and food chemistry are "science-based" in the classic sense and rely heavily on advances in basic research to feed directly into their innovations (Levin et al. 1987). In non-science-based industries much innovation also derives from other-than-basic-research related activities. Nevertheless, even here innovation may be facilitated by better use of basic research resources, such as the training of skilled researchers helping to increase the absorptive capacity of industry.

The supply side of the scientific "knowledge market" includes, apart from universities, other institutions such as publicly funded research organizations. Nevertheless, as science-based innovations increasingly have a multidisciplinary character and build on "difficult-to-codify"

people-centered interactions, universities, which combine basic and applied research with a broader education mission, are seen as enjoying a comparative advantage relative to research institutes. Universities are increasingly demanded not only to play an active role in science development, but also to turn those scientific developments into useful innovations whenever possible and desirable. While basic research results can either be channeled to industry via collaborative research schemes or licensing arrangements of patented university inventions, spinning off is the entrepreneurial route to commercialize public research. The latter attracts a great deal of policy attention in the current wave of start-ups and new venture creation in many countries These new ventures have the potential to introduce technological disequilibria that change the rules of competition in existing industries.

Empirical studies have attempted to quantify knowledge transfers from academic research through various proxies. Shane (2002) investigated licensing of university generated innovations. Other papers have examined academic spin-off activities as well (Audretsch and Stephan 1996; Zucker, Darby and Brewer 1998) and yet others looked at citations to academic patents (Henderson, Jaffe and Trajtenberg 1998) and university science parks (Siegel, Westhead and Wright 2003). Citations in corporate patents to scientific literature have also been investigated (Branstetter 2003). Finally, university-industry collaborative research has received substantial attention in empirical studies (Cockburn and Henderson 2000; Hall, Link and Scott 2000; Mohnen and Hoareau 2003; Veugelers and Cassiman 2005).

All these empirical studies, using various industry science links indicators, suggest an intensification of the interactions between universities and industry over time (e.g. Branstetter 2003; Hall Link and Scott 2000). This holds *a fortiori* for the fastest growing technologies: biotechnology, information technology and new materials, which are all more closely science linked. Corporations appear to look more extensively towards public science as one of the external sources allowing rapid and privileged access to new knowledge, especially in the life sciences (Cockburn and Henderson 2000; Mowery 1998; Zucker Darby and Brewer 1998). Behind this rising trend is a change in the institutional environment, with public policies designed more to encourage the commercialization of university developed scientific discoveries.

While on average the evidence suggests a growing trend in—and a positive effect of—knowledge transfers from science to industry, there is nevertheless a strong suggestion of an inadequate scale and intensity of such transfers, with the link between science and innovations neither direct nor close. Differences in cultures and a highly uncertain and non-codifiable nature of scientific know-how result in high transaction costs

and systemic failures in the market for scientific know-how. Improving industry science links has thus figured high on the policy agenda in many countries, especially in Europe.

With universities being an important actor in delivering economic development, either through their education and/or through their research activities, and with the public good nature of the services provided by universities, both in education and research, there is a clear case for policy to be concerned about how well their universities are performing, and to intervene if necessary. This holds particularly in those countries or regions that have moved closer to the world technological frontier, and want to become leading knowledge-based societies. The next section takes a closer look at the performance of universities in Europe.

3 Performance of Europe's universities

By now a wide series of rankings abound, comparing the performance of universities across countries.[3] The most "mediatic" representatives, and also the ones most criticized, are the Times Higher Education Supplement, and the Shangai Jiao Tong University Ranking. Both rankings,[4] THES and Shanghai, paint a somewhat similar picture of Europe lagging behind especially at the top, and especially the larger continental European countries. Overall, the results from the rankings indicate the lower performance of Europe's universities relative to the US, especially at the top.

A closer look at the hard data shows however a more nuanced picture on Europe's performance. Veugelers and van der Ploeg (2008) take a look at the more standard official statistical evidence that is available to measure across countries the performance of universities on higher education and research, including the quality dimension of educational and research performance, and arrive at the following conclusions:

- The proportion of the population in the EU that has graduated from higher education is relatively low; Relatively few young people in the EU enroll in higher education but enrollment is growing strongly.
- The EU produces more mathematics, science and technology graduates than the USA but has fewer researchers in the labor market.
- The European Union produces a higher number of PhDs than its major competitors.

[3] For a discussion on the how to use rankings, see UNESCO, Berlin principles on ranking of higher education institutions, http://www.che.de/downloads/Berlin_Principles_IREG_534.pdf.

[4] Other rankings are Center for Higher Education German, bibliometric ranking by Leiden and ranking web of universities by CSIC Spain.

- Tertiary Education leads to higher employment, lower unemployment and higher earnings, also in the EU.
- Europe has caught up with the US on quantity of publications, a gap remains on quality.
- No sufficiently reliable data are available yet to measure performance of universities on knowledge transfer across countries.

Overall the statistical evidence indicates that Europe has made improvements, made especially in quantitative terms (number of graduates and number of publications). It also illustrates the heterogeneity within Europe, with a number of countries, particularly the Nordic countries, even outperforming the US on a number of indicators. At the same time, it shows the need for further improvements of the European higher education system, particularly on the quality of education, research and transfer dimensions.

4 Drivers of performance: funding and governance of Europe's universities

What explains these differences in performance of universities between the EU and other international competitors like the US, and among EU countries? Two components always show up in the discussion: funding and governance.

On *funding* for universities, Veugelers and van der Ploeg (2008) provide an overview of the recent statistical evidence:

- Total investment in higher education in the EU is below the level of key competitors. In particular, per student it is almost half the level of that in the US.
- The nature of public funding for education varies considerably across countries and time with the Scandinavian countries having much higher funding.
- Differences across countries in spending become even more pronounced when the public vs. private source if this funding is considered; the gap in private funding is particularly important.
- The differences in the level of private investment are a result of differences in tuition fees (most EU countries do not have tuition fees), in the share of private institutions, in philanthropic funding, contributions by alumni and in the level of funding provided by enterprises. This is why US universities are much better funded than their EU counterparts.
- There is no clear statistical evidence supporting less funding of research at higher education institutes in the EU as compared to the US,

although the way most of the research funding in the US is allocated may be different.

On *governance* of universities, OECD (2007) has developed a series of indicators, on the basis of surveys of its member countries measuring autonomy [financial autonomy, staff policy autonomy (hiring/firing and wages), student selection and course content] and accountability (evaluation mechanisms and funding rules).

The evidence shows a high variance in university governance across countries. There are also a lot of differences in different dimensions of governance across countries. It also shows the multifaceted nature of governance, where different dimensions of autonomy and accountability are not necessarily correlated. As a consequence, each system can be characterized as a relatively unique bundle of governance characteristics.

The US has the highest scores on all dimensions of autonomy. In Europe, the better performing countries, i.e. UK, Finland, Sweden and Denmark, also score high on autonomy, although there are some differences depending on the type of autonomy. On accountability, there is much more variance among the well performing countries with the UK high on both dimensions of accountability while the US (like Japan) is low on financial accountability (consistent with their high budget flexibility). Finland is high on financial accountability, but not to strong on evaluations.

Among the continental weak performers, France, Germany, Spain and Italy, there is also a large dispersion in governance characteristics. The common theme, nevertheless, seems to be low levels of autonomy, but relatively high levels of accountability. This is consistent with the complaint of overregulation in these systems. Nevertheless, the dimensions of (lack of) autonomy are different, with Germany and Italy particularly restricted with respect to students, course contents and wages, France on selection of students and both hiring and wages, Spain restricted in both hiring and wages.

A striking fact is thus the high variance in university governance across European countries. Also Bruegel researchers (Aghion et al. 2007), using survey information collected from European universities that belong to the Top-500 of the Shanghai Ranking, found a high variance in university governance, even among those countries which are performing well in terms of research. For example, among the three European countries with the best performance index, the practice of appointing people from within the own group (“endogamy”) is high in Sweden but low in Switzerland and the UK. Swedish and UK universities can set wages but Swiss cannot, and universities are mostly public in Sweden and Switzerland, whereas they are mostly private in the UK. They also found a high degree of

heterogeneity between countries in terms of size of universities in the Top-500: Southern Europe (Italy and Spain) has very large (more than 40,000 students on average) universities, while the UK and Switzerland have small (10–15,000 students) universities.

5 Explaining performance: funding, governance and size of Europe's universities

The evidence thus shows a high variance in university governance across countries. All this makes governance a very interesting candidate to for explaining the heterogeneity in performance of European universities. Nevertheless, since both the least and best performing countries shows a wide divergence in governance, a crude bird's eye view already suggests that the link between governance and performance will be complex and bodes badly for the quest for a unique optimal governance model.

The Bruegel study (Aghion et al. 2007) reports some first interesting findings on the relationship between their set of proxies for governance and research performance, as measured by the Shanghai Ranking of their set of surveyed universities. First, the results indicate that it is important to correct for other determining factors besides governance. Size, age and budget per student all positively affect research performance. But once these factors are included, the only governance indicator that turns out to be significant is budget autonomy. Perhaps the most important finding of the study is that the positive effects of having larger budgets per student are higher if institutes enjoy a higher degree of budget autonomy. This suggests that policy should tackle simultaneously funding and governance.

On economies of scale and the size of universities and countries, the evidence is not clear. Countries with a large population may benefit from returns to scale and be more efficient in providing public goods and generate higher productivity (Alesina and Spolaore 2003). Within the context of the market for higher education and research, it is clear from the law of large numbers that in such countries the chances of a genius surfacing is larger than for a small country. This is why it is important to engender competition (as well as cooperation) on a European level. However, the evidence so far fails to support that the number of top universities per million inhabitants is an increasing function of the size of the population (Thissen and Ederveen 2006). However, historical empirical comparisons neglect the potential of upcoming countries with a huge population like China and India.

At this stage, the most important conclusion that can be drawn from the available evidence is that more research is needed to pin down the drivers

of university performance. Nevertheless, a few policy implications for the reform agenda can already be put forward.

6 The policy agenda for higher education reform in Europe

The previous analysis has shown that the EU needs to improve its access to higher education, improve its higher education attainment levels and the quality of its education and research. For this it needs to increase total investment in higher education and research. Funding universities will become increasingly more challenging due to the relentless operation of Baumol's cost disease. Productivity growth in universities inevitably lags behind that in manufacturing, so the cost and price of university education inevitably rise over time. This is Baumol's cost disease applied to higher education (e.g. Jacobs and van der Ploeg 2006). On the plus side, the ongoing technical progress in the rest of the economy makes society much richer all the time and it is thus able to afford the escalating costs of higher education. Teaching and research need to be done by highly qualified people and is difficult to be replaced by technology.

If the EU has to make an effort to bridge its funding gap, be it public or private, this can only be realized if at the same time the *governance* of universities is tackled. This is necessary to increase the efficiency of spending by these organizations, thereby delivering results. To attract more *funding*, universities first need to convince stakeholders—governments, companies, tax payers and above all students—that existing resources are efficiently used and would produce added value for them. Higher funding cannot be justified without profound change. Providing for such change is the main justification and prime purpose for fresh investments.

6.1 Increasing total investment in higher education

While public investment in higher education in the EU is at the same level or even slightly higher than in key competitor countries, levels of private investment are clearly lower. A major effort will be needed to locate the necessary public and private financial resources to bring the EU countries closer to the standards of key competitors.

The debate on social and private returns from higher education has highlighted its role as an investment, benefiting both the individual as well as society as a whole. If *social returns* exceed private returns, education causes positive external effects to society and the government should support education. Although positive external effects may be substantially larger for secondary and especially primary education, they are nevertheless likely to prevail also for certain types of university education. For basic research, the public good characteristic is well known.

But beyond the need for a sufficiently large *public investment* in universities, there is also an issue of how to best invest public money. Governments should strike the right balance between core, competitive and outcome-based funding (underpinned by robust quality assurance) for higher education and university-based research. Competitive funding should be based on institutional evaluation systems and on diversified performance indicators with clearly defined targets and indicators supported by international benchmarking for both inputs and economic and societal outputs.

Beyond the case for public spending, the empirical evidence suggests that *private returns* to higher education are substantial, also in continental Europe.[5] All this evidence suggests more scope for *private funding* of higher education and in particular for asking students to pay higher tuition fees, particularly for those degrees where private returns are substantial. Free higher education does not by itself suffice to guarantee equal access and maximum enrollments. This casts the much debated issue of higher tuition fees in a fresh perspective, isolated from the discussion on access, which is better targeted through other instruments, such as income-contingent loans and scholarships for the brightest students from backgrounds with not much money. The experience with social credits in the form of an income-contingent loan system of the type used in Australia suggests that this need not jeopardize accessibility of higher education (Barr and Crawford 2005; Jacobs and van der Ploeg 2006). Since peer effects are important in higher education, it is crucial to attract the best students regardless of background. Europe would therefore benefit from shifting attention from scholarships for the poor to scholarships for the brightest regardless of background.

6.2 Improving governance

There is relatively little hard data and analysis on the link between governance and performance and the evidence not in favor of a unique optimal model. Hence, European policy makers should be careful not to impose a standardized, micro-managed governance model on their universities. They should rather try to nurture the heterogeneity of its institutions, allow for experimentation and learn from it. This calls for granting

[5] Canada is an interesting testing ground, since provinces levy different fees. Evidence suggests that rising fees by about 2,000 dollar in the 1990s reduced the probability of participation by persons aged 17, 18 and 19 relative to trend by amount 2 percent-points. Nevertheless, university participation increased dramatically during this period (Johnson and Rahman 2005). Unfortunately, this interesting study did not take account of factors like family income or parental education.

universities the space and thrust to develop autonomously their own strategies and structures. Public authorities should guide the university sector as a whole through a framework of general rules, policy objectives, funding mechanisms and incentives for education, research and innovation activities. In this way they can develop their own strategy, specialization and structures to respond to their heterogeneous environments.

In return for being freed from the stifling blanket of over-regulation and micro-management, universities should accept full *institutional* accountability to society at large for their results. In many countries this would mean a new approach to policy making with less *ex ante* checks and greater *ex post* accountability of universities for quality, efficiency and the achievement of agreed objectives. For universities, this requires new internal governance systems based on strategic priorities and on professional management of human resources, investment and administrative procedures. A pivotal area of university management is personnel management. Human resources are a core determinant of quality in higher education and research. Universities must therefore work to enhance their human potential, both qualitatively and quantitatively, by attracting, developing and keeping talent in the teaching/research career. Excellence can only emerge from a favorable professional environment based in particular on open and transparent procedures.

6.3 More competition among universities

Public and private stakeholders should provide the funds for universities to develop their own structures while holding them accountable for delivering results. Yet combined under-funding and system rigidities are so acute in some countries of the EU that they impede the reform process at universities, who are consequently trapped in a vicious circle. Differences in perspectives on reforms abound in the EU, so that it is not difficult to predict a tough political economy process of reforms.

To unlock the reform process, perhaps the most important driving force for modernizing higher education in Europe emerges from competition. Increased competition for students, faculty and funding, combined with more mobility of students and faculty and allocation of resources through open, competitive criteria, will lead universities to offer a more open and challenging environment to the most talented students and researchers, thereby making them more attractive to Europeans and non-Europeans alike.

In response to scarcer public budgets, a rationalization of the supply side of the higher education market has taken place in Europe. The resulting increase in the scale of universities has, however, generated the danger of creating (local) public monopolies. In the Netherlands the rapid

increases in scale and monopolistic practices have gone hand in hand with huge increases in overhead and capital expenditures leading to substantial falls in resources for teaching. Such monopolies reduce quality (''grade inflation''), ignore demand of students and employers, and increase overhead costs. Monopolistic price setting drives up tuition fees and lowers quantity and quality of supply of education, especially if the price elasticity of demand is low.

Competition for talents and brains is a global game, which is already removing the barriers within Europe and establishing a large, integrated market for higher education and research in Europe. This will provide an excellent environment for European universities to develop their comparative advantages and make them stronger players on the world scene.

7 Challenges for research into the economics of higher education reform

Universities are key players in the successful transition to a knowledge-based economy and society. However, this crucial sector of society needs restructuring if Europe is not to lose out in the global competition in education, research and innovation. While European universities have improved their quantitative performance with respect to the number of graduates and publications, it needs to further increase higher education attainment levels and improve the quality of its education and research. For this, public and private stakeholders should provide the funds for universities to develop their agenda while holding them accountable for delivering results.

Although the general principles of the policy reform agenda are clear, the details are not. The link between governance, funding and performance is not obvious and needs still further data and research. All this implies at this stage a careful stance for policy makers on which governance and funding structures to strive for. Perhaps the most important conclusion is to invest in more data and analysis to support a more evidence-based reform process.

This special issue collects a number of papers that provide more data and empirical analysis on various dimensions of university governance, funding and performance. We believe that many of these papers show that good empirical research, backed up with theory, can generate evidence-based ideas for policy reform of European university systems. The empirical literature on the economics of higher education is only beginning to emerge. The papers in this issue are not the definite statement, but they are state of the art and may show other researchers the road ahead in the burgeoning fields of the economics of higher education.

Looking at an interesting data set on the population of newly enroled students at the University of Brussels, Arias Ortiz and Dehon (2008) attempt to sheds light on the determinants of their success in the first year exams. They find that for the prior high school program, the mother's level of education and the father's occupation are important determinants. Still, one wonders whether parental background is not also a determinant of whether students go to university in the first place. Arias Ortiz and Dehon also suggest that foreign students coming to Belgium looking for a diploma do much better in their first year than Belgian students. Obviously, it is important to improve accessibility of higher education in order to get the brightest students from underprivileged backgrounds as well. This study also suggests that internationalization is crucial, since this can via peer effects raise the average level of university education.

In an interesting paper Bagues, Labini and Zinovyeva (2008) document detailed empirical evidence that grading standards vary significantly across Italian public universities and degrees. It is important to realize that the Italian government rewards universities according to the number of exams passed by their students. In contrast to the experience with the taximeter model in Denmark where there was almost no grade inflation, this empirical study suggests that this Italian puzzle can be resolved by heterogeneous grading standards. Effectively, universities whose graduates perform relatively bad in the labor markets more easily give higher grades. The lesson from this study is that governments should be very careful about output-based funding systems, since they can easily favor universities that do worse and generate less value added in economic terms.

Using a unique panel data set of German universities across German states on a stochastic frontier approach, Kempkes and Pohl (2008) relate the cost inefficiencies of German universities to differences in the liberal character of state regulatory regimes and to governance features like the management structure and characteristics of the university staff body. This type of study suffers from lack of good data on efficiency of universities. For example, bigger class size may lead to a lower cost per student but may also lead to a worse quality of education per student. Nevertheless, this study asks the right questions and already gives some suggestive evidence that stifling blankets of regulation can lead inefficient universities.

Flanders has proposed a reform of its university funding system, which aims to save costs by reducing the diversity and duplication of the various study programmes on offer. The detailed econometric analysis of Kelchtermans and Verboven (2008) suggests that reducing programme diversity typically induces a saving in fixed cost, but this saving is actually less than loss in consumer surplus due to students having to travel to

another town for their degree. This empirical result is due to the low mobility of students in Flanders. This article also shows that decentralized incentive mechanisms may be counterproductive, since they often promote programme cuts when this is undesirable, and vice versa. The main policy insight we draw from this innovative article is that savings and cuts in higher education may have perverse effects, especially when students have little willingness to travel. In that sense, it may be better to give universities the freedom to raise more funds from students and sponsors.

One of the few policy reforms that have been instigated at the European level is the Bologna process whereby European countries agreed to move to a system of Bachelor's and Master's degrees. Such a system is common in Anglo-Saxon countries and thus promotes internationalization. Mores students will find it easier to study abroad, both inside the EU and outside the EU, and European universities will become more attractive to the best students and staff from outside the EU. The more flexible system encourages students to take more difficult studies, to pursue an interdisciplinary career and to pursue the ideal of permanent education, since it is easier to switch later on to a Master's course in a related topic. Furthermore, the Bologna process has made a contribution to the much needed reduction in the effective study duration in Continental Europe. Of course, a proper implementation of the Bologna process requires not just a splitting up of old-style degree programmes but a restructuring of degree programmes. It is therefore comforting to know that the paper by Cardoso et al. (2008), using regression analysis with count data, finds empirical evidence in Portugal that degree programmes that did properly restructure in line with the Bologna process experiences greater demand from students than programmes that did not restructure. This suggests that universities that reform fastest stand to gain.

In their analytical paper Demange, Fenge and Uebelmesser (2008) investigate within a general equilibrium setting what role international mobility of skills can play in the reform agenda. Taking into account the individual incentives to invest in higher education, they examine how optimal government instruments, such as financing and quality standards, will differ depending on the mobility of skills. If only skilled workers are mobile, government have an incentive to cut subsidies and risk lowering the quality of education to sub-optimal levels or to raise tuition fees. Promoting the international and within-country mobility of students helps to offset some of these inefficiencies and provides a justification for the Bologna process. As pointed out by Ferreira (2007), the European Investment Bank may play an important role in setting up a European-wide system of income-contingent loans. This could avoid problems of graduates moving to another country in order to avoid repaying their loans, but more importantly it would give a real boost to

pan-European mobility of students. Also, Parey and Waldinger (2007) use a detailed data set on ERASMUS student exchange programmes to provide empirical support that student exchange mobility is an important determinant of later international labor market mobility. This may also help to boost economic integration and growth in Europe.

A very useful study on the determinants of investments in higher education beyond the upper-secondary level is provided by Boarini et al. (2008). They explore for a set of OECD countries the impact of the institutional setting of the higher education system on graduation rates, taking simultaneously into account the availability of funding for students and the private returns to tertiary education. Their results point to a strong potential for increasing graduation rates by improving the supply side of the higher education section, especially autonomy and accountability of higher education institutes. Furthermore, graduation rate can be raised by increasing funding per student and will be higher if private returns on higher education are higher. This OECD study thus also points in the direction of more autonomy and accountability for higher education institutes and boosting funding for universities by raising tuition fees and helping students with income-contingent loans. As private returns on higher education continue to rise, graduation rates and demand for higher education continue to rise.

Stephan (2008) closes this special issue with a keynote contribution discussing the new challenges faced by universities on both sides of the Atlantic. The challenges she discusses arise from increased incentives to publish, changes in the reward system and increased calls from society on universities to contribute to economic growth, through technology transfers. She outlines where further research is urgently needed.

Although each of these chapters improve our understanding of the economics of higher education and provide interesting new empirical and policy insights, they also at the same time call for more and better analysis with more and better data at the micro level. Still, the results in this issue already point to interesting directions of policy reform. We hope that these issues will incite further research on this fascinating topic in much the same way that is already prevalent in the economics of primary and secondary education.

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What are the Factors of Success at University? A Case Study in Belgium

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Abstract

By using a unique data set containing the entire newly enrolled student population at the University of Brussels, this case study aims to be the first complete analysis of the determinants that influence the student's path at university in Belgium. We analyse the probability of succeeding the first year at university in Brussels taking into account individual characteristics, prior schooling and socioeconomic background. Our results show that the socioeconomic background of the student influence success in a significant way. More specifically, the mother's level of education and the father's occupational activity seem to predominate. We observe also a difference in performance between students coming from different high school programs. Indeed, students coming from one of the two high school systems existing in Belgium's French Community ("traditionnel" and "rénové"), present non-homogenous results at the end of their first year. In addition and in contrast with some of the literature findings, Belgians and foreigners have the same first year performances if we take into account their socioeconomic environment. Moreover, the same results are obtained when we look at European and non-European students. Nevertheless, when we distinguish foreign students with respect to their level of integration, our analysis shows the existence of a "European elite" that comes to Belgium looking for a diploma and that do much better in their first year than Belgian students.

Keywords: Academic achievement, logit models, socioeconomic factors.

1 Introduction

A child's academic path is the result of a comprehensive set of choices made successively from birth to adulthood. Parents and children make decisions in a given economic environment defined by the government (taxes, public spending and regulations). This implies that some

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educational choices are not made by the individual himself but by the government and his family. Evaluating to which extent these two agents will influence children's achievement has been widely studied in the empirical literature. Interestingly, the results obtained depend on how academic achievement is defined. These different definitions of success depend on the stage of the academic path at which they are measured. For example, the scores obtained in different kinds of test (reading test, mathematical tests, social test, etc.) or the probability of high school completion are early measures of success whether the number of years of schooling is a global measure at the end of the academic path of each individual. This article focuses on a particular stage (not studied so far): achievement during first year at university. We identify which factors influence success at university through the case study of Belgium's French Community (BFC).

Belgium is a federal state where the communities are competent for the educational system. This french speaking community offers an unique framework for the analysis of success at university: an important part of higher education is financed through public funds so that all universities have very low, common entry fees and no entry barriers (there is no entry exam[1]). As a result, almost 60 percent of the secondary student population that finishes the general high school system,[2] enrolls at university. However, during the first year very high rates of failure and drop out are observed, increasing the cost of publicly financed mass higher education. In this framework, we analyse success at university through the first year because it is considered as an information "key point" about student success.

The problem is that until now the existing studies in Belgium's French Community have either lacked socioeconomic information about the students (Droesbeke, Hecquet and Wattelar 2001), or precise evaluation methods of how the different factors interact (Demeulemeester and Rochat 1995 and Alaluf et al. 2003). With the help of a new database collected by the Université libre de Bruxelles (ULB), this article is a first step towards a complete analysis of students' path in a Belgian university. This implies that the higher education system in Belgium's French Community is analysed through the student population of the ULB, a case that offers two main advantages. On the one hand, even if all universities have the same entry fee and no entry exam, in 2001, the ULB was the one

[1] Except for the faculty of applied sciences.
[2] Note that this fact does not concern students from the technical or the professional high school system.

that recruited the most first year students across the eight existing universities in this french speaking community.[3] On the other hand, unlike the rest of Belgium's French Community, Brussels has two different high school systems (the "Rénové" and the "Traditionnel") co-existing at the same time, an unique setting to analyse the influence of the high school system on success at university.

In this framework, we address three main questions. First, in this mass higher education system, does the socioeconomic status of the family still influence the probability of succeeding the first year at the ULB? Second, even taking into account familiy's characteristics, do we observe large differences between students coming from a specific high school program? And third, are these effects the same for natives and foreigners? Our findings suggest that the socioeconomic background of the student clearly influences the probability of succeeding the first year at the ULB. However, even if couples' characteristics are closely related, the parents do not seem to have the same channel of influence. The educational level of the mother is statistically closer to success than that of the father but when it comes to professional activity, the opposite is observed. In addition, the students that come from the "Traditionnel" system do better during their first year. These effects must be interpreted with caution given that high school choices might be endogenous to the model. Finally, there is no significant difference in success between natives and foreigners[4] if we take into account their socioeconomic background. Differences do arise when we look at the "type of immigration" of the foreign students at the ULB, since students that come alone to Belgium to enroll at university are more successful during their first year than Belgian students.

This article is organized as follows: in Section 2 we provide a brief review of the literature's main findings about the socioeconomic determinants of children's general academic achievement. Section 3 discusses the data, the variables chosen and the methodology that will be used to analyse them. Section 4 presents the results of the empirical analysis and Section 5 concludes.

2 Review of the literature

The theoretical framework of the parental decision making process and its influence on children's educational attainment has been studied through

[3] According to Droesbeke et al. (2005), 28.91 percent of all first year students were enrolled at the ULB, with respect to 23.3 percent for the Université Catholique de Louvain (UCL) and 20,59 percent for the Université de Liège (ULg).

[4] In the sample composed of students that attended a Belgium's French Community high school.

the theory on family behavior. In the seminal paper by Becker and Tomes (1976), family is viewed as a production unit that generates utility for all of its members. Their results showed that parents influence their children in three different ways. First, through the endowment of ability transmitted directly to their children at birth. Second, under the assumption that parents care for the success of their children, when they make specific expenditures in order to influence their level of human capital.[5] Third, when deciding on other factors than the allocation of resources, like for example location, family structure and fertility that will also affect the environment in which children grow. However, given that family decides not only on goods inputs but also on time inputs, Arleen Leibowitz (1974) introduces a different channel of influence of parental background. The author argues that parents can influence their children's attainment through a more behavioral effect since the quality of time inputs is positively influenced by the educational level of the parents.

This theoretical link between parental decisions (or home characteristics) and children's educational success gave rise to an important line of empirical economic research. Most of the empirical studies concentrate on the analysis of this specific set of explanatory variables. Contrarily, our aim is to do a global analysis of the factors that influence success during first year at university. The problem is that, theoretically, there is an infinite number of channels through which parents can influence their children. Therefore, in order to determine which variables have been identified as the most important to explain academic attainment, we review the empirical international literature on academic attainment.

In the international literature, different approaches can be found as there is no unique definition of children's academic achievement. The most frequently used definitions depend on the stage of the academic path at which they are measured: the scores obtained in different kinds of test (reading test, mathematical tests, social test, etc.) or the probability of high school completion are the early measures; the number of years of schooling is a global measure at the end of the academic path of each individual. Given that in our article we analyse a new dependent variable (success at higher education), it is interesting to test all the proposed variables. For example, the articles using the scores obtained at different tests put

[5] This second influence channel would not exist if capital markets were perfect, if parents knew exactly the initial endowment of their children and if debts could be passed to the next generation. In this setup, parents could borrow money for each child subject to their own ability that they will refund when they get to the labor market. If these economic conditions are not fulfilled, the level of investment in children's human capital will enter the maximization problem of the family and hence, will depend on parental choices.

forward a common set of variables that explain success. Indeed, Murnane et al. (1981) and Sammons (1995) argue that gender and ethnic origin are important to explain differences in test scores but the skills of the mother also play a significant role in children's achievement. This finding is in agreement with Blau (1999), who shows that income effects are small compared to other individual characteristics such as race, gender or mother and household characteristics.

More global measures of achievement have been used, such as the probability of completing high school or even the total number of years of schooling. In this type of studies, family structure plays a significant role in explaining success. Indeed, Ermisch and Francesconi (2001) and Ermisch, Francesconi and Valin (2003) showed that individuals who experience single parenthood as children, have significantly lower attainments (defined as the number of years of schooling). In the same way, Manski et al. (1992) found that the probability of graduating from high school increases if the student lives in an intact family. Finally, as noted by Haveman and Wolfe (1995) in their survey on American studies, living in a single parent family has a negative impact on achievement, independently of the measurement used. Another common factor of papers using these two types of measures for achievement is that ethnic origin is not significantly associated with neither high school completion nor with the level of schooling attained when background characteristics are included in the model (Haveman and Wolfe 1995; Cameron and Heckman 2001). It is important to notice that some articles include both types of measures of achievement, like the relevant work of Altonji, Elder and Taber (2005) and Evans and Schwab (1995). They are mainly focused on the effects of catholic schools and their results show that attending a catholic school has a positive impact on both high school completion and years of schooling. Some dissimilarities do exist: studies using the number of years of schooling tend to put forward the effect of family characteristics on child outcomes. In almost every study, parental human capital is statistically significant but are both parents equally important? Many authors determine that the number of years of schooling of the mother is more closely related to school achievement than that of the father (Blau 1999; Ermisch and Francesconi 2001; Black, Devereux and Salvanes 2005).

We argue that the existing definitions of academic success may not be able to capture all the factors that influence higher education achievement since it is a particular and later stage on the academic path. Given that further years of schooling requires the completion of a cycle, we cannot distinguish students that wanted to invest on higher education but failed from those that chose not to invest at all. This point is of special interest in the countries were the costs of enrollment are low as in Belgium's

French Community.[6] According to the *Global Higher Education Ranking 2005*,[7] Belgium's French community has the second cheapest educational costs among several industrialized countries in terms of tuition and costs of books and study materials.[8] If we consider enrollment as an experiment, in Belgium's French community the experience is a less expensive private decision. In addition to low fees, there is no entry exam. As a result, almost 60 percent of the secondary student population that finishes the general high school system,[9] enrolls at university. However, very high rates of failure and drop out are observed during the first year of university. Thus, this first year is considered as an information "key point" for understanding the determinants of success at university since most of the students that drop out seem to be discouraged during their first year. Studying this new dependant variable may reveal new factors that cannot be captured by the existing measures of achievement.

Previous studies have analysed this question in Belgium's French community (Demeulemeester and Rochat 1995; Droesbeke, Hecquet and Wattelar 2001; Alaluf et al. 2003) but had some serious drawbacks. For example, some use a small and undefined sub-sample increasing the risk of having a sample selection bias that they do not control for. Others do not include any information about students' socioeconomic background and it only analyses an aggregate rate of success. Finally, conclusions are only based on qualitative analysis since the methodology used is strictly descriptive. Thus, a multiple analysis of academic achievement needs both an appropriate measure of achievement and a large variety of variables explaining success. Several features distinguish our research from the studies discussed above. First, a bigger sample of students for whom we have socioeconomic information about their families and a broad range of variables that accounts for prior schooling. Second, we analyse a new dependant variable and we control for all the variables highlighted as important in the international literature.

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[6] Belgium is a federal state where the organization of the educational system is the competence of each community. In the French community an important part of higher education is financed through public funds that considerably lower the share of the private contribution.

[7] Usher and Cervenan (2005).

[8] The countries included are: Sweden, Finland, The Netherlands, Belgium (Flemish Community), Ireland, Belgium (French Community), Austria, Germany, France, Italy, Canada, Australia, Unites States, United Kingdom, New Zealand and Japan.

[9] Does not concern students from the technical or the professional high school system.

3 Data and methodology

3.1 The database

Our research on the determinants of success in the first year at university is based on a new data set granted by the ULB authorities. At the beginning of the academic year 1997–1998, the ULB launched a survey based on a non-compulsory sociological test filled in by newly enrolled students at inscription, in order to get information about the student's socioeconomic background. The experience was repeated during the academic year 2001–2002 and as a result, the ULB created a database that contains 5822 individuals from two different generations.[10] Thus, the data offers several research projects: the factors of drop out, the probability of succeeding after the first year, the influence of ability (through grades of the entry exam at the faculty of applied sciences). As said before, we start by studying what we called a "key point" of information, the first year at university. In this case study, the truncated sample that is analysed is exclusively composed of first year students at the ULB that attended a Belgian's French Community high school and that filled in the sociological questionnaire at enrollment (2531 students).

3.2 The variables and some descriptive statistics

In this section, we briefly describe the different types of explanatory variables included in the model: those that account for individual characteristics, those for prior schooling and those that measure socioeconomic factors. We also control for the year of the first enrollment at university (1 if 2001, 0 if 1997) and for the field chosen by the student (human sciences, science, health sciences) to account for differences across fields and across time. Table 1 presents the variables included in the model, as well as some descriptive statistics of the explanatory variables.[11]

Individual characteristics

Student's gender and ethnic origin are two individual characteristics that do not depend on personal choices but that are part of the determinants of children's success. Droesbeke, Hecquet and Wattelar (2001) found that success rates at university in Belgium's French Community are persistently higher for women than for men. Thus, we include a dummy variable that accounts for gender differences (1 if female, 0 if male) and expect to have a

[10] Repeaters are excluded i.e. only the freshman enrolled for the first time were taken into account.

[11] By a confidentiality clause agreement with the ULB authorities, we can only publish variations in rates of success not the actual levels. That implies that no descriptive statistics of the dependant variable will be presented.

Table 1 Descriptive statistics of independant variables ($n = 2531$)

Definition	Codification	Percentage	DFR(%)[+]
Personal characteristics			
Year of first enrollment	1 = 2001	0.6120	−5.32*
Domain of enrollment	Human Sciences	0.6752	——
	Science	0.2007	6.81*
	Health Sciences	0.1241	−0.75
Gender	1 = Female	0.4591	7.69*
Nationality	1 = Not Belgian	0.0680	−9.55*
High-school path characteristics			
Years repeated in high school	On time	0.7222	——
	1 year "late"	0.2066	−19.89*
	2 years "late"	0.7110	−35.09*
Type of high school	1 = "Traditionnel"	0.1549	14.63*
Math-intensive profile at high school (hours per week)	Low (less 3)	0.0838	——
	Middle (4 or 5)	0.4536	1.78
	Strong (more than 6)	0.4627	15.24*
Lessons of latin greek in high school	1 = yes	0.2967	15.2*
Socioeconomic factors and family structure			
Reduced fees because of low income	1 = yes	0.2864	−13.53*
Household structure before university	Parents	0.8111	——
	Single parent	0.1849	−4.31
	No parent	0.0400	−28.28*
Educational level of parents	primary school, high school, higher education out of university, university		
Parental occupational activity	"farmer", "low or medium level employee", high level employee, Professor, liberal or independent, Unemployed/No profession		

[+]Differential rate of success in first year of university. *Difference significant at 5%.

coefficient that has a positive sign in accordance with Belgium's French Community characteristics. Indeed, Table 1 shows a difference in success rates of female and male students of 7.69 percentage points. Concerning ethnic origin at the ULB, previous results show that nationality does influence student's success at university (Demeulemeester and Rochat 1995) and indeed, in our sample, the difference in the success rate reaches 9.55 percent between Belgian and foreign students (in favor of

Belgian students). However, in the international literature, this debate boils down to whether ethnic origin or nationality differences help to explain educational attainment, even after controlling for differences in socioeconomic background in a multivariate model.

Prior schooling

The empirical model includes three variables that account for student's high school path prior to university. The first one is relative to repetition during high school. Theoretically, in Belgium's French Community a student should finish high school on the academic year that started 17 years after his date of birth[12] (student is "on time"). The dummy created controls for the number of years that the student is "late" with respect to his peers of the same generation ("on time", 1 year "late", 2 or more years "late").

Droesbeke, Hecquet and Wattelar (2001) finds that high school repetition is relevant in explaining success at university in the case of Belgian students. We expect this variable to have a negative impact on success increasing with the number of years failed during high school. Second, a variable that takes into account some of Belgium's French Community institutional characteristics (1 Rénové, 0 Traditionnel). In this community, two educational systems co-exist at the same time, the "Rénové" and the "Traditionnel". In the former type, students follow a smaller amount of compulsory hours that in the latter type i.e. optional hours per discipline are much more important. In practice, the "Traditionnel" schools are known as being "difficult" schools and in our sample, students coming from this type of school have a mean rate of success much higher than the students from the "Rénové" (i.e. a difference of 14.05 percent). Third, given that students get to university with large differences on the disciplines they follow during high school and even in intensity for disciplines took in common, the empirical model accounts also for the intensity of the "math profile" (less than 3 hours per week, 4 or 5 hours per week, 6 or more hours per week) and of the "latin and greek profile" (1 if latin and greek classes, 0 if never took latin and greek) chosen by the student.

Socioeconomic background

As stated in the review of the literature, parental choices can influence academic achievement. However, the socioeconomic environment in which children develop cannot be defined in one dimension. This is why we include four different variables that will account for home environment. First, parents' academic attainment, measured by the higher educational level attained by each parent (primary school, high school,

[12] There are 12 years of compulsory schooling that starts at the age of 6.

higher education non-university, university). The second variable analyses a different type of choice made by the parents, that is the parents occupational activity (“farmer”, “low or medium level employee”, high level employee, professor, liberal or independent, unemployed/no profession). We also include a proxy for the level of income of the households that captures if the student paid a reduced fee because of low income (1 if low income reduction, 0 if not). Indeed, several studies showed that money inputs can have an influence on success (Blau 1999). Finally, we include a proxy for household structure: with whom the student has lived before university (both parents, single parent, alone etc.). For all variables, the difference in the success rates between each category and the control dummy variable are displayed in Table 1.

3.3 Methodology and the sample selection bias

In this article, we study success for first year students enrolled at the ULB for the first time. The dependant variable is defined as follows: either you succeed or you fail your first year.[13] Thus, success is analysed by a logit model. Let y_i be our dependant dichotomous variable such that $y_i = 1$ if the i^{th} individual succeed his first year and $y_i = 0$ if he failed. In this model the probability of success on the first year can be expressed as:

$$P(y_i = 1|X_i) = F(\beta_0 + \beta_1 x_{i1} + \cdots + \beta_p x_{ip}) \text{ for } i = 1, \ldots, n$$

where n is the sample size, $X_i = (1, x_{i1}, x_{i2}, \ldots, x_{ip})$ is the p-vector of independent variables of the i^{th} individual and $F(t) = \exp(t)/(1 + \exp(t))$, the logistic distribution function.

However, our specification includes some socioeconomic variables that are only available for the individuals that completed the sociological survey. This implies that we have a dependent variable (success or failure in first year) studied in a truncated sample. The seminal work of Heckman (1979) proposed a solution to avoid a potential severe bias of the estimates in the context of attrition. In our case, the missing data does not concern the dependant variable (success is observed for every student on the database) but some independent variables missing for individuals that did not filled in the sociological survey.[14] This type of selection is not as serious as selection by the dependent variable but it cannot be ignored. Indeed, it could still affect the randomness of the sample and thus yield

[13] Given that during first year, students may take some time to adapt to the new educational system and so may have a second session but to succeed anyway, we decided for now not to detail the dependant variable on whether a student succeeded with a second session or not.

[14] This does not mean that the student chose not to enter university, this only means that the student chose not to fill in the survey at inscription.

biased coefficient estimates. This is why, before interpreting the empirical results of the estimated model, we need to make sure that the truncated sample is still representative of the studied population. In order to facilitate comprehension, in what follows y_i will be used to express the random variable as well as the observation.

The special case presented here is close to the one described in Wooldridge (2001). We estimate a partially observed bivariate probit model with sample selection and thus, instead of having a standard discrete dependant variable model, we can rewrite the model as:

$$y_i = \begin{cases} 1 & \text{if } x_i'\beta + \varepsilon_i > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$z_i = \begin{cases} 1 & \text{if } w_i'\gamma + u_i > 0 \\ 0 & \text{otherwise} \end{cases}$$

where y_i is observed only if $z_i = 1$ (where z_i is equal to one when the student completed the sociological survey and zero otherwise) and the error terms ε and u follow by assumption a bivariate normal distribution with correlation ρ. Note that the problem including endogenous explanatory variables in the equation of success is a very difficult one and for the moment, no answer exists in the literature. Unfortunately, we think that the effect of the high school variables may be due to spurious correlation between the choice of a high school system and unobserved characteristics.[15] This is the reason why we use independent variables in these two equations as only the variables for which we are sure about their exogeneity to the model, that is:

x : *generation*, *gender*, *domain*, *lowfee*, *socioeconomic factors*, *foreigner*

w : *generation*, *gender*, *domain*, *lowfee*, *foreigner*, *Brussels*

where *Brussels* is equal to one if the student lives in Brussels and zero otherwise. It is also known that if the set of explanatory variables for the selection equation (w) is the same than the set for the equation of success (x) then the identification is based only on the non-linearities in the probit models.[16] In order to have a more convincing analysis, one variable that determines selection and not success should be added to the model. The only variable in the database that met these requirements was the variable *Brussels*. It is important to notice that the socioeconomic factors could

[15] See Section 4 for more details of this matter.

[16] Note that the non-singularity of the information matrix is sufficient to obtain locally identified parameters for partially observed bivariate probit model (Poirier, 1980). Then the identification problem is solved as soon as the exogenous variables exhibit sufficient variation over the sample, which is the case in our study.

also influence the decision to fill in the survey and thus they should be included in the selection equation. However, as already stated, we do not have this information for all students and this is precisely the reason why we might have a selection bias. In any case, our results hold for different types of specification. Whether we take into account or not the socio-economic factors in the success equation or whether we add *Brussels* in the success equation the conclusions remain valid.

The estimates of this binary response model can be obtained through a two-step procedure. The first step is to get estimates of γ by doing a probit regression on the selection equation. The second step requires finding the density of y conditional on x and $z=1$ that will be used to compute the likelihood function of the sample and obtain our maximum likelihood estimates (MLE) of β and ρ. According to Wooldridge (2001):

$$P(y_i = 1|u_i, w_i) = \Phi\left(\frac{x_i'\beta + \rho u_i}{(1-\rho^2)^{\frac{1}{2}}}\right)$$

leading to

$$P(y_i = 1|z_i = 1, w_i) = \frac{1}{\Phi(w_i'\gamma)} \int_{-w_i'\gamma}^{\infty} \Phi\left(\frac{x_i'\beta + \rho u_i}{(1-\rho^2)^{\frac{1}{2}}}\right) \phi(u_i) du_i$$

Thus, the log-likelihood function of the sample can be expressed as:

$$\ln L(\beta|y_i, z_i) = \ln\left(\prod_{i=1}^{n_0} P(y_i = 1|z_i = 1, w_i)^{y_i}\ P(y_i = 0|z_i = 1, w_i)^{1-y_i}\right)$$

where n_0 is the truncated sample size.

We can use the Wald test under the null hypothesis $H_0 : \rho = 0$ to determine if attrition is random. If we do not reject the null hypothesis of zero correlation, the model estimates can be derived with a traditional probit/logit model. With the help of a specialized econometric program, we computed the ML estimates and the results of the Wald test which do not reject the null hypothesis ($p = 0.3013$), that is, the hypothesis that the error terms of the two equations are independent.[17] Therefore, the truncated sample of students that filled in the sociological survey constitutes a faithful representation of the student population at the ULB and thus, unbiased estimators can be obtained by standard regression methods.

[17] We have also performed the Wald test excluding the instrument (Brussels) of the second equation, and the conclusion is the same ($p = 0.4230$).

4 Empirical results

This section focuses on the analysis of the empirical results. Our findings deal with two different aspects of student life that influence success at university: family environment and high school choices. Table 2 presents the results of the logit estimation on the sample composed of first year students at the ULB that attended a high school in Belgium's French Community and that filled in the sociological questionnaire at enrollment. The first estimated model (Model 1) focuses on the personal characteristics and family background of the student. The second model (Model 2) reveals the estimated results of the full model, which includes the variables of the first model plus all of the variables that account for prior schooling. As discussed below, the two remaining models (Models 3 and 4) are used to determine which specification is more appropriate to deal with the fact that the couple's socioeconomic variables provide the same information about home environment. For each model, the coefficient estimates are displayed in the first column and the odds ratios in the second column. At the end of this section, we also discuss more in detail the case of immigration and success at university on a larger sample that includes students who attended other high school systems (international or other systems).

Family characteristics and children's success

The empirical results show that the family environment influences the probability of success for students at the ULB and we present evidence against the existence of a unique channel of influence: parental choices can affect their children's success in multiple ways (even beyond compulsory schooling). In the first model, the sign of the coefficient associated with having a father with a university diploma is positive (with respect to a father with a primary school diploma). This implies that students whose father has a higher educational level are more successful during their first year at university. However, to evaluate the magnitude of the difference in their performances, it is interesting to interpret the odds ratio. Considering Table 2, we see that a student whose father holding an university diploma has twice the odds of succeeding of a student whose father only attended primary school. The three remaining models will be analysed more in detail given that they take into account the past schooling characteristics of the students.

The second specification contains all of the variables considered in the first model plus the high school choices. The results show that all socioeconomic characteristics and family structure variables become non-significant. This is probably due to a multicollinearity problem. Indeed, as

Table 2 Estimation results for the logit model (Sample size = 2531)

	Model 1		Model 2		Model 3		Model 4	
Symbol	Coeff.	OR	Coeff.	OR	Coeff.	OR	Coeff.	OR
Personal characteristics								
gen2001	−0.307***	0.736	−0.360***	0.698	−0.324***	0.723	−0.360***	0.697
Science	0.407***	1.503	0.095	1.100	0.090	1.094	0.084	1.088
Health Sciences	−0.136	0.873	−0.412***	0.662	−0.405***	0.667	−0.411**	0.663
gender	0.530***	1.700	0.508***	1.662	0.513***	1.670	0.490***	1.632
Belgian	−0.074	0.928	0.001	1.000	−0.008	0.992	−0.041	0.960
Socioeconomic factors and family structure								
Father—High school	0.368	1.444	0.345	1.413	0.275*	1.316		
Father—Higher studies	0.497*	1.644	0.431	1.539	0.507**	1.661		
Father—University	0.698**	2.010	0.562	1.755	0.753	2.124		
Mother—High school	−0.173	0.841	−0.228	0.796			−0.085	0.919
Mother—Higher studies	0.089	1.093	0.023	1.024			0.290	1.336
Mother—University	0.383	1.466	0.257	1.293			0.591**	1.806
Father—Low/med. empl.	−0.134	0.875	−0.254	0.775			−0.186	0.830
Father—High level empl.	0.134	1.143	0.039	1.040			0.193	1.213
Father—Professor	0.231	1.260	0.203	1.226			0.429**	1.536
Father—Liberal/ind.	0.272	1.313	0.177	1.194			0.312*	1.366

Father—No prof/unempl.	−0.182	0.834	−0.245	0.783			−0.145	0.865
Mother—Low/med. empl.	0.367	1.444	0.202	1.224	0.190	1.209		
Mother—High level empl.	0.548*	1.730	0.404	1.498	0.538*	1.713		
Mother—Professor	0.690**	1.994	0.513	1.671	0.704**	2.023		
Mother—Liberal/ind.	0.456	1.578	0.346	1.413	0.550*	1.733		
Mother—No prof/unempl.	0.356	1.428	0.305	1.356	0.322	1.380		
Low fee	−0.234**	0.791	−0.144	0.866	−0.193*	0.824	−0.161	0.851
Lived—single parent	−0.154	0.857	−0.012	0.988	−0.018	0.982	−0.018	0.982
Lived—other than parent	−1.602	0.201	−1.231	0.292	−1.174	0.309	−1.154	0.315
High school path charac.								
1 year "late"			−0.727***	0.483	−0.712***	0.491	−0.720***	0.486
2 or more years "late"			−1.441***	0.237	−1.437***	0.238	−1.460***	0.232
"Traditionnel"			0.580***	1.785	0.593***	1.809	0.595***	1.813
Latin and greek profile			0.582***	1.790	0.580***	1.785	0.593***	1.810
Math profile—Middle			0.201	1.223	0.180	1.197	0.204	1.226
Math profile—Strong			0.962***	2.617	0.961***	2.616	0.976***	2.654
Pseudo—R^2	0.0612		0.1221		0.1151		0.1191	

*Statistically different from zero at 10%. **Statistically different from zero at 5%. ***Statistically different from zero at 1%.

mentioned before, intuition leads to believe that the father's level of education will tend to be very close to the level of education of the mother. In order to evaluate to which extent these two variables are related, we performed a multiple correspondence factor analysis (MCFA) on the socioeconomic variables.[18] The results show that the levels of education of each parent are indeed located very close to one another. Therefore, these two variables capture the same kind of information about the cultural environment at home. This implies that one variable could be removed without any significant explanatory loss, leaving us with a more parsimonious model and avoiding the multicollinearity problem. However, to find out which variable to remove from the model, we must evaluate its overall significance as a factor of success. This information is not provided by student test scores in Table 2 given that this test evaluates the individual significance of each level of education with respect to the reference group (for example: the influence on the probability of success of having a mother with an university diploma with respect to having a mother with a primary school diploma). The test we need is one that tells us whether having a mother with any diploma other than primary school has an impact on success or not, i.e. a Wald test:

$$\begin{cases} H_0 : \beta_2 = \beta_3 = \beta_4 = 0 \\ H_1 : \exists\, j \in \{2, 3, 4\} \text{ such that } \beta_j \neq 0 \end{cases}$$

where subscript 1 indicates the reference group (primary school). The results of this joint test[19] reveals that the test statistic is larger for the mother's level of education than for the father's. Moreover, we always reject the null hypothesis for the educational level of the mother, whereas we do not reject it for a majority of specifications for the father. Even when they are both significant, the mother's level of education is systematically closer to children's success, as often stated in the literature. Given the test results, the concern of parsimony and the fact that explanatory power of the model is practically identical between a model having both educational level variables and one with only the educational level of the mother (Table 2), we decided to exclude the educational level of the father in our final specification.

The same reasoning applies to another important aspect of the house environment that has to be taken into account: the occupational activity of the parents. The analysis of this variable is identical to that of the educational level of the parents. Indeed, the professional status of the mother and the father are closely related and thus capture the same kind of

[18] The graphical representation of the MCFA can be found in the Appendix.
[19] The results for the joint tests can be found in the Appendix (Figure A1).

information, as shown by the results of the MCFA. The difference in this case is that even if they capture almost the same information about the household socioeconomic status, the professional activity of the father is closer to success. According to the results of the Wald test (Table A1 in the Appendix), the mother's professional status is not significant to explain success in the full model, whereas the father's occupational activity is significant. Again, for all of these reasons, we should also exclude the professional activity of the mother (as done for the father's level of education) from our final specification (Model 4).

In the first model, the results of the *t*-test show that the coefficients related to the father's education and to the mother's profession are significant. Intuitively, it may seem contradictory to exclude them from the model, as it will be done if we follow the conclusions derived from the MCFA and the Wald test. This is why we also estimated Model 3, to show that first of all, the Pseudo-R^2 of Model 4 is higher than the one of the third estimated model. This implies that the education of the mother and the professional activity of the father have a larger explanatory power than the father's diploma and the mother's occupation. Second, we also compared the full model to the two restricted models (Model 3 and model 4) by means of a likelihood ratio test. The results of the fourth model show that we do not reject the null hypothesis (at the 5 percent level) that the set of parameters associated with the education of the father and the occupation of the mother are null, leading to the conclusion that the unrestricted model is not more informative than the restricted model ($p = 0.2626$). The opposite is observed in the case of the third model, given that the likelihood ratio test rejects the null hypothesis that the occupation of the father and the education of the model are null ($p = 0.0029$).

The educational level of the mother seems to be the most influent on academic achievement while the occupational activity of the father affects his children success at university. In general, most studies conclude that the mother has a stronger effect on the academic path of their children. The question that arises is whether this influence is due to time inputs given by the mother through child care as suggested by Leibowitz (1974) and Murnane et al. (2001) or due to inherited endowments as stated by Behrman and Rosenzweig (2002). As far as professional activity is concerned, the fourth model shows that it is having a father who is a professor that influences the most academic achievement since the odds of succeeding the first year at the ULB are 53 percent higher than those of a student whose father is a workman or a farmer. It is important to highlight that the occupation and the educational level of the parents are significant in the presence of our proxy of the household level of income, which is the dummy for paying a reduced fee at university or not (*lowfee*). Unfortunately, *lowfee* does not capture the difference between households with

middle and high levels of income but it still captures the influence of having a really low income. Thus, material inputs are not the only channel through which parents can influence their children's success given that in our model, education and occupational activity are significant.

Finally, our findings regarding the influence of the family structure are different from those found in the literature. As mentioned before, in their survey on American studies, Haveman and Wolfe (1995) claim that living in a single parent family has a negative impact on achievement, independently of the measurement used.[20] However, the studies that get significant results about family structure are either the ones focused on high school completion or on years of schooling. In our article, students that live with a single parent do not display significant differences in achievement at university with respect to those living with both parents. This result is not surprising since we can assume that students that get to university are often living away from their parents and are becoming more independent individuals. Thus, they should be less affected by the family structure at home when they are at university than during high school (since a large majority of students live with their parents).

Decisions made during high school also matter

The results of Model 4 in Table 2 reveal that success of ULB first year students is also related to their high school path. First of all, in accordance with other Belgian empirical studies, students that have repeated during high school have lower rates of success during the first year at university. In our final specification, a student that is 1 year "late" has 52 percent smaller odds of succeeding than a student that never failed in his academic path. The difference in the odds of succeeding can go up to 77 percent for students that are 2 or more years "late", i.e. those that met multiple failures during their scholarship. This result is particularly important in the case of Belgium's French Community given the extremely high rates of repetition in schools. Indeed, the last report from the education minister revealed that in 2006, only 50 percent of the students that graduate from high school are on time.[21] Thus, an important part of student population has a lower probability of succeeding even before getting to university. The second variable capturing high school choices was the type of school where the student attended (between the two types of systems that co-exist

[20] For more information on family structure, see also Ermisch and Francesconi (2001) and Ermisch, Francesconi and Pevalin (2003) or Manski et al. (1992).

[21] Ministère de la Communauté française and l'Entreprise des Technologies Nouvelles de L'information et de la Communication (2006), "Les indicateurs de l'enseignement", Ministère de la Communauté française, pp. 44.

in Brussels) and it is statistically significant in explaining success at the ULB. A student that attended a school of the type "Traditionnel" has 81 percent higher odds of succeeding first year at university than a student of the "Rénové" type of school.

Which factors could explain this difference in performance? As mentioned before, the "Rénové" type of school has a smaller amount of compulsory hours leaving the student a broader choice of disciplines to follow and even the frequency of each subject. In order to know the educational profile of the students that attend this particular system, the ULB recorded the number of hours received by each student in disciplines like mathematics and latin and greek. Our final model includes these variables and the results show that both variables are highly significant. Students that received any amount of hours of latin and greek lessons are more successful during their first year (higher odds of succeeding of 80 percent) than students that did not received any. In the same way, a student that attended 6 or more hours of mathematics per week (Strong Math Profile) has more than twice the odds of succeeding first year than a peer that attended 3 or less hours per week. Furthermore, controlling for differences in the mathematical or latin and greek profile of the students brought evidence against the ULB common belief that students in science have higher rates of success than students in other domains. In the first model, we can see that a student enrolled in the domain of science has 49 percent higher odds of succeeding relative to a student enrolled in the domain of human sciences. However, in the other models this effect no longer holds when we account for differences in prior schooling. More precisely, this effect will remain significant until we include the math or latin and greek profile variables.

Nonetheless, in this section, we use a standard logit model that implicitly assumes that explanatory variables are exogenous. This assumption is easily verified for a majority of variables (i.e. gender, socioeconomic factors, family structure) but can be questionable for others variables like the attended high school system ("Traditionnel" versus "Rénové"), the success obtained in past schooling (i.e. the number of years "late") or the type of profile chosen (mathematical or latin). For example, the positive effect of the "Traditionnel" system can be due to spurious correlation between the choice of a high school system and unobserved characteristics (Altonji, Elder and Taber 2005) for the case of catholic school). In human sciences with respect to laboratory sciences, causal effects are more difficult to identify because experiments are generally not randomized in the sense that the individuals exposed to one "treatment" (in this case, attending the "Traditionnel" system) can differ systematically from individuals exposed to the other "treatment" (the "Rénové" system). In our regression, we can suspect that our four high school variables

could be endogenous so their estimates could be biased. More research is needed to solve this issue but meanwhile, it is important to notice that the estimates of the remaining variables are stable no matter the specification chosen.

Immigration and higher education

The most important result about student's personal characteristics is that nationality appears as not significant in explaining student's success at university. This is observed when we include in the model the variables that account for the socioeconomic status of the family (on the sample of students from a high school in BFC). As already mentioned, the literature has been trying to find out if differences in school attainment can partially be explained by ethnic origin even if we take account of the differences in socioeconomic backgrounds. In contrast with Demeulemeester and Rochat (1995), we show that this is not the case. Nowadays, being a foreigner at the ULB is not statistically significant in explaining success if we account for the student's socioeconomic status. However, do all foreign students have the same characteristics once they get to university? For example, we could control for the country of origin to take into account ethnic differences. Surprisingly, the results remain unchanged since there are no significant differences in first year performances between European and non-European students[22] (Model 1 in Table 3).

A solution for this problem could be to identify another key element that differentiates immigrants, like for example the level of integration of the student i.e. to characterize if he is a first or a second generation immigrant. This information is not explicitly available in the database but we created a proxy using the country of residence of the parents of all foreign students. The resulting variable is structured as follows: the student can either be Belgian (control dummy), foreigner with no parents in Belgium (first generation immigrant), foreigner with only one parent in Belgium and foreigner with both parents in Belgium (at least second generation). Replacing the variable Belgian by this more detailed variable implied changing the variable for the high school type, given that the first sample only included students enrolled in a Belgium's French Community high school (the amount of mathematics and latin and greek was only available for students in a school that was part of a Belgium's French Community educational system). The new high school type variable captures if the student went to a ''Rénové'' high school (control dummy),

[22] We also checked for ethnic origin by controlling for the continent of origin of the student and in the same way, we found no significant difference in first year performances.

Table 3 Estimation results of the analysis of immigration and higher education ($n = 3712$)

Model 1		Model 2		Model 3	
Symbol	Coeff.	Symbol	Coeff.	Symbol	Coeff.
EU	0.199	Foreigner—Alone in BE	0.524*	EU—Alone	0.695**
		Foreigner—1 parent in BE	−0.460	Non-EU—Alone	−0.446
		Foreigner—both parents in BE	−0.281*	EU—1 parent	−1.481*
				Non-EU—1 parent	0.573
				EU—Both parents	−0.278
				Non-EU—Both parents	−0.278
Personal characteristics					
gen2001	−0.302***	gen2001	−0.316***	gen2001	−0.313***
Science	0.298***	Science	0.293***	Science	0.301***
Health Sciences	−0.276**	Health Sciences	−0.290**	Health Sciences	−0.287**
gender	0.501***	gender	0.499***	gender	0.501***
High school path characteristics					
1 year "late"	−0.836***	1 year "late"	−0.854***	1 year "late"	−0.857***
2 or more years "late"	−1.502***	2 or more years "late"	−1.556***	2 or more years "late"	−1.597***
Traditionnel	0.498***	Traditionnel	0.497***	Traditionnel	0.499***
International or other	0.114	International or other	0.065	International or other	0.054

(continued)

Table 3 Continued

Model 1		Model 2		Model 3	
Symbol	Coeff.	Symbol	Coeff.	Symbol	Coeff.
Socioeconomic factors					
Mother—High school	−0.061	Mother—High school	−0.082	Mother—High school	−0.077
Mother—Higher studies (NU)	0.385*	Mother—Higher studies (NU)	0.359*	Mother—Higher studies (NU)	0.361*
Mother—University	0.669***	Mother—University	0.653***	Mother—University	0.661***
Father—Low/medium employee	0.173	Father—Low/medium employee	0.165	Father—Low/medium employee	0.165
Father—High level employee	0.435***	Father—High level employee	0.429***	Father—High level employee	0.424***
Father—Professor	0.723***	Father—Professor	0.701***	Father—Professor	0.701***
Father—Lib/ind.	0.433**	Father—Lib/ind.	0.422	Father—Lib/ind.	0.425***
Father—No profession	0.093	Father—No profession	0.101	Father—No profession	0.107
Low fee	−0.245**	Low fee	−0.235**	Low fee	−0.235**
Lived with 1 parent	−0.140	Lived with 1 parent	−0.135	Lived with 1 parent	−0.135
Lived with no parent	0.750**	Lived with no parent	0.696*	Lived with no parent	0.773**

*Statistically different from zero 10%. **Statistically different from zero 5%. ***Statistically different from zero 1%. EU, European Union; NU, non university; BE, Belgium.

"Traditionnel" school or an "International or other" school (international being a school in Belgium that is not part of the community's system and other meaning school in another country or graduation through other particular paths).

The second model in Table 3 presents the results obtained using the detailed version of the "Belgian" variable and they reveal that foreigners that are alone in Belgium have higher odds of succeeding than Belgian students. The opposite is observed with foreigners living with both parents in Belgium since they have lower probability of succeeding their first year at university than Belgian students. This result is in agreement with the conclusions from our first estimated model. Given that some foreigners do better and other do worst than Belgian students, if we use an aggregated variable for nationality, it is normal that Belgians and foreigners have on average the same odds of succeeding. Note that the effect of being a foreigner alone in Belgium becomes significant when we take into account socioeconomic differences, meaning that this group has a lower socio-economic status with respect to Belgian students. Furthermore, being a foreigner with one parent in Belgium has no significant impact in the probability of success. Our results show that foreigners alone in Belgium at university are definitely a type of immigration specific to university: students that come to get their higher education diploma. The motivation to succeed for these students can be different from students that immigrated with their parents and that did not explicitly chose to be there. However, does this effect holds for all types of foreigners? For example, is it likely that European and non-European students alone in Belgium have the same performances? As shown by the third model in Table 3, the "elite immigration effect" is only valid for European students.

Finally, it is interesting to note that our results are in line with the recent study of foreign students in secondary education made by Jacobs, Rea and Hanquinet (2007) using the PISA database for Belgium. One of their main conclusions is that even if we take into account socioeconomic differences, foreign students have poorer success profiles than their Belgian peers. Intuitively, a large majority of foreign high school students do not move to Belgium alone but belong mainly to our groups "foreigner with 1 parent" or "foreigner with both parents in Belgium" and for these groups we observe the same kind of results. Again, we see that the factors that influence success at university need to be analysed separately. A different type of immigration arises at this stage (immigrate to study) and since it influences positively the odds of succeeding, in aggregate it makes being a foreigner not different from Belgians in terms of the probability of succeeding their first year at university.

5 Conclusion

By using a unique dataset containing the entire newly enrolled student population at the ULB, our research aimed to be the first complete analysis of the determinants that influence the university path of the student. We decided to start by studying what we call an information "key point", the analysis of student success on the first year at university. This first year is of great importance because of the high rates of repetition and drop out observed during this year across universities in Belgium's French Community. Several features distinguish our research from the existing literature. First, a bigger sample of students for whom we have socio-economic information about their families and broad range of variables that account for prior schooling. Second, we analyse a new dependant variable and we control for all the variables highlighted as important in the international literature.

What influences students success on the first year at the ULB? We show that the educational level of the parents has a positive impact on the probability of success. In agreement with the literature, the mother's schooling is more importantly related to their children's success. However, we went a step further and reveal that if we control for the parental occupational activity, the father's profession is more important to student success than the profession of the mother. In any case, we still do not know if the effects are different because of old beliefs about child care (a more educated mother raises the quality of time inputs) or because of inherited abilities. Furthermore, as opposed to the studies on the factors of high school completion, students living in a single parent family do not have a different success profile at university than those in intact families. The difference could come from the fact that at university, students are young adults that are learning to be independent and living with only one parent will not affect their achievement at university. Finally, if we look at Belgians and all foreign students, they have the same success profile if we account for differences in the socioeconomic environment. However, detailing the profiles of foreign students showed that this result comes from the fact that some students belong to an immigrating "European elite". This particular group has higher odds of succeeding their first year than Belgian students, while the opposite is observed for foreign students living with both parents in Belgium. We think that this first generation students present in the higher education system immigrated with a particular goal (getting a degree) and thus face a particular motivation (or pressure?) that the others foreign students do not have.

Prior schooling also appeared to be an important element for student success. Important achievement differences exist between the two types of

high school systems in Belgium's French Community: the "Traditionnel" and the "Rénové". The students that attended the former have higher odds of succeeding than the "Rénové" students. In addition, a student that has met several failures during high school has almost twice as high odds of failing their first year of university than a student that finished "on time". This result is of special interest in the case of Belgium's French Community where high school repetition concerns a majority of the student population. Finally, analyzing in detail the "math-intensive" profile of the students erased the previous belief about the better performance of students enrolled in the faculty of applied sciences, given that the difference comes exclusively from their high school profile. Individual endogeneity tests were used to check for the doubtful exogeneity of the prior schooling variables and they revealed that indeed the high school system variable and the "late" variable are endogenous to the model. Then, the estimated effect of these two variables has to be interpreted with caution. We are conducting further research on the endogeneity problem, which clearly needs to be solved in order to identify causality effects of the high school variables. Meanwhile, it is important to highlight that the estimates of the exogenous variables are incredibly stable (as shown by the preliminary sensitivity analysis we have conducted).

Finally, we can see that this first step was somewhat revealing in itself. It also raised new interesting questions that deserve some special attention in the future. For instance, it would be interesting to study the sub-sample of students enrolled in the faculty of applied sciences. Using their scores at the entry exam as a proxy for ability, we could determine if the influence of the parent's educational level is due to inherited ability or to time inputs. In addition, we could analyse the effects of failure on the future academic path of the student, by analysing for example, the factors that influence the drop out and the re-orientation. Similarly, what about the student that succeeds his first year? We could find out if the elements that influence success during the first are the same that could help the student until the completion of his higher education studies. Finally, our results showed that there are high achievement differences between students determined not only by the type of high school attended but also by the options chosen.

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Appendix

Table A1 Joint dummy tests of the socioeconomic variables in the full model (Model 2)

Wald test		
Variable	Coefficient tested	Result
Father—Level of education	(1) High school = 0 (2) Higher studies (NU) = 0 (3) University = 0	chi2(3) = 4.84 Prob > chi2 = 0.1841
Mother—Level of education	(1) High school = 0 (2) Higher studies (NU) = 0 (3) University = 0	chi2(3) = 12.06 Prob > chi2 = 0.0072
Father—Occupationnal activity	(1) Low or medium employee = 0 (2) High level employee = 0 (3) Professor = 0 (4) Liberal or independent = 0 (5) No profession/unemployed = 0	chi2(5) = 11.46 Prob > chi2 = 0.0431
Mother—Occupationnal activity	(1) Low or medium employee = 0 (2) High level employee = 0 (3) Professor = 0 (4) Liberal or independent = 0 (5) No profession/unemployed = 0	chi2(5) = 5.32 Prob > chi2 = 0.3777

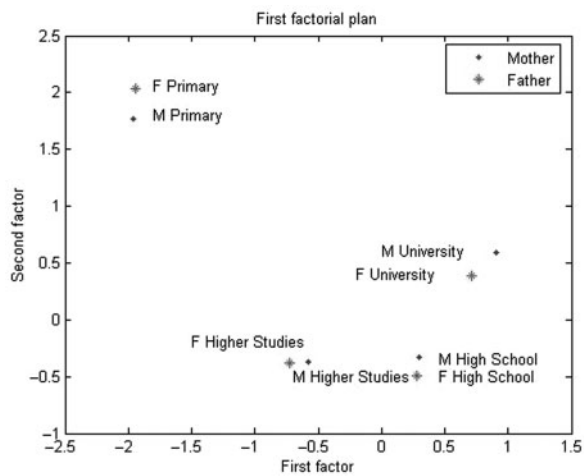

Figure A1 MCFA results for the socioeconomic variables in the full model (Model 2)

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Differential Grading Standards and University Funding: Evidence from Italy

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Abstract

This article documents that grades vary significantly across Italian public universities and degrees. We provide evidence suggesting that these differences reflect the heterogeneity of grading standards. A straightforward implication of this result is that university funding schemes based on students' academic performance do not necessary favour universities that generate higher value added. We test this for the case of the Italian funds allocation system, which rewards universities according to the number of exams passed by their students. We find that university departments that rank higher according to this indicator actually tend to be significantly worse in terms of their graduates' performance in the labour market. (JEL codes: I2, J31, J64)

Keywords: Higher education, grading standards.

1 Introduction

In a number of European countries—including Italy, Spain and France—university grading standards are presumed to be similar across institutions. This presumption justifies the legal value that is typically given to university titles and explains why public funding of universities is increasingly related to the number of diplomas or grade points assigned by universities.

This article empirically investigates the existence of differences in grades and grading standards across Italian universities. It exploits three editions of a survey run on a representative sample of Italian graduates. The survey contains information about graduates' academic and labour market performance, as well as a large set of individual characteristics, including high-school grade, province of origin and various measures of family background. Conditional on this extensive set of controls, we find that

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grades vary considerably across universities and disciplines. Evidence from graduates' labour market performance and post-university external professional qualification exams (''abilitazione professionale'') suggests that these variations in grades do actually reflect differences in grading standards and not true changes in students' quality. Indeed, we find a significant negative correlation between departments' average grades and the labour market outcomes of their graduates, i.e. graduating from a high grading department leads to a higher unemployment probability and lower wages. As well, graduates from departments with high average grades do not have higher chances to get professional qualifications in external examinations.

A straightforward policy implication follows from the above results. Policy makers should be very cautious about using students' academic performance as a proxy for university value added. If, as shown in this article, grading standards vary significantly across departments and universities, rewarding universities with high graduating rates may lead to undesirable consequences.

We test the relevance of this hypothesis using the main output variable that the Italian government takes into account in order to finance universities: the number of full-time equivalent students (FTE), which measures the number of exams that students have passed in a given year. Consistently with our predictions, we find that graduates from universities with a relatively higher number of FTE perform significantly worse in the labour market and do not obtain better results in professional qualification exams. The evidence thus suggests that a financing scheme which is meant to reward those universities that produce higher value added is, instead, favouring those universities with lower standards.

The rest of the article is organized as follows. Section 2 presents the existent literature on grading standards. Section 3 describes the data and the main variables used in the empirical part. Section 4 presents the empirical analysis and discusses policy implications. Finally, Section 5 summarizes the main results and provides the conclusions.

2 Background

The issue of educational standards has been widely discussed in the economics literature both from a theoretical and an empirical perspective. Grading standards may vary over time and across higher education institutions for a number of reasons. Standards may adjust to the quality of students (Strenta and Elliott 1987). As well, professors may inflate grades to escape negative evaluations by students, whose opinions matter for tenure and promotion decisions (Siegfried and Fels 1979; Nelson and

Lynch 1984). Some departments may also increase their grades to fill poorly attended courses that might otherwise be canceled (Dickson 1984; Staples 1998). In addition, Freeman (1999) argues that given the institutional constraints that prevent, within each university, a system of flexible money pricing for those courses with different expected earnings, instructors and departments may act strategically to manage enrolment by adjusting the time and the effort cost of achieving a given grade. More generally, Costrell (1994) notes that if institutions choose grading standards in a decentralized way a free rider problem may arise, as high standards might not be fully appropriated by each institution. De Paola and Scoppa (2007) point out that, in a decentralized setting, educational standards might be also influenced by the existence of labour market distorsions.

An extensive empirical literature has documented the existence of variations in grades over time across American universities and colleges. In particular, there has been, at least since the 1960s, an increase in the grades issued by American universities, coupled with the perception of a deterioration in academic standards (Kolevzon 1981; Sabot and Wakeman-Linn 1991; Anglin and Meng 2000). As well, there exists a line of studies, which provide evidence on divergence in grades across different disciplines (Dickson 1984; Sabot and Wakeman-Linn 1991; Freeman 1999). For instance, Sabot and Wakeman-Linn (1991) report average grades received by students in several disciplines in eight American colleges and universities, finding a clear division of colleges into high and low grading departments.

Differences in grades are also observed in Europe. A report on the development of exam grades in Germany finds that the average grades vary widely across universities (Wissenschaftsrat 2004). Several authors also observe that in the UK degree results vary according to institution. For example, Chapman (1997) studies the degree results from 1973 to 1993 for eight disciplines and finds a clear tendency for certain universities to award consistently higher percentages of top degrees in all disciplines with respect to the corresponding national average. As far as Italy is concerned, Boero et al. (2001) report that grades tend to vary significantly across degrees and regions.

Unfortunately, in most of these studies it is difficult to disentangle whether the observed differences in grades reflect different qualifications and performance or, conversely, differences in teaching and assessment practices. As Boero et al. (2001) put it, whether the observed differences "indicate use of differential standards across the different institutions or genuine institutional differences in value-added cannot be identified from the data" (Boero et al. 2001, p. 27). However, assessing whether the observed heterogeneity in grades stems form different grading standards or from differences in graduates' true performance might be important for

a number of reasons. Both in Europe and in the US, variations in grading standards might be problematic in the presence of informational asymmetries about the quality of graduates and/or institutions. Most importantly, in many European countries the institutional design of higher education typically requires the homogeneity of grading standards across institutions. This assumption explains why titles have a legal value and are legally required for many occupations and, as well, why several countries, such as Italy and Denmark, have adopted output funding schemes based on the number of diplomas or grade points each higher education institutions delivers.

3 Data

We investigate the potential existence of differences in grading standards across Italian universities and fields of studies using a very detailed dataset concerning Italian university graduates, which allows to observe their socioeconomic background, high-school grades, university performance and, finally, their outcomes in the labour market and in professional qualification exams.

More specifically, our main data are drawn from three distinct but almost identical surveys named Indagine Inserimento Professionale Laureati (Survey on University-to-Work Transition) run in 1998, 2001 and 2004 on individuals that graduated in 1995, 1998 and 2001, respectively.[1]

The target samples consist of 25,716 individuals in 1998, 36,373 individuals in 2001 and 38,470 individuals in 2004. They represent respectively the 25, 28.1 and 24.7 percent of the total population of university graduates in Italian universities. The response rates were of 64.7, 53.3, and 67.6 percent for a total of 17,326, 20,844 and 26,006 respondents. In all 3 years, the sample is stratified according to sex, university and obtained degree and in the analysis below all estimations are performed using stratification weights. We exclude from the sample graduates from physical education studies and from the so-called ''laurea primo livello'', since they were surveyed only in the 2001 edition (501 and 475 observations, respectively).

As other European continental countries, Italy has a system of open admission into public universities: most departments are obliged to admit every applicant, without being allowed to set up any entry restrictions.

[1] Differences may stem from the different interviewing technologies used in the surveys: in 1998 ISTAT mailed paper-based questionnaires, while in 2001 and 2004 graduates were first contacted by mail and then questions were asked following the so-called CATI. (Computer-assisted telephone interview) technique.

This system is common to all public universities and all disciplines except medicine, veterinary and architecture. For a number of reasons, grading standards are likely to be different in those universities and fields of study that can select their students; thus, we further restrict our sample to those departments that cannot select students. This reduces the total size of the sample to 61,844 observations.

The surveys provide information on (i) individual characteristics that are pre-determined with respect to college choices and outcomes, (ii) college-related individual indicators and (iii) labour market outcomes. The first set of variables includes information on the individual sociodemographic background such as gender, nationality, number of siblings, province of residence before college enrolment, parents' education and employment when respondent was around 14-years old, the situation of military service obligations before attending university and self-reported high-school curricula–high-school grade and type of school attended. The second includes university-related indicators: the type of degree and university attended, educational outcomes—i.e. final grade obtained and the number of years spent for the completion of the degree[2]—and additional information such as occupational status during studies, changes in the degree followed, attainment of an other degree and whether the respondent originated from a town or province other than the one where her university was located. Official grades range from 66 points to a maximum of 110 e lode. Third, the survey collects self-reported information about a number of occupational outcomes 3 years after graduation. Among others, it is possible to observe whether the graduate is employed, whether the job requires a university degree, her wage and several indexes of job satisfaction. Table 1 depicts descriptive statistics for the key individual variables.[3]

In addition to the individual information, we use data on several college characteristics. Fields of study are aggregated in 12 different

[2] In Italy, the final grade is calculated as the sum of the grades obtained by the graduate during her courses plus the grade received for the so-called degree dissertation (*tesi di laurea*). Any student whose final grade is higher than 110 obtains what is known as ''110 e lode''. For simplicity, in the empirical analysis reported bellow the potential existence of grades above 110 has been disregarded. The results obtained using a tobit regression, available upon request, are very similar to the ones reported here. Also, note that in the Italian education system in the analysed period students were not constrained either in time or in the number of trials taken for passing exams.

[3] The unemployment rate for graduates in our sample is 14.7 percent. It is consistent with the OECD 2003 data suggesting that 13.6 percent of Italian graduates aged 25–29 not being in education are unemployed. Italian graduates experience disadvantage in terms of early performance in the labour market as the overall unemployment rate among individuals aged 25–29 is 10.4 percent (OECD, Education at a Glance 2005).

Table 1 Descriptive statistics—individual characteristics

	Mean	Min	Max
Pre-determined Individual Characteristics			
Gender (share of females)	0.532	0	1
Age	27.587	21	75
When an individual was 14-years old his father was			
Working	0.960	0	1
Looking for a job	0.004	0	1
A pensioner	0.017	0	1
Other	0.019	0	1
When an individual was 14-years old his mother was			
Working	0.494	0	1
Looking for a job	0.004	0	1
A pensioner	0.020	0	1
Other	0.482	0	1
When an individual was 14-years old his father's highest educational title was			
Elementary license or none	0.190	0	1
Secondary education license	0.236	0	1
Higher education diploma	0.340	0	1
University degree	0.226	0	1
No answer	0.008	0	1
When an individual was 14-years old his mother's highest educational title was			
Elementary license or none	0.250	0	1
Secondary education license	0.259	0	1
Higher education diploma	0.350	0	1
University degree	0.135	0	1
No answer	0.006	0	1
Father's sector of work			
Agriculture	0.050	0	1
Industry	0.260	0	1
Services	0.672	0	1
No answer	0.018	0	1
Number of siblings	1.313	0	4
Nationality			
Italian	0.991	0	1
European Union	0.006	0	1
Extra-communitarian	0.003	0	1

(continued)

Table 1 Continued

	Mean	Min	Max
Type of high school			
Scientific lyceum	0.413	0	1
Classic lyceum	0.193	0	1
Technical industrial institute	0.062	0	1
Technical institute for geometers	0.034	0	1
Technical commercial institute	0.128	0	1
Other type of technical institute	0.030	0	1
Teachers school or institute	0.062	0	1
Language lyceum	0.036	0	1
Professional institute	0.029	0	1
Art lyceum or institute	0.013	0	1
High-school grade	49.085	36	60
Military service obligations			
Exempt	0.219	0	1
Before university	0.039	0	1
Other	0.742	0	1
College-related individual characteristics			
Number of extra years taken to graduate after the end of the official program duration*	2	0	4
University grade	103.628	66	110
Moved from other course	0.107	0	1
Second degree	0.014	0	1
Studied in the region of birth	0.793	0	1
Studied in the province of birth	0.519	0	1
Studied in the town of birth	0.412	0	1
Moved from own town to study	0.300	0	1
Graduates' post-graduation performance			
Passed profession qualification exam	0.452	0	1
In the labour force	0.843	0	1
Employed if in the labour force	0.853	0	1
Employed in a job for fulfilling of which the obtained university degree is necessary if in the labour force	0.644	0	1
Wage**	1135.786	77.468	10 000

Notes: The number of observations is 61,844. *In this case the median value is reported instead of the mean. Value 4 means that 4 or more extra years to graduate have been employed. **The number of observations with non-missing wage is 37,552.

Table 2 Descriptive statistics—department characteristics

	Year	Mean	Std. Dev.	Min	Max
Full-time equivalent (FTE) Students (%)	1995	46.394	12.748	13.118	94.608
University ordinary financial funds*	1995, 1998, 2001	188.982	186.856	11.3	1186.1
Professor per student ratio**	1996, 1999	0.093	0.101	0.004	1.429

Notes: In 2001, there were 410 different departments. *In this case the statistics are reported at the university level in billions of lire. Note that the ordinary financial funds are only available for public universities. **This is the ratio of the number of professors to the total number of non-delayed students.

disciplines.[4] Table 2 displays descriptive statistics at the department level on the share of full-time equivalent (FTE) Students—the main measure used by the Ministry for distribution of ordinary financial funds across universities—and ordinary financial funds themselves.[5] Finally, we also consider a number of demographic and economic indicators at the provincial level such as gross domestic product (GDP), total population and unemployment.

4 Empirical analysis

To begin with, we investigate whether grades vary significantly across disciplines and universities. Then, we analyse whether the potential existence of differences in grades across institutions stems from differences in grading standards or, rather, it reflects genuine differences in institutional value added. Finally, we analyse how the existence of differential grading standards affects the funding of Italian universities.

4.1 Grades

The grades obtained by a university graduate are likely to be related to a number of personal characteristics including parental background and pre-university ability. We estimate the following model:

$$G_i = \beta X_i + \gamma D_f + \delta D_u + \alpha_t + \varepsilon_{itfu}, \quad (1)$$

[4] The *aggregated disciplines* are Agriculture, Architecture, Chemistry and Pharmacy, Economics and Statistics, Engineering, Law, Literature, Medicine and Surgery, Pedagogy, Political and Sociological Studies, Sciences, Veterinary. In what follows the term *department* stands for the corresponding disciplinary unit within a particular university.

[5] Information on the number of FTEs comes from the Osservatorio per la valutazione del sistema universitario (1998). See Perotti (2002) for detailed information on how the number of FTEs affects universities' funding.

where G_i is a measure of the academic results obtained by individual i and X_i is a set of individual characteristics, as described in Table 1, including dummies for the province where the individual lived before attending university and gdp and unemployment rates at the provincial level. D_f and D_u are the sets of dummies corresponding, respectively, to the field of study (or discipline) and university. The time dummy α controls general changes across time. Finally, the error term ε_{itfu} captures any remaining factor affecting academic performance.

Column 1 of Table 3 shows the results of an ordinary least square (OLS) estimation of Equation (1) where the dependent variable is the final aggregate grade obtained by the individual during her studies. In addition to individual pre-determined characteristics, the regression also controls for the number of extra years taken to graduate.[6] The effect of individual characteristics is largely consistent with those obtained by previous studies.[7] We also observe that grades are positively correlated with unemployment rates. This is consistent with the work of Dornbusch et al. (2000) and Di Pietro (2006), who point out that local labour market conditions may influence students' decisions. Lower unemployment rate may encourage a number of students to devote less effort to studying in university, in order to take advantage of the improved labor market conditions.

Moreover, grades tend to vary to a large extent both across universities and across faculties.[8] Figure 1 shows the set of estimated university dummy coefficients, i.e. the component of an individual's grade that is statistically explained by her attendance to a given institution, conditional on her observable characteristics, discipline, geographical origin and the time she took to graduate. Universities are ordered from left to right according to their official university code, lower codes corresponding in general to northern locations and bigger codes' to southern ones. The positive slope suggests that, as one moves across universities from the north to the south of Italy, grades—conditional on individual's observable characteristics—tend to increase. Similarly, Figure 2 shows how grades vary across disciplines. This figure suggests that there are

[6] The difficulty of each particular program could be described in two ways: as the time that is necessary in order to complete a program and obtain a certain grade or as the final grade that an individual will obtain if she takes a given period time to graduate.

[7] See, for instance, Boero et al. (2001) who studies the determinants of academic success using the ISTAT survey corresponding to year 1998.

[8] The inclusion in equation (1) of university and discipline fixed affects significantly the explanatory of the model. Including university dummies increases the *R*-square from 21.68 percent to 28.54 percent. The subsequent inclusion of the discipline fixed effects raises *R*-square to 39.82 percent.

Table 3 Individual characteristics and performance in university, labour market and external professional qualification exams

	(1) University grade		(2) Extra years in university		(3) Employment probability		(4) Log wage		(5) Employment with knowledge match		(6) Qualification exams	
	OLS		OLS		Probit		OLS		Probit		Probit	
Pre-determined individual characteristics												
Female	0.757***	(0.081)	−0.067***	(0.015)	−0.047***	(0.005)	−0.128***	(0.007)	−0.068***	(0.008)	0.001	(0.006)
Age	−0.169***	(0.011)	0.160***	(0.004)	0.002***	(0.001)	0.012***	(0.001)	−0.002**	(0.001)	−0.007***	(0.001)
Father was												
Working	Benchmark		Benchmark		Benchmark		Benchmark		Benchmark		Benchmark	
Looking for a job	−0.060	(0.496)	−0.229**	(0.101)	−0.013	(0.025)	−0.019	(0.052)	−0.002	(0.048)	−0.011	(0.034)
A pensioner	0.308	(0.217)	−0.007	(0.045)	−0.011	(0.014)	−0.034	(0.021)	−0.026	(0.021)	−0.006	(0.018)
Other	0.329	(0.272)	0.087	(0.057)	0.003	(0.015)	−0.076***	(0.030)	0.033	(0.024)	−0.004	(0.023)
Mother was												
Working	Benchmark		Benchmark		Benchmark		Benchmark		Benchmark		Benchmark	
Looking for a job	0.575	(0.376)	0.195**	(0.087)	−0.007	(0.024)	−0.216***	(0.064)	−0.021	(0.049)	0.003	(0.031)
A pensioner	0.150	(0.215)	−0.047	(0.042)	−0.016	(0.017)	−0.019	(0.017)	−0.023	(0.022)	0.005	(0.016)
Other	−0.118*	(0.064)	0.001	(0.013)	−0.004	(0.004)	−0.005	(0.007)	0.000	(0.006)	−0.010**	(0.005)
Father's education												
Elementary license or none	Benchmark		Benchmark		Benchmark		Benchmark		Benchmark		Benchmark	
Secondary education license	−0.136	(0.094)	−0.016	(0.020)	−0.003	(0.006)	0.022***	(0.008)	0.017*	(0.009)	0.001	(0.007)
Higher education diploma	−0.193*	(0.100)	0.004	(0.021)	0.000	(0.006)	0.033***	(0.009)	0.028***	(0.010)	0.010	(0.007)
University degree	−0.204*	(0.120)	−0.048*	(0.025)	−0.013*	(0.008)	0.035**	(0.011)	0.037***	(0.012)	0.018**	(0.008)

(continued)

Table 3 Continued

	(1) University grade	(2) Extra years in university	(3) Employment probability	(4) Log wage	(5) Employment with knowledge match	(6) Qualification exams
	OLS	OLS	Probit	OLS	Probit	Probit
Mother's education						
Elementary license or none	Benchmark	Benchmark	Benchmark	Benchmark	Benchmark	Benchmark
Secondary education license	−0.216** (0.088)	−0.036* (0.018)	0.012** (0.005)	0.020* (0.007)	0.012 (0.009)	0.000 (0.007)
Higher education diploma	−0.420*** (0.098)	−0.087*** (0.021)	0.014** (0.006)	0.030** (0.009)	0.021** (0.010)	−0.003 (0.007)
University degree	−0.260** (0.131)	−0.204*** (0.028)	0.019** (0.007)	0.028*** (0.013)	0.036*** (0.013)	0.015 (0.009)
Father's sector of work						
Agriculture	Benchmark	Benchmark	Benchmark	Benchmark	Benchmark	Benchmark
Industry	0.375*** (0.140)	0.016 (0.030)	0.024*** (0.008)	0.004 (0.013)	0.021 (0.013)	0.005 (0.010)
Services	0.504*** (0.134)	0.039 (0.029)	0.020*** (0.008)	−0.016 (0.013)	0.012 (0.013)	0.000 (0.010)
Other	0.831** (0.347)	0.026 (0.079)	−0.004 (0.021)	(0.071*** (0.033)	−0.053 (0.037)	0.043* (0.018)
Number of siblings	0.085** (0.033)	0.012* (0.007)	(0.007*** (0.002)	0.005* (0.003)	0.005 (0.003)	−0.000 (0.003)
Nationality						
Italian	Benchmark	Benchmark	Benchmark	Benchmark	Benchmark	Benchmark
European Union	0.989 (0.819)	0.055 (0.147)	0.066* (0.024)	0.094 (0.080)	0.162** (0.055)	0.027 (0.043)
Extra-communitarian	1.786*** (0.688)	0.054 (0.129)	0.058 (0.057)	0.069 (0.070)	0.124* (0.069)	0.001 (0.047)
Type of high school						
Scientific lyceum	Benchmark	Benchmark	Benchmark	Benchmark	Benchmark	Benchmark
Classic lyceum	0.409*** (0.080)	0.034** (0.017)	−0.025*** (0.005)	−0.030*** (0.009)	−0.015* (0.009)	−0.005 (0.007)
Technical industrial institute	−1.062*** (0.133)	−0.021 (0.026)	0.030*** (0.008)	0.019*** (0.009)	−0.016 (0.012)	0.014** (0.007)

(continued)

Table 3 Continued

	(1) University grade		(2) Extra years in university		(3) Employment probability		(4) Log wage		(5) Employment with knowledge match		(6) Qualification exams	
	OLS		OLS		Probit		OLS		Probit		Probit	
Technical institute for geometers	−1.458***	(0.167)	−0.020	(0.034)	0.009	(0.010)	−0.035**	(0.014)	0.008	(0.016)	0.026***	(0.008)
Technical commercial institute	−1.544***	(0.102)	0.050**	(0.020)	−0.005	(0.006)	−0.009	(0.008)	−0.033***	(0.010)	−0.001	(0.011)
Other type of technical institute	−1.516***	(0.172)	0.039	(0.035)	0.004	(0.011)	0.020	(0.013)	−0.008	(0.017)	0.021**	(0.009)
Teachers school or institute	−0.882***	(0.122)	0.221***	(0.030)	0.003	(0.007)	0.027***	(0.011)	0.022*	(0.013)	0.017	(0.011)
Language lyceum	−1.181***	(0.141)	0.198***	(0.038)	−0.004	(0.010)	0.011	(0.013)	−0.052***	(0.015)	−0.004	(0.019)
Professional institute	−2.223***	(0.181)	0.034	(0.041)	−0.004	(0.011)	−0.023	(0.019)	−0.021	(0.018)	0.002	(0.013)
Art lyceum or institute	−1.524***	(0.237)	0.221***	(0.045)	−0.029*	(0.016)	−0.070***	(0.022)	−0.052**	(0.024)	0.001	(0.013)
Other	−1.092***	(0.416)	−0.039	(0.094)	0.006	(0.024)	−0.013	(0.045)	0.080**	(0.038)	0.027	(0.031)
High-school grade	0.303***	(0.004)	−0.016***	(0.001)	0.002***	(0.000)	0.005***	(0.000)	0.003***	(0.000)	0.001*	(0.000)
Military service obligations												
Exempt	−0.077	(0.093)	0.008	(0.017)	0.002	(0.006)	0.023***	(0.008)	0.009	(0.009)	−0.019***	(0.006)
Before university	0.085**	(0.033)	−0.691***	(0.044)	0.047***	(0.009)	0.092***	(0.013)	0.049***	(0.017)	−0.024*	(0.015)
College-related Individual characteristics												
Moved from other course	0.021	(0.095)	−0.320***	(0.024)	0.012**	(0.006)	0.017***	(0.008)	−0.001	(0.010)	0.006	(0.008)
Second degree	1.184***	(0.420)	−1.151***	(0.137)	0.047	(0.047)	0.049	(0.098)	0.127	(0.079)	−0.079	(0.049)

(continued)

Table 3 Continued

	(1) University grade		(2) Extra years in university		(3) Employment probability		(4) Log wage		(5) Employment with knowledge match		(6) Qualification exams	
	OLS		OLS		Probit		OLS		Probit		Probit	
Studied in the region of birth	0.262***	(0.100)	0.147***	(0.021)	0.004	(0.006)	−0.035***	(0.008)	−0.027***	(0.010)	0.025***	(0.008)
Studied in the town of birth	0.687***	(0.078)	−0.050***	(0.016)	0.004	(0.005)	0.020***	(0.007)	−0.009	(0.008)	−0.038**	(0.006)
Moved from own town to study	0.020	(0.073)	0.056***	(0.015)	0.004	(0.004)	0.009	(0.007)	0.020***	(0.007)	0.006	(0.009)
Province of birth characteristics, 2 years before graduation												
GDP* (10)	0.064	(0.082)	−0.013	(0.017)	−0.002	(0.005)	−0.011	(0.008)	0.020**	(0.009)	0.018***	(0.001)
Unemployment	0.054***	(0.019)	0.010***	(0.004)	−0.001	(0.001)	0.011***	(0.002)	0.007***	(0.002)	0.002	(0.002)
Population* (10,000)	−0.003	(0.003)	0.004	(0.006)	0.001	(0.002)	0.005*	(0.003)	0.003	(0.003)	−0.005**	(0.002)
Other dummies and controls												
Province of origin	Yes		Yes		Yes		Yes		Yes		Yes	
Course fixed-effect											Yes	
Discipline fixed-effect	Yes		Yes		Yes		Yes		Yes			
University fixed-effect	Yes		Yes		Yes		Yes		Yes		Yes	
Extra years taken to graduate	Yes											
University grade			−0.033***	(0.001)								
(Pseudo) *R*-squared	0.403		0.361		0.157		0.226		0.0811		0.1726	
Number of observations	61,844		61,844		52,532		37,552		49,103		26,344	

Notes: *Significant at 10%; **significant at 5%; ***significant at 1%. For probit regressions marginal effects at mean values are reported. Standard errors in parentheses.

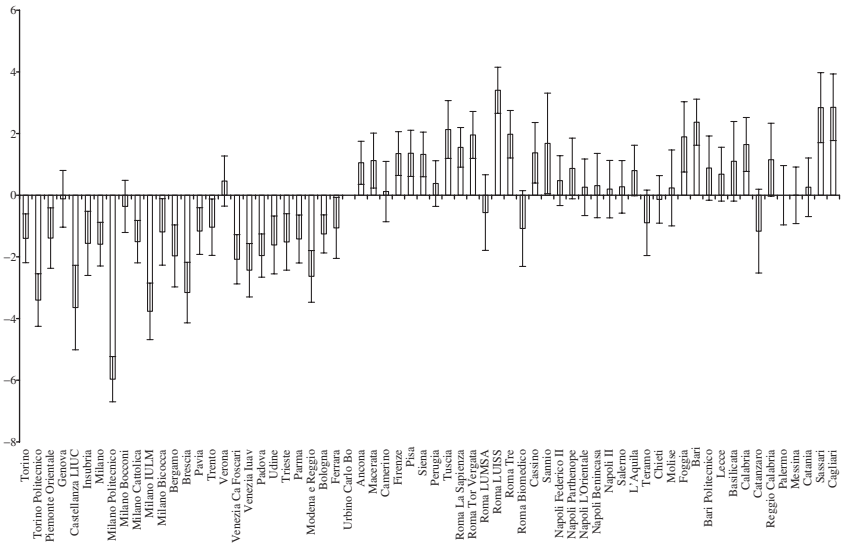

Figure 1 Grades across universities
Notes: Bars' length represent university dummies obtained from a OLS regression, where dependent variable is grades. Controls include individual characteristics, discipline and time taken to graduate. Universities are ordered by official code, university of Urbino is the benchmark. The error bars indicate the confidence intervals at the 5% significance level.

notable differences in the size of discipline fixed-effects on grades with Engineering, Economics and Statistics, Chemistry and Pharmacy, and Law being among the lowest grading and Agriculture, Literature, Pedagogy and Architecture among the highest grading disciplines.

The second column of Table 3 displays the results of the above model when we use as dependent variable the number of extra years taken to graduate. The previous findings are largely confirmed. Results concerning the variation of university and discipline dummy coefficients in this case are qualitatively very similar to the ones of Figures 1 and 2 and are available upon request.

Two important caveats apply to the above estimations. First, note that the estimation builds on the information provided by individuals with similar characteristics, including geographic origin, but who decide to attend different departments. This strategy provides consistent estimates as long as these individuals do not differ significantly in their unobservable characteristics. Second, another important concern regards the

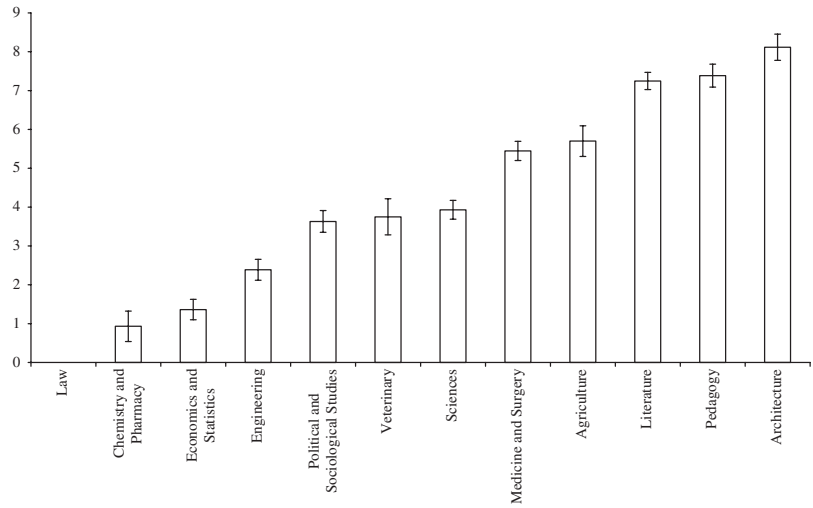

Figure 2 Grades across fields
Notes: Bars' length represent discipline dummies obtained from a OLS regression, where dependent variable is grades. Right hand side controls include individual characteristics, university and time taken to graduate. Law is the benchmark. The error bars indicate the confidence intervals at the 5% significance level.

endogeneity of the sample. In fact, we observe only graduates, but not drop-outs.[9]

4.2 Differences in quality or differences in grading standards?

The above results show that grades, conditional on graduates' pre-determined characteristics, tend to vary greatly across universities and fields. In principle, these differences could be due either to the value added by universities or to their grading standards. To investigate these

[9] This shortcoming generates two problems. First, the factors that afect the grades obtained by those students that do not manage to graduate could differ from the factors affecting the grades obtained by graduates. A key assumption is, therefore, that the grades obtained by graduates consistently reflect, conditional on observables, the grades obtained by those students that dropped out before graduation. Second, a more subtle problem is related to the fact that the very same unobservable characteristics—i.e. talent or grading standards—that affect grades do also affect selection into the sample, this is, graduation. This makes the usual selection based on observables assumption likely to fail. Still, the nature of the problem allows us to make some predictions about the direction of the bias, at least among the cohort of students that graduate on time. Any factor that generates an increase in grades would presumably increase the size of this cohort. The new sample would include individuals which are, conditional on observables, relatively worse in unobservables. This suggests that the effect of factors that generate an increase in grades will tend to be underestimated or, in other words, that the estimated coefficients will tend to be a lower bound of their true value.

alternative explanations, we use two additional proxies of quality. First, we exploit the indicators detecting graduates' labour market performance. If higher grades reflect higher value added, graduates from high grading departments should perform better in the labour market. Second, we use the outcomes of external professional qualifying exams. In Italy, they are compulsory for a number of professional occupations. If higher grades reflect higher quality, graduates from high grading institutions should display higher passing rates.

Labour market outcomes

Graduates' labour market performance L_i is likely to be affected by a number of socioeconomic characteristics X_i, by their field of study D_f and by the university attended D_u. Equation (2) analyses this relationship:

$$L_i = \alpha_t + \beta X_i + \gamma D_f + \delta D_u + \varepsilon_{itfu}. \quad (2)$$

Table 3 presents the estimation results of this model when labour market performance is measured, 3 years after graduation, by the employment status (column 3), the wage (column 4) and the probability of finding a job, which requires a university degree (column 4) of those individuals who are in the labour force.[10] If, on the one hand, female perform better in terms of grades, on the other, they exhibit a worse performance in the labour market. Similarly, foreign graduates are not able to transform their higher academic performance into better labour market outcomes.

In addition to personal characteristics, the institution attended is a key predictor of future labour market performance. Figure 3 depicts the estimates of universities' fixed effects on wages conditional on the individuals' observable characteristics, their geographical origin and discipline. Again, universities are ordered from left to right according to their official ISTAT code number, which increases as we move from the north to the south of Italy. Thus, the negative slope observed in Figure 3 suggests that northern universities' graduates tend to earn higher wages than southern universities' ones. A similar pattern is observed if we restrict our analysis to graduates who finished their studies on time. Including the region of actual residence does not affect the pattern observed in the histogram. Thus, our results are not driven by unobserved labour market conditions. The picture is similar if we use as dependent variable graduates' employment status: given two students with similar socio-economic backgrounds and geographical origins, those who graduate from a northern university are more likely to be successful in the labour

[10] Results are essentially unchanged, if we consider instead the whole population of graduates, including also those graduates that do not look for a job.

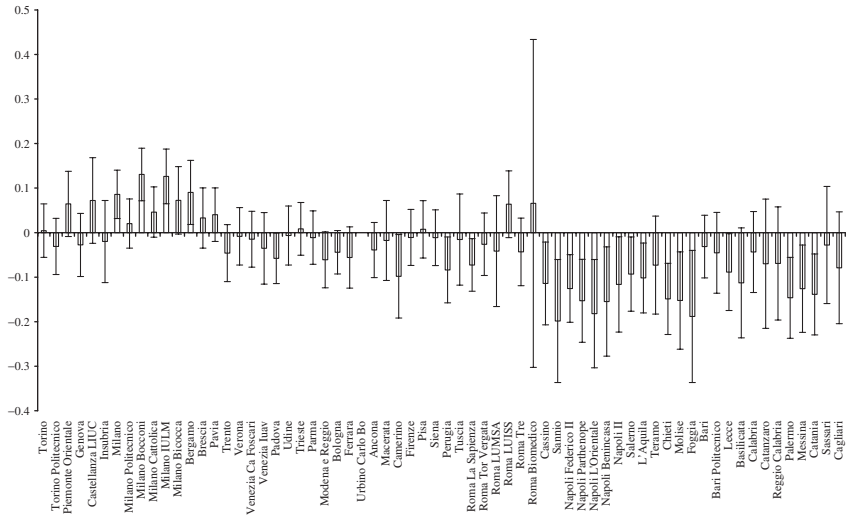

Figure 3 Wages across universities
Notes: Bars' lengths represent universities dummies obtained from an OLS regression, where the dependent variable is wage. Right hand side controls include individual characteristics, discipline and time taken to graduate. Universities are ordered by official code, university of Urbino is the benchmark. The error bars indicate the confidence intervals at the 5% significance level.

market than those who graduates from a southern university, even if they end up working in the same region. This result is consistent with previous studies that also find a premium for graduating in the north (Brunello and Cappellari 2005; Pozzoli 2006; Makovec 2007). Moreover, we observe significant differences across disciplines in terms of wages. In particular, conditional on graduating in the same university, high-school grades, individual background and province of origin, graduates in Engineering, Economics and Statistics, Chemistry and Pharmacy and Medicine are likely to have higher wage with respect to graduates in Veterinary, Literature, Law and Pedagogy (Figure 4).

As shown in Figures 1 and 3, while grades tend to be higher in southern universities, labour market outcomes tend to be better for those that graduate in the North. With the exception of Law departments,[11] the same pattern generally holds at the discipline level: high grading disciplines tend to provide lower labour market opportunities for their student.

[11] Law is a quite particular case. Note that in Italy, graduates in Law must spend at least 2 years as interns before taking professional qualification exams and becoming lawyers.

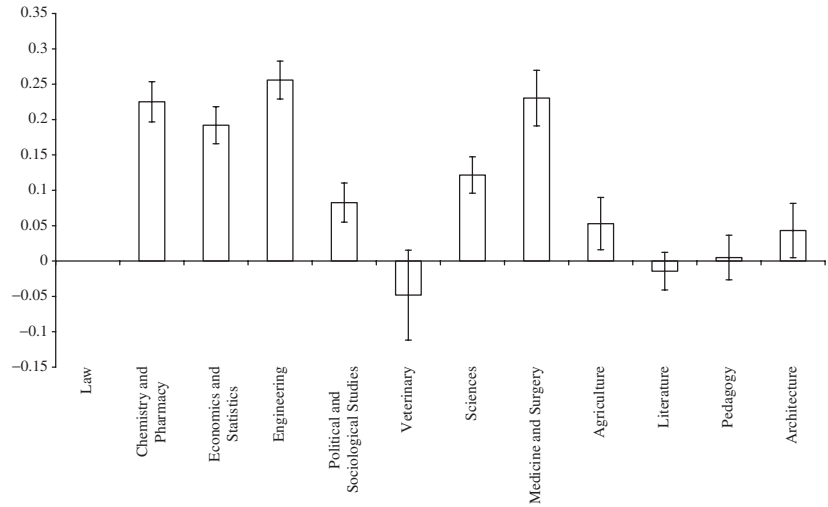

Figure 4 Wages across fields
Notes: Bars' lengths represent discipline dummies obtained from an OLS regression, where the dependent variable is wage. Right hand side controls include individual characteristics, university and time taken to graduate. Law is the benchmark. The error bars indicate the confidence intervals at the 5% significance level.

This descriptive evidence suggests that there exists a negative correlation between departments' grades and their graduates' labour market outcomes, both across universities and across fields of study. Bellow, we formally test this statistical relationship.

First, we estimate an equation, in which—as in Equation (1)—we analyse the determinants of grades, but we substitute the discipline and university dummies with a set of dummies specific to each university department separately for 1995, 1998 and 2001 D_{td}:

$$G_i = \beta X_i + \gamma D_{td} + \alpha_t + \varepsilon_{itd}. \tag{3}$$

Second, using the department dummies coefficients ($\widehat{\gamma}$), we decompose individuals' grades into two components: (1) $\widehat{\gamma}_{td} D_{td}$, reflecting the (conditional) average grade obtained by individuals that graduated within the same cohort and department and (2) the relative grade obtained by the individual, calculated as a difference between the actual grade and the estimated grade conditional on personal characteristics $[\widetilde{G}_i = G_i - \widehat{\gamma}_{td} D_{td}]$. Third, we study how these components affect labour market performance measures:

$$L_i = \alpha_t + \beta X_i + \eta \widetilde{G}_i + \mu \widehat{\gamma}_{td} + \varepsilon_{itd}, \tag{4}$$

Table 4 presents the estimation results of Equation (4) using three different measures of graduates' labour market performance: the probability of being employed (columns 1 and 2), the probability of finding a job that requires a university degree (columns 3 and 4) and the expected wage (columns 5 and 6). Conditional on their observable personal characteristics, the number of years spent in university and the discipline chosen, students that obtain higher grades *relative to their classmates* are more likely to be employed 3 years after graduation and, if employed, tend to earn a significantly higher wage. However, the department's average grade has the opposite effect. Students that graduated from universities where average grades were higher are significantly less likely to be employed (column 1) and, if employed, they are not more likely to have a job that requires a degree (column 3) and do not tend to earn more (column 5). Results remain essentially the same if we include among the controls graduates' class size or the region of graduates' residence when being interviewed. In columns 2, 4 and 6, we compare individuals who graduated in the same university but who had enrolled into different fields. We find that those individuals who obtained their degree in departments with relatively higher average grades are significantly less likely to find a job which requires being a graduate (column 4) and actually tend to earn significantly less (column 6). As in the previous analysis, controlling for the region of current residence does not have a significant effect on the estimates.

The above results may help to rationalize the puzzling correlation that arises when we compare the academic performance of Italian graduates with their performance in the labour market. A simple descriptive analysis of the data provided by the ISTAT surveys on year 1995, 1998 and 2001 graduates reveals that those individuals that had obtained higher grades in university do not obtain higher wages later on (see Table 5, columns 1, 2 and 3).[12] In the last edition of the survey, it turns out that grades are negatively correlated with earnings: graduates who obtained lower grades tend to earn relatively more. Of course, as our above results suggested, this negative relationship is driven by the different grading standards that departments apply. As expected, once we take into account the university and the department from which an individual has graduated the expected positive relationship between grades and salary is re-established (though, significant only at 11 percent).

[12] Boero et al. (2001) already point out that the grades of 1998 graduates show no correlation with their wages.

Table 4 The effect of grades on labour market outcomes

	(1) Employment		(2) Employment		(3) Knowledge match		(4) Knowledge match		(5) Log wage		(6) Log wage	
	Probit		Probit		Probit		Probit		OLS		OLS	
Individual relative grade	0.003*	(0.002)	0.003	(0.002)	0.010***	(0.002)	0.010***	(0.001)	0.003***	(0.001)	0.004***	(0.001)
Department fixed effect on grade	−0.020***	(0.006)	0.005	(0.004)	0.006	(0.004)	−0.014***	(0.003)	0.001	(0.001)	−0.009***	(0.001)
Controls												
Year of graduation	Yes		Yes		Yes		Yes		Yes		Yes	
Extra years taken to graduate	Yes		Yes		Yes		Yes		Yes		Yes	
Individual characteristics‡	Yes		Yes		Yes		Yes		Yes		Yes	
Province of origin* (High-school grade)	Yes		Yes		Yes		Yes		Yes		Yes	
Province of origin characteristics‡	Yes		Yes		Yes		Yes		Yes		Yes	
Discipline dummies	Yes				Yes				Yes			
University dummies			Yes				Yes				Yes	
Observations	42,819		42,819		40,051		40,051		31,040		31,040	
(Pseudo) *R*-square	0.1614		0.1431		0.0780		0.0684		0.2335		0.2081	

Notes: *Significant at 10%; ***significant at 1%. For probit regressions marginal effects at mean values are reported. Standard errors in parentheses. Students from private universities and departments with constrained admission are excluded. ‡Variables listed in Table 3 are included among the regressors.

Table 5 The (puzzling) relationship between grades and wages

	(1) 1995	(2) 1998	(3) 2001	(4) 2001	(5) 2001	(6) 2001
University grade[†]	0.007	−0.004	−0.017**	0.010	−0.008	0.015
	(0.010)	(0.006)	(0.008)	(0.009)	(0.009)	(0.010)
Controls						
Year of enrolment	Yes	Yes	Yes	Yes	Yes	Yes
Extra years taken to graduate	Yes	Yes	Yes	Yes	Yes	Yes
Individual characteristics[‡]	Yes	Yes	Yes	Yes	Yes	Yes
Province of origin					Yes	Yes
Province of origin characteristics[‡]	Yes	Yes	Yes	Yes	Yes	Yes
Discipline dummy				Yes		
University dummy					Yes	
Department dummy						Yes
Observations	8700	10,697	11,643	11,643	11,643	11,643
R-squared	0.1481	0.1543	0.1271	0.1706	0.145	0.1976

Notes: **Significant at 5%. Standard errors in parentheses. Students from private universities and departments with constrained admission are excluded. [†]The coefficient shows the effect of a 10-point increase in grade. [‡]Variables listed in Table 3 are included among the regressors.

Professional qualification exams

An additional way to test whether higher grades reflect higher quality or simply different standards is to exploit the outcomes of post-university professional qualification exams (“abilitazione professionale”). These exams are granted by official professional organizations and are meant to certify that a given graduate holds a minimal set of competencies for a given profession. They are not compulsory but are required in order to perform legally a number of professions. The set of professions for which an exam is required includes Architects, Chemists, Accountants, Physicians, Psychologists or Engineers.[13]

The ISTAT survey allows to observe whether a given graduate has passed the corresponding external qualification exam within 3 years of her graduation. A potential source of bias of this measure might arise from the fact that we only observe whether individuals succeeded in the professional qualification exam, but not whether they took it and failed. This problem is likely to be bigger in those disciplines where graduates have other professional possibilities that do not require an official qualification.

[13] For a complete list of Italian professional organizations and details of respective exams see http://it.wikipedia.org/wiki/Albo_professionale.

As it is shown in Table 1, about half of respondents have passed an external qualification exam after graduation. However, the distribution of this percentage across fields is not homogenous[14]: the probability that a graduate pass the qualification exam ranges from 0 to 40 percent in 66 percent of courses, from 40 to 60 in 4 percent of courses and from 60 to 100 percent in 30 percent of courses. In other words, there exist a big group of courses in which more than 60 percent of graduates do not ever pass the exam, another group of courses in which more than 60 percent of graduates pass the exam and very few courses that could not be attributed either to the first or to the second group. In order to minimize the problem of self-selection described above, we restrict the analysis to those occupations where graduates have a very limited scope for professional possibilities unless they pass the external qualification exam. In what follows only the latter group of courses, namely, the one in which more than 60 percent of graduates passed the exam (mainly Engineering and Chemistry courses), is considered.

Column 6 of Table 3 shows the relationship between individual characteristics and the probability of success in qualification exams. As expected, success in this exam is closely related to graduates' quality, as measured by high-school grades and other socioeconomic characteristics.

In Table 6, we analyse the relationship between university grades and performance in external qualification exams. We find that conditional on the department and university attended, those graduates that obtained relatively better grades than their classmates in university are significantly more likely to pass the qualification exams. Then, we investigate whether the (conditional) average grade of all individuals that graduated within the same cohort and department $\widehat{\gamma}_{td}D_{td}$, as defined in the previous subsection, has a similar positive effect on graduates' performance in professional qualification exams A_i, estimating the following regression:

$$A_i = \alpha_t + \beta X_i + \eta \widetilde{G}_i + \mu \widehat{\gamma}_{td} + \varepsilon_{itd}. \tag{5}$$

As shown in column 2 of Table 6, while we still find that within each department better students are more likely to succeed in professional qualification exams, in general graduates from departments with higher average grades tend to be less successful in professional qualification exams. Given that in these fields the lack of success in external exams is associated with significantly lower employment rates and with significantly lower probabilities of finding a job, which requires a degree, our

[14] Degree course defines graduates' specialization within a certain discipline. Each disciplinary field on average offers around 10 different degree courses.

Table 6 The effect of grades on performance in external qualification exams

	(1)	(2)
University Grade	0.002*** (0.001)	
Individual relative grade		0.002***
		(0.001)
Department fixed effect on grade		−0.008**
		(0.004)
Controls		
Year of graduation	Yes	Yes
Extra years taken to graduate	Yes	Yes
Individual characteristics‡	Yes	Yes
Province of origin* (High-school grade)	Yes	Yes
Province of origin characteristics‡	Yes	Yes
Course dummies	Yes	Yes
Department dummies* (Year of graduation)	Yes	
Observations	16,261	16,261
(Pseudo) *R*-square	0.2068	0.2018

Notes: **Significant at 5%; ***significant at 1%. Marginal effects at mean values are reported. Standard errors in parentheses. Students from private universities and departments with constrained admission are excluded. ‡Variables listed in Table 3 are included among the regressors.

results suggest that the variations in the department-average component of grades are not likely to reflect better quality.[15]

4.3 Differential grading standards and the funding of italian universities

Before 1993, the Italian national ministry of education was in charge of fixing the total amount of funds, their shares across public universities and their allocation across disciplines. Its decisions were largely made on historical bases and were sometimes affected by distinct deals with single institutions and faculties within institutions. In 1993, a reform was approved allowing each university to become an autonomous entity with its own budget to be allocated across distinct disciplines (law n.537/1993). Moreover, discretion was replaced by a complex set of rules, which in the short run left about 90 percent of the big bulk of public funding to be assigned on historical basis and the rest to be allocated via an equalization

[15] Those graduates who passed the professional exam have a probability of finding a job that matches the knowledge acquired in university, which is 11 percentage points higher than the rest of individuals in the sample. Note also that if individuals' unobserved ability in university performance was positively correlated to individuals' unobserved ability in professional qualification exams, the estimated coeffcient must be considered as an upper bound of its true value.

component (EC). The latter is supposed to progressively substitute the former. The EC objective is 2-fold: first, to reduce public funding disparities across universities and across disciplines and, second, to incentivate quality. On the incentives side, the EC seeks to reward the quality of teaching linking funding to the number of exams passed by enrolled students. Technically, the funds depend positively on the share of FTE students, which is defined as the ratio between the number of exams that students passed and the number of exams that students should have taken. See Perotti (2002) for details.

In principle, the measure of quality based on the share of FTE students might be subject to at least two problems. First, it fails to take into account the initial quality of students. Universities that attract students of better quality will tend to perform relatively better even if they fail to provide better education. Second, in the absence of quality assurance mechanisms, the FTE might capture both the students true quality and the easiness (or grading standards) of a given institution.[16] In fact, the evidence provided in the previous section suggests that the relationship between the average grades issued by different universities and the performance of their graduates in the labour market or in qualification exams is, if any, negative. A straightforward implication of this result is that financing universities based on their self-evaluated academic performance does not necessary reward those universities that generate a higher value.

Table 7 shows the relationship between graduates' labour market outcomes and the share FTE students in the department where they graduated, conditional on graduates' socioeconomic background and pre-university measures of quality. While the number of FTE students is meant to proxy the quality of a department, we find a strong and significant negative relationship between this measure and graduates' labour market outcomes, as measured by occupation rates (column 1) and obtaining a job which requires a university degree (column 2). We also find no significant relationship whatsoever between the share of FTE students and graduates' wages (column 3) or their performance in professional qualification exams and (column 4).

To sum up, FTE fails to capture quality of institutions, at least as measured by graduates' performance in the labour market and in professional qualification exams.

[16] In 1996 and 1999, two distinct kinds of evaluating committees were established to preserve quality: a National Committee (Comitato Nazionale per la Valutazione del Sistema Universitario) and several Internal Committees (Nuclei di Valutazione Interna). However, as convincingly argued by Perotti (2002), their objectives are too vague and they turned out to be to be largely ineffective.

Table 7 The relationship between the share of FTE students and labour market performance

	(1) Employment	(2) Knowledge match	(3) Log wage	(4) Qualification exams
	Probit	Probit	OLS	Probit
FTE students[†]	−0.032*	−0.032*	−0.006	0.013
	(0.018)	(0.018)	(0.004)	(0.031)
Controls				
Year of graduation	Yes	Yes	Yes	Yes
Extra years taken to graduate	Yes	Yes	Yes	Yes
Individual characteristics[‡]	Yes	Yes	Yes	Yes
Province of origin* (High-school grade)	Yes	Yes	Yes	Yes
Province of origin characteristics	Yes	Yes	Yes	Yes
Discipline dummies	Yes	Yes	Yes	
Course dummies				Yes
Observations	13,579	13,579	10,424	5233
(Pseudo) *R*-square	0.1667	0.1667	0.2151	0.1814

Notes: *Significant at 10%. Standard errors in parentheses. [†]The coefficient shows the effect of an increase of 10 Full Time Equivalent Students in 1995. [‡]All variables listed in Table 3 are included among the regressors. Only students that graduated in 1998 from a public universities and from a department with open entry have been considered.

5 Conclusion

In recent years, a number of European countries, including Italy, have adopted output funding schemes based on the number of diplomas or grade points each institution delivers. One of the pre-conditions for such systems to be effective in providing quality enhancing incentives is ensuring homogeneity of educational quality and grading standards across institutions. Otherwise, as noted by Jacobs and Van der Ploeg (2006), this practice might undermine incentives to improve educational quality, as in most cases the quantity rather than the quality of output is rewarded due to the difficulties in measuring the later.

In this article, we analyse grading standards across Italian universities and disciplines. More specifically, we study the performance of several cohorts of Italian graduates in the labour market and in external qualification exams and analyse how it relates to their performance in university. We find that, conditional on a large set of individuals' observable characteristics that includes geographical origin, high-school grade and socioeconomic background, graduates from high-grading departments tend to perform significantly worse in the labour market.

Moreover, graduates from high-grading universities are less likely to succeed in external qualifying exams that are required for many professional activities. These results suggest that the significant variations in grades that can be observed in Italy across disciplines and universities reflect to a large extent differences in grading standards.

In line with this evidence, we also find that the output measure of university quality that has been adopted by the Italian Ministry of Education to allocate funds across universities—i.e. the number of FTE students defined as the ratio between the number of exams that students passed and the total number of exams that they should have taken—is negatively correlated with graduates' labour market outcomes.

This finding rises concerns on the effectiveness of such funding mechanisms. In light of this evidence, the implementation of quality ensuring mechanisms–such as a system of external examiners as in the UK—should be seriously considered as a necessary complement to any output funding scheme. Additionally, given that obtaining objective evaluations of external examiners might be itself problematic and costly, a more radical policy option may involve fostering reputation effects in the market for higher education. This goal may be approached in different ways, for instance, by allowing universities to select their students and, simultaneously, promoting student mobility, by letting universities set tuition fees and introducing efficient student loan systems.[17]

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[17] See Mas-Colell (2003–2004) for a thorough discussion on reforms that might foster competition and reputation effects in the European higher education space.

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Do Institutions Matter for University Cost Efficiency? Evidence from Germany

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Abstract

Efficiency analyses on higher education institutions have so far primarily focussed on the identification of inefficiency and less on the explanation of differences in efficiency performance. In this article, we study the impact of institutional factors on the efficiency of 67 publicly financed German universities for the years 1998–2003. We present some evidence that university costs and outputs are correlated with institutional settings such as the management structure of universities or the universities' staff body. Furthermore, econometric evidence from a single-stage stochastic frontier model (based on a cost function) suggests that universities which are located in states with a comparatively liberal university legal framework are more efficient than those universities operating under more restrictive state regulation. (JEL codes: I28, L32, H72)

Keywords: Higher education, institutions, cost efficiency, stochastic frontier.

1 Introduction

Economic growth theory as well as a substantial body of empirical studies is important for its economic and non-economic well-being to a significant extent (OECD 2006). Human capital formation in turn is based on public higher education in many countries. In times of tight public budgets the efficient spending of public funds is receiving increasing attention in the economic-political debate. Despite the importance of the education sector for the economy, the question of efficient allocation of public resources in the university landscape has only recently been investigated for industrialized countries. Existing studies have predominantly focussed on the identification of differences in efficiency scores across universities (see Worthington 2001 for an overview). In contrast, there are only few empirical investigations that focus on the *determinants* of these inefficiencies. A prominent exception is a recent study, which finds university research performance and university efficiency to be related to university autonomy (Aghion et al. 2007).

Against this background, we first derive hypotheses with regard to the impact of institutional settings on university cost efficiency. Using a data set of 67 publicly financed German universities for the years 1998–2003

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we study whether university costs and outputs are correlated to institutional settings and whether institutions may explain differences in cost efficiency performance across German universities. We present some evidence that university costs and outputs are correlated with the management structure of universities or characteristics of universities' staff body. Furthermore, econometric evidence from a single-stage stochastic frontier model (based on a cost function) suggests that universities which are located in states with a comparatively liberal university legal framework are more efficient than those universities operating under more restrictive state regulation.

The remainder of this article is organized as follows. In section 2 the related literature on efficiency analysis of universities is surveyed. Based on this review we derive our hypotheses on the determinants of university inefficiency in section 3. In section 4, we provide descriptive statistics for our data set. In section 5, we first conduct a correlation analysis between university in-/outputs and institutional variables. Second, a single-stage stochastic frontier model, which is based on a cost function, is estimated in order to shed some light on causation of institutional settings on university efficiency. Section 6 concludes.

2 Related literature

Early studies on university cost efficiency have predominantly focussed on single departments across universities since these can be assumed to have similar structures (e.g. Dundar and Lewis 1995; Johnes and Johnes 1995; Madden and Savage 1997 or Tomkins and Green 1988). More recent studies have evaluated entire universities because this often makes available panel data sets in the first place (e.g. Izadi et al. 2002 or Flegg et al. 2004). Empirical investigations on university cost efficiency have been conducted particularly for anglo-saxon countries such as the United Kingdom or Australia. In contrast, the efficiency of higher education institutions in Germany has only recently been studied by Warning (2004, 2005) for cross-section data as well as by Kempkes and Pohl (2007) in a panel data context. Since divergent institutional frameworks complicate cross-country comparisons there are only few investigations that have applied efficiency analysis on higher education institutions across countries (e.g. Agasisti and Pérez-Esparrells 2007 or Doucouliagos and Abbott 2007).

Whereas the large majority of existing studies reveal differences in cost efficiency across universities and/or single departments, little is known about the factors that drive these inefficiencies. In this context, the survey on frontier efficiency measurement in higher education by Worthington (2001) shows that early investigations have focussed primarily on the socio-economic background of students and/or parents

since these characteristics have also been shown to be important determinants for educational achiement.[1] More recent studies do not only use characteristics of the enrolled students (proportion of female students, arts students, etc.) but also of university staff (age structure, proportion of professors, etc.). For instance, Stevens (2005) finds that a higher proportion of quality staff corresponds to more efficient universities. In line with this approach, Doucouliagos and Abbott (2007) include the ratio of non-academic to academic staff and the proportion of senior administrative employees as determinants of efficiency. The authors do not only find that a higher proportion of senior administrative staff is associated with higher levels of efficiency but also show the ratio of non-academic to academic staff is positively correlated with efficiency. Overall, these results suggest that (senior) administrative staff is able to disburden academics from time-consuming but unproductive administrative responsibilities.

However, due to endogeneity concerns, these results have to be interpreted with some caution due to endogeneity concerns. For instance, the causality between university cost efficiency and the share of professors in total staff might run both directions. On the one hand, a higher density of full professors might *cause* the university to operate more efficiently, but on the other hand, more efficient universities might simply choose to employ a higher density of full professors. For this reason, we suggest to include only variables that can—a priori—assumed to be strictly exogenous as explained in the hypotheses section.

Regarding institutional settings, Kuo and Ho (2007) investigate the impact of a university funding reform in Taiwan on university efficiency. The introduction of the University Operation Fund (UOF) in 1996 was intended to improve the cost efficiency of the Taiwanese university landscape. Comparing university efficiency before and after the introduction they conclude that the reform had a negative effect on the efficiency of public universities in Taiwan. Based on US state-level data and on evidence from OECD countries, Aghion et al. (2007) and Aghion (2007) suggest that university autonomy is not only associated with better research performance of universities but also with more efficient use of university funds.

Overall, the literature does not provide a clear-cut guidance on which set of explanatory variables should be included as determinants of cost inefficiency in an analysis on higher education institutions. Existing studies were instead driven by data availability for possible

[1] In this context, Ortiz and Dehon (2008) show that the mother's level of education as well as the father's occupation are important factors of success at university.

environmental variables. In particular, it is only recently that some evidence on the link between the efficiency of spending and institutional settings in universities and the governing public body or the corresponding legal frameworks has been presented.

In the next section, we derive hypotheses on the determinants of university efficiency focussing on institutional factors. As institutional variables we consider factors that are related to the management, the staff and student body, and the legal framework under which the university operates.

3 Hypotheses

As argued previously, recent empirical evidence suggests that the autonomy of universities plays a significant role in determining the efficiency of university spending. Budget- and wage-setting autonomy in the German higher education system is rather low. However, the hiring autonomy is considered to be relatively high (Aghion et al. 2007).

Whereas the general institutional framework framework for the German university system is set by the federal government level (''Hochschulrahmengesetz''), higher education remains a core responsibility of the German states. The states define the institutional framework for higher education in more detail, which gives us the opportunity to exploit variation in the regulation of higher education across the German states.[2] State legislation for the universities encompasses a wide variety of aspects such as the allocation of university funds (e.g. the ability of universities to carry over year-end balances, lump-sum vs. line-item budgets), employment of professors (e.g. whether universities can autonomously decide on employment of professors without consulting state ministries), managerial power of the university management (power of decision of the rector/president as opposed to state intervention) and teaching (autonomous establishment of new university career programmes).

In 2000, the ''Stifterverband für die Deutsche Wissenschaft'', an influential think tank for the German university landscape, set up a commission of experts in order to evaluate the state laws for higher education which emerged after 1998. This evaluation has been conducted with an explicit

[2] Specifically, in 1998 the federal government passed the framework legislation's fourth amendment. This amendment leaves the states more room for modifying or cutting university regulation with respect to organization and management of the universities (Stifterverband 2002). In addition, the federal government is currently planning to abolish federal framework legislation in October 2008 (Deutscher Bundestag 2007).

focus on the autonomy of German universities.[3] The Stifterverband (2002, p. 28) concludes with a final classification of state laws, dividing them into three groups: a "best-law" group, a "medium-law" group and a "worst-law" group with respect to self-governance and autonomy of universities, which is reported in Appendix 1.[4] The category "best-law" stands for a relatively autonomous legal framework whereas "worst-law" corresponds to restrictive rules.

Given the evidence presented by Aghion et al. (2007), Aghion (2007) and related evidence from the literature on educational production functions (e.g. Wößmann 2007) and given the variation of university regulation across the German states, we formulate hypothesis 1:

Hypothesis 1: Universities located in states which allow universities more autonomy are more cost efficient than universities operating under a more restrictive regulatory framework.

Furthermore, it would be interesting to test the impact of performance-based funding mechanisms that have been implemented by some German states at the end of our sample period (2003). These mechanisms are often a means of increased budget autonomy for the universities. However, to this day "*in many cases, performance-based funding only determines a marginal part of total budget allocations and discretionary, incremental funding dominates*" (Orr, Jaeger and Schwarzenberger 2007).[5] Thus, assessing these reforms is not very promising since the share of funding which is allocated based on university performance is marginal. Moreover, due to the time span of our data set, we cannot expect to measure any impact of these reforms.[6]

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[3] There are nine main characteristics of the state legislation, i.e. structure of the university, state-university cooperation, budget affairs, labour relations, management, foundation of new universities, teaching (establishment of new degree programmes), teaching evaluation and research. The state laws have been assessed with respect to the degree of autonomy that the universities enjoy in the nine categories presented above.

[4] Most states changed their university frameworks in 1999. Some states lagged behind in the transformation of the legal frameworks for universities; however, Berlin was the only state that had not changed state legislation by 2002. In the empirical investigation, we could therefore not assess the effect of the state law on the three Berlin universities.

[5] See Appendix 2 for a short outline of the mechanisms for allocating university funds in Germany.

[6] Bagues, Labini and Zinovyeva (2008) as well as Kelchtermans and Verboven (2008) investigate reforms in the university funding system in Italy and in Belgium, respectively. The former study finds that an output-based funding system may create an incentive for underperforming universities to increase the number of exams passed and thus, generate less value added in economic terms. The latter article shows that the proposed system in Flanders may overall entail a loss in consumer surplus that exceeds the saving in fixed costs resulting from a reduction in the university's programme diversity.

In Germany within the group of publicly financed universities there are universities which allow earning classical university degrees only whereas at so-called comprehensive universities both, classical university degrees as well as degrees of universities-of-the-applied-science—status may be earned. Note that the quality of the latter degrees is considered to be below the classical university degrees. Comprehensive universities have been established since the beginning of the 1970s. The idea was to have a unified organizational structure for universities and universities of applied science. In addition, the merger of scientific personnel between these two types of institutions was assumed to provide beneficial effects for teaching and research output. Hence, given this framework one may assume that comprehensive universities "produce" more graduates ceteris paribus and thus operate more efficiently than classical universities.

Hypothesis 2: Comprehensive universities are more cost efficient than classical universities.

Almost 20 years after German reunification, universities in Eastern and Western Germany have quite similar structures. However, evidence presented by Warning (2005) as well as Kempkes and Pohl (2007) suggests that universities in Western regions are more efficient than higher education institutions in Eastern Germany. In order to make sure that we are not only exploiting East/West differences with our institutional variables, we include the dummy variable EAST as a control.

Hypothesis 3: Universities in Western Germany are more cost efficient than universities in Eastern Germany.

The empirical literature on the link between demographic structure and public education spending finds for many countries that total education spending is not adjusted proportionately in response to varying sizes of the student cohort. Thus, spending per student rises if cohort size decreases and vice versa. (see e.g. Poterba 1997 for the US, Baum and Seitz 2003 for West Germany or Grob and Wolter 2007 for Switzerland). One of the main reasons for this phenomenon seems to be institutional inflexibility of public administration. Since the large majority of students in German universities are native from the state in which the university is located, one can expect university efficiency to increase (decrease) rather mechanically if the relevant age cohort (aged 18–35) in the respective state increases (decreases). Note that the source for this inefficiency is not rooted in the university but rather in state management of university funds.

Hypothesis 4: Universities can improve cost efficiency in times when demand for higher education in the state increases.

The Bologna process might be considered a further aspect in altering the efficiency performance of German universities. One key element is the introduction of internationally accepted bachelor and master degrees replacing national "Diplom"-degrees, which may be measured by the share of bachelor/master degrees out of total degrees. While some German universities have immediately followed the Bologna declaration other universities lag behind. Thus, efficiency could be improved/deteriorated by adapting to the requirements of the Bologna process; specifically universities adapting faster might boost their efficiency performance given that the Bologna declaration states inter alia that European higher education institutions should become more compatible and comparable in order to promote the exchange of students as well as the employability of citizens in the EU (van der Ploeg and Veugelers 2007). The reluctance of the remaining universities might be interpreted as an aversion to realize reforms, which suggests that these institutions are less efficient. However, it is rather obvious that it is not easy to identify causes and consequences in this case. Fast adapting universities may thereby boost efficiency but it may also be the case that more efficient universities adapt faster to the Bologna requirements. Our hypothesis is therefore restricted to correlation and does not suggest causation.

Hypothesis 5: Universities that rapidly adapted to the Bologna requirements are more efficient than slowly reforming higher education institutions.

Traditionally, German universities were managed by a university rector while younger universities are often operated by a university president. The differences between these two regimes are generally considered to be of minor importance. However, there are some differences, e.g. the minimum incumbency for presidents is four years, while rectors use to stay in office for shorter periods (Kühler 2005; Landfried 2000). Moreover, candidates who run for rectorate usually come from the inhouse-professorate, whereas university presidents may also come from external institutions (Kühler 2005). These differences lead to the common perception that university presidencies have somewhat more decision-making power and may thus lead a more professional university management.

Hypothesis 6: Universities managed by a president are more efficient than universities managed by a rector.

However, state legislation in some cases permits universities to choose between the presidential/rectoral regimes (Kühler 2005). Thus, we cannot

completely rule out that the university regime is chosen contingent on the degree of university efficiency and that the university regime may have to be considered as endogenous.

With regard to the composition of university staff Duncombe, Miner and Ruggiero (1997) derive from public choice theory that tenure of public service employees is negatively associated with efficiency in public service provision. Since in Germany professors at universities have tenure we use the proportion of professors on total scientific staff as a determinant of university efficiency. However, Stevens (2005) finds that a higher share of qualified personnel (proportion of professors) has a positive influence on the efficiency of universities (net of the higher wages higher quality staff usually earns).[7] Hence, there are ambiguous predictions from theoretical and empirical literature with regard to the efficiency in public service provision. Moreover, note that the staff composition of universities may merely be an indicator of efficient universities and that there may be no/little causal effect. Thus, we cannot even provide a clear-cut hypothesis on the *correlation* between the ratio of professors over total scientific staff and university efficiency.

University efficiency might also be influenced by the socio-demographic composition of enrolled students. As pointed out in the literature survey, previous studies investigating the determinants of university efficiency have predominantly focussed on this issue. In particular, Stevens (2005) as well as Doucouliagos and Abbott (2007) use the proportion of foreign students arriving at mixed results. Whereas Stevens (2005) does not find significant effects for British universities, Doucouliagos and Abbott's (2007) estimates suggest that a high proportion of overseas students is positively linked to efficiency performance in Australian universities. Following the literature, we also include the proportion of foreign students in our investigation. In Germany, international students are assumed to enrol in a particular university on purpose whereas native students predominantly study in the state they grew up. A priori, we assume that foreign students study at universities which offer the best education and/or which provide a good organization and thus permit to graduate faster. For this reason, the share of foreign students may be interpreted as a sign of quality and/or of efficiency of the university.[8] Again, causation may run both directions: A positive correlation between the share of foreign students and the

[7] It may also be the case that professors are more/less efficient when they have more assistance from scientific and/or technical staff.

[8] However, there are no data available on the quality of the enrolled students, e.g. grade of high school diploma, at single universities. Higher education institutions in Germany do not require the successful achievement of a standardized test for admission such as the SAT/ACT in the US.

efficiency performance of universities may simply reflect the preference of foreign students to study in an efficient institution and thus may be far from showing a causal effect on university efficiency.

Hypothesis 7: Universities with a high share of foreign students are more efficient than universities with a lower share.

In summary, we derived seven hypotheses on the link between university cost efficiency and several institutional characteristics of universities and/or state regulation. Recall that we restrict hypotheses 4–7 to correlations.

4 Data

We use data on 67 German public universities for the years 1998–2003.[9] Private universities, universities of applied science, universities of the armed forces as well as specialized universities are excluded from our data set. These institutions are either oriented towards business management or medical studies, focus on teaching only or are not open to students without military background. Their inclusion would result in an even more heterogeneous data set. Our data set represents roughly 90 percent of students enrolled in German universities and about 65 percent of students enrolled in tertiary education (including universities of applied science, art colleges, conservatoires and theological universities).

Data on the cost function, i.e. on costs, third-party funds, graduates and on the number of students as well as on staff expenditures, the number of employees and on faculty composition have been provided by the Federal Statistical Office of Germany. Information on institutional variables such as the share of professors out of total scientific staff, the share of Bachelor/Master degrees awarded out of total degrees (without PhDs), the share of university-of-applied-sciences degrees out of total degrees has been provided by the Statistical Office as well. The management structure of universities has been taken from university homepages. Population data has been obtained from the Federal Statistical Office of Germany. Due to data availability problems, a wage variable is approximated by divding total personnel expenditures in a university by the total number of university's staff (as in Stevens 2005). Monetary variables, i.e. costs, third-party funds and wages, have been deflated using the government consumption deflator published by the German Council of Economic Experts (2006). With regard to the self-governance and autonomy of the universities we use a study conducted on behalf of the "Stifterverband für

[9] Unfortunately, in 2004, the definition of medical students has been changed. As a result, student shares in some cases show dramatic increases/decreases. Consequently, 2004 and 2005 data cannot be compared with our sample period.

Table 1 Descriptive statistics

Variable	Mean	Standard deviation	Min	Max
Cost function				
C	14,224	10,449	1,339	103,776
Third-party funds (TPF)	2,283	1,659	95	11,799
Graduates (GRA)	0.093	0.026	0.019	0.185
Wage	35,741	4,167	16,026	55,893
FACULTY				
MEDICINE	0.075	0.092	0	0.51
SCIENCE	0.216	0.088	0	0.48
ENGINEERING	0.137	0.201	0	0.83
SOCIAL	0.573	0.222	0	1
BESTLAW	0.388	0.488	0	1
MEDLAW	0.448	0.498	0	1
WORSTLAW	0.164	0.371	0	1
EAST	0.209	0.407	0	1
COHORT	0.218	0.012	0.19	0.26
APPLIED	0.007	0.030	0	0.24
BOLOGNA	0.015	0.044	0	0.4
PRESIDENT	0.366	0.482	0	1

Notes: Variables that enter the model as natural logs are reported in Euros or numbers respectively. Monetary variables are reported in Euros with base year 2000. Costs (C) are total costs net of third-party funds. Costs, third-party funds and graduates are normalised by the number of students.
Sources: Own calculations based on data from the Federal Statistical Office of Germany and from universities' home pages.

die Deutsche Wissenschaft'' (Stifterverband 2002), which evaluated state university laws.[10] In line with these results we distinguish between three mutually exclusive groups: a ''best-law'' group, a ''medium-law'' group and a ''worst-law'' group. The ranking indicates that universities located in federal states which belong to the best-law-group operate under a relatively liberal legal framework when compared to other German federal states.

Table 1 reports descriptive statistics for our dependent and independent variables. There is considerable variation in the data. One important

[10] The three universities located in Berlin had to be excluded from our investigation since this state's university regulation has not been evaluated by Stifterverband (2002). The reason for this is that Berlin lagged behind in passing the amendment of the legal framework for universities. Thus, no reliable classification of the Berlin university regulation is available.

reason for this is the differing faculty composition of the universities. For instance, the university with the highest costs per student in the sample is the university with the highest share of students enrolled to cost intensive medical/veterinarian and agricultural faculties. On the other hand, the university with the lowest costs per student is a distance learning university.

The average individual wage for a university employee amounts to 35,741 EUR in the years 1998–2003. Note, however, the rather crude wage definition. Around one-third of the higher education institutions in Germany are run by a presidential regime (PRESIDENT). Interestingly, between 1998 and 2003 only 1.5 percent of all graduates in Germany received a bachelor or a master degree although the Bologna declaration was already signed in 1999. One-fifth of all considered universities are located in Eastern Germany (EAST). With respect to university regulation we find that 39 percent of the universities operate under a relatively liberal legal framework (''best-law'' group), whereas 16 percent of all higher education institutions are located in federal states which are considered to have a rather restrictive university regulation (''worst-law'' group).

5 Empirical analysis

For the empirical investigation we follow two approaches. First, we provide a correlation analysis in order to show how the cost and output variables are related to all considered institutional variables. Second, using the single-stage stochastic frontier model proposed by Battese and Coelli (1995) we investigate the effect of institutional settings on university cost efficiency focussing on variables that may be considered exogenous.

5.1 Correlation analysis

The correlation matrix for the costs, output and the institutional variables are provided in Table 2. The share of students enrolled in MEDICINE-, SCIENCE-, ENGINEERING- or SOCIAL SCIENCES-careers are included as controls in the cost function since the university cost structure and endowment depend substantially on the faculty composition. As expected a high share of medical students in a university corresponds to higher costs per students (0.8109). A high share of students in natural science also corresponds to more cost intensive universities (0.4014). In contrast, a high share of social sciences (−0.3920) or engineering students (−0.1140) comes along with lower costs per student.

With regard to the institutional variables we study correlations with the cost and two output variables. As explained in the previous section we distinguish between three groups of state regulation, i.e. ''best-law''

Table 2 Correlation analysis

	Costs	TPF	Graduates
SOCIAL SCIENCE	−0.3920*	−0.7360*	0.0262
MEDICINE	0.8109*	0.3830*	0.1974*
SCIENCE	0.4014*	0.5590*	−0.0137
ENGINEERING	−0.1140*	0.3949*	−0.1144*
BESTLAW	0.0511	0.1837*	0.1990*
MEDLAW	−0.1264*	−0.1114*	−0.2026*
WORSTLAW	0.1024*	−0.0921*	0.0102
EAST	0.1275*	0.0051	−0.3290*
COHORT	0.0857	0.1003*	0.2969*
APPLIED	−0.1604*	−0.1384*	0.1223*
BOLOGNA	0.0166	0.0749	−0.1538*
PROFS	0.3115*	0.1020*	−0.0299
FOREIGN	−0.0173	0.3457*	−0.1739*
PRESIDENT	−0.1495*	−0.1140*	0.1948*

*Denotes significance at the 5% level.

Source: Own calculations.

group, ''medium-law'' group and ''worst-law'' group. Interestingly, universities which operate under a relatively liberal legal framework display a significant, positive correlation with third-party funds and the number of graduates per student. In contrast, for universities located in a state that is classified in the ''worst-law'' group there is a positive and significant correlation with the cost variable. Finally, universities in the ''medium-law group'' show a negative correlation with third-party funds but also with the cost variable. Hence, these correlations suggest one specific property of ''best-law'' universities is the ability to ''produce'' a higher amount of outputs per student with an average amount of inputs (costs) per student.

In addition to the autonomy of universities, we consider the cohort size of individuals aged 18–35 (COHORT) living within the region of the university, the university type (APPLIED) as well as a regional dummy in order to account for differences between Eastern and Western Germany (EAST). The correlation matrix in Table 2 shows that universities in Eastern Germany are more cost-intensive than their counterparts in Western Germany. In addition, universities in the new federal states seem to generate fewer graduates per student than higher education institutions in the West. A large cohort size of individuals aged 18–35 is not associated with lower costs per student but it comes along with a higher number of

graduates per student reflecting that students usually enrol in a university of the state where they obtained their high school diploma. Comprehensive universities (APPLIED) not only display on average lower costs per student but also a positive correlation with respect to the number of graduates per student suggesting that these universities offer shorter career-programmes.

Further, we study the correlations between the presidential regime (PRESIDENT), the adaptation to the Bologna requirements (BOLOGNA), the share of foreign students in the overall number of enrolled students (FOREIGN), the share of professors in the overall staff of the university (PROFS) and the cost/output variables. For the endogeneity concerns discussed earlier, we only included these variables in the correlation analysis. A presidential regime (PRESIDENT) is negatively associated with the cost variable (−0.1495). A possible explanation is the better management capacity discussed in hypothesis 6. However, this correlation might also simply show that less cost-intensive universities choose the presidential regime. With regard to the adaptation to the Bologna process no statistically significant relationship with regard to the cost level and third-party funds is found. However, there is a negative and significant correlation between the BOLOGNA variable and the number of graduates per student (−0.1538). This negative correlation may either show that universities with a low ratio graduates per student have opted first for the introduction of international degrees compared to universities with a higher turnover rate or that the early adaption of the Bologna requirements has induced somewhat slower graduation of students.

Universities with a higher share of professors in the overall staff also display higher costs per students (0.3115). A simple explanation could be that full time professors have an income above the average employee at a university. A higher share of professors is also positively associated with third-party funds. However, as explained in the hypotheses section it is far from evident whether the number of full time professor is the cause for higher expenditures per student or more third-party funds per student. Likewise, more third-party funds might require the employment of more full professors. With respect to the student body we find that a high share of foreign students is only marginally (negatively) correlated with the costs per student (−0.0173). Thus, a high or a low share of foreign students in the overall number of enrolled students is neither associated with increasing nor decreasing costs per student. Interestingly, FOREIGN is significantly correlated to third-party funds per student (0.3457). A possible explanation might be that foreign students prefer research-intensive universities. At the same time, FOREIGN is related to fewer graduates per student. Thus, descriptive analysis can neither reject nor confirm hypothesis 7.

5.2 Econometric analysis

Kumbhakar and Lovell (2000) compare and contrast various econometric models that permit to study the influence of environmental variables on efficiency performance. In the past, two-stage approaches have been quite popular, i.e. efficiency scores obtained from standard SFA settings in the first stage are regressed upon a set of environmental variables in the second stage. However, it is well known that this approach is problematic if explanatory and environmental variables are correlated: Efficiency scores obtained from the first-stage regression will be biased if relevant variables are omitted and only included in the second-stage.[11] Moreover, Wang and Schmidt (2002) report Monte-Carlo evidence that also the second-stage estimates are biased. This result holds even if environmental and explanatory variables are independent.

For these reasons, Wang and Schmidt (2002) strongly advocate single-stage procedures, in which efficiency estimates and the influence of environmental variables on the efficiency scores are estimated simultaneously. They find these approaches also to perform well in finite-sample settings. Such models have been proposed by Kumbhakar, Ghosh and McGuckin (1991), Reifschneider and Stevenson (1991) as well as Huang and Liu (1994) or Battese and Coelli (1995) among others (Kumbhakar and Lovell 2000).[12] We investigate the influence of our institutional variables on university cost efficiency using the single-stage model proposed by Battese and Coelli (1995).

As discussed in more detail in Kraus (2004), for German universities neither the behavioural assumption (cost minimizer or output maximizer) nor the assumption regarding the functional form is undisputed. However, applying the cost function approach has become standard in the empirical evaluation of higher education (e.g. Cohn, Rhine and Santos 1989; de Groot, McMahon and Volkwein 1991; Glass, McKillop and Hyndman 1995 or Izadi et al. 2002). Moreover, the evidence presented by Kempkes and Pohl (2007) suggests that—at least for the German university data—parametric efficiency analysis based on a translog cost function and

[11] Additionally, the two-stage approach postulates inconsistent econometric assumptions. While in the first-stage regression, efficiency scores (one component of the error term!) are assumed to be identically distributed, in the second stage, it is assumed that the environmental variables have a systematic effect on the efficiency scores.

[12] Another popular method to assess the influence of environmental variables on efficiency performance is to regress efficiency predictions from a non-parametric efficiency frontier on environmental variables. However, as Simar and Wilson (2007) point out, conventional confidence intervals of the second-stage regression are biased due to unknown serial correlation in the efficiency estimates. They propose a double-bootstrapping procedure to overcome these problems. The proposed procedure is shown to be related to single-stage econometric approaches (Simar and Wilson 2007, pp. 44–45). See also Daraio and Simar (2007) and Bonaccorsi, Daraio and Simar (2007).

standard non-parametric efficiency analysis lead to broadly similar efficiency predictions.

Based on this evidence, we argue that the translog cost function used in earlier studies is a proper starting point for assessing the influence of institutional factors on German university efficiency. We start from the following cost function:

$$\ln C_{\mathrm{it}} = \alpha + \theta_t t + \sum_{j=1}^{2} \beta_j \ln Q_{jit} + \frac{1}{2}\sum_{j=1}^{2}\sum_{k=1}^{2} \beta_{jk}(\ln Q_{jit} \ln Q_{kit}) + \kappa_1 \ln w_{it} + \kappa_2 \frac{1}{2}(\ln w_{it})^2 + \sum_{j=1}^{2} \kappa_{3j}(\ln w_{it} \ln Q_{jit}) + \sum_{m=1}^{3} \delta_{1m}(\mathrm{FACULTY}_{mit}) + u_{it} + v_{it} \quad (1)$$

The index i denotes the universities and t are the years. While α represents a constant, t is a linear time trend to account for technological change. As cost variable C_{it} we choose university total costs net of the third-party funds the university has acquired, i.e. we take up the perspective of the German state governments by focussing on public costs.[13] Universities produce $j=2$ outputs (Q_{jit}). Acquired third-party funds are used as a proxy for the research output and the number of graduates is incorporated to capture the teaching output.[14] Admittedly, our selection of output variables is mainly driven by data availability. Specifically, research and teaching quality is not accounted for. Moreover, third-party funds are of course only one dimension of the various possible measures of research (e.g. publications, citations, etc.). One consequence of this approach is that research output is biased towards certain types of research, namely towards science and medical research in contrast to social sciences. Another consequence is that research and teaching output are considered to be of homogeneous quality. It is a common perception in the German

[13] Total costs include all current expenditures of the universities, e.g. salaries, administrative expenses, etc. Note that capital expenditures, i.e. construction of buildings, etc., are not included. Moreover, due to a peculiarity of the German public sector accounting system, pension payments for civil servants are not included either. Pension payments for public servants are reported in the general function ''Allgemeine Finanzwirtschaft'', which cannot be traced back to specific public functions.

[14] There is an ongoing debate about using acquired third-party funds as a proxy for research output (see Worthington 2001 for an overview of the discussion). Some researchers have argued that third-party funds are actually inputs to the production process. However, we argue that these funds are basically earned by the universities on a competitive basis and that the amount of third-party funds that a university acquires can be interpreted as market revenue earned on a research market. Thus, third-party funds contain a *quality dimension* (the price that the university is able to charge for research activities) as well as a *quantity dimension* (the amount and size of projects the university can acquire).

university landscape that this is of course a simplification with respect to third-party funds as well as to graduates. For these reasons, our study has to be interpreted with considerable caution.

The cost variable as well as both university outputs are normalized by the number of enrolled students (not graduated). To get a proxy for wages (w), we divide total staff expenditures by the number of employees in the university. Wages, total costs and third-party funds are deflated using the government consumption deflator published by the German Council of Economic Experts (2006). The specification of the translog function requires the inclusion of interaction terms between the two outputs as well as between the outputs and wages in order to account for substitution and complement effects. FACULTY represents shares of students enrolled to different faculty groups ($m = 3$): engineering careers (ENGINEERING), science careers (SCIENCE) and medical, veterinarian plus agrarian careers (MEDICINE). The share of students enrolled to social sciences and languages (SOCIAL) constitutes the base category. Thus, FACULTY controls for the faculty composition of universities because, as described in the previous section, different faculties have quite different cost structures (see also Kempkes and Pohl 2007).[15]

Based on the incremental funding mechanisms that have been used by the state governments in the sample period (see also Appendix 2), one may argue that the true model is not static but rather dynamic. Thus, the lagged cost variable should be included as a regressor. However, since most of the institutional variables are dummy variables or change little over time, the inclusion of the lagged endogenous variable is likely to create endogeneity problems because in this case, the time-invariant error components would be correlated with the lagged cost variable.

The classical error term is denoted by v_{it}, which is i.i.d. $N(0, \sigma_v^2)$ and also independent of u_{it}. The non-negative random variable u_{it} is assumed to display total economic inefficiency in the university production of teaching and research, i.e. technical inefficiency plus allocative inefficiency. This ''inefficiency'' error term u_{it} is assumed to be independently distributed and following a truncated normal distribution: $N(\mu_{it}, \sigma_u^2)$.

[15] Note that Kempkes and Pohl (2007) not only introduced faculty dummy variables but also interaction terms of the faculty dummies with university outputs and wages. This was possible due to the focus on the measurement of university efficiency rather than on the determinants of inefficiency. The present study focusses on the determinants of inefficiency, which calls for a more complex specification of the inefficiency term (see below, Equation 2). However, complex modelling of the cost function *and* the inefficiency term leads to overparameterization of the model, which is not uncommon in the application of stochastic frontier models (Fernández, Osiewalski and Steel 1997, p. 170: ''... it is in the context of stochastic frontiers that the main problem referred to in this paper, namely overparameterization is most frequently encountered'').

The environmental variables Z_{it} are assumed to determine μ_{it} (Battese and Coelli 1995 and Coelli 1996). This setup allows testing our hypotheses concerning the influence of the exogenous institutional variables (Z_{it}) on university efficiency (u_{it}):

$$\mu_{it} = \delta_0 + \delta_1 \text{BESTLAW}_{it} + \delta_2 \text{WORSTLAW}_{it} + \delta_3 \text{EAST}_{it} + \delta_4 \text{APPLIED}_{it} + \delta_5 \text{COHORT}_{it} \quad (2)$$

BESTLAW and WORSTLAW capture whether a university operates under comparatively liberal or restrictive state regulation according to Stifterverband (2002). The variables are dummy variables that take the value of 1 if the university is located in a state with liberal (BESTLAW) or restrictive (WORSTLAW) state university regulation. Note that the classification of medium-ranking state laws represents the reference category. EAST accounts for differences in East/West German universities and takes the value of 1 if a university is located in the Eastern states. APPLIED accounts for the share of graduates who have been awarded degrees of the ''university of applied sciences''—status. Thus, APPLIED is a proxy for the degree of comprehensive university. COHORT measures the share of population aged 18–35 at the state level.

We estimate three different specifications of the inefficiency term by subsequently adding more institutional variables. Since hypothesis 1 may be considered most important, we include BESTLAW and WORSTLAW in all specifications (models 1, 2 and 3). Based on the evidence presented in Kempkes and Pohl (2007), EAST is also included in all models; moreover, it may also be considered a control variable (hypothesis 3). APPLIED is included in models 2 and 3 to test hypothesis 2. COHORT is only included in model 3 (hypothesis 4). Each of these estimations is based on the same cost function as shown in Equation (1).

Finally, Equation (3) reports the share of deviations from the estimated cost function that is due to inefficiencies rather than noise. In Table 3, σ^2 denotes the sum of σ_u^2 and σ_v^2 (see also Coelli 1996).

$$\gamma = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2} \quad (3)$$

In Table 3 we present our empirical results. Estimations have been conducted using FRONTIER 4.1 (Coelli 1996).

The estimation results of the cost function indicate that the coefficients remain quite stable across the three alternative specifications. In particular, all models show that a high ratio of graduates/student is associated with lower public costs per student. Our results also suggest that there are economies of scope between teaching and research. The coefficient of the interaction term between the number of graduates and

Table 3 ML estimates of cost function coefficients and of institutional variable coefficients

	Coefficient (standard error)					
	Model 1		Model 2		Model 3	
Cost function						
Constant	−15.044***	(0.913)	−14.924***	(0.913)	−14.935***	(0.912)
Year	−0.022***	(0.009)	−0.022***	(0.009)	−0.022***	(0.009)
Third-party funds	0.198	(0.943)	0.246	(0.942)	0.236	(0.936)
Graduates	−2.512***	(0.820)	−2.489***	(0.820)	−2.490***	(0.820)
Third-party funds2	0.068	(0.060)	0.070	(0.059)	0.070	(0.059)
Graduates2	−0.361	(0.245)	−0.381	(0.240)	−0.377	(0.239)
TPF*Gra	−0.229***	(0.065)	−0.222***	(0.064)	−0.223***	(0.064)
Wage	7.888***	(0.641)	7.828***	(0.641)	7.832***	(0.641)
Wage2	−1.906***	(0.310)	−1.900***	(0.309)	−1.899***	(0.309)
Wage*TPF	−0.105	(0.257)	−0.117	(0.257)	−0.114	(0.255)
Wage*Gra	0.478*	(0.266)	0.458*	(0.264)	0.461*	(0.263)
MEDICINE	4.163***	(0.282)	4.181***	(0.251)	4.183***	(0.250)
SCIENCES	0.452**	(0.209)	0.447**	(0.208)	0.443**	(0.207)
ENGINEERING	−0.201*	(0.108)	−0.194*	(0.103)	−0.195*	(0.105)
Institutional variables						
Constant	−0.192	(0.162)	−0.214**	(0.108)	−0.276*	(0.153)
BESTLAW	−0.422***	(0.157)	−0.393***	(0.105)	−0.394***	(0.135)
WORSTLAW	0.239***	(0.101)	0.258***	(0.070)	0.256***	(0.071)
EAST	0.322**	(0.140)	0.346***	(0.093)	0.345***	(0.099)
APPLIED	–		−0.845	(1.063)	−0.836	(1.040)
COHORT	–		–		0.300	(0.990)
Sigma2	0.083***	(0.005)	0.082***	(0.005)	0.082***	(0.005)
Gamma	0.068***	(0.004)	0.066***	(0.003)	0.066***	(0.028)
Log(Likelihood)	−9.141		−11.217		−20.166	
Observations	402		402		402	

Note: ***, **, * denote significance at the 1%, 5%, 10% level, respectively.
Source: Own calculations.

the amount of third party funds varies between −0.222 and −0.229 and is significant at the 1 percent level, which is consistent to Kempkes and Pohl (2007). In addition, we find evidence that wages have a positive impact on costs. This result contrasts previous findings presented by Kempkes and Pohl (2007). The reason for this is probably the more restrictive specification of the cost function in this article regarding the wage variable. Here, we control for faculty composition, but we do not control for interaction terms of wages with faculty controls. This different way of modelling the cost function is enforced by econometric concerns

(see footnote 9). With respect to the faculty controls, we find that—as expected—universities with a higher share of medical as well as natural science students (MEDICINE and SCIENCE) operate on a higher cost level than higher education institutions with a high proportion of social science students (SOCIAL, base category). Our results also weakly suggest that universities with a high share of engineering students (ENGINEERING) have lower costs than universities with other foci. Of course, all of these findings are conditional on the absence of a measurement of teaching/research quality.

Focussing on the effect of the institutional variables, we find that indeed a state regulation favouring university autonomy (BESTLAW) has a positive effect on cost efficiency. The estimated coefficient lies between −0.422 and −0.394 and is significant at the 1 percent level in all three specifications. Note that this effect has to be interpreted relative to the reference category, which are the medium-ranking state laws. As expected, a rather restrictive state legal framework (WORSTLAW) seems to decrease university efficiency compared to the medium-ranking state laws. Again, this effect is significant at the 1 percent level in all three specifications and the coefficient is ranging from 0.239 to 0.258. These results are robust over the three models and are also robust to the exclusion of the East dummy variable (not reported here). In this respect, our econometric analysis confirms our findings from the correlation analysis.

The dummy variable for Eastern Germany (EAST) indicates that universities in the new federal states are significantly less efficient than their counterparts in Western Germany (0.322–0.346), which is consistent to previous findings (Warning 2005 as well as Kempkes and Pohl 2007). As expected, the results from models 2 and 3 suggest that comprehensive universities (APPLIED) are more efficient than ''classical'' universities (−0.836 to −0.845); yet the coefficient is not significantly different from zero. The population share aged 18–35 (COHORT) yields a positive coefficient, which is not in accordance with our hypothesis. However, the coefficient is insignificant. This is not surprising since it is a phenomenon of sluggish adjustment that is essentially based on time-series variation. Our estimation results, however, rely mainly on cross-sectional variation due to the structure of the data set and due to the nature of the benchmarking exercise.

Overall, the coefficients of the institutional variables are quite robust across the specifications. This suggests that there might indeed be beneficial effects of more liberal state regulation on university efficiency. In turn, restrictive university regulation seems to translate into less efficient universities. However, our models explain only a somewhat low fraction of the total variance in the error components. All three models

suggest that roughly 7 percent of total variance of the v_{it} and the u_{it} is accounted for by our model of the inefficiency error (see gamma in Table 2) and more than 90 percent of deviations from the cost function are due to stochastic (or not explained) sources. Apart from institutions, other variables (e.g. regional GDP per capita) seem to explain more of the differences in efficiency performance (Kempkes and Pohl 2007). Thus, the effect of state regulation on university efficiency may be somewhat limited in scope; however, one has to bear in mind, that federal deregulation amendment was only passed in 1998. One would expect major impacts of deregulation to unfold with a considerable time lag.

Models 1, 2 and 3 may be compared to a model which includes only a constant term in the inefficiency specification based on their log(likelihood) functions (Berndt 1991). A likelihood-ratio test of the null hypothesis that the coefficients of all institutional variables are zero indicates strong joint significance in all models. Hence, although the institutional variables do not explain much of the deviations from the estimated cost function for German universities, models 1–3 do a much better job than a model without these variables. Moreover, models 1, 2 and 3 may be compared among one another. Likelihood-ratio tests of the null hypotheses that the coefficients of APPLIED and COHORT are indeed zero decide against models 2 and 3 at the 1 percent level of significance. Thus, model 1 is our preferred specifications.

6 Conclusion

Recent empirical studies suggest that spending on higher education in the EU-15 countries including Germany is low compared to the United States or Switzerland (Aghion et al. 2007 and OECD 2006). Since public budgets are tight, the efficient spending of public funds in universities is receiving increasing attention in the economic-political debate. Previous research has predominantly focussed on the identification of inefficiencies in the university landscape instead of analysing the determinants of university efficiency.

Against this background, we tested the effects of institutional settings on university costs, outputs and efficiency based on a data set of 67 German universities for the years 1998–2003. In particular, we focussed on exploiting differences in university regulation across the German states that have emerged after the 1998 amendment of the federal university framework regulation in Germany (''Hochschulrahmengesetz'').

Evidence from a single-stage stochastic frontier model suggests that characteristics of state university regulation have indeed a significant effect on university cost efficiency. More liberal state regulation is significantly

linked to more efficient universities while a restrictive framework is associated with less efficient universities. This result can also be retraced by looking at the correlations of university costs and outputs with state regulation. Moreover, we find that presidential regimes are associated with lower costs, more teaching output, but less third-party funds. This may partly reflect that candidates from external institutions with a relatively long incumbency might have fewer concerns to adapt university structures to the requirements of tight public budgets; however we cannot rule out that more efficient universities simply choose the presidential regime.

This article has of course some important limitations. *First*, for policy relevance, it is of paramount importance to account for the quality of research and teaching outputs, which was—due to data availability—not possible in our investigation. In future studies it would be a good start to incorporate the number of publications and/or citations as indicators for the quality of research as well as graduate wages as a proxy for the quality of teaching. *Second*, the measure of research output has certainly to be broadened in order to account in a more encompassing way for the research in social sciences, which could also be accomplished by incorporating publications or citations as an additional research output. *Third*, in order to allow for a comprehensive evaluation of state legal frameworks in the German university landscape, the time-span of the data set should be increased. Here, changing accounting designs complicate things. *Fourth*, our analysis cannot answer the question by which channels more liberal state regulation translates into higher efficiency. The correlation analysis suggests that it affects both costs and outputs. However, it would be interesting to reveal the micro-channels by which efficiency is increased.

The empirical findings of our study may be relevant for political decision makers and also for the management of public universities, of course keeping in mind all the limitations mentioned supra. In particular, our results suggest that differences in cost efficiency within the German university landscape can be partly explained by—or are at least related to—institutional settings. Institutions are subject to political decisions and thus might be reconsidered in reforming the sector of higher education. Moreover, with regard to the higher education reform in the European Union and the renewed Lisbon Strategy it might not only be promising to assess the effect of institutions on university efficiency on a national level but also in a European context. The much richer cross-country variation in institutions across the European Union represents a good starting point in order to provide better founded empirical evidence which institutional settings benefit a cost efficient university landscape.

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Appendix 1

Classification of state higher education laws as published by the Stifterverband für die Deutsche Wissenschaft

''Best-law-group''	Baden-Wuerttemberg Bremen Hamburg Hesse Lower Saxony
''Intermediate group''	Bavaria Brandenburg Mecklenburg-Vorpomerania North Rhine Westphalia Saxony
''Worst-law-group''	Rhineland-Palatinate Saarland Saxony-Anhalt Schleswig-Holstein Thuringia

Source: Stifterverband für die Deutsche Wissenschaft (2002, p. 28).

Appendix 2

Allocation of university funds in the German states. In Germany, the states (Bundesländer) are responsible for the university system and consequently, there is no uniform allocation mechanism for public university funding. In fact, the allocation mechanisms differ considerably from one state to another. Moreover, when compared to other countries, the allocation mechanisms for higher education in Germany can be characterized as highly complex (Leszczensky and Orr 2004, p. 2). However, one can observe some common patterns and trends over the states: University outputs only determine a marginal part of state grants, e.g. third-party funding determines about 2.5 percent of state grants to universities on average (max. about 7 percent in Baden-Württemberg) while graduates determine about 3 percent of state grants to higher education on average (max. about 8 percent in Brandenburg). PhDs

determine less than 1 percent of state grants to universities on average and publications have only recently been taken into account by one state (Bavaria). In some states, gender equality or the share of foreign students also determine marginal parts of state university funding (Orr, Jaeger and Schwarzenberger 2007, p. 13).

However, the most important determinants of state grants are discretionary incremental components (e.g. previous year's budget adjusted for inflation, etc.) and the number of students who study still within the ''regular study duration''. Regular study duration (''Regelstudienzeit'') denotes a subject-specific limit of semesters for a specific career that is fixed by the university examination regulations.

In the sample period, discretionary incremental components still dominated the allocation of state university funding; however, there is a clear trend towards indicator-based funding mechanisms (often relying on the number of students as the most important indicator), see Leszczensky and Orr (2004) and Orr, Jaeger and Schwarzenberger (2007).

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Regulation of Program Supply in Higher Education: Lessons from a Funding System Reform in Flanders

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Abstract

It has become well documented that the performance gap between European and US universities is at least partly due to lower spending on higher education in Europe. Rather than raising the public budget or promoting private contributions, many governments have attempted to make public spending more efficient in various ways. This article reports the results from a proposed funding system reform in Flanders (Belgium), which aimed to save costs by reducing the diversity and duplication of study programs. We draw the following lessons. While reducing program diversity may save on fixed costs, this is typically insufficient to compensate for consumer surplus losses due to low student mobility. Furthermore, decentralized financial incentives mechanisms may be ineffective since they may often promote program cuts when this is undesirable, and vice versa. These findings illustrate the difficulties with regulatory reforms that mainly aim to reduce costs. Hence, the question how to raise total spending on higher education (whether through public or private means) cannot be avoided. (JEL codes: I20; I23; C25)

Keywords: Higher education, program diversity, student mobility, policy reform.

1 Introduction

There is a growing awareness that European universities are lagging behind and are in need for reform. For example, in a recent policy brief Aghion et al. (2007) find that the performance gap between European and US universities is due to poor governance and incentives, but also due to insufficient investment in higher education. Total public and private spending on higher education amount to only 1.3 percent of GDP in the EU, compared with 3.3 percent in the US. Most European governments have not yet succeeded in promoting a substantial increase in higher education spending. On the one hand, because of tight government budgetary constraints, it is unrealistic to drastically expand public spending on higher education. On the other hand, politicians in many countries still show a reluctance to promote private contributions through tuition fees.

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As an alternative, some governments have attempted to increase the efficiency of the public funding systems. An example is the case of Flanders (Belgium), where the government has recently encouraged mergers and formal collaboration agreements, and attempted to provide incentives to institutions to reduce the large diversity and duplication of study programs. According to the 2005 proposals, institutions would receive public funding based on their achieved concentration index (CI), i.e. the average number of students per program, thereby providing incentives to cut the smaller programs. Furthermore, funding incentives were proposed to offer joint programs between universities. The idea behind these proposals was to provide decentralized incentives to make the higher education system more cost efficient, hence reducing the need to expand the overall public budget. However, while there may indeed be cost savings from increased scale and less duplication of supply, this is only part of the welfare picture. It is also necessary to take into account how students will be affected by changes in the supply of higher education.

This article reports on the findings in Kelchtermans and Verboven (2007) to draw some general lessons on social desirability and the effectiveness of funding system reforms that attempt to reduce program diversity. They develop a model to estimate both the profit and welfare effects of reducing program diversity, including the effects on consumer surplus (students), variable and fixed cost savings. They find that the social desirability of reducing diversity is limited to only 10 percent of the programs, because students show a limited willingness to travel to other institutions. The fixed cost savings from program cuts are thus usually too limited when compared with the consumer surplus losses. Kelchtermans and Verboven also find that a funding system based on the CI may be very ineffective: it frequently creates incentives to cut programs when this would be socially undesirable, and vice versa. This stresses that decentralized mechanisms should be chosen with care if they are to achieve the intended objectives.

More generally, these findings emphasize the complexities in regulating program diversity in publicly financed systems of higher education. Governments need to take into account both the universities' and the students' responses to their policies. In this light, no magical solutions can be expected from policies that aim to reduce costs. So the question how to raise total spending on higher education (whether through public or private means), cannot be avoided.

The remainder of this article is organized as follows. Section 2 discusses the cross-country evidence available from the academic literature on diversity in higher education. It also discusses current program diversity in Flanders in this international context. Section 3 discusses international policies towards program supply and diversity, and then describes the

recent Flemish reform proposals. Section 4 provides an economic framework for analyzing program diversity in higher education, stressing the importance of trading off both the benefits and costs. Section 5 summarizes the profit incentives and welfare effects of the funding system reforms in Flanders aimed at reducing program diversity, based on the methodology and detailed analysis in Kelchtermans and Verboven (2007). Finally, section 6 concludes and draws more general lessons on reform.

2 Previous evidence on diversity

Most of the literature has been preoccupied with defining and measuring diversity in higher education. This has resulted in a number of comparative studies documenting the evolution of diversity in several countries. We first review this literature and then discuss current program diversity in the region of our case study, Flanders (Belgium).

2.1 International context

Dill and Teixeira (2000) distinguish between institutional diversity and program diversity.[1] Institutional diversity refers to diversity among institutions in size (number of students), in mission, in type of control (public vs. private) and in location. Program diversity refers to diversity in subject, in degree level (bachelor vs. master), in orientation (academic vs. vocational) and in forms of program delivery (e.g. full-time, part-time, distant learning). According to Dill and Teixeira (2000), the term diversity often refers to institutional diversity in the US and to program diversity in Europe.

An influential early study on the evolution of diversity in the US is Birnbaum (1983). His composite indicator includes the institution's size, institutional control (public or private), enrollment of females and minorities, program types and degree levels. He therefore considers elements of both institutional and program diversity.

Several other studies focus exclusively on program diversity. For example, Ben-David (1972) looks at the number of new programs created in the US and Germany between 1900 and 1930. He finds that both countries started of with a similar number of programs but the US has a much higher number in 1930 because of the stronger competition between universities in the US. Huisman and Jenniskens (1994) compared the evolution of study programs and their locations in Denmark, Germany and the Netherlands; Jenniskens (1997) considers the evolution of new

[1] The literature review in this section draws extensively on Dill and Teixeira (2000).

programs in the Netherlands, France, England and Pennsylvania. Huisman and Morphew (1998) study the evolution of program diversity in the Netherlands and various US states, using the ratio of duplicate programs to the total number of programs. Their findings suggest that program diversity is low because institutions tend to copy the programs of leading institutions.

More recent and complete cross-national evidence is provided by Huisman, Meek and Wood (2007). Following Birnbaum (1983) and several others, they define diversity based on the following variables: the institution's size, institutional control, range of disciplines offered, degrees awarded and modes of study. They find that the group of countries with most diversity in higher education consists of the United Kingdom, Flanders and the Netherlands. Finland, Germany and Austria belong to the second group. The group with the lowest diversity consists of Sweden, France, Denmark and Australia. Overall, the authors conclude that even the countries in the third group show a large degree of diversity, so that there is currently no need to encourage diversity further, except perhaps in some specific areas. The authors also performed a longitudinal analysis for Australia and the Netherlands and caution that some recent mergers may entail the risk of being counterproductive in reducing diversity.

To summarize, there is quite an extensive descriptive literature documenting diversity in higher education. This literature is mainly motivated by a concern whether diversity is sufficiently high. This is in stark contrast with Flanders where policy makers' concern is the opposite: they consider the high diversity of the Flemish system[2] as an indication that there may be excess diversity, as discussed in more detail in section 3.2.

2.2 Program diversity in Flanders

Table 1 describes the diversity of first-year undergraduate higher education in Flanders in 2001. There are two types of institutions: colleges (''hogescholen'') and universities. There are 44 college campuses and 9 university campuses. Given the small size of Flanders this amounts to a high density of one campus per 250 km^2.

The colleges offer a total of 414 vocational programs, and the universities a total number of 148 academic programs. There is considerable duplication of program supply since most fields and programs are broadly available at multiple campuses across the region. This is particularly true for vocational fields such as engineering, economics and business, education science, and medicine, all offered at

[2] This is considered common wisdom but is also supported by studies such as Huisman, Meek and Wood (2007).

Table 1 Diversity of higher education in Flanders (2001)

	Number of campuses	Number of study programs	Number of students	Students/ study program
		Colleges (vocational programs)		
Total	44	414	25,182	61
By study field				
Architecture	9	11	912	83
Engineering	25	76	4,425	58
Science	n/a	n/a	n/a	n/a
Economics and Business	22	105	7,853	75
Education Science	26	67	6,065	91
Other Social Sciences	13	15	1,572	105
Medicine and Paramedics	23	54	1,904	35
Bio-engineering	15	26	644	25
Languages	5	5	738	148
Cultural Studies	10	55	1,069	19
		Universities (academic programs)		
Total	9	148	12,299	83
By study field				
Architecture	3	3	198	66
Engineering	3	3	834	278
Science	7	33	1,169	35
Economics and Business	7	12	1,700	142
Education Science	3	6	711	119
Other Social Sciences	6	19	3,701	195
Medicine and Paramedics	6	19	933	49
Bio-engineering	6	13	1,177	91
Languages	6	17	842	50
Cultural Studies	6	23	1,034	45

Own calculations based on a dataset from the Flemish Ministry of Education. The first column counts the number of campuses offering at least one study program of a given study field. The second to fourth column show averages over all study programs of a given study field.

more than 20 campuses throughout Flanders. The average scale per program is correspondingly low, usually less than 100 incoming students per program at colleges and between 50 and 200 per program at universities.

A key question is whether this level of program diversity is too low or too high. The recent policy reforms aiming to cut diversity (to be discussed subsequently) suggest the level of diversity is too high. From an economic perspective, however, the answer is not clear. It depends on various

factors, including student preferences (mobility), and the variable and fixed costs of providing program diversity.

3 Funding policies towards diversity

Governments in different countries have followed a wide range of different policies towards higher education. Jongbloed and Koelman (2000) classify the higher education funding systems according to two dimensions (Figure 1). The first dimension (horizontal axis) describes to what extent funding is allocated based on output or input criteria (outcoming vs. incoming students). The second dimension (vertical axis) describes the extent of direct government control over the funding arrangements. This dimension is most relevant for our purposes. It ranges from heavily centralized, regulated systems to decentralized, market-driven systems. At the one extreme, we find public funding systems of bilateral negotiated funding (strong central control) while at the other end of the spectrum we find market-oriented approaches such as voucher systems. In reality, funding systems will combine different funding instruments and it is not straightforward to unambiguously classify them as centralized or decentralized. Generally speaking there has been a common trend towards more decentralization, with more autonomy for institutions. This partly follows from the fact that higher education has turned into a mass market,

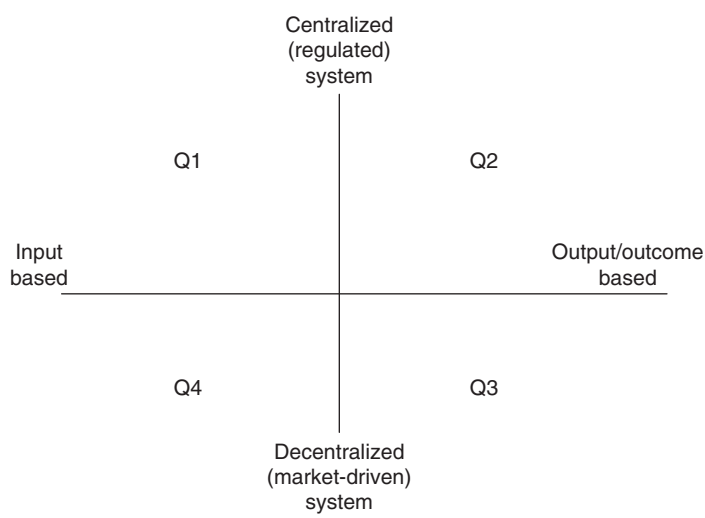

Figure 1 Classification of public funding regimes (Jongbloed and Koelman 2000)

making the funding problem too complex for a central planner (Barr 2004).

Our interest here is in one specific and important aspect of government control over funding arrangements: the regulation of program supply and diversity. We first discuss differences in policies towards program regulation in several countries, and then describe the policy and recent reforms in Flanders.

3.1 International context

Governments typically intervene in public systems of higher education by providing subsidies to universities and regulating tuition fees. At the same time, governments intervene by regulating program supply, since otherwise institutions would have distorted incentives for the sake of obtaining the subsidies.

The regulation of program supply is therefore a crucial aspect of government policy intervention, but there has been fairly little comparative research on the different approaches followed in different countries. To our knowledge, Huisman, Beerkens and Goedgebuure (2003) provide the only detailed cross-country comparison. To put the regulation of program supply in the Netherlands in perspective, they consider the situation in several other systems: Australia, Denmark, Finland, Flanders and Scotland. They look at the regulations on how to set up new programs and at the quality control of existing programs. They summarize their findings by classifying the countries according to the extent of government control (the vertical dimension of Jongbloed and Koelman's framework, Figure 1). They come up with three different groups of countries.

- Flanders and the Netherlands are characterized by strong government involvement in program supply decisions. Educational authorities put forward a number of quality requirements before an institution is allowed to offer a new program. In addition, the Flemish government applies "macro-efficiency criteria" such as the societal relevance of the program, the relation with existing supply and the potential demand for the program.
- In Denmark and Finland, the extent of government control is more limited. For example, in Finland, the establishment of a new program requires the approval from the Ministry of Education, but the universities have the freedom to decide on its content. Government control is rather performance-based, by means of a contract with the institution specifying targets such as the number of graduates.
- In Scotland and Australia, the government hardly interferes in program supply, and only indirectly so. The higher education institutions are

themselves responsible for their supply decisions. Instead of judging requests of institutions to set up new programs, a maximum number of fundable student places per study field is set, which acts as an incentive for the institutions to organize their supply in an efficient way.

Note that the Flemish system is the only one using macro-efficiency criteria in its supply regulation policy. Although this seems a sensible thing to do, our analysis will show that a formal welfare analysis allows a more precise answer to program diversity questions than the currently used criteria of efficiency and transparency.

In sum, this brief review shows that government control over program supply and diversity shows a lot of variation across countries. Flanders is one of the heavily regulated countries during the time of Huisman et al. study in 2003. We now turn in more detail to the case of Flanders, in particular its recent funding system reform proposals.

3.2 The recent funding system reform in Flanders

The Flemish government intervenes by regulating tuition fees, currently uniform at €425 for colleges and €445 for universities, and subsidizing the higher education institutions. The subsidies consist of a fixed component (independent of the number of students) and a variable component, a constant amount per student (specific per program field).

At the same time, the Flemish government intervenes heavily in the quality and diversity of program supply. The quality is controlled through a system of self-assessments and external visiting committees. The diversity is regulated since institutions are not automatically eligible to offer all possible study programs. In practice, however, the institutions form a continuous pressure to be entitled to supply additional programs and attract additional subsidies through the enrolled students. As discussed in section 2.2, this has resulted in large program diversity, relative to other countries, with 562 programs offered across 53 institutions in the academic year 2001–02 (Table 1).

The 2005 reform proposals aimed to make the funding system more efficient. The constant subsidy per student has been made in line with recent and more accurate estimates of the variable cost per student, as obtained by Deen et al. (2005) for various programs and fields. The subsidies per student tend to be lower for colleges than for universities, and lower for humanities and social sciences than for medical and exact sciences.

The more crucial 2005 part of the reform proposals, and the focus of our analysis, consisted of a series of financial incentives to induce institutions to limit the number of institutions and programs. These decentralized

incentives served as an alternative to the former approach which had unsuccessfully attempted to limit product diversity through direct government control.[3,4] There were three main measures to cut program diversity. First, institutions were required to reach a minimum size to be eligible for funding. Second, there were financial bonuses through phase-out funding for programs that an institution decided to cut; institutions could also earn additional funding by jointly offering study programs. The third incentive proposed to reduce product diversity was the replacement of the fixed funding component by a variable scheme based on the institutions' achieved CI.

The CI of an institution k, C_k, is the average number of students per offered study program:

$$C_k = \frac{Q_k}{J_k}$$

where Q_k is the total number of students and J_k is the total number of study programs at institution k. An institution would then receive a subsidy amount r per unit of the achieved CI.[5] We will refer to this system as the CI funding system. It provides an incentive to reduce the number of programs J_k, though at the risk that the number of students Q_k also goes down. We come back to the effect of the CI in more detail in section 4.4.

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[3] During a previous legislation (i.e. prior to the 2005 reforms discussed here), the Minister of Education commissioned former KU Leuven rector Dillemans to work out a plan to optimize higher education supply, which was proposed in 1997. These efforts were not very successful, in part because the government used 'soft' instruments such as consultation with the higher education sector. The next Minister of Education (1999) relieved Dillemans of his tasks and shortly after that the policy debate became dominated by the introduction of the Bachelor-Master structure and overshadowed the plans for the one-shot optimization envisaged in Dillemans' plan. The latest government (2004) showed attention again to optimize supply diversity, in the context of the funding system reforms we are discussing here.

[4] Next to these incentives aimed at optimizing supply, the funding system reform stepped away from pure input-financing and now includes students' success (in terms of acquired credits) as a criterion of funding. In terms of the funding system classification presented in Figure 1, the reforms therefore represent a move towards not only increased decentralization but also more output-orientation. It is generally recognized that the use of an output-based funding policy may raise concerns of deteriorating educational quality if not accompanied by quality assurance mechanisms. A nice example is provided in the paper by Bagües, Sylos Labini and Zinovyeva (2007) who analyze the impact of the adoption of such a policy in Italy on universities' grading standards.

[5] In practice, the index is slightly more complicated (Vandenbroucke 2005). It is normalized by the average index over all institutions. Further, this normalized CI is constrained within bounds of 0.5 and 1.5. We account for this in our empirical analysis, but not in our discussion since it complicates the exposition and it only matters for a minority of the institutions. The lower bound is obtained for 5 and the upper bound for 4 out of the 53 institutions.

Although the CI still relies on student counts, the use of formula-based funding rather than negotiated funding clearly represents a decrease in direct government control.

In the remainder of the article we will address the following questions regarding the Flemish higher education system:

(1) Is reducing current program diversity socially desirable?
(2) Does the decentralized CI funding system provide incentives to reduce diversity whenever this is socially desirable?

In essence, the second question asks whether an all-in-all modest adaptation of the funding regime is able to create the right incentives and improve efficiency without relinquishing public control of the higher education system. We note, however, that the 2005 proposed CI funding system was not actually incorporated in the 2007 reforms for practical reasons.[6] Nevertheless, our analysis of the proposed reforms remains of general interest, since it will emphasize the key importance of properly accounting for students' demand responses. It is therefore also relevant for other financial incentive schemes designed to reduce product diversity (such as the financial bonuses to eliminate or merge study options).

4 Economic framework

Despite the policy importance, there has been only limited literature on the benefits of diversity in higher education, and even less on the associated costs. The empirical literature documenting diversity as reviewed in section 2.1 tends to start from an implicit presumption that more diversity is always better. To evaluate diversity, there is clearly a need for a transparent economic framework that clarifies the potential objectives of policy makers, and considers both the benefits and the costs. This section provides such a framework, and applies it in the next section borrowing from the more elaborate analysis in Kelchtermans and Verboven (2007).

We first discuss the effects of diversity on participation, and subsequently the effects on total welfare (which trades off the monetary benefits and costs). We next ask whether the existing market structure is likely to provide too much or too little diversity from a total welfare perspective, and finally consider the effects of the funding system reform in Flanders regarding diversity.

[6] For example, it was argued by universities that it is common to pool students and share them across study programs so that critical mass is achieved whilst the CI is not able to capture such initiatives.

4.1 Participation

To our knowledge, the only available literature on the economic effects of diversity in higher education relates to the effects on participation. Trow (1972) was an important early author on this issue. He argued that greater diversity was essential for the growth to massification in higher education. As discussed by Huisman, Kaiser and Vossensteyn (2000), this hypothesis is based on the presumption that increased diversity implies more choice and therefore increased the chances to participate. They test this hypothesis based on a cross-section of nine European countries. They construct measures of participation and diversity for each country, and measures for other variables that may affect participation (financial incentives and selection). They find no support for Trow's hypothesis: there is no positive relationship between high diversity and participation. If anything, the relation is negative. For example, France shows a low diversity yet a high participation rate, whereas the United Kingdom and Flanders have a high diversity and a relatively low participation rate.

This conclusion is consistent with our own research for Flanders (Kelchtermans and Verboven 2006). We estimated a logit model of educational choice at the level of potential new students deciding whether to pursue higher education. We found that the travel costs and program availability did not significantly affect the decision whether to participate, but only the decision at which institution to study and which program to take.

Combining these findings, we will henceforth assume that modest variations in program diversity have no significant effects on participation in higher education. This is not to say that large changes in program diversity would not have significant effects, which is perhaps what Trow originally suggested.

4.2 Total welfare

Economic theory has long been interested in the question whether alternative market structures, such as monopoly or free entry, can generate the socially optimal level of product diversity.[7] To address this question, it is necessary to first define total welfare. Total welfare in the market of higher education is approximately equal to:

- *gross consumer surplus*, i.e. the students' total willingness to pay;
- minus *total variable costs* of providing higher education;
- minus *total fixed costs*.

[7] For the large economic literature on optimal product diversity and comparisons with free entry or monopoly, see for example Spence (1976), Dixit and Stiglitz (1977) and Mankiw and Whinston (1986).

Note that this definition of total welfare entails some simplifications. First, this welfare definition abstracts from income effects and distributional considerations. In reality, a social planner may want to put a higher weight on low income groups to obtain a fair distribution. Second, the government pays subsidies to the institutions. The welfare definition does not include these since they merely transfers. However, there may be social costs of public funds (e.g. because of distortionary taxes required to finance the subsidies). In this case, a fraction of the paid subsidies would have to be subtracted from the welfare definition. Third, the gross consumer surplus refers to the students' private benefits from higher education and the welfare definition assumes that these coincide with the social benefits. In reality, the social gains from higher education may exceed the private gains if there are spillovers, i.e. students' education may cause positive benefits to society which the students do not take into account. The evidence on the presence of positive spillovers is however mixed, so we do not take this into account.

Consider now the effects on each of the three components of total welfare when a hypothetical social planner with perfect information would eliminate one product, i.e. one program at one institution.

First, such a program cut generally results in a reduced surplus to consumers, i.e. the students. They face less choice so that some students have to substitute to their next best alternative. This effect will especially be strong if students do not find good substitution possibilities for the dropped study program. In higher education substitution may occur in two directions: students may substitute to another program at the same institution or they may decide to pursue the same program but at another institution.[8] Hence, a program cut at a certain institution is bad for students if they have a strong preference for this particular program, or if they have high mobility costs so that they are not willing to travel to other campuses.

Second, eliminating a program will involve a fixed cost saving because the product no longer needs to be supplied. This fixed cost saving may for example include a reduction in the required classroom space, or a reduced teaching staff (to the extent this is independent of the number of students). The fixed cost savings may be limited if there are important economies of scope, i.e. economies from offering two or more programs at the same institution. For example, different study programs may share some of the courses, in which case classrooms and teaching staff remain needed when only one program is dropped.

[8] Students may also respond by no longer participating, but as discussed in section 4.1, it is reasonable to assume this effect is very small.

Third, a program cut may result in variable cost savings if students decide to substitute to other programs that have lower variable costs. For example, closing down a medical program at a university may induce some students to substitute to a social sciences program with lower variable costs. Of course, the converse is also possible, i.e. there may be variable cost losses if students substitute to higher variable cost programs after a program cut. For example, closing down a relatively inexpensive vocational engineering program at a college may result in substitution towards a more expansive academic engineering program at a university. A program cut may therefore result in a reallocation of students to more or less expensive programs, so that the variable cost savings may be either positive or negative.

The effects of eliminating a program on total welfare are thus not clear a priori. It will be positive if the savings in fixed costs and variable costs (if any) outweigh the losses to students from the reduced product diversity. There is almost no empirical evidence that has attempted to estimate the students' willingness to pay for program diversity. The evidence on fixed and variable costs associated with program diversity is also limited, but there is at least some indirect evidence suggesting that scale economies are important. Cohn, Rhine and Santos (1989) and Koshal and Koshal (1999) find evidence of economies of scale and scope for US universities.[9] These findings suggest that higher education institutions can reduce their average costs by growing in size. This indirectly supports the view that reducing program diversity within an institution may raise the size of the remaining programs, and therefore imply average cost savings.

4.3 Too much or too little diversity?

A key question is whether the current market structure provides the correct incentives to higher education institutions to invest in program diversity. The issues are complex, but economic theory suggests that a monopolist tends to invest in too little product diversity from a total welfare perspective, whereas a market with free entry tends to generate too much diversity. The divergence from the welfare optimum stems from the fact that both a monopolist and an individual entrant do not have the same objective function as a social planner, implying both positive and negative externalities.

To understand the institutions' incentives to invest in program diversity, first assume that each institution behaves as a local monopolist. This means that dropping or adding programs does not result in students

[9] At the secondary school level, Riew (1966, using US data) and Smet and Nonneman (1998, using Flemish data) find evidence of scale economies.

substituting to other universities or colleges. This assumption would be realistic to the extent that students have high mobility costs, i.e. a low willingness to travel to other institutions when a program is cut. Such a monopolist typically has an incentive to invest in too little product diversity. The economic intuition is that a monopolist correctly takes into account fixed cost and variable cost savings, but does not correctly take into account consumers' total willingness to pay. Put differently, it cannot appropriate all consumers' surplus, because it charges a uniform (and actually low) tuition fee regardless of each student's actual willingness to pay. In sum, because a monopolist institution cannot extract all consumer surpluses, an essential component of total welfare, it tends to have a too low incentive to invest in product diversity.

In practice, however, the higher education institutions are not local monopolists. Students can decide not to go to the nearest institution if they find that more distant campuses offer more interesting study programs. As a result, universities and colleges may attempt to compete and steal business from other institutions by introducing additional study programs. This may ultimately lead to too much product diversity, because the business stealing effect implies only a transfer of subsidies from one institution to the other and may not mean a real contribution to total welfare.

The overall conclusion is that universities and colleges may have too little or too much incentives to invest in product diversity depending on whether the non-appropriability of consumer surplus effect or the business stealing effect dominates. The business stealing effect would dominate if student mobility costs are low so that they can easily substitute to other institutions in response to changes in program diversity.

4.4 Impact of the funding system reform in Flanders

Because institutions do not necessarily have the correct incentives to provide program diversity, there is room for government intervention. In section 3.1 we discussed how governments in many countries intervene by controlling quality and deciding on new programs, either through direct control or in a decentralized way through a maximum number of fundable students. Flanders had a tradition of strong direct intervention, but with its new proposed CI funding system, discussed in section 3.2, it aimed to provide decentralized incentives to reduce diversity. We are interested to know (i) whether reducing diversity is actually desirable from a welfare perspective and (ii) whether the decentralized CI funding system provides the right incentives to do so.

To understand the incentives created by the CI funding system, consider the effects of a program cut on the institutions' profits. Suppose first for simplicity that a program cut leads to a complete loss of students, i.e. all

students from the cut program either drop out or substitute to another institution. In this case, dropping a program raises the institution's CI if and only if the program has a below-average size, i.e. the number of students in the concerned program is below the CI. Hence, the CI funding system would provide an extra incentive to drop the programs that are smaller than average. In practice, however, an institution does not loose all students of the dropped program. Some of the students may decide to go to another program within the same institution. The extent to which this happens is measured by the *diversion ratio*. The ratio is the fraction of students that goes to another program within the same institution after the institution drops a program. The diversion ratio is between zero and one. If the diversion ratio is high, the incentive to cut a program will also be high: the CI funding system may then even provide an incentive to drop programs with an above-average student size. In the extreme case where a program has a diversion ratio equal to 1, the institution does not loose any students after cutting the program, so it would even want to drop very large programs under the CI funding system.

The general conclusion is that the CI funding system provides an extra incentive to cut the smaller programs, especially if these have good substitution possibilities within the same institution. It is not however clear whether the correct financial incentives to cut programs are given in precisely those cases where this is socially desirable.

Table 2 compares the profit incentives of the CI funding system with the welfare effects and shows that there are four possibilities:

- Under "desirable status quo", it is socially desirable not to cut product diversity and the CI funding system does not provide the incentives either.
- Under "undesirable status quo", it would be better to cut product diversity, but the CI funding system does not provide the necessary incentives (because the program is large or has little substitution possibilities).
- Under "undesirable reform", the CI funding system provides incentives to cut the program whereas this is not socially desirable.

Table 2 Possible profit incentives and welfare effects of unilateral program cuts

	Welfare effect	
Profit incentive	$\Delta W < 0$	$\Delta W > 0$
$\Delta \prod < 0$	Desirable status quo	Undesirable status quo
$\Delta \prod > 0$	Undesirable reform	Desirable reform

- Finally, ''desirable reform'' means that it is good to cut product diversity and the CI funding system provides the proper incentives to do so.

5 Empirical findings

We now report on the findings of the empirical and simulation analysis by Kelchtermans and Verboven (2007). We first briefly sketch the essential aspects of the approach, and then discuss the effects of reducing diversity on demand, and on the institutions' profits and total welfare. We focus mainly on the economic intuition without a detailed analysis of methodology and results.

5.1 Methodology

We look at the effects of reducing program diversity by considering all possible unilateral program cuts, i.e. cutting each of the 562 programs. We first simulate the demand effects from these unilateral program cuts, i.e. how students substitute to other programs. We subsequently compute the profit incentives and the various welfare effects from the unilateral program cuts.

To compute these effects we first estimated a logit model of educational choice. We had access to a rich data set from the Flemish Ministry of Education on 37,481 students, which choose one out of 562 possible alternatives (programs at different institutions). The data (summarized in Table 3) include the students' actual choices, the student characteristics (sex, nationality, years of repetition in high school, high school program, high school religious affiliation, etc.), the institution characteristics (college vs. university, religious affiliation, etc.) and program characteristics (study fields). In addition, there is information on the students' and institutions' locations, enabling to compute travel distances and travel times for every student to every possible institution.

Estimation of the logit model enables us to compute the substitution effects from the hypothetical unilateral program cuts.[10] Furthermore, the

[10] We assume students continue to participate. As discussed in section 4.1 this assumption is based on Kelchtermans and Verboven's (2006) finding that mobility costs only have a very small effect on the participation decision (though a large effect on where and what to study). We also assume that educational quality remains constant. Given the nature of our simulations, i.e. unilateral program cuts, we consider this a reasonable assumption. Conversely, multilateral program cuts resulting in a substantially increased scale of higher education institutions may raise concerns of reduced competition. Jacobs and van der Ploeg (2005) argue this may be the case in The Netherlands where the massive increases in scale in the past 20 years have been accompanied by a dramatic increase in overhead costs and a corresponding fall in real resources per student available for teaching and research.

Table 3 Summary statistics of 2001 eligible pupils

	All students	College	University
Demographic			
Male	0.45	0.45	0.45
Foreign	0.01	0.01	0.01
Catholic high school	0.78	0.79	0.76
Ability			
Years of repetition	0.36	0.46	0.16
	(0.95)	(0.99)	(0.83)
General high school	0.60	0.44	0.94
Classical languages	0.14	0.05	0.33
Modern languages	0.24	0.22	0.27
Economics	0.19	0.19	0.17
Sciences	0.20	0.11	0.40
Mathematics	0.30	0.15	0.60
Technical high school	0.33	0.47	0.04
'Product'-focused	0.12	0.17	0.02
Mobility			
Distance (kms) by road to campus	34.71	30.96	42.38
	(28.17)	(25.65)	(31.37)
Time (mins) by road to campus	30.74	28.33	35.67
	(17.33)	(16.2)	(18.47)
Travel cost to campus ($\times$10,000€)	0.38	0.35	0.46
	(0.28)	(0.25)	(0.31)
Number of observations	37,481	25,182	12,299

Standard errors for the continuous variables are in parentheses. Demographic and ability data are based on the dataset from the Flemish Ministry of Education; mobility statistics are based on own calculations using postal code information.

logit model enables us to compute the effect on the first welfare component: gross consumer surplus or students' total willingness to pay for the various programs.[11] To compute the effect of the program cuts on the other two welfare components, variable and fixed costs, requires additional cost information. As a proxy for variable cost, we use the government's estimates that they also used to determine the cost-based variable subsidies per student (see section 3.2). We do not have a fixed cost measure per program for each institution. However, we were able to impose reasonable upper bounds on these costs, based on the economic assumption that institutions would not offer programs if they are

[11] Estimating total willingness to pay is possible because we include travel costs in our model, and convert this in a monetary measure.

unprofitable. This enabled us to obtain unambiguous conclusions about profit and welfare effects for the majority of the 562 considered unilateral program cuts.

Based on this methodology we are then able to determine the demand, profit and welfare effects of reducing program diversity through unilateral program cuts. This enables us to shed light on whether the funding reform based on the CI was socially desirable and effective.

5.2 Demand effects of reducing diversity

Before looking at the demand effects of reducing program diversity, we review some of the empirical findings from estimating the logit model on our data set. The key finding is the ambiguous role of travel costs. Students tend to be quite mobile with respect to their decision whether to participate. Students living relatively far from any campus are not deterred from entering higher education. Stated differently, total demand for higher education is very inelastic with respect to travel costs.

However, students are very immobile with respect to their decision where and what to study. They often tend to choose the most nearby institution, regardless of the programs offered at that institution. This student immobility may be due to two broad reasons. First, students may perceive programs from different universities as close substitutes so that it is not worthwhile to travel further (as emphasized by Kelchtermans and Verboven (2006) based on their nested logit model results). The perceived substitutability partly follows from the large duplication of program supply (the same program being offered at multiple campuses). It may also follow from the fact that we only considered first-year undergraduate education programs, where there is naturally more homogeneity across institutions and reputational differs are less important. See also Aghion et al. (2007) who point at the limited reputation-based competition in most European systems of higher education.[12] Second, it is possible that students are intrinsically immobile, i.e. have high monetary or non-monetary travel costs. Monetary travel costs may be particularly high for our sample of undergraduate students, or because of socio-economic characteristics (as proxied by secondary school variables). Regarding non-monetary travel costs, students in Flanders may have comparatively strong ties with their social networks at home. Because the Flemish higher

[12] It is sometimes argued that student mobility is larger in a country such as the US. However, this belief appears to be based on the casual observation that students travel long distance to top universities. For lower ranked universities and colleges mobility also tends to be lower, see in particular Long (2004) for an empirical analysis of the role of distance in educational choices in the US.

education area is small, students typically tend to maintain active relations with family and friends at their home location and this may induce them to choose their higher education institution while anticipating frequent weekend trips back home. This may contrast with larger countries where students know that due to large distances any schooling decision rules out frequent home visits and accordingly attach lesser importance to distance, implying higher student mobility. In sum, the observed student immobility is a relative phenomenon: it may be either due to close substitutability of programs or due to intrinsic student travel costs.

To gain further intuition on how students value current program diversity, one may use the logit model estimates to calculate the students' willingness to pay for certain study option characteristics.[13] For example, pupils who previously attended a catholic high school have an additional willingness to pay of €2,500 for attending a catholic higher education institution. Similarly, pupils who took a strong high school education (the "general" type, with classical languages) are willing to pay an additional €3,035 to attend an academic program at university instead of a short vocational program at a college (compared to pupils who took a "professional" type high school education). As a final example, pupils without repetitions during high school are willing to pay an additional €1,534 to attend an academic engineering program instead of a short vocational college program (compared to pupils who had to repeat one year in high school).

These examples indicate that removing a study program may imply big consumer surplus losses. This does not say much however about the likely substitution effects of a program cut. This will depend on the availability of close substitutes at the given campus, and on the availability of duplicate programs at other campuses (as described in Table 1).

To summarize the demand effects of reducing program diversity, the concept of the diversion ratio is very informative. Table 4 presents two kinds of diversion ratios. Diversion ratio 1 is the fraction of students that goes to another institution to attend the same field of study. Diversion ratio 2 is the measure introduced in section 4.4, i.e. the fraction of students substituting to another program within the same institution after a program cut. Both measures are of interest and capture the two dimensions of student choice. The first says how close substitutes other institutions are for taking the same program. The second says how close substitutes other programs are within the same institution. We report the

[13] This is done by dividing the estimated valuation parameters of the study option characteristics by the travel cost parameter (expressed in Euro). We refer to Kelchtermans and Verboven (2006) for details.

Table 4 Diversion ratios resulting from unilateral study field cuts

Study field	Colleges		Universities	
	Diversion ratio 1	Diversion ratio 2	Diversion ratio 1	Diversion ratio 2
Architecture	0.04	0.11	0.03	0.36
Engineering	0.39	0.11	0.22	0.31
Science	n/a	n/a	0.07	0.22
Business and Economics	0.30	0.15	0.27	0.19
Education	0.22	0.15	0.10	0.30
Society	0.16	0.17	0.15	0.18
Medicine and Paramedicine	0.08	0.18	0.08	0.27
Bio-engineering	0.06	0.18	0.08	0.27
Languages	0.12	0.08	0.14	0.23
Cultural studies	0.16	0.11	0.08	0.20
Total	0.21	0.14	0.13	0.24

The diversion ratios are computed for a unilateral cut of a study field by a single institution, based on the parameter estimates of the logit model. The results reported here are averages across institutions within a given field.
Diversion ratio 1 = average percentage of students choosing the same study field at another institution.
Diversion ratio 2 = average percentage of students choosing the same institution but another study field.

diversion ratios from unilateral *field* cuts per institution, instead of unilateral *program* cuts reports.[14]

Table 4 shows that college students are on average more loyal to their initially chosen study field than university students: the average of diversion ratio 1 across fields is 21 percent for colleges, vs. 13 percent for universities). This may be explained by the broader supply of college programs across the region of Flanders, so that college students are more likely to find a nearby substitute campus than university students who face the elimination of their original field choice. There are important differences between study fields. For example, on average only 6 percent of college students and 8 percent of university students in bio-engineering stick to this study field when confronted with a cut of this field. In contrast, up to 30 percent of college students and 27 percent of university students in business and economics substitute to another institution to be able to stay in the same field after the field is dropped at their institution.

[14] This captures the content dimension more clearly. In the profit and welfare analysis subsequently we look however at unilateral *program* cuts, as this was the main interest of the Flemish government.

Table 5 Actual profit incentives and welfare effects of unilateral program cuts

Profit incentive	Welfare effect		
	Negative (%)	Positive (%)	Total (%)
Negative	37.0 (desirable status quo)	0.3 (undesirable status quo)	37.3
Positive	53.7 (undesirable reform)	9.0 (desirable reform)	62.7
Total	90.7	9.3	100.0

Percentages of program cuts for which it was possible to derive unambiguous conclusions on both profit and welfare effects.

Diversion ratio 2 shows that university students are on average more loyal to their initially chosen institution than college students (average across fields of 24 percent vs. 14 percent, diversion ratio 2 in the Table). Universities are thus able to retain a larger share of the affected students after cutting a study field, thanks to their broader supply and less competition (fewer universities across the region). Again, there is substantial heterogeneity between study fields.

In sum, the relatively low diversion ratios in Table 4 show that there is some loyalty to institutions and fields, but students substitute quite substantially to other institutions and fields.

5.3 Profit incentives and welfare effects of reducing diversity

Now consider the profit and welfare effects from reducing diversity through unilateral program cuts. Recall that Table 2 classified the effects of program cuts into four possible cases: desirable status quo, undesirable status quo, desirable reform and undesirable reform. Table 5 applies this classification. Using the fixed cost bounds approach mentioned earlier, we are able to unambiguously classify 65.4 percent of all 562 cases. For the remaining part of supply, we cannot draw an unambiguous conclusion without more precise fixed cost information. We therefore focus only on the cases for which we can draw unambiguous conclusions.

We summarize here the main findings and deal with the welfare results first, as reported in the columns of Table 5. This shows that it is socially undesirable to cut a program at an institution in 90.7 percent of the cases.[15] Only in 9.3 percent of the cases it would be socially desirable to cut these

[15] Note that this classification is relative to the number of programs we were able to unambiguously classify (368 programs out of a total of 562 programs). As discussed in section 5.1, we made an assumption on the upper bound of programs' fixed costs which allows us to evaluate the welfare and profit effects for the majority of study programs. Details are provided in Kelchtermans and Verboven (2007).

programs. This is a remarkable result in the light of the common concerns by policy makers in Flanders with the diversity and duplication of program supply. It is driven by the low student mobility and the corresponding large willingness to pay for a given study program at a given institution. Stated differently, the large consumer surplus losses from the program cuts are typically not compensated by a sufficient amount of fixed and variable cost savings.

Next consider the profit effects of the CI funding system, reported in the rows of Table 5. In the majority of the cases (62.7 percent) the CI funding system gives a positive profit incentive to cut programs. This contrasts with our earlier finding that it is usually not socially desirable to reduce diversity. Considering the four individual cells we find the following:

- We can classify 37 percent of current higher education supply as desirable status quo cases, i.e. the CI funding system correctly does not give an incentive to cut programs.
- However, we can also classify 53.7 percent of current supply as undesirable reform cases, where the system does give the wrong profit incentive to cut the program.
- Furthermore, we can classify a negligible fraction of 0.3 percent as undesirable status quo, i.e. where cutting diversity would be desirable but the CI funding system fails to provide the incentives to do so.
- Finally, 9 percent of the cases are desirable reform, where the CI funding system provides the proper incentives to cut supply.

We can draw two policy conclusions from this discussion. First, the high program diversity and the associated duplication of fixed costs across campuses are economically justified because of the low student mobility. In other words, the intuition that there is too much diversity in Flemish higher education is based on a duplication of fixed costs argument, and it ignores that students actually put a high value on this duplication. Second, policies such as the CI funding system aiming to provide decentralized incentives to reduce product diversity may easily be ineffective. The decentralized policy would have been fully effective if it had led to either desirable status quo or desirable reform (upper right or lower left cells of Table 5). In practice, this is only true for the minority of cases (37 percent + 9 percent). In the majority of cases policy would have led to undesirable reform by cutting diversity where this is not wanted.

6 General conclusion

We have discussed how European countries with a public system of higher education are facing increased financial challenges and how they differ in

their approaches to meet those challenges. Some countries, notably the UK, have made a clear choice towards the private model by (drastically) raising private contributions. Most other countries seem reluctant to make such choices and seek other solutions to increase the efficiency of their higher education systems while keeping them essentially public. Common trends include more performance orientation as well as decentralized decision making.

One particular policy domain that is bound to attract more attention from policy makers given the pressure on public budgets is the regulation of program supply and diversity. Governments are necessarily involved in controlling program supply, either through direct control (as in Flanders and the Netherlands) or through decentralized mechanisms (as in Scotland and Australia). Cross-country evidence suggests that program diversity is large, especially in Flanders, the region of our study. Nevertheless, despite the policy importance very little is known about the optimal degree of program diversity in higher education and even less on how policy can achieve it.

Our analysis shows that reducing supply as a way to cut costs is no magical solution. Although it may yield some fixed costs savings, i.e. efficiencies in the sense of less duplication, these are typically more than outweighed by other major inefficiencies, i.e. consumer surplus losses. Thus our analysis shows the importance of including the demand side effects, a perspective that is typically omitted from the analysis of diversity in higher education. Furthermore, we found that decentralized financial mechanisms carry a substantial risk of being ineffective, in the sense of promoting reductions in program diversity when this is undesirable from a total welfare perspective.[16] Hence, if one would want to take the route of optimizing supply diversity, a well-informed regulatory approach may be preferable unless sufficiently effective decentralized financial incentive schemes can be installed. While there is little doubt that institutions would respond to financial incentives, it is far from certain their decisions would be effective beyond a narrow definition of efficiency. In the absence of full-blown market-oriented approaches to organize higher education, it is therefore important not to make public funding mechanisms overly simplistic.

[16] Although the incentive for reducing supply diversity that we analyzed in this article (the CI) was eventually dropped from the final funding system proposal, the government reaffirmed its position that "current higher education supply is too fragmented" (Vlaamse Regering 2007).

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Demand for Higher Education Programs: The Impact of the Bologna Process

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Abstract

While several aspects of the Bologna process deserve wide public support, the reduction of the length of the first cycle of studies to three years in several continental European countries, where it used to last for four or five years, is less consensual. This paper checks the extent of public confidence in the restructuring of higher education currently underway by looking at its impact on the demand for academic programs in Portugal. We concentrate on students revealed first preference when applying to higher education. Results indicate that the programs that restructured to follow the Bologna principles were subject to higher demand than comparable programs that did not restructure; that effect, however, varies across fields of study and with program size. (JEL codes: I28, I21, F15)

Keywords: European Higher Education Area, education policy, count data, first preference.

1 Introduction

Major steps are currently being taken to create a European Higher Education Area by 2010. They include the creation of a comparable structure of academic degrees, mutual recognition of diplomas and course units, the assessment of academic institutions and programs based on common quality standards and direct incentives for geographical mobility of students and staff. The implementation of a common structure of academic degrees means that some continental European countries are moving away from a four- or five-year first cycle of studies to a shorter three-year one, which has led to some controversy. On the one hand, the advantages of having a degree recognized in a wider geographical space are praised, together with the re-development of curricula to make

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learning more student-centered and focused on the development of competencies, while enabling earlier entrance into the labor market. On the other hand, distrust has been expressed over the academic contents of the curricula and the adequacy to labor market needs of the competencies gained in a shorter three-year period, with fears that the employability of graduates will be reduced, when compared to graduates of the longer cycle.

This study concentrates on the reaction of students, as indicated by their revealed first preference, to analyze the impact of the Bologna restructuring on demand for academic programs by candidates to higher education. We focus on the Portuguese system.

We take advantage, first of all, of the legal setting in Portugal, where institutions were given the option to adjust their academic programs to the Bologna curricula starting in the academic year 2006/2007, or to defer adjustment to one of the two following years. Therefore, in 2006/2007 a group of early implementers co-exists with a group of academic programs that still have not undergone change, and students were free to choose where they would like to be admitted.

Second, the analysis is facilitated by the system of access to higher education in Portugal. Candidates must clearly rank up to six choices of institution and academic program, and a national competition follows, run by the Ministry of Science, Technology and Higher Education (MSTHE), which allocates candidates based on their relative performance and the number of available vacancies posted by each institution for each program. Third, we have a comprehensive data set on the application process, which renders this analysis feasible.

The article proceeds in Section 2 by describing the main characteristics of the Bologna process, emphasizing the potential advantages and disadvantages of the Anglo-Saxon two-tier system and its implementation in the Portuguese higher education system. Section 3 presents the data set, describes the method and discusses the results. Section 4 concludes.

2 The Bologna process

2.1 Objectives and debates

Initial steps towards some convergence of European higher education systems were taken with the signature of the Sorbonne declaration by the Ministers in charge of higher education in France, Italy, the United Kingdom and Germany, in 1998, and later, in 1999, with the signature of the Bologna declaration. The Bologna process aims at creating a European Higher Education Area by implementing a comparable degree

structure, common quality assurance standards and by promoting mobility of students and faculty.[1]

Globalization, technological change and increased international competition for scarce high-skilled labor highlighted the importance of making European higher education institutions attractive and competitive worldwide. A more integrated European Higher Education Market enhances competition between European universities—a necessary condition for producing leading-edge innovations and for catching up with the US economy (see, for example, Aghion 2006; van der Ploeg and Veugelers 2007), which has great influence in modernizing the European higher education (Van der Ploeg and Veugelers 2008).[2]

Even though the process is far-reaching and multifaceted, much of the attention has been devoted to the changes in the degree structure. Indeed, according to the model that predominated in most continental European countries, the first higher education degree was obtained after four to five years of successful study. Therefore, the curricula changes necessary to reduce the first degree to three years were implemented amidst some controversy.

Jacobs and van der Ploeg (2006) discuss the potential benefits of a two-tier system of three- or four-year bachelor's degrees and one- or two-year master degrees, as in the UK, US, Canada, Australia and India. According to those authors, a comparable degree structure would make the system more transparent and obstacles to the mobility of students and workers are expected to be reduced. Additionally, the two-tier Anglo-Saxon system presents a better performance relative to Continental Europe—for example, in 2004, 39 percent of the US population aged 25–64 had attained tertiary education, against only 23 percent in Europe (Aghion 2006). Jacobs and van der Ploeg (2006) present several possible explanations for the better performance of the two-tier Anglo-Saxon system relative to Continental Europe. On the one hand, students can complete their studies more quickly. On the other hand, a two-tier system reduces the cost of wrong choices made by students. The two-tier system also promotes a more flexible progression into postgraduate studies by allowing students to enter the labor market sooner and to find out what competences they should develop when they go back to university to take a Master's degree. All those factors, it has been argued, may render the European higher education more responsive to the needs of an increasingly flexible labor market and, therefore, enhance graduate employability and returns to education.

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[1] See European Ministers of Education (1999).

[2] See also Stephan (2008) on the issue of the increased reliance by governments on universities as a source of growth.

However, critics of the Bologna process stress that new curricula are a compressed version of the longer programs, and that there will not be enough time for assimilation, reflection and a critical approach to learning, which will undermine the quality of the degree. Under these circumstances, the employability of the new graduates might be reduced, when competing with graduates from the previous system of a longer first cycle. However, Harmon, Oosterbeek and Walker (2003) found that in countries where the graduates enter the labor market earlier, as in the UK two-tier system, returns from education tend to be the highest, which may suggest diminishing returns of further years of study (Jacobs and van der Ploeg 2006). It is still too soon to evaluate here the impact of the implementation of the Bologna two-tier system on labor markets, namely, on graduates' employability and wages.

Another argument against the two-tier system is that public funding may be restricted to the first (three-year) cycle, thus imposing a higher burden on students if they want to progress beyond the first degree, when compared to the system that used to guarantee public funding for four or five years. The relevance of this issue varies across scientific fields, with the problem usually not arising in the Humanities, while it is highlighted in several countries for occupations regulated by professional bodies (Reichert and Tauch 2005) and subject to specific European Union coordination mechanisms (Architecture and Health Sciences are two examples).

Between optimism and skepticism, it is not certain whether, during the period of adjustment, labor market agents and students will sort academic programs by looking at whether the curriculum has been adapted to Bologna. Although it would be very interesting to evaluate the reaction of labor markets to the Bologna process, we do not have the data to evaluate directly the impact of the Bologna process on the labor market, namely, on graduates' employability and wages. In fact, Crosier, Purser and Smidt (2007), using survey evidence, concluded that, so far, there is insufficient information about the nature and potential benefits of this reform in society and labor markets. In this article, we circumvent those problems by assessing the confidence of society in this reform by measuring the impact of the adoption of the Bologna principles on students' demand.

2.2 The Portuguese setting

The Portuguese setting is of particular interest to the study of the impact of the implementation of the Bologna process. Higher education institutions were given the option of implementing the required changes immediately in 2006/2007 or postponing to one of the two following academic years. Given that, in 2006/2007 a group of early implementers coexists with a group of old style study programs.

These changes took place in a framework of increasing competition between institutions. In 1990/1991, there were almost 200 thousand students enrolled in higher education; between 1990/1991 and 2002/2003 that number more than doubled; however, since then it has decreased. Therefore, Portugal has moved from a period of sharp rise in demand to excess supply. A number of factors have combined to generate excess of capacity and increasing competition for students between institutions. Among these factors, the MSTHE (2006) stresses: the decline in the number of candidates due to demographic changes; the increasingly strict admission conditions, following the reintroduction of national admission exams and minimum grades and the increased number of vacancies, due to large investments made in the public sector.[3]

This increased competition motivated strategies of differentiation by institutions, namely by defining different entry conditions, with the most recognized institutions setting higher entrance standards and, therefore, targeting different segments of the student population (MSTHE 2006). The speed of adjustment to the Bologna process has often been pointed out as an instrument in this strategy of differentiation. As in other continental European countries, the reduction of the length of the first cycle of studies was one of the more debated changes. The common duration of a higher education degree in Portugal used to be five years, until the mid-90s, it is reduced to four years; the Bologna process further imposes a reduction to three years. There is, nevertheless, the possibility to keep the duration of a program longer. Whereas the first cycle (*licenciatura*) has a normal duration of three years and the second cycle (*mestrado*) has a normal duration of one and a half or two years, in special cases it is feasible to offer a combined degree, the so-called integrated Master's, lasting for five to six years.

Some institutions saw the prompt implementation of the Bologna process as an opportunity to establish or reinforce their reputation as an up-to-date institution, whose graduates would benefit from the opportunities of a wider labor market. Institutions taking the lead might gain a comparative advantage over the late-comers, not also attracting more applicants in the first year after restructuring, but also gaining a reputation beneficial for future years. Other institutions, instead, opted to delay the process, arguing that changes should be thought over. The result of these two strategies is visible in Table 1, which shows that the adjustment of curricula to Bologna varied across higher education institutions. The decision taken by the University of Coimbra to defer

[3] Portela et al. (2007) provide a detailed analysis of the recent imbalances in the Portuguese Higher Education System as a whole, and per institution and field of study.

Table 1 Proportion of academic programs adopting Bologna in 2006/07 by subsystem and by institution

Polytechnics	Nr	%	Universities	Nr	%
E Nautica Infante D. Henrique	5	60	ISCTE	15	93.3
ES Enf Artur Ravar	1	0.0	U Açores	27	29.6
ES Enf Bissaya Barreto	1	0.0	U Algarve	50	38.0
ES Enf C Goulbenkian Lisboa	1	0.0	U Aveiro	50	68.0
ES Enf Cidade do Porto	1	0.0	U Beira Interior	27	59.3
ES Enf D. Ana Gudes	2	0.0	U Coimbra	51	2.0
ES Enf Dr. Angelo Fonseca	1	0.0	U Évora	32	12.5
ES Enf Francisco Gentil	1	0.0	U Lisboa	48	64.6
ES Enf M.Fernanda Resende	1	0.0	U Madeira	18	0.0
ES Enf São João	1	0.0	U Minho	43	65.1
ES Hotelaria Turismo Estoril	5	100.0	U Nova de Lisboa	34	85.3
IP Beja	18	55.6	U Porto	56	19.6
IP Bragança	41	68.3	U Técnica de Lisboa	51	60.8
IP Castelo Branco	30	53.3	U Trás-os Montes e Alto Douro	34	23.5
IP Coimbra	42	2.4			
IP Cávado e Ave	8	25.0			
IP Guarda	22	50.0			
IP Leiria	41	22.0			
IP Lisboa	30	50.0			
IP Portalegre	22	31.8			
IP Porto	50	44.0			
IP Santarém	22	63.6			
IP Setúbal	26	30.8			
IP Tomar	20	40.0			
IP Viana do Castelo	22	36.4			
IP Viseu	35	51.4			

Notes: This table considers 985 academic programs, of which 419 have adjusted to the Bologna principles; 185 in the polytechnics and 234 in the universities. Although some universities offer polytechnic-type studies, these are shown only in the university sector column. For more details on data description see Section 3.1. U = *Universidade* (University), IP = *Instituto Politécnico* (Polytechnic Institute), and E Superiores = *Escolas Superiores* (other polytechnic institutions). Nr is the total number of programs offered in each institution, and % is the proportion of those study programs that restructured according to the Bologna rules.

the adoption of the new model to 2007/2008 (with exceptions authorized for programs on which a national consensus for change had been reached among institutions) is evident in the table, as is the fact that the University of Madeira did not adapt any of its programs. This decision contrasts with that of Universidade Nova de Lisboa and Instituto Superior de Ciências do Trabalho e da Empresa (ISCTE), which both moved ahead in restructuring most of their programs.

In this context, the decisions by academic institutions and students can be interpreted within the conventional signaling framework (Gibbons 1992; Salanié 2000).[4] Academic institutions decide whether to adopt the Bologna principles immediately and students decide whether to apply to a Bologna program. Institutions are in this case the informed players, who have insider information on program quality, which they can choose to reveal (or not) by means of signals. Interestingly, in the public debate surrounding the Bologna changes, the idea that institutions which adapted first were signaling their readiness for change and their higher quality was often stressed. Prospective students, on the other hand, are interested in attending institutions that guarantee a certain education quality (Long 2004). Whereas the program quality is the institution's private information, the decision to conform to the Bologna principles is publicly observed.

Referring to Portugal, the OECD stresses that on the students' side "public information on course content, program goals, quality and opportunities and graduate employment is inadequate or unavailable" (OECD 2006, p. 27), which makes the impact of the implementation of the Bologna principles on demand for academic programs even more uncertain.

Therefore, in this article we test whether students sort academic programs by whether the curriculum has been adapted to Bologna. Some students may associate Bologna with a quality stamp and a guarantee of recognition of the degree in a wider geographical space, yielding better employment opportunities, whereas others may attach a higher importance to a more established older program. In this article, the agent we will consider are the candidates to a higher education degree and their demand for higher education programs.

3 Evaluating the impact of the Bologna process on program demand

3.1 Data and sample

This study concentrates on the publicly funded Portuguese higher education system, which comprises 14 universities and 26 polytechnics. The analysis of the impact of Bologna on program demand is rendered feasible by the fact that admission into public higher education in Portugal is strictly regulated and implemented through a nation-wide competition.

[4] For an example of a signaling game applied to the higher education system, see Mizrahi and Mehrez (2002).

Enrolment in higher education is limited by a system of numerus clausus, with the number of vacancies defined yearly by the MSTHE. The application process takes place at the centralized national level and each candidate ranks up to six institution/program pairs. Demand for a given program can thus be quantified in an unequivocal way.[5]

The allocation of the candidates follows their stated preferences and is based on their grade point average, which is a weighted average of their marks in secondary school and in national examinations. The performance in national exams affects the pool of candidates that can apply to higher education first cycle programs. Traditionally hard subjects are: Mathematics, where only 26 percent of the students obtained a pass grade in 2006; Physics, where the share of students passing the exam in that year was 30 percent and Chemistry, where that share was 35 percent.

The empirical analysis of the paper uses a comprehensive data set on the application process to public higher education, collected from the website where the Department of Higher Education (DGES) of the MSTHE announces the results of the process of allocation of candidates to higher education programs.[6] Data for the academic years 2003/2004 to 2006/2007 and for the first and second phase of the application process in each year have been collected.[7]

The following variables are available: demand for each program (number of students who have selected each program as their first choice); number of vacancies available for each program in each of the two stages of the application process; national admission exams required by the program, with the major ones being Mathematics, Physics, Chemistry, Biology and Portuguese and the field of study of the program.[8]

Table 2 provides descriptive statistics on the dataset. A declining trend in the average number of applicants per study program can be detected between 2003/2004 and 2005/2006, with an increase in the number of applicants in the following year. The second phase of application involves, as expected, remarkably less applicants, since it is a residual phase. The table also shows a declining proportion of programs requiring an entrance exam in Mathematics, Physics, Chemistry, Biology or Portuguese.

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[5] Throughout the text, a program is meant to refer to a institution/academic program pair, unless otherwise explicitly explained.

[6] *Direcção Geral do Ensino Superior*, at http://www.acessoensinosuperior.pt.

[7] Students who are not successful in the first phase, or who are successful but wish to change the institution/program where they were placed, and those who did not apply in the first phase, are eligible to apply in the second phase.

[8] We have consistently used the classification adopted by the Ministry in 2006, which includes ten areas: Agriculture, Architecture, Natural Sciences, Law and Social Sciences, Economics and Business, Sports and Arts, Education, Humanities, Health and Technologies.

Table 2 Summary statistics

	2003		2004		2005		2006	
Variable	Ph1	Ph2	Ph1	Ph2	Ph1	Ph2	Ph1	Ph2
Demand: number of first options	42.56 (63.06)	15.76 (18.27)	41.91 (61.91)	10.14 (14.07)	37.68 (65.91)	13.07 (17.60)	40.92 (66.87)	15.64 (18.97)
Bologna implementer							0.43	0.43
Bologna leader							0.17	0.17
Integrated master							0.04	0.04
Program size (vacancies)	45.66 (33.19)	14.21 (13.40)	44.69 (39.27)	12.92 (12.24)	44.23 (38.99)	16.96 (17.46)	46.96 (38.76)	17.20 (16.69)
Exams:								
Mathematics	0.33	0.33	0.28	0.28	0.26	0.27	0.21	0.21
Physics	0.05	0.06	0.03	0.03	0.03	0.03	0.02	0.02
Chemistry	0.07	0.07	0.07	0.06	0.07	0.06	0.05	0.05
Biology	0.16	0.15	0.13	0.13	0.14	0.13	0.11	0.11
Portuguese	0.12	0.13	0.10	0.11	0.08	0.08	0.07	0.07
Field of study:								
Agriculture	0.06	0.07	0.07	0.06	0.05	0.06	0.06	0.06
Architecture	0.05	0.04	0.05	0.05	0.06	0.06	0.07	0.07
Natural Sciences	0.07	0.07	0.07	0.08	0.07	0.07	0.08	0.08
Law and Social Sciences	0.11	0.11	0.13	0.13	0.14	0.14	0.16	0.17
Economics and Business	0.10	0.10	0.10	0.11	0.10	0.11	0.11	0.11
Sports and Arts	0.02	0.02	0.03	0.02	0.03	0.03	0.03	0.03
Education	0.13	0.14	0.11	0.11	0.09	0.09	0.07	0.08
Humanities	0.11	0.11	0.11	0.11	0.10	0.10	0.08	0.08
Health Sciences	0.10	0.10	0.11	0.10	0.11	0.10	0.11	0.11
Technologies	0.24	0.24	0.24	0.24	0.23	0.24	0.22	0.22
Number of institutions/programs	946	903	989	942	1012	976	985	965

Notes: Ph1 and Ph2 stand for phases 1 and 2 in the application process, respectively. Standard deviations are shown in parenthesis. For more details on variables' description, see Sections 3.1 and 3.2.

The share of applicants to each field of study has remained comparatively stable over time. Law and Social Sciences, Education and Humanities are the exception, as they show some variation in demand. In the academic year 2006/2007, 43 percent of the study programs have restructured according to the Bologna rules.

3.2 Empirical model and variables

The present analysis aims at determining to what extent the introduction of the Bologna process has had an impact on the demand for academic programs. The dependent variable is operationalized as the number of applicants who placed a given program/higher education institution pair as their first option. The number of first options is a positive integer and its distribution is skewed to the right, which implies that count data models are the adequate tool (Cameron and Trivedi 1998). Since the over-dispersion test rejects the null hypothesis of absence of over-dispersion, the negative binomial model is more appropriate when compared to the Poisson alternative. Because the data have a panel structure at the level of program/institution, we estimated a conditional fixed-effects negative binomial model.

The analysis considers a set of program attributes as explanatory variables. The main program attributes are the so-called Bologna variables. These are three dummy variables that describe the way the Bologna process has been implemented in Portugal. The first dummy variable is simply *Bologna implementer* and takes the value one for programs that have been restructured according to the Bologna process. *Bologna leader* is another dummy variable, which takes the value one for implementers which were the only institution in the country that restructured that program. This group of early-implementers has set itself apart from the other institutions in the country, making an early move and most likely expecting to gain from its timing. Finally, the dummy for *integrated masters* achieves the value one for implementers that opted for combining the first and the second cycle into a single program, which leads to the Master's degree.

Apart from the Bologna variables, departing from a simpler specification, we successively control for additional program characteristics. Given sharp differences in the dimension of the different programs and across institutions, we control for the size of the program (number of vacancies posted in each phase). The dependent variable is a proxy for absolute demand, which depends on the number of places offered for each study program, with larger programs expected to get higher demand. We also control for the phase of the application process, with a dummy variable equal to one in the second phase, since this is a residual phase. Program attributes include whether it requires a national admission exam in a particular subject (dummy variables for Mathematics, Physics, Chemistry, Biology and Portuguese). Controlling for the subjects required as admission exams is particularly relevant. Indeed, a generally poor performance in the admission exam in a certain subject reduces the pool of candidates that can apply to programs requiring that exam. Finally, we

control for the scientific field of the program (captured by nine dummy variables). Different scientific fields reacted differently to the implementation of the Bologna process (consider for example the contrast between Humanities and other fields).[9] Estimation of the model including field-specific dummy variables can control for these differences. Interactions between Bologna and control variables enter the model specification as well, in the final richer specification, which is aimed at uncovering contrasts in the impact of Bologna within the higher educational system.

3.3 Impact of the Bologna process

This section presents results of the estimation of the negative binomial model described above. Alternative specifications of the model are reported in Table 3, where, as previously described, the dependent variable is the total number of candidates that chose the program as their first option.

The first two specifications are simpler models presented for comparison purposes. In Specification 1 we only include the Bologna implementer dummy variable, and dummies for the phase, year and admission exam required. These control variables are required in order to control for aggregate changes in demand across time, considerable differences in demand between the first and the second phase, and the fact that programs requiring different admission exams face different segments of applicants to the higher education system. The results indicate that the adoption of the Bologna model led to a significant increase in demand. In Specification 2 we added the program size, attaining results qualitatively similar to Specification 1, a positive impact resulting from the Bologna stamp. The third specification accounts for the variation in the impact of Bologna across fields of study and program sizes. Specification 4 further allows the impact of Bologna to diverge between leader and non-leader programs. Specification 5 checks whether the impact of the Bologna process has been different for integrated Master's degrees. Finally, Specification 6 is a combination of the previous two specifications. Results are fairly robust across specifications. As such, we interpret the coefficients of Specification 6, which uses the most complete set of regressors.

Bologna restructuring is associated with higher demand for a study program, when compared to programs that did not restructure. However, that effect decreases with the size of the study program. For example, in the Humanities, the overall impact is equal to $100 \times [exp(0.2250 - 0.0024 \times size) - 1]$. In this case, a restructured study

[9] In Humanities, 58 percent of the programs adopted the Bologna principles, while for example, in Health Sciences only 9 percent did so and in Natural Sciences 39 percent.

Table 3 Demand for academic programs (first choices), negative binomial model

Variable	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6
Bologna implementer	0.0697**	0.0629**	0.2041*	0.1998*	0.2257*	0.2250*
	(0.0296)	(0.0291)	(0.1205)	(0.1221)	(0.1206)	(0.1223)
Bologna impl. × Progr.size			−0.0016***	−0.0016***	−0.0022***	−0.0024***
			(0.0006)	(0.0006)	(0.0006)	(0.0007)
Bolgna leader				0.0023		−0.0142
				(0.0777)		(0.0770)
Bologna leader × Progr.size				0.0011		0.0018
				(0.0015)		(0.0015)
Integrated master					0.3632***	0.3666***
					(0.1093)	(0.1100)
Integr.master × Progr.size					0.0017	0.0018
					(0.0012)	(0.0012)
Bologna × Field of study						
Agriculture			−0.1082	−0.1092	−0.1723	−0.1743
			(0.2042)	(0.2043)	(0.2035)	(0.2036)
Law and Social Sciences			0.0061	−0.0008	0.0105	0.0011
			(0.1332)	(0.1334)	(0.1329)	(0.1331)
Architecture			−0.1150	−0.1312	−0.2073	−0.2278
			(0.1664)	(0.1676)	(0.1674)	(0.1683)
Natural Sciences			−0.2607	−0.2706	−0.2589	−0.2726
			(0.1710)	(0.1713)	(0.1708)	(0.1710)
Economics and Business			0.0382	0.0356	0.0510	0.0486
			(0.1410)	(0.1412)	(0.1408)	(0.1409)
Sports and Arts			0.0765	0.0597	0.0700	0.0539
			(0.2639)	(0.2667)	(0.2638)	(0.2660)
Education			0.6312***	0.5927***	0.6390***	0.5879***
			(0.2115)	(0.2156)	(0.2110)	(0.2148)

Health Sciences			−0.2807*	−0.2730***	−0.3583**	−0.3500**
			(0.1667)	(0.1671)	(0.1671)	(0.1674)
Technologies			0.0132	0.0103	−0.1102	−0.1169
			(0.1377)	(0.1378)	(0.1404)	(0.1405)
Phase 2	−0.8534***	−0.7473***	−0.7555***	−0.7545***	−0.7588***	−0.7572***
	(0.0118)	(0.0144)	(0.0141)	(0.0141)	(0.0141)	(0.0141)
Program size		0.0029***	0.0030***	0.0030***	0.0030***	0.0031***
		(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Exam						
Mathematics	−0.4980***	−0.5205***	−0.5354***	−0.5369***	−0.5417***	−0.5437***
	(0.0362)	(0.0359)	(0.0362)	(0.0363)	(0.0362)	(0.0363)
Physics	−0.4354***	−0.4089***	−0.5118***	−0.5109***	−0.5101***	−0.5085***
	(0.0733)	(0.0722)	(0.0745)	(0.0746)	(0.0741)	(0.0742)
Chemistry	−0.0954	−0.0797	0.0063	0.0057	0.0141	0.0135
	(0.0679)	(0.0678)	(0.0663)	(0.0663)	(0.0664)	(0.0664)
Biology	−0.5896***	−0.5851***	−0.5869***	−0.5872***	−0.5958***	−0.5963***
	(0.0474)	(0.0473)	(0.0459)	(0.0459)	(0.0459)	(0.0459)
Portuguese	0.0192	0.0199	0.0043	0.0055	−0.0011	0.0002
	(0.0505)	(0.0489)	(0.0490)	(0.0491)	(0.0490)	(0.0490)
Year						
2004/05	−0.2522***	−0.2485***	−0.4745***	−0.4745***	−0.4747***	−0.4748***
	(0.0150)	(0.0149)	(0.0505)	(0.0505)	(0.0504)	(0.0504)
2005/06	−0.4133***	−0.4116***	−0.5663***	−0.5662***	−0.5673***	−0.5673***
	(0.0159)	(0.0157)	(0.0527)	(0.0527)	(0.0526)	(0.0526)
2006/07	−0.4352***	−0.4338***	−0.5031***	−0.5031***	−0.5036***	−0.5037***
	(0.0196)	(0.0193)	(0.0813)	(0.0813)	(0.0811)	(0.0811)
Constant	2.7225***	2.5981***	2.6796***	2.6801***	2.6909***	2.6920***
	(0.0339)	(0.0360)	(0.0362)	(0.0362)	(0.0362)	(0.0362)
Log-likelihood	−19952.28	−19882.42	−19685.15	−19684.60	−19669.06	−19667.81

Significance levels: *:10 percent **:5 percent ***:1 percent. Standard errors in parentheses. All regressions are estimated by a fixed-effects negative binomial model, controlling for program/institution heterogeneity and include the interaction of year dummies with field of study dummies.

program offering 40 vacancies would be subject to 13.8 percent higher demand, whereas for a study program posting 80 places the impact would be about 3.4 percent. However, as will be discussed below, these marginal effects are not statistically significant.

In fact, the statistical significance of those marginal effects needs to be checked. In the presence of interaction terms, Table 3 only reports limited information for the test of the marginal effect of being a Bologna implementer. Figure 1 is particularly relevant for the analysis, as it reports the marginal effects of being a Bologna implementer by field of study according to program size, as well as their 95 percent confidence intervals based on the correct standard errors accounting for interaction terms.[10] Vertical lines in each graph indicate the 10th, 50th and 90th percentile of vacancies for each field of study. Additionally, the 99th percentile of vacancies is indicated. A horizontal line is placed at the null marginal effect.

We conclude from Figure 1 that the impact of Bologna restructuring differs across educational programs and as a function of the program's size. The impact is positive for education programs and negative for health programs, regardless of the size of those two programs. Evidence of positive impact is found for very small programs in Law and Social Sciences and Economics and Business, while a negative impact is observed for large programs in Law and Social Sciences, Architecture, Natural Sciences and Technologies. Finally, demand for programs such as Humanities, Agriculture and Sports and Arts appears not to be affected by Bologna's restructuring.[11] In one field of study (Education), implementation of Bologna had an unequivocal positive impact on

[10] For a discussion on the analysis of interaction effects see, for example, Brambor, Clark and Golber (2006).

[11] Looking at Figure 1, we conclude that for study programs in the field of humanities, the impact of the Bologna stamp is not statistically different from zero, irrespective of the program size. The same conclusion holds for studies in the fields of Agriculture, and Sports and Arts. In architecture studies, the effect of the Bologna stamp is almost always statistically not significant, and becomes negative in programs posting more than 88 vacancies, which is above the 90^{th} percentile. On the other hand, in the field of education the marginal effect of being a Bologna implementer, though decreasing with program size, is always positive. For economics and business programs the marginal effect is statistically positive for programs with less than 45 vacancies, which coincides with the 50^{th} percentile, and it becomes statistically negative after 207 vacancies, which only occurs for three programs in this field. Similarly, in the field of Law and Social Sciences, the marginal effect is statistically positive for programs with less than 40 vacancies (the median of the field). This corresponds to 167 programs, for which the marginal effect of the Bologna stamp is bounded between 14 percent and 25 percent. The marginal effect becomes negative only after the 90^{th} percentile, namely for programs posting more than 173 vacancies (i.e. two programs). In the field of technologies, only those programs with a size above the 90^{th} percentile (i.e. 27 programs) show a statistically negative marginal effect. This effect is bounded between −27 percent and −14 percent. When looking at

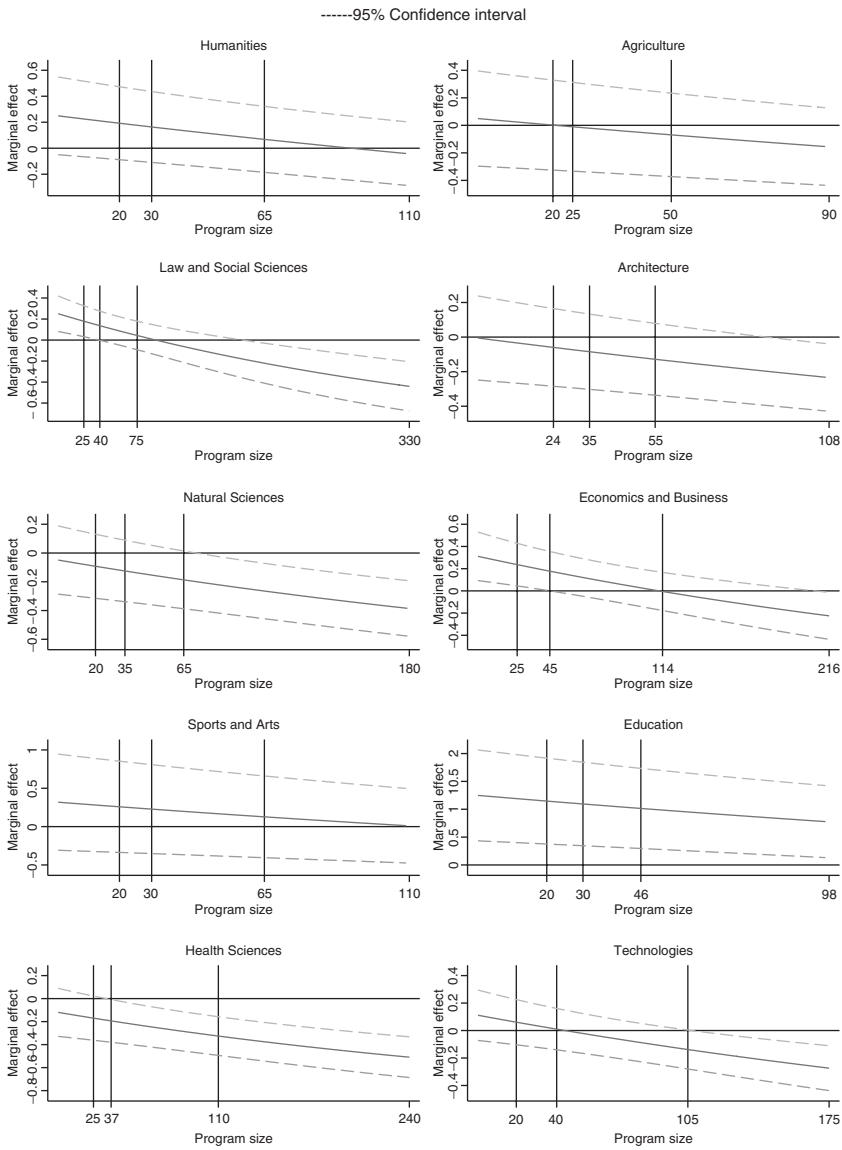

Figure 1 Marginal effects of Bologna implementer by field of study

programs in the field of natural sciences, the marginal effect is statistically negative for the eight study programs posting more than 71 vacancies. In health, for study programs offering more than 33 places (just below the median) the marginal effect is statistically negative. For the corresponding 81 programs the effect is between −51 percent and −12 percent.

demand and in another (Health), there has been lower demand for programs restructuring along Bologna's directives, which might indicate that students/public were skeptical about the restructuring.

We further checked whether the impact of the Bologna process could be different depending on the implementation strategy. Firstly, we considered whether being a national leader in a certain program implementing the Bologna curricula was associated with some benefit (or penalty) in terms of demand by prospective students. Results for Specification 6 in Table 3 reveal that being a leader in the implementation of the Bologna curricula had no impact on demand for a program as a first choice, above the increase experienced by Bologna implementers in general. This effect holds irrespective of the size of the program.

Second, we checked whether restructuring to offer a joint first and second cycle degree (i.e. integrated Master's) of a longer duration yielded some benefit in terms of demand. Results indicate that there was a positive impact on demand for programs that restructured and kept a long duration, above the impact for Bologna implementers in general; this increase in demand took place irrespective of the size of the program.

As expected, larger programs attract a larger number of candidates. In the second phase, the number of applicants is remarkably lower. Admission exams in Biology, Mathematics or Physics, known to be the toughest, reduce the pool of potential applicants and thus lower the demand for the program. The demand for university programs decreased between 2003 and 2005, recovering in 2006.

4 Conclusion

The Bologna process aims at creating a European Higher Education Area where inter-country mobility of students and staff, as well as workers holding comparable degrees, is facilitated. Despite the advantages of the Bologna process, it has been implemented amidst some controversy. The emphasis of the public discussion has centered on the changes in the degree structure, namely the reduction of the first cycle of studies to three years and its implications for knowledge acquisition and the integration of the graduates into the labor market.

In this article, we have checked the degree of public confidence in the Bologna changes in curricula in Portugal. Namely, we have looked at students' demand behavior during the period of adjustment, as expressed by their first choice when applying to higher education. Precise quantification of the demand for each academic program is facilitated by the rules of access to higher education, in a nation-wide competition, where candidates must list up to six preferences of institution and program pairs.

We use regression analysis applied to count data, estimating negative binomial models on the number of students who placed a program/institution pair as their first option. Results indicate, in general, a positive impact on demand for programs that have adapted to the Bologna rules. We observe an unambiguous higher demand for programs in the field of education adopting the Bologna principles. At the same time, the lower demand for health programs that followed Bologna's directives might reflect some skepticism. For some programs, namely in Economics and Business, Law and Social Sciences, Architecture, Natural Sciences and Technologies, the impact of Bologna turns out to be conditional on the size of the program; for some other Bologna does not have any impact (Humanities, Agriculture and Sports and Arts). Programs that restructured to offer an integrated Master degree were subject to rising demand.

However, the degree of confidence of labor market agents in the changes in curricula should be the object of future research, since the evaluation of the integration of the new graduates into the labor market will be the real test to the current reform of the European Higher Education Area. Crosier, Purser and Smidt (2007), using survey evidence, concluded that there is much to be done to translate the priority of employability into institutional practice, suggesting that the objective of employability of the current European higher education reform was not yet fulfilled.

In this article we focused on the demand for first cycle programs. However, an assessment of the two-tier system also implies an evaluation of the demand for second cycle degrees. Although we will have to wait for the data to make an accurate analysis, Crosier, Purser and Smidt (2007) concluded from survey analysis that, in some countries, the duration of studies may have actually increased rather than decreased as the old long cycle degree programs were divided into two cycles. Additionally, there is evidence that higher education institutions have been encouraging students not to leave for the labor market before finishing the two cycles.

As remarked by Jacobs and van der Ploeg (2006), for the Bologna reform to materialise its potential benefits, two conditions must be observed. In the first place, the reform of the European Higher Education System should result in more competition. Second, students should make more informed choices and become more critical consumers. For these conditions to be verified, better communication between higher education institutions, employers and students of the results and implications of the reforms is called for (Crosier, Purser and Smidt 2007). More transparency, namely through common quality assurance systems, in the new degree structures and their learning outcomes is necessary to guarantee the more efficient and competitive European Higher Education System, which is at the core of the Bologna process. Additionally, for students to vote with "their feet", they should have the material means to choose the best

program, which means that more grants and student loan schemes should be promoted.

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The Provision of Higher Education in a Global World—Analysis and Policy Implications

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Abstract

Mobile students and graduates react to the institutional framework of higher education and on their turn induce changes in governmental policies. In this article, we are interested in how governmental decisions about the financial regime and the quality level of higher education interact with individual incentives to invest in higher education in closed economies and in economies open to migration. We show that mobility of (part of) the population results in a situation where the optimal instruments of the closed economy are no longer necessarily viable. The aim of the article is to derive policy implications as to the optimal financial regime and quality level of higher education in the presence of migration opportunities. (JEL codes: H77, I22, I28)

Keywords: Higher education, funding, quality competition, migration, policy implication.

1 Introduction

Mobility is a driving force in the labour market. It is especially crucial as higher education is concerned because mobility enlarges the opportunities of students and graduates or skilled workers, respectively, and affects the returns to their investment in education. Mobile students and graduates react to the institutional framework and on their turn induce changes in governmental policies as competition between educational institutions and countries becomes more intense. We are here interested in how governmental decisions about the financial regime and the quality level of higher education interact with individual incentives to invest in higher education in closed and in open economies.

The Bologna Process, which was launched in 1999, aims at removing the obstacles to mobility for students by establishing the so-called European Higher Education Area by the year 2010. Due to the common structure of

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higher education and the more comparable university systems across Europe, students should be able to choose from a wide range of high-quality programmes and both students and graduates should benefit from standardized recognition procedures as their qualifications are concerned.[1] These measures—especially those which increase transparency and comparability of different degree programmes—should lower migration costs. Acquiring a degree in a particular country should be less risky if it no longer restricts the relevant geographical area for the professional career as much as before to the boundaries of this country. A similar argument should also hold for graduates for whom more standardized educational degrees make it easier to work in countries other than the country where they received higher education.

With equal conditions for access—following the non-discrimination principle, which holds for EU-citizens—increased mobility is supposed to lead to more competition in terms of quality among different institutions of higher education.[2] But the European Higher Education Area also creates incentives for governments to free-ride on other countries and regions. Free-riding should be especially strong if students are less mobile than skilled workers and if most of those who study abroad return to their home country after graduation. This shows how important it is for an evaluation of the Bologna Process to study different mobility scenarios.[3] One may suspect that the Bologna Process—due to the fact that it aims above all at promoting the mobility of students—will also affect the policy of governments, both in terms of how higher education is financed and what quality level is chosen. Two main questions arise. What is the rationale to increase student mobility? What will be the impact on the financing of higher education and its quality level? Our aim is to address these questions, relying on a simple general equilibrium model.[4]

We look at a two-period model with two *ex ante* identical jurisdictions and individuals who differ in their innate abilities. The optimum is analysed and contrasted with the outcome in the absence of an omniscient social planner in a setting where we allow for distortions on

[1] See, in particular, http://www.europeunit.ac.uk/bologna_process/index.cfm and http://ec.europa.eu/education/policies/educ/bologna/bologna_en.html.

[2] For a discussion of the benefits of degree standardization and harmonization and of international mobility in creating competitive European higher education institutions see, among others, Veugelers and van der Ploeg (2008).

[3] It should be noted, however, that if governments draw some private benefits in educating students, free riding due to the public-good aspect should be softened. For an example, see Gérard and Ruiz (2006).

[4] A more extensive presentation of the model can be found in Demange, Fenge and Uebelmesser (2007).

capital markets. Depending on the degree of integration and on the specific assumptions as to mobility, in the first period, individuals decide whether and where to study and in the second period, educated workers decide where to work. In a first part, we look at a closed economy that serves as a benchmark. It turns out that the optimum in terms of the quality level of and the access restrictions to higher education can be achieved with a well chosen mix of fee- and tax-financing. In a second part, we analyse open economies. Mobility of (part of) the population results in a situation where the optimal instruments of the closed economy are no longer necessarily viable. The aim is to derive policy implications as to the optimal financial regime and quality level of higher education in the presence of migration opportunities.

Our article is related to the literature on higher education, which focuses on financing as well as on quality issues. In a closed economy set-up, one of the earlier contributions is Johnson (1984) who analyses the distributional effects of educational subsidies. He argues that even though these subsidies benefit only those who study, there is not necessarily a conflict of interest due to complementarities between skilled and unskilled labour. Creedy and Francois (1990) more directly address the underlying political-economy aspects by looking at majority voting on higher education subsidies when education generates a positive growth-enhancing externality. Both Johnson and Creedy and Francois abstract, however, from capital market distortions and uncertainties related to the education investment. The riskiness of this investment is at the core of the analysis by García-Peñalosa and Wälde (2000) who compare the efficiency and equity effects of a tax-subsidy scheme to loan schemes and graduate taxes. All these papers have in common that they abstract from an integrated labour market.

The analysis has therefore been extended to an open economy framework in newer contributions. Wildasin (2000) studies the effects of labour market integration on human capital investment in a general equilibrium model with uncertainty where education may be either publicly or privately financed. (Industry-specific) skills expose individuals to wage risks, while mobility across jurisdictions can help to eliminate these risks. The focus is thus on the decision to acquire education in an open economy setting with uncertainty where two financial regimes are compared and workers are mobile. In Del Rey (2001) students are mobile. The analysis concentrates on the ensuing fiscal competition and how this affects the governmental decision about the public provision of higher education.

A further aspect is central in Kemnitz (2005). He looks at the impact of tuition fees on the quality of higher education under decentralized and centralized decision making. Special attention is given to the question as to

what extent fees crowd out public funds under both regimes. Busch (2007) and Mechtenberg and Strausz (2008) also look at the quality level of education in an open economy. While in Busch the positive correlation between education quality and the mobility of graduates induces governments to lower the quality level to counteract the threat of a brain drain, Mechtenberg and Strausz come to similar conclusions in a setting with mobile students where governments fear free-riding.[5]

Our article contributes to this literature by systematically analysing in a general equilibrium framework how closed-economy results change in open economy with mobility of students and/or skilled workers. A special focus is on deviations from the optimal policy as the choice of the financial regime and of the quality level of education is concerned. Allowing for mobility of both groups at the same time goes beyond the analysis in the existing literature. We show in particular that mobility of students helps to alleviate the sub-optimality of both the finance-mix and the education quality, which emerge when only skilled workers are mobile. Furthermore, our model is the first one to analyse the interdependency of the (simultaneous) decisions of whether to study or not and where to study. This helps us to better understand the consequences of mobility for the provision of higher education and allows formulating policy implications.

We will proceed as follows. In the next section, we present some empirical evidence that motivate some of the basic assumptions of the model to be developed in the following sections. In Section 3, the basic set-up of the model is introduced. The individual and governmental decisions in a closed economy are discussed in Section 4 and compared to the optimum. In Section 5, the economy is opened up. The sustainability of the policies of the closed economy is analysed when students and/or skilled workers are mobile. Policy implications are derived in Section 6 and Section 7 concludes.

2 Empirical evidence

We present empirical evidence on the relative mobility of different groups (unskilled versus skilled individuals, students versus graduates) and on the dominant funding regimes of higher education (public versus private) in developed countries, especially EU countries.

[5] The incentives for a government or an old generation to invest in internationally applicable education are studied in Thum and Uebelmesser (2003) and Poutvaara (2004). These questions will, however, not be included in the analysis here.

2.1 Mobility

When comparing mobility of unskilled and skilled workers, there is evidence that migrants tend to be high-skilled. This has been shown for inner-country migration, e.g. by Ehrenberg and Smith (1994) for the United States, by Mauro and Spilimbergo (1999) for Spain, by Coniglio and Prota (2003) for Italy and by Hunt (2006) for Germany.[6] Migration within a country is certainly of interest here—at least for countries where the education policy and the funding regimes are decided in a decentralized way on a sub-national level. Migration across countries is, however, also relevant as far as it affects the provision of higher education on a national level. In general, whether low- or high-skilled individuals are more likely to migrate depends on the dispersion in returns to education, i.e. the inequalities of (net) earnings, as emphasized by Borjas (1987) on the basis of the model by Roy (1951). Given that we focus here on migration of EU citizens within the European Union, the cross-country differences in inequality can be expected to be not very pronounced even though redistributive activities are in general more important in continental Europe and less so in the Anglo-Saxon world. When the inequality is comparable in both countries—and even when the inequality in the sending country exceeds the one in the receiving country, it is possible to identify mechanisms which lead to positive self-selection. Brücker and Defoort (2006) extend Roy's model by including migration costs. This suffices to render the theoretical impact of the inequality of earnings on the selection of the migrant population ambiguous. Their empirical analysis shows that the majority of migrants are in fact favourably selected.

Even more interesting for our analysis of the impact of mobility on the provision of higher education is the question whether students, i.e. those who are in the process of becoming skilled, show a smaller or higher propensity to migrate than graduates, i.e. those who have already acquired the necessary qualifications, which allow them to be employed as skilled workers. More precisely, the relevant (potential) difference concerns the degree of mobility of students at the beginning of their studies and of graduates at the beginning of their professional career.[7] In general, mobility decreases with age. This might be due to emotional ties to a specific region, which grow stronger the longer one stays there. But this might also stem from job-related aspects if firm-specific (and thus also

[6] Based on data about migration intensions from Germany, this is also confirmed by Uebelmesser (2006).

[7] We thus abstract from migration during the period of higher education as well as later during the working life.

country-specific) human capital becomes important soon after entering the labour market.

Students seem to have a strong preference for studying close to home (Kelchtermans and Verboven 2008); those who study abroad, however, are more likely to stay abroad (Oosterbeek and Webbink 2006; Parey and Waldinger 2007, among others). If the general migration propensity of graduates indeed is largely determined by previous migration for educational purposes, one might be tempted to conclude that student mobility is a precondition for graduate mobility and thus plays a more important role—even though empirical evidence is difficult to get hold of.

Apart from the difficulties to find migration data that allow differentiating between the different groups, it is also important to note that data on migration flows are only helpful as far as they allow to draw conclusions about the (actual and potential) relative mobility of students and graduates. The absolute magnitude of the migration flow is of minor relevance as it is likely that the financing decision of higher education is not so much affected by it as by the general propensity to leave the home country, i.e. by the threat of migration (cf. Andersson and Konrad 2005).

What can be observed, though, is the steady increase in foreign enrolment. Over the past three decades, the number of students in a foreign country has more than quadruplicated rising from 0.6 millions in 1975 to 2.7 millions in 2004 (OECD 2006). This process has accelerated over the last 10 years, where the number of foreign students has doubled. This can be seen as reflecting the general globalization trend. It can be expected that the internationalization of tertiary education will be further boosted by the Bologna process, which we will discuss in some detail subsequently.

2.2 Financial regimes

Total expenditure on higher educational institutions is non-negligible in most countries. As a percentage of gross domestic product (GDP) it ranges from 0.9 percent to 1.8 percent in the EU-25 countries for which data are available with Denmark, Finland and Sweden leading the list and Italy and the Slovak Republic spending the least (cf. Figure 1, all data for 2003). For comparison, the United States exceeds all EU-25 countries with 2.9 percent. Between 1995 and 2003, total expenditure slightly increased in most countries.

The two main financial regimes of higher education are a system where education is publicly financed via taxes and a system where financing of education is private, i.e. where it is based on fees. In all EU-25 countries, some combination of these two systems can be observed, but public financing clearly dominates. Only in Poland, private financing plays a

	1995	2003		
	Total	Public	Private	Total
Austria	1.2	1.1	0.1	1.1
Belgium	–	1.2	0.1	1.3
Czech Republic	1.0	0.9	0.2	1.1
Denmark	1.6	1.7	0.1	1.8
Finland	1.9	1.7	0.1	1.8
France	–	1.1	0.2	1.4
Germany	1.1	1.0	0.1	1.1
Greece	0.8	1.2	–	1.3
Hungary	1.0	1.0	0.3	1.3
Ireland	1.3	1.0	0.1	1.2
Italy	0.8	0.7	0.2	0.9
Netherlands	1.4	1.1	0.3	1.3
Poland	0.8	1.0	0.5	1.5
Portugal	0.9	1.0	0.1	1.1
Slovak Republic	0.8	0.8	0.1	0.9
Spain	1.0	0.9	0.3	1.2
Sweden	1.6	1.6	0.2	1.8
United Kingdom	1.2	0.8	0.3	1.1
United States	2.7	1.2	1.6	2.9

Source: OECD (2006) – tables B2.1b

Figure 1 Expenditure on higher education as a percentage of GDP—EU25 and United States

significant role. Private sources are more important than public ones, however, in the United States.

3 The model

As already mentioned, we focus here on a two-period, two-stage game with two countries.[8] The production sector in each country uses two kinds of input: skilled and unskilled labour. Production takes place according to a neoclassical production function with constant returns to scale and complementarity between skilled and unskilled labour. Labour markets in each country are competitive and wages correspond to the respective productivities per skill-unit.

In accordance with the empirical evidence cited earlier, we assume that unskilled individuals are immobile and analyse the impact of mobile

[8] See the Appendix for a more technical presentation of the basic ingredients of the model.

students and/or mobile graduates on the provision of higher education.[9] We also choose a general setting with a mixed financial regime with pure tax-financing and pure fee-financing as special cases.

Individuals differ with respect to their innate ability where we assume a uniform distribution of abilities. For unskilled jobs, the ability level is not relevant. Only if individuals receive some education, their ability becomes important as the returns of higher education depend on the quality level of education as well as on the innate ability. Both together generate the skill-units an individual is endowed with after having acquired education.

For simplicity, we assume that the amount of money spent for higher education per individual only depends on the level of education quality. Costs of education are thus proportional to the number of students, given the quality; they increase in a convex way. This reflects that education is considered here to be a private good.

Apart from the technology-related interpersonal links, which are reflected in the complementarity between skilled and unskilled workers, we do not consider any additional externalities—in particular, we abstract from positive spill-over effects among students and skilled workers. We follow here the interpretation of the empirical literature by Jacobs and van der Ploeg (2006) according to which the empirical evidence in favour of human capital externalities is not very strong. The social (macroeconomic) returns to education are approximately equal to the private (micro-economic) returns.[10] It is important to note that this implies that in our framework public funding of higher education needs to be justified on other grounds than externalities.

The set-up we have in mind is the following: at the first stage, governments choose the quality level of education and how higher education is financed, i.e. via taxes and/or via fees. Both countries may differ with respect to both dimensions. At the second stage, individuals make their education and migration decisions given the governmental arrangements for higher education. We introduce a two-period life-cycle model. In the first period, individuals decide whether (and where) to study. For this, they compare the maximal lifetime income with higher education to the lifetime income they receive when uneducated. Individuals without higher education are assumed to be immobile.

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[9] The framework is thus more general than in most of the papers cited below—with the exception of Kemnitz (2005)—which focus on either the possibility of migration before studying (cf. Mechtenberg and Strausz 2008) or on possible migration of graduates or skilled workers respectively (cf. Wildasin 2000; Thum and Uebelmesser 2003; Poutvaara 2006; Busch 2007).

[10] For more details, see the empirical literature cited there.

Thus, individuals who choose not to study work and earn the wage income of an unskilled in their home country in both periods of their life. As for those who choose to acquire education, in the first period, they receive no wage income. In the second period, if they are mobile, they decide in which country to work and earn the wage income of a skilled there. Taxes and/or fees are paid according to the financial regime in place. We investigate the impact of distortions on credit markets by which we understand an interest rate that exceeds the population growth rate. Young individuals have to bear an extra cost for borrowing. In particular, those who choose to study bear the cost because they have no earnings in the first period and must borrow to finance the fees (if any) and their consumption.

4 Education decision in closed economies

As a benchmark, we start with the non-migration case and analyse the individual and governmental decisions within a closed country. In particular, we contrast the individual choice of studying with the decision problem of the government to choose the quality level without observing abilities. We allow for different financial regimes. With this we are able to capture the fact that the importance of fee- and tax-financing varies across countries (cf. Figure 1).

It is important to note that we assume here a uniform level of education quality in the sense that—once decided by the government—it applies to all students. This implies in particular that it cannot be topped up privately. This assumption is approximately satisfied in most EU-countries since higher education is predominantly publicly financed (cf. Figure 1).

4.1 Individual decisions

When individuals face the decision whether to acquire higher education or not, they compare their lifetime incomes with and without education and choose the option which maximizes their income.

If higher education is purely tax-financed, students do not have to contribute at all to the costs of higher education while studying. The necessary taxes are levied from the unskilled in both of their working periods and from the skilled after having completed their studies. With pure fee-financing of higher education, on the contrary, students have to fully cover the costs of higher education while studying, whereas there are no taxes to be paid by skilled or unskilled workers.

The focus here is on a mixed system where higher education is financed partly by fees paid by students and partly by taxes levied on labour income. This represents the most general case.

In all cases, the decision whether to study or not depends on the ability of the individual. The periodic net wages—appropriately discounted—allow us to determine the marginal ability type who is just indifferent between studying or not. In general, we find that—quite intuitively—the higher the share of education costs financed by taxes, the more attractive it is to become skilled: this allows escaping the tax duties during the first period when studying and above all this implies a reduced total financial burden as part of the costs are co-financed by the unskilled via their tax payments. In fact, an important difference between both systems is that with a tax-regime—but not with a fee-regime—students partially free-ride on the unskilled who contribute to the financing of higher education via tax payments in both of their working periods.

We focus here on an equilibrium under rational expectations. This means that the individual decisions to be skilled or unskilled are based on "expected" wages. These decisions or more precisely the ability threshold of the marginal individual determines the supply of skilled and unskilled labour, which in turn determines the wages that clear the markets. At an equilibrium, these realized wages must be equal to the initial expected wages.[11]

For the following analysis, it is important to get a more precise idea of how the level of education quality affects the ability threshold, which is implicitly given by the employment equilibrium. The quality level has two direct effects: one is beneficial because the total wage of a skilled worker is proportional to the quality level of education; the other one is harmful because the individually relevant costs increase with the quality level. The total impact of these direct effects depends on the financing of the system. More precisely, the cost effect for the individual decision to acquire higher education is the less important the larger the share of the costs financed by taxes.

In our general equilibrium modelling framework, there is an additional indirect effect on wages that always lowers the benefits: increasing the level of education quality is akin to an increase of the amount of skilled labour. Hence skilled wages decrease and unskilled wages increase. The more elastic wages are, the stronger the indirect impact is. In particular, with full complementarity between skilled and unskilled labour, increasing the quality level of education always discourages some individuals to acquire education.

[11] In our companion paper, Demange, Fenge and Uebelmesser (2007), we have established that for the given modelling framework the equilibrium is unique. The intuition is that as there are fewer skilled individuals, the incentives to become skilled are enhanced through the impact on wages, which gives an equilibrating force. In other words, increasing the threshold ability means that fewer workers acquire skills, which raises the wage rate for skilled and decreases the wage rate for unskilled.

The total effect can therefore not be determined unambiguously: it is well possible that a higher quality level induces more individuals to become skilled, which would lower the ability threshold. It is, however, also possible that a higher quality level discourages some individuals from acquiring higher education if the negative relative wage effect as well as the cost effect dominate. This would then lead to a higher ability threshold.

To get a better idea of which of the two cases is more likely, we look at some (indirect) evidence taking both sides of the market, i.e. the supply and the demand of skilled workers, into account, as both sides are important as relative wage changes are concerned.

In fact, when studying the college graduate wage relative to the high school wage in the United States, we see a clear upward trend of the college wage premium since the 1950s—interrupted only by a decrease between 1970 and 1980 (Goldin and Katz 2007).[12] During this period, demand of college "equivalents" relative to high school "equivalents" has increased—most strongly in the period 1980–90.[13] At the same time, supply of college "equivalents" has also increased—especially between 1970 and 1980 and to a lesser extent after 1990. The slowdown of the growth of relative supply for the last 15–25 years could be interpreted as a reaction to expected lower relative wage growth by individuals who have consequently abstained from higher education. Indeed, Goldin and Katz state that the observed rise in the college wage premium after 1980 has been mainly due to the strong decrease of the growth of the skilled labour supply. This would point towards a negative correlation between the quality level of education and the number of students if indeed changes of the quality level could be identified as the driving factor.

It is evident, however, that if changes of the supply of skilled workers coincide with changes of the demand, it is not easy to isolate the effect of an increase in the education quality on the number of students, i.e. on the ability threshold. This shows that a more general framework, which allows that the correlation can be negative or positive, has some benefits.

4.2 Government decisions

We first look at the optimum as implemented by a social planner and then derive the decisions of a government as the provision of higher education is concerned.

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[12] This can also be observed in the UK and to a lesser extent in continental Europe (Davis, 1992).

[13] College "equivalents" comprise college graduates plus one half of those with some college education, while high school "equivalents" refer to those with 12 or fewer years of schooling and the other half of those with some college education.

Under complete information about individual abilities, a social planner can decide on the level of education and on the ability of those who study, i.e. on the ability threshold. The objective function of the social planner is aggregate production net of education cost at a steady state.[14] In other words, we are at the golden rule with an implicit interest rate equal to the population growth rate, which is here equal to zero.

The ability threshold is then chosen such that for the marginal student the net gain of education is null, i.e. the skilled wage in the second period net of the costs of education in the first period just equals the opportunity costs in form of unskilled wages in both periods. As concerns the education quality, the optimal level is determined by the social planner such that the marginal gain from a change in education for the average student is equal to the marginal cost.

For the following analysis, we enlarge the setting in two ways:

First, individual abilities are no longer observable (or contractible). Due to these informational asymmetries, the set of students can no longer be directly chosen but it depends on the decisions by the individuals. The best the government can do is to determine the level of education taking account of these decisions.

Second, the interest rate faced by the individuals is no longer necessarily at the golden rule level. A positive interest rate can be interpreted as a risk premium charged by credit markets due to the risky investment in human capital and moral hazard problems leading to distortions, which we want to capture (von Weizsäcker and Wigger 2001; Jacobs and van der Ploeg 2006).

We look at the general case where the costs of higher education are mixed-financed. The specific financing regime affects the budget constraint and thus the optimization problem of the government. The government maximizes again aggregate production net of education costs by choosing simultaneously the quality level of education and the share of costs financed by fees where the tax rate is endogenously determined by the budget constraint.

As the government now disposes of two instruments, it is well possible that the optimal policy of the social planner can be mimicked. In fact, if the interest rate is at the golden rule level, the optimum is reached with pure fee-financing. This is intuitive as in the absence of any distortions, there is no reason for governmental intervention in the form of tax-financing of higher education. If, however, the interest rate exceeds the golden rule level due to distortions on credit markets, these distortions justify a (partial) intervention of the government via tax-financing.

[14] This is the criterion that obtains in a fully fledged overlapping generations economy in which the social planner treats all generations equally.

The optimal policy can be reached with a mixed-financing regime. The reason for the optimality of mixed-financing with distortions on the credit markets is that with pure fee-financing too few individuals decide to study. The welfare can thus be increased by subsidizing higher education via taxes as this encourages more individuals to study. It should, however, be noted that if the distortions on the credit markets are high, the fee level has to be negative, meaning that students then are even directly subsidized for acquiring education.

In a framework with skill complementarities, but in the absence of any externalities, we have thus established the optimality of partial tax-financing, which rests entirely on efficiency (and not on equity) considerations. We have argued that the optimal share of taxes and fees depends on the degree of distortions on capital markets. As it is likely that capital market institutions vary across countries, the implemented financial regimes should differ as well. We are thus able to give a rationale for why different countries resort to different systems as the relative importance of fees and taxes for financing higher education is concerned as long as borders are closed.

5 Education and migration decisions in open economies

With open borders, the relative importance of taxes and fees and the quality of education can be expected to be affected. We take the closed economy as a starting point for the following analysis where we allow for mobility—first only of skilled workers and then of both students and skilled worker.[15]

We consider two identical countries A and B. The number of students depends on the decisions of the different ability types to take up a university education in one of the two countries, which in turn depends on the institutional framework and expected wages. This determines the labour force of skilled and unskilled workers in the whole economy. We focus here again on the case where capital markets are distorted. As we know from the previous analysis, in a closed economy setting, at least, an appropriately chosen mixed-financing regime would achieve the optimum. The question is then how the financing of education, the level of education quality and also the number of students and skilled workers change if the governments take mobility into account.

[15] The focus is here on two political entities—countries or regions—with the competence to determine the education policy and to raise the necessary financial resources. We comment on other settings in the conclusion.

5.1 Only skilled workers are mobile

First, only skilled workers are mobile, while students and unskilled workers are immobile. Skilled workers will migrate between both countries as long as the net-of-tax wage income is different. Thus, the migration equilibrium requires that skilled workers receive the same net wage income in both countries (arbitrage condition).[16]

Let us consider the mixed system that implements the optimal policy in a closed economy. Starting from this situation, we want to determine how welfare of one country, say country A, changes, when this country modifies its financial regime. We are thus interested in seeing whether the optimal policy is a Nash equilibrium, and if not, in which direction a country is incited to change the fee level.

To be more precise, we first consider the welfare of a country at the new equilibrium induced by the new fee level but keeping the level of education quality fixed. The equilibrium is again determined by the ability thresholds, the taxes and the migration levels that satisfy the budget constraints in the two countries as well as by the arbitrage condition. We assume that the migration equilibrium is stable. The stability condition needed to ensure this is that the net skilled wage in the country which receives migrants decreases with migration. This simply implies that if the net skilled wage in one country, say A, exceeds the net skilled wage in the other country, say B, migration from B to A reduces the gap between the skilled net wage in the two countries accounting for equilibrium effects, i.e. for the decisions to acquire education and the impact on wages and taxes. If we can establish that the stability condition holds, it can be shown that both countries will increase fee-financing above the level necessary to achieve the optimum.

Let us provide some intuition for this: if country A increases its fee without changing the quality level of education, there will be fewer individuals who decide to study, i.e. the ability threshold will increase. The higher share of fees as well as the smaller number of students enable country A to lower its tax rate. In addition, since the number of skilled individuals decreases the wage rate of the skilled relative to the unskilled increases. The higher net wage attracts skilled workers from country B who have received higher education there: country A free-rides on country B.[17] So far, we have assumed that country B does not react to the outflow of (part of) its skilled labour force. Country B has, however, the same incentives to increase its fee as country A has. It follows that the

[16] We rule out corner solutions where all skilled individuals move to the same country by assuming that the Inada condition holds for the production function.

[17] There is, however, a countervailing equilibrium effect: the higher skilled net wage incites more people to study. But this (second-order) effect does not dominate here.

closed-economy level of the fee is not a Nash equilibrium when skilled workers are mobile. In the new equilibrium, the fee level in both countries will be higher than the level that achieves the optimum as both countries aim at attracting foreign skilled workers as tax-payers, while free-riding on the other country's provision of higher education.

For the question of how the chosen level of education quality changes in an open-economy setting with mobility of skilled workers, it is again necessary to consider what happens to the net wages of the skilled when a closed economy modifies its quality level. It is reasonable to conjecture that when the level is decreased fewer individuals decide to study. This increases skilled wages and decreases the total costs of education which triggers a decrease in taxes. This leads to higher skilled net wages. Under a stability condition, skilled workers are again attracted from the other country when economies are open. Thus, if the conjecture is true, both countries have an incentive to decrease the quality level of education below the optimal one.

To sum up, when students are assumed to be immobile, the rationale for countries to adjust their education policies is to attract skilled workers. This is achieved by increasing the net-skilled wage rate, i.e. by decreasing the tax rate or by increasing the skilled wage rate (or by both). It has been shown that under some technical conditions (specifically an arbitrage and a stability condition) and given that the quality level of education and the number of students are positively correlated, countries can reduce education costs borne by the public via taxes by increasing fees or by lowering the quality level of education. In both cases, the number of students is reduced thereby making the skilled labour force scarcer.

The deviation from the optimal policies results from the exclusive focus on skilled workers as the only mobile group. One possibility to counteract this is to increase the mobility of other groups as well. We investigate this rationale for promoting the mobility of students in the following.

5.2 Skilled workers and students are mobile

We next consider the case where students are mobile and have access to the education system of a foreign country at the same conditions as natives in line with EU non-discrimination rules. Graduates are assumed to be (partially) mobile as well. We thus allow for some non-perfect link between student and graduate mobility following, e.g. the evidence provided by Parey and Waldinger (2007). Now, young individuals not only have to decide whether to study but also where to study. In both countries, in the first period, individuals then compare their net lifetime incomes for all possible education and migration choices. This gives the

marginal ability types of the young individuals who are indifferent between studying or not and migrating or not.

Let us start again from the symmetric mixed-financed system which is optimal in closed economy. As before, we want to distinguish two cases in the following.

We assume first that the quality level is kept unchanged in both countries. Let a country, say A, contemplate increasing its fee. Only fees matter as by the arbitrage condition the net skilled wages are equalized if a sufficiently large part of the skilled workers is mobile. It follows that for any ability level the net lifetime income of a skilled would be larger by studying in country B: all individuals will study in B if they decide to study. As a result of the large inflow of students, country B would then have to increase fees up to the same level as in A. This would lead to the same financing policy with the same number of students in both countries. Higher education, however, would now be financed by a sub-optimal mixture of fees and taxes. If A anticipates the reaction of B, it is plausible to expect country A to abstain from increasing the level of fees in the first place. A symmetric equilibrium would then result where the optimal finance mix of the closed economy could be sustained.

Next, we consider the case where the quality level can be adjusted as well. From the previous argument it follows that a migration equilibrium with different levels of fees and taxes in the two countries can only realize if the quality level of education in a country, say A, which increases its fees exceeds the one in country B. Then A specializes in attracting high-ability students while B focuses on low-ability ones. Whether this constitutes an equilibrium when general equilibrium effects are taken into account, depends on the specific functional forms. The relative importance of student and graduate mobility will be essential for the financial regime and the quality level of education. Note, however, that, in general, this differentiation could present one possibility to alleviate a sub-optimality inherent in our model. By assuming a uniform level of education quality which applies to all students in a country, we have ruled out that education can be topped up individually to better correspond to individual ability. If migration and the ensuing competition between countries result in differentiated quality levels across countries, the uniformity of education quality on a country-level is no longer as detrimental from a welfare point of view.

In fact, even though it is difficult to identify clear instances of intentional differentiation strategies across countries, within countries, examples can be found. In the United Kingdom, for example, the Russell Group, an association of 20 major research-intensive universities, strives at maintaining the highest standards of research, education and knowledge transfer. By doing so, the universities which belong to this

group clearly want to differentiate themselves with respect to other British and possibly European and North American universities. This can, however, be only partially translated into a correspondingly large differentiation of fees as British students are concerned given the maximum of £3000 which universities are allowed to charge per year for full-time undergraduates. This upper bound also applies to students from the European Union due to the non-discrimination rules, but there is no limit for fees for students coming from outside the European Union.

Summarizing, with mobile students in addition to (partially) mobile skilled workers, the suboptimality of the finance structure of higher education, which was the case when only skilled workers were mobile, can be expected to vanish. If, in addition, the requirements that the quality levels of education have to be the same in both countries are relaxed, differentiated quality levels could result. This would then alleviate the inherent inefficiency that stems from the imposition of a uniform level of education quality within a country.

6 Policy implications

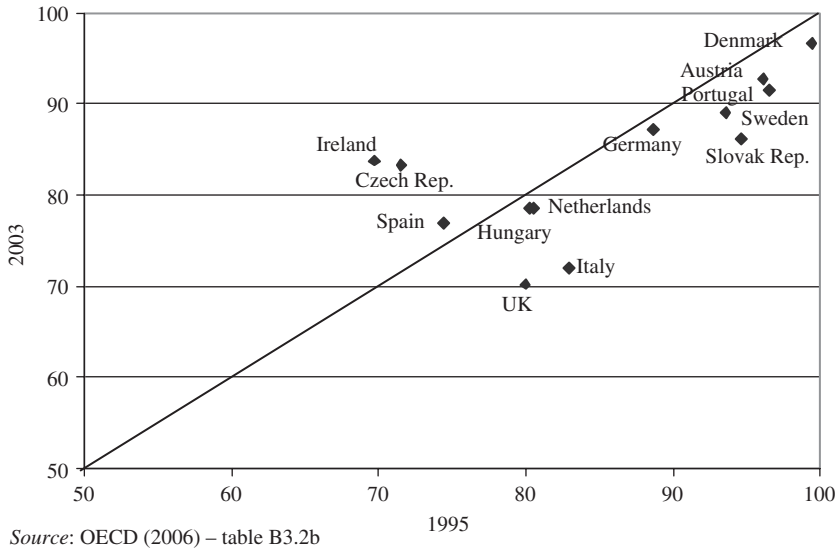
The analysis has shown that with integrated labour markets where students and/or skilled workers are mobile, the financing decision and the chosen quality level of education are affected. This conclusion points to relevant policy issues (cf. Del Rey 2001). We will first elaborate on policy conclusions which can be directly derived from the model and then discuss related issues.

6.1 Conclusions from the model

In the context of the European Union, the principle of non-discrimination on the basis of nationality prevents the differential treatment of native and foreign students and thus restricts the set of possible financial instruments.[18] It is thus necessary to be clear about how higher education should be financed.

As long as no full-cost fees are charged and as long as no transnational compensation mechanisms exist, it is likely that foreign students pay only part of the costs with the rest being subsidized by the tax-payers of the country that provides higher education. There are some complaints, in particular by Austria and Belgium because of the many students from

[18] This has been challenged—albeit unsuccessfully—by Belgium, Denmark and the UK. They were taken to court in 1985 as they insisted that according to the subsidiarity principle every Member State should have responsibilities towards its natives, but not towards the citizens of other countries (Gravier judgement, European Court of Justice, 1985 – cf. also Del Rey 2001).



Source: OECD (2006) – table B3.2b

Figure 2 Share of public expenditure for higher education as a percentage of total expenditure – EU25

Germany and France, respectively, who go there to pursue their studies before returning back home in order to get around the access restrictions, which exist in their home countries. As has been shown in the model when skilled workers, i.e. graduates, are mobile, countries give a more important role to fees. This tendency towards more fee-financing can also be seen in the data.

Figure 2 displays the share of public expenditures for higher education of the EU-25 countries in 1995 and 2003. In countries which are above the diagonal line, the relative proportion of public expenditure has increased between 1995 and 2003, while taxes have become relatively less important in countries below the diagonal line. With the exception of Ireland, Spain and the Czech Republic, we find for all countries for which data are available that the share of public expenditures decreased implying that the share of private expenditures increased for the period under consideration.

There are different possible explanations for this trend towards relatively more fee-financing (cf. Jacobs and van der Ploeg 2006): On the one hand, the growth of public funds has decreased and can be expected to continue to do so due to ageing and due to restricted borrowing possibilities for members of the European Union for which the Maastricht criteria apply. On the other hand, as the analysis here has shown generating public funds has also become more costly because of the increased mobility of the tax-payers. The interplay of the financing regime

of higher education and the mobility of students and/or graduates is of particular relevance. This is also what can be observed when following the recent discussions and reforms in some European countries.

For illustration, we briefly summarize the debate in Germany. There, student tuition fees were banned until January 2005 when the Federal Constitutional Court abolished this ban. Since then, 8 of the 16 German States have passed laws to introduce fees in the range of €300–€500 per semester. Those which have abstracted from charging fees—mostly states in East Germany—hope to attract more students to their universities. This change of policy has been accompanied by intensive discussions of advocates and opponents. Those in favour of student fees claim that these fees will provide universities with the additional funds needed, in order to overcome the international disadvantages of German universities. Fees are intended to improve teaching and learning conditions and thus the quality of higher education in a significant way (cf. HRK 2005). Given the federal structure in Germany with the states being responsible for all educational issues, it will be interesting to observe whether the initially chosen fee policies can be sustained and whether there will be any impact of the different funding structures on the quality levels of education.

Even though it is too early for first conclusions, critical voices point out two possible drawbacks. First, as total expenditure for higher education is concerned there is fear that public funding is reduced in reaction to the increased private sources. Partial crowding-out of tax-financed contributions would not help the catching-up process (Kemnitz 2005). Second, in the presence of distorted capital markets, this shift towards more fee-financing might distort the optimal financing-mix. But as we have seen, this last problem is mitigated if not only skilled workers, but also students are mobile. This provides, of course, a rationale for the Bologna process.

In addition, those who are against fees worry that equality of chances is endangered concerning access to higher education.[19] This makes it necessary to think about loan facilities and grants (Jacobs and van der Ploeg 2006) and more generally, to discuss how to best allocate the competence for higher education across the different political entities—something which we will do in the following.

[19] Note that even before the introduction of fees, higher education tended to be regressive reinforcing economic inequalities. This was due to the relatively strong selection of children from a high-income background into universities compared to the economically disadvantaged (see Frick, Grabka and Groh-Samberg 2007, for Germany and Chapman 2006, for Australia).

6.2 Further considerations

The questions about how to best fund higher education are closely related to the questions of which country should be hold responsible for (the organization of) the financing of studies pursued abroad. Gérard (2007) distinguishes between the home country of the student and the country that provides higher education—or correspondingly the origin principle and the production principle.

As long as financing is based on a mix of fees and taxes where the taxes are levied from those working in the country which provides higher education, the production principle applies—at least as the share of tax-financing is concerned. One possible remedy could be to move closer to the origin principle.

We distinguish here between a larger financial responsibility for education acquired abroad, which is borne by the foreign students or their home country. With the tax liability shifted to the home country of the students, an appropriate system of compensatory transfers—similar to what exists in Switzerland on an inter-cantonal level—could be installed in order to internalize the externalities generated by student and/or graduate mobility. This could be seen as a "natural" consequence of the Bologna process, which shifted some functions such as standardization of degrees and transparency of contents to the European level without realizing that this half-heartedly approach is responsible for the distortions that can be observed today.

Alternatively, the students could be more strongly involved financially by moving more towards fee-financing—a tendency which can be observed in most countries (cf. Figure 2). To alleviate distortions related to imperfect capital markets, the specific design of the financial regime would then be of importance.

Income-contingent loans present one possible instrument. First introduced in Australia in 1989, they have been adopted since then in New Zealand, South Africa, the UK and Thailand, and are planned for 2008 in Israel (see Chapman 2006, for an analysis of the Australian case). They provide students with the sources necessary to finance their education while repayment is conditioned on their income after graduation. Income-contingent loans can thus be seen as a mixture of loan and insurance.[20]

[20] Means-tested subsidies present another option. In contrast to income-contingent loans, they are targeted at poor students or students with low-income parents in order to remove the particularly adverse conditions faced by this group. In the absence of distortions on the credit market, equality of chances can already be achieved by income-contingent loans, which have the additional advantage of avoiding any negative repercussions on the saving-incentives of students and their parents.

Graduate taxes constitute an alternative policy to provide students with the necessary financial means to pursue their studies. Repayment constitutes, however, a certain fraction of future income. This implies that the payments of some graduates with high incomes will exceed the costs of education, while they will fall short of them for other graduates with low incomes. Only on an average is there a correspondence between per student costs and per graduate contributions. Exit taxes or "brain taxes" as first proposed by Bhagwati (1972) in the context of the brain drain from developing to developed countries can be considered as a special version of graduate taxes.

Compared to a traditional tax-subsidy scheme similar to the one in our model, income-contingent loans and graduate taxes are superior in terms of efficiency and/or equity (cf. Poutvaara 2004; García-Peñelosa and Wälde 2000; Jacobs and van der Ploeg 2006). While García-Peñalosa and Wälde (2000) find that when education outcomes are uncertain, graduate taxes are to be preferred because they provide more insurance, Jacobs and van der Ploeg (2006) argue in favour of income-contingent loans because in their view they are more flexible and better able to avoid moral hazard problems.

Given the increasing mobility of students and skilled workers, repayments of the costs of higher education are not always guaranteed if they are moved to periods after graduation. This problem equally concerns financing via loans and graduate taxes. In fact, by moving from fees, which have to be paid up-front, to income-contingent loans or graduate taxes, which are both due after graduation, an enforcement problem as in a tax-financing system is reintroduced.

A central, supra-national institution would then be needed. This could mean to assign a more active role to the European Union. One could think about establishing a monitoring system to guarantee the compliance of the financial obligations—either by foreign students or by their home countries. As the individual repayment behaviour of students is concerned, this would very probably only help to partially alleviate the problem given the number of students and graduates of whom it would be necessary to keep track. It would be probably more promising—and also more in line with the subsidiarity principle—if the European Union coordinated the compensatory transfers across countries, while the countries remained responsible for generating the necessary resources from their citizens. With full-cost compensations, the incentives to free-riding on other countries' provision of higher education would then vanish.

A more pronounced involvement of the European Union as the financial side is concerned—in addition to its involvement with the standardization and transparency of degrees—is a pre-condition for the further development of the European Higher Education Area including policies which

further stimulate the mobility of students. This brings us, however, to the question of the preferred allocation of competance for higher education. There is some evidence that transferring more financial competence to the European level might face some resistance. Given the general understanding of most governments—and their citizens (cf. Cerniglia and Pagani 2007)—that education should remain a national area of competence, a stronger involvement of the European level might be considered to be wishful thinking at the moment. Instruments which would allow achieving the optimum might not be feasible. It is thus necessary to consider the best policies given these constraints and to think about further reforms necessary to minimize the distortions stemming from an integrated economy.

7 Concluding remarks

We are now able to answer the two questions which we have asked at the beginning. With mobility of skilled workers only, governments have an incentive to decrease education spending—either by increasing fees or by decreasing quality to sub optimal levels as compared to the closed economy. This allows increasing net skilled wages and attracting skilled labour. As we have seen, promoting mobility of students helps to counteract this exclusive focus on skilled workers and can alleviate the sub-optimality of both the finance-mix and the quality level of education. This may provide a justification for the Bologna process.

We have restricted our analysis to symmetric countries, which have the competence to determine the education policy and to raise the necessary financial resources. Both assumptions deserve some discussion.

It is, first of all, evident that countries in the European Union differ as their attractivity for foreign students and/or foreign graduates is concerned. We have seen above that, e.g. the small countries Austria and Belgium complain about the significant net inflow of students—mostly from their big neighbours Germany and France. The question is whether these asymmetric flows of migrants constitute an equilibrium or whether they must be interpreted as a transitional phase from one (closed economy) equilibrium to one (open economy) equilibrium. As long as it is not the case that some countries possess a more efficient production technology for education or other inherent advantages in relevant areas, there is no strong case to believe that these observed asymmetries will persist permanently.

It is also evident that not all political entities—especially on a sub-national level—have the competence to decide about education and tax policy. If, e.g. only the education policy is decentralized, but not the

tax policy, it depends on the financial compensation scheme in place how the decision about the quality of higher education is affected by the mobility of students and/or skilled workers. If there is a full-cost compensation, the incentives are certainly larger to implement a high quality level than if there is a lump-sum compensation—perhaps based on some average cost or quality level. For certain compensation schemes, it might thus be worthwhile to try to attract students, while inducing more skilled workers to move to a certain region does not seem to be very profitable when taxes are collected centrally anyway.

We have found in our analysis that the policy is always targeted at the mobile group of individuals. This is intuitive and has also been shown in other papers with different modelling set-ups (Andersson and Konrad 2005). It is therefore worthwhile to stress again what we consider to be the advantage of our approach. Due to the general-equilibrium effects present in our analysis and the explicitly considered education and migration decisions, the results are often ambiguous. It has become clear indeed that the results rely on some technical conditions—in particular, the arbitrage and the stability condition—as well as on several assumptions—above all the assumed positive correlation of the quality level of education and the number of students. It is therefore ultimately an empirical question whether, in a specific context, the assumptions are fulfilled and the conditions hold. It is well possible that this is not always the case. The chosen general-equilibrium approach allows modelling the complete picture including all relevant effects and is thus flexible enough to be applied to different institutional environments.

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Appendix

Basic ingredients of the model

We sketch here the model for the closed economy presented in Demange, Fenge and Uebelmesser (2007).

Production in each country takes place according to a neoclassical production function with constant returns to scale

$$F(L_u, L_s) = L_u f\left(\frac{L_s}{L_u}\right) = L_u f(l) \tag{1}$$

with $l = L_s/L_u$ where L_s and L_u denote skilled labour and unskilled labour, respectively. With competitive labour markets in each country productivities of skilled and unskilled workers are equal to their respective wage rates w_s and w_u:

$$w_s = f_l \tag{2}$$

$$w_u = f - lf_l \tag{3}$$

Individuals are distinguished by an ability parameter, y, uniformly distributed in the range $[0, \overline{y}]$. To be skilled, an individual must receive some education denoted by e. The quantity of skilled labour provided by an educated worker is then given by ye. We assume that the amount of money spent for higher education per individual only depends on the education level, i.e. $c(e)$. The cost function c is assumed to be increasing and convex.

Throughout the article, to avoid corner solutions, we assume Inada conditions: $\lim_{L_u \to 0} F_{L_u}(L_u, L_s) = \infty$ and $\lim_{L_s \to 0} F_{L_s}(L_u, L_s) = \infty$ as well as $\lim_{e \to \infty} c'(e) = \infty$.

Individual decisions

Higher education may be financed by fees paid by students and by taxes levied on labour income. A student with ability y then pays a fraction $0 \leq f \leq 1$ of her education costs as fees during the first period of studying

and receives a wage income net of tax of $w_s ye(1-\tau)$ in the second period, where τ is the tax rate levied to finance the remaining costs of higher education. Thus, her lifetime income—appropriately discounted by r—is

$$(1-\tau)w_s \frac{ye}{1+r} - f \cdot c(e). \tag{4}$$

If the individual decides not to study, she receives a wage income net of tax of $(1-\tau)w_u$ in both periods. Hence, her lifetime income is

$$(1-\tau)w_u \frac{2+r}{1+r}. \tag{5}$$

The marginal ability type who is indifferent between studying or not can then be characterized by

$$y^{FT} = \frac{w_u(2+r)}{w_s e} + \frac{(1+r)f\, c(e)}{(1-\tau)w_s e} \tag{6}$$

The pure fee and pure tax financing systems can be obtained as special cases.

The education level e and the financing parameters f, τ and r determine a (steady state) equilibrium of the labour markets. Given e and y, the employment of unskilled labour is given by

$$L_u = 2\int_0^y 1\mathrm{d}z = 2y = 2N_u \tag{7}$$

where N_u is the number of unskilled workers and where the population growth rate is assumed to be zero. The effective skilled labour is

$$L_s = \int_y^{\overline{y}} ze\,\mathrm{d}z = e\left(\frac{\overline{y}^2 - (y)^2}{2}\right) = (\overline{y}-y)e\left(\frac{\overline{y}+y}{2}\right) = N_s e\left(\frac{\overline{y}+y}{2}\right) \tag{8}$$

where N_s is the number of skilled workers and $\frac{\overline{y}+y}{2}$ is the average ability of those workers.

The above expressions determine the labour forces and hence the wages of skilled and unskilled labour thanks to Equations (2) and (3) as a function of the threshold y. These wages in turn determine the incentives to be skilled, i.e. y^{FT} as given by Equation (6). At an equilibrium of the labour markets, the obtained value y^{FT} must be equal to the initial value y.

Government decisions

Under complete information on individuals' abilities, a social planner can decide on the level of education and on the ability of those who study. The objective is to maximize aggregate production net of education cost at

a steady state, $W(y, e) = F(L_s, L_u) - N_s c(e)$, by choosing e and y, where L_s, L_u are functions of e and y from Equations (7) and (8) and N_s is a function of y alone,

The impact of a marginal increase in e keeping the set of students fixed is given by

$$\frac{\partial W}{\partial e} = F_{L_s}\frac{\partial L_s}{\partial e} + F_{L_u}\frac{\partial L_u}{\partial e} - N_s c'(e) = (\overline{y} - y)\left[w_s\frac{\overline{y} + y}{2} - c'(e)\right] \qquad (9)$$

The impact of a marginal increase in the minimum ability level y, keeping the education level fixed is given by

$$\frac{\partial W}{\partial y} = F_{L_s}\frac{\partial L_s}{\partial y} + F_{L_u}\frac{\partial L_u}{\partial y} - c(e)\frac{\partial N_s}{\partial y} = -w_s e y + 2w_u + c(e) \qquad (10)$$

At the optimum, the level of education and the threshold ability level are given by Equations (9) and (10) set equal to zero.

Now individuals' abilities are no longer observable. The cost of higher education is partly financed by fees paid by the students and partly by taxes levied on wage income. The budget of the government is given by

$$\tau(w_s L_s + 2w_u N_u) = (1 - f)c(e)N_s, \qquad f \in [0, 1] \qquad (11)$$

The government maximizes aggregate production net of education costs by choosing e and f

$$\underset{e,f}{Max}\ W(y^{FT}(e), e) = F(L_s, L_u) - N_s c(e) \qquad (12)$$

where the tax rate is endogenously determined by the budget constraint in Equation (11). The threshold ability for studying is now given by Equation (6).

To check whether the optimum can be achieved, let us consider the optimal levels e^* and $y^* = y^{FB}(e^*)$. To be implemented, one must find f and τ for which individuals have incentives such that the threshold equilibrium value y^{FT} is given by y^* and the budget constraint in Equation (11) is satisfied.

Given e^* and y^* the budget constraint determines the ratio $\rho = \tau/(1 - f)$. Now consider the expression of y^{FT} as given by Equation (6) where the right hand side is computed at the optimal levels (including the wages) and $\tau = \rho(1 - f)$. Using $y^* = y^{FB}(e^*) = \frac{1}{w_s^* e^*}[2w_u^* + c(e^*)]$, we have

$$y^{FT} = y^* + \frac{1}{w_s^* e^*}\left[r w_u^* - c(e^*) + c(e^*)\frac{(1 + r)f}{1 - \rho(1 - f)}\right]$$

The optimum is implemented for f such that $y^{FT} = y^*$, or equivalently for f for which the term in square brackets is null. As expected, for $r = 0$, the optimum is reached with pure fee-financing, i.e. $f = 1$. For $r > 0$, the optimum can be reached with mixed-financing if $rw_u^* - c(e^*) < 0$, i.e. if the distortion on the credit market is not too high.

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Investment in Tertiary Education: Main Determinants and Implications for Policy

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Abstract

Many OECD countries are aiming to reform their tertiary education (TE) systems. This work explores the determinants of the investment in TE, with a focus on institutional setting of TE systems and private incentives to undertake years of schooling beyond upper-secondary degree level. For this purpose the article first develops estimates of three main drivers of graduation patterns, namely institutional arrangements of TE supply, availability of funding for TE students and private returns to tertiary studies. Second, the article empirically assesses how these three factors affect graduation ratios. Based on this analysis, the article then discusses policy-levers of TE investment and explores possible routes of reform for TE systems in OECD countries. The main findings are as follows: graduation ratios increase with private returns to TE as well with the autonomy and accountability of the supply of education. Lack or insufficient financial help to tertiary students negatively affects graduation ratios. There is a number of policy-levers to stimulate investment in TE. They include policies affecting labour market *premia*, the degree of flexibility of TE provision and the availability of funding for students. (JEL codes: I21, I22, I28, J24)

Keywords: Investment in tertiary education, returns to education, supply of tertiary education.

1 Introduction

Tertiary Education (TE) is a key asset in knowledge-based economies: tertiary educated workers stimulate economy-wide productivity and growth, and are crucial for innovation and the use of new technologies (Aghion and Cohen 2004; Vandenbussche, Aghion and Meghir 2006). The role of higher education has often provided the case for massive public funding and regulation of this sector in many OECD countries. Yet, rising dissatisfaction with the performance of TE outcomes in a number of OECD countries has increasingly questioned the scope and the

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forms of public intervention. Calls for reform have been motivated by low quality and the excessive duration of studies, the substantial drop-out and the loose matching between qualifications and labour market-specific needs (Jacobs and van der Ploeg 2006). In this context, OECD countries face two main related challenges: how to make the most of public expenditure in TE and how to increase the overall resources invested in TE without further hinging on the public sector.

Against this background, this article aims at informing TE reform on several aspects. First, it documents TE outcomes, including the labour market rewards accruing to graduates. Second, it explores how policies and institutions affect private incentives to invest in tertiary human capital, the ability of individuals to finance this investment and the characteristics of university systems. Third, it provides some illustrative discussion of the possible routes of actions to reform TE system. In particular, the article provides guidelines on the governance of TE institutions and argues for flanking policies to the possible increase of private participation in the sector, with the objective of preserving or enhancing equality of access to higher education.

In assessing how policies can affect accumulation of tertiary human capital, the article draws on the extensive economic literature on the determinants of investment in TE. Traditionally, this literature has focused on demand-side determinants of investment (e.g. Becker 1967; Freeman 1986; Heckman, Lochner and Todd 2005) and, more recently, on the role of the supply structure (e.g. Rostchild and White 1995; Epple, Romano and Sieg 2006). Along these lines, we develop a number of indicators measuring the main demand-side investment determinants, namely the private rates of return to TE and the availability of individual financing. The role of TE supply side is assessed through specific indicators built to capture selected features of the institutional set-up of TE sector, such as the degree of autonomy, flexibility and accountability of universities. The article then tests for an empirical relationship between investment in TE, as measured by graduation rates, and its main demand-side and supply-side determinants. In this context, various issues are explored, as for instance, the relationship between short-term incentives to undertake higher education and the long-run feedbacks from the labour markets.

Main findings of the article are as follows: countries with incentive-based TE systems (i.e. characterized by higher educational input and output flexibility and higher accountability) display higher graduation ratios than countries with centralized and administrative-based systems. Private incentives to invest, measured by internal rates of return (IRR) reflecting net labour market *premia*, net replacement income and costs of education, are also positively related to the accumulation of tertiary

human capital. High tuition fees do not systematically lead to lower accumulation of human capital, when comprehensive and consistent funding systems are put in place to defray schooling and living costs for students and when side-effects from greater reliance on household sector lead to efficiency gains in TE systems (e.g. through lower study duration and strengthened competition in the TE sector). From these results, the main policy conclusions of this work are that OECD countries with low levels of investment in TE can increase graduation patterns by: (i) increasing returns to education, through specific policy-levers; (ii) making individuals aware of both the cost and future returns of their investment; (iii) further development of individual funding system together with increased private participation in the TE sector and (iv) allowing for more autonomy and enhancing accountability in the TE sector. Reforming TE systems along these lines implies costs and trade-offs with other policy objectives, which vary from country to country and with the mix of policy options retained. While this article does not address the latter issues explicitly, it often argues that consistent and simultaneous policy measures are needed to achieve efficient and equitable TE systems.

The article is organized as follows. Section 1 describes some stylized facts on TE outcomes in OECD countries. Section 2 presents the analytical framework and discusses some pieces of the literature on determinants of graduation ratios. Section 3 discusses the key features of supply of TE in OECD countries and describes a summary indicator. Section 4 presents estimates of internal returns to TE. Section 5 discusses the affordability of TE in presence of financial market imperfections and presents an indicator measuring the availability of funding for tertiary studies. Section 6 empirically assesses the impact of the demand and supply indicators estimated on graduation ratios. Section 7 builds on these empirical findings to draw policy recommendations. Section 8 concludes.

2 Cross-country differences in TE outcomes

We define investment in TE as the number of new graduates (ISCED-5/6)[1] and expressed as a share of the cohorts of age 20–29.[2] This measure is harmonized across countries in that graduates are recorded by their highest degree achieved. Thus, it makes it possible to look at the determinants of TE investment in countries with different structure of TE

[1] ISCED-5 includes Tertiary-type A programmes and the more vocationally oriented Tertiary-type B programmes. ISCED-6 refers to advanced research qualifications, such as PhDs (OECD 2004b).

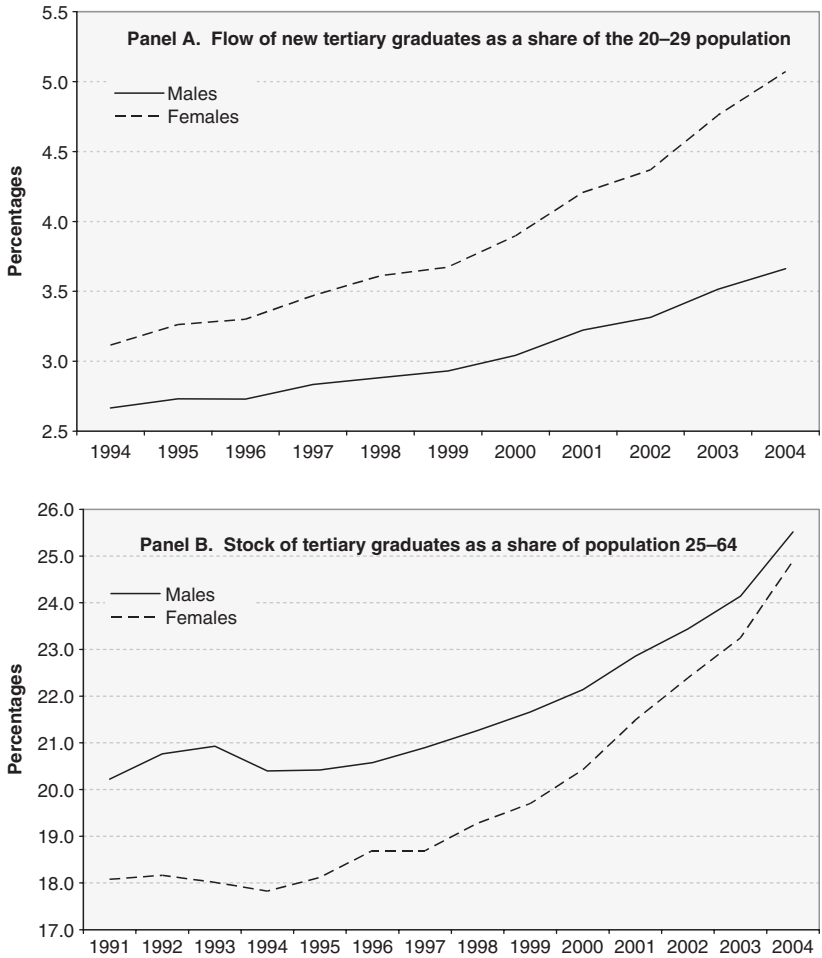
[2] See Oliveira et al. (2007) for details about the construction of this variable.

studies (e.g length and type of programmes). However, it is purely quantitative and neither accounts for the quality dimension of the investment, nor for its composition (i.e. TE fields). We choose to focus on the *flow* of the investment in TE rather than the stock of human capital, since factors other than current policy and TE settings could have a bearing on the latter. These factors are beyond the scope of this study, which is identifying the possible policy-levers of the investment.

During the last two decades, graduation ratios have strongly progressed in the OECD area, particularly so at the turn of the century. The increase in TE investment has been impressive for women, with female graduates almost doubling between 1994 and 2004 (Figure 1). This pattern reflects a likely catching-up with men in terms of the underlying stock of graduates. However, the companion paper Oliveira Martins et al. (2007) shows that the composition of investment across genders is still pretty uneven, with women graduating relatively more in Education, Health & Welfare and Humanities & Arts, while men's degrees being more concentrated in Science and Engineering. The accumulation of tertiary human capital has also been unequal among OECD countries, as shown in Figure 2. Despite a general tendency to increasing TE investment, differences in graduation ratios level remain substantial among OECD countries: New Zealand, for instance, records almost eight times as many tertiary graduates as Turkey and four times as many as Greece. Another interesting feature of graduation patterns over the 90s and early 2000s is that several small OECD countries have recorded stronger increases than big OECD countries with historically high levels of human capital. This is the case of Korea, New Zealand or Ireland, where investment in TE has been higher than in the United States or Canada.

3 Structural and policy determinants of investment in TE: a short literature review

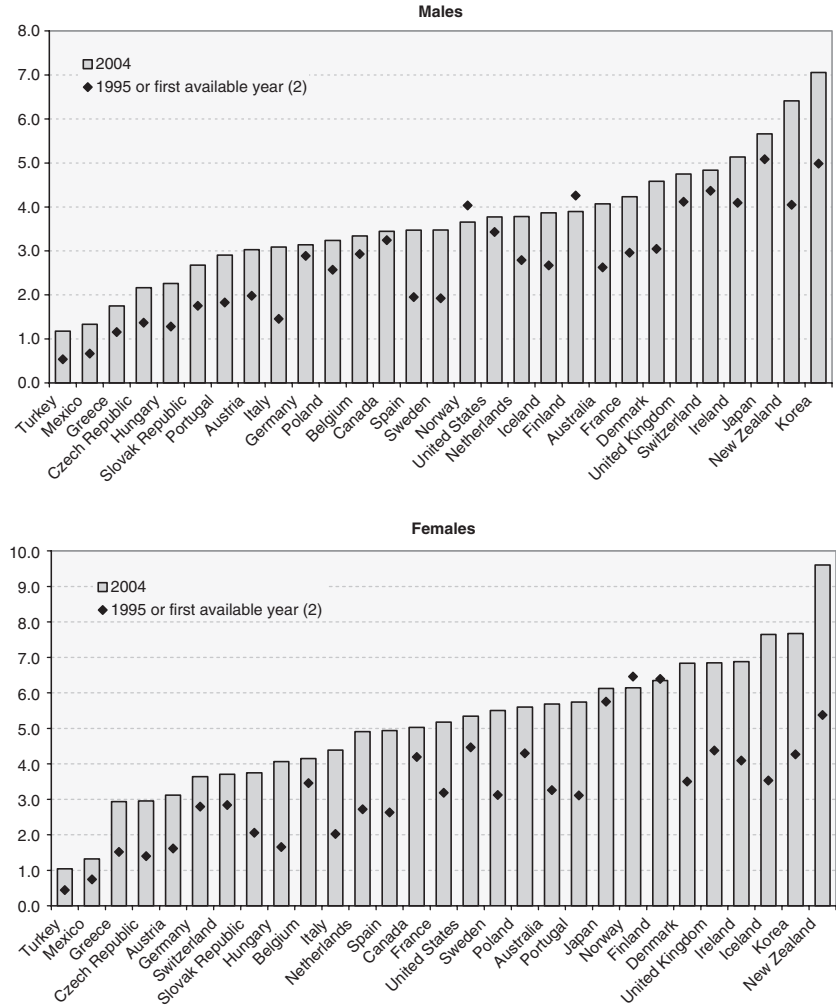
The economic literature has put forward several demand-side determinants of investment in TE (see Becker 1967; Freeman 1986 for a seminal review and Heckman, Lochner and Todd 2005, for a survey on recent developments). These include: (i) the standard model where investment depends on the expected returns from an additional year of schooling net of direct and opportunity costs of schooling; (ii) liquidity constraints and financial market failures that prevent individuals from financing their tertiary studies through borrowing; (iii) any cyclical, structural and demographic effects on expected future earnings, not contemplated in the standard model (Card and Lemieux 2000; Heckman, Lochner and Todd 2005); (iv) the disutility of school versus work (Card 2001;



1. Tertiary graduates cover all individuals, including individuals over 29.
Source: OECD, EAG (2006), UNESCO education database, Eurostat and OECD calculations.

Figure 1 Trends in tertiary human capital

Heckman, Lochner and Todd 2005); (v) the quality of TE investment, as a function of peers' ability and resources specifically directed to enhance quality (Hoxby 2005; Epple, Romano and Sieg 2006); (vi) gender-specific social and behavioural determinants of the investment in TE, including the rise in divorce rates, women's greater responsibility for children, girls' earlier maturity and higher level of non-cognitive skills (Goldin, Katz and Kuziemko 2006). Some of these determinants can be estimated for OECD



1. Tertiary graduates cover all individuals, including individuals over 29.
2. 1996 for Mexico and New Zealand, 1998 for Iceland, 1999 for Switzerland and 2000 for Belgium and Poland.
Source: OECD, EAG (2006), UNESCO education database, Eurostat and OECD calculations.

Figure 2 New tertiary graduates as a share of the 20–29 population by gender for selected years

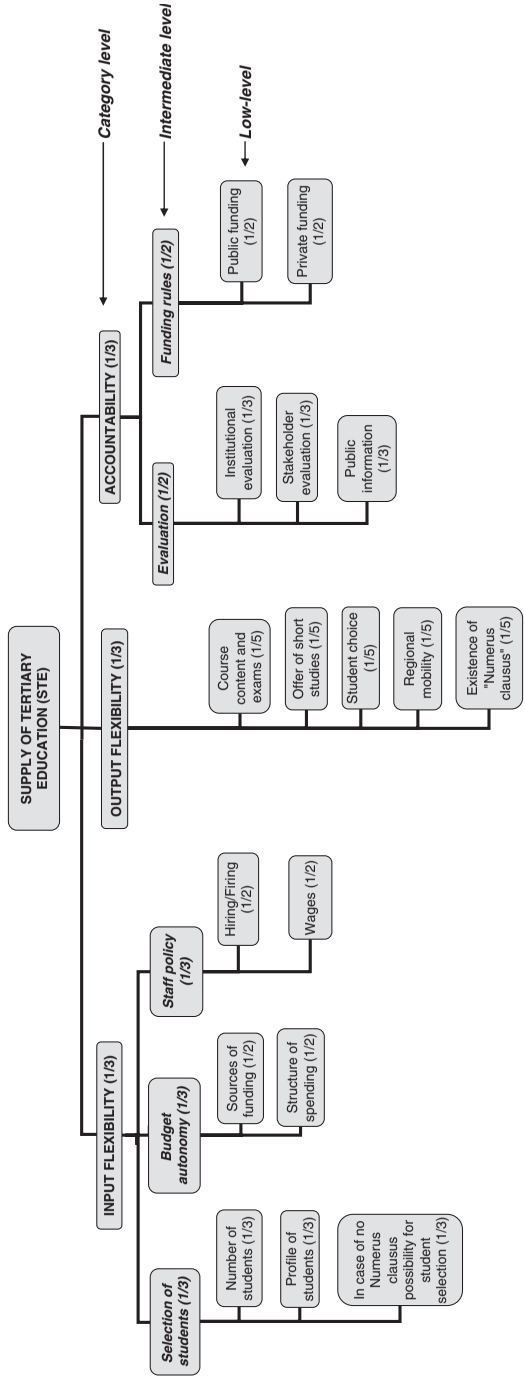
countries, as for instance the returns to schooling and liquidity constraints, or at least controlled for (e.g. demographic effects and structural trends); however, due to the lack of data on other demand drivers (preferences, abilities, behavioural determinants), we have to neglect these latter aspects in the analysis.

Concerning the supply determinants of TE, the literature is more recent and the empirical evidence less well-established. There are at least two aspects of this literature that deserve mention. First, there is some debate on whether the Industrial Organization approach can be applied to the supply of TE and in particular, whether objective functions of TE institutions are identifiable (Winston 1999). Second, TE supply is rather heterogeneous among OECD countries, with English-speaking countries closer to a market system while continental European countries being typically administratively based supply systems. In the latter, governments set tuition fees almost irrespective of the production costs and of the quality of students enrolled.[3] This is opposite to the experience of TE system in the United States (Hoxby 2005; Epple, Romano and Sieg 2006), where students match universities along quality and quality is a function of both initial students' level and the resources invested by the universities. Two issues then challenge the use of a standard TE supply-demand framework of the schooling decision. First, as argued above, this would not be relevant for the majority of OECD countries. Second, the data required for the estimation (measures of ability, TE investment by family income level, production costs at TE institution level, etc.) are lacking. Therefore, the approach adopted here consists of explaining investment decisions by its main drivers, without imposing a structural relationship. The following determinants of investment in TE are considered: (i) the institutional set-up of TE systems; (ii) the expected private returns from engaging in TE studies and (iii) individual financing opportunities that are made available to students. We present estimates of these three determinants first and assess their impact on graduation ratios in turn.

4 Supply side: the institutional set-up of TE

There is a consensus that the performance of TE institutions critically depends on three main aspects: (i) freedom in managing resources and setting objectives; (ii) performance-based allocation of resources; (iii) and incentive-compatible public funding rules (OECD 2003; Kis 2005; Teixeira et al. 2004). Along these lines, we use a summary indicator of supply of tertiary developed by Oliveira Martins et al. (2007). This indicator is based on a survey to OECD member countries and covers three main sub-categories (Figure 3): (i) *input flexibility*; (ii) *output flexibility* and (iii) *accountability* of institutions.

[3] See Jacobs and van der Ploeg (2006). The authors also observe that universities have managed to take in larger cohorts of students, which would suggest that supply is fairly elastic.



Note: The weights of each sub-level indicator are in parentheses.

Figure 3 The structure of the supply of TE indicator

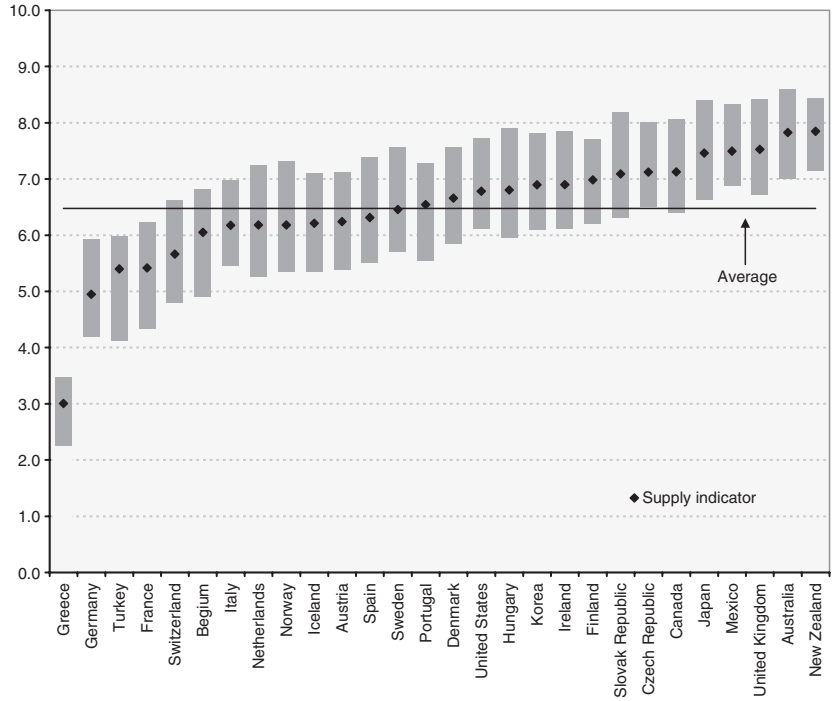
Input flexibility measures the extent to which TE institutions are free to allocate their resources and to shape their "production" function. Input flexibility puts together criteria for students' selection, autonomy to decide on sources and structure of funding (e.g. level of tuition fees) and staff policy (e.g. hiring/firing rules, wage setting, etc.). *Output flexibility* reflects the capacity of TE institutions to diversify their products and provide educational services as to better accommodate demand, such as the possibility to decide on course content, structure (short-term, part-time, distant learning studies). Possible restrictions to access universities are captured by the degree of regional mobility of students and the existence of *numerus clausus* for the number of diplomas attributed each year. *Accountability* summarizes features of TE evaluation and funding. Accountable systems provide incentives to excellence, by allocating resources on a performance basis and by sanctioning unsatisfying outcomes. Accountability is gauged through evaluation rules (independent agency, stakeholders) and funding rules (grand-fathering, input or output based).

A composite indicator is then built by aggregating these three sub-categories using uniform weighting. This composite indicator classifies TE systems as ranging from administratively based (low input and output flexibility, low accountability) to incentive-based systems.

In general, continental European countries are found to have relatively rigid supply systems, while English-speaking countries are more often characterized by incentive-based systems (Figure 4). Many OECD countries are, however, not statistically different from the average, as the 95 percent confidence interval around the point estimate of the indicator would show.[4] Exceptions to this are New Zealand, Australia, United Kingdom and Mexico (on the right side of the spectrum) and Greece, Germany, Turkey and France (on the left side of the spectrum).

This supply indicator comes with a number of caveats. First, the indicator should not be interpreted as a measure of outcomes, but rather of whether TE systems are endowed with the means to achieve performance and quality. Moreover, while this indicator gathers together many institutional aspects of TE supply, it has some limitations. For instance, it could be less informative for federal countries, such as the United States, Canada, Belgium and Germany, where the organization of TE can differ substantially across local states/regions. In addition, in countries where provision of educational services is market based, incentives to excellence are transmitted through mechanisms other than public funding/

[4] Confidence intervals obtained by random choice of the weights used to aggregate low-level indicators into the sub-category. For details, see Oliveira et al. (2007).



Note: For Canada we show the population-weighted average of the 7 provinces
For Belgium we show the unweighted average of the three communities.
The bars correspond to the 95% confidence intervals obtained through the random weight technique.
Source: OECD calculations based on questionnaire answers received from member countries.

Figure 4 Composite supply indicator of TE (STE), 2005–2006

evaluation. These market dimensions of accountability are not captured in this institutional indicator.[5]

5 Demand side: the Internal Rate of Return to education and its drivers

IRRs are a comprehensive measure of private incentives to undertake TE. While several methods exist to compute IRR (Psacharopoulos 1995), we follow here De la Fuente and Jimeno (2005). They developed an unified framework combining a standard discount method with the estimation of labour market *premia* on micro-data. In their model, individuals are

[5] For example, higher education institutions in the United States are subject to evaluation by bond rating firms that review and assess the credit-worthiness of institutions, a feature that is not reflected in the summary indicator above.

supposed to choose the optimal level of schooling by maximizing the present value of the expected life-time income, net of costs associated to education. Individual wages are a function of the number of years of schooling and evolve over time at a constant rate given by productivity growth and accumulation of experience. Individuals are entitled to unemployment benefits when they are unemployed. At the end of their working life, they receive some retirement benefits according to statutory replacement rates. Individuals pay taxes on wages, unemployment benefits and retirement income. In this context, the profitability of pursuing education beyond the upper-secondary degree is measured by the ratio comparing marginal benefits from TE to marginal costs[6] (Boarini and Strauss 2007, for a detailed presentation of the formula used to compute IRR). Marginal benefits comprise a net wage premium, a net employability premium and a net pension premium. The marginal costs are given by the opportunity costs and the direct costs of TE.[7]

The various components of the IRR are either estimated on individual-level data by multivariate regressions[8] (labour market *premia*) or drawn from various OECD tax and benefit models. IRRs are computed for 21 OECD countries, between 1991 and 2005 (but with unbalanced time-coverage) and separately for men and women.

Wage and experience *premia* are estimated trough Mincerian wage equations, where the log of gross hourly wage is regressed on educational attainment (gender-specific), number of years of experience in the labour market, working in the public sector, working part-time, tenure, having an indefinite-term contract, size of the company, right qualification for the job, gender and marital status.[9] Wage equations are estimated by country with repeated cross-sectional OLS. Gross wage *premia* are found to vary substantially across countries; in 2001, for instance, they ranged

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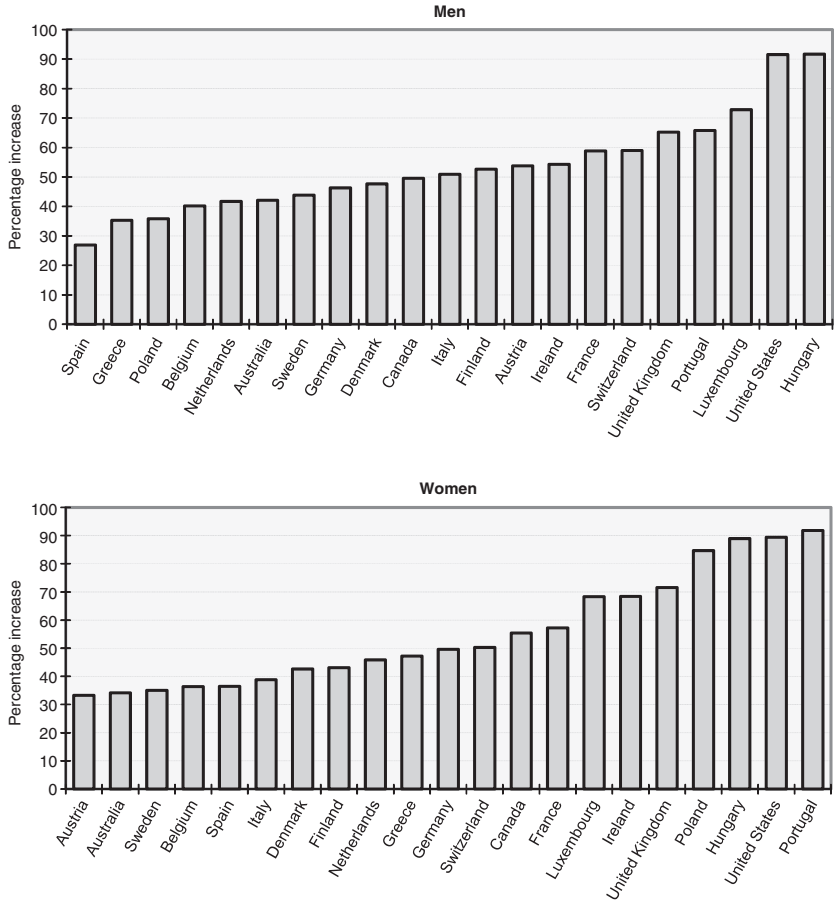
[6] See Boarini and Strauss 2007, for a detailed presentation of the formula used to compute IRR.

[7] The main assumptions behind the computation of the stream of benefits and costs associated to education are: (i) the wage *premium* is an increasing and time-invariant function of schooling; (ii) the experience *premium* is constant across schooling levels; it is supposed to be a function of potential experience rather than actual years of employment and to grow at a constant rate over time; (iii) the employment probability is an increasing and time-invariant function of schooling; (iv) individuals receive out-of-work benefits if unemployed and pay taxes on either labour income or unemployment benefits. Benefits and taxes are constant over the life cycle; (v) the number of working hours and the length of working life are the same across levels of schooling; (vi) there is no part-time student work.

[8] The following household surveys were used: ECHP for 14 European countries; BHPS for the United Kingdom; HILDA for Australia; CPS for the United States; SLID and CNEF for Canada and CHER for Hungary, Poland and Switzerland.

[9] See Strauss and de la Maisonneuve 2007, for more details on the construction and interpretation of those variables.



Source: the European Community Household Panel (ECHP), the Consortium of Household Panels for European Socio-Economic Research (CHER), the Cross-National Equivalent File (CNEF), and the Household, Income and Labour Dynamics in Australia Survey (HILDA) and OECD calculations.

Figure 5 Gross Wage *premia* for 21 OECD countries, 2001

from 27 to 92 percent (Figure 5). In 2001, women's tertiary wage *premia* were higher than men's (positive interaction coefficient) in 9 of 21 countries, the difference being significant in Poland and Portugal. By contrast, male graduates appear to yield significantly higher wage returns than their female counterparts in Australia, Austria, Finland and Italy. The experience *premium* per year of accumulated labour market experience also shows large cross-country variation. It is the lowest in Germany (0.23 percent) and the highest in Switzerland (1.69 percent). Overall, the TE wage *premia* are found to be fairly stable over time (Boarini and Strauss 2007).

The gross employability premium and the conditional probability of employment are estimated in a two-stage approach, which jointly determines employment and participation probability. The two-stage approach enables to correct for a possible selection bias, with the probability of participation being first estimated as a function of a range of individual characteristics and its residual used as a control in the estimation of the employment equation. In particular, a two-stage Probit model is used where the probability of being active is estimated as a function of educational attainment (gender-specific), age (quadratic), gender, marital status, having children and being a discouraged worker because of persistent unemployment; and the probability of being employed is regressed on the same variables with the exception of having children and the region of residence in addition.[10]

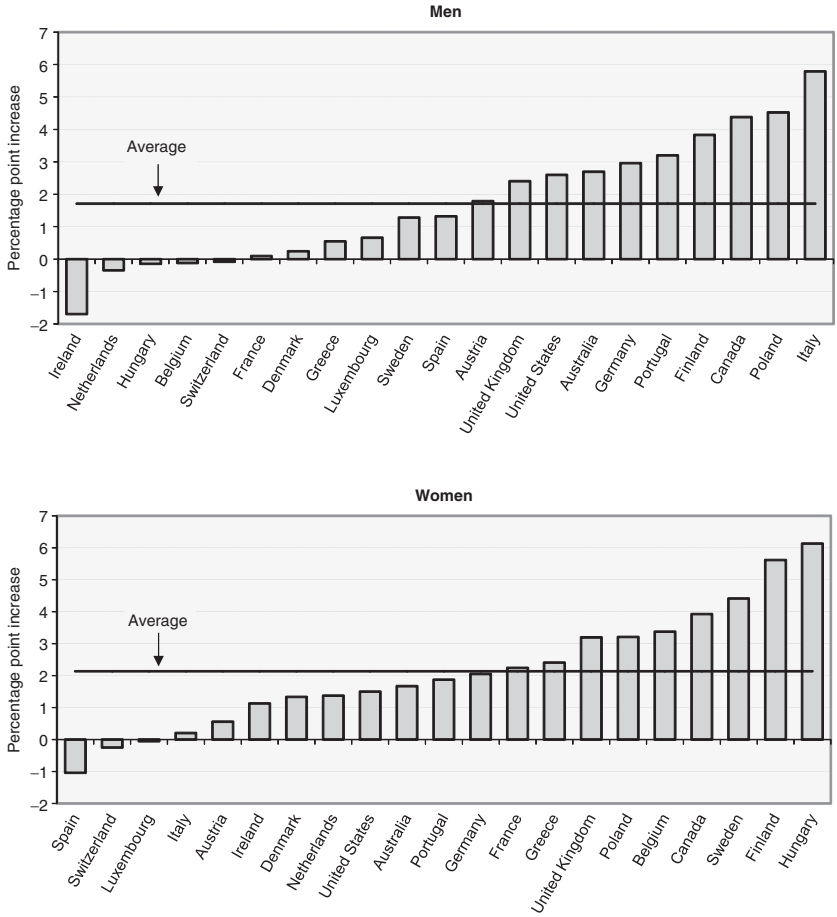
As for Mincerian equations, the two-stage estimation of employment and participation equations is done by country and by year. We find that education increases both the probability of participating in the labour market and of finding a job. In 2001, the estimated conditional probability of employment for an upper-secondary degree holder was around 92 percent for women and 95 percent for men in most countries. With a TE degree the employment probability increases on average by around two-percentage points (Figure 6).[11] The largest employability *premia* (above 3–4 percentage points) are found for men in Italy,[12] Poland and Canada, and for women in Hungary, Finland and Sweden. Small (or even negative) effects are found for men in Ireland, the Netherlands, Belgium, Switzerland and France, and for women in Spain, Switzerland, Luxemburg and Italy. As showed in Boarini and Strauss (2007), the employability *premia* display stronger cyclical sensitivity than the wage *premia*.

The next main components of IRR are fiscal parameters, comprising tax rates, out-of-work-benefits and retirement benefits. Both *progressivity* and *the level* of fiscal parameters matter. The additional schooling-related net

[10] See Boarini and Strauss (2007) for more details on the specification and the construction of the variables.

[11] This increase is computed as the difference between the estimated employment probabilities for tertiary and upper-secondary graduates, using the coefficients β_3 and β_5 estimated in the equations above. In this calculation, the other variables are fixed at a reference level (corresponding to a single prime-age individual without children).

[12] Employment probabilities refer to the average man/woman for all countries except Italy, where these probabilities are calculated for a woman/man coming from middle-income regions (mostly central regions). This isolates the impact of education on employment probabilities from the impact of idiosyncratic labour market conditions. In fact, Italy is the country where the regional characteristics of the reference individual matter the most for the marginal effect of schooling on the employment probability. For other countries, the marginal effects were computed without specifying the region of residence.



1. Increase in probability of employment: Tertiary degree holders relative to holders of upper secondary degree.
2. Except Hungary 1997 and Poland and Switzerland 2000.
Source: the European Community Household Panel (ECHP), the Consortium of Household Panels for European Socio-Economic Research (CHER), the Cross-National Equivalent File (CNEF), and the Household, Income and Labour Dynamics in Australia Survey (HILDA) and OECD calculations.

Figure 6 Marginal effect of TE on the employment probability, 2001

labour earnings and unemployment benefits can be decomposed into a marginal factor (*additional net* hourly wage/unemployment benefit, for a given (un)employment level) and an average factor (higher employment probability for a given *average net* hourly wage/unemployment benefit). The marginal and average tax rates (on labour earnings, unemployment benefits, retirement income) as well as marginal and average out-of-work and retirement replacement rates take as reference the earnings of upper-secondary degree holder. The fiscal parameters are

proxied by the rates applying to workers at 100 percent of Average Earning (AE), as defined in various OECD tax and benefit models.[13]

Among the cost components of the IRR, opportunity costs are defined as the sum of after-tax labour market earnings and after-tax unemployment benefits (respectively weighted by employment and unemployment probabilities) for upper-secondary degree holders. Direct TE costs include tuition fees and other education costs (e.g books), but exclude student living costs. They are measured as the share of (total) annual expenditure per student in TE borne by the private sector and net of possible public subsidies earmarked on tuition fees.[14]

These various ingredients are put together to compute IRR for several years and for the 21 OECD countries covered (Table 1). We find that IRR vary from over 4 to over 14 percent in 2001. The average return (across both countries and gender) is 8 1/2 percent, which is slightly lower than previous OECD estimates but still substantially higher than long-term real interest rates. The range of returns for women is somewhat wider than for men (from 4.2 to 14.4 percent versus 4.9 to 11.8 percent). By ascending order, Italy, Spain, Sweden, the Netherlands, Germany, Austria, Hungary, Belgium, Greece and Finland have below OECD average returns. In these countries, low *IRRs* are driven by below average net labour market *premia*, and not compensated by low direct and/or opportunity costs. Moderate and above OECD average *IRR* are found in Canada, France, Poland and Denmark, where labour market *premia* are around the country average. Finally, the United States, Australia, Luxembourg, Switzerland, the United Kingdom, Portugal and Ireland have the highest returns because these countries have the highest wage *premia*, reinforced either by high employability *premia* and/or low costs of education. The cross-country cross-time average IRR is found to be slightly above 8 percent both for men and women. IRR vary more across countries than over time. IRR are indeed relatively stable, with the OECD average IRR slightly increasing between 1994 and 2001. The strongest upward trends are observed for Ireland, Portugal and Canada. Conversely, UK displays a downward trend, especially at the end of the observed period.[15]

A sensitivity analysis shows that the main positive drivers of IRR are wage *premia*, average tax rates and employability *premia*, while the main negative drivers are marginal tax rates, tuition fees and study duration.

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[13] Average Earnings are defined according to the new definition of the Average Worker (see OECD 2004a), covering a broad set of industries than before and also including non-manual employees.

[14] See Boarini and Strauss 2007, for a discussion of this measure of costs and of alternative measures.

[15] For the interested reader, sensitivity analysis and robustness tests on the IRRSs can be found in Boarini and Strauss (2007).

Table 1 Estimates of IRR, 1991–2005

Country	Men														
	1991 (%)	1992 (%)	1993 (%)	1994 (%)	1995 (%)	1996 (%)	1997 (%)	1998 (%)	1999 (%)	2000 (%)	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)
Australia											10.4	10.2	10.1		
Austria					8.4	8.3	7.4	7.7	8.3	8.5	7.8				
Belgium				5.9	5.9	6.0	6.2	7.3	6.3	6.2	6.9				
Canada						7.3	5.9	7.1	7.0	8.7	8.7	8.4			
Denmark				5.4	7.0	6.5	6.7	8.1	8.5	8.4	9.6				
Finland						8.5	8.7	7.6	8.6	8.8	8.6				
France				9.5	9.3	9.4	9.8	10.2	9.3	10.1	9.1				
Germany				5.5	5.7	5.5	5.8	6.4	7.3	6.7	6.2				
Greece				5.4	5.2	5.6	5.7	4.9	5.8	6.0	6.0				
Hungary		7.3	6.4	6.4	5.0	6.8	6.2								
Ireland				7.2	8.1	8.5	9.8	9.0	8.8	8.6	11.8				
Italy				4.8	4.6	5.3	5.5	6.1	6.0	5.7	6.1				
Luxembourg					11.5	10.8	10.0	11.8	11.4	12.2	10.2				
Netherlands				6.9	6.9	6.7	5.6	6.3	4.4	5.0	6.0				
Poland							7.5	8.7	8.9	6.5					
Portugal				11.4	13.8	15.7	13.0	13.7	12.3	13.6	11.2				
Spain				5.0	5.4	5.5	4.4	3.9	3.1	2.2	4.9				
Sweden							6.4	7.3	7.2	7.0	6.4				
Switzerland									12.1	11.3					
United Kingdom	12.4	12.2	12.5	12.2	11.6	12.2	11.9	12.1	12.2	11.7	11.8	11.5	10.9	9.9	
United States				9.1	9.1	9.4	9.2	9.0	9.9	9.9	10.1	10.7	10.1	10.4	10.4

(continued)

Table 1 Continued

Country	Women														
	1991 (%)	1992 (%)	1993 (%)	1994 (%)	1995 (%)	1996 (%)	1997 (%)	1998 (%)	1999 (%)	2000 (%)	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)
Australia											8.9	10.0	9.9		
Austria					9.3	9.5	7.5	6.9	7.1	5.7	5.0				
Belgium				4.4	5.1	4.4	5.4	5.5	7.4	6.0	6.4				
Canada						7.3	6.6	7.5	7.4	9.5	9.4	9.3			
Denmark				5.8	6.4	6.8	5.7	7.9	7.5	7.8	8.7				
Finland						6.5	6.1	5.8	6.7	6.4	7.1				
France				8.3	8.3	8.4	9.1	9.2	8.6	8.7	9.0				
Germany				5.2	6.0	5.3	5.9	5.9	6.5	5.7	6.4				
Greece				4.7	4.3	5.2	6.4	7.9	7.2	7.5	8.3				
Hungary		5.7	6.3	6.9	6.8	6.7	6.5								
Ireland				7.5	8.7	9.4	11.6	9.5	11.0	9.8	14.4				
Italy				4.3	4.4	4.2	4.3	4.4	4.5	4.8	4.2				
Luxembourg					12.2	10.4	10.1	11.2	10.5	10.9	9.9				
Netherlands				5.5	5.9	5.9	4.2	4.9	4.1	4.1	6.5				
Poland							9.2	10.3	11.3	11.8					
Portugal				10.6	11.3	12.6	11.5	13.3	12.2	15.6	13.3				
Spain				6.5	7.0	6.9	6.1	5.0	4.8	4.6	6.5				
Sweden							6.2	5.8	4.4	5.2	5.4				
Switzerland									10.4	10.1					
United Kingdom	12.6	13.9	13.3	12.7	12.7	12.3	12.6	12.8	12.2	11.5	12.3	12.1	10.9	9.9	
United States				8.6	8.6	8.9	8.7	8.5	9.0	8.9	9.1	9.4	8.7	9.2	9.1

Many are, thus, the policy-levers of private returns to TE, and governments may use some of them as to set individual incentives to invest in TE.

6 Financing the individual investment in TE

If financial markets were perfect, students were risk-neutral and perfectly informed about returns to education, the latter should be perfectly correlated to individuals' schooling decisions. However a number of these conditions are not fulfilled in many OECD countries, as argued by Barr (2001). On the supply side, the imperfections are mainly related to asymmetric information on students' abilities and motivation, the uncertainty about their future income and the lack of collateral. On the demand side, students engaging in higher education are not always in possession of all relevant information on future labour market prospects (Romer 2000) and may display some aversion to undertake a risky investment, particularly so if they come from low-income families (Chapman 2005).

For all these reasons, we need to introduce in our analysis a proxy of availability of funding which might explain why individuals do not enroll in tertiary studies even when the private incentives to do so are considerable. The literature has variously dealt with the impact of financial constraints on the accumulation of human capital in different ways. Evidence is available, especially at individual-level (see for instance Cameron and Taber 2000), while few studies explore the impact of financial restrictions on the accumulation of human capital at aggregate level. As to the latter, Benhabib and Spiegel (2000) approximate financial constraints by the Gini Index (at country level), the (under) development of financial markets and the (low) share of banking sector in total assets. They find that only the latter variable robustly explains the accumulation of human capital. For the sake of our analysis, however, it is preferable to build a more specific measure on the affordability of tertiary studies, which accounts for the current financial conditions of access to TE. OECD countries funding systems are extremely heterogeneous with respect to rules, coverage and actual take-up rates of grants/loans. For descriptive purposes, systems can be classified along two dimensions: the target and the composition of funding (see Oliveira Martins et al. 2007 for a detailed discussion of the typology). Funding systems are either targeted on students themselves or on the households where students live. In addition, funding systems can either rely on loans, grants or some other measures (tax-credits, family allowances). Many OECD countries offer several types of funding, but we decided to classify countries according to

the predominant funding option. *Universal funding systems* rely on either grants or loans. The main feature of these systems is that they provide universal funding to students as individuals, i.e. irrespective of family-income conditions. By contrast, *family-based funding systems* generally offer limited help for studying, and the help is conditional on mean-test at family level. Within individual-based systems, loans and grants schemes are quite diverse, especially with respect to the magnitude of public subsidies available (OECD 2006b).

While it is possible that the composition of funding matters for easing liquidity constraints over and above the overall amount of funding available, it is not possible to build a summary indicator reflecting the differential impact of grants and loans on financial restrictions for accessing TE. Essentially, this is due to the paucity of data on the actual repayments of loans (regardless of statutory rules) and of the sometimes awkward functioning of borrowing schemes, which makes it difficult to conjecture about the real part of subsidy in attributed loans. For the sake of our analysis we thus build an indicator of overall availability of funding, which regards grants and loans in the same way. This indicator is defined as the ratio of the overall costs of TE to the total resources available to students to cover these costs. Costs include tuition fees (average of public and private sector) and an estimate of living costs for students (Table 2). Resources made available to students are the sum of specific funding in the form of grants and loans, an estimate of students' earnings from part-time work and an estimate of resources available at household level. Students' earnings are assumed to be equal to 80 percent of the wage of an upper-secondary degree holder (working half-time) and adjusted for youth unemployment rate. Private resources to fund FE are assumed to be equal to the equivalized median household disposable income. The indicator ratio of funding availability (shown in last column of Table 2) ranges from less than 20 percent for Nordic countries to 135 percent for Mexico. While little informative in absolute terms, this indicator allows for meaningful cross-country comparisons of the extent to which the access to TE is likely to be restrained even for someone living in a family with median incomes. Results on this indicator show that financial constraints are the least (most) binding in individual (family)-based funding systems.

7 Explaining aggregate investment in TE

The institutional set-up of TE, the IRR and the indicator on availability of funding to students are now used to explain aggregate graduation patterns in OECD countries. As discussed in the first section, the empirical strategy

Table 2 Estimated total student cost and available financing per year (in US$ PPP)

	(Data correspond to the latest available date up to 2006)							
	Average of public and private sector's tuition fees[a]	Living costs[b]	Total investment costs	Maximum amounts of loans and grants[c]	Expected earnings for student parttime work[d]	Median equivalised disposable income[e]	Total resources	Total investment costs/Total resources (in %)
Universal funding								
Denmark	0	6,647	6,647	10,294	5,606	19,832	35,731	18.6
Finland	0	5,229	5,229	7,015	3,703	17,070	27,788	18.8
Luxembourg	0	8,325	8,325	5,020	3,176	27,403	35,599	23.4
Sweden	0	5,431	5,431	10,534	2,544	17,157	30,234	18.0
Iceland	390	5,769	6,159	11,531	4,255	18,085	33,871	18.2
Norway	630	5,769	6,399	8,711	4,119	22,131	34,962	18.3
Netherlands	1,565	4,924	6,489	8,427	5,201	20,050	33,677	19.3
United Kingdom	1,794	8,602	10,396	11,644	4,620	18,987	35,250	29.5
New Zealand	2,548	7,546	10,094	7,849	2,696	13,680	24,225	41.7
Canada	2,967	4,909	7,876	8,750	2,591	21,172	32,512	24.2
Australia	3,791	6,720	10,511	5,995	4,631	16,371	26,997	38.9
United States – Federal loans	8,653	6,344	14,997	18,500	2,105	23,954	44,559	33.7
United States – Private loans[f]	8,653	6,344	14,997	40,000	2,105	23,954	66,059	22.7
Average	2,384	6,351	8,735	11,867	3,642	19,988	35,497	24.6
Family-based funding								
Greece	0	3,618	3,618		2,040	11,656	13,696	26.4

(continued)

Table 2 Continued

	(Data correspond to the latest available date up to 2006)							
	Average of public and private sector's tuition fees[a]	Living costs[b]	Total investment costs	Maximum amounts of loans and grants[c]	Expected earinings for student parttime work[d]	Median equivalised disposable income[e]	Total resources	Total investment costs/Total resources (in %)
Mexico	0	5,625	5,625		386	3,816	4,203	133.8
Slovak Republic	0	2,165	2,165		659	6,757	7,416	29.2
Germany	55	4,417	4,472		4,217	15,632	19,849	22.5
Czech Republic	172	2,057	2,230		923	9,411	10,334	21.6
Turkey	274	4,800	5,074		862	4,568	5,429	93.5
Hungary	426	2,995	3,421		1,155	6,743	7,898	43.3
Poland	426	1,444	1,871		654	6,308	6,962	26.9
Belgium	625	4,380	5,005		3,903	16,919	20,822	24.0
France	703	5,401	6,104		2,997	16,178	19,175	31.8
Ireland	748	4,957	5,705		3,902	17,824	21,726	26.3
Spain	801	5,563	6,364		3,047	12,084	15,131	42.1
Austria	847	5,821	6,668		2,940	16,419	19,358	34.4
Switzerland	849	4,881	5,730		1,836	23,534	25,370	22.6
Italy	1,174	4,421	5,595		3,104	14,794	17,898	31.3
Portugal	1,688	4,030	5,718		1,864	10,714	12,578	45.5
Japan	5,285	6,156	11,441		2,244	17,871	20,114	56.9
Korea	6,210	5,890	12,101		1,445	10,182	11,628	104.1
Average	1,127	4,368	5,495		2,121	12,300	14,422	38.1

(contiuned)

Table 2 Continued

	(Data correspond to the latest available date up to 2006)							
	Average of public and private sector's tuition fees[a]	Living costs[b]	Total investment costs	Maximum amounts of loans and grants[c]	Expected earinings for student parttime work[d]	Median equivalised disposable income[e]	Total resources	Total investment costs/Total resources (in %)
Average excluding Korea, Mexico, Turkey	920	4,154	5,074		2,366	13,523	15,889	31.9

[a]Weighted by the percentage of full-time students in public and private institutions. When range of fees was provided in OECD Education at a Glance, a point estimate was derived by taking the middle value. Where data were not available, tuition fees were assumed to be zero. Public institutions only for Canada, Spain and Switzerland. For Germany, the value refers to contributions paid to TE institutrions for the use of social facilities and to other registration fees. For Ireland, the value refers to registration, examination and services charges. For Poland, tuition fees were assumed to be the same as in Hungary.

[b]Living costs were derived from Usher and Cervenan (2005) and other sources. When not available in this source, living costs were estimated using the average share of living costs to average wages of an upper-secondary educated worker (around 40%). For Czech Republic, Korea, Mexico and Turkey, living costs are derived from International Student Guides. For Iceland and Norway, living costs were estimated as the average of Nordic countries and for Slovak Republic as the average of Eastern European countries.

[c]Universal grants and loans only. For Australia, corresponding to the HECS-HELP loan.

[d]80% of the part-time wage, calculated as 1/3 of a secondary worker's average wage or 1/3 of a minimum wage and adjusted for youth unemployment rate. For Iceland and Norway, income from student work was estimated as the average of Nordic countries.

[e]The "equivalised" income is the household income adjusted for household size (i.e. the household divided by the square root of household size). For Belgium, Iceland, Korea and Slovak Republic, the equivalised disposable income was estimated as a share of GDP per capita (using the OECD average share).

[f]Government guaranteed loans, such as the Sallie Mae scheme.

Sources: OECD, *Education at a Glance*; Usher and Cervenan (2005) Center for Higher Education Policy Studies, *Student Financial Report* (for Germany and Ireland) and Secretariat estimates.

consists of estimating the investment in TE, without identifying restrictions on the structural determinants. The econometric analysis assumes first that individuals take the decision to invest in TE on the basis of a pre-determined return to tertiary degrees and for a given quantity of tertiary educated graduates. In a second step, the returns to schooling are let to be endogenous, and modelled as depending on the quantity of human capital demanded and supply in labour markets and on labour market institutions [employment protection legislation (EPL), union density, bargaining arrangements, etc.].

Higher IRR are expected to lead to higher investment in TE while lower availability of funding should have the opposite effect. The institutional set-up of TE sector may shape investment through several channels. Highly incentive-based systems may attract more students, allowing for more and better services. Moreover, highly accountable TE systems may respond better to the positional component of the demand for higher education (notably through rankings and reputation factors). In addition, more flexible systems, such as those where the educational track allows students to opt out from the educational investment more often than rigid system, are potentially more attractive.[16] Incentive-based systems may also induce faster completion of studies and lower drop-out.

A number of other factors, for which we need to control for, may influence the graduation ratios. First, structural trends as the increasing labour participation of women or the increasing demand of high-skilled workers may explain graduation ratios. More generally, all structural and cyclical components of return on skills not comprised in the baseline calculation of the IRR could be retained as additional explanatory variables. In the baseline, we adopted a parsimonious specification where graduation ratios are solely determined by IRR, supply conditions, availability of funding, gender effects and output gaps. This specification also controls for common time-dummies and country-specific trends. The analysis is performed in an unbalanced panel using 19 countries[17] and gender as the cross-section dimension. The maximum time span covered is 1992–2002, but for several countries only some years are available.

Table 3 shows the results for this specification (column "Baseline") and of a number of alternative specifications (column 1–8), controlling for other explanatory variables. In the preferred specification, the explanatory

[16] See Heckman, Lochner and Todd 2005 for an application of the Option Value Model to the demand for higher education.

[17] This includes all countries for which the IRRs were available except Luxembourg and Poland, where the STE indicator is not available.

Table 3 Graduation ratios regressions results

Dependent variable: Log of graduation ratio	Assumption: exogenous IRR									Assumption: endogenous IRR		
	Baseline	Col. (1)	Col. (2)	Col. (3)	Col. (4)	Col. (5)	Col. (6)	Col. (7)	Col. (8)	System of simultaneous equations		
										Tertiary graduation rate (log)	Wage Premia	System explanatory variables
IRR	3.19***	1.65	3.50***	2.69**	2.10*	2.54***	1.97*	3.95***	2.77**	4.96***		IRR
	[1.02]	[1.04]	[0.96]	[1.11]	[1.12]	[0.86]	[1.04]	[1.05]	[1.08]	[1.65]		
Supply indicator	0.21***	0.12***	0.21***	0.24***	0.17***	0.09**	0.23***	0.17***	0.20***	0.18***		Supply flexibility indicator
	[0.02]	[0.04]	[0.02]	[0.03]	[0.05]	[0.05]	[0.02]	[0.03]	[0.02]	[0.03]		
Financial constraints	−0.03***		−0.02***	−0.03***	−0.02***	−0.01***	−0.02***	−0.03***	−0.04***	−0.03***		Financial constraints
	[0.00]		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]		
Output gap	−0.03***	−0.04***	−0.04***	−0.03***	−0.03***	−0.01	−0.04***	−0.03***	−0.02**			
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]			
Female dummy	−0.21***	0.21***	0.18***	−0.21***	0.22***	0.21***	0.21***	0.21***	0.21***	0.23***		Female dummy
	[0.02]	[0.02]	[0.03]	[0.02]	[0.03]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]		
Family-based funding systems		−0.43***								0.44***	−0.07***	Ratio of tertiary to upper-secondary human capital stock
		[0.07]								[0.08]	[0.01]	
Students working part-time			0.03***							0.03***		PISA score (standard deviation)
			[0.01]							[0.00]		

Share of students in private institutions				0.01*** [0.00]							−0.02** [0.01]	Tertiary graduation rate (log)
PISA score (mean)					0.01*** [0.00]						0.01*** [0.00]	EPL (regular workers)
PISA score (standard deviation)						0.02*** [0.00]					−0.01*** [0.00]	EPL (temporary workers)
Upper-secondary degree holders ratio							0.30** [0.15]				−0.05*** [0.01]	Bargaining coordination
Share of foreign students								0.88* [0.45]			0.02* [0.01]	Trade openness
Ratio of expenditure in tertiary education (per student) to GDP per capita									0.26*** [0.05]			
Constant	−0.21 [0.20]	−0.09 [0.26]	−1.72** [0.77]	−0.52** [0.20]	0.01 [0.36]	−5.05*** [1.61]	−2.33*** [0.44]	0 [0.20]	0.25 [0.20]	−2.11*** [0.44]	0.17*** [0.03]	Constant
Observations	266	266	266	266	266	266	266	266	266	266	266	Hansen-Sargan test
R^2	0.85	0.85	0.85	0.86	0.82	0.86	0.86	0.86	0.86	0.9	0.73	Chi2(4):5.51

All the specifications include country-specific trends and year dummies.
Standard robust errors in brackets.

*Significant at 10%; **significant at 5%; ***significant at 1%.

Source: OECD calculations.

variables have the expected sign and are significant: graduation ratios increase with IRR,[18] flexibility and accountability of TE supply and with availability of funding. Graduation ratios are found to be negatively affected by the output gap, possibly reflecting relatively better employment and income perspectives for non-graduates during periods of strong economic activity (not captured by IRR). As suggested by the effect of the female dummy, graduation ratios are generally higher for women than for men. This seems to be in line with Goldin, Katz and Kuziemko (2006), for which, in the United States, women graduates outnumber men graduates because of changing social patterns and behavioural differences[19] across genders and increasing expectations in terms of high-paying careers.

In order to test for the sensitivity of these estimates several other specifications are tested. To avoid multi-collinearity, each additional variable is introduced separately. In particular, two other proxies of financial constraints are retained: a categorical dummy for countries with family-based systems (the reference being individual-based system) and the incidence of part-time student work (see OECD *Education at a Glance*, indicator C4.2a). Relying on family-based financing systems (col. 1) tends to depress graduation ratios, probably because family-based funding systems tend to deliver less generous financial help than individual-funding systems, and possibly because they give less responsibility to students on completing their studies. The coefficient of the students' part-time work variable has a positive sign (col. 2), suggesting that liquidity constraints are somehow relaxed when students work.[20] We also find that countries with high share of students in private universities display higher graduation ratios (col. 3). This may be explained by private universities being more autonomous than public institutions,[21] but could also be due to that they sometimes offer easier curricula. Both the Programme for International Student Assessment (PISA)[22] mean score and its standard

[18] In a robustness check, the basic components of IRR have been entered as separate regressors. We found that graduation ratios increase with wage premia and average tax rates and decrease with marginal tax rates. This is line with the sensitivity analysis of IRR carried out in Boarini and Strauss (2007). The coefficients of the other variables are robust to this specification.

[19] For example, Goldin, Katz and Kuziemko (2006) report that grades K-12 boys have higher incidence of behavioural problems; teenage boys display higher (self-reported) incidence of arrests and school suspensions than teenage girls; girls spend more time doing homework than boys.

[20] On top of relaxing liquidity constraints, student part-time work leads also to higher IRR, as shown in Boarini and Strauss (2007).

[21] See Aghion et al. (2007).

[22] PISA (Programme for International Student Assessment) is an international study conducted by the OECD which measures how well young adults of age 15 are prepared for possible later studies or direct entry into the labour market.

deviation have a positive influence on TE investment (col. 4 and 5). The former effect is not surprising: better-prepared students from the primary and secondary-level are expected to enrol and to complete tertiary studies more often. The impact of PISA standard deviation is less intuitive. One possible interpretation is that countries where pre-tertiary systems are less comprehensive (i.e. less egalitarian) tend also to have more selective TE institutions, which lead to higher graduation ratios. Another explanation could be that countries where PISA scores are distributed more unequally, less able students do not make it to the university or to the completion of studies. Not surprisingly, the size of upper-secondary graduates' cohort is also positively related to tertiary graduation ratios (col. 6). Graduation ratios depend positively on the share of foreign students (col. 7). This could be due to the positive correlation between ability and mobility, and to related peer effects. Per student expenditure[23] as a share of GDP per capita is found to be positively related to graduation ratios (col. 8). In principle, the direction of influence is ambiguous since expenditure per student could capture both the input price of factors[24] and input quantities invested in the production of educational services. Since the expected correlation to graduation ratios would be, respectively, negative and positive, the empirical finding would rather support the interpretation of this variable in terms of input quantities.

In a second step, the assumption of a pre-determined IRR is relaxed.[25] Two issues are considered here. First, returns to investment may fall with a rising number of tertiary graduates. More specifically, an increasing supply of tertiary graduates is likely to put downward pressure on gross wage *premium*. In turn, a lower wage *premium* reduces the incentives to invest in TE. Second, labour market policies and institutions influence wage dispersion and hence may also affect incentives to invest in TE. To take into account the potential simultaneity issues, we estimate a system of two equations modelling the investment in TE and the determination of the relative price of skills.[26]

The first equation is the same than the baseline specification estimated above, while in the second equation gross wage *premia* are regressed on the

[23] This includes both private and public spending.

[24] The factor price usually includes the cost of academic staff and infrastructures, but this price should also include subsidies paid to students as a result of the customer-input technology used in the production of human capital (Winston 1999).

[25] This approach is further developed in Boarini, Nicoletti and Oliveira Martins (2008, forthcoming).

[26] The main identifying assumptions are: (i) the relative supply of skills is proxied by the relative stock of human capital in the population, i.e. the labour market participation is assumed to be constant across skills; (ii) there is no lag in the transmission of the price signals, i.e. wage premia and graduation ratios are determined contemporaneously; (iii) the structural relationship between IRR and wage premia is not specified.

log of tertiary graduation ratio, the lagged stock of human capital, EPL for temporary workers, EPL by type of contract (temporary and regular), the degree of bargaining coordination and the trade openness of the economy. Indeed the specification of a wage *premia* equation follows a standard approach accounting for labour supply and demand forces, as well as labour market policies and institutions (Katz and Autor 1999). The wage level can be seen as the result of a competitive wage plus or minus a deviation due to either labour market institutions or measurement problems.[27] The competitive wage is a function of the relative supply of skills (decomposed into the lagged levels of the tertiary and secondary human capital stocks and inflows of tertiary human capital). The relative supply of skills is let to be endogenous in the estimation procedure. Deviations from competitive wages are proxied by a number of labour market institutions; in the specification shown here these are the degree of coordination of wage setting negotiations and EPL. The equation also controls for (exogenous) relative demand shifts arising from trade openness, and include country-specific time trends and common time dummies. The estimation is based on the standard three-stage least square estimator (3SLS). We find that the impact of determinants of graduation ratios is relatively robust to the assumption of exogenous IRR (see the last two columns in Table 3). We also find that the impact of labour market institutions on wage *premia* turns out to be considerable. EPL for temporary contract is found to have a negative impact on wage *premia* while the opposite is obtained for EPL for regular workers. Coordination bargaining is found to have a negative impact on wage dispersion, corroborating previous evidence in the field (Barth and Lucifora 2006).

8 Policies to enhance TE outcomes

Shortage of skills is as a serious handicap for the growth potential of economies. Low efficiency of public expenditure on TE is another issue, considering the large amount of public resources allocated to TE in some countries and the relatively modest outcome of this investment. Last but not least, rising mobility and labour market integration across OECD countries raise new challenges for TE systems, with TE institutions increasingly competing for scholars, students and resources on a global scale. Reforms of TE systems are thus on the current agenda of many OECD countries, with the two-fold objective of making TE systems respond to labour market dynamics of global economies and obtaining the most from the public financial effort in the sector.

[27] Measurement problems arise from differences in non-wage compensation across jobs.

With regard to the latter, we have argued in previous sections that TE institutions may not operate in incentive-compatible settings in countries where TE systems are little accountable and autonomous.[28] Reforming those systems by putting in place adequate governance settings which allow for an efficient provision of high-quality educational services should be seen as a priority. Getting an efficient TE system might not be enough, however, in a context of increasing search of excellence. Increasing both the quality and quantity of tertiary graduates seems to be hardly feasible without injecting more resources in the system (Teixeira et al. 2004). A widely shared position is that pressure on public budgets makes it difficult to increase public funds. Augmenting the role of the private sector seems viable, not only because in many OECD countries the current level of the private participation is limited but also for the potential efficiency gains that this solution may induce. If more resources are warranted by the household sector, typically through higher tuition fees, students could be made more responsible with respect to completion, quality of learning and fast progression in their studies. Greater reliance on tuition fees may also have positive effect on the supply side: notably tuition fees may transmit signals on the quality of education provided, as well as increase effective competition among universities by pushing institutions to cost-efficient delivery of educational services. Increased financial participation of the industrial sector could be appealing to the extent that it were to allow partnership between firms and universities and improve the matching between the education delivered and skills required by production needs. Finally, equity concerns (Barr 2001; Jacobs and van der Ploeg 2006; Oliveira Martins et al. 2007), such as public spending in TE being regressive and crowding out public resources that could otherwise be earmarked for liquidity-constrained students, suggest that making students paying for education and at the same time introducing appropriate financial help such as income-contingent loans or means-tested grants, could increase both efficiency and equity.

Against this background, the empirical findings of the previous section suggest some avenues for reform. Accordingly, we present suggestive policy simulations on the increase of flexibility and accountability of

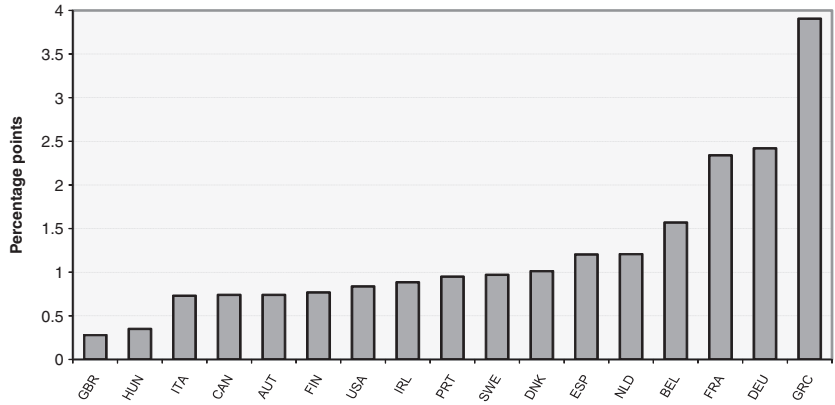
[28] The article does not provide a direct test of the importance of public financing of tertiary education, though this dimension is partly captured by the financial constraint indicator which measures the extent to which public resources are made available to finance tertiary studies for a representative student in the economy. While we do not attempt to provide an assessment of cost-effectiveness of public spending on tertiary education, our finding such that graduation ratios are affected by institutional set-up of supply suggests that efficiency-enhancing reforms in this sector may be adopted in the form of higher autonomy and accountability of education supply.

supply, tuition fees and availability of funding for students. The first simulation consists of benchmarking the summary indicator of flexibility and accountability of supply side on the best performer in the sample (Australia). Indeed, catching-up with the Australian system would require ambitious reforms for a number of OECD countries. The objective here is not to suggest drastic policy changes but rather to give a flavour of the room of high-potential returns to policy action in the field of TE. This simulation suggests that countries such as Greece, Germany and France would benefit the most from reforming the supply of TE (Figure 7).

In the second simulation, tuition fees are increased to the sample mean plus two standard deviations (around 4,000 US$ at PPPs). This policy shock is considerable in all countries where tuition fees are nil (e.g Nordic countries, Greece, etc.) and negligible in countries which already feature high tuition fees (Australia, United States). The increase in fees has a two-fold negative effect (Figure 8). The first operates through a fall in the *IRR* (as direct costs go up), while the second, much stronger effect, works *via* stronger liquidity constraints (assuming unchanged individual-funding systems). The cumulated negative effect can be large in absolute terms. This result suggests that an increase in tuition fees may call for other flanking policies.[29] Given that the main effect relates to increased liquidity constraints among possible compensating policies, a natural candidate is the development of individual financing. Indeed, countries introducing or raising tuition fees have usually taken simultaneous action in this field, as in Australia, New Zealand and the United Kingdom.

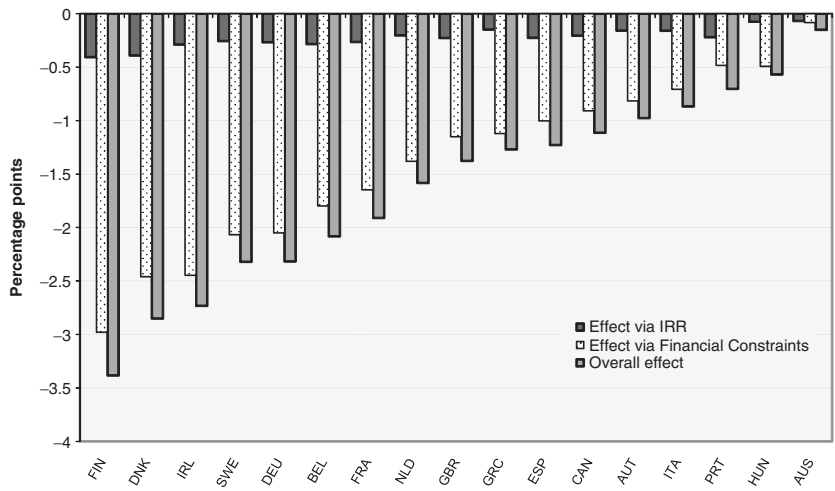
To assess the beneficial effect of flanking policies to the greater reliance on tuition fees that TE system may opt for, we simulate the impact of aligning the ratio of costs to financing resources (Table 2 above) to the minimum in the sample. The impact ranges from nearly 1.5 percentage points in Portugal and Spain to virtually zero in Denmark and Finland

[29] A simulation where financial help to students is increased together with tuition fees (not shown here) suggests that graduation ratios would still decrease but by much less than in the case where no flanking policies are put in place. However, the effect of higher tuition fees is not zero because of the way the financial constraints indicator is constructed. An increase of tuition fees in the numerator matched by an equal increase of resources in the denominator would still entail an increase of the overall ratio. This could be interpreted as the fact that education cost would rise comparatively to other items, notably living costs, and this would discourage demand for tertiary education. However, if the additional financial help to students were made strictly conditional on paying the additional tuition fees, this should not affect decisions of (potential) students and both flows would be best interpreted as a zero addition to (net) costs, i.e. the indicator would remain unchanged. The financial constraints indicator in this article does not apply a net cost concept due to the lack of data on the breakdown of financial help to students into grants and loans, earmarked for tuition fees or living costs.



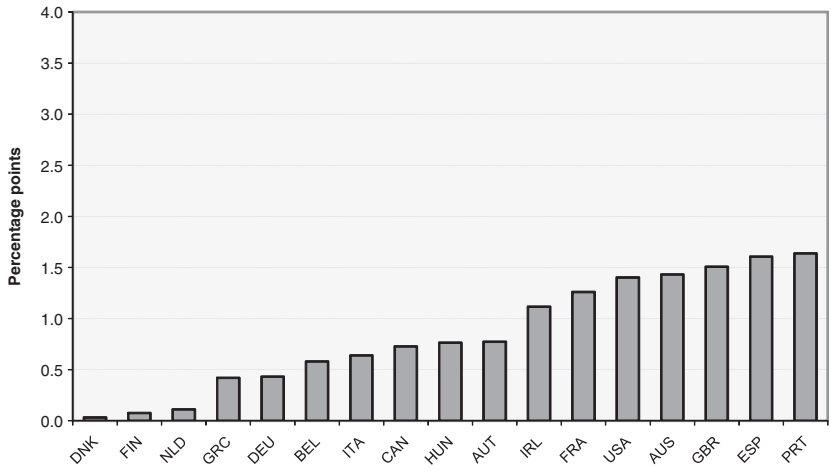
1. Effect of aligning the STE indicator on the maximum in the sample of the regression presented in table 3.5 (Australia).
Source: OECD calculations.

Figure 7 Impact of increasing the flexibility and accountability of TE supply on graduation ratios



1. Effect on graduation ratios of increasing tuition fees up to the sample mean plus two standard deviations. (The United States are not included because the level of net tuition fees are already above the sample mean plus two standard deviations).
Source: OECD calculations.

Figure 8 Impact of an increase in tuition fees on graduation ratios



1. Effect of an alignment of the ratio of investment costs to financing resources (see table 3.4) on the minimum in the sample.
(This benchmark was preferred as the sample mean minus two standard deviations is below the minimum).
Source: OECD calculations.

Figure 9 Impact of easing liquidity constraints on graduation ratios

(Figure 9). The simulation results are clearly more relevant in the case of family-based systems, where liquidity constraints are likely to be more binding. However, insofar as reforms of universal funding systems involve use of tuition fees, easing liquidity constraints will have a positive impact in those systems, too.

9 Summary and conclusions

In this work we have explored the main determinants of investment in TE and focused on policy-levers of these determinants. OECD countries' TE systems have been shown to differ across many dimensions: in terms of the quantitative outcome (graduation ratios), the gender-field composition, the degree of flexibility and accountability in supplying educational services, the private returns to tertiary studies and the financial conditions of access to TE. It has also been shown that graduation ratios are shaped by institutional settings of both TE systems and labour markets, as well as by the availability of financial help to students and other structural factors like the increasing participation of women in TE. In this context, we have simulated the potential impact of some reforms in the TE sector. The results suggest that, depending on the existing institutional conditions, there is a strong potential to increase graduation ratios by introduction/strengthening of flexibility and accountability in TE supply. In order to

increase the amount of resources injected in the system without having a detrimental effect on the graduation ratios, the increase of tuition fees requires the introduction/extension of individual funding to TE students. Overall, the different TE indicators and their estimated relationships provided in this article can provide some guidance for reforming TE systems in many OECD countries. Future research in this field is needed to cover some of the aspects that were not sufficiently tackled by our analysis, as the role of public versus private funding and management of TE institutions, as well the possible complementarity between policy actions. It would be also of great importance to look at the quality of the investment of human capital, since a quantitative perspective as the one adopted by this article is necessarily restrictive. In this respect, distinguishing between graduation ratios across fields or across different educational programmes would be relevant and worthwhile. Finally, the analysis of the institutional framework of TE supply could be further enhanced by giving consideration to the extent and shape of market competition in the sector.

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Science and the University: Challenges for Future Research

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Abstract

Scientific research has played a critical role in the life of the university for a considerable period of time, both in Europe and in the US. While much remains the same in the relationship between science and the university, considerable change has occurred in recent years. Here we outline three changes in this relationship, focusing both on the consequences for the university and on questions of research interest to those interested in higher education. The three changes are: (i) increased incentives to publish; (ii) changes in the reward system and (iii) increased reliance by governments and communities on universities and institutes as a source of economic growth. (JEL codes: I23)

Keywords: Science policy, research, universities.

1 Increased incentives to publish

The incentive to publish in scientific journals has increased considerably in recent years, both at the system level and at the individual level. Examples of this are everywhere: the budgets of universities and departments in certain countries depend heavily on publication and citation counts. Funding for the research of individual scientists depends increasingly on the publication track record of the scientist; in certain countries bonus payments are made, based on publications.

By way of example, in the United Kingdom the ranking of departments and the allocation of department funds, undertaken by the Research Assessment Exercise, are based in part on publication and citation counts. A somewhat similar system exists in Australia and an increasing share of funding for Flemish universities is now based on research performance as evaluated through publication and citations. In the Netherlands, publications and citation counts play a key role in determining the reputation of a university, although they do not figure into the allocation of funds for the university/department. At the individual level, publication and citations play a key role in garnering research resources. For example, the publication record of the scientist plays a key role in the evaluation of

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grant applications submitted to the National Institutes of Health in the United States (NIH), with a $29 billion budget. Likewise, and by way of example, the Flemish Science Foundation makes research awards to applicants based in part on their reputation as established through publication. Chinese researchers who place in the top half of colleagues in terms of bibliometric measures can earn three to four times the salaries of co-workers (Hicks 2007). Some Chinese institutes pay cash bonuses for publishing in *Science*, *Nature* and *Cell*.

The increased emphasis on publication affects the publication strategies of faculty, the level of competition at journals and the hiring strategy of departments. Faculty arguably are paying more attention to where they submit an article for publication, with whom they co-author and how they carve the research up into publications—or what some would call "least publishable unit" or LPU (Stephan and Levin 1992). An imminent life scientist in the US recounted to us how his European co-authors consistently aimed at the top journal *Science*, even when he felt the research did not merit publication in *Science*. Although he understood the incentive for aiming so high, he was frustrated by the lag this created between completing the research and publishing the research.

The increased emphasis on publication (and publication at top journals) has arguably increased the level of competition at journals and the demand for new journals. While the latter is well documented, the increased level of competition at journals, and how it relates to changing incentives to publish, has not been addressed to the best of our knowledge and invites investigation (see subsequently). A related consequence is that the need for referees is growing. Journals (and funding agencies) increasingly report a "shortage" of knowledgeable reviewers. Study groups at NIH (where review occurs) have reduced the amount of time they spend reviewing proposals in response to the demand from reviewers to spend less time away from their labs.

A major news article in 2004 in the US (front page headline in the *New York Times*) concerned the decline in article counts written by US scientists and engineers (Broad 2004). More recently the National Science Foundation (2007) has released a report showing how US output has fared relative to other countries (Figure 1). Hicks (2007) and others have argued that the decline relates to the changing incentive structure: US scientists now face considerably more competition than in the past as incentives to publish have grown outside the US.

Increased reliance on reputation for the awarding of grants and department funds has also led to changes in hiring practices. The market for stars (especially just before the evaluation of departments and programs) is fierce—what one might call "just-in-time hiring". Highly cited scientists are routinely sought by universities and departments to

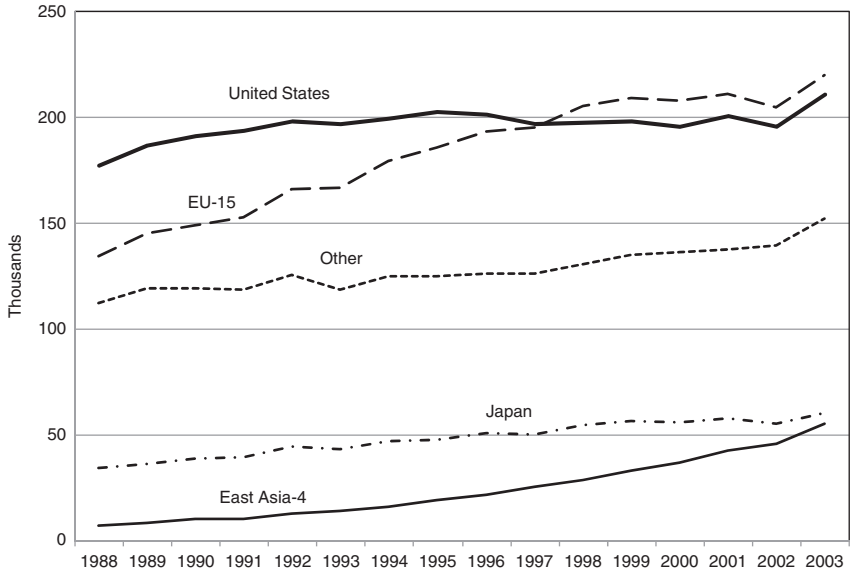

Figure 1 S&E article output (fractional counts) of major S&E publishing centers: 1988–2003. S&E = science and engineering, EU = European Union. *Notes*: Article counts are on a fractional basis, i.e. for articles with collaborating institutions from multiple publishing centers, each publishing center receives fractional credit on the basis of the proportion of its participating institutions. East Asia-4 includes China, Singapore, South Korea and Taiwan. China includes Hong Kong
Source: National Science Foundation (2007, Figure 6)

enhance their funding chances (senior faculty with strong research records have a high probability of bringing large grants, thus offsetting some of the growing costs associated with research). Moreover, such offers often are accompanied with sufficient flexibility to permit the researcher to remain in the current position while accepting a position at the new institution as well. Such strategies are not limited to the West. In recent years China has sought "trophy" professors, allowing them to maintain their full-time position overseas, while paying them handsomely for short working stints in China (Normile 2006).

The emphasis on stars has consequences for newer cohorts of scientists. In the US, for example, the age distribution of faculty is changing (see Figure 2, for an example of the biomedical sciences). Universities are hesitant to hire junior faculty, whose research records (and funding records) have yet to be established. Instead, they prefer senior faculty with strong research records. These same senior faculties rely on graduate

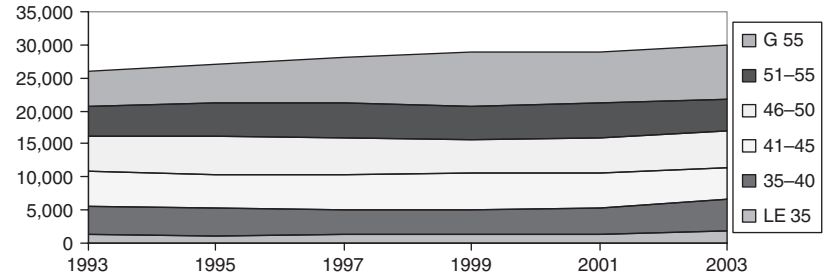

Figure 2 Tenure track biomedical faculty by age
Source: Survey of Doctorate Recipients, NSF. The use of NSF data does not imply NSF endorsement of the research methods or conclusions contained in this report

students and postdocs and other "temporary" workers to staff their faculty research labs. Richard Freeman estimates that the ratio of postdocs to tenured-faculty positions in the life sciences in the US grew from 0.54 to 0.77 between 1987 and 1999 (a 43 percent increase) (Stephan forthcoming). The increase in the number of postdoctoral positions is due to both supply and demand factors. On the supply side, there is an increased number of newly-awarded PhDs in the biomedical sciences. On the demand side, these newly-minted PhDs have been experiencing difficulty in finding tenure-track jobs as universities have reduced the ratio of tenure-track positions to non-tenure track positions. At the same time, the demand for postdoctoral positions has been augmented because of the dramatic increase in funds available to hire postdoctoral students.[1] The situation is not limited to the US. Schulze (forthcoming) shows that the number of Habilitationen in Germany grew from approximately 1,300 in 1992 to 2,300 in 2004. In terms of Habilitationen per 100 professors, this represents more than a 66 percent increase.

There is a need for systematic research into these observations. Research questions include: (i) how the composition and number of submissions to journals relates to changing incentives; (ii) how hiring patterns and associated mobility of faculty have responded to changes in incentives; (iii) the degree to which the distribution of university salaries has changed; the (iv) the degree to which the market for "dual positions" has increased and (v) the effects of these trends on the quality of research.

[1] Stephan and Ma (2005) find a strong negative relationship between taking a postdoc position after graduation and the demand for academic positions, as measured by the percentage change in total current fund revenue for public institutions. Demand for postdocs, especially in the life sciences, grew dramatically in the US between 1998 and 2003 when the NIH budget doubled.

2 Change in the reward system for university scientists

The earnings profile of university scientists has traditionally been relatively flat over the career. Ehrenberg (1991) for example, estimated that the average salary of a full professor in the physical and life sciences in the US was approximately 1.7 times that of an assistant professor. The shape of the profile relates arguably to monitoring problems and the need to compensate scientists for the risky nature of their work (Stephan forthcoming). The flat shape of the profile is reinforced in countries where scientists are civil-service employees.

In addition to the increase in salaries associated with increased competition, scientists increasingly have opportunities to enhance their earnings. They can do so by consulting with industry, by patenting and receiving associated royalty payments, by starting-up companies, or by serving on the advisory board of a start-up company. These changing opportunities affect the shape of the earnings profile for those who participate in these various forms of technology transfer. Given the highly skewed nature of patenting and the even more highly skewed nature of licensing and royalty revenues, these enhanced income effects are not widely experienced by the average scientist. Yet, by increasing the amount of inequality in the reward structure of science they arguably affect the fabric of scientific collaboration as well as the satisfaction that average scientists experience from their work.

Thursby and Thursby (2007), for example, find that 10.3 percent of US faculty at top universities discloses an invention to their university. While not all disclosures are patented, many are. The number of US patents assigned to universities has increased by a factor of 2.6 during the past 10 years from 1993 to 2003 (National Science Board 2006, tables 5–28). It is increasingly common for faculty to patent in Europe as well. While it is more difficult to count patents attributed to European university faculty (since more are assigned outside the university), the work of Lissoni et al. (2007) suggests that the rate at which faculty are patenting in Europe is not substantially different from that in the US.

Faculty receives royalty payments associated with these patents. While the percent that faculty receives varies across university, the amount they receive has definitely increased as royalty payments have grown. In the US, for example, between 1993 and 2003 royalty payments received by universities grew from $195 million to $867 million. In rare instances the royalty stream produced by a patent is extraordinary. For example, Emory University in July 2005 sold its royalty interests in emtricitabine, also known as Emtriva®, and used in the treatment of HIV, to Giliad Sciences, Inc. and Royalty Pharma. The University received $525 million (US). The three Emory University scientists involved received

approximately 40 percent of the sale price, reflecting the university policy that was in place at the time (http://sec.edgar-online.com/2005/08/04/0001193125-05-157811/Section7.asp).

Another way in which faculty can earn extra income and enhance wealth is through involvement in a start-up company. The greatest rewards to such involvement come when (and if) the company goes public. Sometimes the rewards are of staggering proportions, at least on paper. A case in point is Eric Brewer, a computer scientist at UC Berkeley, who was listed on *Fortune* magazine's list of the 40 richest Americans under 40 in October 1999 with a net worth of $800 million (US), a result of the role he played in founding a company that went public in 1998 (Wilson 2000). Edwards, Murray and Yu (2006) document that, in the event a biotechnology firm makes an initial public offering, the median value of equities held by an academic with formal ties to the company, based on the IPO's closing price, ranged from $3.4 million to $8.7 billion, depending upon the period analyzed. The incidence of being on a scientific advisory board (SAB) is non-trivial. Ding, Murray and Stewart (2006) identify 785 academic scientists who are members of one or more SABs of companies that made an initial public offering in biotechnology in the US. Stephan and Everhart (1998) find 420 university scientists working with 52 biotech firms that made an initial public offering in the early 1990s. Members of such boards generally hold equity in the firm as well as receive annual compensation for attendance at meetings.

Changes in the reward structure (and the competition associated with such a change) arguably affect access to materials and information. Walsh, Cho and Cohen (2007) find that 19 percent of material requests made by their sample were denied. Competition among researchers played a major role in refusal. The cost of providing the material also was important, as well as whether the material in question was a drug or whether the potential supplier had a history of commercial activity. Research by Blumenthal and his colleagues (1997) suggests that faculty involvement with companies can delay the speed with which faculty publishes and their willingness to talk openly about their research. Heller and Eisenberg (1998) argue that increased patenting by university faculty, and the multiple property rights associated with such patents (sometimes in the hundreds, as in the case of genes) can dampen research by requiring researchers to bargain across multiple players to gain access to foundational upstream discoveries.

There is also the question of whether the focus on patenting detracts from publishing. While the presence of time in the production function for knowledge suggests that patenting and publishing may be substitute activities, there are good reasons to argue that complementarity is more likely and that patents can be a logical outcome of research activity that is

designed first and foremost with an eye to publication. The reasons for complementarity are three-fold. First, the results of research, especially research in Pasteur's Quadrant, can often be both patented and published, having a dual nature. Second, the increased opportunities that academic researchers have to work with industry may enhance productivity and encourage patenting. Third, the reward structure in academe encourages patenting as one outcome of research.

A handful of studies in recent years have examined the relationship of publishing to patenting (Agrawal and Henderson (2002); Carayol (2007); Calderini, Franzoni and Vezzulli (2007) and Stephan et al. (2007). While various methodological issues arise, such as endogeneity, most find evidence that publishing and patenting are complementary rather than substitute activities. Researchers have also examined the relationship between patenting and publishing. Azoulay, Ding and Stuart (2006), for example, examine the impact of patenting on the publication activity of university researchers working in areas related to biotechnology and find that patenting has a positive effect on publication. Markiewicz and DeMinin (2004) also find patents to have a positive and significant effect on publication production of university researchers in their sample of US scientists, as do Breschi, Lissoni and Montobbio (2007) in a study of Italian scientists.[2]

Changes in the reward structure and the competition associated with such changes can also have consequences for students (Stephan 2001). On the positive side, faculty involvement with industry can provide job opportunities, create research opportunities and influence the curriculum. But the changing nature of the reward structure can also have negative effects on students. Conflict can arise between the faculty member and the student concerning the attribution of credit for an invention. Faculty may choose to allocate less time to students as they focus increasingly on technology transfer. And peer learning can also be affected. There is considerable evidence that students learn from students (Hoxby 2000; Sacerdote 2001; Symons and Robertson 1996; Zimmerman 2003). Yet an increased emphasis on patenting can discourage peer learning. A principal investigator recounted to the author how he told an undergraduate working in his lab that, for patent purposes, she should not identify the compound they were working on. To which she reportedly replied: "Oh, I know that. In the lab I worked in last summer we didn't talk about anything."

[2] Their research suggests that the positive effect is not due to patenting *per se* but to advantages derived by having strong links with industry.

Some of these consequences, such as access to information and cell lines, have been investigated already. Other questions remain wide open for investigation. These include changes in the shape of the earnings profile when the definition of earnings is expanded to include royalty payments, consulting fees, etc.; changes in the distribution of faculty earnings and the degree to which the process of technology transfer affects peer learning. There is also the issue, once again, as to how these trends affect the quality of research and by way of extension the accumulation of scientific knowledge.

3 Increased emphasis on universities as a source of growth

Considerable evidence exists that science is a source of economic growth (Adams 1990). There is also considerable evidence that knowledge spillovers are geographically bounded (Acs, Audretsch and Feldman 1992; Jaffe 1989). This has led governments and communities to invest in universities and programs with the expectation that they will create more Silicon Valleys and Route 128's. For example, the news from Texas in August of 2006 was that the state had decided to invest $2.5 billion for science teaching and research in the University of Texas system. The primary focus was to build the research capacity of San Antonio, El Paso and Arlington (all cities in Texas) with the goal of turning these into the next Austin. Texas is not alone. The University of California system recently built a new campus at Merced. Many argue that a leading factor in establishing the new campus was the desire to turn the San Joaquin Valley into another Silicon Valley. Many states in the US possess biotech initiatives as do many European countries. Initiatives are underway in other areas. Singapore is one case in point.

The consequences of this increased emphasis are several: it augments the competition for stars, discussed earlier and it can create excess capacity, much like the situation where cities build sports arenas with the belief that "if we build it they will come". An emphasis on local economic development also affects the technology transfer process. Belenzon and Schankerman (2007) find, for example, that "universities with strong local development objectives generate about 30 percent less income per license". Belenzon and Schankerman also find that such universities are more likely to license to local (in-state) startup companies. Perhaps most importantly, the focus on economic development may ultimately affect the university's ability to garner resources in the future. If universities cannot deliver the level of regional economic growth that the public anticipates, especially within the time frame that states expect, the public's enthusiasm for supporting universities may diminish. Adams (1990) finds extremely

long lags between research and economic growth, on the magnitude of 20–30 years.

Clearly we need more than anecdotal evidence regarding the local growth story. Granted, the importance of proximity to knowledge sources has been demonstrated in much of the work on spillovers. But this is a long way from demonstrating a relationship between knowledge production and local economic growth. There is a need to create systematic longitudinal databases to track economic development associated with local science initiatives. Questions to be analyzed include, but are not limited to, the degree to which growth is "local" vs. national and international and the period of time required to realize benefits.

4 Conclusion

We have identified three changes occurring in the relationship between science and the university. The three are: (i) increased incentives to publish; (ii) changes in the nature of the reward system and (iii) an increased reliance by governments and communities on universities as a source of local and regional economic growth. These changes in turn have led to changes in hiring practices, decreased opportunities for newer cohorts to engage in research, especially research directed by themselves, changes in the availability of materials and information used in research, changes in the peer learning environment, changes in publication practices, and increased expectations from the public regarding what the university can contribute to economic development.

Much of our discussion concerning the consequences of these changes has relied on anecdotal evidence. There is a need to systematically examine the relationship between these changes and some of the outcomes discussed in this article. For example, we need to know (i) the degree to which changing incentives affect submission behavior and referee behavior; (ii) how changing practices in compensation affect the shape of the earnings profile and the distribution of earnings; (iii) the degree to which faculty have become more mobile and the extent to which faculty, especially star faculty, hold dual positions; (iv) the degree to which "knowledge" initiatives create local economic development. Finally, and most importantly, is the need to have a clear understanding of how the three trends that we have chosen to focus on affect the quality of research and hence the accumulation of scientific knowledge.

Changes in policy are most effective when they are accompanied by research that evaluates and examines the effects of the policy. Such evaluation and examination, alas, require the systematic collection of data. A necessary step in answering these, as well as other questions is to begin the systematic collection of data.

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