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# CESifo Economic Studies

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# Speculative Eurozone Attacks and Departure Strategies

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## Abstract

This article shows that the eurozone payment system does not effectively protect member states from speculative attacks. Suspicion of a departure from the common currency induces a terminal outflow of central bank money in weaker member states. TARGET2 cannot inhibit this drain but only protects central bank assets. Evidence presented here suggests that a run on Italy is already on the way. The article also considers departure strategies of strong and weak member states and the distributive effects of an orderly eurozone dissolution. (JEL codes: E52, E58, and F45)

**Key words:** currency speculation, TARGET2, eurozone, Italexit, Dexit, trilemma

## 1. Introduction

Is the eurozone safe from speculative attacks? Which form would such attacks take? And if a single member state were to leave the common currency, either voluntarily or after an assault, what would its departure strategies look like, and what are the probable distributive consequences? These interrelated questions are motivated by European experience with fixed exchange rate regimes and, notably, by the increasing economic and political tensions that commenced after the financial crisis of 2007/2008 and continue until today.

European monetary cooperation started in May 1972 with the Exchange Rate Arrangement, the famous ‘snake in the tunnel’. After the effective termination of the Bretton Woods system in 1971, the snake prescribed narrow bands of  $\pm 2.25\%$  for major European currencies. The arrangement was characterized by frequent exchange rate realignments as well as by exits and re-entries. For instance, the UK left in June 1972, Italy left in 1973, and France left in 1974, rejoined in 1975, and left again in 1976.

In March 1979, the European Community (EC) replaced the snake with the European Monetary System, the core elements of which were a narrow exchange rate band of  $\pm 2.25\%$ , a broad band for the Italian lira of  $\pm 6\%$ , and an exchange rate mechanism (ERM) that provided for extended credit facilities between central banks. Notwithstanding several exchange rate realignments, the ERM worked fairly well until approximately 1990,

when EC member states gradually removed capital controls; see [Higgins \(1993\)](#). On 16 September 1992, ‘Black Wednesday’, Italy and the UK, plagued by high inflation and double deficits, were compelled to leave the ERM. Investors such as George Soros, who had built up short positions in British pounds and Italian liras, made huge profits.

Previously, the UK and Italy had heavily intervened in the foreign exchange markets to stabilize their currencies against the Deutschmark and avoid a departure. As they ran out of reserves, the Bank of England and Banca d’Italia received Deutschmark loans from the German Bundesbank. Under the ERM, the Bundesbank was obliged to grant support, but (as it pointed out in the famous *Emminger letter*) only to the extent that this did not interfere with its monetary policy objectives. When the Bundesbank feared losing control of the monetary base, it removed assistance to its fellow central banks, and the latter were forced to surrender. All things considered, the ERM broke because the Bank of England and Banca d’Italia were not prepared to raise interest rates to any desired level, while the Bundesbank was not prepared to lose control of its monetary base.

Immediately after these failures, the European Union (EU) started a 3rd and hitherto final venture to discard exchange rate flexibility. Specifically, the EU established the European Monetary Institute (EMI), the predecessor of the European Central Bank (ECB), and decided to form a unified currency area rather than just pegging individual currencies. Already in 1995, an EMI working group presented a draft of the monetary union’s core element, the Trans-European Automated Real-Time Gross Settlement Express Transfer System (TARGET), which has since been replaced by TARGET2. With ‘Black Wednesday’ as a recent reminder, the principle objective of TARGET was ‘to serve the needs of the single monetary policy’. Improving the payment system was only noted as a secondary aim; see [EMI \(1995, p. 1\)](#). To avoid speculative attacks, the system provides unlimited overdraft between national central banks (NCBs). [Tornell \(2018, p. 11\)](#) speaks aptly of a ‘seamless currency union’.

Due to the thorough debate on TARGET2 initiated by [Sinn and Wollmershäuser \(2012\)](#), the design of this system is well known, so that a very brief recollection may suffice here.<sup>1</sup> TARGET2 essentially interconnects the payment systems of the eurozone countries. Italian bank A can transfer central bank money to German bank B, provided it has sufficient reserves available in its account with Banca d’Italia. The latter debits bank A’s account and sends a payment message to the Bundesbank, which credits bank B’s account. In this way, the liabilities of Banca d’Italia toward bank A are reduced, while the Bundesbank’s liabilities toward bank B are increased. To restore the original net asset positions, Banca d’Italia incurs a TARGET2 liability toward the ECB, and the Bundesbank obtains a TARGET2 claim against the ECB. This netting occurs at the end of each trading day.

Until the outbreak of the financial crisis in 2007, TARGET2 balances were unobtrusive; but thereafter they climbed to ever higher levels.<sup>2</sup> At the time this article was written, Banca d’Italia’s TARGET2 liability approached 500 billion euros, whereas the Bundesbank’s TARGET2 claim came near 1000 billion euros. Would these horrific amounts be settled in the event of a eurozone collapse? The Lisbon Treaty, the ECB’s statute and innumerable further regulations are silent about this matter. Therefore, many economists from TARGET2 claim countries consider the balances hazardous, while economists

1 [Cecchetti et al. \(2012\)](#) and [Homburg \(2011\)](#) provide expositions of the early TARGET2 debate.

2 [Potrafke and Reischmann \(2014\)](#) analyze the explosion of TARGET2 balances empirically.

from TARGET2 liability countries, most notably Paolo Savona from Italy, play around with profitable departure strategies.<sup>3</sup> The underlying fears of a eurozone meltdown are reinforced by increasing political tensions. Meanwhile, Eurosceptic parties have been established in practically all member countries. Northern factions such as the ‘True Finns’ or ‘Alternative for Germany’ consider the eurozone as a scheme that transfers wealth from the core to the periphery; southern camps see their countries trapped in a kind of *Dutch disease*.

The article is organized as follows: Section 2 examines, and challenges, the view that the TARGET2 mechanism precludes intra-eurozone attacks. Proceeding from standard international macro theory, the section demonstrates that ‘Black Wednesday’ can still occur within the eurozone because unlimited overdraft between NCBs does not yield airtight protection. This conclusion runs counter to most of the TARGET2 literature.<sup>4</sup> Section 3 supports the preceding theory with evidence indicating that a run on Italy is already on the way. Section 4 considers departure strategies of weak and strong member countries, taking Italy and Germany as examples. According to the section’s main finding, leaving the eurozone yields a 1st-mover advantage, which is a characteristic feature of this currency union and does not exist in the case of departures from fixed exchange rate regimes. Section 5 concludes the article.

Before starting, the motive to write the present article should be disclosed. Before 1990, virtually no economic research on German reunification was conducted because, first, such an event seemed far-fetched and, second, questioning the mere existence of the iron curtain appeared politically incorrect. Lacking economic advice, policy makers had to experiment when the wall was torn down, and in retrospect many decisions were decidedly suboptimal. Such a research vacuum should be avoided as a matter of principle. With this in mind, the article offers a modest piece of research on eurozone collapse and departure.

## 2. TARGET2 Cannot Inhibit Speculative Attacks

In an early contribution, Peter Garber asked whether the eurozone’s payment system would be suitable to shield it from speculative attacks. His main conclusion was as follows:

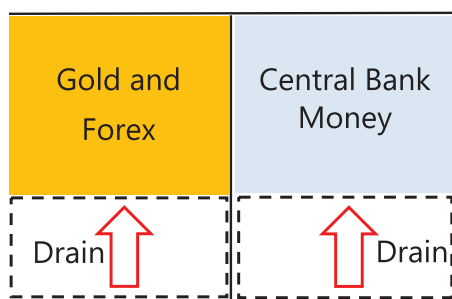
TARGET and its surrounding accounting procedures are the means by which the National Central Banks (NCBs) will provide credit to each other when there are cross-border payments imbalances in the euro. It may be that the sovereign governments are always willing to permit their NCBs to provide unlimited credit to each other, consistent with the obligations of the Maastricht treaty. Then, there is no possibility that a collapse of the system will occur. Alternatively, they may be unwilling to provide continued credit—especially if they are already contemplating withdrawal—and this will set the parameters for the dynamics of collapse.<sup>5</sup>

By now, it has become clear that member states are indeed willing to permit their NCBs to provide unlimited overdraft to each other, even though other obligations under the Maastricht treaty were consistently and heavily violated. In view of this fact, Garber’s analysis implies that successful attacks on the eurozone are impossible. The following line of reasoning challenges this claim and shows that unrestricted TARGET2 balances do not

3 Gros (2018) reviews Savona’s plan ‘Piano B’.

4 An exception is Steiner et al. (2017) who focus on the 2011 to 2012 period.

5 See Garber (1999, p. 197) and Kenen (2000) for a similar argument.



**Figure 1.** NCB balance sheet.

suffice to protect weak eurozone members from speculation. To present the argument in familiar terms, the exposition starts with a hypothetical NCB balance sheet under a gold-exchange standard. In a balance of payments equilibrium, a country's current account balance (exports minus imports) and its capital account balance (capital imports minus capital exports) sum to zero, and the NCB's gold and foreign exchange reserves remain constant.

Figure 1 represents a balance of payments disequilibrium, which can occur due to a current account deficit, a capital account deficit, or both. The NCB loses gold and forex reserves. As long as it adheres to the rules of the gold standard, it has to reduce central bank money (domestic banknotes, coins, and bank reserves) at the same pace because central bank money is fully backed by gold and forex. An NCB aiming for external stability will raise interest rates in such a situation. This measure attracts foreign capital and depresses domestic absorption, thus restoring a balance of payments equilibrium. However, if the NCB aims at internal stability and leaves interest rates unchanged or does not raise them enough, speculators can make a safe bet because reserves are finite; a drain of gold and forex cannot last forever, so the country must eventually go off the gold standard and devalue.<sup>6</sup> By shortening domestic currency and investing the funds abroad, investors make a profit after their debt becomes devalued.

Like the gold standard, Europe's currency union is also a fixed exchange rate regime. However, its treatment of balance of payments disequilibria differs from the gold standard in an important respect because the TARGET2 system protects NCB assets: If a member state becomes confronted with a current account deficit or capital flight, the resulting drain of central bank money does not induce a corresponding reduction in NCB assets but is fully offset by a TARGET2 liability.

Figure 2 shows Banca d'Italia's balance sheet in a simplified form that abstracts from gold, forex, equity, etc. The dominant items on the asset side are loans to domestic commercial banks and securities such as government bonds. In this fiat money system, NCBs create central bank money simply by granting loans or acquiring securities in the open market. The central bank money thus produced is also used for settling international payments within the eurozone. Sending central bank money abroad via a payment message does not oblige the NCB to sell parts of its assets but is automatically accounted for by an increase in

6 Such a restriction did not hold for the USA during the Bretton Woods System, as long as the other countries were content with receiving dollars. The system broke down after some countries, most notably France, started insisting on gold payments.



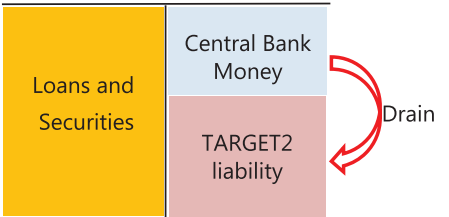


Figure 2. Banca d'Italia balance sheet.



Figure 3. Banca d'Italia balance sheet.

its TARGET2 liability. As legal regulations do not limit such liabilities, the system appears as a gold standard with unbounded gold reserves, which would be safe from speculation. This seems to be the gist of Garber’s widely accepted contention.

We do not concur with this view. Under any monetary arrangement, a country falls into trouble if its banks run out of central bank money. Banks need reserves to fulfill minimum reserve requirements, to satisfy their customers’ demand for notes and coins, and to make payments to one another. Under the gold standard, central bank assets and central bank money move concurrently, because they are connected through the balance sheet identity. Therefore, central bank money drops to zero only when gold and forex reserves become depleted. In the European currency union, however, a country’s total amount of central bank money may vanish even when central bank assets are still plentiful. This occurs when TARGET2 liabilities completely crowd out central bank money.

Such a hypothetical deadlock is shown in Figure 3. The gradual accumulation of TARGET2 liabilities has diminished Italy’s central bank money to zero. Italian banks can neither execute payments on behalf of their customers nor refill their ATMs. Of course, the figure abstracts from notes and coins that have been issued in the past as well as from minimum reserves. Neither qualification detracts from the basic message, but reinforces it. In practice, the deadlock will already be reached at a point where the amount of central bank money is still strictly positive.

Postponing the discussion of countermeasures, the previous finding may be summarized in the form of a proposition: With a given amount of NCB assets—which are protected by the TARGET2 system and limited by decisions of the ECB Governing Council—a eurozone member country can become illiquid after a terminal outflow of central bank money. If

such an event seems likely, TARGET2 speeds up rather than deters speculation because it facilitates transfers of huge money amounts within seconds.

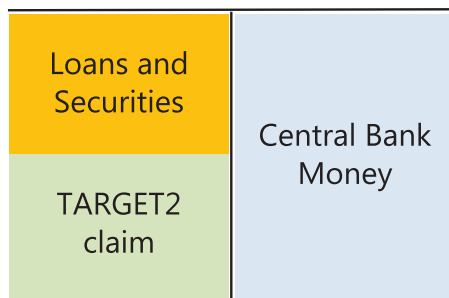
The proposition sheds an interesting light on the rebalancing dispute. ‘Rebalancing’ means settling balances periodically such that NCBs with TARGET2 liabilities transfer parts of their assets to NCBs with TARGET2 claims. This procedure synchronizes central bank assets with central bank money, just as under the gold standard. TARGET2 balances would largely disappear. Rebalancing is actually employed in the USA, where so-called Interdistrict Settlement Accounts that resemble TARGET2 accounts are settled each year on 1 April via a redistribution of shares in a joint portfolio that is managed by the Federal Reserve Bank of New York; see [Wolman \(2013\)](#).

[Sinn’s \(2014, p. 245 ff.\)](#) plan to augment TARGET2 with a US style rebalancing mechanism has been fiercely opposed by ECB representatives. According to [Bindseil and König \(2012\)](#), ‘such a proposal is tantamount to abandon the monetary union’. In a press conference, [Draghi \(2018\)](#) went even further and remarked on TARGET2 that ‘people who want to cap it, collateralize, limit—the truth is that they don’t like the euro’. Both quotes reiterate Garber’s contention that only a scheme of unlimited inter-NCB overdraft can effectively protect the eurozone. These views are fallacious because the eurozone’s susceptibility to attacks has nothing to do with the *asset side* of NCB balance sheets; the real danger comes from the *liability side*.

To substantiate this claim, [Figure 4](#) starts with a look at the Bundesbank’s stylized balance sheet. For the Bundesbank, rebalancing entails an asset swap that substitutes loans and securities for TARGET2 claims, without any effect on central bank money. The same holds true analogously for Banca d’Italia ([Figure 2](#)), which relinquishes some of its assets and discards its TARGET2 liabilities. Again, rebalancing has no impact on central bank money.

Finally, in a deadlock such as that depicted in [Figure 3](#), Italy is finished anyway: With rebalancing, Banca d’Italia has neither assets nor liabilities; without rebalancing, its central bank money is completely crowded out by the TARGET2 liability. Italy’s bank system is illiquid in both cases. The forgoing quotes indicate that the ECB is not aware of this additional Achilles’ heel of the eurozone, which is located on the liability side of NCB balance sheets, not on the asset side.

It seems useful to point out that speculative eurozone attacks resemble classic attacks on pegged exchange rate regimes as studied by [Krugman \(1979\)](#). In both cases, speculators face a ‘one-way option’: they profit from devalued debt if the attack proves successful, and



**Figure 4.** Bundesbank balance sheet.

do not lose money, apart from transaction costs, if the attack fails. Under a pegged exchange rate regime, speculators target central bank reserves; in the eurozone, they target central bank liabilities.

Having established this theoretical point, the following section will examine concrete defense strategies. For the moment it suffices to note that a currency union composed of distinct NCBs, which may possibly depart at some point, differs markedly from a monetary system with a single central bank; it is more akin to a pegged exchange rate regime.

### 3. A Silent Run on Italy

The preceding section has shown that weak eurozone members are liable to lose their central bank money. TARGET2 balances cannot inhibit such a drain. According to the evidence presented in this section, monetary drying up is not a mere theoretical possibility but is what actually occurred in recent years.

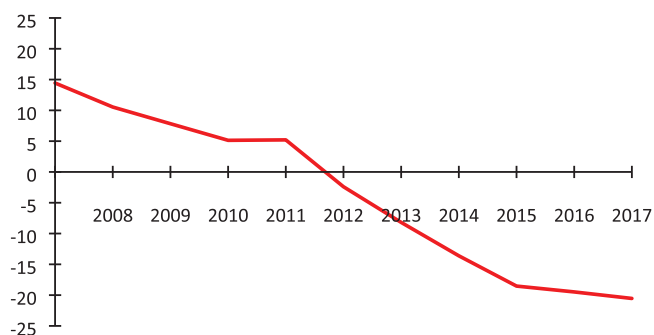
Central bank money comprises bank reserves (booked in the current account and the deposit facility), banknotes, and coins. In what follows, coins are disregarded because they make up a trifling amount of central bank money (<1%) and need special treatment. Banknotes are considered first. The Eurosystem, which consists of the ECB and the NCBs of eurozone member countries, is the sole issuer of banknotes. It discloses them as liability item ‘banknotes in circulation’, a designation that is misleading on three counts:

- Many banknotes do not circulate at all but serve as a store of value. Measured by value, over a quarter of euro banknotes come in denominations of 200 and 500. These are not ordinarily accepted in daily transactions. In September 2008, when Lehman Brothers went bankrupt, the demand for banknotes of higher denominations spiked because customers became concerned about bank solvency.<sup>7</sup>
- Banknotes do not necessarily stay in the country whose NCB has issued them. A banknote issued by the Banque de France, for instance, may circulate in Finland or Greece, or it may sit under a mattress in Russia or Chad. All major currency issuers such as the Federal Reserve System, the Bank of England, or the Eurosystem know they cannot determine the geographical positions of their banknotes.
- The 3rd point is subtler. According to Eurosystem regulations, 8% of banknotes are allocated to the ECB. The remaining 92% are allocated to the NCBs according to their ECB capital share (which is determined according to population and gross domestic product). This fictitious allocation affects the distribution of seigniorage among eurozone member countries.

As a result, the liability item ‘banknotes in circulation’ in NCB balance sheets should be read as ‘fictitious banknote issue’. It is possible, however, to infer actual banknote issues from NCB reports by adding the item ‘net liabilities relating to the allocation of euro banknotes within the Eurosystem’ or by subtracting ‘net claims relating to the allocation of euro banknotes within the Eurosystem’, respectively. If the 1st item is positive, the country under consideration has issued banknotes in excess of its ECB capital share, and vice versa.

Until 2011, Italy’s NCB issued banknotes in excess of its ECB capital share, as shown in Figure 5. The graph demonstrates that Italy’s banknote share fell sharply in 2012 when the

7 According to ECB (2011), only one-third of euro banknotes is used for transaction purposes.



**Figure 5.** Banca d'Italia's banknote surplus/deficit (percentage deviation from fictitious allocation).

Source: Banca d'Italia, *Annual Reports for 2008–2014* and *Annual Accounts for 2015–2017*.

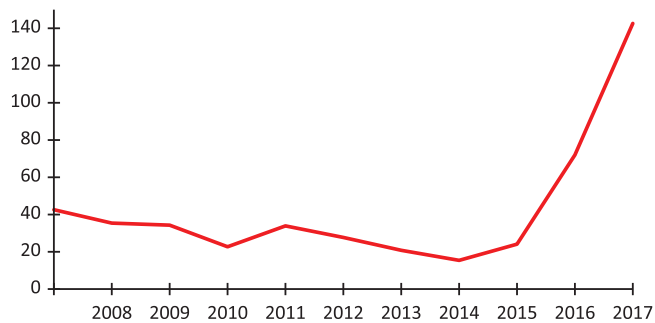
financial crisis turned into a sovereign debt crisis and Italy's solvency became questionable. Since then, Italy's share in eurozone banknote issues has fallen steadily to ever lower levels. How can this observation be accounted for?

One possible explanation runs as follows: The 1st series of euro banknotes, brought into circulation after 2000, came with country labels. Serial numbers started with letters that indicated the issuing NCB. Notes from Banca d'Italia were marked by an 'S', notes from the Bundesbank by an 'X', and so forth. When concerns about a eurozone collapse emerged, owners of S-euros feared that their banknotes could become converted to Italian New Liras. With a prevailing 1:1 exchange rate between S-euros and X-euros, it was profitable for citizens (and criminals) to exchange S-euros for X-euros—an application of Gresham's Law. Therefore, the number of Italian banknotes as a fraction of total eurozone banknote issues declined, and the respective fraction of German banknotes increased.

In 2013, the Eurosystem released the 2nd series of euro banknotes, thereby changing the meaning of the 1st letter in the serial number. The letter no longer reveals which NCB had issued the note but rather the printing plant where it was physically produced. In the 2nd series, 'S' stands for Banca d'Italia's own printing press, whereas the letters 'R', 'W', and 'X' represent factories in Berlin, Leipzig, and Munich, respectively. This change in definition has not impressed banknote owners much. Clearly, banknote use depends on various country specific determinants such as payment habits or tourism. However, the abrupt plunge in Italy's banknote issues after 2011 can hardly be explained by such factors.

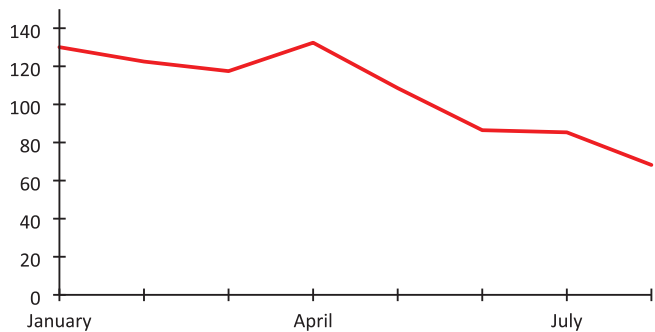
Alternatively, one could think of attributing the sharp drop in Italy's banknote issue to the Monti legislation that introduced a limit (with exceptions) of 1000 euros on cash payments. However, the lasting currency drain is inconsistent with the fact that Renzi lifted the cash limit to 3000 euros in 2016. Moreover, Italy is not alone; during 2012, banknote liabilities dropped by 7% in Spain, 8% in Greece, and 194% in Portugal.<sup>8</sup>

8 Sources: Banco de España, Bank of Greece, Banco de Portugal, *Annual Reports 2012*. Portugal's total banknote liability was in fact negative.



**Figure 6.** Banks’ reserves with Banca d’Italia (billion euros).

Source: Banca d’ Italia, *Annual Reports for 2008–2014 and Annual Accounts for 2015–2017*.



**Figure 7.** Banks’ reserves with Banca d’Italia 2018 (billion euros).

Source: European Central Bank Statistical Warehouse, [sdw.ecb.europa.eu](https://sdw.ecb.europa.eu), series ILM.M.IT.N.L020000.U2.EUR.

Banks’ reserves with Banca d’Italia, the other major part of Italy’s central bank money, followed a different pattern, as shown in Figure 6. In spite of the easing policies undertaken during and after the financial crisis, notably long-term refinancing operations, bank reserves flew off continuously from 2007 to 2014, when they reached a minimum of only 15.4 billion euros. Then came APP, the Eurosystem’s asset purchase program. Between the end of 2014 and October 2018, the APP increased eurozone bank reserves from 367 to 2023 billion euros. Its main component, the public sector purchasing program, worked as follows: The ECB’s Governing Council determined the total amount of Eurozone monthly purchases and distributed it among NCBs according to their ECB capital share, with each NCB buying sovereign bonds only from its own country. The additional central bank money thus created allowed reserves with Banca d’Italia to increase, at least for a while.

This lulling picture, however, shifted dramatically with the change of government that took place in spring 2018. Figure 7 makes use of a set of monthly data that the ECB provides since 2016. The graph shows a sharp drop in Italian bank reserves, from 132 billion euros in April 2018 to 68 billion euros in July. This means that Italian banks lost almost one half of their central bank reserves within just 4 months. One cannot avoid the

impression that the APP stopped Italy's depletion of central bank money only temporarily. When the program is terminated at the end of 2018, the ongoing drain will no longer be replenished by freshly created reserves.

Between December 2014 and August 2018, Banca d'Italia created central bank money amounting to 390 billion euros by granting loans and buying securities.<sup>9</sup> Of this newly created money, only 53 billion euros stayed in Italy, whereas the rest flew off. If this process continues, it goes without saying that, under a Soros-type attack, Italy's banks will be unable to find funds in the interbank market. For fear of redenomination, banks located in other eurozone countries will simply refuse to purchase Italian financial assets or grant loans.

Two countervailing forces determine the further dynamics. On the one hand, Italy's banks will request additional loans from Banca d'Italia to replenish their reserves. Such is possible under the ECB's full allotment policy as long as the banks are considered solvent and can post eligible collateral. On the other hand, domestic and international speculators will borrow in Italy, transfer the money, and make safe investments abroad (that can be used as collateral for further rounds of borrowing). This resembles Soros's short-long strategy and accelerates the central bank drain.

Is Banca d'Italia in a position to offset arbitrary money outflows by acquiring additional assets? To answer this question, one must remember that it is the ECB Governing Council alone that implements monetary policy through decisions on interest rates and the joint monetary base, the sum of currency issues and bank reserves. The Council also determines which assets are eligible as collateral or for outright purchases. Under the asset purchase program, NCBs must even accept specific amounts of securities allocated to them. However, there are two exceptions:

- The agreement on net financial assets (ANFA) gives NCBs some discretion to buy securities beyond what is necessary for monetary policy purposes. Such discretion can be used to delay a monetary drain but cannot stop it because the Governing Council annually determines the maximum amounts of net financial assets.
- In exceptional cases, NCBs may grant emergency liquidity assistance (ELA) to banks. Legally, ELA is a part of ANFA.

The point of interest here is that the ECB Governing Council can inhibit ANFA and ELA measures with a majority of two-thirds of the votes, cf. article 14.4 of the ECB statute. Although the Council may at first be permissive, it will eventually pull the plug if other eurozone members are not prepared to lose control of the monetary base. After all, losing control of the monetary base would mean that some country injects ever higher portions of central bank money into the system at the expense of the others; [Steinkamp et al. \(2017\)](#) and [Tornell \(2018\)](#) characterize this as a common-pool problem. Greece, which had to accept fiscal assistance and capital controls in 2015 after the Council banned further increases in ELA, provides a clear example that the Council will eventually inhibit national money printing. In Latin, *mors certa, hora incerta*.

Returning to the question of disproportionate bank loan provision, the ECB Governing Council faces essentially the same choice: Either it stops the process (e.g., by repealing the

9 The figures refer to the monetary instruments A5 and A7. Sources: *Banca d'Italia Annual Report for 2014* and series ILM.M.IT.N.A050000.U2.EUR, ILM.M.IT.N.A070000.U2.EUR from the ECB database.

full allotment policy) or it loses control of the monetary base and authorizes an unbounded negative externality that is placed upon other eurozone countries.<sup>10</sup>

As a concrete example of the final stage of a Soros-type attack, consider an Italian bank whose customer orders a transfer of 1 million euros. Like its Italian fellow banks, the bank has depleted its reserves, as in Figure 3. After excessive rounds of Italian central bank money creation, the ECB Governing council has blocked further credit access to Banca d'Italia, and with Italexit in the air, banks abroad will surely refuse to provide credit in the interbank market. Hence, the Italian bank under consideration cannot execute the money transfer.<sup>11</sup> Importantly, TARGET2 is incapable of stopping this terminal outflow because it only safeguards Banca d'Italia's assets and not Italy's central bank money.

To emphasize the core point, the above argument does not presume an outright inhibition of credit expansion in Italy. The Governing Council may approve a 1st round of ordinary loans, ELA or ANFA measures, and maybe a 2nd and 3rd round. However, as each newly created euro represents a claim on the eurozone's joint domestic income, the Council will almost certainly obstruct unlimited, asymmetric money creation.

#### 4. Departure Strategies

ECB representatives have stressed on countless occasions that a country's decision to adopt the euro is irrevocable. However, history teaches that transnational currency unions are normally dissolved after some time. The Latin and the Scandinavian monetary unions come to mind; other examples include the Ruble zone, the Yugoslavian dinar, and the Czechoslovak corona. Concerning the euro, there is even a perfectly legal route to exit: Article 50 of the Treaty on European Union (TEU) allows EU member states to withdraw from the union, and article 3 TEU restricts the use of the common currency to EU member states. Therefore, EU exit means euro exit. A country not wishing to break completely with the union could arrange to re-enter after a legal second, with a clause (such as for Denmark) that exempts it from adopting the common currency.

If a member state were to leave the eurozone, it would redenominate all domestic claims and liabilities, as well as wages, prices, and rents, into the new national currency. However, the Lisbon Treaty does not provide the details of eurozone withdrawals. This section discusses departure strategies for a single country, assuming the rest of the eurozone remains intact. The text shows that weak and strong countries use different tactics and illustrates the findings numerically, again taking Italy and Germany as the two archetypes.<sup>12</sup>

Assume that Italy leaves the eurozone and introduces New Liras, which are almost certain to devalue against the euro. While the departure raises a number of economic and legal

10 Italian banks pay an interest of 0% (marginal financing rate), whereas banks located in countries to which the central bank money flows have to pay a penalty of 0.4% on their reserves (deposit rate). Moreover, this process deteriorates the Basel III leverage ratios of the receiving banks.

11 As a stylized numerical example, assume that Italy's commercial banks hold 101 units of M3 deposits against 99 units of loans and 2 units of reserves. Following a money transfer of only 1 unit abroad, deposits fall to 100, and reserves plunge to the level of required reserves, 1% of deposits. Then, further payments become impossible.

12 The following text concentrates on the financial consequences for central bank balance sheets. Related thoughts on exit and departure scenarios are provided by Born et al. (2012) and Fuest (2018).

issues, the following exposition focuses on two monetary implications. The 1st point concerns Italy's TARGET2 liability, which stood at 437 billion euros as of December 2017. While Italy may be morally required to settle this debt, it can point to the fact that no such obligation exists in European law. In the negotiations that are likely to follow, Italy will seek to settle part of the TARGET2 debt in the form of (redenominated) claims and securities, while the remaining eurozone member states will insist on a full settlement with gold and foreign exchange (which, by the way, is impossible because the latter items amounted to only 126 billion euros in December 2017, not even a third of Italy's TARGET2 liability).

The 2nd point regards the treatment of euro banknotes. Balancing Italy's fictitious banknote issue and its net claims relating to the allocation of euro banknotes within the Eurosystem, Italy has incurred a respective liability of approximately 150 billion euros. After leaving the eurozone, Banca d'Italia may try to dump this amount on the remaining member states, obtaining an extraordinary profit of 150 billion euros. How would this work? To eliminate the banknote liability, Italy must only declare New Lira banknotes as its sole legal tender. Crucially, this would not hurt Italian citizens by any means because they can use their existing euro banknotes for shopping in the eurozone, or exchange them in the market at a favorable rate. Italian euro banknotes would mostly migrate to the remaining eurozone in the long run, while New Liras circulate in Italy. However, as with the TARGET2 liability, one must expect that the Eurosystem will ask for some compensation.

To sum up, Banca d'Italia's maximal profit from an exit comes to 587 billion euros. The actual profit will likely be smaller, due to negotiations, but will probably be still substantial. If Italian lawmakers thought Banca d'Italia would not need an increase in equity, they could ask it to cancel a portion of sovereign debt, perhaps enabling the government in this way to avoid an open default that would mainly hurt Italy's own citizens.

Turning to Dexit, Germany faces a different prospect. As of December 2017, the country owned a nominal TARGET2 claim of 907 billion euros whose fair value is highly uncertain for the reasons already outlined. If Germany introduced a New Deutschmark and redenominated its financial assets into the new currency, it would seem virtually impossible that the country obtained full compensation from its former euro partners. Hence, there is an asymmetry between TARGET2 debtors and creditors in that the former are likely to obtain an exit gain, while the latter are liable to suffer a loss. On the other hand, Germany has a superior bargaining position because it is the most important contributor to the EU budget.

Regarding banknotes, circumstances are more favorable for Germany in that the Bundesbank's liability from banknote issues amounted to a massive 635 billion euros at the end of 2017. Unlike Italy, however, Germany could not simply dump this debt on the remaining eurozone members but had to follow a more sophisticated strategy to avoid internal uproars. Because the New Deutschmark will almost certainly appreciate against the euro, individuals would perceive a Bundesbank default on euro banknotes as a partial confiscation. To overcome this problem, German lawmakers could stipulate a free initial endowment of, say, 100 New Deutschmarks for each domestic individual. Assuming a New Deutschmark appreciation of 20%, domestic individuals whose initial banknote holdings fell short of 500 euros would benefit from the conversion, and only those with higher holdings would suffer. By an appropriate choice of the initial endowment, lawmakers could ensure that the median voter makes a profit. The Bundesbank's balance sheet would be relieved by 635 billion euros, minus the total initial endowment that amounts to 8 billion



New Deutschmark in the preceding calculation. Therefore, the Bundesbank could avoid an exit loss if it managed to save approximately one-third of its TARGET2 claim.

Accepting euro banknotes at par would not be a viable strategy because such an offer would effectively burden the Bundesbank's balance sheet with the eurozone's total banknote liability of over 1 trillion euros—and even more, because printing additional euro notes and converting them into New Deutschmarks at par would be profitable for other member states. As explained in the previous section, serial numbers no longer indicate the country of origin, and with Europe's open border policy, banknote smuggling can hardly be inhibited. Even if the Bundesbank restricted the exchange to German residents, the latter would find relatives and 'friends' abroad that endowed them with additional euro banknotes.

Before concluding this section, an important qualification needs to be made. The above line of reasoning relates to scenarios where a single country, or a small group of countries, withdraws from the eurozone. In the case of a simultaneous eurozone collapse, the TARGET2 arguments are still valid. The banknote arguments, however, are not; there is simply no remaining eurozone on which the banknote liability could be dumped. All former eurozone member states would need to compensate their citizens for the loss of euro banknotes, and the banknote gains outlined above would disappear. Therefore, eurozone departures come with a 1st mover advantage, a point that may accelerate the currency union's dissolution.

## 5. Conclusion

The present article made tentative steps toward an analysis of eurozone collapse and departure scenarios. This venture was motivated by increasing economic and political tensions within the currency union and also by a shortage of relevant papers. While central bankers probably have departure plans in their desks (and emergency banknotes in their cellars), there exists a gap in the academic literature regarding the dissolution of and departure from the eurozone. Two main results emerged, which may be summarized as follows.

First, as the TARGET2 mechanism protects only central bank assets but not central bank money, it is unsuited for inhibiting speculative attacks. In the final stage of a run on a eurozone member state, banks in that state will not get central bank money through the interbank market, and the ECB Governing Council is essentially confronted with the same choice as was the Bundesbank in 1992: either they give up control of the monetary base, or the attacked country must depart and devalue. In this respect, there is no difference between the eurozone and the former ERM. An alternative would be reintroducing capital controls. Such a measure, admittedly, would enhance incentives to withdraw from the eurozone, break the single market, and set Europe's capital markets back to the 1980s.

Second, NCB exit gains and losses are associated with five balance sheet items, namely, TARGET2 claims and liabilities, banknote claims and liabilities, and banknotes in circulation. An NCB's overall gain, positive or negative, equals the sum of its TARGET2 liability, its banknote liability, and banknotes in circulation, minus the sum of its TARGET2 claim and its banknote claim. However, the banknote component produces a gain only if a country departs from the eurozone and dumps its respective liability on the remaining member states. Such a country realizes a 1st-mover advantage.

Combining the two previous findings suggests a novel interpretation of TARGET2 as not effectively deterring speculative attacks but determining the bargaining positions of

withdrawing countries. The mechanism discourages strong eurozone members from departing, but encourages weak members to do so.

In the preferable scenario of an organized eurozone dissolution, the 1st-mover advantage disappears, and the member states will hopefully negotiate a fair settlement that takes account of TARGET2 and banknote balances, because both items are covered by NCB assets. Assuming partial compensation, strong eurozone members would exchange one-shot losses for permanent crisis assistance through the existing bailout schemes and the ever closer debt and banking union (EDIS), whereas weak members could obtain start-up assistance. Dissolving the eurozone means recognizing that its design contradicts the ‘impossible trinity’ (cf. also [Steiner et al. 2017](#)), an undisputed concept in international economics: free movement of capital under antithetical fiscal policies, fixed exchange rates, and unified short-term interest rates do not fit together.

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# Are Supply-side Reforms Contractionary at the Zero Lower Bound?\*

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## Abstract

Research suggests that if supply-side reforms take place as the nominal interest rate hits the so-called ‘zero lower bound’ (ZLB), the benefits of reforms are outweighed by the negatives, and the net effect is contractionary (Eggertsson et al. 2014; Fernandez-Villaverde 2014). In this article, we show that the effectiveness of temporary reforms that reduce price markups is determined by the interaction between two offsetting effects on the real interest rate: one deflationary and one inflationary. If the latter outweighs the former, the reforms can become expansionary. The effectiveness of permanent reforms is determined by the monetary policy outside the ZLB: a wealth effect. If the effect is large enough, the reforms can also become expansionary (JEL codes: E30, E50, E60).

**Key words:** supply-side reforms, zero lower bound, price markup, wage markup

## 1. Introduction

Recent research suggests that if supply-side reforms are not properly timed, the effect can be contractionary. Specifically, if such reforms take place as the nominal interest rate hits the so-called ‘zero lower bound’ (ZLB), the benefits of reforms are outweighed by the negatives, and the net effect is contractionary (Eggertsson et al. 2014; Fernandez-Villaverde 2014). The economic mechanism is this: supply-side reforms improve efficiency and reduce price and wage markups, and thus reduce marginal costs for firms. This in turn lowers expected inflation. In an environment where the nominal interest rate is pegged at 0, lower *ex ante* inflation raises the real interest rate and causes aggregate demand to fall. These authors go so far as to make a prediction that European structural reforms will harm the recovery, since the European nominal interest rate has been kept at near-zero levels for a prolonged period of time in the wake of the recent financial crisis, and if structural reforms are short-lived due to political reasons, their contractionary effect will be especially

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detrimental, since the negative effect will not be balanced by the long-run benefit of improved efficiency.

In this article, we argue that when certain economic conditions are satisfied, supply-side reforms can be expansionary even when the ZLB is binding. Using a standard New Keynesian model with sticky prices and wages, we show that when reforms reduce price markups temporarily, there may exist two offsetting effects on the real interest rate: one deflationary and one inflationary. The deflationary effect is what drives Eggertsson et al. (2014) and Fernandez-Villaverde (2014)'s result: lower price markups tend to increase the real interest rate and depress demand. But if price inflation falls faster than wage inflation, the real wage will increase, which increases demand. This will in turn raise price inflation and lead to a lower real interest rate—the inflationary effect. If this effect more than offsets the deflationary one, the net effect lowers the real interest rate, and the ultimate result can be expansionary. But in Eggertsson et al. (2014) and Fernandez-Villaverde (2014), only the deflationary effect exists, since they assume that price and wage inflation falls at the same speed.

Given that price inflation can fall faster than wage inflation, when will the inflationary effect dominate the deflationary one? We find at least two separate sets of conditions. One, the inflationary effect dominates if the degree of wage stickiness is a lot higher than that of price stickiness. This is quite easy to understand: if wages are a lot stickier than prices, price inflation will fall much faster than wage inflation when price markups decrease, and so it will be highly likely that the real interest rate gets lowered, which cannot happen in Eggertsson et al. (2014) and Fernandez-Villaverde (2014), since they assume that prices and wages are equally sticky. The second set of conditions is subtler. The expected durations of the ZLB regime and supply-side reforms that reduce price markups can differ. It turns out that if economic agents expect the reforms to be short compared with the ZLB regime, the inflationary effect will more likely dominate the deflationary one. The reason is that when the duration of the reforms is shorter, the decrease in expected inflation is milder, which in turn mitigates the deflationary effect. This leads to a novel prediction: when supply-side reforms that reduce price markups are known to be temporary in a period of prolonged low nominal interest rates, they can actually be expansionary. An immediate implication is that European structural reforms can be expansionary, even when they are temporary. This result does not emerge in Eggertsson et al. (2014) and Fernandez-Villaverde (2014), because they implicitly assume that the expected durations of the ZLB and structural reforms are the same.

What about permanent supply-side reforms? It turns out that expectations again play a critical role. Since the reforms are expected to last much longer than the ZLB regime, the monetary authority is expected to eventually decrease the nominal interest rate, which raises future output and lifetime wealth, and thus in turn generates an expansionary effect on current output—a wealth effect. If the effect is not suppressed by monetary policy (or more specifically, the output stabilization policy), permanent reforms can also be expansionary at the ZLB—in stark contrast to what Eggertsson et al. (2014) and Fernandez-Villaverde (2014) find, suggesting that their results may not be robust to model uncertainty.

Our article is not a critique of Eggertsson et al. (2014) and Fernandez-Villaverde (2014) but shows that their results can be reversed under some plausible circumstances. They use a complicated model with many channels but only focus on the reforms' deflationary effect without analyzing how those channels interact with each other and how such interactions affect the effectiveness of reforms. Fully understanding them is truly a daunting task. So, to study the interaction of some of the most important channels, we choose a simple textbook

model. The result for permanent reforms is a good example. We still do not know why they are expansionary in our model but contractionary in theirs. Finally, we do not argue why it is worth studying temporary supply-side reforms, given that reforms are usually designed to be permanent. Eggertsson et al. (2014) and Fernandez-Villaverde (2014) provide enough reasons.

Our article can potentially reconcile the inconsistency between the theoretical predictions and empirical findings in the literature on the effect of supply-side reforms. Most empirical studies find negative supply shocks to be contractionary (so positive supply shocks should be expansionary), even when the ZLB is in place. Bordo et al. (2000) and Cole and Ohanian (2004) study the Great Depression. For the recent Great Recession, Wieland (2016) and Cohen-Setton et al. (2017) find that supply-side shocks, such as the Great East Japan Earthquake in 2011; oil shocks; mandatory wage increases and hour reductions, lower output, even though the *ex ante* real interest rate is lowered at the ZLB.

Our article makes a contribution to the literature that studies the perverse effect of economic policies under the ZLB. A list of papers would include those of Eggertsson et al. (2014), Roulleau-Pasdeloup and Zhutova (2015), Eggertsson (2010, 2011, 2012), Christiano et al. (2011), Woodford (2011), Carlstrom et al. (2014), and Eggertsson and Krugman (2012). A general finding is that if a demand or supply shock raises marginal costs or expected inflation, it is typically expansionary. Our analysis offers a fresh perspective on this issue.

The rest of the article is organized as follows. Sections 2 and 3 lay out the model and solution method. Section 4 presents the main result. Section 5 concludes.

## 2. Model

The model is a micro-founded New Keynesian model with sticky prices and wages, based on the textbook version of the model by Galí (2015).<sup>1</sup> Eggertsson et al. (2014) use a calibrated open economy model to study the policy implications of European structural reforms. In this article, we show that their basic result holds in a standard, closed economy model.

The model economy is represented by the IS and Phillips curves. The nominal interest rate is assumed to stay at its lower bound temporarily and will eventually follow the Taylor rule. The log-linearized IS curve is given by:

$$\tilde{y}_t = E_t \tilde{y}_{t+1} - \frac{1}{\sigma} (i_t - E_t \pi_{t+1}^p - r_t^n) \quad (1)$$

where  $\tilde{y}_t = y_t - y_t^n$  denotes the output gap,  $i_t$  the nominal interest rate,  $\pi_t^p$  the price inflation rate, and  $r_t^n$  the natural rate.  $\sigma$  denotes the coefficient of relative risk aversion.  $r_t^n$  is assumed to be driven by a financial sector shock  $d_t$ . A negative innovation to this shock can induce a simultaneous fall in consumption, the inflation rate, hours worked, the nominal interest rate, and output, a pattern that is observed during the recent Great Recession. If the magnitude of the shock is big enough, the nominal interest rate reaches its lower bound and cannot fall any further. A deflationary spiral is created. With the ZLB binding, deflation

1 Chapter 6 of the text provides detailed derivations of the equilibrium relationships used in this article.

increases the real interest rate, which further discourages private spending and decreases inflation and output.

Absent any demand-side shocks, the equilibrium solution under flexible prices and wages implies  $y_t^n = v_y$  and  $r_t^n = \rho + d_t$ .  $v_y = -\frac{(1-\alpha)(\mu^p + \mu^w - \log(1-\alpha))}{\sigma(1-\alpha) + \varphi + \alpha}$  is the steady state of output, a function of structural parameters, which are  $\alpha$ , the share of income paid to capital,  $\varphi$ , the inverse of the (Frisch) wage elasticity of labor supply,  $\mu^p$ , the desired price markup, and  $\mu^w$ , the desired wage markup.  $\rho$  is the discount rate.  $d_t$  is assumed to follow a two-state Markov process with probability  $p$  of being equal to  $\bar{d}$ , a negative value that is big enough to induce a large and simultaneous fall in aggregates and to have the ZLB bind, and with probability  $1 - p$  of reverting back to 0.

The nominal interest rate is described by a Taylor rule in normal times and is set to 0 when the value of the nominal interest rate implied by the rule becomes negative. In the latter case, the ZLB binds. But it should not bind permanently, or else the economy becomes indeterminate. The policy reaction function is given by:

$$i_t = \max(\rho + \phi_p \pi_t^p + \phi_y \tilde{y}_t + \epsilon_t^i, 0), \quad (2)$$

where  $\epsilon_t^i \sim \text{i.i.d.} N(0, \sigma_i^2)$  represents a monetary policy shock.

The price and wage Phillips curves are given by:

$$\pi_t^p = \beta E_t \pi_{t+1}^p - \lambda_p \hat{\mu}_t^p \quad (3)$$

$$\pi_t^w = \beta E_t \pi_{t+1}^w - \lambda_w \hat{\mu}_t^w \quad (4)$$

where a hat above a variable denotes the log deviation of the variable from its steady-state value.  $\beta = e^{-\rho}$  is a discount factor,  $\lambda_p = \frac{(1-\beta\theta_p)(1-\theta_p)(1-\alpha)}{\theta_p(1-\alpha+\alpha\epsilon_p)}$  and  $\lambda_w = \frac{(1-\beta\theta_w)(1-\theta_w)}{\theta_w(1+\epsilon_w\varphi)}$  are functions of structural parameters:  $\theta_p$ , the index of price stickiness,  $\epsilon_p$ , the elasticity of substitution between differentiated goods,  $\theta_w$ , the index of wage stickiness, and  $\epsilon_w$ , the elasticity of substitution between labor varieties.  $\hat{\mu}_t^p$  and  $\hat{\mu}_t^w$  are price and wage markups that are equal to 0 under flexible prices and wages.

Nominal rigidities make it possible for the markups to vary over time and to be subject to structural shocks. They are determined by:

$$\hat{\mu}_t^p = -\delta_p \tilde{y}_t - \tilde{w}_t \quad (5)$$

$$\hat{\mu}_t^w = -\delta_w \tilde{y}_t + \tilde{w}_t \quad (6)$$

$$\tilde{w}_t = \tilde{w}_{t-1} + \pi_t^w - \pi_t^p - \Delta w_t^n \quad (7)$$

where  $\tilde{w}_t = w_t - w_t^n$  denotes the real wage gap,  $\delta_p = \frac{\alpha}{1-\alpha}$  and  $\delta_w = \frac{\sigma(1-\alpha)+\varphi}{1-\alpha}$  are functions of underlying structural parameters. The equilibrium solution under flexible prices and wages implies  $w_t^n = \log \frac{\epsilon_w}{\epsilon_w - 1} + \frac{\sigma(1-\alpha)+\varphi}{1-\alpha} v_y$ . We will now express all endogenous variables as percentage deviations from their zero-inflation steady-state values. The equilibrium solutions under flexible prices and wages for  $\hat{y}_t^n$ ,  $\hat{r}_t^n$  and  $\hat{w}_t^n$  are given by  $\hat{y}_t^n = 0$ ,  $\hat{r}_t^n = d_t$ , and  $\hat{w}_t^n = 0$ . With sticky prices and wages, all equations except equations (1) and (7) will retain the same functional forms. The output gap, the real wage gap, equations (1) and (7) become  $\tilde{y}_t = \hat{y}_t$ ,  $\tilde{w}_t = \hat{w}_t$ ,  $\hat{y}_t = E_t \hat{y}_{t+1} - \frac{1}{\sigma} (\hat{i}_t - E_t \pi_{t+1}^p - r_t^n)$ , and  $\hat{w}_t = \hat{w}_{t-1} + \pi_t^w - \pi_t^p$ .

### 3. Calibration and Solution

When possible, we use standard values in the literature to calibrate parameter values. These include:  $\beta = 0.99$  (the discount factor),  $\rho = 0.01$  (the steady-state value of the nominal interest rate),  $\alpha = \frac{1}{3}$  (the share of income paid to capital),  $\epsilon_p = 6$  (the elasticity of substitution between differentiated goods),  $\epsilon_w = 6$  (the elasticity of substitution between labor varieties),  $\sigma = 0.5$  (the coefficient of relative risk aversion),  $\varphi = 2$  (the inverse of the (Frisch) wage elasticity of labor supply),  $\phi_p = 1.5$  (the monetary policy response to price inflation),  $\phi_y = 0.5/4$  (the monetary policy response to the output gap). Except for monetary policy, Eggertsson et al. (2014) use the same values for these parameters.<sup>2</sup>

Some parameters are critical in generating the economic mechanisms that we analyze in the next section. For those, we provide two sets of calibrated values. Set 1 closely resembles those in Eggertsson et al. (2014). With those values, the model can reproduce their results. The parameters are:  $\theta_p = 0.66$  (the index of price stickiness) and  $\theta_w = 0.66$  (the index of wage stickiness).

Values in Set 2 are the key values that produce the distinct mechanisms that we analyze in the next section. They are  $\theta_p = 0.3$  and  $\theta_w = 0.8$ . As we will explain, these parameters defining price and wage stickiness are important in altering the economic mechanisms.

Standard solution methods such as the method of undetermined coefficients cannot solve this model because a binding ZLB creates a kink that is non-differentiable everywhere. The trajectories of the model economy can be simulated in a deterministic environment, as long as the stochastic persistence of the shock ( $p$ ) is taken as given. The mechanism is to incorporate a non-linear switching process between the ZLB state and the normal state. The switch is triggered by a deterministic shock that takes on values of either 0 or 1, and the period in which the shock is operative can be pre-specified. The ZLB binds whenever the shock equals 0. Another deterministic shock is the financial sector shock that is assumed to be large enough to trigger a liquidity trap and a binding ZLB. These two shocks occur at the same time and a deflationary spiral is created (Cogan et al. 2010; Christiano et al. 2011; Woodford 2011; Eggertsson 2011, 2012; Coenen et al. 2012; Eggertsson et al. 2014; Carlstrom et al. 2014; Zubairy 2014; Drautzburg and Uhlig 2015; García-Schmidt and Woodford 2015; Wieland 2016; Gabaix 2016; Kiley 2016; Cochrane 2017). Any deterministic shock that buffets the model economy over a certain period of time is known by model agents in the beginning of simulations, which is the reason why the stochastic persistence of the shock ( $p$ ) needs to be taken as given. The model solution is based on model agents' perfect knowledge of the model trajectory starting from the steady state and then to the ZLB and then back to the steady state after the ZLB ceases to bind. Expectations effects are fully captured by leads and lags of the model structure used in this article.<sup>3</sup>

2 In Eggertsson et al. (2014), a strict inflation targeting rule is assumed, which is  $\phi_p = 10$  and  $\phi_y = 0$ .

3 We perform our simulations using Dynare. Its user guide provides more detailed explanations. For temporary reforms, please refer to the User Guide's 3.7.1 Deterministic models—temporary shocks; for permanent reforms, please refer to the User Guide's 3.7.2 Deterministic models—permanent shocks. Eggertsson et al. (2014) also use Dynare.

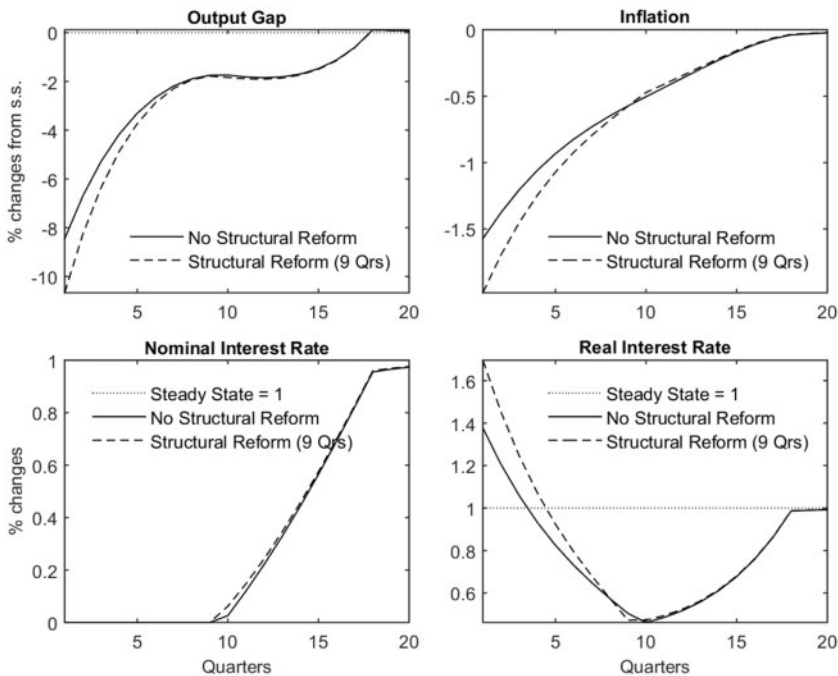


## 4. Result

### 4.1 Temporary reforms

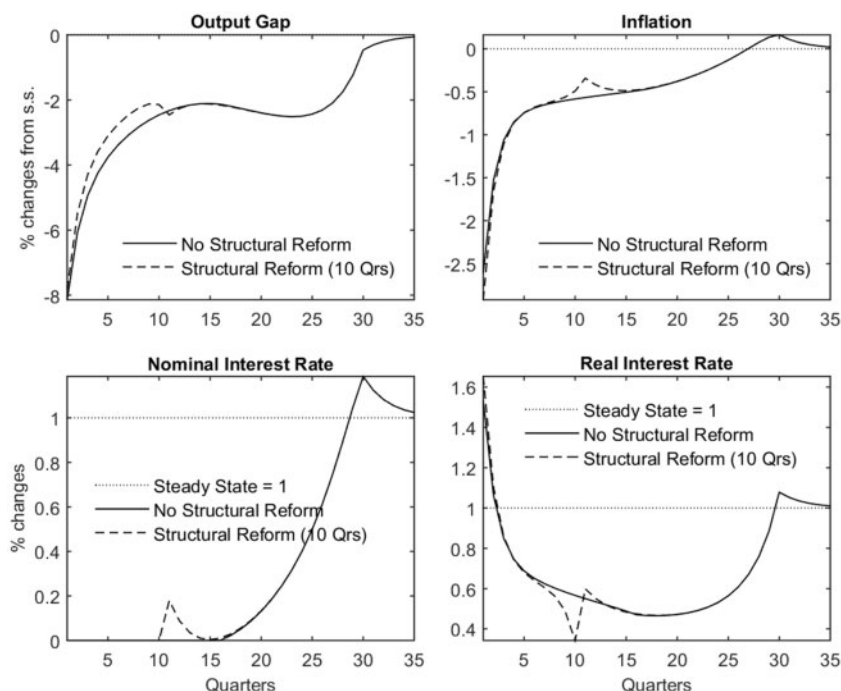
First, we show that our closed economy model can reproduce the result in Eggertsson et al. (2014). To do so, we calibrate the model to match their setup as closely as possible (details are explained in the previous section). We also follow Eggertsson et al. (2014) in assuming that the expected duration of structural reforms equals the expected duration of the ZLB. To generate relatively realistic liquidity-trap scenarios, we assume that the discount-factor shock falls by 0.5% and lasts for 17 quarters. In each policy experiment considered below, we will adjust the duration of the shock in order that the output gap will always fall by about 8% at the onset of a liquidity trap. The Appendix will show that such adjustments do not affect results. In Figure 1, we plot the response of the output gap, inflation, the nominal interest rate, and the real interest rate to a 1% negative shock to the price markup. It can be easily seen that the policy effect is contractionary. This is the now well-known result: lower markups create lower *ex ante* inflation, which raises the real interest rate and depresses demand and output. Given the effect of the discount-factor shock, both the ZLB and the reform last for nine quarters.

Now we switch to our key set of calibrated values and re-run the simulation. Given the parameter reconfiguration, for the output gap to fall by about 8% initially, assume that the discount-factor shock lasts for 29 quarters. The result is plotted in Figure 2. Strikingly, the



**Figure 1.** Responses of the output gap, inflation, the nominal interest rate, and the real interest rate to the crisis without reforms (the solid line) and with a temporary decrease in the price markup by 1% (the dashed line).

*Note:* Assume that prices and wages are equally sticky ( $\theta_w = \theta_p = 0.66$ ), and the expected durations of the ZLB and the reform equal (nine quarters in both cases).



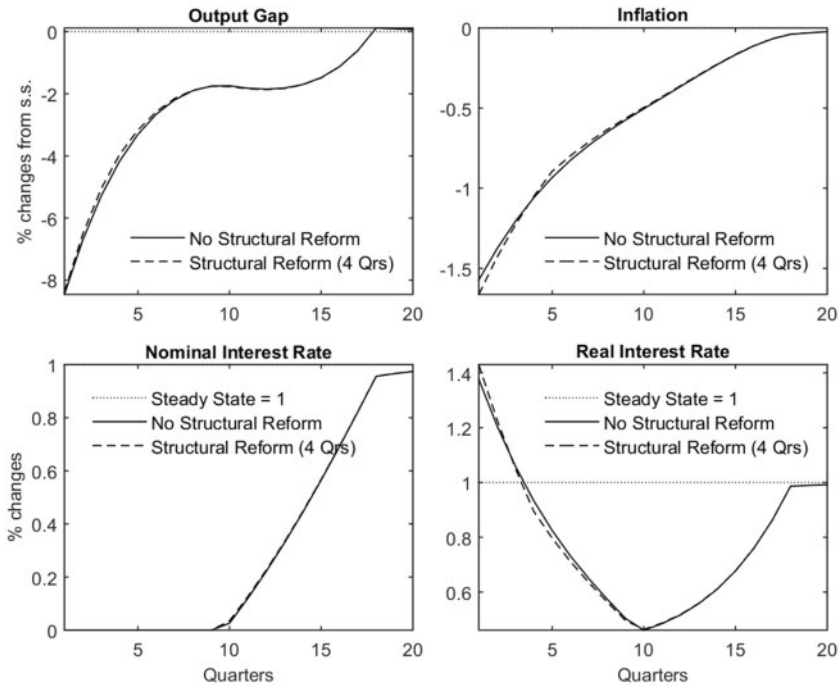
**Figure 2.** Responses of the output gap, inflation, the nominal interest rate, and the real interest rate to the crisis without reforms (the solid line) and with a temporary decrease in the price markup by 1% (the dashed line).

*Note:* Assume that wages are stickier than prices ( $\theta_w = 0.8$  and  $\theta_p = 0.3$ ), and the expected durations of the ZLB and the reform equal (15 quarters without reforms and 10 quarters with the reform).

response to a negative price markup shock becomes expansionary. As we expand the number of quarters to determine the length of the reform, we find that given the effect of the discount-factor shock, the length of the ZLB keeps shrinking, and after 10 quarters, the model economy gets out of the liquidity trap. So, due to the assumption just mentioned, the reform also lasts for 10 quarters. Those parameters that are re-calibrated are found to alleviate the output collapse. As shown below, the mechanism that works for the reform also works for the discount-factor shock.

So, what creates the distinct responses? We find that when there is a negative price markup shock (or a negative discount-factor shock) at the ZLB, there are two different effects on the real interest rate: one deflationary and one inflationary. The deflationary effect is what drives the result in Figure 1: lower price markups tend to increase the real interest rate and depress demand. But if price inflation falls faster than wage inflation, the real wage will increase, which increases demand. This will in turn raise price inflation and lead to a lower real interest rate, which will in turn further raise the real wage, and so on—the inflationary effect. If this effect more than offsets the deflationary one, the ultimate result can become expansionary.

The inflationary effect arises from the assumption of wage stickiness. The effect is strengthened if the real wage significantly deviates from the equilibrium flexible wage. Two parameters are critical here: (i)  $\theta_w$ : it measures wage stickiness. The larger the parameter, the smaller the fall in nominal wages, the bigger the rise in real wages. (ii)  $\theta_p$ : it measures price



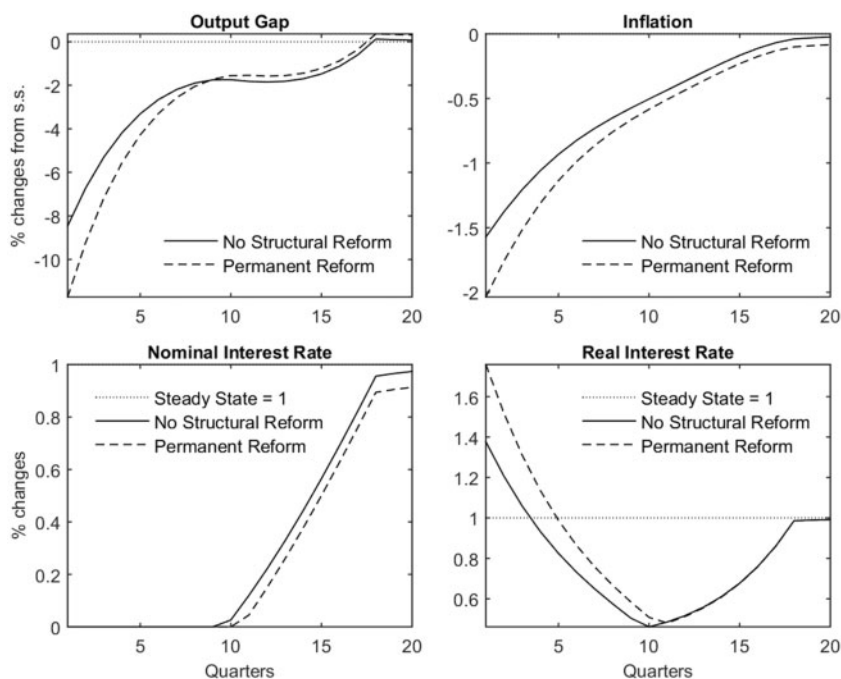
**Figure 3.** Responses of the output gap, inflation, the nominal interest rate, and the real interest rate to the crisis without reforms (the solid line) and with a temporary decrease in the price markup by 1% (the dashed line).

*Note:* Assume that prices and wages are equally sticky ( $\theta_w = \theta_p = 0.66$ ), and the expected duration of the reform (four quarters) is shorter than that of the ZLB (nine quarters both with and without the reform).

stickiness. The smaller the parameter, given wage stickiness, the bigger the rise in real wages. In Figure 1, we assume  $\theta_w = \theta_p = 0.66$ , while in Figure 2, assuming  $\theta_w = 0.8$  and  $\theta_p = 0.3$ .

The inflationary effect does not have a direct, economic link with the ZLB or the expected duration of the ZLB. The deflationary one, on the other hand, is directly linked to differences in the expected duration of the policy intervention (in this case, a fall in the price markup) and the expected duration of the ZLB. The shorter the expected duration of the policy intervention, the smaller the fall in price inflation, given the same expected duration of the ZLB, the smaller the rise in the real interest rate. This immediately implies that if there is a wedge between the expected durations of the policy intervention and the ZLB regime, the deflationary effect can be weakened. A weakened deflationary effect makes it more likely for the inflationary one to dominate, and for output responses to become expansionary.

Figure 3 highlights the importance of the expected durations of structural reforms that reduce price markups and the ZLB. We still assume that prices and wages are equally sticky ( $\theta_w = \theta_p = 0.66$ ). Given that no parameter value is altered, we assume the same duration of the discount-factor shock as in Figure 1. As the gap between the two durations widens, the response of output to a negative price markup shock becomes more and more expansionary. We reduce the length of the reform to four quarters. But due to the less importance of the reform, the length of the ZLB is now mostly determined by the discount-factor shock. It can be clearly seen that the output gap improves. The reason is just a smaller deflationary effect.



**Figure 4.** Responses of the output gap, inflation, the nominal interest rate, and the real interest rate to the crisis without reforms (the solid line) and with a permanent decrease in the price markup by 1% (the dashed line).

*Note:* Assume a standard Taylor rule outside the ZLB ( $\phi_p = 1.5$  and  $\phi_y = 0.5/4$ ), and that prices and wages are equally sticky ( $\theta_w = \theta_p = 0.66$ ).

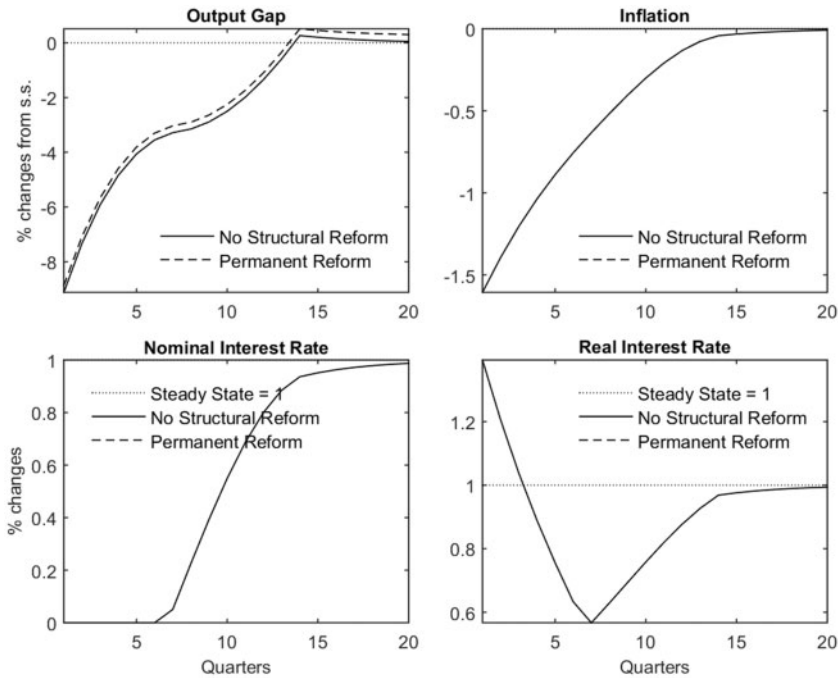
With stickier wages or more flexible prices, supply-side reforms that reduce price markups can actually be expansionary, and if equipped with appropriate lengths of duration, they can even help an economy out of the liquidity trap sooner. An immediate implication is that European structural reforms can be expansionary, even when they are temporary. This stands in sharp contrast to the prediction in Eggertsson et al. (2014) and Fernandez-Villaverde (2014). Their results are not robust to some key parameter configurations.

## 4.2 Permanent reforms

Structural reforms are designed to be permanent. While in some cases the political process can make some reforms short-lived, it is never the intended consequence. Can permanent structural reforms be expansionary?

The effectiveness of structural reforms also depends on a wealth effect. The wealth effect refers to the effect on current output of the expected monetary policy reaction to inflation and the output gap outside the ZLB. The importance of the wealth effect is stressed by Eggertsson et al. (2014), Fernandez-Villaverde (2014), and Fernandez-Villaverde et al. (2014). Consider a permanent decrease in the price markup by 1%. Figure 4 shows the result.

Figure 4 replicates Eggertsson et al. (2014) and Fernandez-Villaverde (2014)'s result. Without any parameter reconfiguration, we assume the same duration of the discount-factor shock as in Figure 1. It can be seen that the permanent reform aggravates the output



**Figure 5.** Responses of the output gap, inflation, the nominal interest rate, and the real interest rate to the crisis without reforms (the solid line) and with a permanent decrease in the price markup by 1% (the dashed line).

*Note:* Assume that monetary policy outside the ZLB does not stabilize the output gap ( $\phi_y = 0$ ), and prices and wages are equally sticky ( $\theta_w = \theta_p = 0.66$ ).

collapse during a liquidity trap, although improving the output gap after the ZLB ceases binding (10 quarters)—the wealth effect does not seem to work at all. In this figure, we assume that monetary policy outside the ZLB follows a standard Taylor rule that not only stabilizes price inflation ( $\phi_p = 1.5$ ) but also the output gap ( $\phi_y = 0.5/4$ ), which can partially prevent output from rising even with the improved efficiency. To test this explanation and to study the effectiveness of the wealth effect, suppose no output stabilization outside the ZLB ( $\phi_y = 0$ ). Given that a parameter value is changed, we set the duration of the discount-factor shock to 13 quarters to generate a relatively realistic liquidity-trap scenario. As shown in Figure 5, the result is reversed. So, permanent reforms can also be expansionary, as long as monetary policy outside the ZLB does not suppress the wealth effect. This result contrasts with what Eggertsson et al. (2014) and Fernandez-Villaverde (2014) find.

It should be noted that Eggertsson et al. (2014) and Fernandez-Villaverde (2014) use a medium-sized dynamic stochastic general-equilibrium (DSGE) model with many nominal and real rigidities. They assume a strict inflation targeting rule ( $\phi_p = 10$  and  $\phi_y = 0$ ), meaning that the wealth effect is not only not suppressed (no output stabilization) but also reinforced (by lowering the real interest rate significantly as the reform lowers price inflation). Probably due to frictions not captured by our standard New Keynesian model, the wealth effect is still not large enough to have permanent reforms expansionary in their model. But this article shows that their quantitative result does not hold in a different model or is not robust to model uncertainty, and thus cannot be used to make a qualitative prediction.

## 5. Conclusion

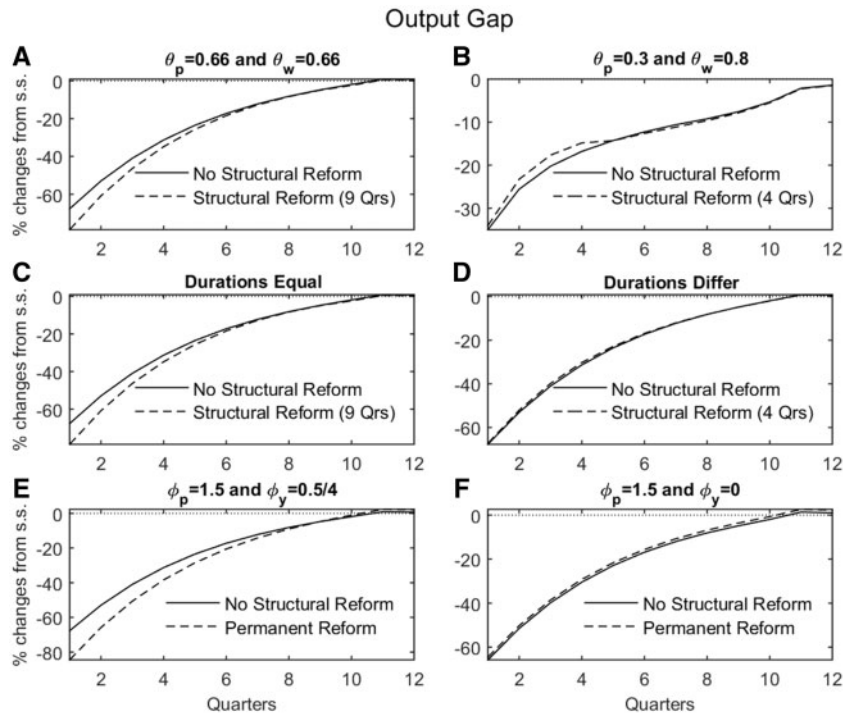
This article studies the effectiveness of supply-side reforms that reduce price markups at the ZLB in a standard New Keynesian model with sticky prices and wages. For temporary reforms, we show that there may exist two offsetting effects on the real interest rate: one deflationary and one inflationary, and if wages are stickier than prices or the expected duration of the reform is shorter than that of the ZLB, the reform can be expansionary. For permanent reforms, we stress the important role played by the wealth effect, and if this effect is not suppressed by monetary policy outside the ZLB, the reform can also be expansionary.

## Appendix

This Appendix shows that the aforementioned mechanisms are invariant to the magnitude and duration of the discount-factor shock. We assume that the shock falls by 2% and lasts for 10 quarters and will not adjust it to generate a relatively realistic liquidity-trap scenario. For both temporary and permanent reforms, we assume a 5% fall in the price markup. Figures 6, 7, 8, and 9 plot the results.

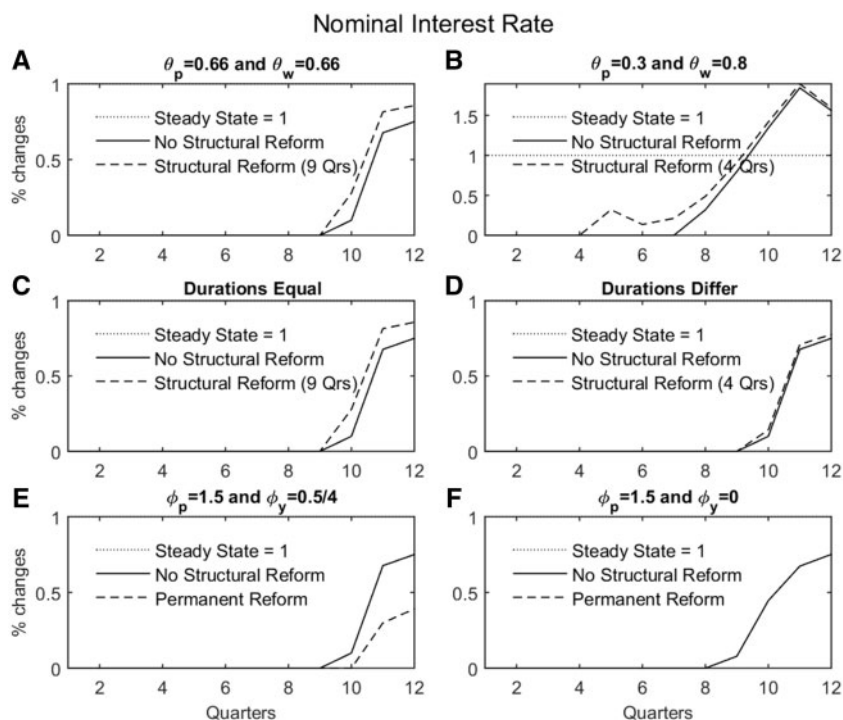
Panels A and B differ only in the relative stickiness between prices and wages. They are equally sticky in Panel A, but wages are stickier than prices in Panel B. Both panels assume that the expected durations of the ZLB and the temporary reform that reduces the price markup equal. Panels C and D preserve the equal stickiness between prices and wages but allow the two expected durations to differ. It can be seen that the special assumptions made in Panels B and D let the inflationary effect of the reform on the real interest rate dominate, and output improves as a result.

Panels E and F consider permanent reforms, the effectiveness of which depends on the wealth effect that will be suppressed if monetary policy stabilizes output outside the ZLB. But as shown in Panel F, the reform can be expansionary if no such assumption is made.



**Figure 6.** Responses of the output gap to the crisis without reforms (the solid line) and with reforms (the dashed line).

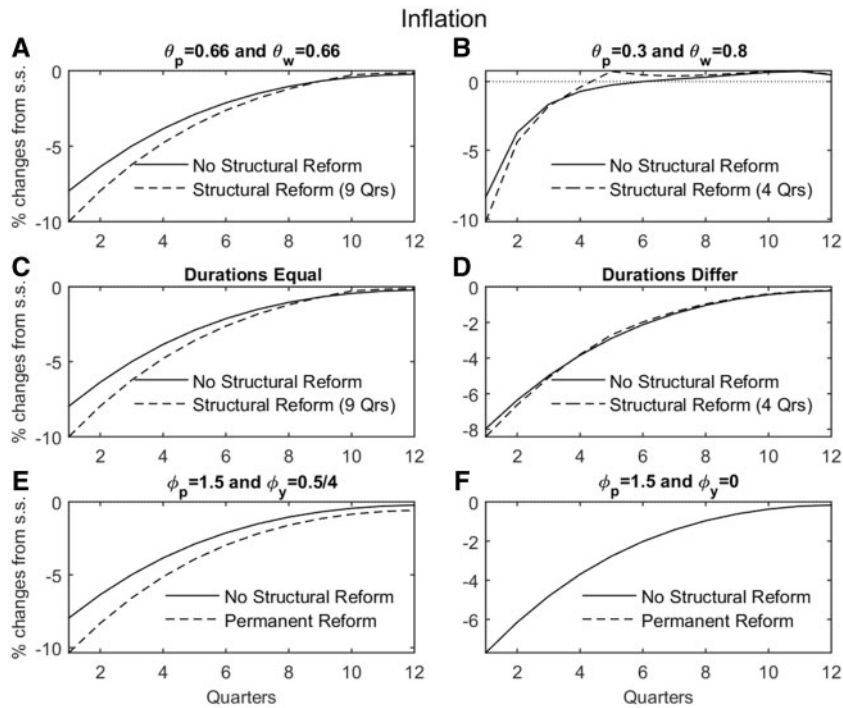
*Note:* Panels A and C correspond to Figure 1, Panel B Figure 2, Panel D Figure 3, Panel E Figure 4, and Panel F Figure 5.



**Figure 7.** Responses of the nominal interest rate to the crisis without reforms (the solid line) and with reforms (the dashed line).

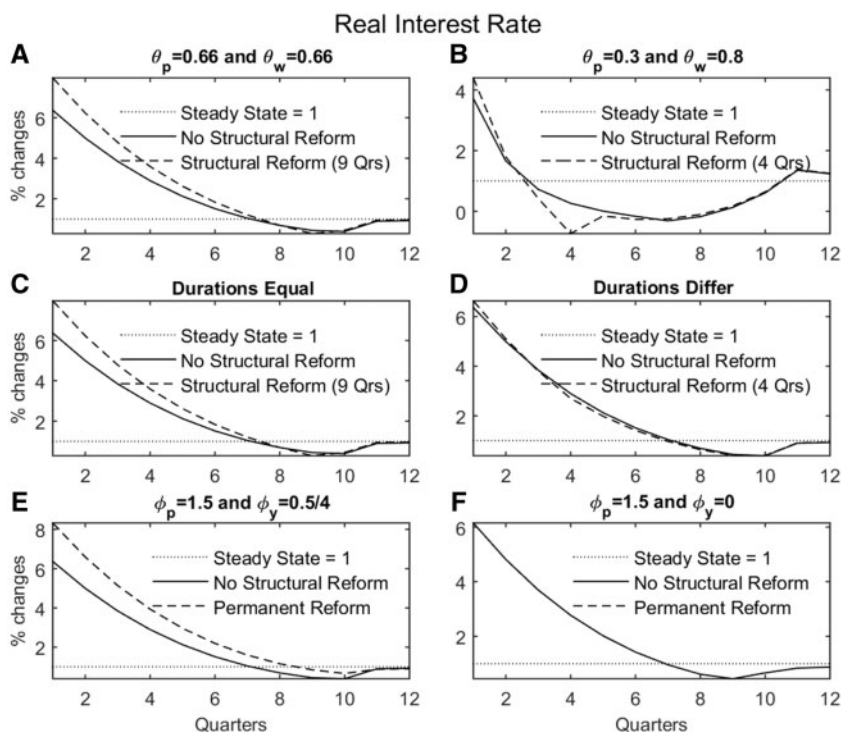
*Note:* Panels A and C correspond to Figure 1, Panel B Figure 2, Panel D Figure 3, Panel E Figure 4, and Panel F Figure 5.





**Figure 8.** Responses of inflation to the crisis without reforms (the solid line) and with reforms (the dashed line).

*Note:* Panels A and C correspond to Figure 1, Panel B Figure 2, Panel D Figure 3, Panel E Figure 4, and Panel F Figure 5.



**Figure 9.** Responses of the real interest rate to the crisis without reforms (the solid line) and with reforms (the dashed line).

*Note:* Panels A and C correspond to Figure 1, Panel B Figure 2, Panel D Figure 3, Panel E Figure 4, and Panel F Figure 5.

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# Self-Employment Income Gap in Great Britain: How Much and Who?

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## Abstract

This article utilizes an expenditure survey-based data set that is rich in terms of observable characteristics to estimate the ‘income gap’ (defined to be one minus the proportion of reported to true income) of the self-employed in Great Britain. It also estimates the evasion response of the individual characteristics of the self-employed. It emerges that self-employed report, on average, around 80.4% of their income to the tax authority, which translates into an income-gap of 19.6% which varies significantly by sex, age, and region. In particular, male self-employed taxpayers under-report more than female ones, and they, in general, become more compliant as they age. Particular emphasis is paid to verifying that the income gap observed cannot be explained by other reasons than under-reporting. (JEL codes: H26, O17, D12, E26)

**Key words:** income-gap, tax compliance, tax evasion, shadow economy, self-employed

## 1. Introduction

Tax non-compliance—taken to be, in its broader form, illegal tax evasion of one’s tax liabilities, either deliberate or from ignorance—undermines revenues, distorts competition (since it puts non-compliant taxpayers at an advantage), and increases inequality. Unsurprisingly, therefore, over the past few years enhancing tax compliance has been a central policy concern of governments in many countries across the world. Tackling non-compliance necessitates an understanding of the scale of the phenomenon and, importantly, its determinants. And this is the objective of this article using a ‘traces-of-true-income’ approach.

Direct measurement of tax non-compliance is notoriously difficult and involves a substantial deployment of resources. Considering the limitations of the direct measurement of non-compliance, the literature has utilized indirect approaches that seek to reveal traces of true income and, in particular, the use of expenditure and income patterns. There are many advantages for the use of indirect methods: (i) they support a lower cost as they are typically a by-product of an existing data set; (ii) they are an independent source of data to the tax administration and thus allow the triangulation of the estimates obtained from register sources; (iii) they are available to tax administrations that either do not have the technology or the resources available to measure non-compliance directly or do so in a non-random manner; (iv) they are neither dependent on the accuracy behind self-reported non-compliance nor on the ability of the auditors to uncover the behaviour; (v) they are available on a more timely manner allowing to track non-compliance along time; (vi) they count with a wider set of observables than tax records do which allows interrogating different aspects of non-compliance. Though indirect methods are not, of course, free of problems (such as, selection bias and untruthful responses), there has been recently a call for the need to increase the credibility of these methods in measuring non-compliance, [Slemrod and Weber \(2012\)](#).

The aim of this article is 3-fold. First, we revisit the measurement of the income-gap (defined to be proportion of true income which evaded) of the self-employed in Great Britain using an extended version of the household expenditure survey (Living Costs and Food Survey—LCFS). We focus particularly on the self-employed who are of interest for two reasons: (i) the self-employed have been shown to systematically under-report their income. Self-employment income, as opposed to employment income, is not subject to third-party reporting providing them with a distinct opportunity to under-report; (ii) self-employment has become an increasingly popular labour choice in Europe (and especially in the UK) in the aftermath of the financial crisis, bringing back the importance of monitoring and understanding the traits that correlate to non-compliance for this particular group.<sup>1</sup>

The second aim of the article is to contribute to the reliability of the expenditure-based method by critically assessing the merits of the approach in measuring non-compliance. Central to the identification strategy is whether the discrepancy observed is due to other alternative reasons more related to the heterogeneous behaviour of occupational groups and differences in preferences than to under-reporting. The availability of a wide range of variables from the restricted version of the survey allows us to assess, to the extent possible, key assumptions of the model and confirm that the observed discrepancy is not driven by other alternative explanations than under-reporting such as preference heterogeneity, savings, or measurement error. Whereas this framework has been previously used by others [see, for example, [Schuetz \(2002\)](#), [Lyssiotou et al. \(2004\)](#), [Johansson \(2005\)](#)], the link between the gap obtained and under-reporting has not been fully investigated.

Unsurprisingly, over the past few years enhancing tax compliance has been a central policy concern of governments in many countries across the world due to its perverse effects (it undermines revenues and distorts competitions). Tackling non-compliance necessitates

1 The number of self-employed individuals was in the first quarter of 2014, 15% higher than in the same quarter of the year 2008, just at the outset of the financial crisis. However, the number of employees in 2014 Q1 was 0.34% lower than in 2008. This trend seems to maintain, in the UK, the number of self-employed increased from amounting to 12.0% of the labour force in 2001 to 15.1% in 2017 ([ONS, 2018](#)).

an understanding of the scale of the phenomenon and, importantly, its determinants. The third aim of this article is to showcase that the expenditure-based method has the potential to go beyond measurement and focus on issues such as the demographics of non-compliance. This provides a useful tool for tax administrations to draw evidence on the profile of the non-compliant.

The data set used is the Secure Access version of the LCFS for the period 2010–2012 which provides us with a rich set of variables. The model exploits the differing opportunity for under-reporting the self-employed and the employed have. As income from employment is subject to withholding taxes, there are minimal possibilities of under-reporting, and thus income of the employed is assumed to be accurately reported. Observing the expenditure pattern of the employed, the level of income necessary to sustain a certain level of expenditure can be ascertained, and thus any discrepancies between the income reported by the self-employed and the employed at a certain level of expenditure can be used to elicit the extent of hidden income the self-employed hold. The analysis provides alternative estimates based on three different measures of expenditure and three different measures of self-employment income. The results from the three product groups are entirely consistent and the findings run in the expected direction. The main results show that, on average, the self-employed report only 80.4% of their true income (or to put it differently, the self-employed income-gap is 19.6%), which translates into a lower-bound estimate of unreported taxable income of 1.6% of gross domestic product (GDP).

As is common with models of the type considered here, there might be several other explanations that challenge the underlying assumptions of the model and could be potentially biasing the results, leading to a false attribution to under-reporting. The analytics show that the result is neither caused by different preferences between the self-employed and the employed nor caused through savings funding current consumption or measurement error. It also emerges that using documents used to report to the revenue authority to fill in the income section of the survey leads to a higher level of under-reporting being detected. Regarding the characteristics of the non-compliant taxpayers, the results suggest that men under-report more than women and that non-compliance decreases with age. We also find suggestive evidence of the geographical heterogeneity of the evasion response.

This article contributes to the literature on measuring non-compliance using traces of true income, first, by providing an updated estimate of the income-gap of the self-employed in the UK and, second, by assessing the merits of the expenditure-based method in measuring non-compliance.<sup>2</sup> We find evidence that this method does indeed perform well in uncovering hidden income. It also contributes more generally to the tax evasion literature surveyed by Andreoni, Erard, and Feinstein (1998) by analysing the heterogeneity of the evasion response with the characteristics of the self-employed individual. The profiling of the non-compliant individual is of interest to tax administrations, as it can inform their compliance activities. We seek with this last application to open the framework to be used in a more general context by tax administrations to investigate traits that can be of interest in understanding the determinants of non-compliance beyond those that are available for tax purposes.

2 For a review of the literature on using indirect methods to infer non-compliance, see Slemrod and Weber (2012).

The organization of the article is as follows. Section II contains a brief literature survey. Section III describes the model, and Section IV presents the data and outlines briefly the empirical methodology. Section V provides and discusses the results, and, finally, Section VI summarizes and concludes.

## 2. Brief Literature Review

One of the first contributions exploiting the discrepancy between income and expenditure to measure the size of the black economy is that of [Dilnot and Morris \(1981\)](#).<sup>3</sup> They computed excess expenditures from survey data for 7200 households in the UK and characterized as ‘black-economy households’ all those where expenditure exceeded income by 20% and by at least £3. They reported an upper and a lower bound distinguishing whether the discrepancy could be explained by the circumstances of the household or whether they included pensioner and unemployed households. They found that the black economy was between £3.2 and £4.2 billion representing around 2.3–3% of 1977 Gross National product. Most of the black economy households were headed by an individual working in a skilled or semi-skilled occupation, and 22% of the black economy households were headed by a self-employed individual. [Dilnot and Morris \(1981\)](#) calculated participation ratios for different observed characteristics. The self-employed were much more likely than other groups to be part of the black economy sample than other employees. Individuals in skilled or semi-skilled manual occupations were more likely to participate in black economy activities than unskilled.

[Pissarides and Weber \(1989\)](#), building on the contribution by [Dilnot and Morris \(1981\)](#), provided a more structural framework for the estimation of under-reporting of the self-employed in Great Britain. Their approach consisted in obtaining a measure of income under-reporting by the self-employed through a comparison of the relationship between food expenditure and income from this group to that of the employees who are assumed to be honest reporters. [Pissarides and Weber \(1989\)](#) recorded that true self-employment income is on average 1.55 times the income reported by the self-employed in Great Britain using the 1982 Family Expenditure Survey, with the uplift factor, which is the scaling parameter that transforms reported to true income, being higher in blue-collar households than in white-collar households (1.65 versus 1.5). Using this estimate of under-reporting, they obtained that the size of the black economy was 5.5% of GDP. [Lyssiotou et al. \(2004\)](#), using the same approach for 1992, estimated the uplift factor to be on average 1.28,<sup>4</sup> and again higher for blue-collar households (1.39) than white-collar (1.18). In addition, using a complete demand system, they found that self-employment income should be multiplied by a factor of 2.18 for the case of blue-collar households and 1.64 for white-collar households. They estimated the size of the black economy to be 10.6% of GDP in 1993.

Similar studies have also been conducted in other countries. In Canada, [Schuetze \(2002\)](#), using the equivalent to the Family Expenditure Survey for 1969–1992, found an average under-reporting factor of 1.2 (1.12 lower bound and 1.23 upper bound). More recently, [Hurst et al. \(2014\)](#) for the USA found that self-employment income is under-reported by 30% which is equivalent to what was found by [Engström and Holmlund](#)

3 We keep the literature intentionally brief by focusing on contributions using the expenditure–income pattern to identify traces of true income.

4 This result was obtained averaging the values of blue-collar and white-collar workers.



(2009) for Sweden; and comparable also to the level of 25% found in Spain (Martinez-Lopez, 2013). Johansson (2005) found that the self-employed under-report their incomes in Finland by 16.5% for households of one self-employed (42% for households of two self-employed) representing 1.3% (3.2%) of GDP. Nygård et al. (2016), analysing the question of the distribution of tax evasion, addressed the estimation of the income under-reported by suppliers using the expenditure-based approach. They find the scaling factor to range from 1.20 to 1.25 for Norway.

Kukk and Staehr (2014) estimated under-reporting in Estonia finding the degree of under-reporting to vary with the extent of reported self-employment income in household finances. They estimated that 62% of true income (reported plus misreported) is under-reported for households where self-employment income represents more than 20% of total reported household income, 50.1% for those with 10–20% share of self-employment income, and 35.9% for those with a share of 5–10%. This entails that the level of under-reporting is still rather significant even when the proportion of reported self-employment to total reported income is small. A drawback of this approach is that selection of the percentage of under-reporting is made upon reported income rather than ‘true’ income, making the selection endogenous. The authors also discuss a definition of under-reporting based on self-reported self-employment status and share of business income finding similar results. Although the estimates are large compared to previously cited studies, it may be more comparable to those found for Russia by Kim et al. (2017) using a panel data version of the Pissarides and Weber approach, 41% of under-reporting.

Feldman and Slemrod (2007) use the same methodology but introduce charitable contributions as their expenditure variable. As they use unaudited tax returns, their methodology allows them to identify the level of income under-reporting by income source. More recently, Artavanis et al. (2016) exploit the asymmetry in the possibilities of under-reporting their incomes of employed and self-employed in a similar model to Pissarides and Weber (1989) where, instead of expenditure, the level of debt acquired with the bank is used as the identifying variable.

Like these contributions, the present article focuses on estimating the degree of income under-reporting by the self-employed (income-gap). Unlike them, however, the emphasis is also on testing the assumptions of the model to ensure the correct measurement of under-reporting and the identification of the profile of the individuals associated with non-compliance which is an issue of significant policy relevance.

### 3. Description of the Model

Our empirical approach uses the expenditure decisions of self-employed and employed households to estimate hidden income. All households make their expenditure decision based on their true income, denoted by  $Y^{True}$ , given by:

$$expenditure = f(Y^{True}, \text{Characteristics of the household/individual}). \quad (1)$$

True income is however unobservable, and its magnitude is to be identified by differences between the expenditure patterns for the two groups: the self-employed and the employed. Expenditure is assumed to be measured correctly for both groups, and reported income, which is the observable income variable in the survey, is allowed to be misreported



by the self-employed.<sup>5</sup> This follows from the observation that income reported by the employed is subject to withholding taxes, and its high visibility makes under-reporting extremely difficult, Slemrod and Gillitzer (2013). The absence of third-party reporting of self-employment income allows the opportunity of income to be misreported, and thus reported income, denoted by  $Y^R$  by the self-employed, is to be scaled by a factor  $k_i$ , where households are indexed by  $i$ , that is:

$$Y_i^{True} = \begin{cases} k_i Y_i^R & \text{if self-employed} \\ Y_i^R & \text{if employed} \end{cases}. \quad (2)$$

Combining equations (1) and (2) and assuming a log-linear relationship between expenditure and income, it is the case that:

$$\ln expenditure_i = \beta \ln Y_i^R + \beta \ln k_i + CHAR_i \alpha, \quad (3)$$

where the term  $\ln k_i$  is the term that differs between the employed and the self-employed. Note that equation (4) is a standard Engel curve where permanent income (unobservable) which is the desired income variable to investigate consumption decisions is imperfectly replaced by reported income (observable). This will require an estimation strategy that accounts for the measurement error in the income variable. Defining  $SE_i$  as a dummy variable that identifies self-employed households, equation (3) can be written in estimation form as:

$$\ln expenditure_i = \beta \ln Y_i^R + \gamma SE_i + X_i \alpha + \epsilon_i, \quad (4)$$

where  $\beta$  identifies the elasticity of consumption with respect to income,  $X_i$  is a vector of covariates including characteristics relevant to the individual and the household,  $\epsilon_i$  is a white noise error, and  $\gamma$  identifies the extended amount of expenditure declared by the self-employed given a certain level of income.<sup>6</sup> An estimation of the average income-gap  $\bar{k}$  and the scaling factor  $\bar{k}$  can be obtained using  $\gamma$  and  $\beta$  as:

$$\bar{k} = 1 - \frac{1}{k} \text{ where } \bar{k} = \exp\left(\frac{\gamma}{\beta}\right). \quad (5)$$

However, income from self-employment is more volatile than income from employment, and a correction for this differing volatility is added which is captured by a difference in the variance of their reported income.<sup>7</sup> In this case, a point estimate is no longer

5 We discuss this point further in Section IV.

6 For the derivations we refer the interested reader to Pissarides and Weber (1989).

7 Ideally one would like to use permanent income as the measure of income that affects consumption. However, permanent income is unobserved as well as true income. Self-employment income can be subject to more volatility than employed income; therefore, one can relate permanent income and true income using a random variable that is log-normally distributed and has a mean equal for both groups but that has different variances for the two groups. This allows the approximation of the difference in volatility of these unobservables by an estimable difference in the volatility of reported incomes obtained independently for each group from the first-stage regression of

attainable and the upper and lower bound of the scaling factor, and its income-gap can be identified as:

$$\bar{\kappa} \equiv 1 - \frac{Y^R}{Y^{True}} = 1 - \frac{1}{\bar{k}} \text{ where } \bar{k} = \exp\left(\frac{\gamma}{\beta} \pm \frac{1}{2}(\sigma_{Y_S}^2 - \sigma_{Y_E}^2)\right). \quad (6)$$

The results report the income-gap with no volatility correction as in equation (5) and for brevity the midpoint of the upper and lower bound obtained from equation (6).

Finally, and importantly, we investigate the heterogeneity of the income-gap to inform the profile of the non-compliant by allowing different characteristics of the self-employed to interact with the self-employment variable. This creates different estimations of the income-gap for each category  $n$  of characteristic  $N$ .<sup>8</sup> Equation (4) can be rewritten as:

$$\ln \text{expenditure}_i = \beta \ln Y_i^R + \gamma_n SE_i * N_n + X_i \alpha + \epsilon_i. \quad (7)$$

Similarly, the income gap can be estimated for the different categories  $n$  using the estimated  $\gamma_n$  from equation (7) in equations (5) and (6), for the specification of the income-gap without and with volatility, respectively.

## 4. Description of the Data

### 4.1 Living Costs and Food Survey

The data comes from the Secure Access version of the Living Costs and Food Survey (LCFS) and cover the years 2010-12.<sup>9</sup> The LCFS uses as unit of survey the household and it captures expenditure decisions and income earned from all the individuals within a household. For consistent comparison across households, and to avoid concerns arising from differences in non-compliance due to the composition of the household, the sample is restricted to households of two adults,<sup>10</sup> either cohabitantes, married or civil partners who live in Great Britain and the Household Reference Person (HRP) is either employed or self-employed. HRP is the householder who: either owns the household accommodation, or 1) is legally responsible for the rent of the accommodation; or 2) has the household accommodation as an emolument or perquisite; or 3) has the household accommodation by virtue of some relationship to the owner who is not a member of the household. If there are joint householders, HRP is the one with the higher income. If the income is the same, then the eldest householder is taken. The age of HRP is also restricted to be less than 60 in order to leave out different expenditure behaviour after retirement, Aguiar and Hurst (2005).

income on the instrumental variables (educational attainment) and the covariates that relates to the household.

8 As an example, say  $N$  is gender, and  $n = (\text{male}, \text{female})$ .

9 Office for National Statistics, Department for Environment, Food and Rural Affairs. (2014). Living Costs and Food Survey, 2006-2012: Secure Access. [data collection]. 4th Edition. UK Data Service. SN: 7047. The original data creators, depositors or copyright holders, the funders of the Data Collection (if different), and the UK Data Archive bear no responsibility for the analysis hereby presented.

10 Household composition is controlled for in the specification using the number of children.

To obtain a reasonable sample size, the 2010 to 2012 waves are pooled. They are also deflated using the consumer price index base of 2010. Income reported has also been adjusted to account for the fact that income reported by the self-employed dates back to the last available record which could well have been obtained a year before and consequently, not to the date of the interview. Failing to correct this time lag could lead to spurious results. Self-employment income reported is updated to the time of the interview using the monthly rate of inflation calculated from the amount of self-employment income per self-employed worker drawn from the Blue Book for the corresponding years.

A self-employed household is defined to be one that draws more than 25% of their income from labour income from self-employment. This threshold is imposed to avoid households that have a substantial amount of self-employment income (e.g. from a subsidiary source) from classifying themselves as employees. For robustness, alternative specifications of the self-employment dummy variable have also been considered as will be discussed in Section V.A.

## 4.2 Measuring income

In the LCFS, self-employed individuals were asked about the profit from their activity and about how much their drawings amount to both for business and non-business purposes or personal use. In the event that the individuals were not able to respond to any of these questions, they were asked for an estimate of how much their income was once expenses were deducted. To capture all income the self-employed take into consideration, it is assumed that their consumption decision is based on their total earnings which include both labour earnings and those reinvested back into the business (a form, perhaps, of precautionary savings). But it is conceivable that income for the self-employed is better proxied by other sources of income. To obtain a comprehensive picture (and also being agnostic of which form of income approximates true income better) use is, therefore, made of three different measures of self-employment income: a comprehensive measure, profits, and drawings.

The comprehensive measure of income takes into account as much data on income as possible, avoiding missing values in the answers, and is computed as follows. The profit figure (transformed into a weekly amount) is taken if reported. If the individual reported a loss (or zero profit) or is not able to report a profit figure, then the estimate of the weekly drawings is taken. If none of the former is available, then the weekly equivalent of the estimation of income minus expenses is taken. The second and third measures consider, respectively, only profits and drawings as the measure of self-employment income.

## 4.3 Measuring expenditure

The correct reporting of expenditure by both groups, self-employed and employed, is one of the assumptions in the model. However, there are significant reasons to believe that food is an item of expenditure that can be considered as being reported with a high degree of accuracy. First, food is one of the items of expenditure that is better captured on the LCFS. [Brewer and O'Dea \(2012\)](#), through a comparison of the National Accounts with the LCFS, find that food together with household fuel and the running costs associated with motoring appear as the categories of expenditure where coverage is higher. Food had a coverage rate above 80% for each year in the period 1974–2009. This is consistent with the patterns

found in the USA by Meyer and Sullivan (2009) who, comparing the Personal Consumption Expenditure and the Consumption Expenditure, have found a good coverage for food eaten in of 85%, while the coverage of food eaten away from home has been declining over time. Second, food, being a necessity,<sup>11</sup> is not an expenditure that can be altered by transitory shocks, its consumption cannot be postponed to future periods, and zeros for infrequency of purchase are not present.<sup>12</sup> Third, food does not represent an item of expenditure that can generally be claimed as a business expense.

The UK tax authority [HM Revenues and Customs (HMRC)] establishes that some of the costs the self-employed face can be claimed as allowable expenses. These include office costs, travel costs, clothing, staff costs, resell of goods, financial costs, and cost related to of business premises and advertising or marketing. Food expenses do not feature in the list of allowable expenses, but there is an exception in that food expenses can be claimed if it is in the case of overnight business travel. Other food costs such as those derived from entertaining clients, suppliers, and customers or those related to event hospitality cannot be claimed, HMRC (2015). In fact, none of the individuals in the sample mentions food as a business expense. Besides, food is expected to be correctly reported, as there is no social stigma associated to it. It is well documented that other items of expenditure such as tobacco or alcohol are usually misreported on surveys, particularly in the LCFS the coverage ratio is 40% (Brewer and O'Dea, 2012). Food does not represent an item that can be suspected of showing a certain lifestyle as opposed to expenditure on holidays or newly bought cars, and therefore the interest in misreporting is minimal. Finally, food expenditures are recorded using a diary during a 2-week period by all individuals over 16 years of age and children of age between 7 and 15 years are offered a simplified version. Other items of regular expenditure, such as the mortgage, are captured in the household questionnaire.<sup>13</sup>

- 11 For a discussion on this, see Attanasio et al. (2004) who also present some evidence that for very poor households (defined as having their income or consumption below 60% of median consumption or income) this might not hold. The fraction of such households, however, in the general population is, in general, very small to significantly change the results.
- 12 This is one of the reasons why durable goods were not taken into account in the measure of expenditure. Ways to mitigate problems with infrequency of purchases have been proposed, but there are limitations too, Meghir and Robin (1992). Lyssiotou et al. (2004) estimated under-reporting using a demand system in which they included durable goods, but problems with infrequency of purchase still remain. Additionally, Brewer and O'Dea (2012) find that durable goods (household and personal services, vehicle purchases, and other durable leisure goods) are an item of expenditure with very volatile coverage ratio in the LCFS (previously named as the Family Expenditure Survey) ranging between 55 and 80%.
- 13 The LCFS uses diaries instead of interviews to collect food expenditure data. Recall data have been long recognized to suffer from different problems: quantities are difficult to remember (Gray, 1955), memory declines with the length of the recall period which Deaton (1997) refers to as 'progressive amnesia' [see Sudman et al. (1973) and Scott and Amenuvegbe (1991)], and telescoping errors (Neter and Waksberg, 1964). Diaries minimize these problems, as respondents are asked to record their expenditure on the day it occurs. However, as Browning et al. (2003) and Battistin (2003) recognize diary, methods are also known to suffer from problems of 'diary fatigue' due to the high burden they pose on the respondents. If diaries are only required to be kept for a short period of time, then problems of infrequency of purchase arises. As Deaton (2005) puts it, there is a trade-off between memory and match between consumption and purchases. Ahmed et al. (2006) exploiting a database with both interview (recall) and diary data find that none of the

**Table 1.** Main summary statistics

	Employed			Self-employed		
	N	Mean	SD	N	Mean	SD
Disposable labour income (ln)	4034	6.528	0.504	738	6.473	0.695
Food (ln)	4026	4.35	0.558	738	4.432	0.579
Utilities (ln)	4021	3.222	0.565	736	3.314	0.585
Non-durables (ln)	4036	5.734	0.524	739	5.81	0.552

The analysis considers two other measures of expenditure apart from food, expenditure on utilities, and a basket of nondurable goods. Expenditure on utilities was chosen, as it is an item of expenditure that could be easily recalled due to the regular payments. However, it raises concerns, as it represents an item typically claimed as a business expense by the self-employed. The higher level of consumption could be masquerading the differing nature of the self-employment activity and its particular fiscal treatment. Therefore, estimates, although presented for comparison, should, in principle, be taken with caution. The third measure of expenditure that is considered is a composite measure of expenditure that considers a basket of nondurable goods.<sup>14</sup> This measure of expenditure is added to test for the robustness of the results when considering a broader basket of goods to which expenditure can be diverted. It offers a sound robustness check for the preferred item of expenditure which is food consumption.

Table 1 reports the summary statistics for the expenditure measures and disposable income for the two groups. Table 1 shows, interestingly, and across all expenditure measures, the self-employed exhibit higher levels of expenditure, whereas their reported income is lower than that of the employed.<sup>15</sup>

5. Estimation and Results

To explain consumption, theory suggests that the measure that relates to consumption decision is permanent income (Friedman, 1957). However, since permanent income is

sources is free of errors, but that recall measures of expenditure were substantially under-recorded. There is an inclination to mix both techniques to minimize their challenges (Gibson, 2002; Battistin, 2003). The Consumer Expenditure Survey in the USA and the LCFS in the UK combine recall and diary data with the intention to capture more infrequently purchased items of expenditure with the former. Browning et al. (2003), comparing recall and diary expenditure on food at home for the USA, recognize that individuals do a ‘remarkably good job’ when recording food at home as opposed to total expenditure. As food expenditure is a frequent item of expenditure, diaries appear to be the appropriate way of recording it.

- 14 The basket of non-durable goods comprises expenditure on food, alcohol and tobacco, clothing, utilities, non-durable expenditure on recreation, non-durable expenditure on transportation and communication, health, education, and other miscellaneous non-durable expenditures. These other items of expenditure have a varying degree of coverage in the survey. As analysed by Brewer and O’Dea (2012) for the case of the UK, the coverage of clothing in later years reaches 60%, while the coverage of transportation reaches 40%. This variable can therefore be affected by a higher measurement error, and therefore, it is reported for the purpose of providing robustness to the results and testing the model under a wider basket of goods.
- 15 The difference in means is statistically significant. Summary statistics of the covariates are provided in Appendix Table A1.

unobserved, current reported income from the survey is used in its place. The existence of transitory variations around the permanent measure of income leads to an attenuation of the estimated elasticities of income with respect to consumption when current income is used. Therefore, to address the measurement error in the independent variable resulting from the use of current income as a noisy proxy for permanent income, income is instrumented in [equation \(4\)](#). The instruments to be used are educational attainment (whether the HRP and spouse had higher education) and whether the HRP is in a white-collar or blue-collar occupation.<sup>16</sup> A summary of the main results of the estimation, these are the income-gaps, is available within the text. Full estimation results are available as an [Online Appendix](#) to the article in the journal's website.<sup>17</sup>

### 5.1 Self-employment income-gap

Estimation of the income-gap for the self-employed as evidenced in [equations \(6\) and \(7\)](#) requires four key parameters: the estimation of the residual income variance for the two employment groups (self-employed and employed) that can be estimated independently from the first-stage regressions ( $\sigma_{Y_S}^2$  and  $\sigma_{Y_E}^2$ );<sup>18</sup> the elasticity of consumption (given by  $\beta$ ); and the coefficient of the self-employment dummy variable ( $\gamma$ ) from the second-stage regressions.

[Table 2](#) displays the estimation of the income-gap of the self-employed including first the specification in which the volatility correction of income is not taken into account, this is  $\sigma_{Y_S}^2 = \sigma_{Y_E}^2$ , as in [equation \(5\)](#); and the specification that accounts for the differing volatility in incomes, this is [equation \(6\)](#). As [equation \(6\)](#) results on a bounded estimation, an upper and lower bound of the income-gaps is obtained. We present and focus the discussion for the sake of brevity around the midpoint of the interval, relegating full estimation results to the [Online Appendix](#). [Table 2](#) reports on the main estimation results and is organized as follows: (i) Panel A considers the robustness of the results to alternative specifications of the dependent variable of expenditure, (ii) Panel B tests for the robustness of different specifications of the self-employment income variable, and (iii) Panel C compares the sensitivity of the results to alternative specifications of the definition of a self-employed household.

Panel A in [Table 2](#) shows that, with food expenditure as a dependent variable, the self-employed income-gap is 19.6% which translates into a midpoint multiplier of  $\bar{k} = 1.24$ , implying that income reported by the self-employed should be multiplied by a factor of

16 In a cross-section setting, instrumental variables have been the preferred estimation method (Pissarides and Weber, 1989; Hurst et al., 2014 for the Consumer Expenditure sample). The difficulty in addressing the measurement error of the income variable in a cross-section setting concentrates on the choice of the instrumental set that satisfies the exclusion restrictions. When panel data on current income are available, average measures of income over time are used in order form a more 'permanent' measure of income (Engström and Hagen, 2017). We find as in the case of Hurst et al. (2014) the educational attainment variables to be suitable instruments for income and the relevant assessment of the quality of the instrumental variables is provided in an [Online Appendix](#).

17 The [Online Appendix](#) is available in the authors' website. It contains the full estimation of the income-gap, including the main results from the regression necessary to estimate the income-gaps, the relevant bounds of the estimate, and the quality of the instrumental variables.

18 The cross-section nature of the data does not allow the calculation of the variance of income over time for each household, and therefore, these variances are calculated for each group.

Table 2. Estimation of the income-gap

	No volatility correction Point estimate	Volatility correction Midpoint
Panel A: Expenditure		
Food	0.187*** (0.043)	0.196*** (0.042)
Utilities	0.214*** (0.045)	0.223*** (0.045)
Non-durables	0.190*** (0.031)	0.199*** (0.03)
Panel B: Income		
Profit	0.180*** (0.066)	0.196*** (0.065)
Drawings	0.368*** (0.099)	0.391*** (0.095)
Proxy	0.187*** (0.043)	0.196*** (0.042)
Panel C: Alternative SE definitions		
Self-employed head	0.215*** (0.038)	0.221*** (0.037)
Any self-employed	0.215*** (0.037)	0.221*** (0.036)
SE (25% rule)	0.187*** (0.043)	0.196*** (0.042)

Notes: 2SLS (two-stages least squares) regressions based on [equation \(4\)](#) and income-gaps estimated as in [equations \(5\)](#) and [\(6\)](#). Robust standard errors are given in parentheses. The stars indicate significance at the following levels: \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . Survey data pooled for waves 2010–2012. The dependent variable in Panel A is (i) food expenditure, (ii) utilities, and (iii) non-durables. The dependent variable is food expenditure in Panels B and C. Independent variable of interest is household disposable labour income instrumented using the level of education and the type of occupation (white or blue collar, defining white collar as those individuals who are employers in small or large organizations or hold a higher managerial, higher professional, lower professional and higher technical, lower managerial and higher supervisory, and intermediate position) and the self-employment dummy variable. All specifications include year and quarter fixed effects and controls for household and personal characteristics (age and number of children in a non-quadratic fashion, number of cars and rooms, type of tenure, availability of drier, and central heating). All dependent and independent variables are in logs and deflated accordingly. The sample is restricted to individuals of age less than 60 years. All specifications are weighted using sample weights. The income-gap presented in this table is the IV (instrumental variables) estimated income-gaps. First-stage  $F$ -statistics, tests on the quality of the instrument, sample sizes, and the ordinary least squares (OLS) specification and estimation are provided in an [Online Appendix](#). SE, self-employed.

1.24 to obtain true income.<sup>19</sup> This value is similar to that obtained for countries such as Sweden or Canada ([Engström and Holmlund, 2009](#); [Schuetze, 2002](#)). Panel A also reports the estimation using two alternative measures of expenditure: expenditure in utilities and a nondurable basket of goods. The concern with using expenditure in utilities, despite being

19 The appropriate standard errors are computed using the delta method.

an item of expenditure, one may expect to be easily recalled, is that it can be claimed as a business expense. This may act as an incentive to the self-employed to carry some of their activity at home and claim the expense on utilities. Thereby we could observe a higher level of expenditure on utilities for a certain level of income that would not be due to under-reporting but that it is only a feature of the self-employed activity and the fiscal treatment. The degree of under-reporting revealed using utilities is only slightly larger: 22.3%. The basket of all non-durable goods as a proxy for expenditure gives a similar degree of under-reporting as using food expenditure, 19.9% which highlights the robustness of our results to different specifications of the dependent variable.<sup>20</sup>

Panel B in Table 2 shows that using alternative measures of our main independent variable of interest self-employment income, the level of under-reporting estimated using the comprehensive measure of self-employment income and profit is identical. Both of these measures highlight the importance of capturing the possibility that the self-employed make their consumption decision based on their available and retained earnings. The use of drawings from the business as the measure of income for the self-employed results in a substantial decrease on the sample size, as not many individuals report taking drawings from their business or report missing answers. Using drawings as the income variable for the self-employed translates into more significant income under-reporting. This result may be over-estimating the amount of under-reporting, as it might be failing to consider the influence of retained earnings in shaping consumption decisions.

The definition of a self-employed household (being those who derive more than 25% of their income from self-employment) might be of concern in the sense that it relies on reported income—which may be misreported—to classify households into employment categories. Using a proportion of reported rather than true income can lead to the misclassification of households into employment rather than self-employment. The aim of this 25-rule definition was to circumvent the use of self-reported employment status to avoid the selection of households into employment when their main source of income is self-employment.<sup>21</sup> We test the robustness of the results to the alternative definitions of self-employed household in Panel C. We show that the income-gap estimated is robust to the definition of the self-employed household be it based on income (25-rule) or defined from self-reports. Two alternative definitions are utilized for the latter: the first uses self-reported employment status of the HRP in their main or subsidiary jobs (Self-Employed Head in Panel C), while the second relates to the opportunity a self-employed household has to under-report income whenever there any of the household members report having a

20 Arguably, estimation should also consider housing as a measure of expenditure. The problem with this, however, is that it would require imputed rent for individuals who own their house something for which data are not available and, more importantly, not easily computed

21 Pissarides and Weber (1989) to overcome the endogeneity of the income definition also instrument for the self-employment dummy variable. However, the bias that can result in the estimates due to weak instruments could outweigh the effect of failing to instrument and accepting the bias introduced by considering that some households that behave as self-employed are classified in our sample as employed. Our approach is to use alternative definitions of a self-employed household to assess the impact of definition on the estimation of under-reporting using definitions of self-employment that are not a function of the proportions of self-employment to total reported income.



self-employment income source (Any Self-Employed in Panel C).<sup>22</sup> For comparison purposes, Panel C again reports the income-gap using the 25% income rule (which is equivalent to the first row Food in Panel A).

## 5.2 Is it under-reporting?

A concern with the analysis so far (and the results obtained) might be whether the estimates obtained can indeed be attributed to under-reporting or whether they are a feature of the assumptions posed to obtain the estimate. It is precisely this issue that the analysis now turns to, paying particular attention to three aspects: heterogeneous preferences for food consumption, heterogeneous spending behaviour, and measurement error in the survey.

### 5.2.1 Preference heterogeneity

It has been assumed [see equation (4)] that both taxpayer groups (self-employed and employed) have the same preferences over consumption and, therefore, the same income elasticity of consumption. One, however, can certainly think of a more structural model where occupational choice is driven by sector-specific skills and different preferences over consumption. To test this assumption, the consumption functions of the two occupational groups have been estimated separately showing that the income elasticities for both occupational groups are statistically indistinguishable from each other.

The data on food expenditure allow us to distinguish between food eaten in the house and eaten out of the house. Since food eaten out is typically more expensive, a difference in the pattern of consumption between the two groups could explain the gap obtained if there was a higher preference by the self-employed for dining out. We have, therefore, tested whether there is a different preference between food eaten in and out between the occupational groups. Estimating the share of food eaten in with respect to total food expenditure, we find that there is no significant difference between the two groups. Therefore, the higher level of expenditure observed for the self-employed can be neither justified by a higher expenditure on food outside from home nor by a different elasticity of consumption.

### 5.2.2 Heterogeneous spending behaviour: financial constraints

Another reason why we might observe a discrepancy between expenditure and income may be a different level of financial stability for the self-employed. What we know, and is controlled for in the model, is that income for the self-employed is more volatile than income for the employed. However, it could still be the case that in the years observed, 2010–2012, the level of expenditure of the self-employed is not funded by current income only but also

22 For clarification purposes, the second definition using self-reports (*Any Self-Employed*) defines a household as self-employed if any self-employment income source is available to them. This definition neither accounts for the importance nor amount of self-employment income: only the opportunity to under-report income matters. This definition is more general than the first definition using self-reports (*Self-Employed Head*) that classifies a household into self-employment regarding the reported status of the HRP. This classification is made solely only the head of the household, whereas the previous one considered any income sources of the household irrespective of who earns it.

**Table 3.** Estimation of the income-gap: alternative explanations of the gap

	No volatility correction Point estimate	Volatility correction Midpoint
Panel A:		
No financial constraints	0.218*** (0.083)	0.229*** (0.082)
Panel B:		
No business expenses claim	0.212*** (0.05)	0.219*** (0.049)
Panel C: Income measurement error		
Any documents	0.206** (0.081)	0.218*** (0.08)
HMRC documents	0.310** (0.127)	0.320** (0.125)

*Notes:* 2SLS (two-stages least squares) regressions are based on [equation \(4\)](#) and income-gaps estimated as in [equation \(5\)](#) and [\(6\)](#). Robust standard errors are given in parentheses. The stars indicate significance at the following levels: \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . The dependent variable in Panel B is utilities. The dependent variable is food expenditure for Panel A and C and is the default expenditure variable unless specified otherwise. Independent variable of interest is household disposable labour income instrumented using the level of education and the type of occupation (white or blue collar, defining white collar as those individuals who are employers in small or large organizations or hold a higher managerial, higher professional, lower professional and higher technical, lower managerial and higher supervisory, and intermediate position) and the self-employment dummy variable. All specifications include year and quarter fixed effects and controls for household and personal characteristics (age and number of children in a non-quadratic fashion, number of cars and rooms, type of tenure, availability of drier, and central heating). All dependent and independent variables are in logs and deflated accordingly. The sample is restricted to individuals of age less than 60 years. All specifications are weighted using sample weights. The income-gap estimations presented in this table are the IV (instrumental variables) estimated income-gaps as in [equation \(6\)](#). First-stage  $F$ -statistics, tests on the quality of the instrument, and the OLS specification are provided in an [Online Appendix](#).

by past savings. If this was the case the model would be misleadingly attributing to under-reporting the fact that some current consumption is not funded by current income but by past income. Using variables from the Secure Access data, we are able to filter out those individuals who claim to be financially constrained: by this it meant individuals who find their current income not sufficient to fund their current consumption and need to recourse to other alternative sources such as loans, savings, or money from relatives. We have created a smaller data set of individuals not financially constrained, rerun the analysis, and are still able to find a substantial income-gap of 22.9%, Panel A in [Table 3](#), which cannot be explained through the use of past incomes for this type of households.

The main category of expenditure analysed in this article is food expenditure for the reasons discussed in Section V.C. However, in [Table 2](#) we also present estimates using utilities as an expenditure category. One of the main concerns that utilities raise is that it is one of the main categories claimed by the self-employed as a business expense. Therefore, a higher level of expenditure on utilities relative to income may not be a sign of under-reporting but the result of a differential fiscal treatment for the self-employed. We have sieved out of the estimation all those self-employed that claim any utilities bill as a business expense. Using utilities as the expenditure category on those self-employed individuals who do not claim any business expenses, we still observe a very similar level of under-reporting (21.9%)—see

Panel B in Table 3. Therefore, there is evidence that neither the role of savings in funding current consumption nor the possibility of claiming of business expenses from some expenditure categories is the driver of the results obtained.

### 5.2.3 Measurement error

As noted earlier, one of the caveats of using surveys relates to the accuracy of the information reported. The nature of the survey makes it likely that expenditure is more accurately reported than income, since the survey makes available instruments for making expenditure as accurate as possible. For example, in the case of food a diary is filled by each member of the family. In the case of utilities, being a recurrent expense, it is easy to recall (Bee et al., 2012). For income, however, under-reporting may not be the only reason behind the discrepancy found. Individuals are asked about their current income. Employees are usually paid on a monthly basis, so their claim of income earned should not deviate in excess of what they actually earn. That is, it should be free from recall error. For the self-employed, however, this is not the case. Recalling their last profit of their businesses may not be such an easy task. Therefore, it may be true that the discrepancy found might stem from measurement error due to recall, that is, the self-employed might be supplying approximate figures for their income that have little to do with their true levels.<sup>23</sup> There is substantive evidence that the length of the recall period, that is the lapse between occurrence and report, influences the accuracy of the report. Scott and Amenuvegbe (1991) find that average daily expenditures reported fall by almost 3% for every day added to the recall period being frequently purchased items the most affected. Deaton (1997) coined the tendency to forget earlier transactions ‘progressive amnesia’.<sup>24</sup> For income, Withey (1954) interviewed participants about their current income in 1 year, and then re-interviewing the participants 1 year later asking them about the past income, only 61% of the cases reported the same income in their current and retrospective reports. Converse evidence is also found on the literature, and Marquis and Moore (2010) only found that increasing under-reporting linked to an increase in the recall period for one of the eight programmes analysed in the Survey of Income and Programme Participation (SIPP).

To assess whether the discrepancy stems from simple measurement error, we have carried out two checks. In the first, we have selected those individuals who consulted any documents to report their profit figures to the survey.<sup>25</sup> These documents could be a Notice

- 23 Two scenarios can arise from the income reported by the self-employed. If the income reported by the self-employed is uncorrelated with their true income or reported income to the tax authority, then this is simply noise and can be direction of the bias is unclear. It could also happen that when reporting to the survey, the self-employed give a measure of income that lines up better with their true income than it does with the reported income to the tax authority. If this was the case, the estimate of under-reporting obtained from this method using survey data on incomes might be underestimating the extent of non-compliance.
- 24 Evidence is mixed, though. The Indian National Sample Survey which surveys households experimented with different recall periods for different groups of goods. They found that decreasing the recall period increased reported expenditure on food by 30% and total expenditure by 17% (Deaton, 2005). But this is not always the case. The NSSO Expert Group on Sampling Errors (2003), however, has noted that for certain foods a longer recall period was better than a shorter one (30 days versus 7 days) (cited in Wodon, 2007).
- 25 The nudge to consult documents is a strategy from the interviewers to reduce recall errors. This procedure has proven efficient as documented by Maynes (1968) who found less errors in reports

of Tax Assessment (form 300), their Annual Accounts (or the summary), their Tax Return, or any other documents. Estimates are reported in Panel C of [Table 3](#), which shows that the level of under-reporting is larger than in the case when no document is consulted (21.8 versus 19.6%). The second check looks at the estimate in the presence of administrative data. One of the differences between filling out a survey and reporting to the revenue service is the incentive to report the true income. In the survey, individuals may report their true income more accurately than they do to the revenue service, as there is no gain from misreporting to the survey while misreporting to the tax authority translates into tax savings. However, one may also argue that some of the individuals, who are afraid of their data being linked to their tax records despite reassurance of the anonymity of their responses, will provide the same answer to the survey as they did to the revenue service for the sake of consistency and to avoid self-incrimination.

To disentangle whether these effects are biasing the results, we repeat the estimation only for individuals who have made use of documents that have already been used for tax purposes or that are from the revenue service: the Notice of Tax Assessment and the Tax Return. Using only individuals who have looked at these documents, we find a larger value of under-reporting of 32%, Panel C in [Table 3](#). However, we need to take these results with care, as the sample size of self-employed using these documents is significantly reduced. Even so, this highlights the potential advantages of using administrative and survey data together, and it outlines that even when using documents to better report income, the income gap is still visible.

### 5.3. Heterogeneity in the income-gap

This section constructs a profile of the non-compliant self-employed.<sup>26</sup> A summary of the results including the income-gaps is contained in [Table 4](#), and full estimation and tests of the adequacy of the instruments are available in an [Online Appendix](#).

#### 5.3.1 Non-compliance: age

To assess the impact of age on self-employment under-reporting, we introduce the interaction of the self-employment dummy variable and different age categories as in [equation \(7\)](#). We have analysed this taking into account the age of the HRP and also the age of the self-employed individual (if different). The results in Panel A of [Table 4](#) show that as individuals age, they become more compliant. That is, in households where the HRP is less than 35 years old, income is under-reported by on average 37.5%; if between 35 and 45 years old, then it is under-reported by 18.2%; and if between 45 and 60 years old, then it is under-reported 13.6%. The finding that the income-gap decreases as age increases is

of individuals who were prompted to look at the records of the amount held in their savings accounts than in those who were not. Same results were found by [Grondin and Michaud \(1994\)](#) and [Moore et al. \(2000\)](#) who found a reduction of errors in reporting of income when using tax forms (cited in [Moore and Welniak 2000](#)). Instructions were given in the LCFS for interviewers to prompt the use of documents.

26 Other characteristics aside from age, gender, and region were tested, but non-compliance did not vary in a statistically significant way between groups. These characteristics were their legal form (whether a partnership or sole trader),

**Table 4.** Estimation of the income-gap: profiles of non-compliance

	No correction for volatility Point estimate	Correction for volatility Midpoint
Panel A: Age (years)		
<35	0.375*** (0.093)	0.375*** (0.093)
35–45	0.172*** (0.063)	0.182*** (0.063)
>45	0.136** (0.066)	0.149** (0.065)
Panel B: Gender		
Wife	−0.051 (0.132)	−0.043 (0.131)
Husband	0.188*** (0.049)	0.196*** (0.048)
Both	0.309*** (0.089)	0.331*** (0.086)
Panel C: Region		
North	0.179* (0.106)	0.188* (0.104)
Yorkshire and the Humber	−0.224 (0.261)	−0.166 (0.249)
Midlands	0.122 (0.118)	0.137 (0.116)
East	0.315*** (0.08)	0.316*** (0.08)
Greater London	0.418*** (0.09)	0.429*** (0.089)
South	0.148* (0.076)	0.156* (0.075)
Wales and Scotland	0.067 (0.149)	0.069 (0.149)

*Notes:* 2SLS (two-stages least squares) regressions based on [equation \(7\)](#) and the income-gaps obtained as in [equation \(5\)](#) and [\(6\)](#). Robust standard errors are given in parentheses. The stars indicate significance at the following levels: \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . Survey data pooled for waves 2010–2012. The dependent variable is food expenditure. Independent variable of interest is household disposable labour income instrumented using the level of education and the type of occupation (white or blue collar, defining white collar as those individuals who are employers in small or large organizations or hold a higher managerial, higher professional, lower professional and higher technical, lower managerial and higher supervisory, and intermediate position). The self-employed dummy variable is interacted with the characteristic  $N$  in question as in [equation \(7\)](#). All specifications include year and quarter fixed effects and controls for household and personal characteristics (age and number of children in a non-quadratic fashion, number of cars and rooms, type of tenure, availability of drier, and central heating). All dependent and independent variables are in logs and deflated accordingly. The sample is restricted to individuals of age less than 60 years. All specifications are weighted using sample weights. The income-gap presented in this table is the IV (instrumental variables) estimated income-gaps. First-stage  $F$ -statistics, tests on the quality of the instrument, and the OLS specification are provided in an [Online Appendix](#).

consistent with the findings in the literature on tax audits in the USA using Taxpayer Compliance Programme (Clotfelter, 1983; Feinstein, 1991).<sup>27</sup>

### 5.3.2 Non-compliance: gender

Gender is another characteristic generally observed by the revenue service. We find that men under-report significantly more than women. Panel B in Table 4 shows that households of two self-employed (both in Table 4) under-report more than households of one self-employed. This result is in line with intuition. A self-employed individual has higher chances of under-reporting their income than an employee due to the absence of third-party reporting. A household of two self-employed has even more opportunities to under-report than a household of a single self-employed individual. These results are in line with those found by Johansson (2005) for Finland but run against those found by Schuetze (2002) for Canada. However, in households of one self-employed, the self-employment dummy variable is not significant when the self-employed is the wife, but income-gap is higher in households where the self-employed is male. Our result is in line with what has been found in studies using surveys and experiments analysing tax compliance (Tittle, 1980; Torgler and Schneider, 2006; Spicer and Becker, 1980; Baldry, 1987; Kleven et al., 2011).

Vogel (1974), using a survey in Sweden, found that men think of themselves as having better illegal opportunities than women. Torgler and Valev (2010) using data from eight Western European countries from the World Values Survey and the European Values Survey that span the period from 1981 to 1999 also find that in the case of bribes men are more frequently asked for bribes by government officials than women. They find, in general, women are more willing to comply.<sup>28</sup> Opposite results can also be found in the literature such as Baldini et al. (2009) who use the discrepancy between the income reported to the fiscal authorities and the income reported to the Survey of Household Income and Wealth in Italy for the region of Modena as a measure of income tax evasion. Using a probit model they find women are more likely to under-report than men. However, their study refers only to a particular region of Italy, and the results of the study cannot be generalized to the whole population. Schuetze (2002), however, finds that the sex of the individual yields no difference in compliance behaviour.

### 5.3.3 Non-compliance: region

Knowing how non-compliance is distributed geographically can provide evidence on which regions are less compliant and therefore may want to be more targeted with the audits by

27 Criminology studies provide evidence of this same finding for crimes in general. It seems that for all types of criminals and crimes, there exists a common distribution for age which shows to be invariant to social and cultural conditions, so that crime is negatively correlated with age. Though the theories for why this happens vary as discussed in Tittle, 1980; Brown and Miller, 1988.

28 Gender differences in delinquency have been largely investigated in criminology, and many theories have been proposed. The fact that this difference in behaviour was due to the inequitable role in society of women and men was discarded, since entrance in the labour market of women did not affect crime rates. The most accepted theory to support this difference points at self-control and opportunities to commit crimes as the drivers. Delinquent men are found to be more exposed to delinquent companions that can influence their behaviour through imitation (Mears et al. 1998).

the tax authority.<sup>29</sup> Panel C in Table 4 reports the results, with the most non-compliant regions in the UK being Greater London followed by the East of England, the North, and the South.

## 6. Concluding Remarks

This article has revisited the use of expenditure and income as one of the methods that rely on traces of true income to identify non-compliance. Using an extended version of the household expenditure survey in Great Britain, we find that the self-employed under-report on average around 80.4% of their true income (or equivalently, their income-gap is 19.6%). Given that self-employment income in the UK for the period of study, 2010–2012, represented 5.5% of GDP, this translates into an estimate of unreported taxable income during this period of 1.6% of GDP. The magnitude of the income-gap has been shown to be robust to the expenditure and income variables used which praises the robustness of the results.

Methods that rely on traces of true income have some desirable advantages: they are less costly as they are typically a by-product of an existing survey; they do not rely on the detection rate of auditors or on self-reported non-compliance; they are available on a timelier manner; and finally, they can offer a wider range of observable characteristics for the individual than those available on tax records. However, as non-compliance is ascertained through the relationship between other variables, it is fundamental in this type of exercises to investigate how closely the gap obtained can be linked to non-compliance. We have done this by identifying other possible explanations of the discrepancy and ruling them out as the main drivers of our findings. Our results identify that the income-gap obtained is neither driven by preference heterogeneity nor by the possibility of households being financially constrained and using their savings to fund current consumption, nor can it be attributable to measurement error.

We showcase also that these indirect methods have an extra advantage: they can be extended not only to measurement but to understanding the traits that relate to non-compliance. This is particularly possible because of the richness in observables that survey data introduce that go far beyond those available on tax records and can enable tax administrations to understand the characteristics that most correlate to non-compliance to better design their compliance activities. We have identified men to be less compliant than women and taxpayers to become more compliant as they age. The income-gap is also found to vary by regions. Other characteristics such as the legal form of self-employment were not identified to correlate in a statistically significant manner.

This article acknowledges, as [Slemrod and Weber \(2012\)](#) highlight, the difficulty in providing evidence of the unobservable and recognizes the need to build trust in the use of indirect approaches to the measurement and understanding of non-compliance. We aimed at contributing to this ‘credibility revolution’ by showcasing the strength of the results obtained using the expenditure-based method to uncover traces of non-compliance and testing that indeed the income-gap observed links to non-compliance. Indirect methods

29 We have tried considering all the regions of England as well as Scotland and Wales. Restrictions on the sample size due to the Secure Access nature of the data used led to the pooling of certain regions together to achieve a sufficient sample size that ensured anonymity.

should not be treated as substitutes of direct methods but rather complements in that they are able to answer questions that cannot be answered using solely administrative sources.

## Supplementary Material

Supplementary material is available at *Cesifo* online.

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Appendix A

Table A1. Summary statistics of the covariates

	N	Mean	SD
Panel A: Employed			
Age	4045	40.053	10.02
Number of children	4045	0.833	0.941
Local authority tenant	4045	0.03	0.169
Other rented	4045	0.122	0.327
Owner with mortgage	4045	0.617	0.486
Number of cars	4045	1.322	0.711
Central heating	4045	0.968	0.176
Drier	4045	0.628	0.483
Number of rooms	4045	5.836	1.78
Panel B: Self-employed			
Age	733	42.175	9.663
Number of children	733	0.956	0.984
Local authority tenant	733	0.027	0.161
Other rented	733	0.112	0.316
Owner with mortgage	733	0.606	0.489
Number of cars	733	1.294	0.758
Central heating	733	0.969	0.173
Drier	733	0.669	0.471
Number of rooms	733	6.218	1.898

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# Long-term Government Bond Yields and Economic Forecasts: Evidence for the EU

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## Abstract

I use a panel of semi-annual vintages of growth and fiscal forecasts of the European Commission, covering the period 1998:II-2008:II, to assess its effects on 10-year government yields for 14 EU countries. Results show that yields increase with better growth forecasts, and with decreases in budget balance-to-GDP ratios, signalling that sovereigns may need to pay more to finance in the market higher budget deficits.

Keywords: interest rates, macro forecasts, EU.

JEL: C33, E62, H62.

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<sup>\*</sup> I am grateful to Philipp Rother and Guido Wolswijk for useful comments. The opinions expressed are those of the author, not necessarily reflecting those of the ECB or the Eurosystem. Emails: antonio.afonso@ecb.europa.eu, aafonso@iseg.utl.pt.

## **1. Introduction**

The result that public deficits and public debt accumulation have implications for interest rates is a common feature in theoretical models and also constitutes an important part of policymakers' conventional wisdom. From a policymaking point of view the nexus between fiscal developments and interest rates is rendered timely in the current era when pressures for macroeconomic activism are exercised on fiscal authorities. Moreover, it is often argued that large fiscal imbalances may endanger the coherence of national macroeconomic policies and jeopardize price-stability oriented monetary policies.

The relationship between the debt/deficit and interest rates remains largely an empirical question. Studies done in the 1980s, largely focused on the US, in the context of crowding-out discussions are inspired by this debate.<sup>1</sup> Some recent studies for the US and for some EU countries, conclude that the reduction of yields and lower spreads of long-term rates over short-term rates follow more positive budget balance projections. For instance, Engen and Hubbard (2004), and Thomas and Wu (2009) have used fiscal projections for the US, and Heppke-Falk and Hüfner (2004) use fiscal projections for some European countries.

This paper contributes to the literature by using a panel of semi-annual vintages of fiscal and macro forecasts of the European Commission (EC), as the measure of the expectations for growth and fiscal stance, covering the 1998:II-2008:II, to assess its effects on 10-year government bond yields in 14 European Union (EU) countries. The paper is organized as follows. Section two explains the modelling strategy. Section three reports the empirical analysis. Section four concludes.

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<sup>1</sup> See Evans (1985) and Wachtel, and Young (1987).

## 2. Model specification

The starting specification relates the changes,  $cg$ , in the 10-year government debt yields,  $i$ , to a set of possible explanatory factors, which include the information revealed via the EC half yearly macro and fiscal forecasts. Within a panel data framework the general testable model can be written as follows:

$$cg_{j,t} = \alpha_j + \alpha_1 \Delta cg_{j,t} + \beta_1 y_{j,t}^e + \beta_2 b_{j,t,k}^f + \beta_3 d_{j,t}^e + \gamma_1 \Delta i_t^{us} + \gamma_2 s_t + u_{jt}, \quad (1)$$

where the index  $j$  ( $j=1, \dots, N$ ) denotes the country, the index  $t$  ( $t=1, \dots, T$ ) indicates the period and  $\alpha_j$  stands for the individual effects to be estimated for each country  $j$ . Moreover, we have:  $i$  – 10-year government bond yield;  $i^{us}$  – 10-year US government bond yield;  $s$  – stock market returns, computed as the logarithmic growth rate of the relevant stock price index,  $P$ ,

$$s_t = \ln(P_t / P_{t-1}) \times 100. \quad (2)$$

$y^e$  is the difference between the EC forecasts for the real GDP growth rate and the growth rate in the last year, while  $d^e$  is the difference between the EC forecasts for the debt-to-GDP, and  $b_{j,t,k}^f$  is the forecast in period  $t$  for the fiscal balance ratio in country  $j$  in year  $k$ . More precisely, and, for instance, for the real growth rate,

$$y_{j,t}^e = y_{j,t,t+1}^f - y_{j,t,t}^f, \quad (3)$$



with  $y_{j,t,t}^f$  – the forecast in period  $t$  for the real growth rate in country  $j$  in year  $t+1$ , and  $y_{j,t,t}^f$  – the forecast in period  $t$  for the real growth rate in country  $j$  in year  $t$ . Additionally, it is assumed that the disturbances  $u_{jt}$  in (1) are independent across countries.

As a departing point one could expect that forecasts of future increases in the debt-to-GDP ratio or in the deficit ratios may imply an increase in the long-term interest rate, since it may impinge negatively on the credit risk and quality of the outstanding sovereign debt liabilities. Indeed, market participants may perceive an additional risk stemming from the implied loosening of fiscal stance under such conditions.<sup>2</sup> On the other hand, capital markets may also value the increased liquidity associated to the existence of additional outstanding sovereign debt, and a decrease in the long-term yields cannot be discarded as well, given that default risk has been perceived as rather mitigated in the EU context.<sup>3</sup>

A direct effect may also be expected when higher real growth forecasts are known, implying a steeper slope of the yield curve. Additionally, increases in the rate of return of equities may decrease the demand for sovereign debt as investors readjust their portfolio allocation. Therefore, bond prices would decline and bond yields could rise.

The 10-year US government debt yield measures international factors that might have an impact on the determination of the long-term 10-year EU yields. One would expect the 10-year US yield to fall if there is a raise in the demand for US government debt. Assuming the existence of spillover effects to the European government bond market, there might also be a raise in the demand for European long-term bonds. This leads to rising prices, declining 10-year government bond yields, and the associated

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<sup>2</sup> See Alesina et al. (1992).

<sup>3</sup> See Codogno et al. (2003), Bernoth et al. (2004), and Afonso and Strauch (2007).

decrease of European 10-year yields. Furthermore, it is assumed that the US long-term interest rate does not react to changes in the European long-term interest rates.

### 3. Empirical analysis

#### 3.1. The data set

I use the semi-annual vintages of the fiscal and macro forecasts of the EC in the period 1998:2-2008:2, as well as the compatible data for 10-year long-term interest rates and for the measure of the stock market index returns. 14 EU countries are included in the analysis: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Ireland, the Netherlands, Portugal, Spain Sweden, and UK.

The publication dates of the semi-annual vintage EC forecasts, the so-called spring and autumn economic forecasts, varied in the past between March and April in the first case, and between October and November in the second case. Table 1 reports the dates of such publications. Since these economic forecasts are regularly produced and are public, one may expect market participants to incorporate this information in their views towards the level of long-term interest rates.

Table 1 – EC semi-annual forecast vintages

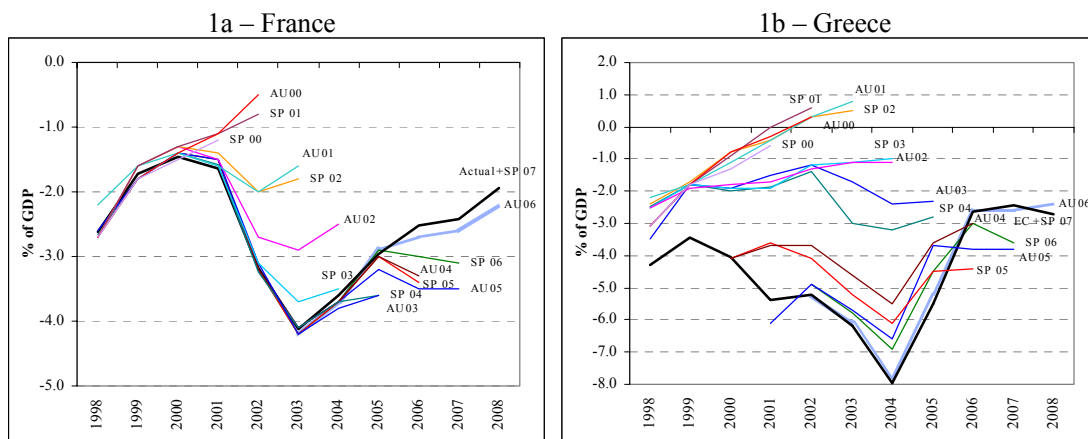
	2008:2	2008:1	2007:2	2007:1	2006:2	2006:1	2005:2	2005:1
Publication date	23-Oct	15-Apr	24-Oct	23-Apr	24-Oct	24-Apr	07-Nov	18-Mar
Month	10	4	10	4	10	4	11	3
	2004:2	2004:1	2003:2	2003:1	2002:2	2002:1	2001:2	2001:1
Publication date	18-Oct	29-Mar	20-Oct	28-Mar	04-Nov	12-Apr	12-Nov	06-Apr
Month	10	3	10	3	11	4	11	4
	2000:2	2000:1	1999:2	1999:1	1998:2			
Publication date	26-Oct	21-Mar	Nov	Apr	Oct			
Month	10	3	11	4	10			

Source: European Commission.

As an example, Figure 1 illustrates the differentials between EC budget deficits forecasts and outcomes for the cases of France and Greece during the period 1998-2008.

It is clear that differences occurred regularly throughout the period under analysis for these two examples, and the same is true for the other EU countries. For instance, during that period, the average difference between the maximum and the minimum forecasted and observed values was 1 percentage point (pp) and 2.6 pp, respectively for France and for Greece. However, such differences were as high as 2.2 pp in 2002 for France and 7.0 pp in 2003 for Greece.

Figure 1 – Budget balance EC forecast vintages



Source: EC semi-annual vintages of fiscal forecasts. AU – autumn; SP – spring.

In the baseline regressions, and for the endogenous change in the long-term bond yields, this is computed as the change between the 10-year interest rate between month 2 and 3 and between month 9 and 10. Naturally, it is not easy to exactly select both the months and the data to use regarding such higher frequency data to align with the semi-annual macro data. Indeed, several irregularities can play a role, for instance, some forecast vintages are coming out instead at the beginning of months 4 and 11, while some data can already be known by the public and capital market participants in advance of its public announcement. I use both end of the month data and monthly averages.

Regarding interest rates, these are the 10-year government benchmark bond yields taken from Reuters, end of month observations and monthly averages, both for the EU countries and for the US. To compute the stock market returns I used the Dow Jones Euro STOXX price index data.<sup>4</sup>

### 3.2. Results

Table 2 reports the results for the change in the 10-year government bond yield for the period 1998:II-2008:II, using as the months to anchor the capital markets data March and October.<sup>5</sup> Table 2 presents estimation results using monthly average yields.

Table 2 – Estimation for the change in the 10-year government yield ( $cg_{j,t} = i_t - i_{t-1}$ )  
(Monthly average yields, 1998:II-2008:II)

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.0114 * (1.7)	0.0104 (1.5)	-0.0010 (-0.1)	0.0131 * (1.9)	0.0115 * (1.7)	0.0035 (0.3)
$\Delta cg_{j,t}$	0.4535 *** (17.8)	0.4679 *** (16.5)	0.4678 *** (16.3)	0.4526 *** (18.0)	0.4689 *** (16.6)	0.4695 *** (16.6)
$\Delta i_t^{us}$	0.0434 *** (3.0)	0.0356 ** (2.4)	0.0355 ** (2.4)	0.0450 *** (3.1)	0.0360 ** (2.4)	0.0358 ** (2.4)
$y_{j,t,t+1}^f - y_{j,t,t}^f$	0.0352 *** (4.0)	0.0361 *** (4.1)	0.0383 *** (4.5)	0.0364 *** (4.2)	0.0370 *** (4.3)	0.0386 *** (4.4)
$b_{j,t,t}^f$	-0.0128 ** (-2.1)	-0.0112 * (-1.8)	-0.0117 ** (-2.1)			
$b_{j,t,t+1}^f$				-0.0104 * (1.7)	-0.0094 (-1.5)	-0.0137 * (-1.7)
$s_t$		0.0005 * (1.8)	0.0003 * (1.7)		0.0006 ** (2.0)	0.0005 * (1.9)
$d_{j,t,t}^f - d_{j,t,t-1}^f$			-0.0052 (-1.0)			-0.0037 (-0.7)
Adj. R2	0.52	0.52	0.52	0.51	0.52	0.52
Observations	267	267	267	267	267	267

Notes: The t statistics are in parentheses. \*, \*\*, \*\*\* - statistically significant at the 10, 5, and 1 percent level respectively. Panel Least Squares, cross-section fixed effects, white diagonal standard errors and covariance.  $y$  – real growth,  $d$  – debt ratio,  $b$  – budget balance ratio,  $s$  – Dow Jones STOXX returns.

The results show a positive relationship between the behaviour of the bond yields in the EU and the 10-year US yields. Better real growth forecasts also push

<sup>4</sup> Euro area (changing composition) - Equity/index - Dow Jones STOXX - Price index - Historical close, end of period - Euro, provided by the ECB.

<sup>5</sup> Panel unit roots tests reject the unit root null for the change in the yield.

upwards the long-term yields while stock returns show an opposite effect. More interestingly, it is possible to observe a statistically significant direct dependence of long-term bond yields on the forecasts of the fiscal balance-to-GDP ratios. Using either forecasts for budget balances for period  $t$ , made in year  $t$  (columns 1 to 3 in Table 2), or forecasts for budget balances for period  $t+1$ , made in year  $t$  (columns 4 to 5 in Table 2), provide quite similar results.

Therefore, such evidence implies that new forecasts provided by the EC on lower government budget balances (higher deficits) push up the price paid by sovereigns to raise financing in the capital markets. On the other hand, the relationship between the vintages of government debt ratios and the developments in long-term yields is not statistically significant.

#### **4. Conclusion**

This paper assessed the effects of macroeconomic and fiscal forecasts on long-term government bond yields for a panel of 14 EU countries. I used the semi-annual vintages of fiscal and macro forecasts of the EC as the measure of the markets' expectations for economic growth and for the fiscal policy developments, covering the period 1998:II-2008:II. Results show that 10-year general government yields increase with better growth forecasts, and with decreases in the budget balance-to-GDP ratios, signalling that sovereigns then need to pay a higher price to finance higher forecasted budget deficits. In other words, the results suggest that market discipline may arise via the expected budget deficit on a given year.

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