

NBER WORKING PAPER SERIES

LIQUIDITY CONSTRAINED EXPORTERS

Thomas Chaney

Working Paper 19170

<http://www.nber.org/papers/w19170>

NATIONAL BUREAU OF ECONOMIC RESEARCH

1050 Massachusetts Avenue

Cambridge, MA 02138

June 2013

During the last year, I have received compensation for teaching activities from the Toulouse School of Economics, as well a research grant from the National Science Foundation (SES-1061622), in excess of \$10,000. I am grateful to Daron Acemoglu, Marc Melitz and Xavier Gabaix for their constant encouragements and their advice. All remaining errors are mine. First draft: March 2005. The views expressed herein are those of the author and do not necessarily reflect the views of the National Bureau of Economic Research.

NBER working papers are circulated for discussion and comment purposes. They have not been peer-reviewed or been subject to the review by the NBER Board of Directors that accompanies official NBER publications.

© 2013 by Thomas Chaney. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

Liquidity Constrained Exporters
Thomas Chaney
NBER Working Paper No. 19170
June 2013
JEL No. F1,F4,G3

ABSTRACT

I build a model of international trade with liquidity constraints. If firms must pay some entry cost in order to access foreign markets, and if they face liquidity constraints to finance these costs, only those firms that have sufficient liquidity are able to export. A set of firms could profitably export, but they are prevented from doing so because they lack sufficient liquidity. More productive firms that generate large liquidity from their domestic sales, and wealthier firms that inherit a large amount of liquidity, are more likely to export. This model predicts that the scarcer the available liquidity and the more unequal the distribution of liquidity among firms, the lower are total exports. I also offer a potential explanation for the apparent lack of sensitivity of exports to exchange rate fluctuations. When the exchange rate appreciates, existing exporters lose competitiveness abroad, and are forced to reduce their exports. At the same time, the value of domestic assets owned by potential exporters increases. Some liquidity constrained exporters start exporting. This dampens the negative competitiveness impact of a currency appreciation. Under some circumstances, it may actually reverse it altogether and increase aggregate exports. This model provides some argument for competitive revaluations.

Thomas Chaney
Department of Economics
University of Chicago
1126 East 59th Street
Chicago, IL 60637
and NBER
thomas.chaney@gmail.com

1 Introduction

Trade economists view the patterns of imports and exports mainly as the outcome of a competition game between producers in different countries. If goods from a given country become cheaper, provided that demand are not too inelastic, producers from this country will export larger quantities. Eventually, general equilibrium adjustments will have to take place to restore trade balance, but in the short and medium run, we should observe such competitiveness effects of devaluations. The only departure from this competition mechanism may happen in the very short run, and has been described as the J-curve: if demand is inelastic in the short run, a devaluation may have a negative impact on the current account in the short run, before the competitiveness effect comes into play and exports catch up. However, we observe relatively little response of trade flows to exchange rate fluctuations. The euro-dollar exchange rate has experienced wide fluctuations since the inception of the euro, without any significant and systematic effect on the patterns of trade between Europe and the US. The US dollar has been steadily depreciating vis à vis most foreign currencies, without any evidence of a reduction in the US trade deficit. On the contrary, there is evidence that foreign companies take advantage of the relatively cheap US domestic prices to enter the US market for the first time. In a different context, there are many examples of middle income countries undergoing massive devaluations of their currency without much gain in terms of current account imbalances. The only way to reconcile the observed impact of exchange rate fluctuations with the existing theory of competitive trade is to assume extremely inelastic demands for foreign goods. Such elasticities are at odds with other evidence of the impact of trade barriers on trade flows, as well as micro economic evidence.

I propose a theory of international trade with liquidity constraints that can account for these facts, along with micro evidence on the characteristics of exporters. The main predictions of the model are, first, that liquidity constraints are a key determinant of the export behavior of firms, and second, that exchange rate fluctuations (or more generally fluctuations of relative prices) may have the opposite effect as predicted by traditional theories. If there are fixed costs associated with exporting, then liquidity constraints at the firm level will come into play. In such a context, few firms will be able to export. Furthermore, an appreciation of the domestic currency, despite the negative effect on the competitiveness of exporters, will not have a large impact on aggregate exports, even if demand is elastic. It may actually have a positive impact on exports in the medium run if goods are not too substitutable.

The reason is the following. In the presence of fixed costs associated with exporting and liquidity constraints, some firms could profitably export, but they are prevented from doing so because they cannot gather sufficient liquidity. Only those firms that are productive enough and generate sufficient cash flows from their domestic sales are able to export. If the exchange rate appreciates, potential exporters lose competitiveness abroad and therefore lose some market shares abroad. Existing exporters reduce their exports. This is the traditional competitiveness effect. But an appreciation of the exchange rate also means that the value of domestic assets abroad increases. Some firms that could not enter foreign markets because of liquidity constraints, enter now that the value of their assets has appreciated. Total trade does not change much: existing exporters export less, but new firms start exporting. If the competitiveness effect is mild enough, that is if goods are sufficiently differentiated, aggregate exports may increase following an appreciation of the exchange rate.

In other terms, it is the extensive margin of trade that responds differently to exchange rate fluctuations in the presence of firm heterogeneity and liquidity constraints. Following an exchange rate appreciation, some firms, favored by the increased value of their domestic assets, enter the export market. This entry of exporters, the extensive margin of trade, may offset the reduction of the volumes exported by existing exporters, the intensive margin of trade.

This theory also accounts for the fact that few firms export, and that exporters will typically be firms that are not liquidity constrained. There is a growing set of evidence from micro data that only a small fraction of firms export. Exporters are different from non exporters in many respects. Exporters are more productive than non exporters, they are larger, more capital intensive, and they tend to belong to large groups more frequently than non exporters. The same hierarchy applies between firms that export to many markets versus firms that export towards a few markets only. Although it is still a matter for debate, it seems that the direction of the causality goes from the characteristics of the firms towards the export status. It is because a firm is more productive that it is more likely to become an exporter, rather than because they export that they become more productive. I develop a model where the selection into the export market is similar. Only those firms that are not liquidity constrained are able to export. The capacity to overcome liquidity constraints is endogenously determined in this model. Firms may have sufficient liquidity, inherited from their past activities, but they can also generate sufficient cash flow from their domestic activities in order to gain access to foreign markets. In equilibrium, only a subset of firms are able to gather enough liquidity and export. The export status is the

outcome of the characteristics of the firm, even though the partition between exporters and non exporters are endogenously determined as the outcome of a competitive game.

Finally, this model has important implications for the link between financial development, macroeconomic stability and openness to trade. The model predicts that a deepening or a widening of the financial markets will increase total exports. When firms get easier access to external finance (what I call a deepening of financial markets), or when more firms get access to cheap external finance (a widening of the financial markets), they become able to overcome barriers associated with international trade. More firms export, and total exports increase. However, the model does not predict that better financial markets will stabilize or destabilize the current account. The predictions of the model about the volatility of exports and the degree of financial development are ambiguous. Only in the extreme case of perfect financial markets can we say that exports will be more volatile than if financial markets were not perfectly developed. Exchange rate fluctuations, for instance, will cause larger movements of the volume of exports if financial markets are perfectly developed than if they are not. The reason is the following. If financial markets are not perfectly developed, there exists a fringe of liquidity constrained exporters. When the exchange rate appreciates, some of those liquidity constrained firms start exporting. This entry of new exporters dampens the negative impact of the exchange rate appreciation on existing exporters. If financial markets are perfectly developed, that is if no firm is liquidity constrained, this dampening channel does not exist anymore. Exports will be more responsive to exchange rate fluctuations. This is the only case where the model can make a clear prediction about the link between financial development and current account volatility. For intermediate levels of development on the other hand, an improvement of financial markets will always increase total exports, but it may or may not increase export volatility. The primary purpose of this model is not to describe the link between financial development and macroeconomic instability. It offers however an interesting angle on a potential link between the volatility of some aggregates (fluctuations in the volume of exports here), and the degree of financial development. It also gives specific predictions for the impact of financial development on the volume of exports.

In the remaining part of this introduction, I review the literature related to this model. First, recent research has widely documented the important of firm heterogeneity and the role of fixed costs in international trade, both empirically and theoretically. Second, there is a large body of literature on the importance of liquidity constraints for firms. Finally, there is a (scarce) literature

on the interaction between firm level liquidity constraints and international trade.

Firm heterogeneity has recently been acknowledged to be a major feature of the export behavior of firms. Exporters are different from non exporters in many respects. They tend to be more productive, larger, more capital intensive. The link between productivity and trade has been analyzed in many different countries. Bernard and Jensen (1999, 2001a, 2001b, 2002) for the US, Aw and Huang (1995) for Taiwanese and Korean firms, Clerides, Lach and Tybout (1998) for Colombian, Mexican and Moroccan firms, and Delgado, Farinão and Ruano (1999) for Spanish firms. The same hierarchy that exists between exporters and non exporters also exists between firms that export to a few foreign markets, and firms that export to many foreign markets. Using firm level data on French exporters, Eaton, Kortum and Kramarz (2001a) uncover systematic regularities for the characteristics of exporters, and for the popularity of foreign market. Not only are exporters more productive, larger, and more capital intensive than non exporters, but firms that export to many markets are also more productive, larger, and more capital intensive than firms that export only to a few markets. In this paper, I propose to extend the study of the heterogeneity between exporters and non exporters to the severity of liquidity constraints. My model predicts that one dimension of heterogeneity along which exporters may differ from non exporters is their ability to access financial intermediaries. Less financially constrained firms are more likely to export.

This dichotomy between exporters and non exporters allows the extensive margin of trade, the entry and exit of firms into the export market, to play a crucial role in determining the volume of trade flows. When trade barriers change, or when the degree of competition in foreign markets evolves, some firms will go in and out of the export markets. The importance of the extensive margin of trade has been pointed out since the seminal work of Paul Krugman (1980). From the microeconomic point of view, trade is as much about how much each exporting firm exports, as it is about how many firms export. Empirically, it seems that, at least in the medium run, most of the adjustment for aggregate trade flows comes from entry and exit of firms into the export market. Eaton, Kortum and Kramarz (2001b), using data on French exporters, disaggregated by trading partner, show that most of the variation in the aggregate French exports comes from variation in the number of exporters, rather than differences of exports per firm. Helpman, Melitz and Rubinstein (2004) use the zeros of trade matrices (which happen when no firm trades between two countries) to infer information about the extensive margin of trade, and derive an estimate of trade barriers between countries. Broda and Weinstein (2004) point out that in the last 30

years, the number of varieties of foreign goods available to US consumers has increased fourfold. They calibrate an extended Krugman model of trade to show that the extensive margin of trade may explain an annual increase in welfare worth 3% of GDP. Their measures of the number of varieties imported by the US, given the extremely high level of disaggregation they use, is a good proxy for the number of firms exporting to the US. Ruhl (2003) uses a theoretical framework with heterogeneous firms to show that the extensive margin of trade may explain the discrepancy between the short run and long run elasticities of trade with respect to trade barriers. Ruhl argues that high frequency variations in exchange rates, because exchange rates are mean reverting, will trigger only negligible adjustments of the extensive margin, which explains why exchange rate fluctuations seem to have so little impact on trade flows, whereas variations in tariffs or quotas have such a large impact. In this paper, I build on this literature and study the extensive margin of trade in the presence of liquidity constraints. If financial markets are underdeveloped, the extensive margin of trade reacts both because there are productivity differences between firms, but also because different firms face different degree of liquidity constraints. I show how predictions of traditional models of trade may be modified, or even overturned. Among others, I offer an alternative explanation for the relatively mild impact of exchange rate fluctuations from that of Ruhl (2003). Even if the extensive margin of trade does respond to exchange rate movements, since there will be simultaneous entry and exit of firms, the impact on aggregate exports will be mild. When the exchange rate appreciates, some existing exporters lose competitiveness in the foreign market and stop exporting. But at the same time, the value of domestic assets denominated in foreign currency increases, so that liquidity constrained firms start exporting. The net effect on the extensive margin is mild. Under some circumstances, despite the loss in competitiveness, a real exchange rate appreciation may actually lead to an increase in aggregate exports.

Alongside the empirical relevance of firm heterogeneity for international trade, theoretical models of heterogeneous firms have recently been developed. The two main models have been separately developed by Eaton and Kortum (2002) and by Melitz (2003). In both models, firms differ in terms of productivity. Eaton and Kortum build a new Ricardian model of trade in the spirit of Dornbusch, Fischer and Samuelson (1977). Heterogeneous firms compete internationally for foreign markets. Competition is perfect. In each sector, only the most competitive firm in the world will service the market in a given country. Firms in a subset of sectors will be exporters. Melitz on the other hand uses a monopolistic competition framework, and fixed costs associated with exporting. Only the most productive firms are able to overcome fixed costs associated

with exporting. I build on the Melitz model and add liquidity constraints to it. Those liquidity constraints interact with productivity heterogeneity. The most productive firms generate enough liquidity from domestic sales to overcome any liquidity constraints. However, some less productive firms would be profitable enough to export, but are prevented from doing so because they are liquidity constrained. On top of interacting liquidity constraints with productivity heterogeneity, one important contribution of this model is to break up the symmetry imposed by construction in Melitz (2003). Exchange rate fluctuations in my model are equivalent to fluctuations in relative real wages in different countries. This formalization is similar to the one used by Atkeson and Burstein (2005). Atkeson and Burstein, using a model with endogenous mark-ups that depend on a firm's market share, are able to generate endogenously pricing to market. Such pricing to market behavior explain first why there is incomplete pass-through of exchange rate shocks on domestic prices, and second why exports may not be as sensitive to exchange rate fluctuations as expected. Exchange rate fluctuations have important implications for the selection of firms into the export market. An important other model that breaks the symmetry imposed in the Melitz model is done by Ghironi and Melitz (2005). They derive an endogenous micro founded explanation for the Harrod-Balassa-Samuelson effect. In their model, as in this one, entry and exit of a specific subset of firms have important implications for the behavior of aggregate variables, such as real exchange rates or total exports.

This paper contributes to the literature on hysteresis in trade, and provides a new angle of explanation for these phenomena. Empirical studies do find substantial hysteresis in aggregate trade flows, in import and export prices, as well as in the export status of firms. Baldwin (1988) documents the hysteresis in import prices. Roberts and Tybout (1994) derive a theoretical model of export decision with sunk costs in order to analyze the sluggish movements in the export status of firms. Campa (1998) calibrates the importance of hysteresis in international trade. Closely related is the fact that pioneer firms, that is firms that are the first to enter foreign markets, tend to differ from followers in many dimensions. In the same way as there is a strong hierarchy between firms that explains their export status, there is also a strong hierarchy in the order in which firms access foreign markets. Trade has been growing continuously since WWII. However, the apparent smooth increase in international trade flows over the last 60 years hides a vast heterogeneity of trade links. As trade grows, new trade links are created. New countries start trading, new product lines start being traded. The firms that pioneer the entry into a new country, or the firms that pioneer the export of a new product line, are substantially different from the firms

that follow them up. Bernard, Jensen and Schott (2005), using a rich dataset on US exporters and multinational firms, find that multinational firms tend to be pioneers. Firms that already export in many other foreign markets are more likely to enter new and relatively isolated markets. Liquidity constraints may play an important role in these hysteresis phenomena. I do not develop a dynamic version of this model in this paper. Hence I can only describe qualitatively how the tools developed in this model may explain these patterns. In a dynamic setting, firms may gradually accumulate enough liquidity from their exporting activity in other countries to eventually enter new markets. The most productive and least liquidity constrained firms are likely to be the first to enter remote markets. Firms that have been trading in many markets (and therefore have been generating liquidity), are the first candidate to enter new markets. If liquidity constraints matter for accessing foreign markets, then the history of previous liquidity shocks matters as well. Even if it could profitably export, a firm has to gather sufficient liquidity to enter a new market. An ordering between pioneers and followers will endogenously emerge. Hysteresis is a direct consequence. Once a firm has covered the fixed costs of entering a set of foreign markets, it is somehow sheltered from higher frequency shocks. By the same token, exporting to other countries provides a form of insurance to multi-country exporters, which explains hysteresis in exported volumes. If firms are heterogeneous, different firms will charge different prices. Since the set of exporters is history dependent (through the history of liquidity shocks), aggregate export prices will tend to display the same hysteresis as aggregate trade flows.

There is a vast literature on the importance of liquidity constraints for firms, which follows the pioneering work of Stiglitz and Weiss (1981). Fazzari, Hubbard and Peterson (1988) study the importance of financing constraints for investment. The importance of the lending channel has been stressed in Holmstrom and Tirole (1997), as well as in Stein (1998). Empirically, there is a strong evidence of the presence liquidity constraints given by the correlation between a firm's financial position and its investments. This is true for firms as well as banks, which would explain the transmission of monetary shocks to the economy. Bernanke and Gertler (1995) and Kashyap and Stein (2000) study the importance of credit constraints for banks. Gertler and Gilchrist (1994) point that small firms' production contracts when money is tight, which is further evidence of the importance of liquidity constraints. Hoshi, Kashyap and Scharfstein (1992) offer a model where net worth determines whether to use direct or indirect finance. I introduce this concept of liquidity constraint in a model of international trade with heterogeneous firms. Liquidity constraints in this model are modelled in the simplest way possible. Without going

into any detail of moral hazard, or endogenous bargaining with financial intermediaries under incomplete contracts, I simply assume that firms cannot borrow externally in order to enter foreign markets. This is the reduced form expression of an unmodelled game between potential financial intermediaries, and potential exporters. However, in the presence of productivity heterogeneity, liquidity constraints will interact with trade barriers, exchange rates, firm level productivity in a complex way. Domestic sales may endogenously relax the liquidity constraints faced by a potential exporter.

To the best of my knowledge, only one paper looks at the relationship between international trade and liquidity constraints. Campa and Shaver (2001) use a panel of Spanish manufacturing firms in the 1990's to test whether there exists any link between the liquidity constraints a firm faces and its exporting status. They do find that liquidity constraints are less binding for exporters than for non exporters. They also find that cash flows are more stable for exporters than for non exporters. They argue that it is the stability provided by foreign sales that relaxes the liquidity constraints of exporters, and not the reverse. Exporters earning profits in different markets the business cycles of which are imperfectly correlated can pledge more stable future earnings, which softens agency problems in their relationship with financial intermediaries, and relaxes their liquidity constraints. The model I build predicts the same raw correlation between liquidity constraints and export status. But I would claim that the causality runs in the opposite direction: it is because they are less liquidity constrained that some firms are able to export, and not the reverse. I believe that Campa and Shaver actually find some suggestive evidence that a relaxation of liquidity constraints causes firms to export, and not the reverse. In page 21, they report that exporting firms are less liquidity constrained than non exporters, but that the fraction of sales exported does not matter for liquidity constraints. The only thing that matters is whether a firm exports or not (a dummy variable for the export status), not how much it exports. This is consistent with my model: firms below a given level of liquidity constraints export. How much they export depends on their productivity, not on how constrained they are. Only the dummy for positive exports should matter, not how much is exported. If the insurance mechanism put forward by Campa and Shaver were at play, the more a firm exports, the more insurance from demand shocks it gets, and the less liquidity constrained it should be. In a signalling model, how much a firm exports carries information about how productive a firm is. It would be surprising that financiers would not use such easily accessible information.

The remainder of the paper is organized as follows. Section 2 introduces a simple model of trade with liquidity constraints and heterogeneous firms. Section 3 describes the impact of exchange rate fluctuation in the presence of liquidity constraints. Section 4 concludes.

2 A model of trade with liquidity constrained exporters

In this section, I develop a model of international trade with liquidity constrained firms. I introduce those liquidity constraints in the context of a model of trade with heterogeneous firms à la Melitz (2002).

There are 2 countries, home and foreign, that produce goods using only labor. All foreign variables are denoted by an asterisk. The home country has a population L (L^* for the foreign country). There are 2 sectors. One sector provides a single homogeneous good that can be freely traded. This good is used as the numeraire, and its price is set equal to 1. It is produced under constant returns to scale. The unit labor requirement for producing the homogeneous good at home is $1/w$ ($1/w^*$ abroad). Provided that each country produces the homogeneous good, the wages will be w and w^* . I shall only consider equilibria where this assumption holds. The other sector supplies a continuum of differentiated goods. Each firm is a monopolist for the variety it produces.

2.1 Demand

The workers are the only consumers, each endowed with one unit of labor. They all share the same CES preferences over the differentiated good. A consumer that receives q_o units of the homogeneous good, $q(x)$ units of each variety x of the differentiated good, for all varieties x in the set X (to be determined in equilibrium) gets a utility U :

$$U \equiv q_o^{1-\mu} \left(\int_{x \in X} q(x)^{\frac{\sigma-1}{\sigma}} dx \right)^{\frac{\sigma}{\sigma-1}\mu}$$

with $\sigma > 1$

where σ is the elasticity of substitution between two varieties of the differentiated good.

If all varieties in the set X are available domestically, at a price $p(x)$ each, I can define the following ideal price index for differentiated goods domestically:

$$P = \left(\int_{x \in X} p(x)^{1-\sigma} dx \right)^{\frac{1}{1-\sigma}} \quad (1)$$

The representative consumer has an isoelastic demand function for each differentiated variety. She spends $r(x)$ on each variety x :

$$r(x) = \mu w L \left(\frac{p(x)}{P} \right)^{1-\sigma} \quad (2)$$

where $\mu w L$ is the total expenditure spent on differentiated goods.

2.2 Production and trade

There are two types of trade barriers, a fixed cost and a variable cost. If a firm exports, it must pay a fixed cost C_f in terms of foreign labor, or $w^* C_f$ in terms of the numeraire. The assumption that the entry cost into the foreign market is denominated in foreign labor is important. An exporter must cover costs both in domestic and in foreign labor. I only need to assume that the part of the fixed entry cost denominated in foreign labor is positive¹. There is evidence that a large share of the cost of entering foreign markets consists of the cost of acquiring local information, setting up a local distribution network, and customizing goods to fit the local market. Arguably, those costs depend on the conditions in the local market. The variable cost takes the form of an "iceberg" transportation cost. If one unit of any differentiated good is shipped abroad, only a fraction $1/\tau$ arrives. The rest melts on the way. The higher τ , the higher the variable trade cost.

Each country has access to the same technology. The marginal product of labor is constant. In order to start production, a firm must pay a fixed entry cost C_d in terms of domestic labor, at a price $w C_d$ in terms of the numeraire. The presence of fixed entry cost means that firms operate under increasing returns to scale. Each firm in the differentiated sector draws a random unit labor productivity $x \geq 0$. For a firm with productivity x , the cost of producing q_d units of good for the home market is $c_d(q_d)$, and the cost of producing q_f units for the foreign market is

¹Adding another part to the cost of entering foreign markets, that would be denominated in domestic labor, would reduce the set of exporters and the total amount of exports, but it would not modify any qualitative result of this model.

$c_f(q_f)$:

$$\begin{aligned} c_d(q_d) &= q_d \frac{w}{x} + wC_d \\ c_f(q_f) &= q_f \frac{\tau w}{x} + w^*C_f \end{aligned}$$

Firms are price setters. Given that demand functions are isoelastic, the optimal price is a constant mark-up over the unit cost (including transportation costs)²,

$$p_d(x) = \frac{\sigma}{\sigma-1} \times \frac{w}{x} \text{ at home, } p_f(x) = \frac{\sigma}{\sigma-1} \times \frac{\tau w}{x} \text{ abroad}$$

Given these pricing strategies, more productive firms are able to charge lower prices, capture a larger market share, and generate larger profits, both at home and abroad. A firm with productivity x potentially generates profits $\pi_d(x)$ in the domestic market, and $\pi_f(x)$ in the foreign market:

$$\begin{aligned} \pi_d(x) &= \frac{r_d(x)}{\sigma} - wC_d = \frac{\mu}{\sigma} wL \left(\frac{\sigma}{\sigma-1} \frac{w}{xP} \right)^{1-\sigma} - wC_d \\ \pi_f(x) &= \frac{r_f(x)}{\sigma} - w^*C_f = \frac{\mu}{\sigma} w^*L^* \left(\frac{\sigma}{\sigma-1} \frac{\tau w}{xP^*} \right)^{1-\sigma} - w^*C_f \end{aligned}$$

Only those firms that can profitably produce domestically will survive, and only those firms that can profitably produce for the export market could export. I can implicitly define two productivity thresholds, \bar{x}_d for survival on the domestic market, and \bar{x}_f for profitable entry into the foreign market, absent any additional constraint. Only those firms that generate non negative profits from domestic sales survive, and only those firms that generate non negative profits from selling in the foreign market could export. The productivity thresholds are defined by³,

$$\pi_d(\bar{x}_d) = 0 \text{ and } \pi_f(\bar{x}_f) = 0 \tag{3}$$

Firm heterogeneity and monopolistic competition gives the following partition among firms. More productive firms (higher x firms) are able to capture larger market shares, and generate larger profits. The least productive firms cannot cover the overhead costs and are not able to survive. However, despite the differences in productivity between firms, some low productivity firms can still survive because of the imperfect nature of competition. As long as the elasticity of

²This price prevents any arbitrage either by domestic firms that might want to resell these goods at home or abroad, or by foreign firms.

³Note that $(\bar{x}_f/\bar{x}_d)^{\sigma-1} = (\tau^{\sigma-1}C_d/C_f) \times (L/L^*) \times (P/P^*)$. I assume that trade barriers are always sufficiently high ($\tau^{\sigma-1}C_d/C_f$ sufficiently high) so that $\bar{x}_f > \bar{x}_d$ always holds. Only a subset of firms are able to export, and no firm is able to sell abroad but not domestically.

substitution between varieties, σ , is finite, low productivity firms are sheltered from competition and may survive. The same selection takes place among firms for the entry into the export market. The highest productivity firms generate enough profits to justify the entry cost into the foreign market. Less productive firms do not export.

Absent any other friction, all firms with a productivity above \bar{x}_f would export. But for the potential asymmetry between countries, this model is almost identical to the Melitz (2003) model of international trade. Among other things, the only reason why the export status of a firm is correlated to the size of its domestic sales, is that more productive firms sell more *and* are more likely to export. There is no direct link between what a firm exports, how many countries it exports to, and what it does at home.

In the next section, I introduce liquidity constraints. We shall see how the presence of financial imperfections creates a link between different markets, and modifies the adjustment to changes in exogenous variables.

2.3 Liquidity constraints

One crucial assumption of the above model is that there are some fixed costs associated with international trade. There is a growing set of evidence that a part of trade barriers take the form of fixed costs. Most of these costs must be paid up-front. These costs are substantial. All previous models assume that there exist perfect financial markets so that any firm that could profitably export will find some investors to finance the entry cost into the foreign markets.

However, there are reasons to believe that such investments may not be easy to finance. The nature of the contracting and informational environment is different from a similar entry cost investment made domestically. This is for two reasons mainly. First, export activities are essentially riskier than domestic ones. Part of it is due to the objective added risks, such as foreign exchange risk. Existing financial hedging products such as swaps and options may not be available, or available at a prohibitive cost for most potential exporters. Information about foreign markets is harder and more expensive to get. It may also be less verifiable. Part of the fixed cost associated with international trade actually corresponds to the cost of acquiring information on a foreign market. Potential investors may not be willing to pay this cost themselves. But since such information is harder to verify than similar information on domestic markets, a potential investor may not be willing to trust a would-be exporter. Second, the contracting environment for international transactions is relatively weak, if existing at all. Sales are done in another country,

and it is hard for investors to collect the proceeds of such sales in case of disagreement. In other words, a potential exporter cannot pledge much collateral for its foreign activities, and this translates into ex ante under investment.

The same problems apply for foreign investors: informational asymmetries and contract incompleteness plague such relations. A foreign investor has little information on foreign firms. If she does enter in a relationship with a foreign firm, and if the terms of their contract are violated, she will find it difficult to seize any asset the firm owns. Arguably, trade credits will alleviate many of these issues. However, trade credits are typically offered to existing exporters, that is firms with a known and verified history of exports into a given market. Such a firm arguably has already covered most of the entry cost into foreign markets.

In the remaining part of this paper, I will take an extreme view on the limitations of financial markets that potential exporters face. I will assume an extreme dichotomy between domestic and foreign markets. A firm may find investors for any investment regarding domestic activities, but none whatsoever for exporting activities. Therefore, a firm must rely on its own existing liquidity to cover entry costs into foreign markets. Moreover, I will assume that firms inherit an exogenous amount of liquidity (it may be thought of as a trustworthiness capital that gives access to financial markets). This is an extreme and oversimplified view of liquidity constraints. These assumptions are designed to carry two properties. First, liquidity constraints are more severe for international trade than for domestic trade. Second, firms are more or less severely hampered by liquidity constraints, and how much constraints they face is not perfectly correlated with their current productivity.

Liquidity constraints are formalized in the following way. Firms only face liquidity constraints for accessing foreign markets. I make the extreme assumption that domestic investors do not have any information on the conditions in foreign markets. Hence they are not willing to lend to firms for the purpose of exporting. Similarly, I assume that the incompleteness of international contracts is such that foreign investors are not willing to finance domestic exporters. Therefore, firms that want to export need to have enough liquidity on their own to cover the fixed cost of entering markets.

I further assume that each firm is endowed with a random liquidity shock A . Since A is a domestic liquidity shock, it is denominated in units of domestic labor, and has a value wA in terms of the numeraire. The profits generated from domestic sales, $\pi_d(x)$ are also pledgeable. (A, x) are

drawn from a joint distribution with c.d.f. $F(A, x)$ over $\mathbb{R}^+ \times \mathbb{R}^+$, and $F_x(x) \equiv \lim_{A \rightarrow \infty} F(A, x)$ over \mathbb{R}^+ . A firm's productivity and its degree of liquidity constraint may or may not be correlated, depending on the specific shape of the distribution F . I also assume that the total mass of firms entering the lottery is proportional to the size of the country, L .⁴

In order to export, a firm must have enough liquidity to cover the fixed entry cost, w^*C_f . It generates some liquidity from domestic sales, $\pi_d(x)$, and it has access to some additional exogenous liquidity wA . So an exporter is subject to the following liquidity constraint,

$$\pi_d(x) + wA \geq w^*C_f \quad (4)$$

More productive firms generate larger profits at home, and therefore are less dependent on external finance. I define $\bar{x}(A)$ as the lowest productivity below which firms with liquidity A cannot gather enough liquidity to enter the foreign market. $\bar{x}(A)$ is defined by,

$$\pi_d(\bar{x}(A)) + wA = w^*C_f$$

All firms with a productivity below $\bar{x}(A)$ are prevented from exporting because of liquidity constraints, even if they could profitably export.

2.4 Open economy equilibrium

Since I am mainly interested in what happens in the home country, I assume that foreign firms face no liquidity constraint. I make one additional simplifying assumption: price indices only depend on prices set by local firms. In other words, prices set by foreign exporters have a negligible impact on the general price index domestically. This is a fair approximation for a relatively closed economy. Formally, I replace the price index Equation (1) by the following approximation,

$$P \approx \left(\int_{x \geq \bar{x}_d} p_d(x)^{1-\sigma} L dF_x(x) \right)^{\frac{1}{1-\sigma}} \quad (5)$$

It will be convenient to define the function $g(\cdot)$ in the following way:

$$g(\cdot) : \bar{x}^{\sigma-1} = \left(\frac{\sigma}{\mu} \int_{x \geq \bar{x}} x^{\sigma-1} dF_x(x) \right) \times C \Leftrightarrow \bar{x} = g(C) \quad (6)$$

⁴Implicitly, we assume that there is a group of entrepreneurs proportional to the size of the country. We could remove this assumption, and allow for the free entry of entrepreneurs, with an infinite set of potential entrepreneurs. Provided that trade barriers are large enough, we would get qualitatively the same results.

It is straightforward to prove that $g' > 0$. Rearranging the conditions for the productivity thresholds in Eq. (3) and the liquidity constraints condition in Eq. (4), I have,

$$\bar{x}_d = g(C_d) \quad (7)$$

$$\bar{x}_f = \left(\frac{\tau w}{w^*}\right) \left(\frac{C_f}{C_d^*}\right)^{\frac{1}{\sigma-1}} g(C_d^*) \quad (8)$$

$$\bar{x}(A) = \left(\frac{C_d + \frac{w^*}{w}C_f - A}{C_d}\right)^{\frac{1}{\sigma-1}} g(C_d) \quad (9)$$

All the firms with a productivity above \bar{x}_d produce and sell their output domestically. Only those firms with a productivity above $\max\{\bar{x}_f, \bar{x}(A)\}$ are able to export.

What are the determinants of the liquidity constraint, $\bar{x}(A)$ in Eq. (9)? $\bar{x}(A)$ is a downward sloping schedule. Firms that only own a small amount of exogenous liquidity, A small, must have a very high level of productivity in order to generate sufficient liquidity on their own and enter foreign markets. Firms with a large amount of exogenous liquidity on the other hand, A large, do not require much additional liquidity, and do not need a high productivity in order to be able to export. The higher the entry cost into the foreign country, C_f , the higher the curve $\bar{x}(A)$. The fixed overhead production cost, C_d , has an ambiguous impact on the curve $\bar{x}(A)$ ⁵. An increase of the domestic fixed cost C_d eats up part of a firm's liquidity, and reduces its ability to enter foreign markets. However, an increase in C_d also makes it harder for firms to survive, and forces some domestic firms out of business. This softens competition, increases the market share of each surviving firm, increases profits, and hence increases available liquidity. Which force dominates depends on the underlying distribution of firm productivity. The higher the exchange rate, that is the lower w^*/w , the lower the curve $\bar{x}(A)$. The reason is straightforward: if the exchange rate appreciates (w^*/w falls), the value of domestic assets in terms of foreign prices increases, and less domestic liquidity is required to enter the foreign market. The more substitutable the goods, that is the higher σ , the flatter $\bar{x}(A)$. This is because when goods are highly substitutable, any small difference in productivity implies large differences in profits, and therefore in the liquidity generated by domestic sales.

Interestingly, only a subset of firms are potentially subject to liquidity constraints. Firms with a very high productivity, no matter how little exogenous liquidity they own, are able to export. Formally, $\bar{x}(0)$ is bounded, so that firms with a productivity above $\bar{x}(0)$ do not need any exogenous liquidity. At the other extreme, firms with a sufficiently large amount of exogenous

⁵See appendix A for a formal proof of this statement.

liquidity do not need to generate any additional liquidity from domestic sales. If their exogenous liquidity endowment A is sufficiently large to cover the fixed entry cost into both the domestic and the foreign market, even without any domestic sales, those firms could export⁶. In formal terms, $\bar{x}(C_d + \frac{w^*}{w}C_f) = 0$. From a social efficiency point of view, there is no need to allocate exogenous liquidity beyond $C_d + \frac{w^*}{w}C_f$. We will see in the next section that profitability conditions imply that the maximum liquidity a firm could ever need to enter foreign markets is actually below $C_d + \frac{w^*}{w}C_f$. We can already see that the distribution of liquidity among firms (and how that correlates with a firm's productivity) will have important implications for the ability of firms to export.

We have seen that a firm's productivity may allow it to overcome liquidity constraints without the need to accessing financial markets. Are liquidity constraints going to be binding for any firm? In other words, is any firm profitable enough to be a viable exporter, but prevented from accessing foreign markets because of liquidity constraints? The following proposition gives conditions under which there will be a set of liquidity constrained exporters.

Proposition 1 *If $\left(\frac{C_d^*}{C_f} + \frac{w^*C_d^*}{wC_d}\right)^{\frac{1}{\sigma-1}} \frac{g(C_d)}{g(C_d^*)} > \frac{\tau w}{w^*}$, then there is a non empty set of liquidity constrained firms (denoted Ω). These firms could profitably export, but are prevented from doing so because they lack sufficient liquidity.*

Proof. See appendix B. ■

From now on, I assume that the condition in Proposition 1 holds, so that the set of liquidity constrained firms, Ω , is non empty.

No firm with a productivity below \bar{x}_f could profitably export. These firms have a productivity too low to allow them to generate enough profits in the foreign market to recover the fixed entry cost. Firms with a productivity above $\bar{x}(0)$ export no matter how little exogenous liquidity they hold: they are competitive enough in the foreign market to generate positive profits, and they generate sufficient liquidity from their domestic activities to cover the entry cost into the foreign market, without the need for any additional liquidity. Firms with an intermediate productivity, $\bar{x}_f \leq x < \bar{x}(0)$, could profitably export, but do not generate sufficient liquidity from their sales on the domestic market. They need extra liquidity. Without this extra liquidity, despite being

⁶Note however that such wealthy firms may not be able to survive in the domestic market, or profitably export. This is precisely described in the next section.

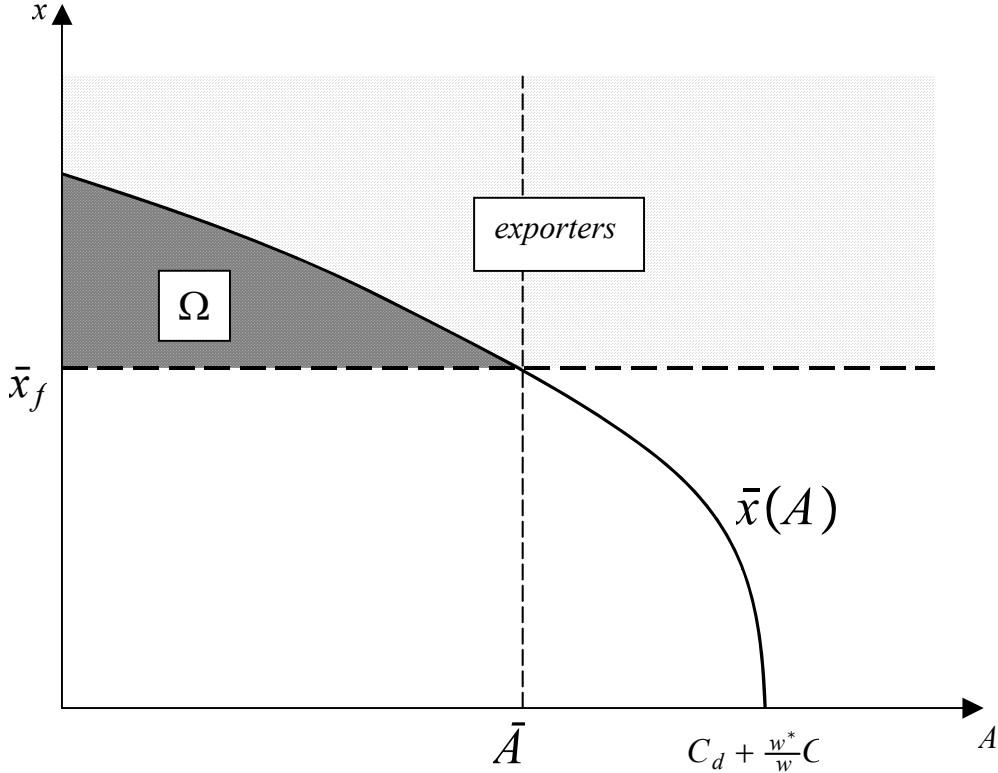


Figure 1: Liquidity constrained exporters. Note: No firm with a productivity below \bar{x}_f can profitably export. On top of this this, firms below the curve $\bar{x}(A)$ are liquidity constrained. All firms in the area Ω between \bar{x}_f and $\bar{x}(A)$ are liquidity constrained exporters. They could profitably export, but are prevented from doing so because of liquidity constraints.

profitable, they would be prevented from exporting. This is shown on Figure 1. The dark shaded area Ω corresponds to liquidity constrained firms: these firms are willing to export ($x \geq \bar{x}_f$), but cannot do so because they lack sufficient liquidity ($x \leq \bar{x}(A)$).

It is interesting to note that the distribution of liquidity among firms does matter. As can be seen graphically, firms with more than \bar{A} (with $\bar{x}(\bar{A}) = \bar{x}_f$) exogenous liquidity have "too much" liquidity. \bar{A} corresponds to the amount of liquidity the least productive exporter would need to enter foreign markets. Any firm with a productivity below \bar{x}_f could not export, and therefore would have no use for exogenous liquidity. Following a similar reasoning, no firm with a productivity above $\bar{x}(0)$ has the need for any exogenous liquidity. Such high productivity firms are already able to generate sufficient liquidity from their domestic sales, and do not need additional source of funding. Only firms with an intermediate level of productivity (between \bar{x}_f and $\bar{x}(0)$)

must have access to some exogenous source of liquidity in order to overcome financial constraints. However none of these firms would need more than a maximum \bar{A} of liquidity. I describe in the next section how the distribution of wealth matters for aggregate exports in the next section.

Proposition 1 is testable. It states that financially constrained firms cannot export. Financially constrained firms are firms that both lack sufficient exogenous liquidity, and that are not productive enough to generate sufficient liquidity on their own. Campa and Shaver (2001) find that more liquidity constrained firms are less likely to export. They define financially constrained firms as firms for which investment is correlated with cash flows. I expect financially constrained firms in my model, that is firms that both lack existing liquidity and generate little liquidity from their sales, to enter Campa and Shaver's category of financially constrained firms. Therefore there is some evidence supporting proposition 1: there exists a set of financially constrained firms that are prevented from exporting.

2.5 Liquidity constraints and missing trade

If it does export, the total value of exports (f.o.b.) by a firm with productivity x is $r_f(x)$. Using the expressions for the productivity thresholds in Eqs. (7), (8) and (9), plugging those and the price index equation (5) back into the revenue equation (2), I get,

$$r_f(x) = \sigma w^* C_d^* \left(\frac{w^*}{\tau w} \times \frac{x}{\bar{x}_d^*} \right)^{\sigma-1} \quad (10)$$

All firms with a productivity above $\max\{\bar{x}_f, \bar{x}(A)\}$ export. All firms in the set Ω are prevented from exporting. The total volume of missing trade (f.o.b.) from these constrained exporters, T_{missing} , and the total volume of exports (f.o.b.), T_{total} , are given by,

$$T_{\text{missing}} = L \int \int_{(A,x) \in \Omega} r_f(x) dF(A,x)$$

$$T_{\text{total}} = L \int_{x \geq \bar{x}_f} r_f(x) dF_x(x) - T_{\text{missing}}$$

The total volume of missing trade depends on several parameters of the distribution of productivity and liquidity shocks. It depends both on the average liquidity available economy wide, and on the distribution of this liquidity. If only highly productive firms are liquidity constrained, there will not be any missing trade. If only those low productivity firms that would not export anyway are liquidity constrained, there will not be any missing trade. To get a better understanding of

the magnitude of this missing trade, I consider a special case for the distribution of liquidity and productivity shocks $F(A, x)$.

In order to get simple predictions for the export behavior of liquidity constrained firms, I will now use a simplified form for the joint distribution of productivity and liquidity shocks, $F(A, x)$. Assume that the liquidity shocks and the productivity shocks are uncorrelated. Further assume that a fraction θ of firms are liquidity constrained ($A < \bar{A}$), and the remaining $(1 - \theta)$ is not ($A \gg \bar{A}$). \bar{A} is defined as the minimum liquidity above which financial constraints are not binding, and the only constraint is the profitability constraint: $\bar{x}(\bar{A}) = \bar{x}_f$. Firms with a high enough positive liquidity shock will always be able to generate enough liquidity on the home market. They will export only if exporting is profitable. I can rewrite the equations for T_{missing} and T_{total} in this special case,

$$T_{\text{missing}} = \theta L \int_{\bar{x}(A)}^{\bar{x}_f} r_f(x) dF_x(x) \quad (11)$$

$$T_{\text{total}} = L \int_{x \geq \bar{x}_f} r_f(x) dF_x(x) - T_{\text{missing}} \quad (12)$$

Definition 2 *A deepening of financial markets corresponds to an increase of A , the amount of liquidity available to financially constrained firms. A widening of financial markets corresponds to a reduction in θ , the number of financially constrained firms.*

Proposition 3 *Both a deepening and a widening of financial markets has a positive impact on total trade flows.*

Proof. See appendix C. ■

This model predicts that financial constraints faced by potential exporters have a negative impact on trade flows. Both the absolute amount of liquidity and the distribution of liquidity among firms matter for the total volume of trade. These predictions are testable. The model predicts that more financially constrained industries should have lower trade flows. Sectors where the distribution of liquidity is more unequal should have lower trade flows. Moreover, financial constraints matter more when entry costs to foreign markets are larger (C_f large). If those entry

costs increase with distance, more financially constrained sectors should have a larger distance elasticity of trade (in absolute value).

In the next section, I turn to the impact of exchange rate shocks on trade in the presence of liquidity constraints.

3 The ambiguous impact of exchange rate shocks on trade flows

In this section, I describe the impact of exchange rate shocks on trade. If the domestic currency appreciates vis à vis the foreign currency, domestic producers lose competitiveness in the foreign market. This is a classic terms of trade effect. However, an appreciation of the domestic currency relaxes the liquidity constraint faced by potential exporters. The value of domestic assets in terms of the foreign currency increases. Liquidity constrained firms are now more likely to be able to pay foreign denominated entry costs and start exporting. Simultaneously, existing exporters lose competitiveness and export less, but new firms start exporting. The intensive margin of trade is negatively affected by an appreciation of the exchange rate, whereas the extensive margin is positively affected.

I model exchange rate shocks in this model as a shock on relative wages (in terms of the numeraire). I will define an appreciation of the domestic currency as an increase in the productivity in the homogeneous sector at home, which leads to an increase in the domestic wages w , all else equal. This definition is similar to the one used by Atkeson and Burstein (2005). If the domestic wage increases, the value of domestic assets (wA and $\pi_d(x)$) increases, whereas potential exporters lose competitiveness in the foreign market ($p_f(x)/P^*$ increases). These effects are exactly equivalent to an appreciation of the domestic currency vis à vis the foreign currency.

Proposition 4 *An appreciation of the exchange rate has 3 effects:*

- (i) *Existing exporters lose market shares abroad and reduce their exports: $\frac{\partial r_f(x)}{\partial w} < 0$.*
- (ii) *The least productive non constrained exporters are forced out of the export market: $\frac{\partial \bar{x}_f}{\partial w} > 0$.*
- (iii) *The most productive constrained firms start exporting: $\frac{\partial \bar{x}(A)}{\partial w} < 0$.*

Proof. (i) The first effect is the classic impact of a loss of competitiveness for exporters. As the value of domestic inputs increases, domestic exporters have to charge higher prices in order to maintain mark-ups, and therefore they lose market shares in the foreign market. This loss of

market shares implies a reduction in exports. Formally, differentiating Eq. (10) with respect to w , I get,

$$\frac{\partial r_f(x)}{\partial w} = -(\sigma - 1) \frac{r_f(x)}{w} < 0$$

(ii) The second effect is the natural corollary of the first effect. As exporters lose competitiveness, they lose market shares, and therefore earn reduced profits:

$$\frac{\partial \pi_f(x)}{\partial w} = -\frac{\sigma - 1}{\sigma} \frac{r_f(x)}{w} < 0$$

At the same time, the cost of entering the foreign market, w^*C_f , denominated in foreign currency, is unchanged. So the least productive firms, earning smaller profits, cannot cover the entry cost into the foreign market anymore. The productivity threshold \bar{x}_f goes up. Formally, differentiating Eq. (8) with respect to w , I get,

$$\frac{\partial \bar{x}_f}{\partial w} = \frac{\bar{x}_f}{w} > 0$$

(iii) The last effect comes from the relaxation of the liquidity constraint. As the domestic currency appreciates, the value of domestic assets (both exogenous liquidity and endogenous domestic profits) in terms of foreign currency increases. Since the entry cost into the foreign market is paid in foreign currency, this means a relaxation of the liquidity constraint for constrained exporters. Formally, differentiating Eq. (9) with respect to w , I get,

$$\frac{\partial \bar{x}(A)}{\partial w} = -\left(\frac{1}{\sigma - 1}\right) \frac{w^*C_f}{w} \left(\frac{C_d}{C_d + \frac{w^*}{w}C_f - A}\right)^{\frac{1}{\sigma-1}} \frac{\bar{x}(A)}{w} < 0$$

■

An appreciation of the exchange rate causes both entry and exit. Non liquidity constrained firms with a low productivity are forced out of the export market because they lose competitiveness in the foreign market. Liquidity constrained firms with a high productivity (close to $\bar{x}(A)$) face a relaxed liquidity constraint and enter the export market. This can be seen on Fig. 2. Low productivity non constrained firms, in the light shaded area, exit the export market. This is due to the fact that they lose competitiveness in the foreign market, and therefore earn less profits. They cannot cover the fixed trade barrier any more, and exit the export market. At the same time, high productivity constrained firms, in the dark shaded area, enter the export market. These firms are sufficiently productive to export (even after the currency appreciation), but they were prevented from doing so because of liquidity constraints. The appreciation of their currency

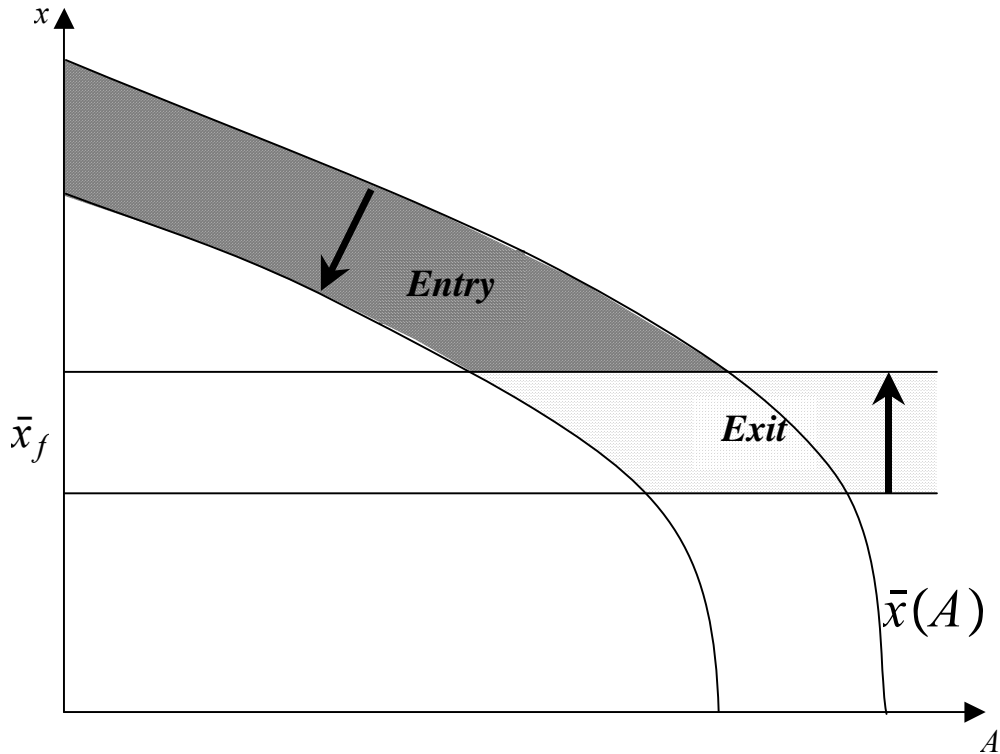


Figure 2: The ambiguous impact of an exchange rate appreciation. Note: An appreciation of the domestic currency erodes the competitiveness of exporters, and forces the least productive exporters to exit (light shaded area). At the same time, it relaxes the liquidity constraint, and allows some liquidity constrained firms to enter the export market (dark shaded area).

increases the value of their domestic assets and allows them to start exporting. Depending both on the strength of the liquidity constraints (the overall scarcity of liquidity in the economy) and on the number of liquidity constrained firms, either effect can dominate. If there are relatively many liquidity constrained firms, there will be a net entry of firms following an appreciation of the exchange rate.

The presence of liquidity constraints introduces investments motive in international trade in goods. Exports do not depend only on the competitiveness of exporters, it also depends on the value of domestic assets relative to the "cost" of exporting. In the same way as an exchange rate appreciation will make investment abroad more accessible, it makes exporting more likely for a group of firms.

Proposition 5 *If competition is soft (σ close to 1), an appreciation of the exchange rate will have a positive impact on exports.*

Proof. See appendix D ■

This model of international trade with liquidity constrained exporters predicts that, under some conditions, an appreciation of the exchange rate, despite negative impact on the competitiveness of exporters, may have a strictly positive impact on exports. If competitiveness does not have too large an impact on the size of market shares, that is if goods are very differentiated (σ low), then the entry of liquidity constrained exporters following an appreciation of the exchange rate will dominate. Total exports increase after an appreciation of the exchange rate.

More generally, even if an appreciation of the exchange rate has a negative impact on exports, the negative impact of an exchange rate appreciation will be milder (or even become positive) the more unequal the distribution of liquidity within the sector (θ low). If liquidity is unequally shared among firms (θ low), many healthy and productive firms are liquidity constrained. This means that many firms could profitably export, but they lack sufficient access to financial markets to cover the entry cost into the foreign market. If the exchange rate appreciates, the liquidity constraint faced by all those firms is relaxed. A fraction of these firms will then start exporting, despite the loss of competitiveness. The more unequal the distribution of wealth among firms, the more firms will start exporting, and the more positive the impact of an exchange rate appreciation.

Liquidity constraints for the access to foreign markets allows effective policy interventions. There is room for temporary competitive revaluations. A temporary revaluation of the domestic currency, by increasing the value of domestic assets, may allow liquidity constrained firms to start exporting. The sunk cost nature of a fraction of fixed costs associated with exporting implies some asymmetry for the response of trade to exchange rate fluctuations. Once liquidity constrained firms have started exporting, insofar as they do not have to pay this fixed cost again, they will continue exporting, even after a devaluation of their currency.

It may also be possible to extend this model to describe phenomena of amplification and contagion in international trade. If a firm exports to a given foreign market, it generates some liquidity, in addition to domestic profits. Such extra liquidity will give this firm an edge for entering other foreign markets. This corresponds to an amplification mechanism: an increase in exports by a firm may trigger additional exports, since it relaxes its liquidity constraint. In a multi country dynamic setting, firms may be able to accumulate liquidity from both their

domestic sales, and from past sales to other foreign markets. Firms that have already entered many foreign markets are more likely to have sufficient liquidity to enter new and less accessible markets. Shocks that affects exports with one trading partner may influence the volume of exports with other trading partners, even absent any direct link between those countries. If trade links with a given trading partner are severed, the liquidity streams generated from exporting to this country cease, and some exporters may be forced to pull out of other markets as well. Moreover, if markets in the same region are characterized by similar trade barriers, they will attract similar exporters. Modifying the access to one of these markets will affect trade with all other countries in the same region. Hence, liquidity constraints may artificially generate contagion phenomena in international trade.

4 Conclusion

I have shown in this paper that liquidity constraints may modify fundamentally the behavior of exporters, and the patterns of aggregate exports. If firms face liquidity constraints when accessing foreign markets, some firms are prevented from exporting. They could profitably enter foreign markets, but are prevented from doing so because they lack the ability to access financial markets and cover entry costs into foreign markets. The main prediction of the model is that financial underdevelopment hinders exports. Both the total amount of liquidity available, and the distribution of this liquidity matters for trade. The model also predicts that the presence of liquidity constraints will reduce the sensitivity of trade barriers to exchange rate fluctuations. When the exchange rate appreciates, exporters lose competitiveness, and they reduce their exports. However, since the value of domestic assets in terms of foreign prices increases, liquidity constraints for accessing foreign markets are relaxed. Some firms start exporting. This entry of liquidity constrained exporters dampens the negative competitiveness effect of an exchange rate appreciation. Under some circumstances, an exchange rate appreciation may have a positive impact on exports. Liquidity constraints also create artificial links between different markets, and thus generate amplification and contagion phenomena. If a firm starts exporting to a new foreign market, it generates some liquidity from its exports. This additional liquidity may allow it to enter more foreign markets in the future.

References

- [1] Aw, Bee Yan and A. Hwang, 1995, "Productivity and the export market: A firm level analysis." *Journal of Development Economics*, v. 47 no.2, pp. 313-332.
- [2] Atkeson, Andrew and Ariel Burstein, 2005, "Trade Costs, Pricing to Market, and International Relative Prices." *Working Paper*.
- [3] Baldwin, R., 1988, "Hysteresis in Import Prices: The Beachhead Effect." *American Economic Review*, v. 78 no.4, pp. 773-785.
- [4] Bernanke, Ben S. and Mark L. Gertler, 1995, "Inside the Black Box: The Credit Channel of Monetary Policy Transmission." *The Journal of Economic Perspectives*, v. 9 no. 4, pp. 27-48.
- [5] Bernard, Andrew B.; Jonathan Eaton; J. Bradford Jensen and Sam Kortum, 2003, "Plants and Productivity in International Trade," *American Economic Review*, v. 93, pp. 1268-1290.
- [6] Bernard, Andrew B. and J. Bradford Jensen, 1999, "Exceptional exporter performance: cause, effect, or both?", *Journal of International Economics*, v. 47 no. 1, pp. 1-25.
- [7] Bernard, Andrew B. and J. Bradford Jensen, 2001a, "Why Some Firms Export," *The Review of Economics and Statistics*, v. 86 no. 2.
- [8] Bernard, Andrew B. and J. Bradford Jensen, 2001b, "Who Dies? International Trade, Market Structure, and Industrial Restructuring," *NBER Working Paper # 8327* .
- [9] Bernard, Andrew B. and J. Bradford Jensen, 2002, "Entry, Expansion, and Intensity in the US Export Boom, 1987-1992," *Review of International Economics*, forthcoming.
- [10] Bernard, Andrew B.; J. Bradford Jensen, and Peter K. Schott, 2005, "Importers, Exporters and Multinationals: A Portrait of Firms in the U.S. that Trade Goods." *Working Paper*.
- [11] Broda, Christian and David E. Weinstein, 2004, "Globalization and the Gains from Variety," *Federal Reserve Bank of New York, Mimeo*.
- [12] Campa, José M., 1998, "Hysteresis in Trade: How Big are the Numbers?" *New York University Working Paper*.

- [13] Campa, José M. and J. Myles Shaver, 2001, "Exporting and Capital Investment: On the Strategic Behavior of Exporters," *New York University Mimeo*.
- [14] Clerides, Sofronis K.; Saul Lach and James R. Tybout, 1998, "Is learning by exporting important? Microdynamic evidence from Colombia, Mexico, and Morocco." *Quarterly Journal of Economics*, v. 113 no. 3, pp. 903-947.
- [15] Dornbusch, Rudiger; S. Fischer, and Paul A. Samuelson, "Comparative Advantage, Trade, and Payments in a Ricardian Model with a continuum of Goods," *American Economic Review*, vol. 67, pp. 823-839.
- [16] Eaton, Jonathan; Sam Kortum, 2002, "Technology, Geography, and Trade," *Econometrica*, vol. 70 no. 5 (September 2002), pp. 1741-1779.
- [17] Eaton, Jonathan; Sam Kortum, and Francis Kramarz, 2004, "An Anatomy of International Trade: Evidence from French Firms," *American Economics Review, Papers and Proceedings*, forthcoming.
- [18] Eaton, Jonathan; Sam Kortum, and Francis Kramarz, 2004, "Dissecting Trade: Firms, Industries, and Export Destinations," *NBER Working Paper 10344*.
- [19] Fazzari, Steven, R.; R. Glenn Hubbard, and Bruce Petersen, 1988, "Financing Constraints and Corporate Investment," *Brookings Papers on Economic Activity*, pp. 141-195.
- [20] Fariñas, Jose C. and Ana Martín-Marcos, 2002, "Exporting and Productivity: Firm-Level Evidence for Spanish Manufacturing." *Universidad Complutense, Mimeo*.
- [21] Gertler, Mark and Simon Gilchrist, 1994, "Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms." *Quarterly Journal of Economics*, v. 59, pp. 309-340.
- [22] Ghironi, Fabio, and Marc J. Melitz, 2005, "International Trade and Macroeconomic Dynamics with Heterogeneous Firms." *Working Paper*.
- [23] Helpman, Elhanan; Marc Melitz and Yona Rubinstein, 2004, "Trading Partners and Trading Volumes," *Working Paper*.
- [24] Holmstrom, Bengt and Jean Tirole, 1997, "Financial Intermediation, Loanable Funds and the Real Sector." *The Quarterly Journal of Economics*, v. 112 no. 3, pp. 663-91.

- [25] Hoshi, T.; Anil Kashyap and D. Scharfstein, 1994, "The Choice Between Public and Private Debt: An Examination of Post-Regulation Financing in Japan." *MIT Working Paper*.
- [26] Kashyap, Anil and Jeremy Stein, 2000, "What do One Million Observations on Banks Have to Say About the Transmission of Monetary Policy." *American Economic Review*, v. 90 no. 3, pp. 407-428.
- [27] Krugman, Paul. 1980. "Scale Economies, Product Differentiation, and the Pattern of Trade." *American Economic Review*, vol. 70, pp. 950—959.
- [28] Melitz, Marc, 2003, "The Impact of Trade on Aggregate Industry Productivity and Intra-Industry Reallocations," *Econometrica*, v. 71 no. 6 (November 2003), pp. 1695-1725.
- [29] Roberts, M. and James Tybout, 1999, "An Empirical Model of Sunk Costs and the Decision to Export." *Policy Research Working Paper Series 1436*, *The World Bank*.
- [30] Ruhl, Kim, 2003, "Solving the Elasticity Puzzle in International Economics," *University of Minnesota, Mimeo (November 2003)*.
- [31] Stein, Jeremy, 1998, "An Adverse Selection Model of Bank Asset and Liability Management with Implications for the Transmission of Monetary Policy." *RAND Journal of Economics*, v. 29 no. 3, pp. 466-86.
- [32] Stiglitz, J. and A. Weiss, "Credit Rationing in Markets with Imperfect Information." *American Economic Review*, v. 71, pp. 393-410.

Appendix

A Proof: monotonicity of $\bar{x}(A, C_d)$

Proposition 6 $\bar{x}(A)$ is increasing in C_d .

Proof. The function $g(C)$ is steeper than $C^{\frac{1}{\sigma-1}}$. This can be seen simply by rearranging the definition of the function $g(\cdot)$ in Eq. (6). We can define the function $\xi(C)$ in the following way:

$$\xi(C) \equiv \frac{g(C)}{C^{\frac{1}{\sigma-1}}} = \frac{\sigma}{\mu} \int_{x>g(C)} x^{\sigma-1} dF_x(x)$$

Since $g(\cdot)$ is increasing in C , $\xi(\cdot)$ is decreasing in C . How steep it is depends on the underlying distribution of productivity F_x . Depending on this distribution, $\xi(\cdot)$ can be arbitrarily steep, or arbitrarily flat.

We can now plug in this new function $\xi(\cdot)$ into the formula for $\bar{x}(A)$ in Eq. (9):

$$\bar{x}(A) = \left(C_d + \frac{w^*}{w} C_f - A \right)^{\frac{1}{\sigma-1}} \times \xi(C_d)$$

When C_d increases, the first term of the product goes up, and the second term goes down. The net effect can go either way, depending on how steep the function $\xi(\cdot)$ is.

We can describe the intuition behind each term of the product. When the domestic fixed cost goes up, it eats up the liquidity of all firms. This pushes up the minimum productivity required for entering foreign markets, at any level of A . This is the increase in the first term of the product.

At the same time, due to the increase in the domestic fixed cost, some firms are pushed out of business. Some firms die, competition softens among survivors, and profits increase. Each surviving firm now generates more liquidity from its domestic sales. The minimum productivity required for entering foreign markets falls, at any level of A . This is the reduction in the second term of the product. ■

B Proof of proposition 1

Proposition 1 (reminded) If $\left(\frac{C_d^*}{C_f} + \frac{w^* C_d^*}{w C_d} \right)^{\frac{1}{\sigma-1}} \frac{g(C_d)}{g(C_d^*)} > \frac{\tau w}{w^*}$, then there is a non empty set of liquidity constrained firms (denoted Ω). These firms could profitably export, but are prevented from doing so because they lack sufficient liquidity.

Proof. All firms below $\bar{x}(A)$ are liquidity constrained, and cannot export no matter how profitable their exporting would be. All firms above \bar{x}_f could profitably export, if they have sufficient liquidity. I want to prove that $\Omega \neq \emptyset$, with $(A, x) \in \Omega$ iff $\bar{x}_f \leq x < \bar{x}(A)$. Firms in Ω could profitably export ($x \geq \bar{x}_f$), but they are prevented from doing so because they are liquidity constrained ($x < \bar{x}(A)$). A necessary and sufficient condition for Ω to be non empty is that $\bar{x}(0) > \bar{x}_f$. I know that:

$$\begin{aligned}\bar{x}_f &= \left(\frac{\tau w}{w^*}\right) \left(\frac{C_f}{C_d^*}\right)^{\frac{1}{\sigma-1}} g(C_d^*) \\ \bar{x}(A) &= \left(\frac{C_d + \frac{w^*}{w}C_f - A}{C_d}\right)^{\frac{1}{\sigma-1}} g(C_d)\end{aligned}$$

so that $\bar{x}(0) > \bar{x}_f$ iff,

$$\left(\frac{C_d^*}{C_f} + \frac{w^*C_d^*}{wC_d}\right)^{\frac{1}{\sigma-1}} \frac{g(C_d)}{g(C_d^*)} > \frac{\tau w}{w^*}$$

If $\left(\frac{C_d^*}{C_f} + \frac{w^*C_d^*}{wC_d}\right)^{\frac{1}{\sigma-1}} \frac{g(C_d)}{g(C_d^*)} > \frac{\tau w}{w^*}$, Ω is non empty, and there are liquidity constrained firms. ■

C Proof of proposition 3

Proposition 3 (reminded) *Both a deepening and a widening of financial markets has a positive impact on total trade flows.*

Proof. A deepening of the financial markets corresponds to a relaxation of the liquidity constraint of constrained firms (a reduction of A). A widening of financial markets corresponds to a reduction in the number of liquidity constrained firms (a reduction of θ). Differentiating the expressions for total trade and missing trade in Eqs (12) and (11), I get,

$$\begin{aligned}\frac{\partial T_{\text{total}}}{\partial \theta} &= -L \int_{\bar{x}(A)}^{\bar{x}_f} r_f(x) dF_x(x) \\ \frac{\partial T_{\text{total}}}{\partial A} &= -\theta T \frac{\partial \bar{x}(A)}{\partial A} r_f(\bar{x}(A)) \frac{\partial F_x}{\partial x}(\bar{x}(A))\end{aligned}$$

From Eq. (9), I get $\frac{\partial \bar{x}(A)}{\partial A} = -\left(\frac{1}{\sigma-1}\right) \frac{\bar{x}(A)}{C_d + \frac{w^*}{w}C_f - A} < 0$, which insures that a relaxation of the liquidity constraint has a positive impact on trade. Therefore,

$$\frac{\partial T_{\text{total}}}{\partial \theta} < 0 \text{ and } \frac{\partial T_{\text{total}}}{\partial A} > 0$$

■

D Proof of proposition 5

Proposition 5 (reminded) *If competition is soft (σ close to 1), an appreciation of the exchange rate will have a positive impact on exports.*

Proof. I can rewrite total exports in Eq. (12) in the following way,

$$T_{\text{total}} = \int_{x \geq \bar{x}(A)} r_f(x) LdF_x(x) + (1 - \theta) \int_{\bar{x}_f}^{\bar{x}(A)} r_f(x) LdF_x(x)$$

Differentiating this equation with respect to w , and using Leibnitz rule, and applying Lebesgues' theorem of monotone convergence to insure existence of the integrals, I get,

$$\begin{aligned} \frac{\partial T_{\text{total}}}{\partial w} = & \int_{x \geq \bar{x}(A)} \frac{\partial r_f(x)}{\partial w} LdF_x(x) + (1 - \theta) \int_{\bar{x}_f}^{\bar{x}(A)} \frac{\partial r_f(x)}{\partial w} LdF_x(x) \\ & - (1 - \theta) \frac{\partial \bar{x}_f}{\partial w} r_f(\bar{x}_f) L \frac{\partial F_x(\bar{x}_f)}{\partial x} \\ & - \theta \frac{\partial \bar{x}(A)}{\partial w} r(\bar{x}(A)) L \frac{\partial F_x(\bar{x}(A))}{\partial x} \end{aligned}$$

Using the formulas for $\partial r_f(x) / \partial w$, $\partial \bar{x}_f / \partial w$, and $\partial \bar{x}(A) / \partial w$ from the previous proof, I can rewrite this as,

$$\begin{aligned} \frac{\partial T_{\text{total}}}{\partial w} = & - \left(\frac{\sigma - 1}{w} \right) T_{\text{total}} \\ & - (1 - \theta) \frac{\bar{x}_f r_f(\bar{x}_f)}{w} L \frac{\partial F_x(\bar{x}_f)}{\partial x} \\ & + \left(\frac{\theta}{\sigma - 1} \right) \frac{w^* C_f}{w} \left(\frac{C_d}{C_d + \frac{w^*}{w} C_f - A} \right)^{\frac{1}{\sigma - 1}} \frac{\bar{x}(A) r_f(\bar{x}(A))}{w} L \frac{\partial F_x(\bar{x}(A))}{\partial x} \end{aligned}$$

The first two terms in the sum are negative (the loss of competitiveness of existing exporters, and the exit of non constrained exporters). The last term is positive (the entry of liquidity constrained exporters).

The first two terms are bounded, and the last term converges to infinity as σ converges to 1. In other words, provided that the loss in competitiveness is not too severe (σ close to 1), the entry of liquidity constrained exporters will dominate the exit of low productivity unconstrained exporters, and the reduction in exports by existing exporters. ■