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FINANCIAL CRISES AND INTERNATIONAL TRADE: THE LONG
WAY TO RECOVERY

Nicolas Berman

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The Long Way to Recovery

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Abstract

Standard theoretical models would predict that a currency depreciation generates an increase in net exports. However, recent emerging market crises, accompanied by sharp exchange rate devaluation, have often been followed by a fall in or a stagnation of exports. This paper provides a simple theoretical framework which shows that a currency crisis affects trade through (i) a competitiveness effect, i.e. a variation in relative prices, that positively influences the intensive margin of trade (the amount of exports by firms); (ii) a balance-sheet effect, i.e. a modification of the fixed cost of exports, which negatively affects the extensive margin of trade (the number of exporters). We derive from our model a gravity-like equation of bilateral sectoral trade which we estimate using data on 27 industries and 32 countries over the period 1976-2002. First, we find that these events have a long-lasting negative impact on exports - which remain below their natural level for five years. We present evidence suggesting that this persistent effect is due to the combination of firms' foreign currency borrowing and fixed costs of exports, which leads to important balance-sheet problems in the aftermath of the crisis. Second, the net effect of crises on exports largely depends on country specialization: the positive competitiveness effect is magnified by a specialization in high elasticity of substitution's industries, while negative balance-sheets effects are exacerbated in industries more dependent upon external finance, in which assets are more tangible, or in high fixed costs sectors.

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I Introduction

According to Fischer (1999), strong exports, expansionary domestic policies and stable foreign financial conditions are the key determinants of growth recovery after a financial crisis. A better understanding of the reaction of trade after crises and the determination of the different elements underlying this reaction are thus especially important to facilitate countries' recovery. As they generally imply important real exchange rate devaluations, the standard macroeconomic theory would predict that currency crises should increase exports through a competitiveness effect. The observation of recent emerging market crises however contradicts this intuitive theoretical effect: Despite real exchange rate devaluations larger than 60 percents in most cases, exports either stagnated or actually fell for a year or more in South-East Asian countries after the 1997-1998 crisis, and after the same kind of events in Argentina, Uruguay (2002) and Brazil (1999).[1] In the same way, no robust empirical evidence emerges from the few papers which tried to assess the effect of currency crises on trade[2]: Campa (2002) studies the impact of currency crises on South American countries' exports, and finds a positive or insignificant impact, depending on the specification. In a more recent paper, Ma and Cheng (2003), using a gravity-like equation, test the impact of financial crises - both currency and banking crises - on international trade. Their results are even less clear-cut: currency crises do no seem to have any impact in the short-run (or a slightly negative impact), and the sign of the long-run impact depends on the period considered.

These sluggish responses of trade are all the more surprising in that there is growing evidence that large devaluations are generally associated with a lower pass-through to domestic prices[3], and are thus more likely to generate larger competitiveness gains. In the same way, the few theoretical works emphasizing a specificity of large exchange rate shocks yield the opposite intuition: because of the existence of sunk costs, only large exchange rate shocks may incite firms' entry into the export market, significantly improving the level of exports (Baldwin and Krugman, 1989). We attribute the lack of robust empirical evidence in past literature to missing variables or to an insufficient consideration of the different mechanisms through which crises may affect imports and exports. The aim of this paper

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[1]For example, exports decreased in the Philippines by 16%, in Thailand by 6% and in Indonesia by 10% in the year that followed the crisis.

[2]The important economic literature generated by the numerous financial crises of the nineties generally looks at the determinants of crises, and tries to predict their occurrence. These papers have studied the role of international trade in explaining financial crises, showing in particular the significant role of trade linkages in facilitating the contagion of crises (see for example Kaminsky and Reinhart, 2000, Glick and Rose, 1999 and Caramazza *et al.*, 2004), or more generally testing the importance of trade openness to the probability of the occurrence of financial crises (see, among others, Frankel and Cavallo, 2004). Another strand of the literature has analyzed the implications of such events, by looking generally at the impact of crises in terms of output variation. Among others, Gupta *et al.* (2003), Dooley (2000) and Hong and Tornell (2005) study the effects of currency, banking and twin crises on output, and describe elements which exacerbate or minimize the output cost. None of these papers look at the impact of crises on trade.

[3]See for example Burstein *et al.* (2005) and Goldfajn and Werlang (2000).

is to disentangle currency crises as both a relative prices change (with a positive effect on net exports) and a financial event (with possibly a negative effect on net exports). The relative size of these two elements, and therefore the total effect of crises on trade, depends on the extent of financial market imperfections and on countries' specialization.

We first build a partial equilibrium model of international trade with monopolistic competition that allows the derivation of a gravity-like equation and clarifies the different mechanisms that a currency crisis implies for trade. We show that when financial market imperfections are observed, such events affect trade through their effect on (i) relative prices, which positively influence the intensive margin of trade through a pro-competitive effect (ii) the fixed cost of entry on export market, which negatively affect the extensive margin of trade through a balance-sheet effect. We then use a sectoral database containing 27 industries and 32 countries over the period 1976-2002 to reveal the different channels through which trade is affected by currency crises. Our empirical identification strategy allows us to assess the significance of both effects and of their determinants.

First, we find that currency crises have a negative impact on both imports and exports. Their impact on exports is long-lasting and negative: when controlling for exchange rate changes, we find that exports remain on average below their natural level for six years after the event. We present evidence suggesting that this persistence is due to balance-sheet problems generated by the combination of high fixed costs of entry and foreign currency borrowing. Hence, both the relative prices and the balance-sheet mechanisms are at work following a currency crisis, explaining the lack of effect found by previous studies.

Second, the net effect of crises on exports largely depends on countries' specialization: the positive competitiveness effect is magnified by a specialization in high elasticity of substitution's industries, while negative balance-sheet effects are exacerbated in industries with a low degree of asset tangibility, more dependent upon external finance or in high fixed costs sectors. Our results strongly support the existence of high fixed costs of exports, and the view according to which aggregate variations of trade flows are the result of an extensive margin adjustment. More generally, this paper provides empirical evidence of a finance-based explanation for the exchange rate disconnect puzzle, i.e. to the apparent disconnection between exchange rate variations and real macroeconomic variables (Obstfeld and Rogoff, 2000).

The present paper is related to the growing literature studying the links between finance and international trade. Since the seminal paper by Kletzer and Bardhan (1987), the important impact of financial development on international trade level and growth has been widely studied (Beck, 2002,

Beck, 2003, Becker and Greenberg, 2004, Manova, 2005). As shown theoretically by Chaney (2005) or Manova (2007), financial market imperfections may be especially important for exporters because they may affect the number of exporters due to the existence *fixed costs of exports*. Empirically, various papers, including Bernard *et al.* (2007), Das *et al.* (2007), Bernard and Wagner (1998) and Bernard and Jensen (2004), provide evidence of such fixed costs using firm-level data. These fixed costs are related to different activities such as gathering information on foreign markets, establishing a distribution system or more generally adapting products to foreign tastes and environment. They explain the important movements of firms' entry and exit on the export market found by other studies. According to Eaton *et al.* (2004), this adjustment on the "extensive margin" is found to explain most of the variation of aggregate French exports.[4] This paper contributes to this literature by showing theoretically that more than influencing the *level* of exports, financial market imperfections may also affect their reaction to exchange rate shocks. In presence of such imperfections, the adjustment of trade flows after exchange rate movements may principally be due to variations in the number of exporters.

The remainder of this paper is organized as follow. In the next section, we present a simple model connecting currency crises to international trade. Section 3 contains our empirical methodology, while section 4 reviews the data used in the estimations. In section 5, we present the results on the overall impact of crises on trade and on the relevance of the different channels of transmission. Finally, section 6 concludes and draws some policy implications.

II   Theoretical underpinnings

The main reason for a potential non-traditional reaction of exports to a currency devaluation relies on the existence of balance-sheet effects. The literature[5] has stressed the important role of foreign currency debt and credit constraints in explaining the occurrence of crises and modifying their impact. In the aftermath of a currency crisis, the increase in the amount of foreign currency denominated debt and the decrease in the amount of home currency denominated cash flow can dampen the positive impact of the devaluation through a diminution of investment capacity. Empirically, it has been shown that the tradable sector is more likely to face this negative effect, exporting firms being typically

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[4]Regarding the theoretical and empirical importance of the extensive margin of trade, see in particular Melitz (2003) or Broda and Weinstein (2006).

[5]See among others Krugman (1999a), Krugman (1999b), Aghion *et al.* (2001), Bacchetta (2000), Cespedes *et al.* (2002), Cespedes *et al.* (2000). Calvo *et al.* (2003) provide empirical evidence of the importance of liability dollarization as a predictor of sudden stops in capital flows for a sample of 32 emerging market countries. If foreign currency borrowing is used as a larger part of total borrowing in countries that experienced financial crises, balance-sheet effects are more likely to be larger after crises.

more prone to borrow in foreign currency because of their better access to foreign financial markets (Aguiar, 2005, Kawai *et al.*, 2003). It is worth noting that, despite the obvious risk of such a behavior, emerging markets' firms seldom hedge against exchange rate fluctuations.[6] Interestingly, an increased expectation of devaluation does not seem to have any significant impact on firms' borrowing and investment behaviors (Galiani *et al.*, 2003). More generally, based on firm-level data, studies have found significant negative balance-sheet effects of currency crises on investment or profitability for Mexico (Pratap *et al.*, 2003, Pratap and Urrutia, 2004), Colombia (Echeverry *et al.*, 2003), Peru (Carranza *et al.*, 2003) and Chile (Benavente *et al.*, 2003). However, these studies do neither look precisely at the effect of currency crises on trade flows nor on firms' export decisions, so that one cannot draw conclusions about the relative size of the two mechanisms, namely the positive competitiveness and the negative balance-sheet effects.

1 Model

We present in this section a partial equilibrium model which aims at understanding the impact of exchange rate movements on the extensive and the intensive margins of trade in the presence of financial market imperfections. The world economy consists of 2 countries, i and j, with populations of, respectively, L_i and L_j households. Consumers in each country maximize utility derived from the consumption of goods from K sectors, each of them being made of a continuum of differentiated goods. Each firm produces a single good variety, and operates under Dixit-Stiglitz (1977) monopolistic competition. Country i's varieties sold in country j, sector k are defined over a continuum of mass n_{ijk}.

The origin of movements in exchange rate will be left unexplained, but could be made endogenous either by introducing monetary shocks moving the exchange rate under the assumption of rigid nominal wages or aggregate productivity shocks that could take the form of productivity shocks in a perfectly competitive tradable sector. The results would not be affected. The introduction of other hypotheses on exchange rate determination would affect the general equilibrium in a way that would depend on the chosen assumption. Since we want to assess the impact of nominal exchange rate variations on trade without studying a determinant underlying the variations, we chose to keep exchange rate exogenous. Depending on what determines them, exchange rate changes lead to other effects on trade, magnifying or dampening the ones presented here.

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[6]A number of theoretical reasons have been proposed to explain this fact. See, among others, Eichengreen and Hausman (2000) and Chinoy (2001). It seems that the problem of the absence of hedging is closely related to the "original sin" one, i.e. the impossibility for developing countries' agents of borrowing in their own currency. According to Eichengreen and Hausmann (2000) "these mismatches exist not because banks and firms lack the prudence to hedge their exposures; the problem rather is that a country whose external liabilities are necessarily denominated in foreign currency is, by definition, unable to hedge". Indeed, assuming that someone on the other side of the market for foreign currency hedges is strictly equivalent to assuming that the country can borrow abroad in its own currency.

2   Set-up

Firms. Varieties are sold to domestic agents, and a subset is also exported. To start the domestic production, a firm needs to employ c_{iik} units of labor in country i, sector k (similarly, c_{jjk} in the country j). Firms use a linear technology in labor, and face two types of trade costs. First, shipping goods abroad entails transportation costs, in the form of "iceberg" trade costs: firms have to export $\tau_{ij}q$ units of their variety in order to sell q units of it in the foreign country, with $\tau_{ij} > 1$.[7] Second, to access market j, sector k, country i's firms have to pay a fixed cost c_{ijk} in units of foreign labor. As mentioned in the introduction, this fixed cost of exporting represents wages paid to foreign workers, for example to acquire information or build distribution networks. We assume that all the fixed cost of export is paid in the foreign country. Relaxing this hypothesis would not modify qualitatively any result of the model as long as at least part of the fixed cost of export is paid in the foreign country. The cost functions for domestically sold and exported productions for a firm h operating in country i, sector k are:

$$C_{iik,h}(q) = \frac{w_i \tau_{ii}}{\alpha(h)}q + c_{iik}w_i \qquad C_{ijk,h}(q) = \frac{w_i \tau_{ij}}{\alpha(h)}q + c_{ijk}w_j\varepsilon_{ij} \tag{1}$$

where $\alpha(h)$ is the productivity of firm h, w_i and w_j are wages in countries i and j, and ε_{ij} is the exchange rate (an increase in ε_{ij} represents a depreciation of the country i's currency vis a vis country j - $\varepsilon_{ii} = 1$). In the spirit of Krugman (1980), we assume that all firms are symmetrical in terms of productivity, and that productivity is the same across countries, i.e. $\alpha(h) = \alpha \ \forall h$. We consider in appendix an extension of our model allowing for firms heterogeneity in terms of productivity. Without loss of generality, in each country domestic labor units are the numeraire in terms of which all prices are measured. Wages in both countries are then $w_i = w_j = 1 \ \forall i$.

Financial Market Imperfections. Contrary to standard international trade models, we suppose here that financial markets are imperfect. Firms need to borrow to finance these entry costs. Each firm's borrowing capacity depends on its collateral $\Omega(h)$, given exogenously. Each firm draws its level of collateral from a distribution with cumulative distribution function (c.d.f.) $F_k(\Omega)$ with support $[\Omega_k^{min}, \Omega_k^{max}]$. The distribution $F_k(.)$ is assumed to be sector k-specific. This assumption reflects the differences across sectors in terms of asset tangibility, as emphasized, among others, by Braun (2003) and Braun and Larrain (2005): sectors characterized by a higher level of asset tangibility have a distri-

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[7]We suppose here that τ_{ij} is country-pair specific, but does not differ across sectors. This assumption is directly driven by our empirical analysis: the lack of data on variable trade costs prevents us from considering cross-sectoral differences.

bution $F_k(.)$ concentrated on the high values of collateral.[8] The idea behind this hypothesis is similar to the one developed developed by Rajan and Zingales (1998) to address the issue of sector-specific needs for external finance: asset tangibility has a large technological component, and is therefore a good instrument for ranking the industries' relative availability of tangible assets in every country. Here, we thus assume that industries differ in terms of collateral distribution. Collateral gives access to external finance to firm h: the amount it can borrow is $\mu_i \Omega(h)$, with $\mu_i > 0$ denoting the extent of credit constraints in country i.

Finally, we assume a simplified view of the "original sin" problem: firms can only contract foreign-currency denominated debt. Here again, assuming that firms borrow in both domestic and foreign currency would make the model more complex without modifying qualitatively the results. Country i's firms then face the following borrowing constraint in country j's currency to access the foreign market:

$$\mu_i \Omega(h)/\varepsilon_{ij} \geq c_{iik}/\varepsilon_{ij} + w_j c_{ijk} \Leftrightarrow \Omega(h) \geq \frac{c_{iik} + \varepsilon_{ij} c_{ijk}}{\mu_i} \tag{2}$$

An exchange rate depreciation, i.e. an increase in ε_{ij}, makes more likely the credit constraint to be binding. Note that an implicit assumption in our framework is that financial constraints only affect fixed costs of entry. The following results would be reinforced by the consideration of financial constraints on both marginal and fixed costs, but our goal here is to emphasize the important role of fixed costs of exports in international trade's adjustment. Evidence in line with this assumption has been found by Berman and Héricourt (2008). Our empirical results will also be in line with it.

Households. Households consume $q_k(h)$ units of each variety h of sector k, for all varieties available in the market, and get a utility defined by:

$$U \equiv \prod_{k=1}^{K} \left[\int_0^{n_{ijk}} q_k(h)^{1-\frac{1}{\sigma_k}} dh + \int_0^{n_{iik}} q_k(h)^{1-\frac{1}{\sigma_k}} dh \right]^{(\frac{\sigma_k}{\sigma_k-1})\beta_k} \tag{3}$$

where $q_k(h)$ denotes consumption of variety h from sector k, $\sigma_k > 1$ denotes the elasticity of substitution of sector k, and $\sum_{k=1}^{K} \beta_k = 1$. The representative household consumes a composite good of all available varieties. The first order conditions leads to the following standard Dixit-Stiglitz demands:

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[8]i.e. a support defined on higher values of Ω

$$q_{ijk}(h) = \beta_k Y_j \frac{[\varepsilon_{ij} p_{ijk}(h)]^{-\sigma_k}}{P_{jk}^{1-\sigma_k}} \qquad \forall i,j \tag{4}$$

where $p_{ijk}(h)$ is the price of a variety produced in country i and sold in country j in sector k by firm h. P_{jk} is the ideal price index for sector k in country j, defined as follows:

$$P_{jk} = \left(\int_0^{n_{ijk}} [\varepsilon_{ij} p_{ijk}(h)]^{1-\sigma_k} + \int_0^{n_{jjk}} [p_{jjk}(h)]^{1-\sigma_k} dh \right)^{\frac{1}{1-\sigma_k}} \tag{5}$$

Prices and Profits. Profit maximization defines optimal prices, which equal marginal costs multiplied by a constant markup:

$$p_{ijk} = p_{iik}\tau_{ij} = \frac{\sigma_k}{\sigma_k - 1} \frac{\tau_{ij}}{\alpha} \tag{6}$$

As firms are homogenous in productivity, those prices do not differ across firms. Using equations (6), (4) and (5), we can express the value of total demands from country j of a firm operating in country i, sector k:

$$x_{ijk} = p_{ijk} q_{ijk} = \beta_k Y_j \frac{\varepsilon_{ij}^{\sigma_k} p_{ijk}^{1-\sigma_k}}{P_{jk}^{1-\sigma_k}} \tag{7}$$

Export-related operating profits for a firm producing in country i, sector k are positive because of monopolistic competition, and can be written as follows:

$$\Pi_{ijk} = \frac{x_{ijk}}{\sigma_k} = \frac{\beta_k Y_j P_{jk}^{\sigma_k - 1}}{\sigma_k} \left(\frac{\sigma_k}{\sigma_k - 1} \right)^{1-\sigma_k} \alpha^{\sigma_k - 1} \phi_{ijk} \varepsilon_{ij}^{\sigma_k} \tag{8}$$

where $\phi_{ijk} \equiv \tau_{ij}^{1-\sigma_k} \in [0,1]$ denotes the "freeness of trade": the larger ϕ_{ijk}, the freer trade. Note that for the sake of simplicity, we assume zero interest rate. Under Dixit-Stiglitz competition, this operating profit is simply the value of sales divided by σ_k. An increase in ε_{ij} positively affects foreign demand and operating profits through a standard pro-competitive effect.

In the next sections, we only consider sector k; we thus drop the k subscript and all sectoral variables will refer to sector k when there is no ambiguity.

3 Financial Market Imperfections, Exchange Rate Movements and Exports

Extensive Margin. In a Krugman (1980) type model of international trade with monopolistic competition, in the absence of financial market imperfection, the number of firms is endogenous and given by the zero-profit conditions:

$$\Pi_{ij} = c_{ij}\varepsilon_{ij} \qquad \forall i,j \tag{9}$$

i.e. operating profit on domestic and export markets equals the fixed cost of entry. These zero-profit conditions give the number of domestic producers and exporters in the absence of any financial market imperfection. An increase in ε_{ij} has a positive effect on export-related total profits: because of the competitiveness gain of domestic firms with respect to foreign ones, some firms enter, and the number of firms operating increases after an increase in ε_{ij} in the absence of financial imperfections. Note that because of the foreign currency denomination of the fixed cost, this effect is lower than in standard models: the pro-competitive gain of the depreciation is dampened by the increase in fixed cost - but the effect is always positive.

Here, in addition to these conditions, the borrowing constraint (2) has to be verified. Only a subset of firms are able to enter the market, this subset of firms depending on the collateral distribution $F(\Omega)$ and on the extent of borrowing constraints μ_i. We can define the threshold of collateral $\overline{\Omega}_{ij}$ such as firms are not credit constrained from entering the export market:

$$\overline{\Omega}_{ij} = \frac{c_{ii} + \varepsilon_{ij}c_{ij}}{\mu_i} \tag{10}$$

An increase in ε_{ij} has a negative effect on borrowing capacity, called the *balance-sheet* effect of the depreciation. Following Chaney (2008), we assume that the total mass of *potential* entrants (i.e. the mass of firms able to draw a collateral in the distribution) is proportional to the country' size Y_i. The maximum number of domestic producers and exporters given by the borrowing constraint (10) is:

$$n_{ij} = Y_i[1 - F(\overline{\Omega}_{ij})] \tag{11}$$

The final number of firms thus depends both on the zero profit conditions and on the borrowing constraints. More precisely, the zero-profit conditions (9) give a number of firms which prevails in the

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absence of financial market imperfections. In the presence of financial imperfections, two cases arise:

1. For a sufficiently low level of credit constraints (high μ_i), or a sufficiently low level of exchange rate ε_{ij} the number of firms given by (9) is smaller than the number of firms given by the borrowing constraint (11). n_{ij} is simply determined by the zero-profit condition - as in the Krugman (1980) model.

2. Otherwise, if credit constraints are binding, the number of firms given by (9) is larger than the number of firms effectively able to enter the market due to the borrowing constraints (11). The number of firms is thus given by (11).

The effect of exchange rate changes on the extensive margin of trade is twofold. In the second case (2), the number of firms simply decreases with ε_{ij}: the threshold of collateral $\overline{\Omega}_{ij}$ increases as the currency depreciates, and the number of exporters decreases. In the first case (1), the depreciation both increases operating profits - inciting entry - and makes the credit constraint more stringent. The number of firms first increases, until some level of ε_{ij}, from which the extensive margin starts to decrease because the credit constraint becomes binding. Large increases in ε_{ij} are more likely to negatively affect the number of exporters, by making the case (2) more likely to prevail. Then:

Lemma 1. *Without financial market imperfections ($\mu_i \to \infty$), n_{ij} is increasing with ε_{ij}. For μ_i small enough or ε_{ij} large enough, the number of exporters n_{ij} is decreasing with ε_{ij}.*

A representation of this result is given in Figure 1. The lower μ_i, i.e. the larger credit constraints, the more negative the reaction of the extensive margin of trade to an exchange rate depreciation. For any finite value of μ_i, there exists a threshold of depreciation from which the borrowing constraints becomes more stringent than the zero-profit conditions, i.e. from which n_{ij} decreases. When μ_i goes to infinity (perfect financial market case), n_{ij} is always increasing with ε_{ij}.

In the rest of this section, we shall only consider the second case (2) mentioned above, i.e. credit constraints are binding and the number of exporting firms n_{ij} determined by the free-entry condition is larger than the number of firms determined by the borrowing constraint. As a consequence, the number of firms is directly given by (11). The first case (1) brings the same qualitative results, with more complex expressions.

Intensive Margin. The values of individual exports - i.e. the *intensive margin* - is simply given by (7), using (6) and (5):
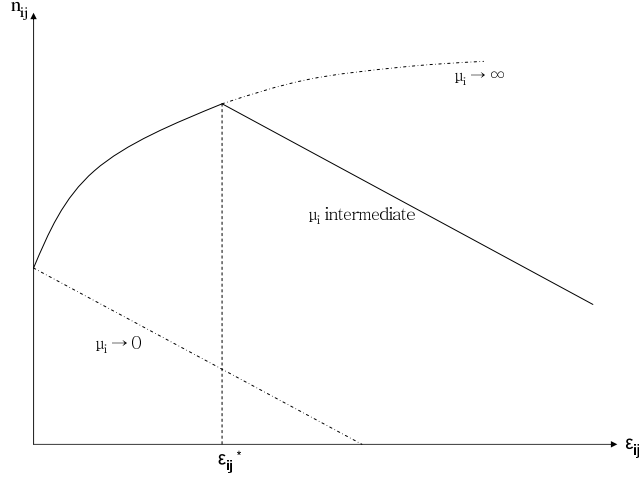
Figure 1: Reaction of the extensive margin of trade to an exchange rate depreciation

$$x_{ij} = \frac{\beta Y_j \varepsilon_{ij}^{\sigma} \phi_{ij}}{\left(n_{ij} \varepsilon_{ij}^{\sigma-1} \phi_{ij} + n_{jj} \phi_{jj} \right)} \tag{12}$$

Differentiating (12) with respect to ε_{ij}, taking (11) into account, it can easily be shown that the intensive margin increases with ε_{ij}.

Lemma 2. $\frac{\partial x_{ij}}{\partial \varepsilon_{ij}} \frac{\varepsilon_{ij}}{x_{ij}} > 0, \forall \mu_i$: *the intensive margin of trade is increasing with the exchange rate whatever the degree of financial market imperfections.*

On the intensive margin, two positive effects are in action. The first is the traditional pro-competitive effect: home varieties become cheaper than foreign ones. The second is due to the decrease in the number of home varieties, which reduces competition and allows each domestic firm to export more. Finally, $x_{ij}(\varepsilon_{ij})$ is concave, i.e. the elasticity of the intensive margin to exchange rate depreciation becomes less and less positive as ε_{ij} increases.

Total Exports. Total exports are the product of both margins of trade:

$$X_{ij} \equiv x_{ij} n_{ij} = \frac{\beta n_{ij} Y_j \varepsilon_{ij}^{\sigma} \phi_{ij}}{\left(\sum_{k=1}^{N} n_{ik} \varepsilon_{ik}^{\sigma-1} \phi_{ik} \right)} \tag{13}$$

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The elasticity of total exports to exchange rate variations is simply:

$$\frac{\partial X_{ij}}{\partial \varepsilon_{ij}} \frac{\varepsilon_{ij}}{X_{ij}} = \frac{\partial x_{ij}}{\partial \varepsilon_{ij}} \frac{\varepsilon_{ij}}{x_{ij}} + \frac{\partial n_{ij}}{\partial \varepsilon_{ij}} \frac{\varepsilon_{ij}}{n_{ij}} \tag{14}$$

The first term is increasing with ε_{ij}, while the second is decreasing with ε_{ij} when the credit constraint is binding. We then find the following testable proposition:

Testable Proposition 1. *In presence of financial market imperfections, exports can either be increasing or decreasing with ε_{ij}.*

Interestingly, not all depreciations are the same here: for a given number of exporters, larger depreciations are associated with a lower elasticity of the intensive margin to exchange rate; at the same time, larger depreciations are more likely to decrease the number of firms, as shown in figure 1. More precisely, the study of (14) leads to the following result:

Testable Proposition 2. *In presence of financial market imperfections, the impact of an increase in ε_{ij} on X_{ij} is non-linear, with a larger increase in ε_{ij} having a more negative impact on total exports.*

Currency crises are thus more likely to be associated with larger drops in the number of exporters and with lower exports. The intuition is represented in Figure 2 and already given by equation (14). Depreciation both increases the intensive margin and decreases the extensive margin. In Figure 2 the absolute values of the reactions of both margins of trade are represented. The drop in the number of exporters due to financial imperfections is more likely to overcome the competitiveness effect on the intensive margin for larger values of ε_{ij}.

Finally, sector specific elements deeply affect exports' reaction to exchange rate variations. More precisely, it can be shown that:

Testable Proposition 3. *The effect of ε_{ij} on X_{ij} is:*
(a) Increasing with elasticity of substitution (σ);
(b) Decreasing with fixed costs (c_{ij});
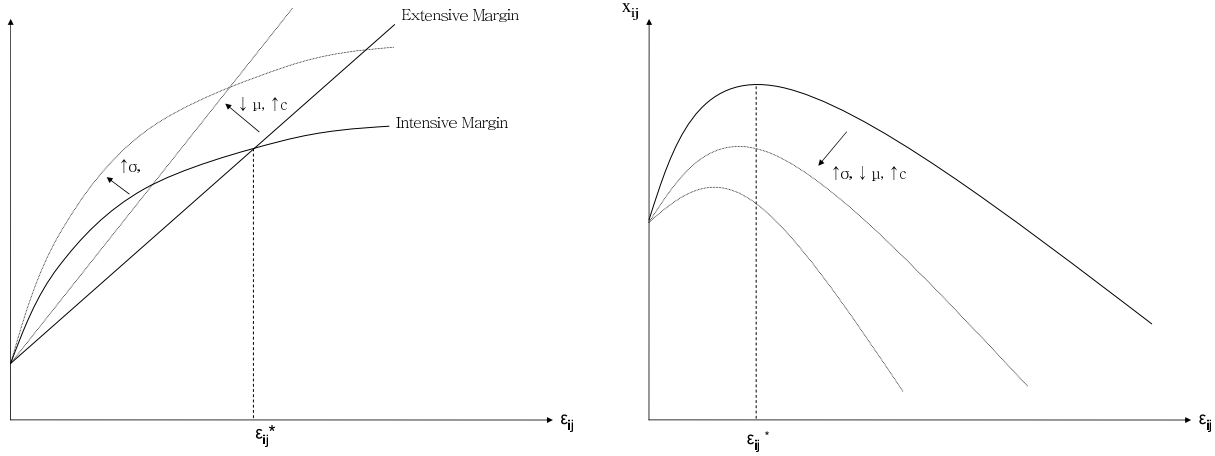*(c) Increasing with asset tangibility ($F(\Omega)$);*

Figure 2: Reactions to exchange rate depreciation of trade margins (left) and total exports (right)

The impact of exchange rate movements is magnified by a high elasticity of substitution because the increase in foreign demand toward home country varieties, i.e. the competitiveness effect is larger when goods are more substitutable (a). On the contrary, larger fixed costs magnify the balance-sheet effect, leading more firms to exit the export market following an exchange rate devaluation (b). Finally, the distribution of collateral matters: if the distribution $F(.)$ is defined over large values of Ω, the balance-sheet effect will be dampened (c). More generally, a sectoral differentiation of trade flows may allow us to understand the way in which countries' specialization affects their reaction to currency crises. In appendix 1 we calibrate the model for different values of these parameters. The impact of the exchange rate on total exports crucially depends on those parameters, which can reverse the response to an exchange rate devaluation, and in particular to large exchange rate shocks.

4 Sunk costs, foreign currency borrowing and the Long-Run impact of crises

The above intuitions are based on a static framework, where firms pay a fixed cost of export, but where there is no difference between sunk and fixed costs. The difference between the short and the long run effects of crises may be important as well. We discuss in this section the long-run impact of currency crises on exports.

Assume that firms have to pay a sunk cost to enter the export market for the first time, and a maintenance cost to remain an exporter in each subsequent period. These fixed costs, as previously, are financed through foreign currency denominated debt. In that case, a permanent decrease in the exchange rate (a currency crisis) that happens after a firm's entry will have two effects: (i) a com-

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petitiveness effect which increases the firm's expected profits, thus generating entry incentives; (ii) a balance-sheet effect, i.e. an increase in the amount of debt repayments, that increases the firm's default and exit probability. For sufficiently large devaluations, the increase in debt repayment will be too strong, so that the firm will default on its debt, this in turn generating in the subsequent period increasing financing difficulties, both because of the lower exchange rate level that increases the borrowing constraints and because of increasing interest rates charged by financial intermediaries due to the previous default. Once they have been forced to exit, and provided that the exchange rate does not return to its pre-crisis level, firms' may not re-enter, as borrowing conditions may be less favorable than before the devaluation. Therefore, both the number of exporters and total exports may be negatively and persistently affected by a currency crisis.

Interestingly, this non-linear effect of exchange rate shocks may be reinforced by the consideration of elements outside the model. In particular, the existence of incomplete pass-through (due to pricing-to-market behavior, staggered price contracts or distribution costs[9]) may limit the competitiveness effect in the short-run, while leaving unchanged the balance-sheet effect. Large exchange rate shocks may exacerbate the gap between the lack of pro-competitive effect and the increase in foreign-denominated debt, and generate an important fall in the extensive margin in the following periods. In the aftermath of the crisis, the coexistence of balance-sheet problems and sunk costs of exports can thus lastingly decrease the number of exporting firms and have a persistent effect on the level of exports. We will test in the empirical part the following proposition:

Testable Proposition 4. *Large increases in ε_{ij} have a negative and persistent impact on exports, especially when firms are more indebted in foreign currency.*

Interestingly, this intuition leads to the exact opposite result of Baldwin and Krugman (1989). According to these authors, when financial markets are perfect, only large devaluations generate a sufficient pro-competitive effect to incite entry and increase exports. Here, when firms borrow in foreign currency under credit constraints, the increase in debt repayment generates financing difficulties in the following period and forces some firms to exit the export market: exports decrease and do not increase as long as the exchange rate remains below its pre-crisis level. This is especially the case when the devaluation is large. This effect should be magnified in sectors associated with a low elasticity of substitution, in which the pro-competitive effect should be lower, and thus more likely to be overcome by the balance-sheet effect. In the same way, sectors in which fixed costs of exports are high and asset

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[9]See, among many others, Corsetti and Dedola (2005), Cook and Devereux (2006) or Devereux *et al.* (2004).

tangibility is low are more likely to endure long-lasting drops in exports following a currency crisis because of the large balance-sheet effect.

5 Imports

This simple model enlightens how high fixed export costs and financial market imperfections can interact with exchange rate movements to create non-conventional effects on international trade. Exports and imports are considered in a symmetrical way. Their reactions may however be distinct if fixed trade costs are mainly supported by exporters. In that case, the above-mentioned balance-sheet effects may only be relevant for the financing of export activities, whereas the effect of foreign currency borrowing on imports is likely to be smaller since the fixed costs associated with this activity are lower. The reaction of imports should then mainly depend on the (negative) pro-competitive effect, and be more transitory than the reaction of exports. In the next empirical section we test the relevance of the balance-sheet effect on both exports and imports. Our results support both the view that balance-sheet effects are relevant because of the existence of fixed costs, and that imports are less dependent on such fixed costs.

6 Summary

Table 1 summarizes the different channels through which trade may be affected by currency crises and the financial or sectoral elements that may magnify or reduce their impact. The impact of currency crises on imports is unambiguously predicted to be negative. Exports can either increase or decrease after a currency crisis. To assess the relevance of the different channels, one needs to take into account firms' borrowing behavior and their sectoral specialization, because differences in the levels of fixed costs, asset tangibility and elasticities of substitution can magnify one channel or the other. Also, a larger sectoral need for external finance (as defined by Rajan and Zingales, 1998) may magnify the balance-sheet effect of crises, since in the aftermath of a currency devaluation borrowing difficulties should be more salient in these sectors. All these elements interact with each other: the level of fixed costs influences the impact of crises in sectors characterized by a low asset tangibility ; the share of foreign denominated debt has a larger impact on the export reaction of industries using a large amount of external finance. Hence, a sectoral differentiation of trade flows allows us to discriminate among the different channels through which currency crises are transmitted to international trade.

Finally, all these effects presuppose that a currency crisis indeed leads to a currency devaluation, and most of them implicitly suppose that a nominal devaluation turns into a real devaluation. The first assumption is actually not systematically true, because a currency can be successfully defended after

Table 1: Currency Crises and Trade: channels of transmission

	Exports	Imports
Currency Crisis		
Competitiveness	+	-
Balance-sheet	-	-
Total Effect	?	-
Magnification		
Fixed Costs	-	
Elasticity of Substitution	+	-
Asset Tangibility	+	
External Financial Dependence	-	

a speculative attack by a variation in the interest rate or international reserves. However, empirically, most of currency crises leads to a currency devaluation[10]. In the same way, empirical evidence shows that only a small share of nominal devaluations after currency crises are transmitted to domestic prices.[11]

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[10]According to Eichengreen and Bordo (2002), only 11% of the 128 crises they registered between 1980 and 1998 did not lead to a devaluation.

[11]Goldfajn and Werlang (2000) have shown that less than 20% of the currency devaluation was reflected in the inflation rate 12 months after the 1997 Asian crisis.

III Empirical Methodology

As mentioned above, total bilateral exports simply equal the product of the intensive and extensive margins of trade, i.e. export per firm multiplied by the number of exporters. Using equations (13), we get:

$$X_{ijk} \equiv n_{ijk} \times x_{ijk} = n_{ijk}(\tau_{ij})^{1-\sigma_k}(P_{jk})^{\sigma_k-1}\left(\frac{p_{iik}}{\varepsilon_{ij}}\right)^{1-\sigma_k}Y_{jk} \tag{15}$$

Following Head and Mayer (2000), taking the ratio of X_{ijk} over X_{jjk}, country's j imports from itself[12] in sector k, we are left with the relative number of firms and relative costs in i and j:

$$\frac{X_{ijk}}{X_{jjk}} = \frac{n_{ijk}}{n_{jjk}}\left(\frac{\tau_{ij}}{\tau_{jj}}\right)^{1-\sigma_k}\left(\frac{\varepsilon_{ij}p_{jjk}}{p_{iik}}\right)^{\sigma_k-1} \tag{16}$$

The main reason for relying on this specification is that the prices indexes disappear from the equation. As suggested by Anderson and Van Wincoop (2003), the impossibility of observing those price indexes (or multilateral resistance indexes) can be solved empirically by introducing country fixed effects. However, whereas this methodology is consistent for cross-section estimations, it is not able to capture the variations in the price indexes, which may be large in a panel estimation with a sufficiently long time dimension. The use of the Head and Mayer's (2000) type of specification solves this problem.

From equation (11), the number of exporters is given by $Y_i(1 - F_k(c_{ijk}\varepsilon_{ij}/\mu_i))$. The number of country j's domestic producers in sector k, n_{jjk}, is positively related to country j's size Y_j, inversely related to the level of financial market imperfections, but does not depend on the exchange rate's level. We finally get:

$$\frac{X_{ijk}}{X_{jjk}} = \left(\frac{Y_i}{Y_j}\right)\left(\frac{\tau_{ij}}{\tau_{jj}}\right)^{1-\sigma_k}\left(\frac{\varepsilon_{ij}p_{jjk}}{p_{iik}}\right)^{\sigma_k-1}\left(\frac{1 - F_k(c_{jjk}/\mu_j)}{1 - F_k[(c_{iik} + c_{ijk}\varepsilon_{ij})/\mu_i]}\right) \tag{17}$$

The last term of equation (17) gives the impact of a currency crisis in countries i, and more precisely on the extensive margin of trade through the balance-sheet effect, which does not come from the competitiveness effect, and which is captured by the real exchange rate term. As mentioned before, the negativeness of this impact is increasing with the extent of foreign currency borrowing, with the level of fixed costs and the lack of asset tangibility. Elasticity of substitution magnifies the competitiveness effect, i.e. the role of relative prices. As mentioned before, we expect large exchange rate devaluations

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[12]i.e. total domestic production minus exports.

to have a more negative impact than smaller variations.

Basic specification

In logarithms, our basic specification takes the form of a traditional gravity-like equation augmented with crisis dummies:

$$\log\big(\frac{X_{ijk,t}}{X_{jjk,t}}\big) = \alpha_1 + \alpha_2 \log\big(\frac{Y_{i,t}}{Y_{j,t}}\big) + \alpha_3 \log\big(\frac{\varepsilon_{ij}p_{jjk,t}}{p_{iik,t}}\big) + \sum_{m=-2}^{7} \beta_m CC_{i,t-m} + \sum_{m=-2}^{7} \gamma_m CC_{j,t-m}$$

$$+ \sum_{m=-2}^{7} \delta_m BC_{i,t-m} + \sum_{m=-2}^{7} \theta_m BC_{j,t-m} + \eta_{ijk} + \xi_t + \nu_{ijk,t} \tag{18}$$

where $CC_{i,tt}$ is a a binary variable which equals 1 when country i experienced a currency crisis at year t. The competitiveness effect is captured by $\frac{\varepsilon_{ij,t}p_{jjk,t}}{p_{iik,t}}$, while $CC_{i,t}$ represents the balance-sheet effect of large devaluations.[13]

To assess the impact of crises on imports, we introduce currency crisis dummies for the importer country $(CC_{j,t})$; we also control for the occurrence of banking crises in exporter $(BC_{i,t})$ and importer countries $(BC_{j,t})$. All crisis variables are introduced with several lags in order to test the long-run impact of such events on trade as evoked in the previous section. ξ_t is a full set of year dummies, and η_{ijk} represents fixed effects specific to the pair of countries ij and to the sector k. We thus use a panel, *within* specification. This allows us to control for bilateral trade costs τ_{ij}; moreover, the inclusion of fixed effects is useful for other reasons, linked to the relationship between crises and trade. We come back to this issue at the end of the section. Finally, we estimate this equation at the sectoral level in order to assess the role of the magnification channels mentioned before.

We expect the signs of α_2 and α_3 to be positive: bilateral exports increase with relative production and the inverse of the real exchange rate (pro-competitive effect). We introduce two leads and seven lags of the crisis dummies into the equation in order to test the long-run or delayed impact of crises on trade. The number of lags is chosen mainly to keep a significant number of crises in the sample: the inclusion of a larger number of lags prevents the crises of the late nineties to be on the estimations. Nevertheless, we present robustness checks in the appendix that show that our results remain qualitatively unchanged when we modify the number of lags. Finally, it seems necessary to

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[13]Note that, as explained in more details in the next section, the currency crisis term is computed using the exchange rate with respect to the US Dollar, whereas the real exchange rate is bilateral. The latter thus captures the competitiveness effect, while the former represents the effect of foreign currency borrowing.

include banking crisis dummies into this specification because both events are often closely related[14], although they theoretically lead to very distinct effects. Banking crises are likely to be followed by important financing difficulties that may have a negative impact on trade.

The inclusion in the specification of relative prices / real exchange rate allows us to capture the competitiveness effect. We estimate the above equation with and without including this variable. When we exclude it, the β_m, i.e. the coefficient on the currency crisis variable for the exporter, can be either positive or negative. The inclusion of the real exchange rate is intended to decrease the estimated value of these coefficients. The γ_m are theoretically negative for all lags, reflecting the negative effect of currency crises on imports. They are expected to be more negative when prices are excluded. Finally, the relative sizes of the estimated β_m and γ_m delivers insights about the persistence of the reactions of exports and imports to currency crises.

Channels of Transmission

The estimation of equation (18) tests the total effect of currency crises on trade, which we expect to be negative. However, it does not allow to draw any conclusion on the precise channels of transmission underlying this effect, i.e. whether it comes from the combination of financial market imperfections and fixed costs of export. The theoretical section highlighted the fact that the relevance of both channels - the competitiveness and the balance-sheet channels - may differ across countries (depending on the extent of foreign currency borrowing) and across sectors (depending on the levels of elasticity of substitution, fixed costs, asset tangibility and external financial dependence). To disentangle the impacts of each channels, we thus introduce interaction terms into the basic equation between our variables of interest and financial imperfections or sectoral characteristics. The second estimated specification will take the form:

$$\log\left(\frac{X_{ijk,t}}{X_{iik,t}}\right) = \alpha_1 + \alpha_2 \log\left(\frac{Y_{jk,t}}{Y_{ik,t}}\right) + \sum_{m=0}^{n} \pi_m \log\left(\frac{\varepsilon_{ij}p_{jjk,t-m}}{p_{iik,t-m}}\right) + \sum_{m=0}^{n} \beta_m CC_{i,t-m} + \sum_{m=0}^{n} \gamma_m CC_{j,t-m}$$

$$+ \sum_{m=0}^{n} \delta_m BC_{i,t-m} + \sum_{m=0}^{n} \theta_m BC_{j,t-m} + \sum_{m=0}^{n} \omega_m FCB_{i,t} * CC_{i,t-m} + \sum_{m=0}^{n} \kappa_m FCB_{j,t} * CC_{j,t-m}$$

$$+ \sum_{m=0}^{n} \tau_m \log(\sigma_k) * \log\left(\frac{\varepsilon_{ij,t-m}p_{jjk,t-m}}{p_{iik,t-m}}\right) + \sum_{m=0}^{n} \phi_m Spec_k * CC_{i,t-m} + \eta_{ijk} + \xi_t + \rho_{ij,t} \qquad (19)$$

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[14]See for example Kaminsky and Reinhart (1999) and the literature on twin crises.

where $FCB_{i,t}$ denotes Foreign Currency Borrowing in country i at year t, σ_k the elasticity of substitution and $Spec_k$ either fixed costs, asset tangibility or the financial dependence of sector k. As argued before, we expect currency crises to have a more negative impact when firms' foreign currency borrowing is large ($\omega_m, \kappa_m < 0$) because of negative balance-sheet effects. The estimated coefficient on exports should be larger than the one on imports because of the potentially higher fixed costs associated with the export activity ($\omega_m > \kappa_m$). The balance-sheet effects are expected to be magnified by greater financial dependence or higher fixed costs ($\phi_m < 0$), and elasticity of substitution is expected to magnify the competitiveness channel ($\tau_m > 0$).

Econometric Issues

Different simultaneity and reverse causality biases may arise when considering the impact of currency crises on trade. First, both trade flows and the probability of a crisis may be affected by external, time-specific shocks - for example commodity prices shocks or US interest rate variations. The inclusion of year dummies in the equation is therefore crucial. Second, some simultaneity problems may be present because of crisis contagion. The use of a gravity-like framework allows us to take this issue into account: the inclusion of the importer crisis dummies captures the decline in trade in the exporting country due to the devaluation of its partner's currency. This contagion issue is even more important when trade is naturally high between the two countries. Introducing country-pair specific effects into the equation solves this problem. There only remain the problems of the country-time specific factors that may affect both trade and the likelihood of crises, and the fact that the level of trade itself should influence the probability of occurrence of crises through trade balance and international reserves. To take the first issue into account, we include in the last set of estimations country-time dummies to check the robustness of our results. These effects cannot be included in the other specifications, in which our variables of interest are country-time specific too. The reverse causality problem is harder to take into account because of the lack of good instruments - variables correlated with currency crises which are not affected by trade. Here again, the use of a gravity equation reduces the problem: it seems less likely that sectoral bilateral trade influences the likelihood of currency crises than total trade. All sectoral bilateral trade levels have to decrease in order to have an impact on trade balance and on currency crises. Moreover, we introduce into the equation leads terms of the currency crisis dummies, which capture the pre-crisis level of bilateral trade.

IV   Data

Gravity Variables

We use a large sectoral database of bilateral trade which combines COMTRADE and CEPII data for bilateral trade and UNIDO data for production, for 26 ISIC 3-digit industries between 1976 and 2002. The relative prices are captured by the price levels of GDP; the data comes from the Penn World Tables v.6.1.[15]

Financial Crises

The simplest way to identify currency crises has been proposed by Frankel and Rose (1996): they define a currency crash as a large change in the nominal exchange rate (25 percent) that is also accompanied by substantial increase in the rate of change of the nominal depreciation (10 percent). As we already mentioned, most often, speculative attacks have been resolved through a devaluation of the currency or its flotation. Nevertheless, it seems necessary to take into account the possibility of currency defenses by central banks through contractionary monetary policies or the selling of foreign exchange reserves. The most common way to put together these elements is to compute a "foreign exchange market pressure" index. This is the method used in most studies that deal with currency crises. The computed index takes into account both exchange rate and international reserves variations:[16] it is a weighted average of these two indicators with weights such that the two components have equal sample volatility.[17] Large positive readings of this index indicate speculative attacks.[18] The problem with this approach is the definition of the threshold above which we consider that the index indicates a crisis. Kaminsky and Reinhart (2000) use a value of three standard deviations above the mean; for Eichengreen and Bordo (2002), a crisis is said to occur when this index exceeds one and a half standard deviations above its mean. The identification of crises is dependent on this choice, so it seems necessary to control the empirical results by using different thresholds.

We have constructed different indexes of currency crises using both Frankel and Rose's (1996) method and the "foreign exchange market pressure" one, with two different thresholds. In the next estimations we use an index of currency crisis computed as exchange rate market pressure as in

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[15]A more detailed description of the trade, production and prices database is available on the CEPII's website, at the following address: http://www.cepii.fr/francgraph/bdd/TradeProd.htm.

[16]It is often difficult to introduce interest rates because of lack of data. Moreover, using a large sample of developed and developing countries, Kraay (2003) has shown that interest rates have generally been ineffective in defending currencies during speculative attacks.

[17]This weighting scheme prevents the much greater volatility in the exchange rate from dominating the crisis measure.

[18]See for example Kaminsky and Reinhart (2000), Hong and Tornell (2005), Eichengreen and Bordo (2000) or Eichengreen *et al.* (1996) for details about the computation.

Eichengreen and Bordo (2002). Robustness checks have been made to check the results with the other indexes.

Finally, to control for the occurrence of banking crises, we use the Caprio and Klingebiel (2002) data. Their list of banking crises is highly consistent with previous studies, and includes a sizeable number of countries and years. Moreover, they provide a description of each crisis and a distinction between small - "borderline" - and large - "systemic" - crises.

Channels of Transmission

Foreign currency borrowing. We use different measures to assess the impact of foreign currency borrowing. The first is constructed from the WBES (World Bank) data, a firm-level survey that covers more than 10, 000 firms in 80 countries, and contains for each firm the share of foreign debt over total debt. For each country, an average index of firms' currency borrowing is computed. The results of our computations are reported in the appendix. As the WBES contains information on small and medium firms, which have restricted access to foreign financial markets, it seems logical to find small shares of foreign borrowing. Nevertheless, the ranking of the different countries is found to be consistent with empirical observations (the level of foreign borrowing in Argentina, a highly "dollarized" economy, is much higher than the share of industrialized countries).

The WBES data is only available for the year 2000 - so we implicitly suppose here that this element relies on financial imperfections that are country-specific, and has an important structural component. It seems however unlikely that the level of dollarization has not evolved over time, in particular during a change of currency regime (Martinez and Werner, 2002). To ensure the robustness of our results, we use two alternative, time-varying measures. The first comes from the Inter-American Development Bank and covers 10 Latin American countries over the period 1990-2002. It has been constructed from a panel of Latin-American listed companies. For more details on this data, see Kamil (2004). The second measure has be constructed by Carlos Arteta[19], and contains data on deposit money banks' foreign-currency-denominated credit to the resident private sector for 40 developing and transition economies. Depending on the country, the data either come from the International Financial Statistics (IMF) or Central Banks. For more information on this dataset, see Arteta (2005) or Arteta (2003). Both databases provide time-varying measures of foreign currency borrowing, but the information is either available for a small number of countries (IADB data) or for a small number of years (Arteta's data). To keep a maximum of observations in our sample, we chose to present the results using the three measures. Table 5 (Appendix) summarizes the results obtained for two selected indicators of

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[19]We are grateful to Carlos Arteta for sharing this database.

financial crises, and for the first measure of foreign currency borrowing.

Sectoral Data. Finally, we use different sectoral data to test the interaction between currency crises, country specialization and international trade. We first consider the role of elasticity of substitution by using the Broda and Weinstein's (2004) estimates. Sectoral asset tangibility comes from Braun (2003), and represents, for each sector "natural availability of assets that serve well at protecting outside investors in an incomplete contracting setting".[20] Finally, the data on external financial dependence comes from Rajan and Zingales (1998); external dependence is defined by these authors as the "share of capital expenditures that are not financed by cash flow from operations". As emphasized by Braun (2003) and Rajan and Zingales (1998), both asset tangibility and external financial dependence are expected to have a large technological component. Therefore, the constructed variable is a good instrument for ranking the industries' relative availability of tangible assets and need for external finance in every country. Sectoral data on elasticity of substitution, asset tangibility and external financial dependence are given in Table 6 (Appendix).

Fixed costs. We use two different proxies for fixed costs. The first is a country-specific proxy coming from the Doing Business Database (World Bank) and consists in the ranking of the destination country in terms of "Trading Across Borders". More precisely, it summarizes different custom procedures, including the number of documents required, number of days, and cost to export to this country. Our second proxy is the Rauch (1999) classification of traded goods. In this classification, goods are separated into three categories: homogenous, reference prices and differentiated. One can expect a larger fixed export cost for differentiated goods because an exporter specialized in very differentiated goods may face larger costs linked to the research for trading partners, marketing or publicity.

Put together, our database covers 32 countries and 27 3-digits ISIC sectors over the period 1976-2002.

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[20]More precisely, at the firm level, it represents the sum of net property, plant and equipment divided by the book value of assets.

V Results

1 Overall Impact

Table 2 summarizes the impact of currency crises on trade during the year of the crisis and the following one. In these estimations we use a broad definition of currency crises[21] and we consider only systemic banking crises as listed by Caprio and Klingebiel (2003). The detailed list of these events is given in the appendix. The first part of the table presents the gravity variables coefficients, and the second part the impact of currency crises. In columns (A) to (E) we include exporter and importer dummies and estimate our basic specification with panel random effects, controlling for country-pair characteristics. The traditional control variables are included: bilateral distance, contiguity, free trade agreement, colonial relationship and common language between countries i and j. The data comes from the CEPII and Rose (2005). Column (F) presents our preferred specification, with fixed effects.

Gravity variables are highly significant and have the expected signs, and the estimated coefficients are in line with the results found by previous studies.[22] The impact of crises on both exports and imports is negative and significant when real exchange is included in the estimations (columns (C), (D) and (F)). The reaction of imports is more negative than that of exports. When the real exchange rate is excluded (column (E)), its effect on bilateral exports in the year that follows the event becomes insignificant. This suggests that - at least in the short-run - the competitiveness effect is not sufficiently important to generate a beneficial impact on the level of exports, i.e. that the other channels (and in particular the balance-sheet channel) are strong enough to cancel the benefits of the currency devaluation. On the import side, the currency crisis coefficients decrease when relative prices are excluded. Finally, as expected, the inclusion of year dummies significantly decreases the negative impact of crises on both exports and imports, but the effect remains significant. These results are robust to the use of different estimation techniques[23] and definitions of currency crises.

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[21]More precisely, a currency crisis is said to occur when the exchange market pressure index exceeds 1.5 standard deviations above its mean.

[22]See for example Mayer and Zignago (2005).

[23]Panel Fixed and Random effects are presented here. The use of a left-censored Tobit estimation, which aims at taking into account the important number of zero values of sectoral bilateral trade flows dependent variable in our sample, leads to the same results, which are available upon request.

Table 2: Short Run Impact of Currency Crises on Trade

Dependent Variable : Relative Trade

	(A)	(B)	(C)	(D)	(E)	(F)
Gravity Variables						
Relative Production	0.550^a	0.531^a	0.550^a	0.531^a	0.514^a	0.520^a
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Real Exchange Rate	0.529^a	0.542^a	0.534^a	0.541^a		0.538^a
	(0.011)	(0.010)	(0.011)	(0.010)		(0.010)
Relative Distance	-1.193^a	-1.294^a	-1.197^a	-1.294^a	-1.297^a	
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	
Contiguity	0.345^a	0.436^a	0.350^a	0.437^a	0.429^a	
	(0.069)	(0.069)	(0.069)	(0.069)	(0.068)	
Free Trade Agreements	0.568^a	-0.009	0.531^a	-0.021	-0.028	-0.088
	(0.021)	(0.022)	(0.021)	(0.022)	(0.021)	(0.022)
Colonial Relationship	0.952^a	0.956^a	0.948^a	0.954^a	0.964^a	
	(0.088)	(0.088)	(0.088)	(0.088)	(0.087)	
Common Language	0.850^a	0.846^a	0.849^a	0.845^a	0.846^a	
	(0.042)	(0.042)	(0.042)	(0.042)	(0.041)	
Crises Variables						
Currency Crisis, exporter			-0.153^a	-0.072^a	-0.070^a	-0.070^a
			(0.010)	(0.009)	(0.009)	(0.009)
Currency Crisis, exporter (t-1)			-0.096^a	-0.053^a	-0.008	-0.056^a
			(0.010)	(0.010)	(0.009)	(0.009)
Currency Crisis, importer			-0.197^a	-0.119^a	-0.106^a	-0.123^a
			(0.010)	(0.010)	(0.010)	(0.010)
Currency Crisis, importer (t-1)			-0.147^a	-0.088^a	-0.117^a	-0.092^a
			(0.010)	(0.010)	(0.010)	(0.010)
Exp. / Importer Dummies	Yes	Yes	Yes	Yes	Yes	No
Sector Dummies	Yes	Yes	Yes	Yes	Yes	No
Year Dummies	No	Yes	No	Yes	Yes	Yes
Adj. R-Squared	0.62	0.63	0.62	0.63	0.63	0.36
Observations			287,791			
Number of groups			23,537			
Estimation			Random Effects			Within

Significance levels: ^{c} 10%, ^{b} 5%, ^{a} 1%. Robust Standard Errors into parentheses. Intercept and banking crises coefficients not reported.

Figures 3 and 4 show the long-run impacts of currency crises on trade. Using a methodology similar to Martin *et al.* (2008), we estimate equation (18), which includes seven lags and two leads of each crisis dummy, and plot graphs with respect to the estimated coefficient of these variables and to their 95% confidence interval - which are represented by the dashed lines. The gravity equation is supposed to give an estimate of the "natural level" of trade flows between two countries, depending on their sizes, distance and others country-pair characteristics, captured here by the fixed effects. Thus, the

estimated coefficients of the lags and leads of the crisis dummies introduced in the gravity equation can be interpreted as deviations from the "natural level" of trade generated by currency crises.
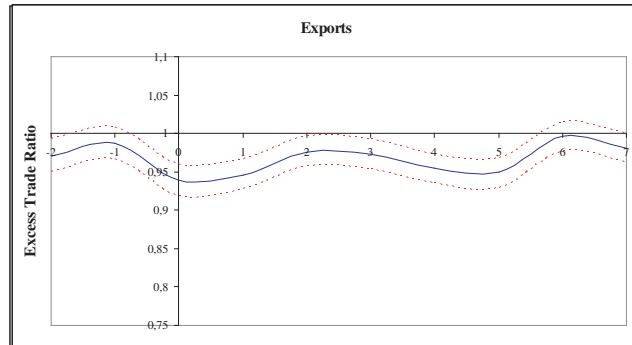

Figure 3: Deviation from the natural level of trade after a currency crisis: Exports

The estimated impact of currency crises on trade is different according to the case considered. Let us first consider the reaction of exports (Figure 3). The crisis has an immediate and long-lasting negative impact: exports decrease during the year of the crises, and remain below their natural level during six years after the event. This result underlines the persistence of large exchange rate shocks on international trade. As the results of the next section suggest, contrary to Baldwin and Krugman (1989), this persistence may not only be due to the sunk character of fixed costs of exports but also to the existence of financial market imperfections generating important balance-sheet effects, which in turn increase the cost of trade during the following years. More precisely, large devaluations can durably decrease the number of exporters and have a persistent negative impact on the total level of trade. Because of the sunk character of fixed costs, exiting firms may not re-enter after the shock.
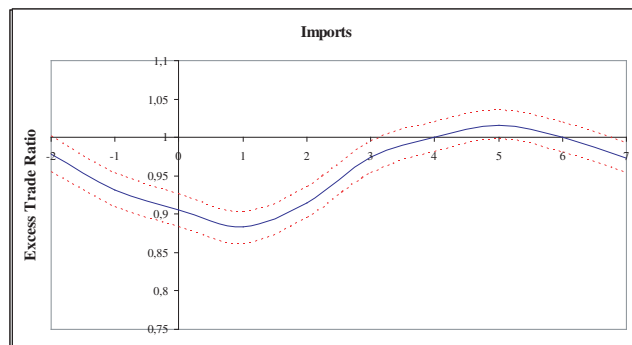

Figure 4: Deviation from the natural level of trade after a currency crisis: Imports

The impact of currency crises on imports (Figure 4) is less persistent. Imports plummet in the short

run by more than 10%, and remains statistically below their natural level during the three years that follow the crisis. As the results in the next section will suggest, negative balance-sheet effects are insignificant on imports, suggesting that fixed costs associated with this activity are lower. The negative impact of currency crises on imports may partly be due to the recession that often follows a financial crisis, and which can involve a fall in demand for both home and foreign goods. As we include in the specification the sectoral production of the country, which is only an imperfect measure of home demand, we cannot fully control for this demand effect.

Finally, these results are qualitatively unchanged by the use of a different number of lags, neither qualitatively nor quantitatively.[24] In the next sections we disentangle the main elements underlying the above-mentioned results, by looking more precisely at the role of financial imperfections and sectoral specialization.

2   Balance-sheet effect of currency crises

We first study the impact of foreign currency borrowing on the reaction of trade to a currency crisis. We introduce interacted terms between currency crisis and foreign currency borrowing into our estimation. We expect the sign of these variables to be negative; the sign of the currency crisis variable alone can become either positive of negative; if it becomes positive, we can conclude that the negative effect of currency crises found previously principally comes from this balance-sheet problem; if the coefficient on the currency crisis dummy remains negative, the other mechanisms (volatility, cost channels) remain relevant in explaining the negative reaction of trade flows after currency crises.

Our results are reported in Table 3. To allow a clearer reading the gravity variable coefficients are not reported. Estimations (A), (B) and (C) use the indicator of foreign currency borrowing constructed from WBES data, presented in the data subsection. In estimation (C), the real exchange rate variable is excluded. We check the robustness of our results by using the time-varying measure of the Inter-American development bank (estimations (D) and (E)) or the measure of Arteta (2005) (estimation (F)). The sample is importantly reduced since these measure are only available for a sub-sample of countries (IADB measure) or for a reduced number of years (Arteta's index). We only introduce three lags in these specifications to keep a sufficient number of observations in our sample.

The results stress an important, negative and persistent role of foreign currency borrowing in the impact of currency crises on exports. After one year, the coefficient of the currency crisis dummy becomes insignificant or positive (depending on whether the competitiveness is taken into account separately, as in columns (A) and (B), or through the currency crisis variable, as in column (C)),

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[24]Results available upon request.

suggesting that the balance-sheet effect of the currency crisis accounts for most of the total negative effect of the event on exports. These results are confirmed by the use of the alternative measures of foreign currency borrowing (columns (D), (E) and (F)). When we exclude the real exchange rate variable (column (C)), i.e. when the currency crisis variable alone captures the whole effect of the event - including the pro-competitive effect -, the coefficient on this variable becomes positive after one year, meaning that, when the degree of foreign currency borrowing is very low, the overall impact of the event on exports is positive. Currency crises then have an expansionary effect on bilateral exports when there foreign currency borrowing is very low.

The reaction of imports is somewhat different. Balance-sheet effects are lower or insignificant (columns (A), (B), (D)). This result supports the view according to which balance-sheet effects arise because of the existence of high fixed costs that are mainly borne by exporters, and that post-crisis export variation is principally explained by an adjustment of the extensive margin of trade.

Estimation (B) includes, in addition to the currency crisis dummy and the term interacted with foreign currency borrowing, a term controlling for exchange rate volatility. Post-crisis exchange rate levels are indeed often characterized by an important uncertainty. The impact of volatility on international trade has been widely studied, but the results are mitigated, both empirically and theoretically (see for example Tenreyro, 2007). Clark *et al.* (2004) explain this lack of robustness by the fact that the exchange rate variability is the result of shocks which can themselves affect trade. For example, exchange rate volatility can originate from measures of trade liberalization that increase the total volume of trade flows. Klaassen (2004) argues that the true effect of exchange rate risk on trade is difficult to assess because export decisions are mostly affected by the probability distribution of the one-year rate, which appears fairly constant over time. However, it seems necessary to take into account the exchange rate riskiness in an empirical treatment of the impact of currency crises since the volatility associated with such events is somewhat different and larger, and could well cause more important effects. We have computed for each pair of countries and year of our sample an index of bilateral volatility based on the monthly exchange rate of each currency against the SDR.[25] The computation of this volatility term follows the methodology of Tenreyro (2007). The introduction of this term does not really modify the results: volatility is found to have an important negative effect on bilateral trade flows. It explains a part of the negative reaction of imports in the short run - comparing estimations (A) and (B), the estimated coefficients of the currency crisis dummies on imports go down in the year of the crisis and the following one when we include the bilateral volatility term, while the coefficient on exports is not significantly modified. Nevertheless, the impact of a currency crisis in the year of the event remains negative even after we take volatility into account. This can be due to the fact that we

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[25]The data comes from the International Financial Statistics (IFS).

Table 3: Balance-sheet effects of currency crises on trade

Dep. Var	Relative Trade											
FCB Variable	WBES						IADB				Arteta (2005)	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Estimation	(A)		(B)		(C)		(D)		(E)		(F)	
Exports												
Currency crisis (CC_i)	-0.127^a	(0.018)	-0.117^a	(0.019)	-0.122^a	(0.018)	-0.012	(0.062)	0.104	(0.106)	0.645^a	(0.157)
$T-1$	0.002	(0.018)	0.003	(0.019)	0.053^a	(0.018)	0.040	(0.091)	0.221	(0.163)	0.059	(0.251)
$T-2$	0.016	(0.019)	0.007	(0.019)	0.067^a	(0.018)	1.511^a	(0.217)	2.184^a	(0.468)	1.683^a	(0.294)
$T-3$	-0.009	(0.018)	-0.019	(0.018)	0.030^c	(0.018)	1.323^a	(0.224)	1.310^a	(0.412)	0.678^a	(0.253)
$T-4$	-0.026	(0.017)	-0.016	(0.018)	0.021	(0.018)						
$CC_i \times FCB_i$	0.014^a	(0.003)	0.019^a	(0.017)	0.015^a	(0.003)	2.298^a	(0.666)	3.063^b	(1.358)	-3.062^a	(0.711)
$T-1$	-0.007^a	(0.003)	-0.005^b	(0.002)	-0.013^a	(0.003)	0.115	(0.243)	0.838	(0.575)	0.305	(0.625)
$T-2$	-0.019^a	(0.004)	-0.019^a	(0.004)	-0.025^a	(0.003)	-2.453^a	(0.452)	-3.125^a	(0.850)	-3.962^a	(0.658)
$T-3$	-0.016^a	(0.003)	-0.013^a	(0.003)	-0.017^a	(0.003)	-2.372^a	(0.475)	-2.286^a	(0.858)	-1.717^a	(0.566)
$T-4$	-0.018^a	(0.003)	-0.019^a	(0.003)	-0.024^a	(0.003)						
Imports												
Currency crisis (CC_j)	-0.087^a	(0.010)	-0.062^a	(0.010)	-0.073^a	(0.009)	-0.105^b	(0.051)	-0.280^a	(0.100)	-0.081^b	(0.041)
$T-1$	-0.105^a	(0.010)	-0.091^a	(0.010)	-0.117^a	(0.009)	-0.147^a	(0.046)	-0.371^b	(0.176)	-0.127^a	(0.040)
$T-2$	-0.113^a	(0.010)	-0.098^a	(0.010)	-0.126^a	(0.009)	-0.085^b	(0.042)	0.218	(0.463)	-0.041	(0.039)
$T-3$	-0.120^a	(0.010)	-0.104^a	(0.010)	-0.144^a	(0.009)	-0.090^b	(0.036)	-0.807^c	(0.437)	0.020	(0.038)
$T-4$	0.010	(0.010)	0.017^c	(0.010)	-0.007	(0.009)						
$CC_j \times FCB_j$	0.001	(0.004)	0.000	(0.004)	-0.000	(0.003)			1.421	(1.347)		
$T-1$	-0.007^b	(0.003)	-0.006^c	(0.003)	-0.006^c	(0.003)			0.693	(0.515)		
$T-2$	-0.002	(0.003)	-0.001	(0.003)	-0.002	(0.003)			-0.093	(0.871)		
$T-3$	-0.010^a	(0.003)	-0.008^b	(0.003)	-0.009^a	(0.003)			1.590^c	(0.882)		
$T-4$	-0.003	(0.003)	-0.001	(0.003)	-0.004	(0.003)						
Bilateral ER Volatility			-0.835^a	(0.090)								
No. Obs.	247,794		240,623		257,199		18,321		3,817		22,280	
No. Groups	23,172		23,162		23,230		5,280		1,482		3,906	
Adj. R^2	0.85		0.85		0.85		0.90		0.92		0.84	
Year Dummies	Yes		Yes		Yes		Yes		Yes		Yes	
Real Exchange Rate	Included		Included		Excluded		Included		Included		Included	

FCB: Foreign Currency Borrowing. Panel, Fixed Effects estimations. Intercept, gravity equation variables and banking crises dummies not reported. Significance levels: ^{c} 10%, ^{b} 5%, ^{a} 1%. Robust Standard Errors into parentheses. Estimations (A), (B) and (C) uses the first measure of FCB, computed from WBES data. Columns (D) and (E) uses the second measure, from the Inter-American Development Bank. Column (F) uses the measure constructed by Arteta (2005).

do not take into account the precise month of occurrence of the crisis. If our sample is biased toward end-of-year crises, the crisis dummy will not capture the proper effect of the crisis, but rather the loss of competitiveness due to the pre-crisis overvaluation of the currency.

Another way to show the significance of balance-sheet effects on exports in the longer-run is to estimate the specification including the crisis lags terms on two different sub-samples, defined according to the level of foreign currency borrowing. Figure 5 represents the deviation from the natural level of trade generated by a currency crisis in highly (respectively lowly) dollarized countries, i.e. in countries in which the level of foreign currency borrowing is above (resp. below) the median of the WBES measure. We do not include the real exchange rate term in these specifications, so that the plotted impact represents the whole effect of the crisis on exports, including the competitiveness effect. The difference between the two sub-samples is striking: exports plummet in the year that follow the crisis in highly dollarized countries, while countries displaying a low ratio of foreign currency debt experience a significant increase in exports. The impact is persistent in both case, but of opposite sign. This is consistent with the idea of Baldwin and Krugman (1989) that large devaluations should have of positive and persistent impact on exports under perfect financial markets. On the contrary, the existence of financial market imperfections such as foreign currency borrowing leads to a reversal of the impact, namely a long-lasting drop in exports.
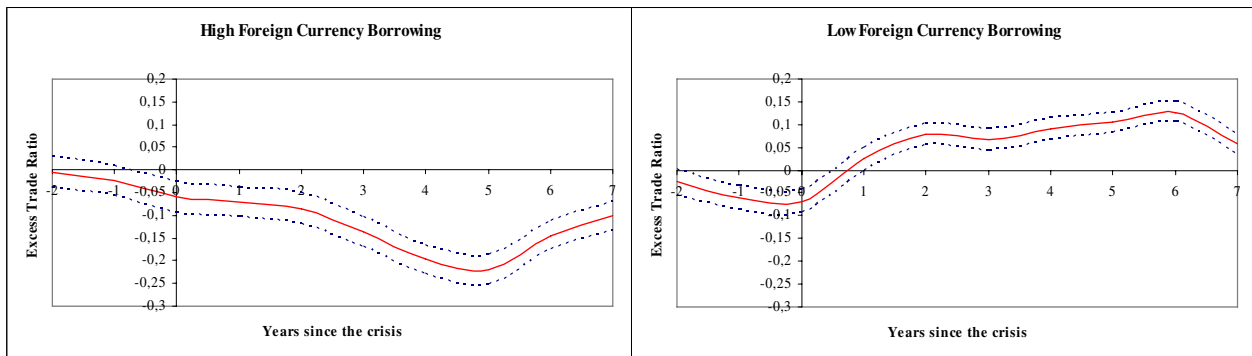

Figure 5: Deviation from the natural level of trade after a currency crisis: foreign currency borrowing sub-samples

These results strongly suggest that the impact of financial market imperfections is active both in the short and long-run, and is especially important three to four years after the event. This supports the view according to which currency crises not only increase entry difficulties, but also force some firms to exit the export market, thus negatively affecting the level of exports in the long term through the extensive margin of trade. Note that the use of alternative measures of foreign currency borrowing does not alter the results.

3 Sectoral Specialization and the impact of currency crisis on exports

As previously emphasized, four major sectoral elements can modify the way exports react to a currency crisis: (i) the elasticity of substitution, (ii) the amount of fixed costs, (iii) the degree of asset tangibility, and (iv) the extent of external financial dependence. We first use as a proxy for fixed costs the ranking of the destination country in terms of custom procedures described in the data section. The estimated coefficient of the interaction of this variable with the currency crisis dummy is expected to be negative. On the other hand, the real exchange rate terms are interacted with the level of elasticity of substitution from Broda and Weinstein (2004), and the currency crisis variable with either the degree of sectoral asset tangibility from Braun (2003) or the sectoral external dependence from Rajan and Zingales (1998). If significant, the two first interaction terms are expected to have a positive sign, while the last one is expected to be negative. Finally, we also interact our currency crisis dummy with elasticity of substitution. As emphasized in the theoretical part, elasticity is supposed to affect only the pro-competitive effect of the currency crisis, which is captured by the real exchange rate term: we thus expect the coefficient on this interaction term to be insignificant.

Our results are presented in Table 4. To allow for a clearer reading, we only report the estimated coefficients of the variables linked to currency crises and exports. To control for foreign currency borrowing and exchange rate volatility does not alter the results. Consistent with theory, a lower elasticity of substitution significantly dampens the competitiveness effect (column (A)): the interacted terms between this variable and relative prices is positive and significant. Also in line with our prediction is the fact that elasticity of substitution does not influence the reaction of trade to larger exchange rate shocks: in estimation (B), the interaction between this variable and the currency crisis term is insignificant. The reaction of exports to currency crises is also significantly affected by the other elements: larger fixed costs (column (C)), lower asset tangibility (column (D)) and higher external financial dependence (column (E)) magnify the negative effect on exports.

As in the previous section, for each sectoral variable, we can separate the sample into two sub-samples according to the degree of fixed costs, asset tangibility and external financial dependence respectively. Figures 6, 7 and 8 represent the deviation from the natural level of bilateral exports generated by currency crises, according to these three elements. Figure 6 uses the Rauch's sectoral classification as a proxy for fixed costs. The created variable takes the value 1 if the sector contains principally homogenous goods, 2 if it contains reference priced goods, and 3 if it contains differentiated goods. An increase in this proxy is interpreted as larger sectoral fixed costs. Similar results are obtained with the Doing Business destination-specific variable.

Table 4: Specialization and the impact of currency crises on exports

Dep. Var	Relative Trade									
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Estimation	(A)		(B)		(C)		(D)		(E)	
Currency Crisis, exporter (CC_i)	-0.021^b	(0.010)	-0.087^b	(0.042)	0.004	(0.029)	-0.123^a	(0.022)	-0.038^a	(0.013)
T-1	-0.017^c	(0.010)	-0.072^c	(0.042)	0.018	(0.029)	-0.117^a	(0.022)	-0.039^a	(0.013)
T-2	-0.036^a	(0.010)	-0.027	(0.042)	0.046	(0.029)	-0.088^a	(0.022)	-0.032^b	(0.013)
T-3	-0.099^a	(0.010)	-0.074^c	(0.042)	-0.061^c	(0.031)	-0.115^a	(0.022)	-0.071^a	(0.013)
...										
Elasticity× Real Exchange Rate	0.039	(0.027)	0.044^c	(0.027)						
T-1	0.108^a	(0.027)	0.103^a	(0.028)						
T-2	0.036	(0.028)	0.030	(0.028)						
T-3	0.061^b	(0.026)	0.060^b	(0.027)						
Elasticity× CC_i			0.049	(0.030)						
T-1			0.040	(0.030)						
T-2			-0.004	(0.031)						
T-3			-0.019	(0.030)						
Fixed Cost (Doing Business)× CC_i					-0.019^b	(0.008)				
T-1					-0.023^a	(0.008)				
T-2					-0.028^a	(0.008)				
T-3					-0.009	(0.008)				
Asset Tangibility× CC_i							0.223^a	(0.076)		
T-1							0.216^a	(0.076)		
T-2							0.132^c	(0.076)		
T-3							0.074	(0.076)		
External Dependence× CC_i									-0.097^a	(0.033)
T-1									-0.095^a	(0.032)
T-2									-0.095^a	(0.033)
T-3									-0.082^b	(0.032)
Observations	235,702		235,702		261,936		246,013		261,936	
Number of groups	23,046		23,046		23,288		21,673		23,288	
Adj. R-Squared	0.85		0.85		0.84		0.85		0.84	
Year Dummies	Yes		Yes		Yes		Yes		Yes	

Panel Fixed Effects estimations. Intercept, gravity equation variables and banking dummies not reported. Significance levels: [c] 10%, [b] 5%, [a] 1%. Robust Standard Errors into parentheses.

Unambiguously, sectors characterized by low fixed costs, high asset tangibility and low external dependence react more positively after the event. However, it is worth noting that neither sub-sample is found to experience a positive and significant reaction, suggesting that, in the presence of financial market imperfections, all manufacturing sectors are affected negatively by the crisis to some extent.
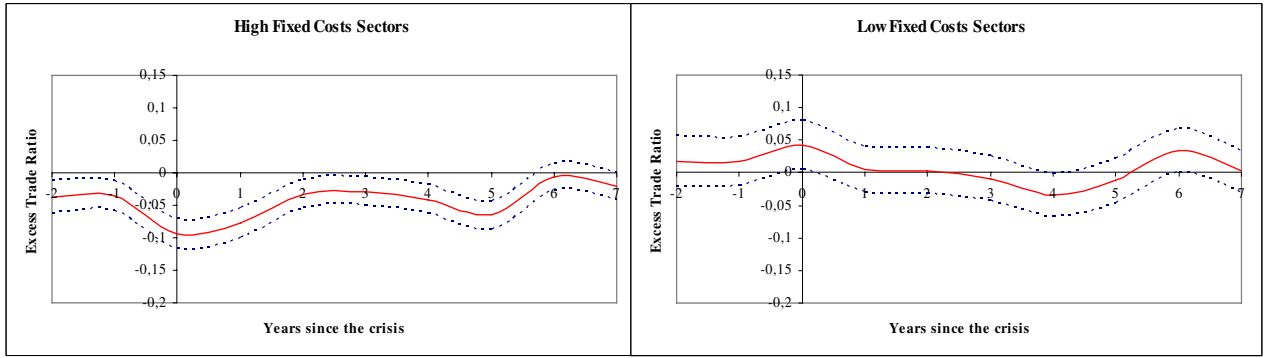
Figure 6: Deviation from the natural level of trade after a currency crisis: sectoral fixed costs sub-samples
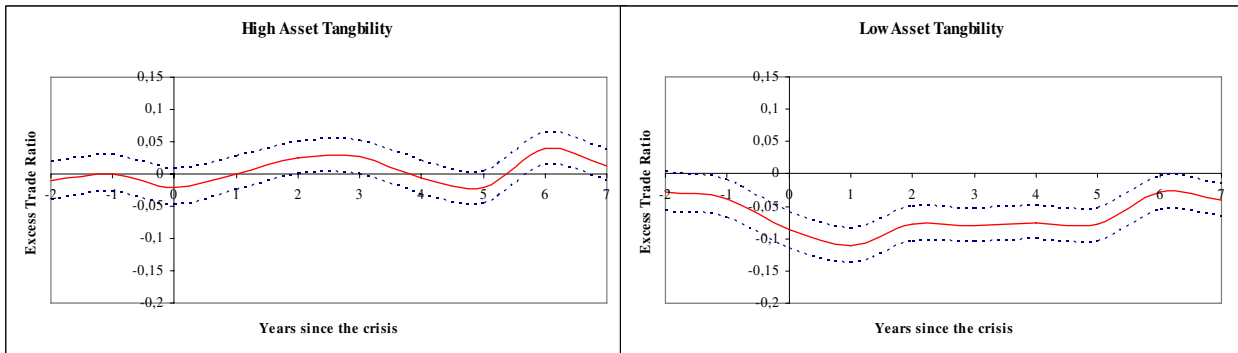

Figure 7: Deviation from the natural level of trade after a currency crisis: sectoral asset tangibility sub-samples

More generally, these results strongly suggest that the adjustment of trade to exchange rate movements is correlated to country specialization. While this result does not constitute a real innovation - sectors with higher price-to-demand elasticity are traditionally expected to react better after a devaluation - the interesting point is that the role of specialization arises from the combination of financial market imperfections and the fixed costs of exports. Moreover, these results support the existence of high fixed costs of exports, and the view according to which aggregate variations of trade flows are the result of an extensive margin adjustment.

Robustness. Different robustness checks were run to control our results. This results are quantitatively the same when: (i) we use different definitions of a currency crisis; (ii) we include country-year dummies in the last set of estimates (where the our variables of interest are also sector-specific) to take into account the potential omitted variable bias mentioned before (i.e. country-year elements that may both affect trade and the probability of occurrence of currency crises); (iii) other estimation techniques, including left-censored Tobit or Poisson estimations to account for the important number
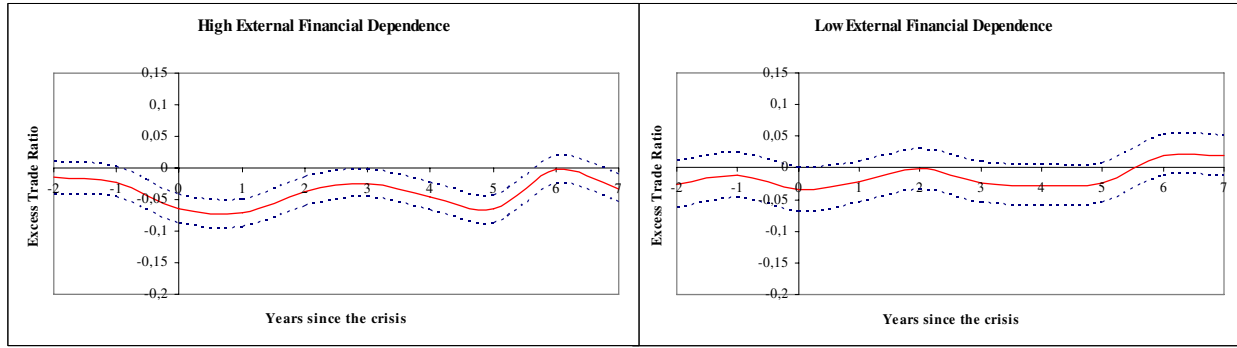
Figure 8: Deviation from the natural level of trade after a currency crisis: sectoral external financial dependence sub-samples

of zeros in the bilateral trade matrix; (iv) inclusion of other variables that can affect the way export react to exchange rate variations, namely vertical integration, vertical specialization, product and labor market rigidities; (v) inclusion of a different number of lags.[26]

4   Comparison of the different effects

Since the total impact of a currency crisis on exports depends on the values of the variables with which the currency crisis is interacted, the previous results are not fully informative to provide a single summary measure of the effect. Instead, it may be better to show how the effect of currency crisis varies for different levels of the different variables. We do so in Figures 9 to 10. Specifically, these figures present the total effect on bilateral exports of a currency crisis on year after the event for each value that a given variable corresponding to a given channel (foreign currency borrowing, fixed costs, asset tangibility and external financial dependence) can take in the sample. Since only linear interaction effects are considered, the effect of crises on exports can be represented as a linear function of each channel variable. The dotted lines represents the corresponding 95% confidence bands, constructed with the estimated coefficient standard errors.[27] These figures are based on estimations given in Tables 3 (estimation (C)) and 4 (estimations (C), (D), (E)). Note that these graphs are based on estimations in which the real exchange rate variable is not included, i.e. they represent the whole impact of the crisis - including the competitiveness effect for different degrees of financial imperfections and sector-specific elements.

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[26]Results are available upon request.

[27]From our regression model, the effect of a currency crisis on exports at year t is given by $(\beta_{CC} + \beta_{INT} * Channel)CC_i$, where β_{CC} and β_{INT} are respectively the estimated coefficients on a currency crisis and on its interaction between a given channel variable. $Channel$ follows a fixed set of values (given in appendix in Tables 5 and 6). The confidence intervals can be constructed from the following expressions for the variance of the currency crisis effect: $Var(\beta_{CC}) + Var(\beta_{INT})Channel^2 + Cov(\beta_{CC}, \beta_{INT})Channel$, where the variances and covariances of the estimated coefficients are obtained from our panel estimation.
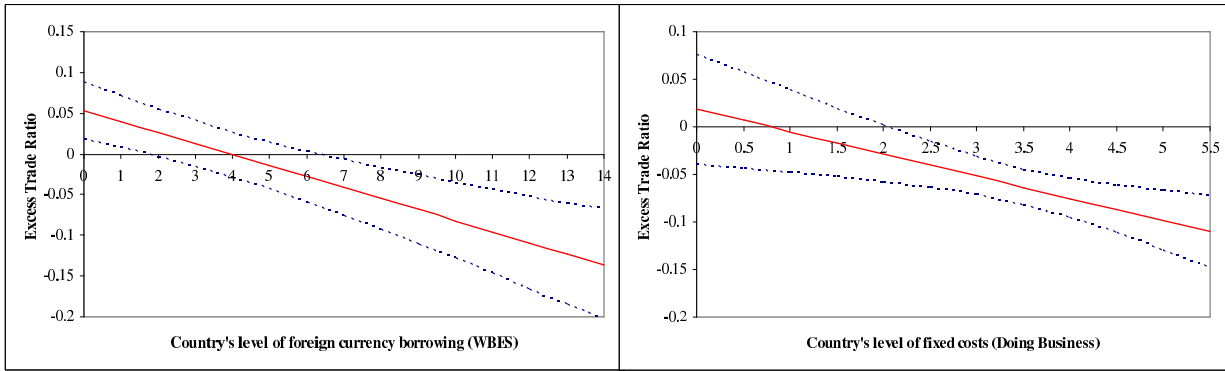
Figure 9: Total effect of a currency crisis on exports one year after the event, according to the country's level of foreign currency borrowing (left) and fixed costs (right)
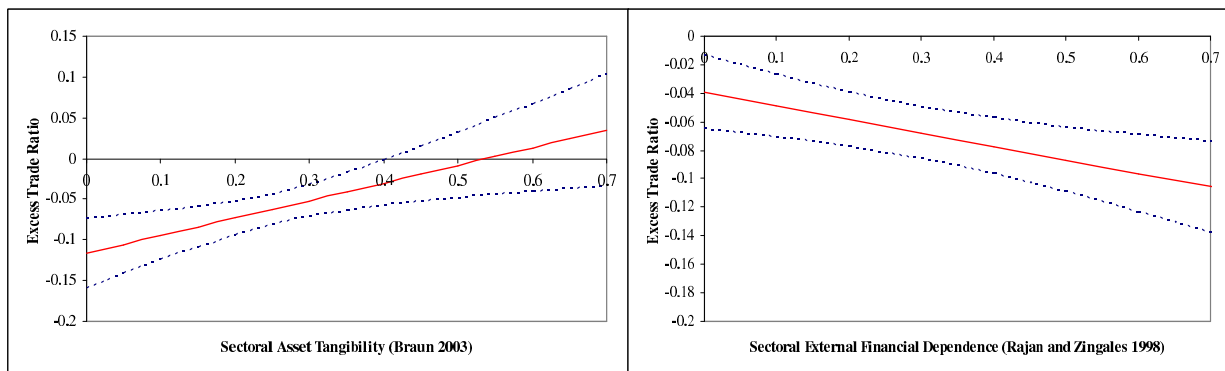

Figure 10: Total effect of a currency crisis on exports one year after the event, according to the sectoral level of asset tangibility (left) and external financial dependence (right)

The total effect is found to be quantitatively different for each channel. The X axis of each figure represents the set of values that can be taken by each indicator, given in Tables 5 and 6. The larger variance is linked to foreign currency borrowing: a currency crisis is found to have either a positive impact on exports in countries characterized by a very low level of dollarization (typically developed countries) or a strong negative impact in highly dollarized countries - after one years, exports are 20% below their natural level in a country like Argentina (Figure 9, left).

The level of fixed costs also influences importantly the reaction of exports to a currency crisis: the reaction range from zero to −15% (Figure 9, right). The degree of asset tangibility strongly drives the reaction of exports: the total effect ranges from −12% for the lowest tangibility to 3% for the highest (Figure 10, left). Finally, financial dependence is found to magnify the negative impact

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of the crisis on exports, but does not fully explains the presence of balance-sheet effects, since the total effect is negative whatever the sector (Figure 10, right). Overall, these graphs clearly suggest that balance-sheet effects due to the combination of financial market imperfections and fixed costs of exports importantly drive the reaction of export to large exchange rate shocks.

VI Conclusions and Directions for Further Research

In this paper we have investigated the impact of currency crises on international trade, and determined the elements that improve or worsen this impact. We have contributed to fill a gap left by the previous literature, which mostly worked on trade as a cause of the crisis.

We first showed that currency crises have a long-lasting negative effects on the level of trade flows. Controlling for real exchange rate changes, we found that exports remain below their natural level for six years after a currency crisis. Moreover, we have studied the relevance of the different channels through which international trade may be affected after a currency crisis. The negative and persistent impact of currency crises on exports is mostly due to negative balance-sheet effects that comes from the high level of firms' foreign currency borrowing in a number of countries. Finally, the specialization of countries deeply affects their reaction to a crisis. Specialization in sectors characterized by important fixed costs, high product differentiation (low elasticity of substitution between goods) and strong financial dependence are more prone to endure important drops in exports after a currency crisis. In addition to allowing a better understanding of the reaction of trade to currency crises, our work has important policy implications since we define elements that should improve of worsen the impact of crises on trade, thus facilitating or worsening the crisis recovery.

More generally, our work contributes to the increasingly large literature focusing on the links between financial imperfections and international trade. The above results suggest that most of the adjustments of international trade to exchange rate shocks comes from variations of the extensive margin of trade, i.e. from variations in the number of exporting firms. The main area of future research on this subject should be a more precise study of the interactions between exchange rate movements, financial imperfections and firms export decisions, using firm-level data. Equally interesting is the reaction of trade structure to exchange rate shocks. A brief look at some descriptive statistics in our database seems to suggest that currency crises modify the number of trading partners and exporting sectors, thus affecting countries' comparative advantage. As the reason for such an adjustment is far from trivial, this should probably be an interesting area for future works.

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VII Appendix

1 Calibration Exercises
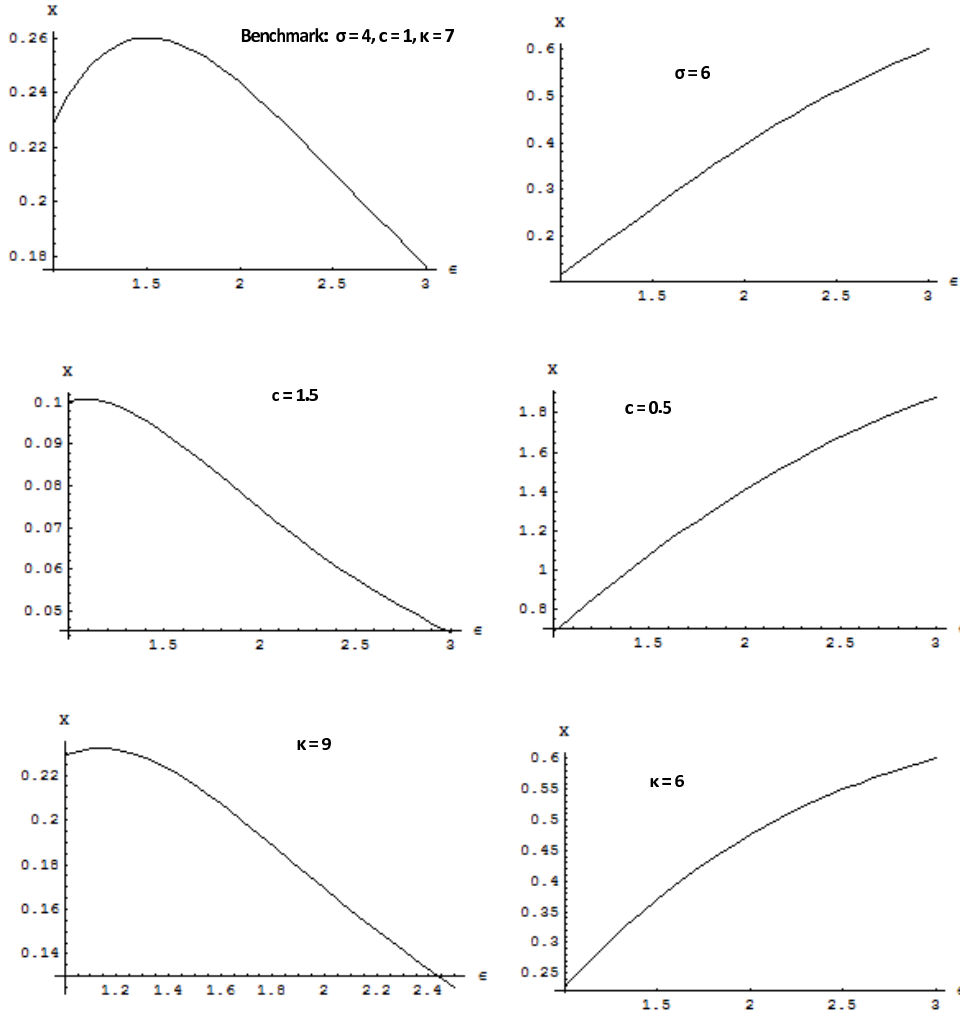
Figure 11: Total Exports and exchange rate movements: Calibration Exercises

Figure 11 represents the effect of exchange rate variations on total exports for different values of σ and c. We calibrate the model for around a symmetrical equilibrium where $L_i = L_j = 1$, and $\mu_i = \mu_j = 3$. These calibrations are based on equation (13). Our benchmark case is characterized by $\tau_{ij} = 1.5$, $\sigma = 4$ and $c_{ij} = 1$. The distribution of collateral is assumed to be Pareto, with lower bound $\Omega_{min} = 1$ and shape parameter κ, i.e. $F(\Omega_h) = 1 - \Omega_h^{-\kappa}$. The choice of the Pareto distribution is *ad hoc*, and the same pictures can be drawn with most common distributions. We try with different

values of κ, i.e. we let vary the shape of the Pareto distribution. A higher κ both means a lower mean and a higher variance of the distribution, and thus can be assimilated to a lower degree of asset tangibility. We also let σ and c_{ij} to illustrate points (a) and (b) of proposition 3. As shown in Figure 11, the impact is non-linear for our benchmark case, and larger increases in ε_{ij} have a more negative impact on exports. High fixed costs, low asset tangibility and and high of elasticity of substitution may reverse the reaction of total exports to exchange rate.

2 Productivity Heterogeneity and the impact of exchange rate on exports

Recent international trade theory, pioneered by Melitz (2003), has emphasized the significant role of firms' productivity heterogeneity in total trade adjustment. We provide in this section evidence that in presence of financial imperfections, productivity heterogeneity may play an important role in the aftermath of a currency depreciation. We consider a given sector, thus dropping the k subscripts for clarity purposes.

When firms are heterogenous in terms of both collateral and productivity, their *willingness* to enter the export market depends on their individual profits, whereas their *ability* of doing so will depend on the borrowing constraints (2). We can define $\overline{\alpha}_{ij}$ as the level of productivity such as total profit are zero, meaning that the firm is indifferent between exporting or not to country j, i.e. operating profits equal fixed cost. Using (8), we find:

$$\overline{\alpha}_{ij} = \frac{\sigma}{\sigma - 1} \left(\frac{\sigma c_{ij}}{\phi_{ij} \beta Y_j} \right)^{\frac{1}{\sigma - 1}} P_j^{-1} \varepsilon_{ij}^{-1} \tag{20}$$

In a Melitz's type model, all firms with productivity larger than (20) enter the export market. Note that an increase in ε_{ij} decreases the threshold value to enter the export market: an exchange rate depreciation allows firms with lower productivity to be profitable enough to export, thus increasing exporting probability. Denote by $G(.)$ the cumulative distribution function (c.d.f.) of firms' productivity. When financial market are complete, exports are simply given by:

$$X_{ij} = \beta Y_i \int_{\overline{\alpha}_{ij}}^{\infty} x_{ij} dG(\alpha(h)) \tag{21}$$

Using the expressions for x_{ij} and $\overline{\alpha}_{ij}$ found previously, we find that this expression is unambiguously increasing with ε_{ij}: a currency depreciation increases demand x_{ij}, decreases the threshold $\overline{\alpha}_{ij}$, and in turn increases total exports through a traditional pro-competitive effect. When financial markets

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are incomplete, only a subfraction of firms can enter the export market, i.e. those owning a collateral larger than the thresholds given by (10). Denoting by $F(.)$ the c.d.f. of firms' collateral, the previous expression becomes:

$$X_{ij} = Y_i \int_{\overline{\Omega}_{ij}}^{\infty} \int_{\overline{\alpha}_{ij}}^{\infty} x_{ij} dG(\alpha(h)) dG(\Omega(h)) = \left[1 - F(\frac{1}{\mu_i}[c_{ij}\varepsilon_{ij}]) \right] \int_{\overline{\alpha}_{ij}}^{\infty} x_{ij} dG(\alpha(h)) \qquad (22)$$

Suppose that both distributions are independent. However, depending on their shapes, they may be more or less correlated. The first term of (22) is decreasing with ε_{ij}, while the second is increasing with ε_{ij}, whatever the chosen distributions $G(.)$ and $F(.)$. As in the previous section, total exports can either increase or decrease after a currency depreciation, depending on the shape of productivity and collateral distributions. Both productivity and collateral heterogeneities matter: more heterogeneity, i.e. a larger variance of $F(.)$ or $G(.)$, dampens the effect of exchange rate variations, either through the pro-competitive effect or through the balance-sheet effect. More precisely, a very concentrated distribution of productivity (less heterogeneity) magnifies the positive impact of an exchange rate depreciation on total exports by allowing more firms to enter the export market. On the contrary, if the distribution of collateral is very concentrated, the balance-sheet effect, i.e. the strengthening of borrowing constraints following an exchange rate depreciation, will be larger: more firms will exit the export market.

In a nutshell, what matters here is not only the *mean level* of financial constraints (captured here by μ_i and by the mean of distribution $F(.)$), but also the *variance of their distribution*: in countries where credit constraints are very concentrated, the reaction of exports to an exchange rate depreciation is more likely to be negative. To summarize, *the overall impact of a currency depreciation depreciation on total exports depends on the relative shapes of collateral and productivity distributions.*

Illustration: Pareto Distributions. To illustrate this, let us suppose, following Chaney (2008) or Melitz and Ottaviano (2008) among others, that productivity shocks are drawn from a Pareto distribution with shape parameter γ. Productivity is distributed over $[1, +\infty)$ according to:

$$G(\alpha(h)) = P(\widetilde{\alpha}(h) < \alpha(h)) = 1 - \alpha(h)^{-\gamma} \qquad (23)$$

with $\gamma > \sigma - 1$ (this ensure that the size distribution of firms has finite mean). Further suppose that the distribution of collateral is also Pareto, but with shape parameter ν, and distributed over $[1, +\infty)$

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according to:

$$F(\Omega(h)) = P(\widetilde{\Omega}(h) < \Omega(h)) = 1 - \Omega(h)^{-\nu} \tag{24}$$

As before, both distributions are supposed to be independent. The Pareto parameters γ and ν are inverse measures of heterogeneity of productivity and collateral. Under these assumptions, total exports become:

$$X_{ij} = \lambda_1 Y_i P_j^\gamma Y_j^{\frac{\sigma}{\sigma-1}} \tau_{ij}^{-\gamma} (c_{ij})^{1-\frac{\gamma}{\sigma-1}} \varepsilon_{ij}^{\gamma+1-\nu} \tag{25}$$

with λ_1 a constant.[28] (25) is decreasing with ε_{ij} when $\nu > \gamma + 1$. In other words, when access to finance is less heterogenous than productivity, firms' exits due to the depreciation will dominate the positive effect on firms' entries and on export by firm, and exports will fall.

Interestingly, it is likely that credit constraints and productivity are very correlated: very productive firms may generate domestically larger profits, and thus should be more likely to invest physically, or to own important amounts of liquidity that can serve as collateral. Here, a large and positive correlation between both distributions, i.e. similar shapes γ and ν, may lead to a very low impact of an exchange rate devaluation: firms' entries, due the decrease in the productivity cut-off (20) are dampened by firms' exits due to the increase of the collateral threshold (10).

3 Data Appendix

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[28] $\lambda_1 = \frac{1}{\gamma-(\sigma-1)} \left(\frac{\sigma}{\sigma-1}\right)^{-\gamma} \sigma^{1-\gamma/(\sigma-1)}$

Table 5: Currency Crises and Foreign Currency Borrowing

Country	Currency Crises	Banking Crises	Foreign Borrowing (%)
Argentina	1982, 1986, 1989, 1990, 2002	1980, 1989, 2001	14.4
Bangladesh	1975	1987	5.78
Bolivia	1982, 1983, 1985	1986	2.52
Brazil	1986, 1989, 1990, 1991, 1999	1994	3.92
Canada	1978, 1985	0	1.97
Chile	1976, 1982, 1984	1981	6.82
China	1980, 1986, 1989, 1993	1998	0.36
Colombia	1983, 1985, 1999, 2002	1982	6.11
Costa Rica	1980, 1981	1987	4.88
El Salvador	1986, 1990	1989	1.73
Ecuador	1983, 1985, 1988, 1992, 2000	1981, 1998	3.21
France	1992	0	1.56
Germany	0	0	2.15
India	1991, 1993	0	1.83
Indonesia	1978, 1983, 1986, 1997, 1998	1997	4.04
Italy	1976, 1992, 1995	0	2.36
Malaysia	1997, 1998	1985, 1998	2.58
Mexico	1976, 1982, 1994	1981, 1994	1.14
Pakistan	1979, 1988, 1990, 1993, 1996, 2000	0	2.91
Panama	1985, 1987, 1994	1988	6.05
Paraguay	1984, 1989, 1992	1995	3.6
Peru	1976, 1987, 1990	1983	5.54
Philippines	1983, 1984, 1986, 1990, 1997	1981, 1998	2.8
Portugal	1976, 1978, 1983	1986	0.35
Singapore	1986, 1997, 1998	1982	7.11
Spain	1976, 1982, 1992, 1993	1977	2.09
Sweden	1977, 1982, 1992	1991	0.92
Thailand	1984, 1997	1983, 1997	5.03
Turkey	1977, 1980, 1984, 1991, 1994, 2001	1982, 1994, 2000	3.31
United Kingdom	1976, 1981, 1981, 1992	0	1.02
Uruguay	1983, 2002	1981, 2002	5.15
United States	1987	0	0.98
Venezuela	1984, 1987, 1989, 1994, 1995, 2002	1980, 1993	5.42

Source: Author's computations from IMF data for currency crises; Caprio and Klingebiel (2002) for banking crises; authors computations from WBES (Worldbank) data for foreign borrowing. In this table are listed our results with a broad definition of currency crises - 1.5 standard deviations above the mean of the computed exchange market pressure index. For banking crises, the table presents systemic crises as listed by Caprio and Klingebiel.

Table 6: Sectoral Data

ISIC Number	Description	Elast. of Subst.	Ext. Dependence	Rauch Class.	Asset Tangibility
311	Food products	6,81	0,14	H	0.38
313	Beverages	2,65	0,08	R	0.28
314	Tobacco	3,73	0	R	0.22
321	Textiles	2,7	0,4	D	0.37
322	Wearing apparel, except footwear	2,82	0,03	D	0.13
323	Leather products	1,82	0	D	0.09
324	Footwear, except rubber or plastic	2,41	0	D	0.12
331	Wood products, except furniture	2,54	0,28	D	0.38
332	Furniture, except metal	2,04	0,24	D	-
341	Paper and products	3,28	0,18	R	0.56
342	Printing and publishing	2,53	0,2	D	0.30
351	Industrial chemicals	4,83	0,2	R	0.41
352	Other chemicals	1,76	0,22	D	0.20
353	Petroleum refineries	8,37	0,04	H	0.67
354	Miscellaneous petroleum and coal products	2,88	0,33	R	0.30
355	Rubber products	2,82	0,23	D	0.38
356	Plastic Products	3,54	1,14	R	0.35
361	Pottery, china, earthenware	1,34	0	D	-
362	Glass and products	1,91	0,53	R	0.33
369	Other non-metallic mineral products	2,89	0,06	D	0.42
371	Iron and steel	5,03	0,09	D	0.46
372	Non-ferrous metals	3,25	0,01	H	0.38
381	Fabricated metal products	3,73	0,24	D	0.28
382	Machinery, except electrical	2,16	0,45	D	0.18
383	Machinery, electric	1,98	0,45	D	0.21
384	Transport equipment	3,63	0,31	D	0.25
385	Professional and scientific equipment	1,58	0,96	D	0.15
390	Other manufactured products	1,76	0,47	D	0.18

Sources: elasticity of substitution: Broda and Weinstein (2006). External Financial Dependence: Rajan and Zingales (1998). Fixed costs: Rauch (1999) classification. Asset tangibility: Braun (2003).