WORKING PAPERS

Col.lecció d'Economia E16/341

Trade Finance Affects Trade Dynamics

Marta Arespa

Diego Gruber

UNIVERSITAT DE BARCELONA

UB Economics Working Papers 2016/341

Trade Finance Affects Trade Dynamics

Abstract: Existent literature is by no means conclusive on the effects of trade finance on trade and the economy. We propose a suitable framework to explore the linkages between international trade and finance based on an international real business cycle model where firms require external finance to import and can be financially constrained. We find that credit shocks do affect the dynamic properties of the economy and they have the potential to cause significant deviations in trade and economic performance. The trade-to-GDP ratio falls following a negative credit shock, as the shock reduces the capability of firms to purchase foreign intermediate goods, thereby reducing efficiency and production. However, it forces a demand substitution towards domestic intermediate goods that limits GDP deterioration. We also find that financially developed countries trade more, are richer and more stable in terms of GDP and consumption, consistent with the empirical evidence. Finally, the model sheds light on persistent contradictions between theoretical business-cycle and their empirical counterparts, namely, the consumption/output anomaly and the volatility of consumption, imports and terms of trade relative to GDP.

JEL Codes: E3, F1, F4, G1.

Keywords: Trade finance, credit constraint, great trade collapse, RBC.

Marta Arespa
Universitat de Barcelona

Diego Gruber
Kernel Analytics

Acknowledgements: Marta Arespa acknowledges the financial support from the Spanish Ministry of Science and Innovation through grant ECO2015-66701-R.

ISSN 1136-8365

1 Introduction

We refer to *trade finance* as either a) one of the mechanisms provided by financial institutions and governments to facilitate international trade activities, or b) an agreement whereby a customer can purchase goods on account, paying the supplier at a later date. When trade occurs across borders, sometimes sellers require either cash-in-advance payments or formal guarantees to cover themselves from the possibility of default or insolvency of their buyers. Importers are usually forced to turn to loans or letters of credit to satisfy exporter requirements before having their orders shipped. Most of these contracts are provided by financial institutions and require some form of collateral. Other times, when the goods are delivered, a trade credit is given for a specific number of days—30, 60 or 90—and it is recorded in the accounts receivable section of the firm's balance sheet.

Trade finance is an extremely important piece of the international trade mechanism; estimates find that around 90% of international trade relies on some form of credit (Auboin, 2009). Yet relative to its importance in the actual workings of trade, very little attention had been devoted until recently to the study of the connection between trade finance and international trade performance in either the theoretical or empirical literature. The "great trade collapse", the dramatic fall in the trade-to-GDP ratio during the current financial crisis, changed that. In spite of these efforts, there is still little consensus on the effects of trade finance on macroeconomic variables and, specifically, on international trade performance.

We make a theoretical contribution to this debate within the framework of an International Real Business Cycle (IRBC) model. We propose a dynamic, quantitative, micro-founded macroeconomic model that builds on the standard model of IRBC proposed by Backus et al. (1992) (BKK). We introduce an additional requirement for importers, who must borrow proportionally to the value of the goods they wish to import. This feature enables us to shed some light on the role of credit in international trade performance.

Our model provides some relevant improvements over standard IRBC models. Indeed, imports are more volatile than GDP, our quantitative analysis does not suffer from the consumption/output anomaly (i.e., GDP cross-country correlation is larger than consumption cross-country correlation, as in the data), and the volatilities of consumption, imports, and terms of trade relative to GDP are close to those in recent US data. The latter is a property that, as far as we know, required the introduction of non-standard preferences into the model of IRBCs (Raffo, 2008). The financially constrained economy produces negative correlations for net exports and terms of trade with national output. These correlations are found to be positive in standard IRBC models, opposite to data.

Using a counterfactual analysis we test the macroeconomic effects of alterations in the availability of finance to importers. Compared to a productivity shock of the same size, we find that trade finance does not

appear to have a large effect on the behavior of macroeconomic aggregates over the business cycle. However, recent empirical literature show that, indeed, credit shocks account for a large share of the fluctuations of macromagnitudes, as large as productivity shocks, suggesting that volatility is, indeed, much larger (See, for instance, Niepmann and Schmidt-Eisenlohr (2014), Helbling et al. (2011) and Hristov et al. (2012)). Moreover, our model concludes that long term variations in trade finance do have the potential to cause significant deviations in trade and economic performance. On the one hand, a negative credit shock reduces the ability of a producer to use foreign inputs, thereby reducing efficiency, which negatively affects aggregate production. On the other hand, it also stimulates demand for domestic goods, making them more expensive and harder to come by in foreign markets and reducing exports as well. The net effect on the trade balance is positive, which together with higher demand for domestic goods from constrained importers alleviates the fall in GDP. Hence, trade falls faster than GDP in our model following a credit shock. However, unless the variance of credit shocks is much larger than that of productivity shocks, these effects appear to be small in comparison to the effects of productivity shocks, which remain the main drivers of business cycles in our model. Finally, we also find that more financially developed countries trade more, have higher levels and lower volatility in GDP and consumption, consistent with the empirical evidence in this area (Kose et al. (2003b, 2006)).

In the following section we offer a literature review. Section 3 presents the model setup and defines an equilibrium of the theoretical economy. Section 4 presents a number of international real-business cycle statistics that we want to capture with our model. We use these numbers to calibrate the model and then test its numerical properties. Section 5 contains our main results. We explore the effects of temporary variations in trade finance as well as to permanent changes in financial development and how they affect the dynamic properties of international trade in the short and in the long run. Section 6 concludes.

2 Literature Review

International trade dynamics have been largely analyzed in both the theoretical and the empirical literature. Unfortunately, this literature has largely disregarded the connection between trade finance and international trade performance; the few exceptions have mostly neglected the important role of export insurance provided by financial institutions and credit offered by suppliers to their customers via open accounts.

A number of papers (for instance Chaney (2005); Manova (2012); Manova et al. (2009)) have focused on the internal and external finance of fixed costs but they have largely ignored the important role of export insurance via trade finance. One important exception is Ahn (2011), who provides a theoretical model of trade finance to explain the great trade collapse. His main conclusions are two: First, international trade takes place in a more risky environment compared to domestic trade and, as a consequence, it is subject to

more demanding financial conditions, a result also sustained in Ellingsen and Vlachos (2009). Second, higher risk makes international trade finance more economically-sensitive and it becomes much more pro-cyclical than domestic trade finance. Having these results in mind, we simplify and assume that finance is required only for international transactions.

A recent paper on IRBCs that considers the financial sector is Kalemli-Ozcan et al. (2012). They explore the implications of financial integration for international business-cycle synchronization. Their empirical analysis concludes that financial integration enhances cross-border co-movement during financial turmoils, demonstrating the importance of the financial channel as a mechanism of contagion. On the theoretical part, they construct a dynamic stochastic general equilibrium model where firms need external resources to finance working capital and this dependence is determinant to produce GDP cross-correlations consistent with their empirical results. However, they do not account for the financial needs for trade activities and disregard international trade patterns in the analysis.

There is very little data available on trade finance and trade credit, and that what is available is not very reliable either. Auboin (2009) finds that around 90% of international trade relies in some form of credit. Asmundson et al. (2011) estimate from four surveys carried out among banks of all sizes and nationalities between 2008 and 2010 that between 35%-40% of international credit was financed by banks, around 20% was paid in advance (and may have been financed by letters of credit) and between 38% and 45% relied on open accounts, although 25% of these open accounts were covered by Berne Union members insurance. Mora and Powers (2009) attribute a larger share to open accounts (40-80%) and a possibly smaller share to banks (10-50%), though they concede the role of bank financing is increased if one includes working-capital loans. These large intervals illustrate the limitations in the availability of data about trade finance. Whatever the precise numbers are, the one thing that is clear is that trade finance is a hugely relevant factor for anyone in the business of importing or exporting goods.

The scarcity of good data is the main cause for the lack of empirical research on this topic. Following the 2008 financial crisis, however, this literature has contributed to underline the importance of trade finance for the dynamics of trade and hinted at some of its main properties, and so that, we detail some empirical findings in the present section.

One of the most recent and complete empirical studies for its data coverage has been conducted by the Bank for International Settlements (BIS (2014)). Its Study Group makes a detailed review of available data on trade finance for developed and emerging countries. Then, they proceed to combine it with information from trade associations and SWIFT and create a panel of 18 major trade countries from 1999 to 2012. Although they recognize that the approach requires significant interpolation and inference to get a general characterisation of the size, structure and trends of the global market, they are able to extract some rele-

vant conclusions: bank-intermediated trade finance fell sharply in the quarters immediately after Lehman bankruptcy, often at rates comparable to declines in the value of trade; and reduced trade finance availability may have accounted for up to one-fifth of the decline in trade volumes in the aftermath of the shock.[1]

Another relevant work isAsmundson et al. (2011). They use survey data to confirm that banks were increasingly cautious with real-sector customers and counter-party banks during the recent crisis and admit to have increased their loans-deposits pricing margins. Most banks (with the exception of the group of *large banks*, which indeed, accounts for a substantial majority of the trade finance share) denied having decreased credit availability in their own institutions, but all confirm they increased their demands for collateral and adopted stricter risk management practices in response to higher risk. Moreover, they argue that exporters have become more risk averse, seeking higher protection from risk and avoiding open accounts. The latter behavior has forced importers to turn to formal credit more often. Hence, the share of world trade supported by bank intermediation has increased considerably. Morel (2010) finds similar results using Berne Union data.

Schott (2009) and Fontagné and Gaulier (2009) show how financial crises affect the volume of exports and imports much more than the range of varieties exchanged. This suggests that, during financial disruptions, firms reduce their scale of international activities although they are able to maintain their international channels open. Another interesting empirical analysis in favor of the financial channel is Van der Veer (2010). He focuses on the role of private trade insurers, who faced mounting risks after Lehman Brothers bankruptcy. He finds that, on average, every €1 of insured exports generates €2.3 of total exports. Thus, the impact on trade of a change in the supply of private trade credit insurance is bigger than the change in the value of insured trade: trade credit insurance improves a buyer's access to supplier credit.

There is, however, some skepticism about the role trade finance played during the great trade collapse, especially in the US. Levchenko et al. (2011) and Eaton et al. (2011) attribute most of the decline in trade to demand shocks and compositional effects. Nevertheless, this lack of consensus may be explained by the focus of the literature on US firms due to data availability; key results may be driven by special features of this country. In fact, Eaton et al. (2009) do find that for countries like Japan or China financial shocks are the largest contributors to changes in trade over GDP ratio. Also, a number of studies find that small and medium enterprises in developing countries were especially affected by the shortage in trade finance (Malouche, 2009; Humphrey, 2009; Berman and Martin, 2010).

Most data sets do not disentangle banking finance from inter-firm finance and none of them capture the relative share of intrafirm credit in different sectors and countries. As a consequence they make it difficult

[1] They use data from 11 of the 18 countries in the GMM panel data analysis: Australia, Brazil, France, Germany, Hong Kong, India, Italy, Korea, Spain, UK and US.

to separate cause and effect. An exception to these limitations in the data is Amiti and Weinstein (2011), who use a unique data-set for Japan which matches firms with their credit banking providers to examine the link between finance and exports during the Japanese financial crises of the nineties. They are the first to establish a causal link from shocks in the financial sector to exporters that result in exports declining much faster than output during banking crises. Their evidence shows that firms that rely more on trade finance are hit much harder when the financial institutions they rely upon run into trouble. These results are robust to a large number of variations in the specification of their model. Paravisini et al. (2011) offer further empirical evidence for the supply-side effects of finance on international trade. They carry out an analysis similar to Amiti and Weinstein (2011) with Peruvian data.

Ahn et al. (2011) argue against the view that the trade finance channel has been of little relevance to the decline in trade during the crisis. They claim that the conventional measures of external finance dependence that are commonly used in the literature are completely unrelated with levels of trade finance. Moreover, they show that: First, during the crisis, export prices rose relative to domestic manufacturing prices across a large number of countries. Second, import and export prices of goods shipped by sea, which are likely to be affected most by trade finance contractions, rose disproportionately more than those shipped by air or land. Indeed, Feenstra et al. (2011) also show that the trade finance channel is quite a different channel than that of the conventional external finance channel. Finally, a recent paper by Niepmann and Schmidt-Eisenlohr (2014) focuses on trade finance through letters of credit. They analyse the effects of country level shocks on the supply of letters of credit and find a significant and sizeable effect of them on international trade.

Berman et al. (2012) also support the latter thesis with a theoretical model and an empirical analysis. They run a historical analysis from 1950 to 2009 for a large number of countries and find a robust time-to-ship effect, i.e., exporters react to an increase in the probability of default of importers by increasing their export price and decreasing their export volumes to the destination in crisis. They conclude that this stylized fact of financial crises strongly suggests that they affect trade, not only because they impact demand, but also through financial frictions which are specific to international trade.

3 The model economy

Let there be two countries, we denote foreign country variables by an asterisk. Countries will be identical except for the stream of productivity shocks they receive. A country consists of four types of agents:

1. Infinitely lived **households** taking decisions every period about their optimal levels of consumption, leisure, investment, and savings. Households are the only agents in this economy taking inter-temporal decisions, and so are the ultimate holders of savings and debt in the model.

2. **Final-good firms** put together a basket of domestically produced intermediate goods; their output is a final good that can be used for consumption or the accumulation of capital by households. Final goods are sold domestically in perfectly competitive markets.

3. **Intermediate good firms**, on the other hand, operate in a monopolistically competitive setting. They use a fixed amount of labor each period to combine domestic and foreign inputs and manufacture their goods. The amount of foreign inputs they use in production is limited by how much they can borrow to finance their imports. How much they produce depends also on their productivity level, which is affected by a random productivity shock.

4. Production inputs are bought from domestic and foreign **input producers**, who combine capital and labor in their production process. They can sell their products in domestic markets or export to foreign intermediate good producers.

Financial intermediaries are not explicitly modeled in this paper.[2] We assume competitive financial intermediaries channel household savings to intermediate good producers, who require financial support to access to imported input goods. They do so in such a way that default is never an optimal choice for borrowers. Household savings are pooled across countries, so it is possible for a household to lend to a foreign intermediate good producer. This allows for unbalanced trade in the model. Negative household savings imply that firms are borrowing more than they could obtain in domestic savings markets.

Though there are important differences between formal borrowing from financial institutions and trade credit (as pointed out in the introduction), we will not treat them separately in the model. In both cases trade finance allows for a variation of risk-sharing configurations between importer and exporter. However, most of the reviewed literature agrees on the substitutability between both types of financing (Fisman and Love (2003); Iacovone and Zavacka (2009); Garcia-Appendini and Montoriol-Garriga (2013)). It seems that this substitutability is especially important when financial disruptions appear (Wilner, 2000), as importers move from formal loans to accounts payable, offered by their foreign suppliers, when banks tighten credit availability. Or the other way around: importers turn to banks when their suppliers are reluctant to risk with accounts receivable from their foreign customers. Some authors also suggest both forms of credit are complementary (Love et al., 2007) in that large and well-reputed firms have easier access to credit issued by financial institutions and play the role of trade finance creditors to their customers, allocating banking credit they obtained via accounts receivable. In view of the aforementioned surveys outcome, we focus on the substitutability

[2] For a model that explicitly models trade finance see Ahn (2011). In his model, banks have access to asymmetric information on their customers and can incur costs to improve this information. However, information is of less quality when the customer performs international transactions. Since importers or exporters depend on foreign firms' success and reliability to pay back their loans, poorer information quality makes them riskier for banks. We bypass this by assuming credit is required only for trade with foreigners.

between them and we do not disentangle banking sector finance from inter-firm finance.

We now proceed to outline in detail the optimizing behavior of each agent in the model as well as the resulting equilibrium.

3.1 Households

Each country has a mass 1 of identical households, who enjoy consumption and leisure every period. Their utility at each period is given by a strictly concave function $u(c_t, 1-n_t)$, where c_t is consumption and n_t the fraction of the time household members spend at work. Furthermore, households must choose how much they invest in new capital (i_t) and how much they lend to importers (s_t). There is a small cost of holding savings in the form of credit to importers equal to $\frac{\phi}{2}s_{t-1}^2$.[3] Household earnings come from the salaries they perceive for the amount of time they spend at work (w_t), from the share of profits they receive from intermediate good firms (π_t), the interest they are paid on their savings (r_t), and the rents that accrue to them from input producers who rent the capital they own (R_t). Putting it all together we obtain the household's budget constraint for each period:

$$c_t + i_t + s_t + \frac{\phi}{2}s_{t-1}^2 \leq w_t n_t + \pi_t + s_{t-1}(1+r_t) + K_{t-1}R_t, \qquad \forall t. \tag{1}$$

Physical capital is subject to depreciation at rate δ every period. Following Backus and Crucini (2000), physical capital formation is subject to adjustment costs, which are captured by a function $\Psi(\cdot)$, which satisfies $\Psi > 0$, $\Psi' > 0$, and $\Psi'' < 0$. Capital evolves according to

$$K_t = (1-\delta)K_{t-1} + \Psi(i_t/K_{t\text{-}1})K_{t-1}, \tag{2}$$

We use $\Psi(i/k) = (i/k)^{\psi}$, $\psi \in (0,1)$, so investment is described by the change in capital stocks as follows:

$$i_t = \left(\frac{K_t}{K_{t-1}} - (1-\delta)\right)^{\frac{1}{\psi}} K_{t\text{-}1}.$$

[3] This cost serves for the purpose of determining the steady-state value of the asset position in a zero-order approximation without the need of taking second-order approximations and ensuring stationarity. See Benigno (2009) and Heathcote and Perri (2002) for detailed discussions. It does not have any other implication for our results.

If households discount utility from future periods at rate β, optimizing behavior is described by the following problem:

$$\max_{\{c_t,n_t,s_t,K_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t u(c_t, 1-n_t) \tag{3}$$

$$\text{s.t. (1) and (2).}$$

We can re-write this problem as:

$$\max_{\{n_t,s_t,K_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t u\left(w_t n_t + \Pi_t + K_{t-1}R_t + s_{t-1}(1+r_t) - i_t - s_t - \frac{\phi}{2}s_{t-1}^2,\, 1-n_t\right)$$

and obtain the following first order conditions:

$$\begin{aligned} w_t u_{c,t} &= -u_{n,t}, \\ u_{c,t} &= \beta(1 + r_{t+1} - \phi s_t)u_{c,t+1}, \\ \frac{1}{\psi}\left(\frac{i}{K_{t-1}}\right)^{1-\psi} u_{c,t} &= \beta\left(R_{t+1} - \frac{i_{t+1}}{K_t} + \frac{1}{\psi}\left(\frac{i_{t+1}}{K_t}\right)^{1-\psi}\frac{K_{t+1}}{K_t}\right)u_{c,t+1}. \end{aligned}$$

Letting $u(c, 1-n) = [c^{\mu}(1-n)^{1-\mu}]^{\theta}/\theta$, the marginal utilities of consumption and labor are given by

$$\begin{aligned} u_{c,t} &= \mu c_t^{\theta\mu-1}(1-n_t)^{\theta(1-\mu)}, \\ u_{n,t} &= -(1-\mu)c_t^{\theta\mu}(1-n_t)^{\theta(1-\mu)-1}. \end{aligned}$$

3.2 Final-good firms

Final good firms are homogeneous and they participate in a competitive market, so they act as price takers and make zero profit. They put together a basket of intermediate goods to create a final good. Their production function is

$$Y_t = \left(\int_0^1 d_{j,t}^{\sigma} dj\right)^{1\backslash\sigma}, \tag{4}$$

where $d_{j,t}$ denotes their demand of intermediate good j. Profits are given by $\Pi_t = Y_t - \int_0^1 d_{j,t}p_{j,t}dj$. Maximizing profits gives their optimal demand of each variety of intermediate goods, which is

$$d_{j,t} = Y_t p_{j,t}^{\frac{1}{\sigma-1}}. \tag{5}$$

3.3 Intermediate-good firms (importers)

Each country has a mass 1 of firms producing differentiated, non-tradable goods. These firms operate in a monopolistic competition setting; we want importers to have some benefits they can use as collateral to

obtain credit. Productivity is given by a random shock z_t common to all firms, and production takes place according to the function:

$$F_{j,t} = z_t h_{j,t}^{\alpha} x_{j,t}^{1-\alpha},\ \alpha \in (0,1),$$

where $h_{j,t}$ represents the demand of domestic inputs and $x_{j,t}$ the demand of imported inputs of firm j. Firms pay a fixed cost Q units of labor to operate every period. Profits for the intermediate good producer are given by

$$\pi_{j,t} = p_{j,t} d_{j,t} - P_t h_{j,t} - (1+r_t) P_t^* x_{j,t} - Q w_t, \tag{6}$$

where input prices are denoted by P_t and P_t^*, while the intermediate good's market price is $p_{j,t}$. Note that the firm must borrow in order to buy imported inputs and therefore also pays an interest r_t over their total cost. Since imports are bought on credit they are subject to a trade credit constraint. We think of the degree $\tilde{\eta}$ to which contracts can be enforced as summarizing the average quality of enforcement in a given economy. The financial intermediary behaves competitively. A credit constraint states that it must be individually rational for the managers to repay their loan. When they abide by the contract, managers receive their net income. When they default, they economize on the payment they owe the intermediary but lose fraction $\tilde{\eta}$ of the resulting resources. i.e.

$$\begin{aligned} \pi_{j,t} &\geq (1-\tilde{\eta}) \left[\pi_{j,t} + (1+r_t) P_t^* x_{j,t}\right], \\ \frac{\tilde{\eta}}{1-\tilde{\eta}} \pi_{j,t} &\geq (1+r_t) P_t^* x_{j,t}, \\ \eta \left(p_{j,t} d_{j,t} - P_t h_{j,t} - Q w_t\right) &\geq (1+\eta)(1+r_t) P_t^* x_{j,t}, \end{aligned} \tag{7}$$

where $\eta = \frac{\tilde{\eta}}{1-\tilde{\eta}}$. Suppose the firm has already chosen a price $p_{j,t}$ inducing demand $d_{j,t}$. Taking them as given, the combination of domestic and foreign inputs that minimize the cost of satisfying this demand is given by

$$\min_{h_{j,t}, x_{j,t}} P_t h_{j,t} + (1+r_t) P_t^* x_{j,t} \tag{8}$$

s.t.

$$z_t h_{j,t}^{\alpha} x_{j,t}^{1-\alpha} = d_{j,t},$$

$$\eta \left(p_{j,t} d_{j,t} - P_t h_{j,t} - Q w_t\right) \geq (1+\eta)(1+r_t) P_t^* x_{j,t}.$$

Kuhn-Tucker conditions (KTCs) with Lagrangian multipliers ζ_t and ξ_t are:

$$\begin{aligned}
(1-\xi_{j,t}\eta)P_t h_{j,t} &= \alpha\zeta_{j,t}d_{j,t}, \\
(1-\xi_{j,t}(1+\eta))(1+r_t)P_t^* x_{j,t} &= (1-\alpha)\zeta_{j,t}d_{j,t}, \\
\xi_{j,t}\left[\eta\left(p_{j,t}d_{j,t}-P_t h_{j,t}-Qw_t\right)-(1+\eta)(1+r_t)P_t^* x_{j,t}\right] &= 0.
\end{aligned}$$

The first two KTCs together imply $h_{j,t}=\lambda_{j,t}x_{j,t}$, where

$$\lambda_{j,t} \equiv \frac{\alpha}{1-\alpha}\left(\frac{1-\xi_{j,t}\eta-\xi_{j,t}}{1-\xi_{j,t}\eta}\right)\frac{(1+r_t)P_t^*}{P_t}.$$

By the first constraint then:

$$x_{j,t} = \frac{d_{j,t}}{z_t\lambda_{j,t}^{\alpha}}. \tag{9}$$

We assume intermediate good firms know demand functions (5) and (9) and set their prices accordingly by solving the following profit maximization problem:

$$\max_{p_{j,t}} \left(p_{j,t}-\frac{P_t}{z_t\lambda_{j,t}^{\alpha-1}}-(1+r_t)\frac{P_t^*}{z_t\lambda_{j,t}^{\alpha}}\right)Y_t p_{j,t}^{\frac{1}{\sigma-1}}-Qw_t. \tag{10}$$

The solution to this problem is given by

$$p_{j,t}=\frac{1}{\sigma z_t\lambda_{j,t}^{\alpha}}\left(\lambda_{j,t}P_t+(1+r_t)P_t^*\right). \tag{11}$$

3.4 Input producers (exporters)

Each country has a mass 1 of identical input good firms with technologies operating in a perfectly competitive environment. Their technology uses capital (k_t) and labor (l_t) to generate output f_t:

$$f_t = k_t^{\gamma}l_t^{1-\gamma},\ \gamma\in(0,1),$$

An input producer seeks to solve the following optimization problem when supplying to domestic and foreign intermediate good firms:

$$\max_{k,l} P_t\, f_t - w_t l_t - R_t k_t \tag{12}$$

The usual FOCs are:

$$P_t\, f_{k,t} = \gamma P_t (k_t/l_t)^{\gamma-1} = R_t,$$
$$P_t\, f_{l,t} = (1-\gamma) P_t (k_t/l_t)^{\gamma} = w_t,$$

which together imply an optimal capital-labor ratio equal to:

$$\frac{k_t}{l_t} = \frac{\gamma}{1-\gamma}\frac{w_t}{R_t}.$$

3.5 Equilibrium

This economy is said to be in equilibrium if every period: given a state of the economy (z, z^*) and prices P, R, r, and w, functions $c(\cdot)$, $i(\cdot)$, and $s(\cdot)$ solve the household's problem (3); given prices p_j, demand functions d_j solve final good firm problem (6) and their profits are equal to zero; h_j, x_j and p_j are the same for all j and they solve the intermediate good firm problem (7) and (10); demands of labor and capital l and k solve the maximization problem of input producers (12) and they have zero profits; good markets clear: $c+i=Y$, $d_j = F_j$, and $f = h + x^*$; labor markets clear: $l + Q = n$; capital markets clear: $k = K$; financial markets clear: $s + s^* = P^*x + Px^*$; and no-Ponzi-scheme conditions hold.

Given that this model does not have an analytical solution, we perform a calibration exercise in the next section in order to understand its quantitative properties by means of a numerical solution.

4 Quantitative exercise

4.1 International business-cycle statistics

Table (1) presents several time-series properties for some of the main aggregates from the largest economies in the OECD, which we want to replicate with our model.

Some facts that stand out are the following: For almost every country, the volatility of consumption is less than the volatility of output; The average volatility of investment and imports are about three times larger than that of output; The average volatility of net exports is about half the volatility of output; Domestic correlations between output, consumption, investment, and imports are strong and positive; The correlation between output and net exports is negative in most cases; And there is no clear rank between the cross-country correlations of output, consumption, and investment.

Table 1: International business cycle statistics 1973-2010.

	Standard deviation[a]					*Domestic correlation*					*International corr.*[b]		
	c	i	m	nx	tot	y,c	y,i	y,m	y,nx	y,tot	y	c	i
United States	0.80	2.86	3.27	0.36	1.64	0.93	0.95	0.79	-0.50	-0.08			
Japan	0.73	2.00	3.42	0.52	3.55	0.81	0.86	0.59	-0.11	0.11	0.52	0.34	0.48
Germany	0.60	2.17	2.16	0.53	1.34	0.65	0.86	0.66	0.23	0.22	0.54	0.41	0.57
France	0.81	2.87	3.62	0.81	2.42	0.79	0.86	0.67	-0.20	0.03	0.50	0.42	0.36
United Kingdom	1.01	2.49	2.54	0.71	1.30	0.90	0.78	0.59	-0.25	0.05	0.64	0.51	0.50
Italy	0.94	2.32	3.53	0.93	2.10	0.68	0.82	0.64	-0.23	0.37	0.50	0.08	0.32
Canada	0.71	2.82	3.05	0.74	1.66	0.79	0.69	0.54	0.29	-0.21	0.68	0.57	0.36
Spain	0.92	2.76	3.52	0.96	2.84	0.85	0.91	0.71	-0.45	0.02	0.41	0.33	0.18
Australia	0.92	3.98	5.26	1.12	4.35	0.42	0.68	0.17	-0.00	-0.05	0.23	0.02	0.37
Mexico	1.03	3.28	4.90	0.81	2.50	0.95	0.88	0.66	-0.52	-0.38	0.22	0.09	0.15
Korea	1.05	2.70	2.65	1.18	1.28	0.81	0.89	0.66	-0.25	-0.29	0.26	0.15	0.26
Netherlands	0.75	2.64	1.84	0.77	0.66	0.70	0.82	0.59	0.05	-0.05	0.59	0.47	0.49

[a] Relative to standard deviation of GDP.
[b] Correlations with corresponding United States series.

4.2 Calibration

To proceed with the calibration we need precise definitions of macroeconomic aggregates in our model, so that, we can match data to our simulations. We shall understand real GDP as the sum of private consumption, investment and exports minus imports: $GDP_t = c_t + i_t + Px_t^* - P^*x_t$, and we will refer to net exports as the result of the trade balance divided by GDP, i.e. $nx_t = (Px_t^* - P^*x_t)/GDP_t$, where P and P^* are steady state values or constant prices for the model and the data respectively. Terms of trade will refer to the ratio of import and export prices, so $tot_t = P_t^*/P_t$, while the real exchange rate will refer to the ratio in the price level of intermediate goods, $rer_t = p_t^*/p_t$.

The model is calibrated to match features of the US economy over the 1973-2010 period as follows: we set the discount factor β to the standard value of 0.99 to match an annualized interest rate of about 4%, the capital depreciation rate δ is set to 0.025 to match an annualized depreciation rate of 10%, and the coefficient of risk aversion θ to -1. Following Mandelman et al. (2011) we assume a cost of holding savings (ϕ) equal to one basis point. We set Q to obtain an import share of 15%,[4] and μ to obtain a share of hours worked equal to 0.34, both also standard targets in the literature. The capital adjustment cost parameter ψ is set so that the standard deviation of investment is about three times that of output. The value of the trade elasticity σ is set to $0.\hat{7}$ to get an elasticity of substitution of 4.5. The parameter α is set so that the volatility of imports is between 2 and 3 times that of output (Engel and Wang (2011)). γ is set to match an investment share of 22% of GDP. As a baseline we set $\eta = 0.57$, which is the baseline value used by Amaral and Quintin (2010) to match the ratio of financial intermediation to GDP in US.[5] We will later perform a sensitivity analysis for this parameter. The shock process has the usual form,

$$\log \begin{bmatrix} z_t \\ z_t^* \end{bmatrix} = A \log \begin{bmatrix} z_{t-1} \\ z_{t-1}^* \end{bmatrix} + \begin{bmatrix} \epsilon_t \\ \epsilon_t^* \end{bmatrix},$$

where $(\epsilon_t, \epsilon_t^*)$ is a vector of normally distributed shocks, independent from past values. The covariance matrix of these shocks as well as the parameters in the transition matrix A are set after the values estimated by Heathcote and Perri (2002). The complete parametrization of the model is given in Table 2.

[4] Simulation results do not change significantly for different values of ϕ and Q, even if they are set to 0.

[5] We performed a robustness test for the results in Table 3 and in the figures using different η. All the qualitative results are robust for a wide range of values. The most relevant changes are in the steady state and we report and analyse them in Section 5.2.

4.3 Simulation

We ran fifty 300-period simulations of this economy, subjected to productivity shocks, and took the log of each series (except for net exports, which may be negative) and used a Hodrick-Prescott filter for quarterly data to remove their trends. We then averaged results from all fifty simulations. Column 3 of Table 3 present these averages compared to their data counterparts, which have also been logged and HP-filtered as needed for comparison. We also provide the results in Heathcote and Perri (2002) in the last column.

Column 4 adds a credit shock to the baseline case. In order to evaluate the effects of temporary credit shocks we need to introduce a second source of uncertainty in our model. The level of development of the financial system in a country and the strength of its institutions are captured by the parameter η. However, η can also capture changes in risk positions taken by the financial intermediaries. Hence, a larger η may represent both a better developed financial market and a higher level of confidence of banks on loan-repayment possibilities. We shall assume that the credit tightness parameter η is now time dependent with mean $\bar{\eta}$ and a random component b_t so that $\eta_t = \bar{\eta} b_t$. The shock process is now

$$\log \begin{bmatrix} z_t \\ z_t^* \\ b_t \\ b_t^* \end{bmatrix} = A \log \begin{bmatrix} z_{t-1} \\ z_{t-1}^* \\ b_{t-1} \\ b_{t-1}^* \end{bmatrix} + \begin{bmatrix} \epsilon_{z,t} \\ \epsilon_{z,t}^* \\ \epsilon_{b,t} \\ \epsilon_{b,t}^* \end{bmatrix}.$$

Table 2: Benchmark parameter values.

Parameter		*Value*	*Source or Target*
Risk aversion	θ	-1	Backus et al. (1994)
Discount rate	β	0.99	4% annualized interest rate
Leisure share	μ	0.46	Hours worked = 0.34
Depreciation rate	δ	0.025	10% annualized depreciation
Adjustment cost	ψ	0.85	Volatility of investment ≈ 2.9
Trade elasticity	σ	0.77	Elasticity of substitution= 4.5
Fixed cost	Q	0.001	15% import share of GDP
Capital share	γ	0.41	22% Investment share of GDP
Home bias	α	0.75	Volatility of imports $\in (2, 3)$
Cost of saving	ϕ	0.01	Mandelman et al. (2011)
Productivity process	V_ϵ	$10^{-6}\begin{bmatrix} 53 & 15 \\ 15 & 53 \end{bmatrix}$	Heathcote and Perri (2002)
Transition matrix	A	$\begin{bmatrix} 0.97 & 0.025 \\ 0.025 & 0.97 \end{bmatrix}$	Heathcote and Perri (2002)

Calibrated to 1973-2010 US data.

Following the estimations in Niepmann and Schmidt-Eisenlohr (2014), we calibrate the standard deviation of the credit shock to 0.26 to match an effect of 1.5% change in exports.[6] Its persistence is set to 0.91 and the cross-country correlation to 0.76, as estimated in Gilchrist and Zakrajsek (2012)[7] and Kollmann et al. (2011) respectively. In Section 5 we consider and compare credit and productivity shocks of the same size under different scenarios and lay out their properties.

The baseline model does a good job at explaining some of the discrepancies between standard international real business cycle models and the data. Excessive consumption smoothness is one such common problem that goes away. Raffo (2008, 2010) suggests introducing an alternative specification of household preferences to increase consumption volatility.[8] Our model, however, is capable of generating consumption that is as volatile as in the data with standard preferences.

The volatility of imports is about two and a half times as large as the volatility of output. While it isn't as large as in the data, it is quite an improvement over standard models, which typically imply lower import volatility than output volatility. Another significant improvement can be seen in the volatility of terms of trade, which is larger than that of output and quite close in magnitude to what we observe in the data. The volatility of hours worked is low, but this is a common problem elsewhere in the literature.

Auto-correlations of the series in the model are very similar to those in the data as are domestic correlations. Our mechanism works as follows: when a positive productivity shock hits the economy, households have more income left after consumption. They decide to allocate these savings between importers that need to finance international purchases and input producers (serving both domestic and foreign markets) that need to finance capital. In any case, the extra resources make international trade cheaper: savings devoted to finance imports reduce the total cost of imported goods and savings used to finance exporters capital allow them to produce inputs at a lower cost, becoming more attractive to foreign customers.

The correlation between output and the terms of trade is another common puzzle of international RBC models. Looking at long time series this correlation is typically negative (Mendoza (1995), Kehoe and Ruhl (2008)),[9] while the standard models predict a positive correlation. Our model predicts a strong negative correlation, a sign consistent with data, the opposite prediction of standard models.[10]The same occurs with

[6]They find that a negative trade finance shock of one standard deviation causes a reduction of 1.5% in exports growth.

[7]Comin and Gertler (2014) also uses this measure for trade finance.

[8]GHH preferences, as introduced by Greenwood et al. (1988), have the property that the marginal rate of substitution between consumption and leisure is independent of the consumption level within the period, which implies that there is no income effect on labor supply and hours worked respond more strongly to changes in productivity. Although this generates volatility of consumption more in line with the data, the unresponsiveness of labor supply to changes in consumption levels appears to be empirically troublesome.

[9]Note that Mendoza (1995) defines terms of trade as the inverse of our terms of trade.

[10]Gruber and Arespa (2015) shows that this correlation is strongly negative in earlier data and positive in recent years. He suggests that in order to explain the negative correlations of the past and their recent reversal, models of these type should introduce the possibility that firms alter the quality and not just the quantity of their production, and that improvements in the measurement of quality should be taken into account. Our model here predicts a strong negative correlation, consistent with earlier data but inconsistent with recent values, the opposite prediction of standard models.

the correlation between net exports and domestic output, which is negative in the data and in our simulations but positive in standard RBC models. The volatility of net exports is a little higher than in the data, but remains lower than the volatility of output.

Another interesting result is that the cross-country correlation of output is stronger than that of consumption, as in the data. This is typically not the case in the literature: Backus et al. (1994) dub this the "consumption/output anomaly". Our cross-country correlations of consumption are somewhat low. But most importantly, the anomaly is gone. We believe this is an important feature of our model. Recall that only national households can invest in national capital. This is a capital restriction than prevents agents from sharing domestic risk further and explains the low cross-country correlation of consumption.[11] The cross-country correlations of investment and hours worked are wrong, another common problem in this type of models. The Backus-Smith puzzle does not go away either, since the correlation between relative consumption and the real exchange rate is near one. [12]

The constrained intermediate good firms would like to use a larger share of foreign inputs. With a positive productivity shock intermediate firms are able to increase their imports with the resources freed by the lower cost of domestic inputs. As a consequence, net exports decrease with output. After the shock, both countries increase the demand for the cheaper input. Foreign intermediate goods firms, which were more constrained before the shock, redirect part of their demand towards the cheaper input. As a result, $P*$ decreases sufficiently to see a reduction in the terms of trade, which have a countercyclical behavior.

Which features of the model make the quantity anomaly disappear? Column "HP 2002" of Table 3 reports the results for the bond economy in Heathcote and Perri (2002). The comparison between their model and ours hints us an answer. Their model differs in two relevant features: they have perfect competition for intermediate good producers, which combine inputs in a CES, while we have monopolistic competition and combine inputs in a Cobb-Douglas and their firms are not credit constrained. The combination of these two structure settings explains a different response of the economies to productivity shocks. A productivity shock in the Home country causes a milder response in terms of output when competition is monopolistic. This causes a smaller change in relative prices and keeps a larger correlation between cross-country outputs. Moreover, with Cobb-Douglas preferences in consumption, Home and Foreign inputs are in the limit between substitutes and complements, while in a CES, it depends on the selected elasticity of substitution. Any change in the relative use of inputs changes their relative price proportionally with a Cobb-Douglas, but not with a CES. Altogether, these features make output across borders more correlated.

[11] See Olivero (2010).

[12] This is another anomaly that Gruber and Arespa (2015) suggests would go away if changes in quality were taken into account.

Table 3: Simulation results.

	Data[b]	*Model*		
Standard deviations[a]	73-10	Baseline	Both shocks	HP 02
Output	1.00	1.00	1.00	1.00
Hours	1.27	0.35	0.10	0.32
Consumption	0.80	0.96	0.49	0.52
Investment	2.86	2.90	2.31	2.73
Imports	3.27	2.50	1.66	0.79
Net exports	0.36	0.62	0.70	0.15
Terms of trade	1.64	1.72	0.26	
Autocorrelations				
Output	0.87	0.77	0.60	
Hours	0.92	0.68	0.62	
Consumption	0.87	0.73	0.84	
Investment	0.90	0.72	0.18	
Net exports	0.78	0.72	0.61	
Terms of trade	0.81	0.68	0.66	
Corr. with domestic output				
Hours	0.89	0.69	0.56	0.97
Consumption	0.93	0.95	0.62	0.95
Investment	0.95	0.82	0.63	0.96
Net exports	−0.43	−0.37	0.68	−0.65
Terms of trade	−0.08	−0.36	−0.24	
Cross-country correlations[c]				
Output	0.58	0.73	0.10	0.17
Hours	0.42	−0.68	−0.10	−0.17
Consumption	0.36	0.22	0.92	0.68
Investment	0.30	−0.38	0.92	−0.29
Rel. consumption-RER	−0.71	0.98	0.34	

[a] Relative to the standard deviation of output.
[b] Source: OECD and FRED.
[c] Refers to the correlation of US series with series for an aggregate of Canada, Japan and EU-15.

EXPLAIN COLUMN WITH BOTH SHOCKS

We can conclude that having a credit constraint allows us to evaluate the effects of changing conditions in financial markets to both the amount as well as the dynamic properties of trade. This is what we do in the next section.

5 How trade finance affects trade

5.1 Effects of a temporary credit shock

In light of all the empirical evidence in favor of the existence of a link between finance of trade and international trade itself, how does our theoretical economy behave in response to an exogenous tightening of credit conditions? In our model, household savings are the crucial source of credit availability determining the volume of trade attainable in this economy. As a benchmark case, we set all correlations and spillovers between financial and technology shocks to zero. Considering that financial shock transmission across borders has been shown to be a very relevant phenomenon among modern capitalist economies in recent history, we allow for a positive international correlation between trade credit shocks, $corr(\varepsilon_b, \varepsilon_b^*) = 0.76$, following the estimations in Kollmann et al. (2011). The standard deviation and the persistence for the financial shock is assumed to be that of the productivity shock to allow comparisons. We will later consider the effects of altering these assumptions.

Continuous lines in Figure 1 show the impulse responses in macroeconomic aggregates for the benchmark case. When a negative financial shock hits our economy, GDP initially increases and then falls below its steady state value for the rest of the transition. The reason for this result is related to the change in the composition of demand by intermediate good producers. When the financial constraint becomes tighter, firms must reduce their demand for imports. They substitute foreign inputs by relatively more expensive national products, pushing domestic production up and, hence, improving GDP. In anticipation of increased demand for domestic products, there is an upsurge in investment causing this effect. Moreover, households lose (at least partially) one of their saving alternatives -the finance of imports-, so they devote more resources to the remaining option -investment in capital-. Foreign input producers lose part of the demand and reduce prices, P_t^*. However, Home input producers reduce their prices further. The upsurge in investment increases capital accumulation just after the shock. This makes it cheaper, generates a substitution from labor to capital and reduces the cost of production of the input and, therefore, its price. As a consequence, terms of trade increases (i.e., deteriorates).

This leads to a fall in exports and, as a consequence, in national GDP. Both imports and exports over GDP are below the steady state during the transition. However, the negative effect of the financial tightening on imports is much larger than on exports, so net exports over GDP improve. The interest rate reduces also because intermediate firms demand less financial resources.

On the other hand, the tightening in the financial constraint affects productivity: firms are forced to choose a less efficient mix of domestic and foreign inputs due to the restriction. The obvious consequence is the increase of intermediate goods prices, which damage consumption. Under the current parametrization, the positive effect described above dominates the negative initially. However after a few periods, investment collapse and the initial surge in GDP disappears.

The dashed lines in the impulse-response figures above show that the balance between positive and negative effects on macroeconomic aggregates crucially depends on the level of financial shock persistence. When persistence is low the surge in demand for domestic goods is much more short-lived, and therefore increases in investment in anticipation of this surge are too weak to counteract the negative effects of credit-tightening on productivity and exports. In this case (0.80) the increase in GDP is both milder and of shorter duration, and of course the economy returns to the steady state much more quickly than in the case of high persistence.

How are results affected by a change in the level of transmission of financial shocks? Figure 2 illustrates what happens if international correlations drop from the benchmark case of 0.70 to 0.50. This change basically affects the magnitude but not the shape of the response to the shock. In the benchmark case, since the shock is transmitted abroad more forcefully, foreign firms find it more difficult to finance imports and hence exports fall significantly more than in the case of milder spillovers. With lower transmission of financial shocks effects over GDP and other macroeconomic aggregates are much milder. We reach virtually the same conclusions if instead of comparing economies with different levels of international correlations we compare economies with different levels of financial spillovers.

Similarly, our results are robust to changes in the correlation between financial and technology shocks. If these are different from zero, only the magnitude of the shocks is affected, but not their qualitative properties. A positive correlation will accentuate the negative effects of a financial shock on productivity, as there will be a loss in efficiency due to both a less desirable mix of foreign and domestic inputs as well as a downgrade in the technology used to combine them.

Finally, how do the effects of credit shocks compare to the effects of technology shocks? This is illustrated in Figure 3 for the baseline parametrization of the credit shock; under these specifications, both shocks have the same variance, and except for the case of GDP and investment, credit shocks have effects in the same

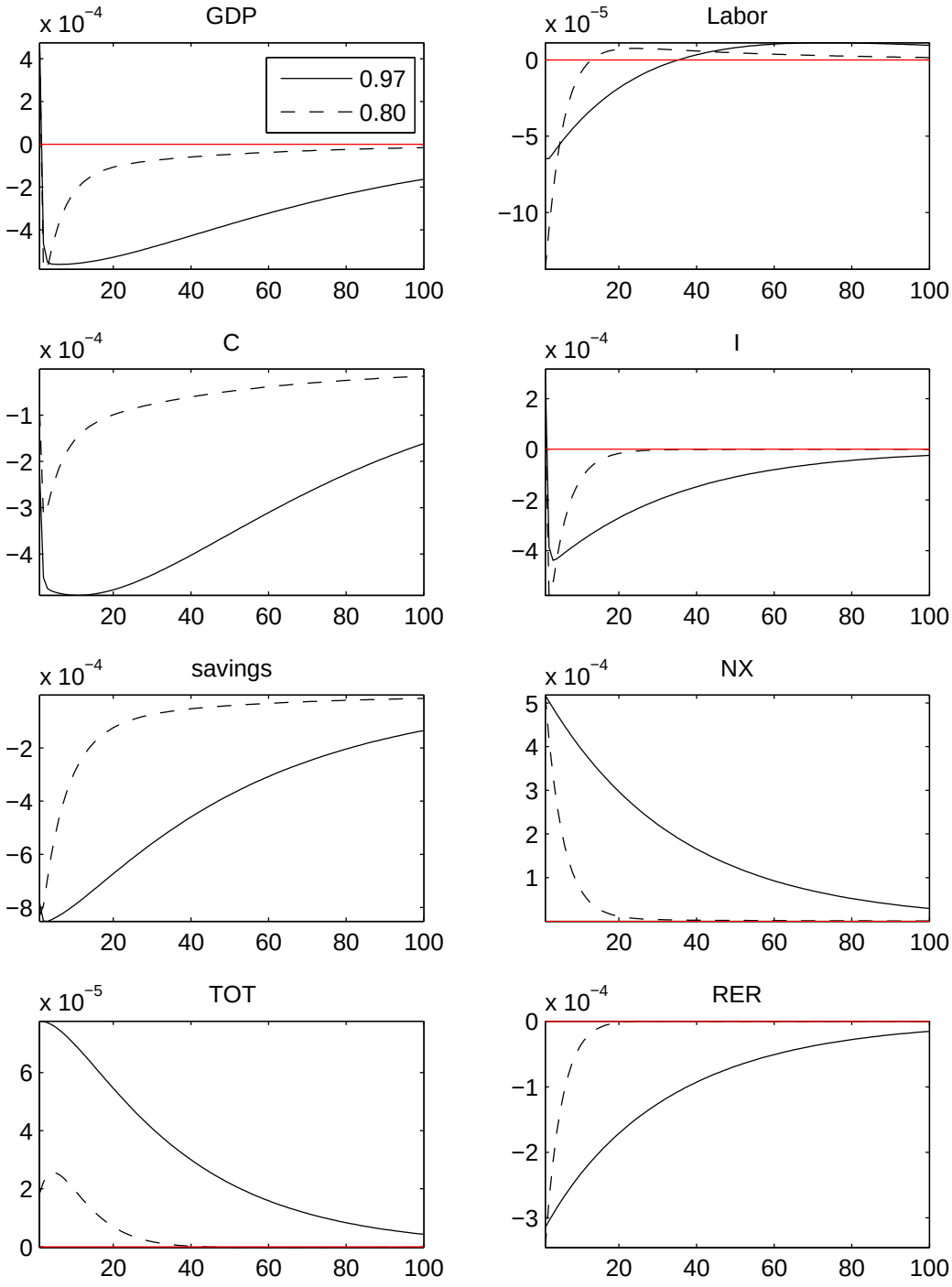

Figure 1: Change in macroeconomic aggregates following a financial shock for varying levels of financial shock persistence.

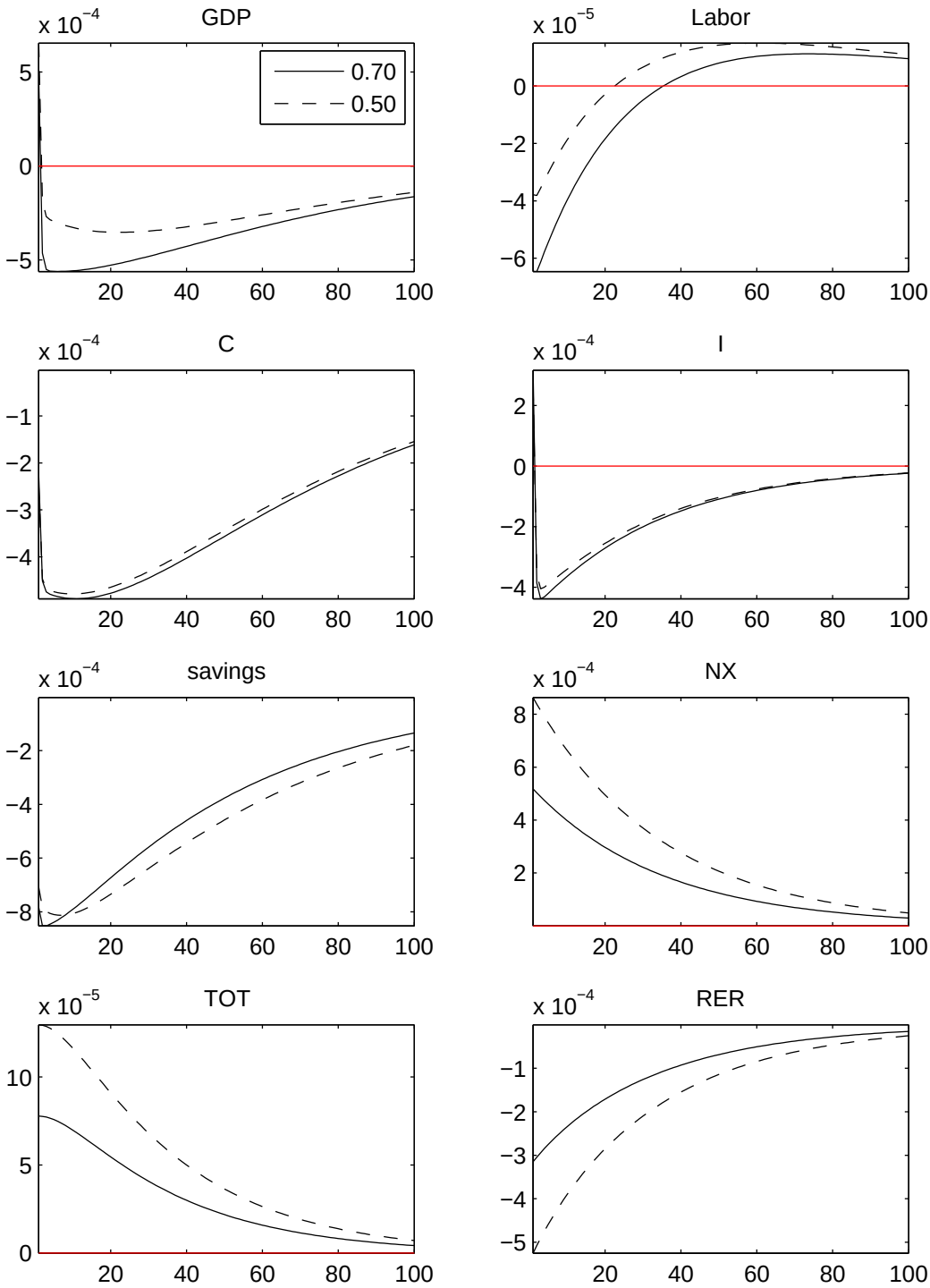

Figure 2: Change in macroeconomic aggregates following a financial shock for varying levels of international correlations.

direction to productivity shocks. The most striking difference though is in the magnitude of the effects, as credit shock effects appear to be much weaker for all aggregates considered. Put differently, for the effects of both shocks to be of roughly comparable magnitude, the variance of credit shocks would need to be much larger than that of productivity shocks. This explains why the introduction of credit shocks appears to make little difference to the business cycle properties of this economy, as pointed out in section 4.3; these properties are largely driven by fluctuations in technology. However, recent evidence by Helbling et al. (2011) show that the insignificance of responses of global real variables to credit shocks compared to productivity shocks of equal magnitude does not imply these are unimportant. Their variance decomposition suggests that credit shocks contribute as much to fluctuations to the global GDP factor. Hristov et al. (2012) account for loan supply shocks, aggregate supply shocks, monetary policy shocks and aggregate demand shocks for the Euro Area countries. They conclude that, in all member countries, a sizable part of the drop in GDP growth (15%) is attributed to loan supply shocks in the recent crisis.

5.2 Effects of a permanent credit shock

We limit the analysis in this section to comparative statics of a change in the financial situation of an economy and by analyzing the qualitative consequences of a permanent tightening in η. Results are summarized in Table 4.

First of all, a more constrained financial market reduces GDP in the steady state. Optimal intermediate firm demand allocation is bounded by the financial constraint, i.e., they would like to import more. Due to this suboptimal demand allocation, the cost of production increases and so do prices, which, in turn, reduce consumption and investment almost proportionally to GDP. This result is supported by several papers showing a positive link between financial development and economic growth (See Levine (2005) and Papaioannou (2008) for a complete survey on the issue.). Imports, on the other hand, decline more than GDP, moving from a 12% to 8% when η changes from .57 to .37, which is approximately the 5% decrease experienced by US real imports over real GDP ratio from its peak to its valley in the recent crisis. When we isolate the financial channel by worsening importers access to financial resources, independently of any other shocks, imports are much more damaged than GDP. This may be the case because imports are restricted and firms need to turn to national production, partially offsetting the downturn in GDP.

Since the economy is less open in trade to foreign markets, cross-border spillovers are milder. This makes all real variables more correlated with national GDP. Net exports react considerably and become much more negatively correlated with GDP. The lower interrelation causes cross-country correlations to decrease.

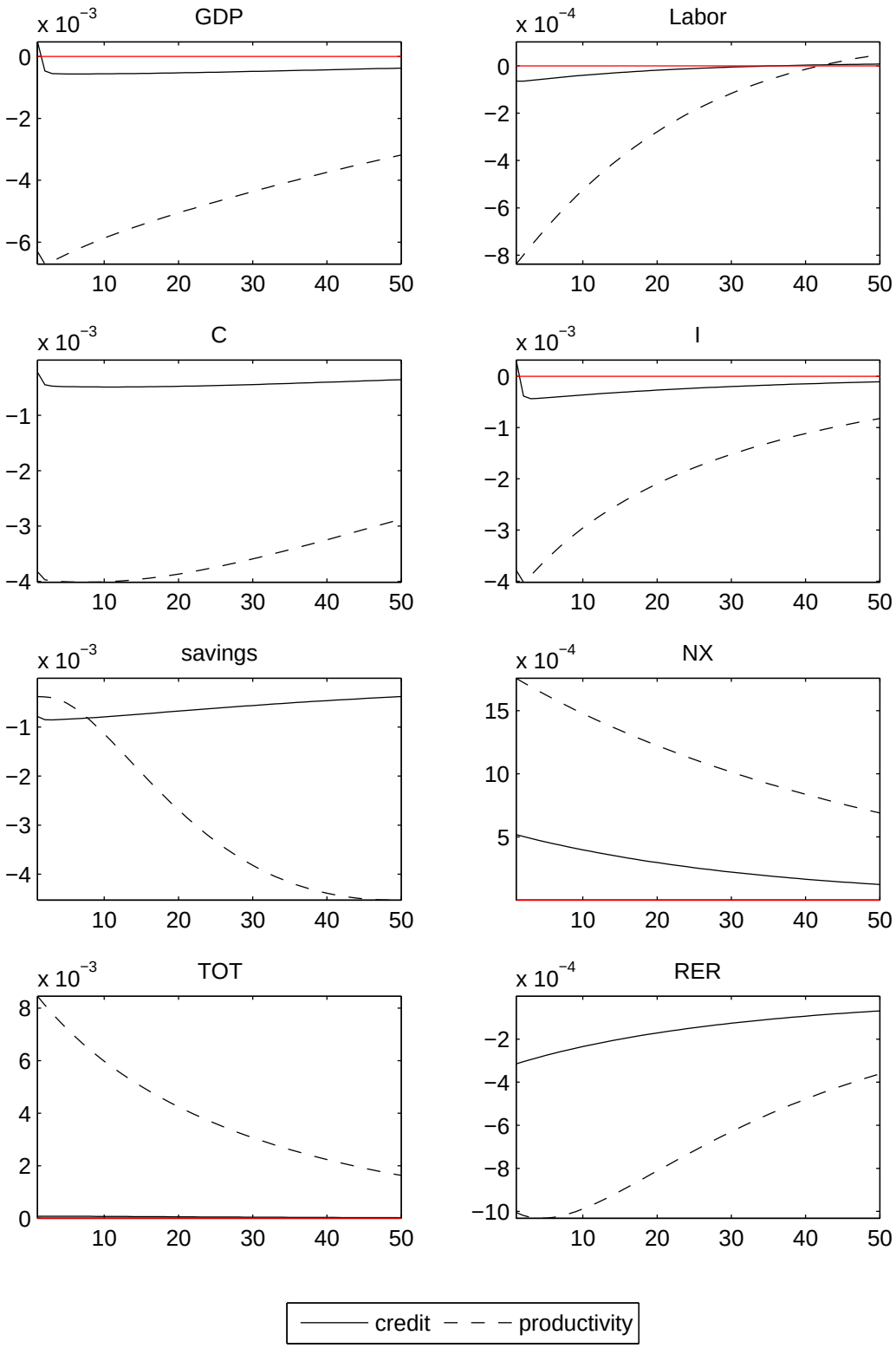

Figure 3: Comparing credit and technology shocks.

Table 4: Simulation results for different η

	η			
Steady state	0.77	0.57	0.47	0.37
Output	0.86	0.83	0.80	0.75
Consumption	0.68	0.65	0.63	0.59
Investment	0.18	0.17	0.17	0.15
Imports/GDP	0.17	0.12	0.10	0.08
Standard deviations[a]				
Output	0.72	0.79	0.82	0.82
Consumption	0.55	0.56	0.54	0.52
Investment	0.44	0.46	0.45	0.44
Imports	0.25	0.17	0.14	0.10
Net exports	0.52	0.37	0.30	0.23
Terms of trade	1.44	1.61	1.70	1.77
Corr. with domestic output				
Imports/GDP	0.75	0.86	0.91	0.93
Net exports	−0.36	−0.56	−0.63	−0.68
Terms of trade	−0.36	−0.56	−0.62	−0.68
Cross-country correlations				
Output	0.88	0.72	0.63	0.55
Consumption	0.63	0.57	0.55	0.53

[a] In percentage.

Although savings are still pooled across borders, one of the international transmission mechanisms, trade, has been partially blocked.

Regarding country uncertainty, credit tightening increases the volatility of GDP and terms of trade, whereas imports, net exports and the real exchange rate are more stable. Consumption volatility has a nonlinear response to credit tightening. Empirical research draws ambiguous conclusions on the effects of financial market development on macroeconomic volatilities. Our results for GDP and consumption are close to those of Kose et al. (2003a) and Kose et al. (2006). In their empirical analysis for 76 countries, comprising 21 industrial and 55 developing countries, they find a negative effect on GDP volatility, in other words, more developed markets suffer from smaller output instability. On the consumption side they show that financial development increases consumption volatility up to certain threshold, following a nonlinear relationship, just as we do. For instance, for $\eta = 0.77$, the standard deviation of consumption is 0.0055, lower than that found with $\eta = 0.57$, our baseline value. Eozenou (2008), on the other hand, finds consumption volatility to increase when financial markets are underdeveloped for a panel of 90 countries. Investment volatility behaves in a similar way for us.

We can explain the increasing volatilities due to the lower possibilities of risk sharing among countries. A highly developed financial market leads to more openness, because firms are able to purchase more imports. Therefore, both transmission mechanisms, trade and financial relationships, complement each other. When a country in a highly constrained world is shocked by a positive change in its technology, its firms can produce cheaper goods, which pushes consumption and investment and increases output. However, when the shock occurs in a relatively unconstrained scenario, foreign firms substitute national inputs by imports, which are now cheaper, and benefit from the shock. These spillovers cause a valuation effect on the production of the shocked country, reducing the response of consumption and investment. By the same token, GDP is also less volatile thanks to the role of trade in risk sharing.

Indeed, the combined effect of the level of trade transmission across borders (or level of spillovers) and the level of risk sharing can explain the nonlinear behavior of consumption volatility. When a country is relatively financially constrained and, hence, relatively closed, it suffers or benefits less from spillovers. This makes it less volatile. On the contrary, a relatively closed country has a worse level of risk sharing capability, which causes consumption to be more volatile in front of domestic turbulence. Both effects are present and act in opposite directions: initially, when a country develops financially, the strength of imported spillovers makes it increasingly unstable. However, for a certain level of development, the risk sharing possibilities offset the damage caused by spillovers, reducing consumption volatility.

6 Conclusions

Regardless of the scarcity of quality data, the importance of trade finance for international trade has been clearly established in the empirical literature. This model provides theoretical support for the role of the financial channel in explaining part of the large decline in the trade levels for many countries following episodes of financial distress. Firms are bound by a financial constraint when they want to import. However, regardless of the explicit financial constraint, which affects importers, all firms in need for external finance rely on households capability for saving, the suppliers of credit resources. This capability is larger and, hence, the constraint is looser during economic expansions because households are able to save more. Indeed, when savings increase, households allocate them between credit to importers and savings in the form of capital which is rented to exporters. Whatever the decision they take, they make international trade finance cheaper. A credit tightening episode worsens the capability of importers to get access to foreign suppliers, who require guarantees to ship their products. This reduces imports dramatically and, although output is also damaged, some demand is reallocated to domestic goods, cushioning part of the decline in GDP. Therefore, while output, consumption and investment decline at the same proportion after a credit tightening, imports are hit much harder.

Despite the importance of credit shocks to individual importers, their large-scale impact on the economy appears to be limited at business cycle frequencies compared to productivity shocks of the same magnitude. Unless trade finance is much more volatile than productivity, it seems unlikely that trade finance could play a large role in short-run fluctuations of the economy. But, this larger volatility that makes the effects of credit shocks sizable is, indeed, what evidence highlights (Recall Niepmann and Schmidt-Eisenlohr (2014), Helbling et al. (2011) and Hristov et al. (2012)). The availability of trade finance is also important to the long-run levels of trade, productivity, and output of an economy. Improvements in trade finance can produce large gains as well as more stability in production and consumption as it allows for an increase in trade performance and a better mix of foreign and domestic goods used in productive activities.

To the best of our knowledge, this paper is the first in the international real-business-cycle literature to consider the role of trade finance. We go a step forward into the understanding of international trade performance in a two-country, three-sector, micro-founded model by introducing a simple representation of the financial sector. Our model is able to shed light on many persistent contradictions between theoretical business-cycle volatilities and their empirical counterparts. First of all, the correlations between net exports and terms of trade with national output are negative in the model, matching actual data and opposite to standard RBC models. Second, we find that imports are more than twice as volatile as output in our simulations. Though this is still low compared to US data, it represents an important improvement, for

previous models generally generate import volatility lower than GDP volatility. Terms of trade volatility in the model is larger than that of GDP and closer to the actual value compared to the existent literature. Our model is capable of generating consumption that is as volatile as in the data without the need to resort to non-standard preferences, thereby correcting the excess in consumption smoothing found in past literature. Furthermore, we overcome the "consumption/output anomaly" by producing cross-country correlations in consumption smaller than in output, as in the data.

The model setup used in this paper is a suitable benchmark to explore the linkages between international trade and trade finance in depth. This has been a step on this direction and further research is necessary to fully understand the implications of financial development and financial turbulence on international trade patterns. Two reasonable extensions from this paper may be, first, to introduce firm heterogeneity and explore the relationship between firm size and trade finance, given that the empirical evidence suggests that smaller firms are the ones that suffer more from the tightening of credit during financial crises; another important source of heterogeneity might be the possibility of intrafirm credit for firms with international subsidiaries. Finally, it would be interesting to allow for asymmetric countries to understand the evolution of trade flows among economic regions with different levels of financial development.

References

Ahn, J. (2011): "A Theory of Domestic and International Trade Finance," *IMF Working Papers*.

Ahn, J., M. Amiti, and D. Weinstein (2011): "Trade finance and the great trade collapse," *The American Economic Review*, 101, 298–302.

Amaral, P. S. and E. Quintin (2010): "Limited enforcement, financial intermediation, and economic development: A quantitative assessment," *International Economic Review*, 51, 785–811.

Amiti, M. and D. Weinstein (2011): "Exports and financial shocks," *The Quarterly Journal of Economics*, 126, 1841–1877.

Asmundson, I., T. Dorsey, A. Khachatryan, I. Niculcea, and M. Saito (2011): "Trade Finance in the 2008–09 Financial Crisis: Evidence from IMF and BAFT–IFSA Surveys of Banks," *Trade Finance During the Great Trade Collapse, The World Bank, Washington DC*, 89–116.

Auboin, M. (2009): "Restoring trade finance during a period of financial crisis: Stock-taking of recent initiatives," *World Trade Organization (WTO) Economic Research and Statistics Division WP*, 16.

Backus, D., P. Kehoe, and F. Kydland (1992): "International real business cycles," *The Journal of Political Economy*, 100, 745–775.

——— (1994): "Dynamics of the trade balance and the terms of trade: The J-curve?" *The American Economic Review*, 84, 84–103.

Backus, D. K. and M. J. Crucini (2000): "Oil prices and the terms of trade," *Journal of International Economics*, 50, 185–213.

Benigno, P. (2009): "Price Stability with Imperfect Financial Integration," *Journal of Money, Credit and Banking*, 41, 121–149.

Berman, N., J. de Sousa, P. Martin, and T. Mayer (2012): "Time to ship during financial crises," *National Bureau of Economic Research WP*, 18274.

Berman, N. and P. Martin (2010): "The vulnerability of sub-Saharan Africa to the financial crisis: the case of trade," *Centre for Economic Policy Research DP*, 7765.

BIS (2014): "Trade finance: developments and issues," *Committee on the Global Financial System Papers, Bank for International Settlements*.

Chaney, T. (2005): "Liquidity constrained exporters," Mimeo, University of Chicago.

Comin, D. and M. Gertler (2014): "The persistence of business cycles," .

Eaton, J., S. Kortum, B. Neiman, and J. Romalis (2009): "Trade and the Global Recession," Tech. rep., mimeo.

——— (2011): "Trade and the global recession," Tech. rep., National Bureau of Economic Research.

Ellingsen, T. and J. Vlachos (2009): "Trade finance in a liquidity crisis," *World Bank Policy Research Working Paper*, 5136.

Engel, C. and J. Wang (2011): "International trade in durable goods: Understanding volatility, cyclicality, and elasticities," *Journal of International Economics*, 83, 37–52.

Eozenou, P. (2008): "Financial Integration and Macroeconomic Volatility: Does Financial Development Matter?" *University Library of Munich, Mpra paper*, 12738.

Feenstra, R., Z. Li, and M. Yu (2011): "Exports and credit constraints under incomplete information: Theory and evidence from china," WP 16940, National Bureau of Economic Research.

Fisman, R. and I. Love (2003): "Trade credit, financial intermediary development, and industry growth," *The Journal of Finance*, 58, 353–374.

Fontagné, L. and G. Gaulier (2009): "French exporters and the global crisis," in *The Great Trade Collapse: Causes, Consequences and Prospects*, ed. by R. Baldwin, CEPR for VoxEU.org, chap. 16, 143–150.

Garcia-Appendini, E. and J. Montoriol-Garriga (2013): "Firms as liquidity providers: Evidence from the 2007-2008 financial crisis," *Forthcoming Journal of Financial Economics*.

Gilchrist, S. and E. Zakrajsek (2012): "Credit spreads and business cycle fluctuations," *American Economic Review*, 102, 1692–1720.

Greenwood, J., Z. Hercowitz, and G. Huffman (1988): "Investment, capacity utilization, and the real business cycle," *The American Economic Review*, 402–417.

Gruber, D. and M. Arespa (2015): "Product Quality and International Price Dynamics," Tech. rep., mimeo.

Heathcote, J. and F. Perri (2002): "Financial autarky and international business cycles," *Journal of Monetary Economics*, 49, 601–627.

Helbling, T., R. Huidrom, M. A. Kose, and C. Otrok (2011): "Do credit shocks matter? A global perspective," *European Economic Review*, 55, 340–353.

Hristov, N., O. Hülsewig, and T. Wollmershäuser (2012): "Loan supply shocks during the financial crisis: Evidence for the Euro area," *Journal of International Money and Finance*, 31, 569–592.

Humphrey, J. (2009): "Are exporters in Africa facing reduced availability of trade finance?" *IDS Bulletin*, 40, 28–37.

Iacovone, L. and V. Zavacka (2009): "Banking Crises and Exports: Lessons from the Past," *World Bank Policy Research Paper*, 5016.

Kalemli-Ozcan, S., E. Papaioannou, and F. Perri (2012): "Global banks and crisis transmission," *National Bureau of Economic Research WP*, 18209.

Kehoe, T. and V. Ruhl (2008): "Are shocks to the terms of trade shocks to productivity?" *Review of Economic Dynamics*, 11, 808–819.

Kollmann, R., Z. Enders, and G. J. Müller (2011): "Global banking and international business cycle," *European Economic Review*, 55, 407–426.

Kose, M., E. Prasad, and M. Terrones (2003a): "How does globalization affect the synchronization of business cycles?" *The American Economic Review*, 93, 57–62.

Kose, M. A., C. Otrok, and C. H. Whiteman (2003b): "International Business Cycles: World, Region, and Country-Specific Factors," *The American Economic Review*, 93, pp. 1216–1239.

Kose, M. A., P. E. S., and M. E. Terrones (2006): "How do trade and financial integration affect the relationship between growth and volatility?" *Journal of International Economics*, 69, 176–202.

Levchenko, A., L. Lewis, and L. Tesar (2011): "The Collapse of International Trade During the 2008-2009 Crisis: In Search of the Smoking Gun," *National Bureau of Economic Research WP*, 16006.

Levine, R. (2005): "Finance and growth: Theory and evidence," *Handbook of economic growth*, 1, 865–934.

Love, I., L. Preve, and V. Sarria-Allende (2007): "Trade credit and bank credit: evidence from recent financial crises," *Journal of Financial Economics*, 83, 453–469.

Malouche, M. (2009): "Trade and trade finance developments in 14 developing countries post September 2008-a World Bank survey," *World Bank Policy Research WP*, 5138.

Mandelman, F., P. Rabanal, J. Rubio-Ramírezc, and D. Vilán (2011): "Investment-specific technology shocks and international business cycles: An empirical assessment," *Review of Economic Dynamics*, 14, 136–155.

Manova, K. (2012): "Credit constraints, heterogeneous firms, and international trade," *Forthcoming Review of Economic Studies*.

Manova, K., S.-J. Wei, and Z. Zhang (2009): "Firm Exports and Multinational Activity under Credit Constraints," WP 16905, National Bureau of Economic Research.

Mendoza, E. (1995): "The terms of trade, the real exchange rate, and economic fluctuations," *International Economic Review*, 36, 101–137.

Mora, J. and W. Powers (2009): "Did trade credit problems deepen the great trade collapse?" in *The Great Trade Collapse: Causes, Consequences and Prospects*, ed. by R. Baldwin, CEPR for VoxEU.org, chap. 14, 115–125.

Morel, F. (2010): "Credit insurance in support of international trade: Observations throughout the crisis," in *Trade Finance during the Great Trade Collapse*, ed. by J.-P. Chauffour and M. Malouche, The World Bank, chap. 20, 337–355.

Niepmann, F. and T. Schmidt-Eisenlohr (2014): "No guarantees, no trade: How banks affect export patterns," *CESifo Working Paper Series*.

Olivero, M. P. (2010): "Market power in banking, countercyclical margins and the international transmission of business cycles," in Olivero (2010), 292–301.

Papaioannou, E. (2008): *Finance and growth: a macroeconomic assessment of the evidence from a European angle*, Freixas, X., Hartmann, P. and Mayer, C., Oxford University Press, chap. 2.

Paravisini, D., V. Rappoport, P. Schnabl, and D. Wolfenzon (2011): "Dissecting the effect of credit supply on trade: Evidence from matched credit-export data," *National Bureau of Economic Research WP*, 16975.

Raffo, A. (2008): "Net exports, consumption volatility and international business cycle models," *Journal of International Economics*, 75, 14–29.

——— (2010): "Technology shocks: novel implications for international business cycles," *International Finance Discussion Papers*.

Schott, P. K. (2009): "US trade margins during the 2008 crisis," in *The Great Trade Collapse: Causes, Consequences and Prospects*, ed. by R. Baldwin, CEPR for VoxEU.org, chap. 15, 127–142.

Van der Veer, K. (2010): "The Private Credit Insurance Effect on Trade," *De Nederlandsche Bank Working Papers*.

Wilner, B. (2000): "The exploitation of relationships in financial distress: The case of trade credit," *The Journal of Finance*, 55, 153–178.