Devaluations and Growth: The Role of Financial Development*

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Abstract

In this paper we rationalize the observation that in emerging markets an exchange rate devaluation might have a negative effect on production, due to the fact that the increase in the value of liabilities denominated in foreign currency causes a tightening in the domestic financial conditions, potentially offsetting the effect of an increase in the value of exports. We build on Melitz (2003) to propose a model with heterogeneous firms in a small open economy where firms face financial frictions when borrowing from abroad. Depending on how strong the friction is, a foreign shock that results in an exchange rate devaluation might translate into lower output, even if exports increase.

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1 Introduction

With the end of the commodity boom in 2014, countries whose economies depended heavily on commodity exports experienced exchange rate depreciations. However, instead of fostering economic growth through an increase in net exports, these currency depreciations have been associated with slower GDP growth. In this paper we investigate how the degree of financial development in an economy affects economic growth during episodes of currency devaluation, and offer a quantitative assessment of its contribution to the observed recent fall in GDP growth in emerging markets.

Kearns and Patel (2016) document empirically that, in emerging market economies, the increase in the value of liabilities denominated in foreign currency during a foreign exchange depreciation can lead to tighter domestic financial conditions, which might offset the effect of an increase in the value of net exports. Therefore, a depreciation does not necessarily lead to an increase in production, and might actually decrease it. Similarly, Leigh et al. (2017) find that the price elasticity of trade volumes is largely stable over time, but financial conditions affect the relationship.

Since there is a tight link between financial and economic development (Greenwood et al., 2010, 2013) and between financial constraints and the ability of firms to export (Minetti and Zhu, 2011), we posit that the effect of changes of foreign exchange on production depends on how developed the financial sector of an economy is. Higher financial development allows economies to adapt to foreign exchange shocks without constraining production, while taking advantage of the fact that more favorable export prices might increase GDP. Financial development allows more foreign flows to reach domestic firms, since it allows firms to relax their borrowing constraint. In this aspect, we follow Bruno and Shin (2015) in analyzing the role of the financial sector as an intermediary of flows from the rest of the world. Rather than modeling directly the banking sector, we study an economy in which borrowing by firms is limited by imperfect enforceability of contracts, which can be endogeneized as in Buera et al. (2011). In our economy, firms pay a cost when borrowing and repaying funds from abroad, which can be a result of firms being able to abscond with a fraction of the loans they receive from foreign creditors. This cost is a proxy for the strength of the legal institutions at enforcing financial contracts, and allows us to incorporate in a parsimonious way the effect of financial development on the ability of firms to borrow. In particular, when the economy has perfect financial markets, the intermediation cost disappears. If legal institutions cannot enforce the full repayment of loans, and firms can abscond with some of them, foreign creditors will limit the amount of funds to be allocated to domestic firms.

Given the significant devaluations experienced by emerging economies, our paper focuses on studying shocks that affect foreign currency. For instance, the Colombian Peso has recorded a 67% nominal devaluation against the US Dollar between June 2014 and December 2015. While firms are heterogeneous in productivity, size, and selling market (domestic vis-à-vis foreign), it is natural to assume that they will adapt differently to a currency shock of this magnitude. In order to account for these differences, we incorporate the aforementioned financial friction into one of the workhorse models of international trade with heterogeneous firms: the Melitz (2003) model. This setup postulates the existence of a continuum of firms with different productivity that produce differentiated varieties of goods sold in monopolistically competitive markets. To account for the effect on foreign shocks on the economy, we state the Melitz model for a small open economy as in Demidova and Rodríguez-Clare (2013).

A related paper by Brooks and Dovis (2018) shows in this setup that modeling financial frictions as imperfect contract enforceability has a drastically different impact on the gains from trade liberalization compared to the case of collateral constraints. A series of recent papers (Leibovici, 2016; Kohn et al., 2016, 2017) analyzes how collateral constraints on firms' borrowing influence export decisions and international trade. We will use firm level data from the Annual Manufacturing Survey of Colombian firms (EAM) in order to discipline our model and be able to get quantitative results. To the best of our knowledge, our paper would the first to quantify the effect on GDP growth in tightening an enforcement type of constraint on firms' borrowing in a small open economy model à la Melitz.

This particular setup allows us to analyze jointly two decisions made by firms: whether to export or not, and how much to borrow from abroad. This way we can deepen our understanding of how trade and borrowing decisions interact. More broadly, we analyze the effect that different stages of financial development have on these decisions by firms, and how this affects aggregate production in the economy. In this way, with this paper we aim to understand further how financial development pays a role in allowing an economy to adapt to shocks in external financial flows.

We propose a general equilibrium model with enough features to allow us to fulfill our objectives. Ours is a small open economy, where firms need to borrow in order to acquire working capital, which they need to produce. Firms will be subject to a borrowing cost that depends on financial development. Furthermore, firms will endogenously choose whether to export to foreign markets or not.

More specifically, we will consider heterogeneous firms that vary in their productivity. They will borrow from international lenders that have access to foreign resources by paying an international interest rate. We abstract from a domestic financial system to understand the role of foreign liquidity in our model. These international lenders will be the main source from which foreign shocks will propagate to the domestic economy. For instance, an increase in the international rate will cause lenders to be less willing to lend to the domestic economy, thus impeding firms from having access to more capital.

In an extension of the model we follow Buera et al. (2011), where firms have the possibility to abscond a fraction of their loans, so lenders will only lend up to the point where firms will be indifferent between paying the full loan or abscond. This causes a borrowing constraint to emerge. Furthermore, if a firm can abscond with a lower fraction, then this constraint will be looser. In this extension the measure of financial development will be the fraction that the firm cannot abscond.

We will also follow Melitz (2003) to model the decision of firms to export or not. Firms need to pay a fix cost in order to access foreign markets. Therefore, both the intensive margin (how much a firm exports) and the extensive margin (measure of firms that export) will be endogenous. In this way, we can differentiate the effect of foreign shocks on both of these effects.

Since we want to rationalize the observed behavior of emerging markets, we follow Demidova and Rodríguez-Clare (2013) in setting up a version of the model in Melitz (2003) for a small open economy. We want to focus on the effect of foreign shocks on the domestic economy, so we abstract from the effect on foreign economies.

With this setup, a foreign shock, which we model as a higher international rate, directly affects the borrowing decision of firms, which in turn affects their profits and therefore how much they produce. On the other hand, a higher international rate causes less funds to flow into the economy, and therefore results in a devaluation. The devaluation causes higher profits from exports. As a consequence there will be a tradeoff between less funds available to borrow and higher potential profits from exports. Which effect dominates will depend on financial development. We posit that for more financial developed economies, the latter effect will dominate.

We will use firm level data from the Annual Manufacturing Survey of Colombian firms (EAM) in order to calibrate our model to the Colombian economy. Having fixed the parameters, we will determine the quantitative impact of financial frictions on production, given an exogenous increase in the international interest rate. Furthermore, we will disentangle the quantitative importance of each effect (tightening of credit conditions vs higher export value) and will perform counterfactual exercises.

2 Model

We consider a two period economy, where domestic heterogeneous firms borrow from abroad in order to acquire capital to produce. We follow Demidova and Rodríguez-Clare (2013) in setting up a Melitz model in a small open economy and we analyze the effect of a devaluation with low and high financial development. We close the model by assuming a representative household that values consumption from goods produced domestically and abroad.

2.1 Timing

Our economy consists of two periods. In the first period domestic and foreign firms draw a productivity level. Then they borrow capital from abroad. Borrowing is constrained according to the financial development of the economy: even though loans are set at an international rate, r^*, firms must pay for an intermediation cost. This intermediation cost represents financial development: a lower cost implies more developed financial institutions. In the second period trade and consumption take place and loans are paid back.

2.2 Household

We assume that the representative household consumes in the second period, when firms produce. She values consumption from domestic and foreign goods that are imported following a CES utility function:

$$U = \left[M \int_{z \geq z_d} c(z)^{\frac{\sigma-1}{\sigma}} dG(z) + M^* \int_{z \geq z_x^*} c^*(z)^{\frac{\sigma-1}{\sigma}} dG^*(z) \right]^{\frac{\sigma}{\sigma-1}},$$

where $\sigma > 1$ denotes the elasticity of substitution, z_d is the cutoff in productivity above which domestic firms produce, z_x^* is the cutoff in productivity above which foreign firms export to home and $G(\cdot)$ and $G^*(\cdot)$ are the distributions of firms at home and abroad. Following Demidova and Rodríguez-Clare (2013), M^*, the mass of foreign firms, is fixed, while z_x^* is an equilibrium outcome. M, which denotes the mass of domestic firms, which is also an endogenous outcome.

The household maximizes its utility, subject to its budget constraint. The household spends in domestic goods, whose price we normalize to 1, and in foreign goods, whose price is e_1 units of domestic good, so that e_1 denotes the real exchange rate, where an increase denotes a real devaluation. The household derives income from supplying a unit of time at a wage w. The household is also the owner of the firms in the domestic economy, so she receives firm profits, denote by Π. Therefore, the household solves the following problem:

$$\max_{\{c(z)\},\{c(z)^*\}} \quad U$$
$$\text{s. t. } M\int_{z\geq z_d} p_d(z)c(z)dG(z) + e_1 M^* \int_{z\geq z_x^*} p_x^*(z)c^*(z)dG^*(z) = w + \Pi.$$

From this problem we can derive the demand for each variety of domestic and foreign goods as follows. First order conditions can be written as

$$\left(\frac{c(z')}{c(z)}\right)^{\frac{1}{\sigma}} = \frac{p_d(z)}{p_d(z')}$$
$$\left(\frac{c^*(z^*)}{c(z)}\right)^{\frac{1}{\sigma}} = \frac{p_d(z)}{ep_x^*(z^*)},$$

which imply

$$c(z') = \left(\frac{p_d(z)}{p_d(z')}\right)^{\sigma} c(z)$$
$$c^*(z^*) = \left(\frac{p_d(z)}{ep_x^*(z^*)}\right)^{\sigma} c(z).$$

Plugging into the budget constraint we have

$$c(z)p(z)^{\sigma} = P^{\sigma-1}(w+\Pi)$$

where

$$P \equiv \left[\frac{1}{M\int_{z\geq z_d}\left(\frac{1}{p_d(z)}\right)^{\sigma-1} dG(z) + M^*\int_{z\geq z_x^*}\left(\frac{1}{ep_x^*(z)}\right)^{\sigma-1} dG^*(z)}\right]^{\frac{1}{\sigma-1}}$$

is the aggregate price level that the household face. Therefore

$$c(z) = \frac{P^{\sigma-1}(w+\Pi)}{p_d(z)^{\sigma}} \tag{1}$$
$$c^*(z) = \frac{P^{\sigma-1}(w+\Pi)}{(ep_x^*(z))^{\sigma}}. \tag{2}$$

2.3 Firms

Firms draw z at the beginning of $t = 0$. They have access to a production technology of the following kind

$$F(k, l) = k^{\alpha} l^{1-\alpha}$$

and their total production is equal to $zF(k, l)$. We assume that firms can export, following a similar structure than Melitz (2003). That is, firms compete in a monopolistic competition fashion. However, in our model in order to produce, firms must borrow from abroad at $t = 0$ the international exogenous interest rate, r^*, in order to get capital to produce one period later.

In order to produce, firms must pay a fixed cost. The fixed depends if the firm produces domestically to sell domestically, in which case we denote the cost by f_d; produces domestically to export, in which case the fixed is f_x, or produces abroad to sell domestically, in which case the cost is f_x^*. Our small open economy assumption allows us to abstract from production abroad that is consumed abroad. Given the fixed cost, production is given by

$$y_i(z) = z\left(F(k, l) - f_i\right)$$

and profits are given by

$$\begin{aligned}
\pi_d(z) &\equiv \max_{p_d(z)} p_d(z) y - q\left(F(k_d, l_d)\right) \\
\pi_x(z) &\equiv \max_{p_x(z)} e_1 p_x(z) y_x - q\left(F(k_x, l_x)\right) \\
\pi_x^*(z) &\equiv \max_{p_x^*(z)} p_x^*(z) y_x^* - q^*\left(F(k_x^*, l_x^*)\right).
\end{aligned}$$

In the expression above $q(x)$ denotes the minimum cost of producing Y. That is,

$$\begin{aligned}
q(x) \equiv \min_{k,l} \quad & (1 + r^*)k + wl \\
\text{s. t. } & k^{\alpha} l^{1-\alpha} = Y.
\end{aligned} \tag{3}$$

We now derive the expression for q in order to fully characterize profits for firms. First order conditions for (3) are

$$\begin{aligned}
1 + r^* &= \alpha k^{\alpha-1} l^{1-\alpha} \\
w &= (1 - \alpha) k^{\alpha} l^{-\alpha}.
\end{aligned}$$

Dividing the first equation over the second one we get

$$l = \frac{1+r^*}{w}\frac{1-\alpha}{\alpha}k.$$

Plugging into the constraint and the result back into the previous equation we get

$$k = \left(\frac{\alpha}{1-\alpha}\frac{w}{1+r^*}\right)^{1-\alpha} Y \tag{4}$$

$$l = \left(\frac{1-\alpha}{\alpha}\frac{1+r^*}{w}\right)^{\alpha} Y. \tag{5}$$

Finally, plugging into the objective function we get

$$q(x) = \left(\frac{1+r^*}{\alpha}\right)^{\alpha}\left(\frac{w}{1-\alpha}\right)^{1-\alpha} Y.$$

Abusing notation we will denote

$$q \equiv \left(\frac{1+r^*}{\alpha}\right)^{\alpha}\left(\frac{w}{1-\alpha}\right)^{1-\alpha}, \tag{6}$$

so that $q(Y) = qY$. Therefore we can express profits as

$$\pi_d(z) = \max_{p_d(z)} p_d(z)y_d - q\frac{y_d}{z} - qf_d$$
$$\pi_x(z) = \max_{p_x(z)} e_1 p_x(z)y_x - q\frac{y_x}{z} - qf_x$$
$$\pi_x^*(z) = \max_{p_x^*(z)} p_x^*(z)y_x^* - q^*\frac{y_x^*}{z} - q^* f_x^*$$

So most of the results in Demidova and Rodríguez-Clare (2013) hold, by replacing w by q in profits function. Domestic demand for both domestic and foreign still only depends on w since capital is not owned by households. Also, our numeraire is now the unit cost of producing abroad, so $q^* = 1$.

Finally, we assume that foreign demand for domestic good z is given by $\frac{A^*}{p_x(z)^\sigma}$, where A^* is a reduced form of foreign demand. Taking into account this demand, as well as the domestic demand faced by domestic firms, (1), the domestic demand faced by foreign firms, (2) and the fact that (4) and (5) determine the amount of capital and labor demanded by firms to produce Y, firms' problems are characterized by

$$
\begin{aligned}
p_d(z) &= \frac{\sigma}{\sigma-1}\frac{q}{z} \\
\pi_d(z) &= \frac{P^{\sigma-1}\left(w+\Pi\right)}{\sigma}\left(\frac{\sigma-1}{\sigma}\frac{z}{q}\right)^{\sigma-1} - qf_d && (7) \\
y_d(z) &= P^{\sigma-1}(w+\Pi)\left(\frac{\sigma-1}{\sigma}\frac{z}{q}\right)^{\sigma} && (8) \\
l_d(z) &= \left(\frac{1-\alpha}{\alpha}\frac{1+r^*}{w}\right)^{\alpha}\left(P^{\sigma-1}(w+\Pi)\left(\frac{\sigma-1}{\sigma}\frac{1}{q}\right)^{\sigma} z^{\sigma-1} + f_d\right) && (9) \\
k_d(z) &= \left(\frac{\alpha}{1-\alpha}\frac{w}{1+r^*}\right)^{1-\alpha}\left(P^{\sigma-1}(w+\Pi)\left(\frac{\sigma-1}{\sigma}\frac{1}{q}\right)^{\sigma} z^{\sigma-1} + f_d\right). && (10)
\end{aligned}
$$

$$
\begin{aligned}
p_x(z) &= \frac{\sigma}{\sigma-1}\frac{\tau}{e_1}\frac{q}{z} \\
\pi_x(z) &= \frac{e_1 A^*}{\sigma}\left(\frac{\sigma-1}{\sigma}\frac{e_1}{\tau}\frac{z}{q}\right)^{\sigma-1} - qf_x && (11) \\
y_x(z) &= A^*\left(\frac{\sigma-1}{\sigma}\frac{e_1}{\tau}\frac{z}{q}\right)^{\sigma} && (12) \\
l_x(z) &= \left(\frac{1-\alpha}{\alpha}\frac{1+r^*}{w}\right)^{\alpha}\left(A^*\left(\frac{\sigma-1}{\sigma}\frac{e_1}{q}\right)^{\sigma}\left(\frac{z}{\tau}\right)^{\sigma-1} + f_x\right) && (13) \\
k_x(z) &= \left(\frac{\alpha}{1-\alpha}\frac{w}{1+r^*}\right)^{1-\alpha}\left(A^*\left(\frac{\sigma-1}{\sigma}\frac{e_1}{q}\right)^{\sigma}\left(\frac{z}{\tau}\right)^{\sigma-1} + f_x\right). && (14)
\end{aligned}
$$

$$
\begin{aligned}
p_x^*(z) &= \frac{\sigma}{\sigma-1}\frac{\tau^*}{z} \\
\pi_x^*(z) &= \frac{P^{\sigma-1}\left(w+\Pi\right)}{\sigma e_1^{\sigma}}\left(\frac{\sigma-1}{\sigma}\frac{z}{\tau^*}\right)^{\sigma-1} - f_x^* && (15) \\
y_x^*(z) &= P^{\sigma-1}(w+\Pi)\left(\frac{\sigma-1}{\sigma}\frac{z}{e_1\tau^*}\right)^{\sigma} && (16) \\
l_x^*(z) &= P^{\sigma-1}(w+\Pi)\left(\frac{\sigma-1}{\sigma}\frac{1}{e_1}\right)^{\sigma}\left(\frac{z}{\tau^*}\right)^{\sigma-1} + f_x^*. && (17)
\end{aligned}
$$

We can plug in the price for goods consumed domestically to get an expression for the price level faced by the household:

$$P = \frac{\sigma}{\sigma - 1}\left[\frac{1}{M\int_{z_d}^{\infty}\left(\frac{z}{q}\right)^{\sigma-1}dG(z) + M^*\int_{z_x^*}^{\infty}\left(\frac{z}{e\tau^*}\right)^{\sigma-1}dG^*(z)}\right]^{\frac{1}{\sigma-1}} \tag{18}$$

We define z_d as the cutoff above which a domestic firm will produce for domestic consumption. That is, z_d is determined by setting $\pi_d(z_d) = 0$. From (7), and the fact that due to free entry we have that $\Pi = 0$:

$$P^{\sigma-1}w\left(\frac{\sigma-1}{\sigma}\frac{z_d}{q}\right)^{\sigma-1} = \sigma q f_d. \tag{19}$$

Similarly, we define z_x as the cutoff above which a domestic firm will export. This cutoff is determined by setting $\pi_x(z_x) = 0$. From (11) we have

$$e_1 A^*\left(\frac{\sigma-1}{\sigma}\frac{e_1}{\tau}\frac{z_x}{q}\right)^{\sigma-1} = \sigma q f_x. \tag{20}$$

Notice that in order to have $z_x > z_d$ our equilibrium must satisfy

$$w\left(P\tau\right)^{\sigma-1}f_x > e_1^{\sigma}A^* f_d,$$

which is a slightly different condition to the one found in the Melitz model.

We denote the cutoff on foreign firms to export to the domestic economy by z_x^*. This cutoff is determined by setting $\pi_x^*(z_x^*) = 0$. From (15), and the fact that due to free entry we have that $\Pi = 0$:

$$\frac{P^{\sigma-1}w}{e_1^{\sigma}}\left(\frac{\sigma-1}{\sigma}\frac{z_x^*}{\tau^*}\right)^{\sigma-1} = \sigma f_x^*. \tag{21}$$

Before drawing a z, firms must pay a fixed cost F. Using (19) and (20) we can write the free entry condition as

$$\int_{z_d}^{\infty}\pi_d(z)dG(z) + \int_{z_x}^{\infty}\pi_x(z)dG(z) = wF$$

$$qf_d\int_{z_d}^{\infty}\left[\left(\frac{z}{z_d}\right)^{\sigma-1} - 1\right]dG(z) + qf_x\int_{z_x}^{\infty}\left[\left(\frac{z}{z_x}\right)^{\sigma-1} - 1\right]dG(z) = wF. \tag{22}$$

Using (9), (13), (19), (20) and (22) we can write the labor market clearing condition as

$$
\begin{aligned}
M\left[F+\int_{z_d}^{\infty} l_d(z)dG(z)+\int_{z_x}^{\infty} l_x(z)dG(z)\right] &= 1 \\
f_d\left(\frac{q}{w}+\left(\frac{1-\alpha}{\alpha}\frac{1+r^*}{w}\right)^{\alpha}(\sigma-1)\right)\int_{z_d}^{\infty}\left(\frac{z}{z_d}\right)^{\sigma-1} dG(z) & \\
+f_d\left(\left(\frac{1-\alpha}{\alpha}\frac{1+r^*}{w}\right)^{\alpha}-\frac{q}{w}\right)(1-G(z_d)) & \\
+f_x\left(\frac{q}{w}+\left(\frac{1-\alpha}{\alpha}\frac{1+r^*}{w}\right)^{\alpha}(\sigma-1)\right)\int_{z_x}^{\infty}\left(\frac{z}{z_x}\right)^{\sigma-1} dG(z) & \\
+f_x\left(\left(\frac{1-\alpha}{\alpha}\frac{1+r^*}{w}\right)^{\alpha}-\frac{q}{w}\right)(1-G(z_x)) &= \frac{1}{M}
\end{aligned}
\tag{23}
$$

We assume that firms incur in a cost of financial intermediation when borrowing from abroad. We represent this cost by an exogenous parameter $\kappa \geq 1$, where $\kappa = 1$ represents perfect financial markets. This cost is paid both when the firms borrow at $t = 0$ and when they pay back one period later. We also assume that there is an exogenous amount that firms can borrow in the first period, denoted by K^*. This amount denotes the total credit capacity of the economy available through international markets.[1]

At $t = 0$ the balance of payments implies that the total amount that firms borrow in foreign currency must equal K^*. Using (10), (14), (19), (20) and (21) we can write this market condition by:

$$
\begin{aligned}
\kappa M\left[\int_{z_d}^{\infty}\frac{k_d(z)}{e_0}dG(z)+\int_{z_x}^{\infty}\frac{k_x(z)}{e_0}dG(z)\right] &= K^* \\
f_d\int_{z_d}^{\infty}\left((\sigma-1)\left(\frac{z}{z_d}\right)^{\sigma-1}+1\right)dG(z) & \\
+f_x\int_{z_x}^{\infty}\left((\sigma-1)\left(\frac{z}{z_x}\right)^{\sigma-1}+1\right)dG(z) &= \left(\frac{1-\alpha}{\alpha}\frac{1+r^*}{w}\right)^{1-\alpha}\frac{e_0K^*}{\kappa M}
\end{aligned}
\tag{24}
$$

At $t = 1$ firms repay their loans at the current exchange rate. Additionally, in this period domestic firms export abroad and foreign firms export to the domestic economy. Balance of payments at $t = 1$ can be expressed as:

[1] κ is a reduced form that can be endogeneized through an endogenous borrowing constraint as in Buera et al. (2011). Having an endogenous borrowing constraint would allow us to analyze heterogenous effects across firms both at the intensive and extensive margin. This is a natural extension to our setup.

$$
\begin{aligned}
M\int_{z_x}^{\infty} p_x(z)y_x(z)dG(z) &= M^*\int_{z_x^*}^{\infty} p_x^*(z)y_x^*(z)dG^*(z) \\
&\quad + \kappa M(1+r^*)\left[\int_{z_d}^{\infty}\frac{k_d(z)}{e_1}dG(z) + \int_{z_x}^{\infty}\frac{k_x(z)}{e_1}dG(z)\right] \\
\sigma q f_x M\int_{z_x}^{\infty}\left(\frac{z}{z_x}\right)^{\sigma-1} dG(z) &= \sigma f_x^* e_1 M^*\int_{z_x^*}^{\infty}\left(\frac{z}{z_x^*}\right)^{\sigma-1}(z)dG^*(z) \qquad (25)\\
&\quad + \kappa M(1+r^*)\left(\frac{\alpha}{1-\alpha}\frac{w}{1+r^*}\right)^{1-\alpha} f_d\int_{z_d}^{\infty}\left((\sigma-1)\left(\frac{z}{z_d}\right)^{\sigma-1}+1\right)dG(z) \\
&\quad + \kappa M(1+r^*)\left(\frac{\alpha}{1-\alpha}\frac{w}{1+r^*}\right)^{1-\alpha} f_x\int_{z_x}^{\infty}\left((\sigma-1)\left(\frac{z}{z_x}\right)^{\sigma-1}+1\right)dG(z)
\end{aligned}
$$

A competitive equilibrium in this environment is characterized by endogenous variables q, P, z_d, z_x, z_x^*, w, M, e, which are pinned down by (6), (18), (19), (20), (21), (22), (23), (24), (25).

2.3.1 Characterizing model with Pareto distribution

We will characterize the equilibrium in our economy under a particular distribution: Assume that $G(z) = G^*(z) = 1 - \left(\frac{\underline{z}}{z}\right)^{\gamma}$. We need to assume that $\sigma < \gamma + 1$. We can characterize the equilibrium as

$$
q \equiv \left(\frac{1+r^*}{\alpha}\right)^{\alpha}\left(\frac{w}{1-\alpha}\right)^{1-\alpha} \qquad (26)
$$

$$
P = \frac{\sigma}{\sigma-1}\left(\frac{1+\gamma-\sigma}{\gamma}\right)^{\frac{1}{\sigma-1}}\left[\frac{1}{M\left(\frac{z_d}{q}\right)^{\sigma-1}\left(\frac{\underline{z}}{z_d}\right)^{\gamma} + M^*\left(\frac{z_x^*}{e_1\tau^*}\right)^{\sigma-1}\left(\frac{\underline{z}}{z_x^*}\right)^{\gamma}}\right]^{\frac{1}{\sigma-1}} \qquad (27)
$$

$$
P^{\sigma-1}w\left(\frac{\sigma-1}{\sigma}\frac{z_d}{q}\right)^{\sigma-1} = \sigma q f_d \qquad (28)
$$

$$
e_1 A^*\left(\frac{\sigma-1}{\sigma}\frac{e_1}{\tau}\frac{z_x}{q}\right)^{\sigma-1} = \sigma q f_x \qquad (29)
$$

$$\frac{P^{\sigma-1}w}{e_1^{\sigma}}\left(\frac{\sigma-1}{\sigma}\frac{z_x^*}{\tau^*}\right)^{\sigma-1}=\sigma f_x^* \tag{30}$$

$$f_d\left(\frac{\underline{z}}{z_d}\right)^{\gamma}+f_x\left(\frac{\underline{z}}{z_x}\right)^{\gamma}=\frac{1+\gamma-\sigma}{\sigma-1}F\frac{w}{q} \tag{31}$$

$$f_d\left(\frac{\underline{z}}{z_d}\right)^{\gamma}+f_x\left(\frac{\underline{z}}{z_x}\right)^{\gamma}=\frac{(1-\alpha)(1+\gamma-\sigma)}{\sigma-1+(1-\alpha)\left(1+\sigma(\gamma-1)\right)}\frac{1}{M}\left(\frac{\alpha}{1-\alpha}\frac{w}{1+r^*}\right)^{\alpha} \tag{32}$$

$$f_d\left(\frac{\underline{z}}{z_d}\right)^{\gamma}+f_x\left(\frac{\underline{z}}{z_x}\right)^{\gamma}=\frac{1+\gamma-\sigma}{1+\sigma(\gamma-1)}\left(\frac{1-\alpha}{\alpha}\frac{1+r^*}{w}\right)^{1-\alpha}\frac{e_0K^*}{\kappa M} \tag{33}$$

$$\begin{aligned}\sigma\gamma qMf_x\left(\frac{\underline{z}}{z_x}\right)^{\gamma}&=\sigma\gamma e_1M^*f_x^*\left(\frac{\underline{z}}{z_x^*}\right)^{\gamma}\\&+\left(1+\sigma(\gamma-1)\right)\kappa M(1+r^*)\left(\frac{\alpha}{1-\alpha}\frac{w}{1+r^*}\right)^{1-\alpha}\left(f_d\left(\frac{\underline{z}}{z_d}\right)^{\gamma}+f_x\left(\frac{\underline{z}}{z_x}\right)^{\gamma}\right)\end{aligned} \tag{34}$$

From (31) and (32) we can solve for M

$$M=\frac{1}{F}\frac{\sigma-1}{\sigma-1+(1-\alpha)\left(1+\sigma(\gamma-1)\right)}. \tag{35}$$

From (28) and (30):

$$\begin{aligned}\left(\frac{z_d}{q}\right)^{\sigma-1}&=\frac{\sigma qf_d}{P^{\sigma-1}w}\left(\frac{\sigma}{\sigma-1}\right)^{\sigma-1}\\\left(\frac{z_x^*}{e_1\tau^*}\right)^{\sigma-1}&=\frac{\sigma e_1f_x^*}{P^{\sigma-1}w}\left(\frac{\sigma}{\sigma-1}\right)^{\sigma-1}\end{aligned}$$

Plugging this into (27) and reorganizing terms we get

$$\sigma\gamma e_1M^*f_x^*\left(\frac{\underline{z}}{z_x^*}\right)^{\gamma}=1+\gamma-\sigma-\sigma\gamma Mqf_d\left(\frac{\underline{z}}{z_d}\right)^{\gamma}$$

Plugging into (34) yields[2]

$$f_d\left(\frac{\underline{z}}{z_d}\right)^{\gamma}+f_x\left(\frac{\underline{z}}{z_x}\right)^{\gamma}=\frac{1+\gamma-\sigma}{\sigma-1+(1-\alpha\kappa)\left(1+\sigma(\gamma-1)\right)}\frac{\alpha}{M(1+r^*)}\left(\frac{1-\alpha}{\alpha}\frac{1+r^*}{w}\right)^{1-\alpha} \tag{36}$$

Combining (33) and (36)

$$e_0=\frac{1+\sigma(\gamma-1)}{\sigma-1+(1-\alpha\kappa)\left(1+\sigma(\gamma-1)\right)}\frac{\alpha\kappa}{K^*(1+r^*)} \tag{37}$$

From (32) and (36)

$$w=\frac{\sigma-1+(1-\alpha)\left(1+\sigma(\gamma-1)\right)}{\sigma-1+(1-\alpha\kappa)\left(1+\sigma(\gamma-1)\right)} \tag{38}$$

2.4 Endogeneizing κ

We follow Buera et al. (2011) in order to endogeneize κ. In our benchmark model κ represents a cost that firms pay in order to access international financial markets. This cost can be interpreted as the result of low financial development. In this extension financial development represents the fraction of a loan that firms repay from their loans.

Specifically, consider an economy where firm with productivity draw z has access to a production technology of the following kind:

$$y=z\left(k^{\alpha}l^{1-\alpha}\right)^{\theta},$$

with $0<\theta<1$. Firms borrow capital from abroad at the international rate r^* and solve the following problem:

$$\pi(z)=\max_{k,l} y-(r^*+\delta)k-wl$$
$$\text{s. t. } k\leq\bar{k}(z),$$

where $\bar{k}(z)$ denotes an endogenous constraint. We follow Buera et al. (2011) to specify this constraint. We assume that firms can abscond a fraction $1-\phi$ of their loans. In this context, then ϕ will denote how developed financial markets are. $\phi=1$ implies perfect markets. $\bar{k}(z)$

[2] This condition imposes a constraint on κ:

$$\kappa<\frac{1}{\alpha}\frac{\sigma\gamma}{1+\sigma(\gamma-1)}.$$

will be determined from the following constraint constraint

$$\max_l \{y - wl\} - (r^* + \delta)k \geq (1 - \phi) \left[\max_l \{y - wl\} + (1 - \delta)k\right].$$

The left-hand side states profits from the firm if the firm repays its debt. The right-hand side states profits if the firms absconds. We assume that firms can only borrow as long as it they have the incentive to repay their debts; that is, as long as the profits they get from repaying are higher than from defaulting. A higher ϕ implies that the firm can abscond with less, so firms can borrow more and still get a higher profit from repaying.

In this case

$$\bar{k}(z) = \left(\frac{\phi(1 - (1 - \alpha)\theta)}{(1 - \phi)(1 - \delta) + r^* + \delta}\right)^{\frac{1-(1-\alpha)\theta}{1-\theta}} \left(\frac{(1 - \alpha)\theta}{w}\right)^{\frac{(1-\alpha)\theta}{1-\theta}} z^{\frac{1}{1-\theta}}.$$

Notice that this endogenous borrowing constraint is less tight for more productive firms and for economies with higher financial development.

3 Conclusion

References

Brooks, Wyatt and Alessandro Dovis, "Credit Market Frictions and Trade Liberalizations," 2018.

Bruno, Valentina and Hyun Song Shin, "Cross-Border Banking and Global Liquidity," *Review of Economic Studies*, 2015, *82* (2), 535–564.

Buera, Francisco J., Joseph P. Kaboski, and Yongseok Shin, "Finance and Development: A Tale of Two Sectors," *American Economic Review*, August 2011, *101* (5), 1964–2002.

Demidova, Svetlana and Andrés Rodríguez-Clare, "The simple analytics of the Melitz model in a small economy," *Journal of International Economics*, 2013, *90* (2), 266–272.

Greenwood, Jeremy, Juan M. Sanchez, and Cheng Wang, "Financing Development: The Role of Information Costs," *American Economic Review*, September 2010, *100* (4), 1875–91.

_ , _ , and _ , "Quantifying the Impact of Financial Development on Economic Development," *Review of Economic Dynamics*, January 2013, *16* (1), 194–215.

Kearns, Jonathan and Nikhil Patel, "Does the financial channel of exchange rates offset the trade channel?," *BIS Quarterly Review*, December 2016, pp. 95–113.

Kohn, David, Fernando Leibovici, and Michal Szkup, "Financial Frictions And New Exporter Dynamics," *International Economic Review*, May 2016, *57*, 453–486.

_ , _ , and _ , "Financial Frictions and Export Dynamics in Large Devaluations," Working Papers 2017-13, Federal Reserve Bank of St. Louis May 2017.

Leibovici, Fernando, "Financial Development and International Trade," 2016.

Leigh, Daniel, Weicheng Lian, Marcos Poplawski-Ribeiro, Rachel Szymanski, Viktor Tsyrennikov, and Hong Yang, "Exchange Rates and Trade; A Disconnect?," IMF Working Papers 17/58, International Monetary Fund March 2017.

Melitz, Marc J., "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, November 2003, *71* (6), 1695–1725.

Minetti, Raoul and Susan Chun Zhu, "Credit constraints and firm export: Microeconomic evidence from Italy," *Journal of International Economics*, March 2011, *83* (2), 109–125.