Financial Dependence and Endogenous Entry of Firms in Emerging Economies

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December 10, 2018

Preliminary version

Abstract

This paper studies the effects of collateral constraints and financial shocks on firm entry dynamics and the real economy in the context of emerging economies. The financial dependence of firms is captured using a small open economy model with endogenous firm entry and external financing of production and startup costs. Firstly, the paper studies the effects of an adverse financial shock that tightens a collateral constraint for working capital borrowing by firms, leading to a decline in real macroeconomic variables, equity price, international debt and firm entry. Secondly, the study is extended to account for an occasionally binding constraint on leverage that introduces non-linearities in the model. The model is evaluated based on results from a panel VAR and it captures the empirical finding that firm entry and GDP declined during the last financial crisis in a group of emerging countries.

Keywords: Firm entry, Small open economy, Financial frictions, Business fluctuations, Emerging economies, Policy function iteration

JEL Classification: D21, E23, F41, G01

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1 Introduction

The global recession of 2008-2012 caused economic turmoil in both emerging and advanced economies. The emerging economies were primarily affected by external shocks originating from advanced economies through international trade and financial channels, as studied in Tsangarides (2012) and Blanchard et al. (2010). While emerging economies have experienced a long series of financial crises, the global recession stands out with its synchronized spreading to a large number of countries. Along with production, the financial crisis led to a fall in firm entry in emerging economies, as shown in figure 1 for a group of 20 countries.[1]

To study the financial side explanation for the declines in both GDP and firm entry, I introduce a small open economy model with endogenously determined firm entry and financially constrained firms. Closed economy models with endogenous firm entry have previously been studied in Bilbiie et al. (2012) and Bergin et al. (2018). This paper builds on the earlier contributions by introducing an open economy model that accounts for the experiences in emerging economies. In order to capture the characteristics of emerging markets, the model incorporates features such as foreign currency denominated borrowing, exogenous pricing for goods that are traded globally and an exogenous real interest rate. Financial shocks that reduce the borrowing of new and old firms are able to generate substantial falls in firm entry, output, foreign debt and equity prices.

The economy has both monopolistically competitive firms and a fully competitive sector. Monopolistic profits attract new firms to enter the market for differenciated goods, and consequently, the number of firms fluctuates procyclically. Monopolistic incumbents and entrants have access to both domestic equity and international debt that they use to finance their production. The capital structure reallocation is at the center of the dynamics of the paper. The equity financing of start-up costs is more expensive than debt to the new entrants and this prevents potential entrants from entering the market. Short-term international debt taken by the firms is bound by an enforcement constraint that is subject to external financial shocks that decrease the value of firm's collateral, and this causes restructuring in firm's financing, as it reduces the foreign debt holdings and amplifies the decline in firm entry and production. This financial friction is similar to the

[1] Klapper et al. (2015) provide empirical evidence for a large panel of 109 countries.

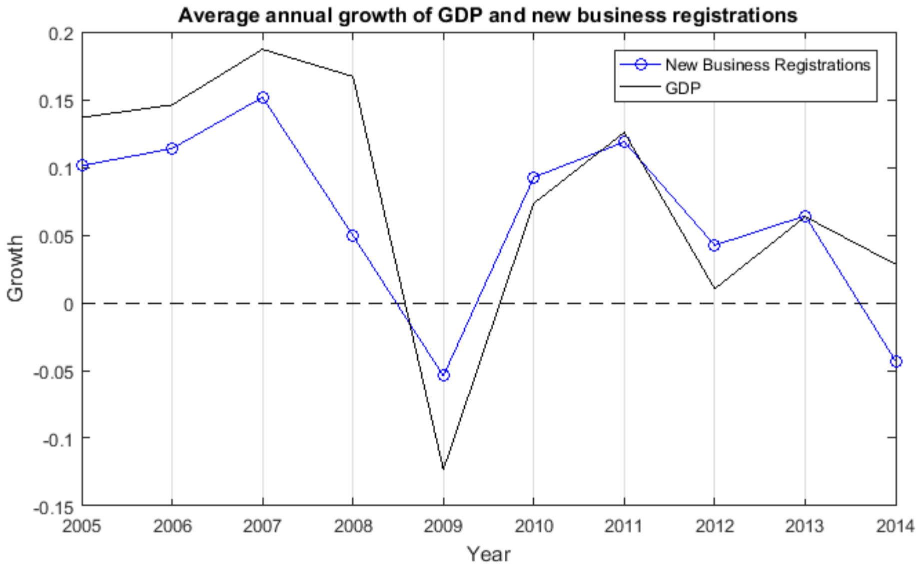

Figure 1: Average growth of log of GDP per capita and log of new business registrations per capita. Source: World Bank, World Development Indicators and Entrepreneurship Database. Countries included are Algeria, Belize, Belarus, Bolivia, Chile, Croatia, Czech Republic, Estonia, Hungary, Georgia, Israel, Jordan, Latvia, Lithuania, Malaysia, Mexico, Morocco, Peru, Romania and Slovak Republic.

collateral constraint presented in Kiyotaki and Moore (1997), and the capital structure of a firm follows the macro-finance structure of Jermann and Quadrini (2012) and Bergin et al. (2018). The fall in firm entry, on the one hand, moderates the negative effect of the shock on individual-level firm production and debt because the incumbent firms benefit from a decrease in the competition. On the other hand, a decline in firm entry has long lasting effects on the aggregate values, since the aggregate production recovers at a slower rate than its individual-level counterpart due to a lower number of firms in the economy.

The model with a financial constraint on working capital can be solved using perturbation methods as the constraint is always binding and can be used to illustrate the regular business cycle properties of the model. In order to capture the financial crisis event, this model is also solved using an occasionally binding constraint that has been studied previously in Mendoza (2010), Kalantzis (2015), Fornaro (2015) and Korinek and Mendoza (2014), just to name a few. An occasionally binding constraint introduces a strong non-linearity to the model. The model is solved using time iteration as introduced in Coleman (1990) together with linear interpolation. The solution method uses the toolboxes and routines provided by Richter et al. (2014) that I extend to account for the collateral constraint.

In order to evaluate the model, I estimate a panel VAR for output and firm registrations with an exogenous financial crisis indicator, as in Cerra and Saxena (2008). This empirical estimation for a panel of 20 countries shows that the financial crisis had persistent negative effects on firm entry and real GDP. The purpose of this study is to examine the role of a financial shock that cuts foreign lending during the crisis and its success in generating the observed negative effects. The resulting impulse response functions are used in the estimation of some key parameters in the model. The evaluation of the model against empirical evidence shows that an adverse financial shock in a small open economy framework is able to account for the strong persistent decline of firm entry while the response of real GDP in the model is volatile but less persistent.

This paper contributes to two strands of literature by combining an endogenous firm entry model presented in Bilbiie et al. (2012) with financial frictions as in Kiyotaki and Moore (1997). Growing literature studies the role of new firm creation for the propagation of business cycle fluctuations, and more recently, for the transmission of financial shocks.[2] The earlier research on this topic has shown that endogenous firm entry is important for assessing business cycle fluctuations. My paper contributes to this literature by studying firm entry dynamics in emerging economies. Research at the intersection of the endogenous entry and financial frictions literature is not new. Financial frictions and endogenously fluctuating firms or varieties have previously been analyzed in Gourio et al. (2016), Bergin et al. (2018), Manova (2013), La Croce and Rossi (2018), Queraltó (2013), Ates and Saffie (2016), Guerron et al. (2016), Casares and Poutineau (2013) and Macnamara (2014). I depart from these papers with a small open economy model with firm's financing of production and entry using equity and international debt. The model presented here is the closest to the research by Bergin et al. (2018), who show in a closed economy setting that when firms rely on external financing for their initial start-up costs, adverse financial shock leads to a fall in firm entry, equity price and various real variables. Complementing these results, I show that a financial shock has negative effects on the firm entry, aggregate international debt and real GDP in an emerging economy framework.

[2] Influential research studying the importance of endogenous entry or market structures for the propagation of business cycles includes closed economy studies of Bilbiie et al. (2012), Colciago and Etro (2010), Colciago (2016), Jaimovich and Floetotto (2008), Bergin et al. (2018), Lewis and Poilly (2012) to name a few. Cavallari (2010), Cavallari (2013) and Cavallari (2015) study productivity and monetary policy shocks in large open economies.

The article is structured as follows. Section 3 introduces the model, and Section 4 presents the results from the model. Section 6 concludes with discussion about the findings and describes further venues for research.

2 Financial dependence in emerging economies

Global banking linkages had a central role in transmitting the financial crisis of 2008–2009 to emerging countries. The financial crisis led to a strong decline in global liquidity, reducing access to finance world-wide. Over the last decades, the financial markets have become increasingly integrated and many emerging economies have implemented measures of financial market liberalization. This has increased both borrowing from international financial markets and the presence of foreign owned banks in these countries.[3] Moreover, in emerging countries, non-financial corporations hold a larger share of the non-financial sector total credit than households. This debt is characterised by foreign currency lending, leading the firm-side of the economy vulnerable to changes in global financial conditions.[4] As the aforementioned developments in emerging economies have continued after the crisis, studying the emerging economy experiences during the recent crisis can provide some important insights of how to cope with these challenges in the future.

3 Model

I construct a two-sector small open economy model with endogenous entry and financial frictions. Monopolistic profits attract new firms to the monopolistically competitive non-tradable sector, and as a result the number of firms fluctuates procyclically. Entry in the model is determined by a zero profit condition, stating that the potential entrants of an unbounded mass have free entry to the market and enter as long as the value of entry is non-negative, as in the seminal paper of Bilbiie et al. (2012). This leads to

[3] Claessens and Horen (2014) document substantial increases in foreign bank presence in many countries over the period 1997-2009. The large presence of foreign banks seems to be typical for small open emerging economies (see figure 11 in appendix G.2). In advanced countries, except for Iceland and Ireland, the share of foreign owned banks was small compared to emerging countries both prior and after the crisis.

[4] According to BIS total credit database, 50 % of total credit was held by non-financial corporations while households held 17 % in emerging economies in 2008. In advanced countries, on average, the non-financial corporations' share was 36% and the households' 33%. Chui et al. (2016) studies the currency mismatch in emerging economies and finds that both tradable and non-tradable sector borrowing is subject to currency mismatches.

procyclical entry. Appendix C illustrates the timing of entry and financial decisions of the monopolistic firms and the structure of the economy.

3.1 Monopolistic competition and firm entry

This section presents the optimization problem of the old, established firms and then introduces the optimal entry of firms.

3.1.1 Established firms

There is a continuum of monopolistically competitive firms, each producing a different variety h. For simplicity, it is assumed that each firm can produce only one variety, such that the number of firms in the economy corresponds to the number of products. All contracts are written in nominal terms but since the prices are flexible, we solve for the real variables.[5] Firms are owned by domestic households and thus the firm's discount factor is given by $m_{t+1} = \beta(1-\delta)\frac{U_{t+1}^C}{U_t^C}$. The firms' objective is to maximize the beginning-of-period market value including dividends $V_{h,t}(b_{h,t-1}^*)$:

$$V_{h,t}(b_{h,t-1}^*) = \max_{p_{h,t}, b_{h,t}^*, l_{h,t}} \{d_{h,t} + E_t[m_{t+1}V_{h,t+1}(b_{h,t}^*)]\}, \tag{1}$$

with the dividends that are given by:

$$d_{h,t} = \frac{p_{h,t}}{P_t} y_{h,t} - w_t l_{h,t} - e_t(b_{h,t-1}^* - \frac{b_{h,t}^*}{R^*}), \tag{2}$$

where $d_{h,t}$, e_t and w_t are, respectively, dividends, real exchange rate and wage.[6] An individual firm chooses the nominal price $p_{h,t}$ and disregards the effects on the aggregate price index P_t. Firms use labor $l_{h,t}$ for their production of good $y_{h,t}$ and pay dividends to the household. Firms have access to the foreign financial market and are able to take on inter-period debt $b_{h,t}^*$ from abroad with an exogenously determined world interest rate

[5] Real variables are defined as nominal priced divided by the consumer price index P_t.

[6] I assume, akin to Obstfeld and Rogoff (1995) and Céspedes et al. (2004), that the foreign currency price of the foreign good is given externally to the small open economy and is normalized to 1: $P_t^* = 1$. Since the law of one price holds, the domestic currency price of the foreign good is equal to $P_t^F = \mathcal{E}_t P_t^* = \mathcal{E}_t$, where the nominal exchange rate $\mathcal{E}_t$ is given by the domestic CPI over the world CPI. The real exchange rate is given by $e_t = \frac{\mathcal{E}_t}{P_t} = \frac{P_t^F}{P_t}$. Higher e_t implies depreciation of real exchange rate.

R_t^*.[7] At the beginning of period t, firms have a predetermined amount of international debt inherited from the previous period. They have to pay for the old debt, and decide how much new debt $b_{h,t}^*$ to take.

In addition to the inter-period debt, firms have to take an intra-period loan from the international financial markets to finance the production costs, the wage to its workers $w_t l_{h,t}$, prior to production and pay it back after the revenue from production has realized. This intra-period borrowing has no interest but is subject to financial frictions.[8] The financial friction is captured in the enforcement constraint that arises from the firms ability to default on the intra-period debt after the firm has collected the revenue from its production:

$$\kappa_t E_t[m_{t+1} V_{h,t+1}(b_{h,t}^*)] = w_t l_{h,t}, \tag{3}$$

where κ_t is the financial shock. The lenders of an intra-period loan know that firms can default on the debt at the end of the period, and thus they are willing to lend up to the amount that they can recover in case of firm default. The dividends of the firm are easily diverted and thus the lender accepts only the expected future flow of dividends, $E_t[m_{t+1} V_{h,t+1}(b_{h,t}^*)]$, as a collateral. There is a liquidation loss κ_t that the international investor takes into account when deciding how much to lend to the small firms. Thus, each monopolistic firm is only able to borrow up to $\kappa_t E_t[m_{t+1} V_{h,t+1}(b_{h,t}^*)]$. κ_t is given exogenously in the model and is subject to a shock that follows and AR(1) process.

Production of these firms requires only one factor, labor. The production function of firm h is:

$$y_{h,t} = Z_t l_{h,t}, \tag{4}$$

where Z_t is an aggregate productivity shock.

[7] All exogenous international variables, such as foreign currency prices, foreign demand and international bonds are denoted with an asterisk.

[8] The assumption that firms have to finance some part of their production costs prior to production is used in many dynamic models with collateral constraints, such as in sudden stop literature following Mendoza (2010), or in financial shock literature related to Jermann and Quadrini (2012) and Bergin et al. (2018). The constraint binds intra-period debt rather than the new inter-period debt b^* in order to ensure that the established firms and the entrants have the same asset portfolios when they proceed to the next period. This removes heterogeneity in firms after the entry period.

The demand for the output of each monopolistic firm h, is determined by the optimal allocation of consumption between the differentiated goods:

$$y_{h,t} = (1-\psi)\left(\frac{p_{h,t}}{P_t^H}\right)^{-\theta}\left(\frac{P_t^H}{P_t}\right)^{-\eta} C_t, \tag{5}$$

where P_t is the constant elasticity of substitution (CES) aggregator over the domestic and world price levels. ψ is the relative weight of foreign goods in consumption and θ and η are elasticities of substitution. The calculations for the demand of the domestic monopolistic goods are given in full detail in the appendix B

During each period t, the firm h chooses the amount of labour input $l_{h,t}$, the domestic price for its product $p_{h,t}$ and new international debt $b^*_{h,t}$ to maximize its beginning-of-period market value given by the equation (1) with the dividend equation (2), subject to the enforcement constraint (3) and taking into account that the output of firm h's production given in (4) has to equal in equilibrium the demand for good h, as given in (5).

Combining the first-order conditions for $l_{h,t}$ and $p_{h,t}$ gives the firm's optimal price setting:

$$\frac{p_{h,t}}{P_t} = \sigma \frac{w_t l_{h,t}}{y_{h,t}}(1+\mu_t), \tag{6}$$

with $\sigma = \frac{\theta}{\theta-1}$ being the markup and μ_t is the Lagrange multiplier of the enforcement constraint.

The first-order condition for debt $b^*_{h,t}$ is:

$$\mu_t = \frac{\frac{e_t}{R^*} - E_t m_{t+1} e_{t+1}}{\kappa_t E_t m_{t+1} e_{t+1}}, \tag{7}$$

where μ_t measures the tightness of the financial conditions and μ_t increases as the enforcement constraint becomes tighter.

3.1.2 Firm entry

Each period, there is an unbounded mass of prospective entrants. These prospective entrants are able to anticipate their expected future profits correctly, and thus firms decide to enter the market if the net value of entry, given by $V_{h,t}^E$, is positive. All new firms enter the period t with no prior debt. New firms pay a one-time sunk entry cost when they enter and start production during that period.[9]The value of entering the market $V_{h,t}^E$ is given by:

$$V_{h,t}^E = \max_{p_{h,t}^E, b_{h,t}^{*,E}, l_{h,t}^E} \{d_{h,t}^E + E_t[m_{t+1} V_{h,t+1}(b_{h,t}^{*,E})]\}, \tag{8}$$

with the dividends of the entrants $d_{h,t}^E$ given by:

$$d_{h,t}^E = \frac{p_{h,t}^E}{P_t} y_{h,t}^E - w_t l_{h,t}^E + \frac{e_t b_{h,t}^{*,E}}{R^*} - K_t^E, \tag{9}$$

where $p_{h,t}^E$, $y_{h,t}^E$, $l_{h,t}^E$, $b_{h,t}^{*,E}$ and K_t^E are, respectively, the price, output, labor input, international debt and sunk entry costs of the entrant firm h.

Entering the market, small firms have to pay an entry cost of K_t^E, given in the units of the final good. The sunk entry cost takes a similar form as the quadratic adjustment cost for investment in physical capital:

$$K_t^E = \left(\frac{N_t^E}{N_{t-1}^E}\right)^\tau. \tag{10}$$

The level of entry cost at each period depends on the evolution in the number of entrants N_t^E. Entry becomes more expensive when a greater number of new entrants enter in a given period.[10] This specification of entry cost is used in the model to ensure that entry is not too volatile.

Substituting the dividends given by (9) into the value of entering (8) and noting that free entry drives the net value of entry $V_{h,t}^E$ to zero, we get the free entry condition:

$$\frac{e_t b_{h,t}^{*,E}}{R^*} + E_t[m_{t+1} V_{h,t+1}(b_{h,t}^{*,E})] + \frac{p_{h,t}^E}{P_t} y_{h,t}^E - w_t l_{h,t}^E = K_t^E. \tag{11}$$

This equation implies that the initial period value of firm's assets, bonds and its equity

[9]This assumption differs from the time-to-build specification in Bilbiie et al. (2012) but has also been adopted in Bergin et al. (2018). The benefit from this timing of production is that all firms, both incumbents and entrants, choose the same amount of new debt that has to be paid back at the beginning of the next period thus preventing firms from having heterogeneity in their capital structures and allowing for full business cycle analysis.

[10]This type of an entry cost has previously been used, for example, in Lewis (2009) and Bergin et al. (2018).

value, together with its profit is equal to the entry cost.

When the new firm has decided to enter the market, it makes the decision of producing a monopolistic good h using the same production technology and facing the same demand for its good as the old firms. A new firm chooses $p^E_{h,t}$, $l^E_{h,t}$ and $b^{E,*}_{h,t}$ to maximize the value of entry (8) subject to dividends (9), enforcement constraint taking the same form as for the old firms (3), and production technology and demand for its output as in (4) and (5), respectively. As a result, the first order conditions take the same form as (6) and (7). Thus, $b^{*,E}_{h,t} = b^*_{h,t}$, $p^E_{h,t} = p_{h,t}$, $y^E_{h,t} = y_{h,t}$, $l^E_{h,t} = l_{h,t}$ and $\pi^E_{h,t} = \pi_{h,t}$. Dividends $d^E_{h,t}$ and the value of entering $V^E_{h,t}$, however, differ from the values for incumbents.

Both the entrants and the established firms are hit by an exogenous, constant exit shock that forces $\delta \in (0, 1)$ of these firms to exit at the very end of each period. Thus, the amount of firms in the economy consists of the new firms and the old firms of the previous period that did not exit.

$$N_t = (1 - \delta)(N_{t-1} + N^E_t), \tag{12}$$

where N_{t-1} is the number of old firms surviving from period $t - 1$ and that are producing at t and N^E_t is the number of entrants at that period.

3.2 Households

The household in the small open economy consumes a final consumption good C_t, provides labor L_t for both tradable and non-tradable good producing domestic firms with a real wage w_t and chooses its equity share holdings of the non-tradable firms. The households own all the small monopolistic firms in the domestic economy through mutual fund shares x_t that are traded domestically. All households are identical in this economy and a representative household maximizes its expected lifetime utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, L_t), \tag{13}$$

$$U(C_t, L_t) = \frac{(C_t - \frac{L_t^\omega}{\omega})^{1-\gamma} - 1}{1 - \gamma}, \tag{14}$$

where the preferences are non-separable.[11] $\beta \in (0,1)$ is the household's discount factor, $\gamma > 0$ is the household's relative risk aversion and $\omega > 0$ is the inverse of the Frisch elasticity of labor supply.

The period budget constraint is expressed in units of consumption:

$$q_t(N_{t-1} + N_t^E)s_t + C_t = (d_t + q_t)N_{t-1}s_{t-1} + w_t L_t, \tag{15}$$

where, on the income side, the household earns labor income, equity sales with the end-of-period value q_t and dividends d_t from N_{t-1} firms according to its share holdings s_{t-1} inherited from the previous period. On the expenditure side, the household consumes a final good and decides the corporate share holdings for the beginning of the next period. Each period N_t^E firms enter the market for monopolistic goods adding to the number of firms in the mutual fund, $N_{t-1} + N_t^E$.

Household's first-order conditions for C_t and L_t give the equation for labor-leisure trade-off:

$$w_t = -\frac{U_{L,t}}{U_{C,t}}, \tag{16}$$

and the Euler equation for corporate shares s_t is:

$$q_t = E_t\left[\beta(1-\delta)\frac{U_{C,t+1}}{U_{C,t}}(d_{t+1} + q_{t+1})\right]. \tag{17}$$

Forward iteration of this equation together with the forward iteration of the monopolistic firm's market value in equation (1) show that the value of firm's equity q_t equals the end-of-period value of firms $E_t[m_{t+1}V_{h,t+1}(b^*_{h,t})]$.

3.3 Final good aggregation

The perfectively competitive final good firm produces a consumption good using a domestic composite good that is an aggregate Y_t^H over all monopolistic firm's production y_t and

[11] Following Mendoza (1991), and many others in the emerging market business cycle literature, I assume that the household's preferences have a non-separable structure studied in Greenwood et al. (1988) (GHH). GHH preferences imply no wealth effect in labor supply, since the marginal rate of substitution between consumption and labor is independent of consumption. This preference structure is important for crisis dynamics, since with wealth effect on labor supply the household could react to lack of resources during a crisis by working more, leading to an economic expansion.

a foreign good basket Y_t^F. It allocates the expenditure optimally by minimizing the cost of purchasing these input baskets. Details of the cost minimization problem of the final good firm are given in the appendix B. The optimal demands for domestic and foreign consumption composites are, respectively:

$$Y_t^H = (1-\psi)\left(\frac{P_t^H}{P_t}\right)^{-\eta} C_t, \tag{18}$$

$$Y_t^F = \psi\left(\frac{P_t^F}{P_t}\right)^{-\eta} C_t. \tag{19}$$

where ψ is the weight of foreign goods in the consumption bundle and η is the elasticity of intratemporal substitution between domestic and foreign goods. Since we are solving for the model in real terms, we can replace the nominal domestic currency prices P_t, P_t^H and P_t^F with the relative price of domestic good $\rho_t \equiv \frac{P_t^H}{P_t}$ and the real exchange rate $e_t \equiv \frac{P_t^F}{P_t}$ in these equations.

Finally, we can aggregate the individual firms' output into domestic good composite using the CES production function $Y_t^N = \left[\int_0^{\tilde{n}_t} (y_{h,t}^N)^{\frac{\theta-1}{\theta}} \, \mathrm{d}h\right]^{\frac{\theta}{\theta-1}}$ that can be solved as:

$$Y_t^H = y_t(N_{t-1} + N_t^E)^\sigma, \tag{20}$$

when all firms produce the same quantity of output $y_{h,t} = y_t$. In the equilibrium, this equation is used to aggregate the monopolistic firm's first order conditions, production function and dividends over all the firms that are producing at time t, as given in appendix B.3. In these aggregated equations, the nominal prices are replaced with the real prices.

3.4 Foreign demand for domestic consumption composites

The small open economy trades with the rest of the world with the is not able to affect the price-level of the rest of the world. The country exports a composite good X_t that is sold in the foreign country with a foreign currency price P_t^*. The demand by the foreigners is a decreasing function of relative domestic currency price of export and foreign income:

$$X_t = \left(\frac{P_t}{\mathcal{E}_t P_t^*}\right)^{-\varphi} \zeta_t^*, \tag{21}$$

where $\mathcal{E}_t$ is the nominal exchange rate and P_t^* is the foreign currency nominal price level that is normalized to one. Since the law of one price hold's $\mathcal{E}_t P_t^* = P_t^F$ and thus the relative domestic currency price of exports equals the real exchange rate. ζ_t^* is an exogenously given foreign demand that follows an AR(1) process.

3.5 Market clearing conditions

The labor is used by the old firms from the previous period and the new firms to produce the monopolistic good:

$$L_t = l_t^N (N_{t-1} + N_t^E). \tag{22}$$

To ensure a unique labor market, the labor services are perfectly substitutable between old and new firms.

Good markets clear, such that all monopolistic output is either consumed by the domestic household, used for the sunk entry cost or exported to the rest of the world.

$$Y_t^{GDP} = Y_t^H = C_t - Y_t^F + K_t^E N_t^E + X_t. \tag{23}$$

Moreover, the domestic market of corporate shares clear and the shares s_t are normalized to 1. Substituting the monopolistic firms' dividends, and the expenditure of entrant firms into the household's budget constraint gives the resource constraint:

$$e_t \left[\frac{b_t^*}{R^*} (N_{t-1} + N_t^E) - b_{t-1}^* N_{t-1} \right] = e_t Y_t^F - X_t. \tag{24}$$

This equation implies that accumulation of foreign debt is positively connected with trade deficit. When a country imports more than it exports, it is only able to do so by taking more foreign debt.

The equilibrium consists of 16 equations and variables. From the monopolistic firms' problem we get the incumbent firm's dividends (2), the enforcement constraint (3), the production function (4), and the firms' first order conditions (6) and (7), together with the free entry condition for the entrants (11) and the accumulation of the monopolistic firms (12). Also, we have the household's first order conditions (16) and (17). Moreover, we need the domestic demands of the domestic and foreign composite goods (18) and (19), respectively, the domestic composite CES production function (20), and the foreign demand of domestic composite good (21). The last equations in the equilibrium are the labor market aggregation (22), the goods market clearing (23) and the resource constraint of the economy (24). The equations above solve for: $\{C_t, L_t, Y_t^H, Y_t^F, X_t, y_t, l_t, e_t, \rho_t, w_t, q_t, d_t, N_t, N_t^E, b_t^*, \mu_t\}$. Appendix A lists all equilibrium equations.

In addition to these equations, the financial shock $\{\kappa_t\}$ is given by an AR(1) process:

$$\kappa_t = (1 - \rho^\kappa)\bar{\kappa} + \rho^\kappa \kappa_{t-1} + \epsilon_t^\kappa, \tag{25}$$

where ϵ_t^κ is a normally distributed financing innovation.

4 Results with working capital constraint

4.1 Parameter values

Parameter values are taken from the small open economy and endogenous firm entry literature. The data is annual, and the household's discount factor is set at $\beta = 0.975$. The target for the external debt-to-output ratio is 0.51 for the long-time average of the countries in our sample. That is achieved by setting $R^* = 1.026$. The elasticity of intertemporal substitution is $\gamma = 2$ and the wage elasticity of labor supply is $\omega = 2$. Both of these are standard values in the literature.

The annual exit rate of firms is set at $\delta = 0.1$, consistent with the quarterly rate in Bilbiie et al. (2012). The borrowing capacity of a firm is captured by $\bar{\kappa} = 0.25$, which roughly corresponds to the long-term average rate of lender's ability to recover the loan in case of the borrower's default for the USA given in Bruche and González-Aguado (2010).

The elasticity of substitution across the monopolists' varieties is $\theta = 10$ and the foreign demand elasticity $\varphi = 10$, following Devereux et al. (2015). The elasticity of intratemporal substitution in consumption between foreign and domestic goods is set at $\eta = 2$. The share of foreign good in the consumption basket is $\psi = 0.4$, following the Galí and Monacelli (2005). The real exchange rate is normalized to 1 in a steady state, which requires $\zeta = 0.12$.

Table 1: Parameter Values

Household's discount factor	$\beta = 0.975$
Household's relative risk aversion	$\gamma = 2$
Wage elasticity of labor supply	$\omega = 2$
Relative weight of foreign goods in consumption	$\psi = 0.4$
Elasticity of substitution between foreign and domestic goods	$\eta = 2$
Elasticity of substitution across monopolistic varieties	$\theta = 10$
Foreign demand elasticity	$\varphi = 10$
Firm exit rate	$\delta = 0.1$
Interest rate on foreign borrowing	$R^* = 1.026$
Enforcement parameter	$\bar{\kappa} = 0.25$
World demand for domestic consumption composite	$\zeta = 0.12$
Entry adjustment cost	$\tau = 1$

4.2 Theoretical impulse responses

The negative financial shock decreases firms' access to working capital loan forcing them to reduce production. Figure 2 shows the impulse responses of the real, financial, and firm dynamics variables to an adverse financial shock. To illustrate the role of firm entry cyclicality, I compare the endogenous entry model to a model with a constant number of firms. The black solid line is used for the model with endogenous firm entry described in section 3 and the blue dashed line gives the impulse responses in a model in which the endogenous entry channel is shut down by assuming that there is no entry or exit of firms and the number of firms is normalized to 1. The initial response in aggregate output, consumption and labor is of the same size in both of the cases, and the firm-level output does not change substantially whether we consider endogenous or zero entry. When firm entry is cyclical, however, a decline in the aggregate variables is driven by both the decline in monopolistic firms' production and the number of producers. Reflecting this, the aggregate values of output, consumption and labor recover substantially faster in a model with zero entry than in a model endogenous firm entry.

Entry is countercyclical recovers slowly and the number of firms stays below the steady state long after the original shock has disappeared. Lower entry during the crisis reduces competitive pressures on the producers of monopolistic goods. Moreover, an increase in the cost for external financing ensures that firms are more likely to adjust the quantities

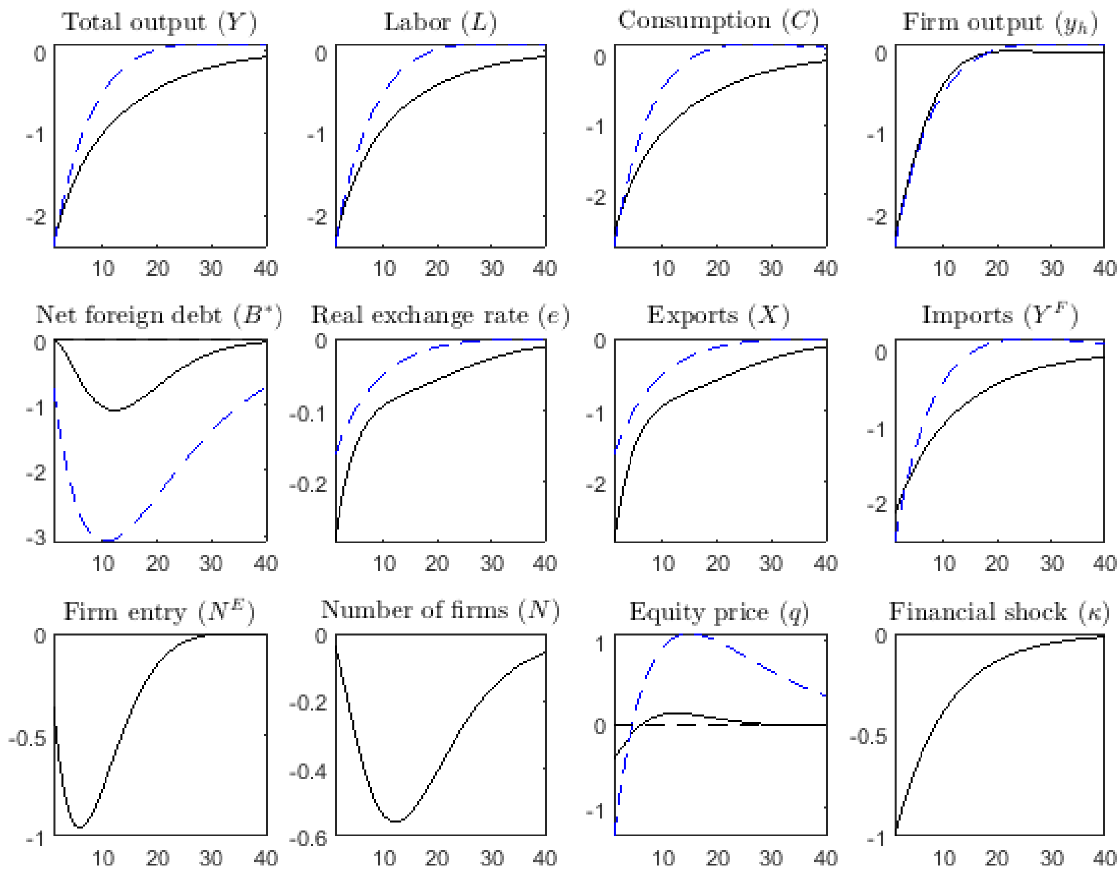

Figure 2: Impulse responses the variables in the model: financial shock that decreases κ_t. ϵ_t^κ has a standard deviation of 0.01 and persistence of 0.9. The variables, aside from the real exchange rate and the equity price, are given as log deviations from steady state. The y-axis is reports the effect of the shock multiplied by 100. Black solid line: model with endogenous firm entry. Blue dashed line: model with zero entry and number of firms normalized to 1.

rather than prices. As the firms are reluctant to cut prices as a response to the financial shock, the real exchange rate appreciates which decreases the net exports to the rest of the world. This is in line with Gilchrist et al. (2016), who find that financial frictions create an incentive for firms to increase prices as a response to a financial shock or a demand shock. A similar idea has been presented earlier in Chevalier and Scharfstein (1996) using firm-level data evidence that liquidity-constrained firms increase prices in order to boost their profits.

On the financial side, the small open economy's net foreign assets decreases due to a reduction in economic activity in the small open economy. The equity price of firms falls, but the effect improves quickly. In the model, this reflects the incumbent firms ability to sustain the equity price in order to relax the enforcement constraint when the decrease in the number of producers lowers the competitive pressures. The short-lived effect on equity prices is also visible in data, illustrated in the figure 11 in the appendix G.2 where the average taken over the S&P global equity indices remains negative only in 2009.

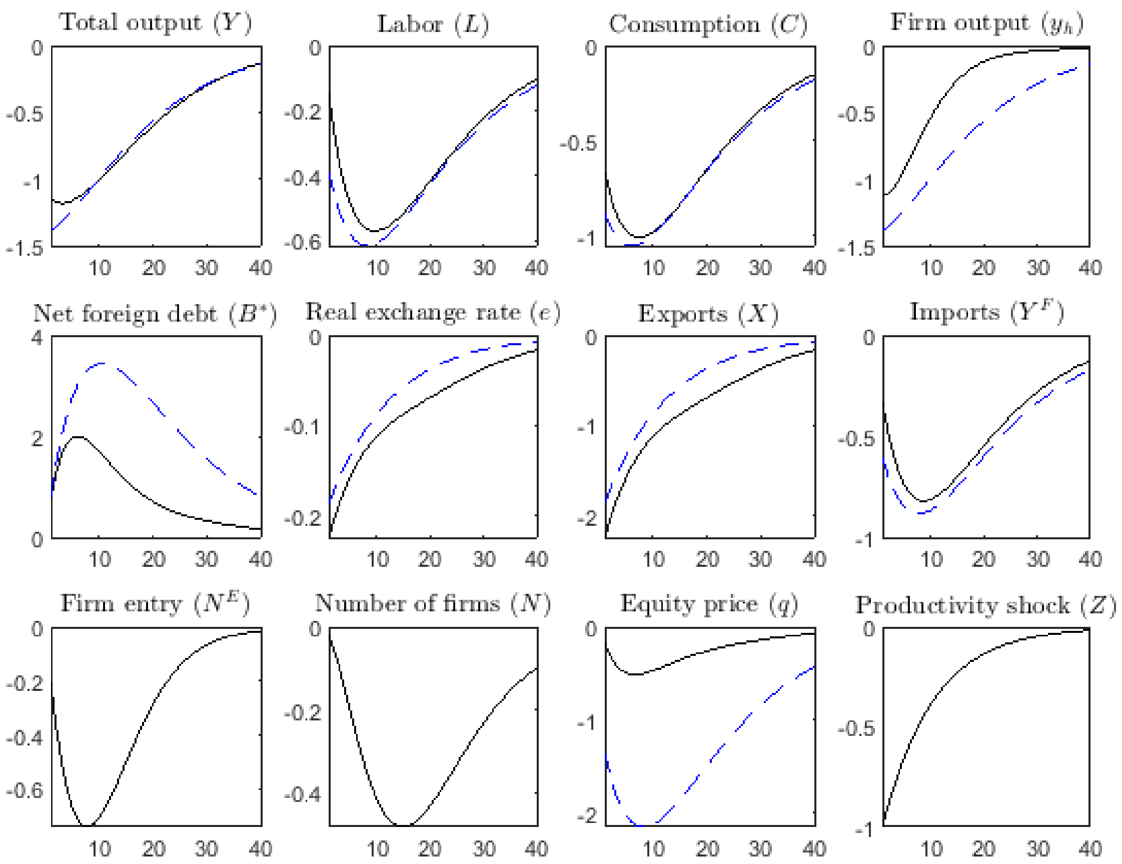

Figure 3: Impulse responses the variables in the model: productivity shock that decreases Z_t. ϵ_t^Z has a standard deviation of 0.01 and persistence of 0.9. The variables, aside from the real exchange rate and the equity price, are given as log deviations from steady state. The y-axis is reports the effect of the shock multiplied by 100. Black solid line: model with endogenous firm entry. Blue dashed line: model with zero entry and number of firms normalized to 1

The effects of the rest of the shocks are described in the appendix D.

4.3 Second moments

TBA

5 Occasionally binding collateral constraint

5.1 Empirical impulse responses

To illustrate the effects of the global financial crisis in emerging economies, I apply an approach that is similar to Cerra and Saxena (2008), and also used in Queraltó (2013).[12] I am using annual panel data from World Bank for 20 emerging countries. Details of the countries and datasets are provided in the appendix G. Estimated impulse responses are obtained using GMM estimation of panel VAR with 1 lag, country-specific fixed effects and global financial crisis dummy as an exogenous variable:

$$X_{i,t} = u_i + AX_{i,t-1} + BD_t + \varepsilon_{i,t}, \tag{26}$$

where $X_{i,t} = [log(Y_{i,t})\ log(N^E_{i,t})]'$ are the endogenous variables GDP and new business registrations, u_i is the country fixed effect and D_t is a dummy that indicates the 2009 crisis. Although the crisis starts in late 2008, the annual data requires the use of the first full year in the estimations. The model is transformed using Arellano and Bover (1995) forward orthogonal deviations and Holtz-Eakin et al. (1988) GMM type instruments, as in Love and Zicchino (2006).

The estimation of the VAR model provides the group averages of the impulse responses of GDP and new business registrations. The lag length is 1 which is supported by MBIC and MAIC criteria but also necessary given the short time dimension of the data. The panel VAR satisfies the stability condition of the estimates as all modulus of the eigenvalues lie inside the unit circle. The 95 % confidence bands are estimated with a Gaussian approximation based on Monte Carlo draws from the estimated model. Figure 4 shows the cumulative empirical impulse responses together with the impulse responses from the model. The empirical impulse responses, marked with blue with the 95 % confidence bands, show that both real GDP and number of firms declined strongly in 2009.

[12]The former research paper estimates an autoregressive model to illustrate the persistence of output losses after banking, currency, and twin financial crises, political disruptions and civil wars using a large panel of countries, with dummy variables indicating the occurrence of financial or political crises.

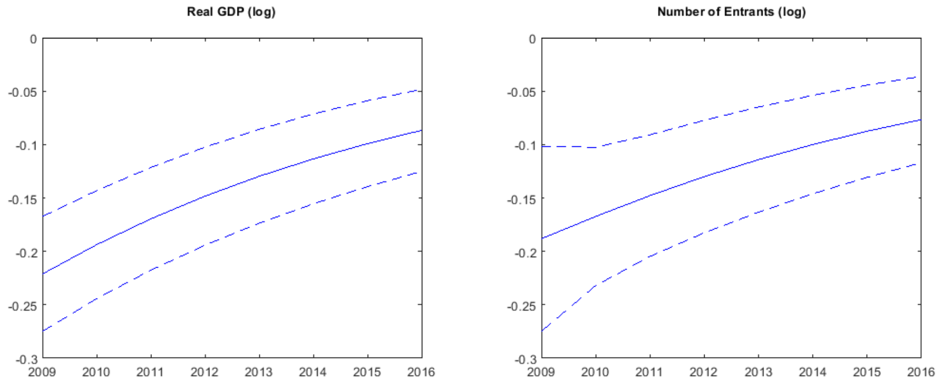

Figure 4: Empirical impulse responses of logarithmic annual variables to the crisis event.

5.2 Results for the OBC model

The constraint in the model presented in section 3 can be modified to include the international debt.

$$\kappa_t E_t[m_{t+1}V_{h,t+1}] \geq w_t l_{h,t} + \frac{b^*_{h,t}}{R^*}. \tag{27}$$

This constraint binds the agents occasionally and thus the model is solved using time-iteration with linear interpolation. The code used toolboxes presented in Richter et al. (2014). The results for this version of the model and the analysis are to be added. The iteration routine and preliminary results from a simplified model are presented in the computational appendix F

6 Conclusions

This article studies the endogenous entry fluctuations when old firms and entrants rely on external debt in a small open economy. I present a small open economy model with endogenous firm entry, financial frictions and firms' issuance of equity and foreign debt. The model implies that the real variables along with the number of entrants, equity price and aggregate debt decrease as a response to a negative financial shock. When firm entry responds endogenously to a financial shock, the model predicts a highly persistent decline in the aggregate output, labor and consumption. The central implications of the model with occasionally binding constraint are compared to the experiences during the financial crisis.

The findings of the research leave room for new interesting venues for research. One possibility is to explore alternative explanations for the slow recovery of the real gross domestic product in the aftermath of financial crises, complementing the explanation emphasizing the slow-down in R&D activities that has been studied extensively in the literature. This result can be contrasted to the findings in Tsangarides (2012). In this empirical research, the author studies the effects of both financial and trade channels on GDP. He finds that both of the channels are important during the crisis but the trade channel becomes more important during the recovery. Thus, the model could be taken to empirical data to evaluate the effects of different channels relevant during the crisis.

To implement the study described above, a crucial step is extending the data sources out sample of countries. As discussed in Bilbiie et al. (2012), the macroeconomic data for firm entry is still scarce, and this is especially true for cross-country data on small emerging economies. The data has both a small number of cross-sectional units and time dimension, and thus issues with consistency prevent strong empirical inference and full estimation. Moreover, the exact timing of the events cannot be fully captured with annual data. As such, the empirical studies in this research paper serve as preliminary results for a more comprehensive examination, and hopefully as a motivation to further study the role of firm entry during financial crises.

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A Model Equilibrium Conditions

Household:

$$w_t = L_t^{\omega-1}, \tag{28}$$

$$q_t = E_t\left[\beta(1-\delta)\frac{U_{t+1}^C}{U_t^C}(d_{t+1}+q_{t+1})\right], \tag{29}$$

$$U_t^C = \left(C_t - \frac{L_t^\omega}{\omega}\right)^{-\gamma}, \tag{30}$$

Entry sector:

$$\kappa_t q_t (N_{t-1} + N_t^E) = w_t L_t, \tag{31}$$

$$d_t = \rho_t \frac{Y_t^H}{N_{t-1}+N_t^E} - w_t \frac{L_t}{N_{t-1}+N_t^E} - e_t\left(b_{t-1}^* - \frac{b_t^*}{R^*}\right). \tag{32}$$

$$Y_t^H = Z_t L_t^H (N_{t-1}+N_t^E)^{\sigma-1}. \tag{33}$$

$$\frac{e_t b_t}{R_t^*} + q_t + \rho_t^N \frac{Y_t^H}{N_{t-1}+N_t^E} - w_t \frac{L_t}{N_{t-1}+N_t^E} = \left(\frac{N_t^E}{N_{t-1}^E}\right)^\tau, \tag{34}$$

$$\rho_t = \sigma \frac{w_t L_t}{Y_t^H}(1+\mu_t), \tag{35}$$

$$\mu_t = \frac{\frac{e_t}{R_t^*} - E_t\left[\beta(1-\delta)\frac{e_{t+1}U_{t+1}^C}{U_t^C}\right]}{\kappa_t E_t\left[\beta(1-\delta)\frac{e_{t+1}U_{t+1}^C}{U_t^C}\right]}, \tag{36}$$

$$N_t = (1-\delta)(N_{t-1}+N_t^E), \tag{37}$$

Final good aggregation:

$$Y_t^H = (1-\psi)\left(\frac{P_t^H}{P_t}\right)^{-\eta} C_t, \tag{38}$$

$$Y_t^F = \psi\left(\frac{P_t^F}{P_t}\right)^{-\eta} C_t. \tag{39}$$

$$Y_t^H = y_t(N_{t-1} + N_t^E)^{\sigma}, \tag{40}$$

Foreign demand:

$$X_t = \left(\frac{P_t}{\mathcal{E}_t P_t^*}\right)^{-\varphi} \zeta_t^*, \tag{41}$$

Market clearing

$$L_t = l_t(N_{t-1} + N_t^E), \tag{42}$$

$$Y_t^{GDP} = Y_t^H = C_t - Y_t^F + K_t^E N_t^E + X_t. \tag{43}$$

$$e_t\left[\frac{b_t^*}{R_t^*}(N_{t-1} + N_t^E) - b_{t-1}^* N_{t-1}\right] = e_t Y_t^F - X_t. \tag{44}$$

Exogenous shocks:

$$\kappa_t = (1-\rho^{\kappa})\bar{\kappa} + \rho^{\kappa}\kappa_{t-1} + \epsilon_t^{\kappa}. \tag{45}$$

$$Z_t = (1-\rho^{Z})\bar{Z} + \rho^{Z} Z_{t-1} + \epsilon_t^{Z}, \tag{46}$$

$$\zeta_t^* = (1-\rho^{\zeta})\bar{\zeta}^* + \rho^{\zeta}\zeta_{t-1}^* + \epsilon_{t+1}^{\zeta}, \tag{47}$$

$$R_t^* = (1-\rho^{R})\bar{R}^* + \rho^{R} R_{t-1}^* + \epsilon_{t+1}^{R}, \tag{48}$$

B Aggregation Appendix

B.1 Consumption good

The final good firm produces a consumption good using a domestic composite good, Y_t^H, and foreign composite good, Y_t^F, as inputs. The production function of the final good firm is:

$$Y_t^C = \left[(1-\psi)^{\frac{1}{\eta}} (Y_t^H)^{\frac{\eta-1}{\eta}} + \psi^{\frac{1}{\eta}} (Y_t^F)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} . \tag{49}$$

where all the final good output is Y_t^C. The optimal allocation between domestic and foreign goods is given by the cost minimization problem of $P_t^H Y_t^H + P_t^F Y_t^F$ subject to (49).

Forming the firm's cost function by plugging the conditional factor demand functions into the objective function, it is straightforward to show that the additional cost incurred per unit change in the target output level is given by:

$$P_t = \left[(1-\psi)(P_t^H)^{1-\eta} + \psi (P_t^F)^{1-\eta} \right]^{\frac{1}{1-\eta}} , \tag{50}$$

and since the final good firm operates under perfect competitions, this unit cost is also the unit price of the final good paid by the household. By applying Shephard's lemma, the optimal demands for domestic consumption composite and foreign imports are, respectively:

$$Y_t^H = (1-\psi) \left(\frac{P_t^H}{P_t} \right)^{-\eta} Y_t^C, \tag{51}$$

$$Y_t^F = \psi \left(\frac{P_t^F}{P_t} \right)^{-\eta} Y_t^C. \tag{52}$$

In the equilibrium, the domestic households consume all the final good output, such that $Y_t^C = C_t$. I denote the prices of domestic and foreign composite goods relative to the consumer price index, respectively, with $\rho_t = \frac{P_t^H}{P_t}$ and $\frac{P_t^F}{P_t} = \frac{\mathcal{E}_t P_t^*}{P_t} = e_t$.

B.2 Allocation between monopolistic differentiated goods

The domestic composite good consists of the output of the domestic monopolistically competitive old and new firms each producing one differentiated good h. The number of firms is given by N_t. The different varieties are aggregated into a consumption composite using a CES aggregator with an elasticity of substitution $\theta > 1$. The production function for the composite good is:

$$Y_t^H = \left[\int_0^{\tilde{n}_t} (y_{h,t})^{\frac{\theta-1}{\theta}} \, \mathrm{d}h \right]^{\frac{\theta}{\theta-1}}, \tag{53}$$

where $\tilde{n}_t \equiv N_{t-1} + N_t^E$ is the number of firms producing during period t, since all the firms get to produce prior to the exit of δ firms. The cost minimization of $\int_0^{\tilde{n}_t} p_{h,t} y_{h,t} \, \mathrm{d}h$ subject to (53) yields the price index:

$$P_t^H = \left[\int_0^{\tilde{n}_t} (p_{h,t})^{1-\theta} \, \mathrm{d}h \right]^{\frac{1}{1-\theta}}, \tag{54}$$

and the optimal allocation between the differentiated goods is given by:

$$y_{h,t} = \left(\frac{p_{h,t}}{P_t^H} \right)^{-\theta} Y_t^H. \tag{55}$$

Moreover, it is shown, using the cost function derived from the firm's cost minimization problem, that $P_t^H Y_t^H = \int_0^{\tilde{n}_t} p_{h,t} y_{h,t} \, \mathrm{d}h$.

B.3 Aggregation of Non-tradable Production

I consider the symmetric equilibrium in which the monopolistic firms set the same price and labor demand. Thus, $l_{h,t} = l_t$, $p_{h,t} = p_t$, $y_{h,t} = y_t$, and $d_{h,t} = d_t$. Let's denote $n_t = N_{t-1} + N_t^E$.

Using $L_t = l_t \tilde{n}_t$ and $P_t^N Y_t^N = \int_0^{\tilde{n}_t} p_t^N y_t^N \, \mathrm{d}h = p_t^N y_t^N \tilde{n}_t$, we get

$$Y_t^H = \frac{p_t}{P_t^N} y_t (N_{t-1} + N_t^E) = y_t (N_{t-1} + N_T^E)^{\sigma}, \tag{56}$$

since

$$\frac{p_t}{P_t^H} = \frac{p_t}{\left[\int_0^{\tilde{n}_t} (p_t)^{1-\theta}\, \mathrm{d}h\right]^{\frac{1}{1-\theta}}} = (N_{t-1} + N_t^E)^{\frac{1}{\theta-1}}. \tag{57}$$

As in Bilbiie et al. (2012), these are used to aggregate the monopolistic firms' first order conditions and the production function. Aggregated monopolistic firms' first order condition (6) becomes:

$$\rho_t = \frac{P_t^H}{P_t} = \sigma \frac{w_t L_t}{Y_t^H}(1 + \mu_t). \tag{58}$$

Aggregated output of the domestic firms is given by:

$$Y_t^H = Z_t L_t (N_{t-1} + N_t^E)^{\sigma-1}. \tag{59}$$

The dividends are given by:

$$d_t = \rho_t \frac{Y_t^H}{N_{t-1} + N_t^E} - w_t \frac{L_t}{N_{t-1} + N_t^E} - e_t \left(b_{t-1}^* - \frac{b_t^*}{R^*} \right). \tag{60}$$

Equity price equals the end-of-period value of firms as the equity price equals the expected discounted value of dividend payouts from $t+1$ onwards: $q_t = E_t[m_{t+1} V(b_{t)}]$.

$$\frac{e_t b_t}{R^*} + q_t + \rho_t \frac{Y_t^H}{N_{t-1} + N_t^E} - w_t \frac{L_t}{N_{t-1} + N_t^E} = K_t^E. \tag{61}$$

C Structure of the Model

C.1 Timing of Entry and Financial Decisions

Beginning of period t	Middle of period t	End of period t
Exogenous shocks Z_t^T, κ_t		
Non-tradable monopolists:		
Dividends and wage payments	Production	Exogenous exit
Take short-term loan	Repay short-term loan	probability δ
Repay old international debt		
Issue new international debt		
Entrants:		
Enter if value of entry ≥ 0		
Wage payments	Production	Exogenous exit
Take short-term loan	Repay short-term loan	probability δ
Issue international debt		

D Additional Impulse Responses

D.1 Shock to Productivity

The shock process is described in equation (46).

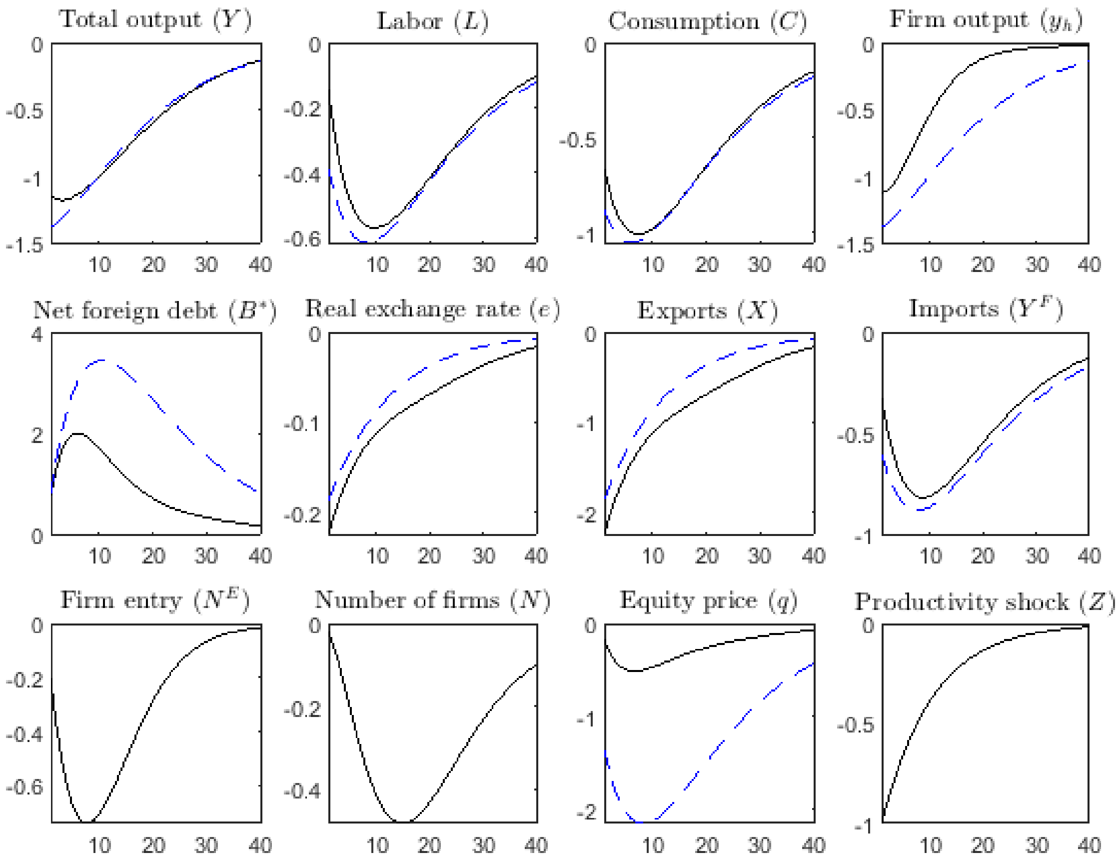


Figure 5: Impulse responses the variables in the model: productivity shock that decreases Z_t. ϵ_t^Z has a standard deviation of 0.01 and persistence of 0.9. The variables, aside from the real exchange rate and the equity price, are given as log deviations from steady state. The y-axis is reports the effect of the shock multiplied by 100. Black solid line: model with endogenous firm entry. Blue dashed line: model with zero entry and number of firms normalized to 1

D.2 Shock to Foreign Interest Rate

The shock process is described in equation (48).

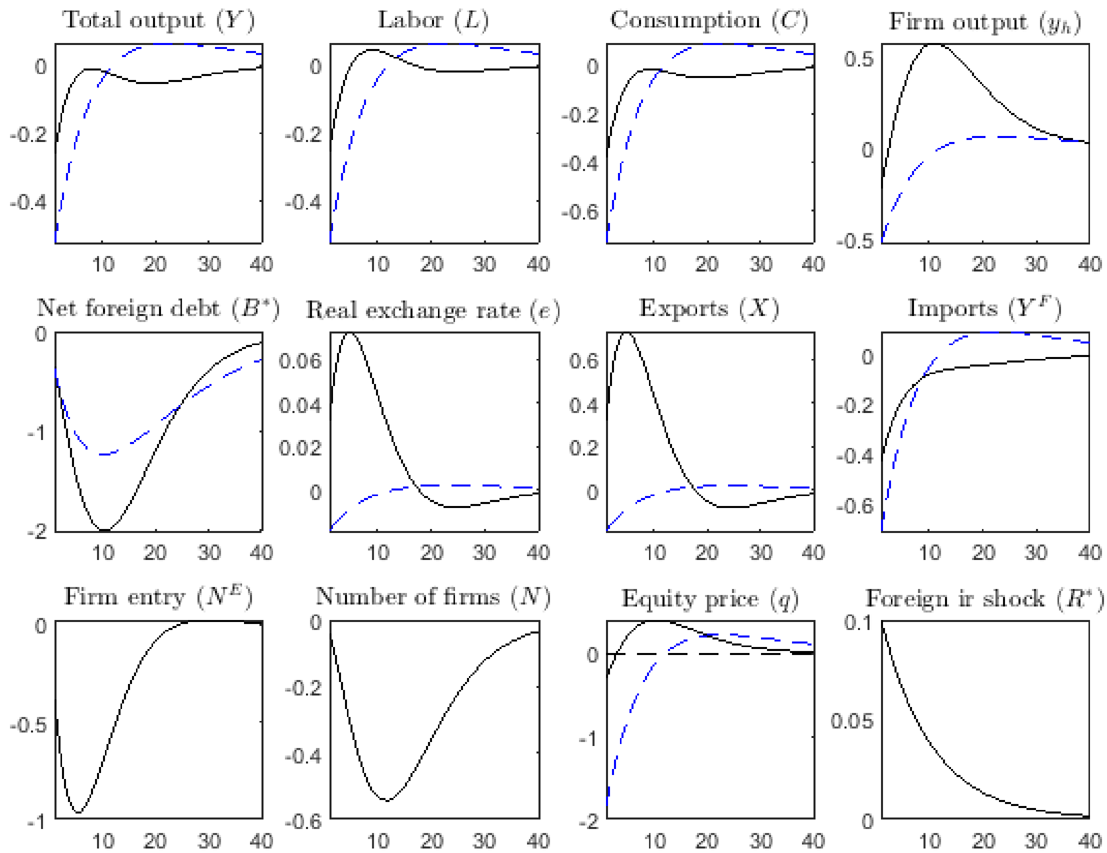


Figure 6: Impulse responses the variables in the model: foreign real interest rate shock that increases R_t^*. $\epsilon_t^{R^*}$ has a standard deviation of 0.01 and persistence of 0.9. The variables, aside from the real exchange rate and the equity price, are given as log deviations from steady state. The y-axis is reports the effect of the shock multiplied by 100. Black solid line: model with endogenous firm entry. Blue dashed line: model with zero entry and number of firms normalized to 1

D.3 Shock to Foreign Demand

The shock process is described in equation (47).

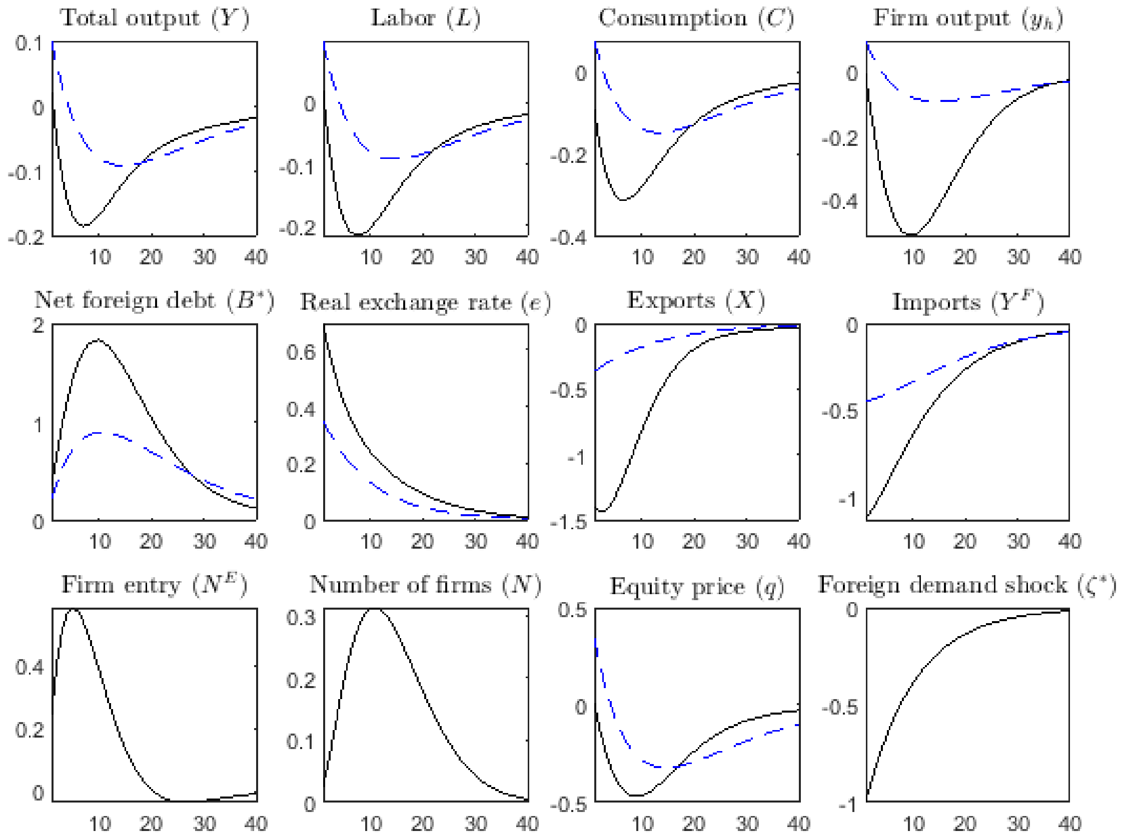


Figure 7: Impulse responses the variables in the model: foreign demand shock that decreases ζ_t. ϵ_t^ζ has a standard deviation of 0.01 and persistence of 0.9. The variables, aside from the real exchange rate and the equity price, are given as log deviations from steady state. The y-axis is reports the effect of the shock multiplied by 100. Black solid line: model with endogenous firm entry. Blue dashed line: model with zero entry and number of firms normalized to 1

E Estimation Appendix

E.1 Data

The time series for GDP is from the World Development Indicators database and the new business registrations is from the Entrepreneurship database, both provided by World Bank. Countries included in the sample are: Algeria, Belize, Belarus, Bolivia, Chile, Croatia, Czech Republic, Estonia, Hungary, Georgia, Israel, Jordan, Latvia, Lithuania, Malaysia, Mexico, Morocco, Peru, Romania and Slovak Republic. The data is annual and covers the years from 2002 to 2014, since this is the longest period for which the data for new business registrations is available. The selection of the emerging countries included in the panel data is chosen such that there are no missing observations in the dataset, and thus the panel is balanced. I use log values of the variables per mean of the country's population.

E.2 Panel VAR

The estimated impulse responses are obtained using GMM estimation of panel VAR with 1 lag, country-specific fixed effects and global financial crisis dummy as an exogenous variable.

$$X_{i,t} = u_i + AX_{i,t-1} + BD_t + \varepsilon_{i,t}, \tag{62}$$

where $X_{i,t} = [log(Y_{i,t}) \ log(N^E_{i,t})]'$ are the endogenous variables GDP and new business registrations, u_i is the country fixed effect and D_t is a dummy that indicates a crisis in 2009. The model is transformed using Arellano and Bover (1995) forward orthogonal deviations and Holtz-Eakin et al. (1988) GMM type instruments. The lag length is 1, which is supported by MBIC and MAIC criteria, but also necessary given the short time dimension of the data. The panel VAR satisfies the stability condition of the estimates, as all modulus of the eigenvalues lie inside the unit circle.

F Computational appendix

The time iteration solution algorithm with linear interpolation uses the Matlab toolbox and techniques described in Richter, Throckmorton and Walker (2014).

F.1 Time iteration algorithm

1. Use static equations to get rid of as many control variables as possible. I am left with prices e_t, q_t, end-of-period foreign bonds B^*_{t+1}, number of firms N_{t+1}, technology Z_t and the multiplier of the borrowing constraint μ_t. These are solved using the 6 equations given in the previous slide.

2. Form evenly spaced grids for all state variables: for endogenous B^* and N and exogenous Z around their steady states. Size of state space: $N = N^B \times N^N \times N^Z$.

3. Guess initial values $g_0^e(B, N; Z)$, $g_0^q(B, N; Z)$, $g_0^{B_{t+1}}(B, N; Z)$ and $g_0^\mu(B, N; Z)$ using the log-linear unconstrained solution.

4. Solve for N_{t+1} using the law-of-motion for firms and Z_{t+1} using the AR(1) process given the policy function guesses

5. Use linear interpolation to find q_{t+1} and e_{t+1} that correspond to these states

6. Evaluate the expectations in the Euler equations

7. Use non-linear solver to verify that the solution satisfies the equilibrium using Euler equations and the resource constraint.

8. Construct $\tilde{g}_1^e(B, N; Z)$ and $\tilde{g}_1^q(B, N; Z)$ based on Euler equation errors. The unbounded part of $\tilde{g}_1^{B_{t+1}}(B, N; Z)$ comes also from this solution. $g_1^\mu(B, N; Z)$ is still zero as we have solved the unconstrained model.

9. Update $g_1^{B_{t+1}}(B, N; Z) = max(\tilde{g}_1^{B_{t+1}}(B, N; Z), -\bar{B})$. Locate the grid nodes with the bounded constraint.

10. For each constrained node, find $\hat{g}_1^\mu(B, N; Z)$ using the bond Euler equation and update $g_1^\mu(B, N; Z) = max(\hat{g}_1^\mu(B, N; Z), 0)$.

11. Use the rest of the model to solve for $\hat{g}_1^e(B, N; Z)$ and $\hat{g}_1^q(B, N; Z)$ based on Euler equation errors of the constrained model for the nodes where the constraint binds. Construct $g_1^e(B, N; Z)$ and $g_1^q(B, N; Z)$ using the unconstrained and constrained parts.

12. Calculate the distance between the updates and the guesses.

13. If the largest distance is smaller than the tolerance 10^{-10}, stop. Otherwise, use the updated policy functions as new guesses and move to step 4.

F.2 Simplified model

Euler equations for bonds and equity:

$$e_t = \beta E_t \left(e_{t+1} \frac{U_{C,t+1}}{U_{C,t}} \right) + \mu_t, \tag{63}$$

$$q_t = \beta(1-\delta) E_t \left[(d_{t+1} + q_{t+1}) \frac{U_{C,t+1}}{U_{C,t}} \right], \tag{64}$$

Resource constraint and law-of-motion for firms:

$$e_t B^*_{t+1} = e_t R^* B^*_t + \rho_t Y_t - C_t, \tag{65}$$

$$N_{t+1} = (1-\delta)(N_t + N^E_t), \tag{66}$$

Borrowing constraint:

$$-B^*_{t+1} \leq \bar{B}, \tag{67}$$

And an AR(1) process for Z. Rest of the variables are solved using rest of the model equations.

F.3 Policy functions and Euler equation errors

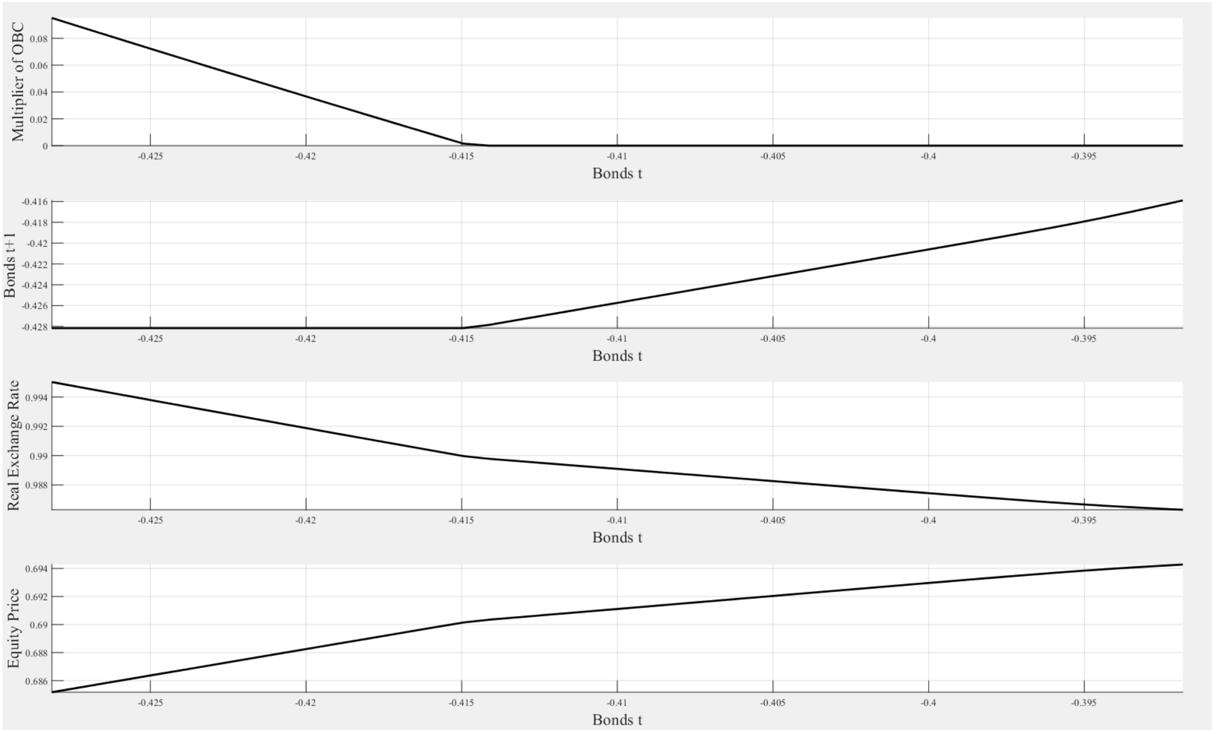


Figure 8: Policy functions of control variables with respect to the state B

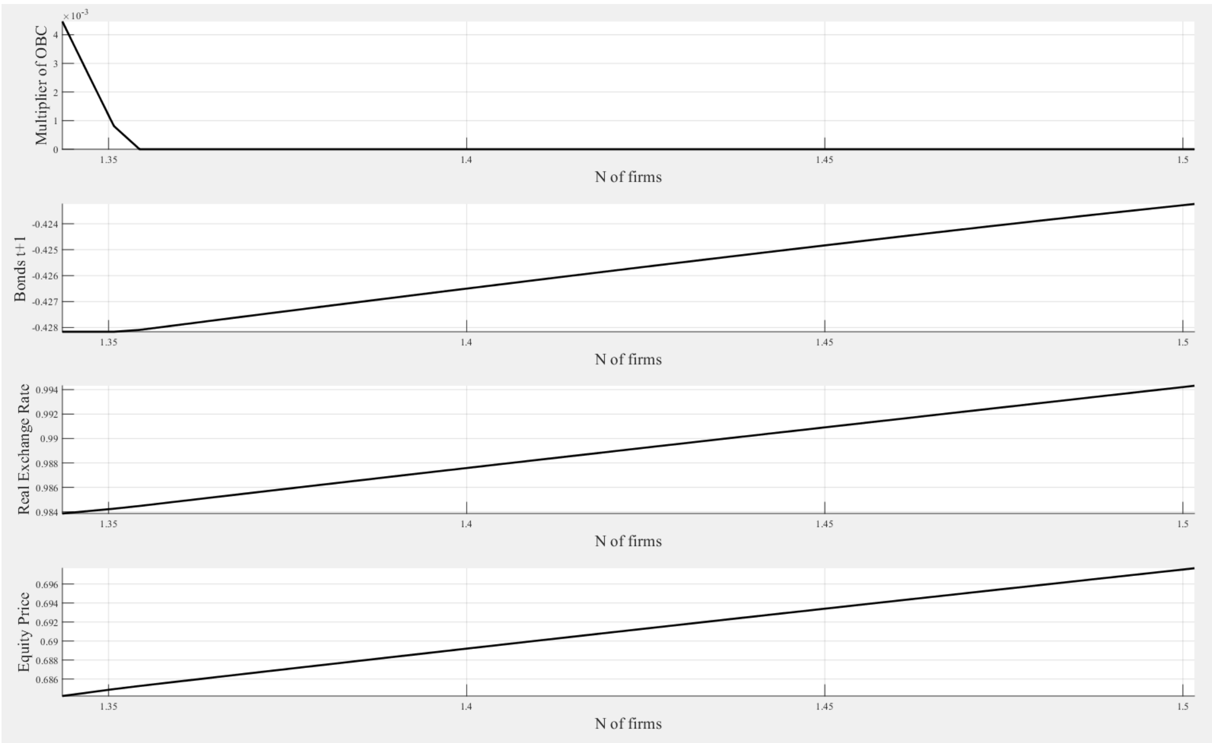


Figure 9: Policy functions of control variables with respect to the state N

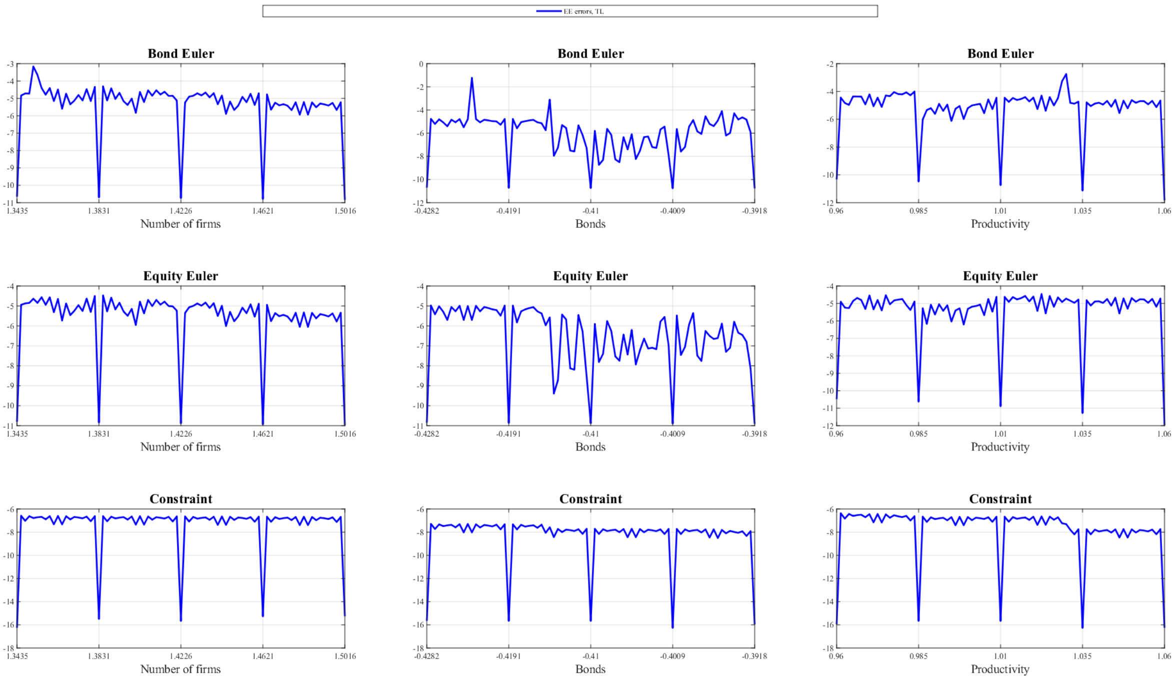


Figure 10: Euler Equation Errors

G Data for Cross-Country Variables

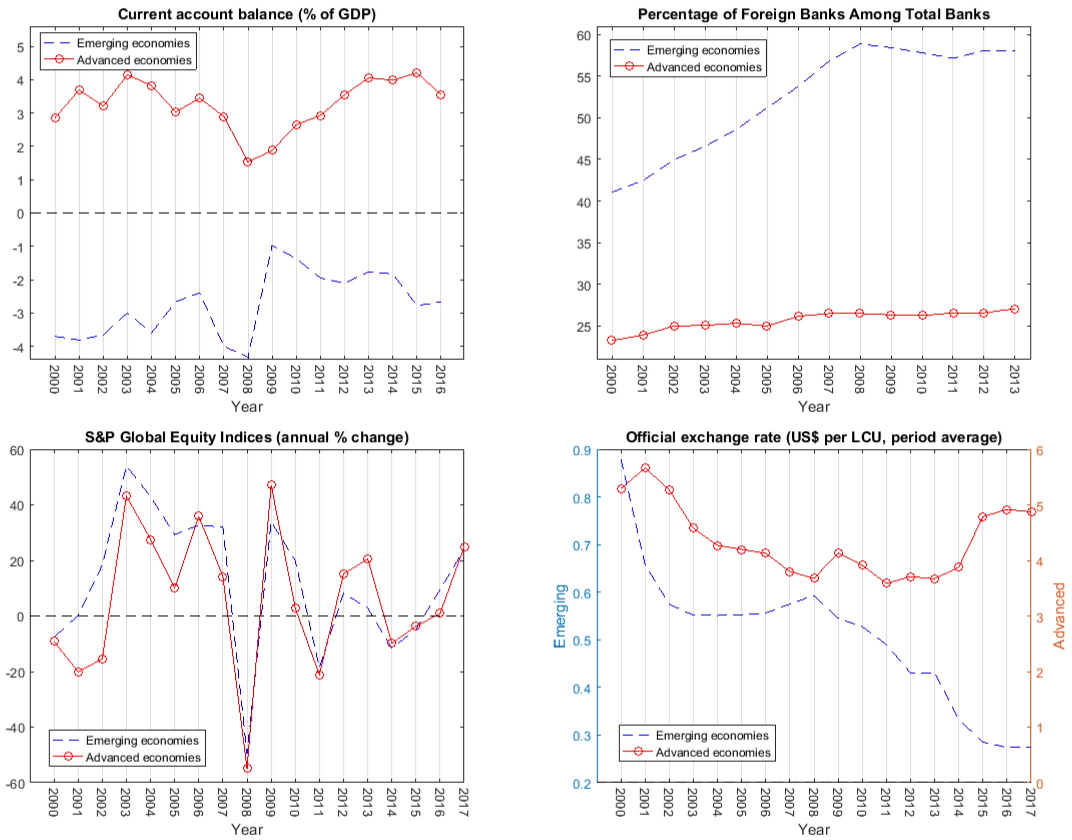
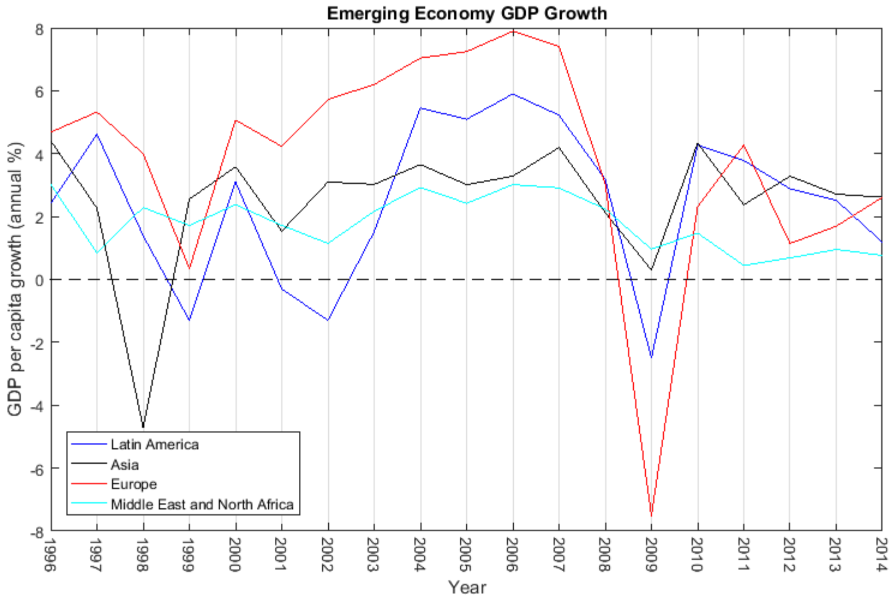


Figure 11: Cross-country averages for emerging and advanced countries in the sample. Source: World Bank, World Development Indicators Database. Countries included are Chile, Croatia, Czech Republic, Estonia, Hungary, Israel, Latvia, Lithuania, Malaysia, Mexico, Romania, Slovak Republic, and Slovenia. Advanced countries are: Austria, Canada, Finland, France, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Singapore, Sweden.

G.1 Emerging Economies and Great Recession of 2007–2009

The financial crisis originated in the USA in 2007 and turned global when Lehman Brothers filed for bankruptcy in September 2008. It soon reached the open economies in the latter half of 2008. Although emerging economies have experienced multiple financial crisis episodes before, the great recession of 2007–2009 stands out from the previous crises in how widely it spread and how simultaneously the global economy responded. To demonstrate the simultaneity and the coverage of the global turmoil figure 12 shows the average gross domestic product growth in emerging countries between different continents. It illustrates how the previous emerging economy crises, such as the East Asian crisis of 1997-1998,



[H]

Figure 12: Average GDP per capita growth in emerging economies in Latin America, Asia and Europe. Asia: Indonesia, South Korea, Malaysia, Philippines, Thailand and Vietnam. Europe: Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Romania, Slovak Republic, Slovenia and Turkey. Latin America: Argentina, Belize, Bolivia, Chile, Colombia, Dominican Republic, Mexico, Peru, Venezuela. Middle East: Algeria, Egypt, Israel, Jordan, Morocco and Tunisia. Source: World Bank.

the Russian crisis in 1998–1999, the Argentinian great depression in 1998–2002 and the South American economic crisis of 2002, compare with the global recession in 2008–2012. Notably, the adverse response of GDP during the recession was quite simultaneous across regions. This is likely to be caused by the global source for the shocks that depressed the emerging economies. East European emerging economies were affected the most, while the emerging economies in Asia managed to sustain GDP growth better on average, and the Middle East and North African countries stand out with low volatility during the crisis.

G.2 Emerging and Advanced Economies

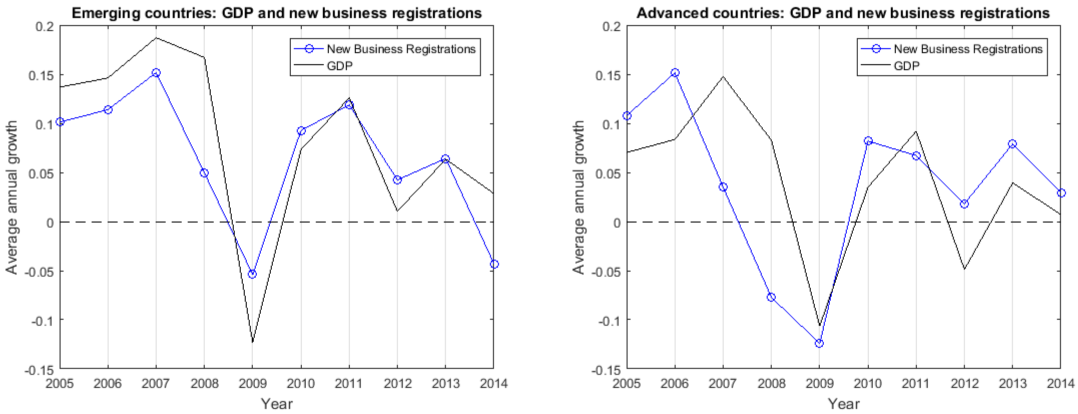


Figure 13: GDP and firm entry growth rates in emerging and advanced economies. Source: World Bank, World Development Indicators Database. Emerging countries are Chile, Croatia, Czech Republic, Estonia, Hungary, Israel, Latvia, Lithuania, Malaysia, Mexico, Romania, Slovak Republic, and Slovenia. Advanced countries are: Austria, Canada, Finland, France, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Singapore, Sweden.

H Note about informal sector

One concern when assessing the data about new firm registrations in emerging economies arises from the inability of the data to assess the fluctuations in informal sector. In countries with a large informal sector, a big share of firms never show up in the formal registers. In order to evaluate the effects of informal sector, I compare the results if I exclude countries in which the informal sector is estimated to be very large. I base this evaluation on World Banks estimates on informality. Schneider et al. (2010) estimate the size of shadow economies 162 advanced, emerging and developing economies. Since there is no threshold that determines when a country has a large informal sector or when is it small, I consider the countries with an estimate for the size of the shadow economy smaller than the average of the countries in 2007: 31.2 %.[13] This sample includes Chile, Croatia, Czech Republic, Estonia, Hungary, Israel, Latvia, Lithuania, Malaysia, Mexico, Romania, Slovak Republic, and Slovenia. The empirical results do not change substantially with this smaller sample of countries.

[13]The maximum value in high income OECD countries is 28 %.