Financial Development, Unemployment Volatility, and Sectoral Dynamics

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Abstract

We document a negative and significant relationship between domestic financial development and unemployment volatility in developing and emerging economies (DEMEs). However, there is no significant relationship between these variables in advanced economies (AEs). A labor-search model with production heterogeneity, sectoral financial frictions, and interfirm input credit can rationalize these differential cross-country results. Unemployment volatility is decreasing in financial development, but the quantitative relevance of this relationship is increasing in the extent to which input credit is prevalent in an economy. This insight is consistent with the fact that, empirically, input credit is much more prominent in DEMEs compared to AEs.

JEL Classifications: E24; E32; E44; F41.
Keywords: Business cycles, financial development, financial frictions, labor markets, large firms, search frictions, small firms.

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1 Introduction

Higher bank credit-GDP ratios are a defining characteristic of greater *domestic* financial development.[1] Moreover, economies differ widely in their domestic bank credit-GDP ratios. Economies also differ in the domestic external financing structure of firms. Specifically, small and medium enterprises (SMEs) face relatively high barriers to access formal external financing from banks compared to large firms, and therefore depend relatively more on *informal* external finance in the form of interfirm input credit. Interfirm input credit is particularly prevalent in developing and emerging economies (DEMEs) relative to advanced economies (AEs) (see, for example, Chavis, Klapper and Love, 2011; Global Financial Development Report, henceforth GFDR, 2014; OECD, 2012, and Presbitero and Rabellotti, 2016, for Latin America; among others).[2] Amid this backdrop, it is important to note that SMEs account for large shares of total aggregate employment *and* employment creation, particularly in the case of DEMEs (Ayyagari, Asli Demirgüç-Kunt, and Maksimovic, 2014).

Within this context, an important question immediately follows: Does domestic financial development have implications for labor-market dynamics and, if so, why? The answer to the first part of our research question is given by a novel and robust stylized fact, which we document in Figure 1: The existence of a negative correlation between financial development and aggregate unemployment volatility in DEMEs, but a positive correlation between these

[1] This is the definition of financial development that we adhere to. Our work does not address issues of financial integration between economies, but rather domestic financial development *centered on firm credit*. Henceforth, we use the terms financial development, financial or credit deepening, and improved credit access interchangeably.

[2] Small firms in DEMEs rank access to formal credit as one of their most important operational obstacles. In fact, the share of total bank credit devoted to SMEs is only 20 percent in Latin America and developing Asia, whereas this share easily surpasses 40 percent in AEs (IMF, 2014; OECD, 2015). Moreover, compared to DEMEs, AEs tend to have higher shares of bank credit to the private sector as a percent of GDP.

variables in AEs. *This relationship is statistically significant for DEMEs, but statistically insignificant for AEs.*

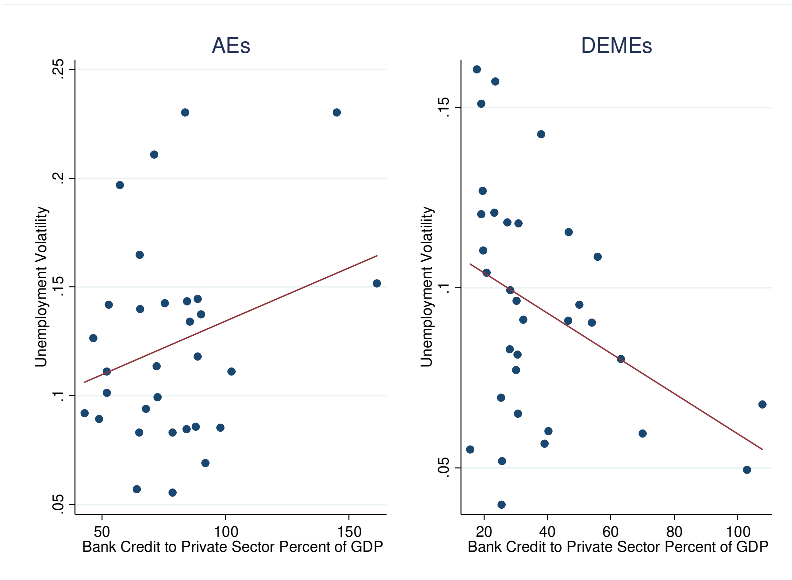

Figure 1: Relationship between unemployment volatility and bank credit to the private sector as a percent of GDP. Red line: OLS regression of a country's average unemployment volatility on a country's average bank credit to the private sector as a percent of GDP. This regression yields: for DEMEs, a slope coefficient significant at the 5-percent level; for AEs, a slope coefficient that is insignificant. Unemployment data are at yearly (time span varies across countries: earliest observation corresponds to 1950 and latest observation corresponds to 2015) frequency and HP-filtered with a smoothing parameter equal to 6.25. Unemployment data are from the International Labour Organization and the OECD. Data on credit are from International Monetary Fund, International Financial Statistics and data files, and World Bank and OECD GDP estimates.[3] Countries are sorted into advanced economies (AEs) and developing and emerging economies (DEMEs) per the International Monetary Fund's classification.

Importantly, these relationships hold even after controlling for additional relevant variables that could influence unemployment volatility across countries, including a host of labor-market regulation measures pertaining to hiring and firing as well as productivity.[4] More-

[3] Unemployment data are from the International Labour Organization for: Albania, Algeria, Argentina, Bahamas, Barbados, Belize, Bulgaria, Chile, China, Colombia, Costa Rica, Ecuador, Honduras, Hong Kong, Indonesia, Israel, Jamaica, Korea, Luxembourga, Macau, Malaysia, Malta, Mauritius, Mexico, Morocco, Nicaragua, Pakistan, Panama, Paraguay, Philippines, Romania, Singapore, Sri Lanka, Syian Arab Republic, Thailand, Trinidad and Tobago, Uruguay, and Venezuela. Unemployment Data are from the OECD for Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.

[4] These labor-market regulation indicators are obtained from the World Bank's *Doing Business Report*

over, the relationship between GDP per capita, which is a standard measure of economic development, and unemployment volatility is insignificant for both DEMEs and AEs.

To answer the second part of our research question, and motivated by our answer to the first part, we use a theoretical approach to shed light on economic fundamentals that may explain the link, or lack thereof, between domestic financial development and unemployment volatility across countries. We develop a small open economy real business cycle model with financial frictions, interfirm input-credit, labor search, and heterogeneous firms that, as a benchmark, captures key structural characteristics of DEME labor and credit markets.

Guiding our analysis is the well-known fact that more financially-developed economies tend to have higher shares of bank credit devoted to SMEs compared to DEMEs (see Table A3 in the Appendix). Amid this backdrop, larger firms on a stronger financial footing and with greater formal credit access extend interfirm input credit—*by definition, a form of informal external finance*—to SMEs.[5] Indeed, an extensive theoretical and empirical literature stresses the role of interfirm input credit as a key source of external financing for SMEs (see, for instance, McMillan and Woodruff, 1999, Demirgüç-Kunt and Maksimovic, 2001, Fisman and Love, 2003, Allen et al. 2007, Beck et al., 2008, Hyndman and Serio, 2010, and GFDR, 2014).[6] The importance of input credit for SMEs in select DEMEs is noted in

(2014) and include: minimum wage for a full-time worker; the ratio of the minimum wage per value added per worker; the notice period for redundancy dismissal, and severance pay for redundance dismissal.

[5] See García-Teruel and Martínez-Solano (2010); Garcia-Appendini and Montoriol-Garriga (2013); Carbó-Valverde, Rodríguez-Fernández, and Udell (2016); and Shenoy and Williams (2017). For example, extending trade credit allows firms to expand their customer base, to operate in a competitive environment, and also to establish alternative insurance mechanisms against shocks. We do not model any specific microeconomic rationales for extending trade credit and instead focus on the implications of extending interfirm input credit.

[6] See Cuñat and Garcia-Appendini (2012) for an in-depth discussion of trade credit. Petersen and Rajan (1997) argue that small firms, which often face credit constraints and limited access to formal financing, rely on suppliers to external resources. These suppliers are generally able to better monitor their customers' activities relative to banks (Jain, 2001; Burkart and Ellingsen, 2004). Burkart and Ellingsen (2004), Daripa and Nilsen (2011), and Burkart, Ellingsen, and Giannetti (2011) provide theoretical rationales behind the use of trade credit. Pavón (2010) documents that input suppliers are the most important source of external

Table 1.

Table 1: Input and bank credit among SMEs for select economies

Country	Input Credit (% of External Financing)	Bank Credit (% of External Financing)
Argentina	73.1	17.7
Brazil	45.2	39.9
Chile	62.7	32.5
Colombia	62.9	23.1
Mexico	62.7	17.6
Peru	40.5	42.1
Venezuela	59.2	28.9
Average	58.0	28.8

Notes: Source are author's calculations using data from OECD (2013, Table 3.A1). Input credit is given by credit-based purchases from suppliers and advances from customers. Other sources of external financing, which are second-order to trade credit and bank credit, correspond to external financing from non-bank financial institutions and from moneylenders, friends, and relatives. Finkelstein Shapiro and González Gómez (2017) present similar evidence.

Importantly, as shown by Figure 2 for a broader set of DEMEs, the share of alternative financing sources—of which input credit is the most important—in total external financing is inversely related to the share of bank credit in total external financing. Of note, relationship is statistically significant and it does not hold by construction as firms can, in principle, tap into *non-bank* credit market finance as well.[7]

financing for small firms in Mexico, accounting for almost 70 percent of total external financing. This share is decreasing in firm size, with commercial banks being comparatively more relevant among larger firms. In other developing and emerging economies (DEMEs) roughly 60 percent of total external finance comes from trade credit (Table A5 in the Appendix). As the Appendix shows in more detail, similar evidence holds in other DEMEs, where more than 50 percent of small-firm entrepreneurs cite increased search for input suppliers to obtain external finance support (see Tables A1, A2, A3, and A5 in the Appendix; IDB, 2005; GFDR, 2014). Furthermore, in-kind-based trade credit relationships are more likely to take place in economies with weaker institutional quality (Burkart and Ellingsen, 2004). Of note, trade credit is, by nature, relationship-based as opposed to spot-market-based. In fact, survey-based evidence confirms SMEs' search efforts to find supplier-based, non-bank external financing (Table A1 in the Appendix). Finkelstein Shapiro and González Gómez (2017) discuss the relevance of input credit and supplier relationships in detail as well.

[7] Of note, recent studies have shown that some firms resort to self-financing in order to overcome limited access to external financing. At the same time, firms' financing patterns evolve as firms age (see, for example, Midrigan and Xu, 2014). Shourideh and Zetlin-Jones (2016) document that, in contrast with publicly-traded firms who primarily finance the bulk of their investment internally, privately-held firms finance most of their investment using external financing. Publicly-traded firms represent a minuscule share of firms in DEMEs as most firms in DEMEs tend to be small (GFDR, 2014). As such, our work focuses only on privately-traded

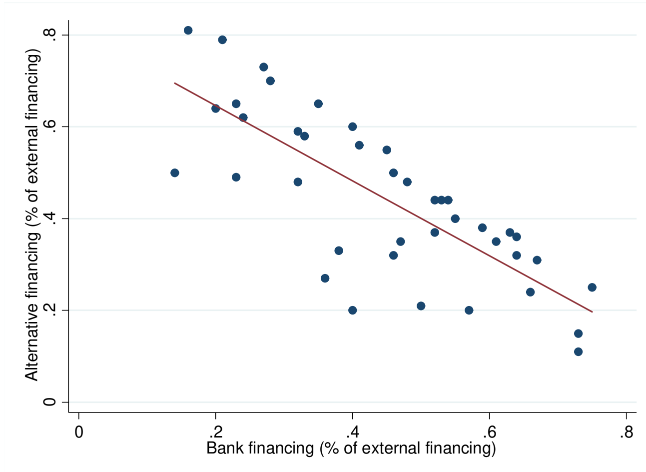

Figure 2: Alternative financing sources versus bank credit, both as a percent of total external financing. Data source: Allen, Carletti, Quianc, and Valenzuela (2012). Red line: OLS regression of alternative financing (as a percent of total external financing) on bank financing (as a percent of total external financing). This regression yields a slope coefficient that is significant at the 1-percent level.[8]

Our framework successfully replicates key labor market and business cycle properties of a representative DEME with quality labor market data: Mexico. We capture the relative importance of input credit among SMEs noted earlier by assuming two firm categories—labeled "large" and "small." While both firm categories use labor (hired via frictional markets) and internally-accumulated capital to produce, we assume that small firms also rely on capital supplied by large firms via input credit. This assumption embodies the *relative* reliance of small firms on informal external finance vis-à-vis large firms documented in the literature on input credit. Given our focus on financial development, our notion of small firms is not related to size or age per se, but instead to the differential external financing sources *and*

firms who, as suggested by existing evidence, do rely on (bank- and non-bank-based) external financing to operate. In addition, given our focus on business cycles and differences across countries and not on firms' life cycle patterns, we follow the literature on labor search frictions and business cycle dynamics and abstract from firm-age considerations.

[8]Country sample: Algeria, Argentina, Bangladesh, Belaruz, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Ecuador, Egypt, Hungary, India, Indonesia, Kazakhstan, South Korea, Malaysia, Mexico, Morocco, Pakistan, Peru, Philippines, Poland, Romania, Russian Federation, South Africa, Syrian Arab Republic, Thailand, Turkey, Ukrain, Venezuela, and Vietnam. These countries fall into the DEME category per the International Monetary Fund's classification.

the degree to which certain firms are less constrained in their access to bank credit.

Our model analysis of the impact of financial development on labor market dynamics suggests that unemployment volatility is decreasing in the borrowing capacity of small and/or large firms *as long as input credit is sufficiently prominent in small-firm production* amid business cycle fluctuations driven by productivity and borrowing financial shocks. Intuitively, an improvement in firms' borrowing capacity boosts the accumulation of capital, which makes firms more resilient to credit disruptions and stabilizes the demand for input credit. These dynamics make vacancy postings and therefore unemployment less volatile for any given set of shocks. This mechanism is always at play, regardless of the degree of input credit in an economy. However, we show that the greater the degree of input credit in an economy, the greater the explicit linkages between large and small firms. In fact, for a sufficiently low degree of input credit the relationship between financial development and unemployment volatility is for all purposes mute. These results are consistent with the relative importance of interfirm input credit in DEMEs versus AEs. Therefore, our work puts forth the importance of input credit as a novel and key amplification channel by which financial development can lead to lower unemployment volatility.

The international business cycle literature has emphasized the role of interest rate shocks for business cycles in DEMEs (Neumeyer and Perri, 2005; Li, 2011; Chang and Fernández, 2013; Boz, Durdu, and Li, 2015). Recent literature has incorporated financial frictions (e.g., Kiyotaki and Moore, 1997; Jermann and Quadrini, 2012; Buera, Fattal-Jaef, and Shi, 2014; Iacoviello, 2015) into settings with frictional labor markets in a DEME context (Lama and Urrutia, 2011; Fernández and Herreño, 2012; Finkelstein Shapiro and González Gómez, 2017). In turn, a number of studies have explored the empirical connection between financial development, growth, and aggregate volatility (Beck, Demirgüç-Kunt, Laeven, and Levine, 2004; Beck, Lundberg, and Majnoni, 2006; Aghion, Bacchetta, Rancière, and Rogoff, 2009; Manganelli and Popov, 2012; Wang and Wen, 2013), and also between financial development and firm dynamics (Arellano, Bai, and Zhang, 2012). While certain studies have explored the importance of sectoral heterogeneity (Beck, Demirgüç-Kunt, Laeven, and Levine, 2004; Manganelli and Popov, 2012; Dabla-Norris, Ji, Townsend, and Unsal, 2015), few, if any, have considered the implications for labor market dynamics.

Relative to existing literature, to the best of our knowledge our paper is the first to: highlight a robust stylized fact explicitly linking financial development to cyclical labor market dynamics; and to stress the importance of firms' external financing structure *along with firm* heterogeneity in access to credit towards understanding a link between financial development and unemployment volatility.

The remainder of this paper is organized as follows. Section 2 develops the model. Section 3 describes the model's operationalization and main results. Section 4 concludes.

2 The Model

Our model is directly related to Epstein and Finkelstein Shapiro (2017) with regards to production, reliance on input-credit by a set of firms, and the labor market, and Epstein, Finkelstein Shapiro, and González Gómez (2017) with regards to financial frictions and collateral constraints in a context of production heterogeneity. In turn, this last paper builds on Jermann and Quadrini (2012) and Iacoviello (2015).

2.1 Domestic Financial Intermediaries

In order to analyze the relevance of firm heterogeneity amid financial development, both small (household) firms and large firms must face collateral constraints and are therefore considered borrowers. As such, domestic financial intermediaries—or banks—can effectively be seen as suppliers of external funds to borrower firms. We assume that financial intermediaries have a unit mass and are a distinct agent that chooses large- and small-firm loan amounts $l_{l,t}$ and $l_{s,t}$, respectively, and consumption $c_{b,t}$ to maximize $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta_b^t u(c_{b,t})$ subject to the constraints $c_{b,t} = R_{t-1} l_{t-1} - l_t$, where: $l_t = l_{l,t} + l_{s,t}$; and $u' > 0$; $u'' < 0$. The subjective discount factor is $\beta_b \in (0,1)$ and R_t is the gross lending rate for large and small firms.[9] The first-order conditions yield $u'(c_{b,t}) = \beta_b \mathbb{E}_t u'(c_{b,t+1}) R_t$.

2.2 Large Firm Entrepreneurs

We assume that large firms can choose how much of their internally-accumulated capital stock to use in their own production and how much of this capital to rent out to small firms—our notion of input-credit.[10] Large-firm entrepreneurs have a unit mass and choose consumption $c_{l,t}$, desired employment (*denoted* $n_{l,t+1}$ *from the demand side perspective*) vacancies $v_{l,t}$, capital $k_{l,t+1}$, the fraction of existing capital to be used within the firm ω_t, and borrowed funds $l_{l,t}$ to maximize $E_0 \sum_{t=0}^{\infty} \beta_l^t u(c_{l,t})$ (where $u' < 0$ and $u'' < 0$) subject to: the resource

[9] The Appendix discusses the results from introducing costly financial intermediation, which generates an explicit spread between lending and deposit rates based on Cúrdia and Woodford (2010), as well as higher lending rates for small firms relative to large firms. Our results remain the same if we characterize financial development by a joint improvement in borrowing capacity and a reduction in both intermediation costs and interest rate spreads.

[10] See, for example, Finkelstein Shapiro (2014) and Epstein and Finkelstein Shapiro (2017) for richer specifications with frictional input credit markets.

constraint

$$c_{l,t} = p_{l,t}y_{l,t} - w_{l,t}n_{l,t} - \kappa(v_{l,t}) - i_{l,t} + l_{l,t} - R_{t-1}l_{l,t-1}$$
$$+ \left(r_{s,t} + \rho^{o} - \delta\right)(1 - \omega_t)k_{l,t},$$

where $p_{l,t}$ is the price of output, $y_{l,t}$ is output ($y_{l,t} = z_{l,t}\mathbb{F}(n_{l,t}, \omega_t k_{l,t})$, $\mathbb{F}$ is constant returns to scale, and $z_{l,t}$ is exogenous sectoral productivity), $w_{l,t}$ is the wage, $v_{l,t}$ are vacancies that are posted at a cost $\kappa(v_{l,t})$ with $\kappa' > 0$ and $\kappa'' > 0$, $i_{l,t}$ is investment, and $r_{s,t}$ is the input-credit capital rental rate; standard laws of motion for employment and capital, $n_{l,t+1} = (1 - \rho^{l})(n_{l,t} + v_{l,t}q_{l,t})$ (where ρ^{l} is the exogenous job-destruction probability and $q_{l,t}$ is the endogenous job filling probability), and $k_{l,t+1} = (1-\delta)k_{l,t} + i_{l,t}$ (where δ is the depreciation rate of capital), respectively; a collateral constraint $R_t l_{l,t} + w_{l,t}n_{l,t} \leq \eta_{l,t}k_{l,t+1}$. Note that in equilibrium, the measure of small firm owners $o_{s,t}$ must be equal to the supply of unused capital by large firms, $(1-\omega_t)k_{l,t}$. Moreover, we assume that any depreciated input-credit capital net of the exogenous depreciation of input credit other than physical-capital depreciation ρ^{o} is covered by large firms. This assumption is captured by the term $(\rho^{o} - \delta)(1-\omega_t)k_{l,t}$.

The sectoral collateral constraint follows Quadrini (2012) and Iacoviello (2015).[11] And, following this literature we assume that $\beta_l < \beta_b$, which guarantees that the constraint holds with equality. Also, note that $\eta_{l,t}$ determines the firm's borrowing capacity: all else equal a larger value of $\eta_{l,t}$ is consistent with the firm's existing capital being worth more as collateral.[12] (We assume that $\eta_{l,t}$ has mean $\overline{\eta}_l$ and follows a stochastic process, and the

[11] For a two-sector application, see Epstein, Finkelstein Shapiro, and González Gómez (2017).

[12] The collateral constraint assumes that the firm must finance the entirety of the wage bill, which is

firm's total wage bill must be paid in advance—see, for instance, Neumeyer and Perri, 2005; Iacoviello, 2015).

Large-firm optimization yields the following 4 equations. First, the large-firm Euler equation

$$1-\lambda_{l,t}\eta_{l,t}=\mathbb{E}_t\Xi^l_{t+1|t}\left(p_{l,t+1}z_{l,t+1}\mathbb{F}_{\omega k_l,t+1}\right)+(1-\delta),$$

where: $\lambda_{l,t}$ is the (collateral) multiplier on the large firm's borrowing constraint normalized by the marginal utility of large-firm consumption; and $\Xi^l_{t+1|t}\equiv\beta_l u'(c_{l,t+1})/u'(c_{l,t})$ is the large firm's stochastic discount factor. Intuitively, the marginal cost of accumulating capital (the left-hand side of this equation, which is decreasing in the collateral multiplier and borrowing capacity) is optimally set equal to the marginal benefit (the right hand side of this equation, which is increasing in the stochastic discount factor and the marginal revenue product of capital, but decreasing in the capital depreciation rate).

Second, the large-firm job creation condition

$$\frac{\kappa'(v_{l,t})}{q_{l,t}}=(1-\rho^l)\mathbb{E}_t\Xi^l_{t+1|t}\left\{p_{l,t+1}z_{l,t+1}\mathbb{F}_{n_l,t+1}-w_{l,t+1}\left[1+\lambda_{l,t+1}\right]+\frac{\kappa'(v_{l,t+1})}{q_{l,t+1}}\right\},$$

which equates the expected marginal cost of posting an additional vacancy (which is equal to the marginal cost of a posting a vacancy per the expected duration of the position being vacant) to the expected benefit of filling an open vacancy with an additional worker (which is increasing in the stochastic discount factor, the marginal revenue product of labor, and the continuation value of a match, but decreasing in a worker's wage adjusted for the collateral

standard in related literature—assuming that only a fraction of the wage bill needs to be financed does not change our main results. A similar comment applies to small firms below.

multiplier as a reflection of the fact that the firm must finance the wage bill, and also decreasing in the exogenous separation probability).

Third, the large-firm input-credit supply condition

$$p_{l,t} z_{l,t} \mathbb{F}_{\omega k_l,t} = r_{s,t} + (\rho^o - \delta),$$

which equates the marginal cost of devoting a unit of capital to a small firm (which is equal to the marginal revenue product of capital) to the marginal benefit (the rental rate and the value of a depreciated unit of capital).

Fourth, an optimal borrowing condition, $1 - R_t \lambda_{l,t} = \mathbb{E}_t \Xi^l_{t+1|t} R_t$, which equates the marginal benefit from borrowing funds (which is decreasing in the gross lending rate and the collateral multiplier) to the expected discounted gross rate on borrowed funds (see, for instance, Iacoviello, 2015). Rearranging this last equation to yield $1/R_t - \lambda_{l,t} = \mathbb{E}_t \Xi^l_{t+1|t}$ it follows that a rise in the gross lending rate or an increase in the collateral multiplier both put downward pressure on the large-firm's stochastic discount factor.

2.3 Small Firms and Households

Following a frictionless input-credit version of Epstein and Finkelstein Shapiro (2017), we assume that each small firm uses one and only one unit of input-credit capital to produce (assuming variable input-credit utilization within a given firm does not change our results).[13] Even though small firms can accumulate capital internally, a prerequisite for the existence of a small firm (and therefore, a small-firm owner) is that it relies on input-credit as an input

[13] We note that modeling input-credit *relationships* via capital search, as in Finkelstein Shapiro (2014) and Epstein and Finkelstein Shapiro (2017), does not change any of our conclusions.

supplied by a large firm. Also, as shown below, household members can be engaged in 4 economic activities: (1) employed in a small firm; (2) employed in a large firm; (3) being a small firm owner; (4) or unemployed. There is no labor force participation margin and the labor force is normalized to one.

Similar to Epstein and Finkelstein Shapiro (2017), total profits for small firms are

$$\Pi_{s,t} = \left[p_{s,t} z_{s,t} F\left(n_{s,t}, k_{s,t}, o_{s,t}\right) - w_{s,t} n_{s,t} - i_{s,t}\right]$$
$$- r_{s,t} o_{s,t} - \kappa(v_{s,t}) o_{s,t} + l_{s,t} - R_{t-1} l_{s,t-1},$$

where: $p_{s,t}$ is the price of output; $y_{s,t}$ is output ($y_{s,t} = z_{s,t} F\left(n_{s,t}, k_{s,t}, o_{s,t}\right)$, F is constant-returns-to-scale, and $z_{s,t}$ is exogenous sectoral productivity); $n_{s,t}$ *is the measure of small-firm salaried workers from the demand-side perspective* (Epstein and Finkelstein Shapiro, 2017); $k_{s,t}$ is the internally-accumulated capital stock; $i_{s,t}$ denotes total small firm investment in capital $k_{s,t}$; $o_{s,t}$ is the measure of small firm owners (given our assumption of one unit of input credit per small firm, $o_{s,t}$ is also the measure of input-credit capital); $w_{s,t}$ is the wage; $r_{s,t}$ is the input-credit-capital rental rate; the cost of vacancy creation per small firm owner is $\kappa(v_{s,t})$ with $\kappa' > 0$ and $\kappa'' > 0$; and small firms borrow external funds $l_{s,t}$ at a gross interest rate R.[14]

Households have a unit mass and own small firms and make decisions for these firms *from an input-demand perspective*. Note that we allow households to hold foreign debt to follow the literature on DEME business cycles. Importantly, given that households account for the

[14] Given that $o_{s,t}$ is the measure of small firm owners and all firms have the same exogenous productivity and a constant-returns production technology, dividing $\Pi_{s,t}$ by $o_{s,t}$ yields profits per small firm.

bulk of total consumption in the model, this assumption gives households an instrument to smooth consumption. At the same time, the presence of collateral constraints implies that the lending rate and foreign interest rate will differ as a result of a positive multiplier on the collateral constraint. This can be rationalized as follows: the positive collateral constraint multiplier may embody other factors (differential access to credit markets, intermediation costs that may differ between firms and individuals, etc.) which we do not explicitly model and that imply a discrepancy between the cost of borrowing for firms and the cost of accessing foreign assets by households.[15]

Households choose consumption $c_{h,t}$, foreign debt b_t^*, desired demand for small-firm workers $n_{s,t+1}$, the desired measure of small firm owners $o_{s,t+1}$, resources devoted towards establishing small firms s_t, internal capital $k_{s,t+1}$, vacancies $v_{s,t}$, and borrowed funds $l_{s,t}$ from domestic financial intermediaries to maximize $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta_h^t u(c_{h,t})$ ($u' > 0$ and $u'' < 0$) subject to the budget constraint[16]

$$c_{h,t} + \pi(s_t) + R_{t-1}^* b_{t-1}^* = \Pi_{s,t} + \Pi_t + w_{s,t} n_{s,t}^s + w_{l,t} n_{l,t}^s + b_t^*,$$

a law of motion for capital $k_{s,t+1} = (1-\delta)k_{s,t} + i_{s,t}$, the perceived law of motion for small-firm labor input $n_{s,t+1} = (1-\rho^s)(n_{s,t} + o_{s,t} v_{s,t} q_{s,t})$, the evolution of small firm owners $o_{s,t+1} = (1-\rho^o)(o_{s,t} + M_k s_t)$, where M_k is scaling parameter, and a borrowing constraint $R_t l_{s,t} - w_{s,t} n_{s,t} \leq \eta_{s,t} k_{s,t+1}$, where $\pi(s_t)$ is a resource cost with $\pi'(s_t) > 0$ and $\pi''(s_t) > 0$; households receive income from final-goods firm profits, Π_t, large- and small-firm workers, $w_{l,t} n_{l,t}^s$ and

[15] Of note, abstracting from foreign debt (which would imply a closed economy) does not change any of our conclusions.

[16] As such, households can be seen as hiring small-firm workers for their firms by posting vacancies to attract unemployed members from households other than their own.

$w_{s,t} n^s_{s,t}$, and take these profits and wages as given—n^s_l *and* n^s_s *denote sectoral employment from the supply-side perspective* and in the absence of labor force participation decisions, n^s_l and n^s_s are taken as given by the household; R^*_t is the gross foreign interest rate on foreign debt and $R^*_t = R^* + \eta_b \left[\exp(b^*_t - b^*) - 1\right]$ with $\eta_b > 0$ and steady-states R^* and b^* (Schmitt-Grohé and Uribe, 2003); $q_{s,t}$ is the endogenous job-filling probability; and workers are separated from small firms with exogenous probability ρ^s. Finally, $\eta_{s,t}$ determines the firm's borrowing capacity (all else equal a larger value of $\eta_{s,t}$ is consistent with the small firm's existing capital being worth more as collateral).

Small-firm and household optimization yield the following 5 conditions. First, a standard Euler equation for foreign debt, $1/R^*_t = \mathbb{E}_t \Xi^h_{t+1|t}$, where: $\Xi^h_{t+1|t} \equiv \beta_h u'(c_{h,t+1})/u'(c_{h,t})$ is the household's stochastic discount factor. Second, an input-credit demand condition

$$\pi'(s_t) = (1-\rho^o)\mathbb{E}_t \Xi^h_{t+1|t} \left\{ \left[p_{s,t+1} z_{s,t+1} F_{o_s,t+1} - r_{o,t+1} - \kappa(v_{s,t+1}) \right] + \pi'(s_{t+1}) \right\},$$

where the marginal cost of getting input credit (or, equivalently, having an additional small firm owner) is equal to the expected marginal benefit of doing so. This is akin to a standard capital Euler equation, but in our case with regards to input credit (i.e. small firm owners given our assumption of one unit of input credit per small firm).

Third, a job creation condition

$$\frac{\kappa'(v_{s,t})}{q_{s,t}} = (1-\rho^s)\mathbb{E}_t \Xi^h_{t+1|t} \left\{ p_{s,t+1} z_{s,t+1} F_{n_s,t+1} - w_{s,t+1}\left[1 + \lambda_{s,t+1}\right] + \frac{\kappa'(v_{s,t+1})}{q_{s,t+1}} \right\}.$$

where: $\lambda_{s,t}$ is the multiplier on the small firm's borrowing constraint normalized by the marginal utility of small-firm consumption. Fourth, a standard internal-capital accumulation condition,

$$\left[1 - \lambda_{s,t}\eta_{s,t}\right] = \mathbb{E}_t \Xi^h_{t+1|t} \left\{ p_{s,t+1} z_{s,t+1} F_{k_s,t+1} + (1-\delta) \right\}.$$

And fifth, an optimal borrowing condition, $1 - R_t\lambda_{s,t} = \mathbb{E}_t\Xi^h_{t+1|t}R_t$. The interpretation of these last 3 equations is entirely akin to their large-firm counterparts.

2.4 Closing the Model

Define unemployment as $\mathbf{u}_t \equiv 1 - n_{l,t} - n_{s,t} - o_{s,t}$. The functions $m_{l,t} = m_l(v_{l,},\mathbf{u}_t)$ and $m_{s,t} = m_s(v_{s,t}o_{s,t},\mathbf{u}_t)$ are standard constant returns to scale matching functions. The job-finding probabilities are $f_{j,t} = m_{j,t}/\mathbf{u}_t$ and for $j \in \{l, s\}$. In turn, the job-filling probabilities are $q_{s,t} = m_{s,t}/(v_{s,t}o_{s,t})$ and $q_{l,t} = m_{l,t}/v_{l,t}$. Labor market tightness in each sector is $\theta_{s,t} \equiv (v_{s,t}o_{s,t})/\mathbf{u}_t$ and $\theta_{l,t} \equiv v_{l,t}/\mathbf{u}_t$. All salaried job-finding probabilities are increasing in labor tightness.

Wages are determined via Nash bargaining. Due to differences in the discount factors between households and firms and the timing of the matching processes, no closed-form solution for wages can be obtained. For expositional briefness, the relevant value functions and Nash bargaining problems that implicitly define these prices are presented in the Appendix.[17]

Total output aggregates large- and small-firm output using the constant elasticity of substitution (CES) function $y_t = y(y_{l,t}, y_{s,t})$. Final goods firms maximize profits $\Pi_t = [y(y_{l,t}, y_{s,t})$

[17] The Appendix also presents implicit expressions for w_l and w_s that show how wages are influenced by (1) formal credit market conditions (embodied in λ_l and λ_s via firms' discount factors), (2) marginal productivities, and (3) sectoral market tightness in their own employment category and in other categories. Of note, volatility in credit conditions influences how firms value future employment relationships, which affects hiring decisions. Also, the hiring decisions of firms in a given sector have spillover effects on the decisions of firms (and households) in other sectors by affecting employment outside options (i.e., sectoral market tightness). Therefore, as financial development takes place, the variability of salaried labor and credit market conditions due to productivity and financial disturbances changes.

$- p_{l,t}y_{l,t} - p_{s,t}y_{s,t}]$, where the price of final output is normalized to 1. We obtain standard relative prices for large and small firm output, $p_{l,t} = y_{y_l}(y_{l,t}, y_{s,t})$ and $p_{s,t} = y_{y_s}(y_{l,t}, y_{s,t})$, respectively.

Finally, the aggregate resource constraint is

$$y_t = c_t + i_{l,t} + i_{s,t} + \pi(s_t) + \kappa(v_{l,t}) + \kappa(v_{s,t})o_{s,t} + tb_t,$$

where: $c_t = c_{h,t} + c_{l,t} + c_{b,t}$ is total consumption; and the trade balance is defined as $tb_t \equiv R^*_{t-1}b^*_{t-1} - b^*_t$.

3 Operationalization and Results

3.1 Operationalization

We assume that $\ln z_{j,t} = (1 - \varrho_z)\ln(\bar{z}_j) + \varrho_z \ln z_{j,t-1} + \varepsilon^z_t$ for $j \in \{l,s\}$, where $\bar{z}_j$ is a sector-specific parameter, $\varrho_z \in (0,1)$, and $\varepsilon^z_t \sim N(0, \sigma^2_z)$ denotes the aggregate productivity shock. Similarly, sectoral borrowing capacity follows an AR(1) process with a common financial shock: $\ln \eta_{j,t} = (1 - \varrho_\eta)\ln(\overline{\eta}_j) + \varrho_\eta \ln \eta_{j,t-1} + \varepsilon^\eta_t$ for $j \in \{l,s\}$, where $\overline{\eta}_j$ is a sector-specific parameter, $\varrho_{\eta_j} \in (0,1)$, and $\varepsilon^\eta_t \sim N(0, \sigma^2_\eta)$.

A time period is 1 quarter. Table 2 summarizes the functional forms we use. Note that although not stated in the model description for expositional simplicity, following related literature, we introduce standard capital adjustment costs $\Phi(k_{j,t}, k_{j,t+1})$.

Also, as shown in Table 2, in the functional form for $F(n_{s,t}, k_{s,t}, o_{s,t})$, γ_k determines the relative importance of capital obtained via input credit in the production function of small firms. Intuitively, γ_k and the ease with which firms can access financial credit may be endogenously related, for instance, if greater financial credit pushes small firms to reduce their dependence on input credit. However, we remain purposefully agnostic about this potentially endogenous relationship, since this approach allows us to carefully dissect the importance of each of the model's ingredients in a disciplined and transparent way. Recall that our objective is not to explain the external financing structure of firms, but rather to shed light on the implications for labor-market dynamics of firms' *existing* external financing structure.

Table 2: Functional forms

Variable	Functional Form	Notes
y_t	$\left[\gamma_a y_{l,t}^{\phi} + (1-\gamma_a)\, y_{s,t}^{\phi_a}\right]^{\frac{1}{\phi_a}}$	$\gamma_a \in (0,1)$ and $\phi_a \leq 1$
$F(n_{s,t}, k_{s,t}, o_{s,t})$	$(n_{s,t})^{1-\alpha_s}\left[(o_{s,t})^{\gamma_k}(k_{s,t})^{1-\gamma}\right]^{\alpha_s}$	$\alpha_s \in (0,1)$
$\mathbb{F}(n_{l,t}, \omega_t k_{l,t})$	$(n_{l,t})^{1-\alpha_l}(\omega_t k_{l,t})^{\alpha_l}$	$\alpha_l \in (0,1)$
$m_{l,t}$	$M_l(\mathbf{u}_t)^{\xi}(v_{l,t})^{1-\xi}$	M_l is match scaling and ξ is match elasticity
$m_{s,t}$	$M_s(\mathbf{u}_t)^{\xi}(v_{s,t}o_{s,t})^{1-\xi}$	M_s is match scaling and ξ is match elasticity
$\Phi(k_{j,t}, k_{j,t+1})$	$(\varphi_k/2)(k_{j,t+1}/k_{j,t}-1)^2 k_{j,t}$	for $j \in \{l,s\}$; standard in related literature
$\pi(s_t)$	$\psi_k (s_t)^{\eta_k}$	$\psi_k, \eta_k > 0$; Merz and Yashiv (2007)
$\kappa(v_{j,t})$	$\psi_j (v_{j,t})^{\eta_v}$	$\psi_j, \eta_v > 0$ for $j \in \{l,s\}$; standard in related literature
$u(c_j)$	$c_j^{1-\sigma}/(1-\sigma)$	$\sigma_j > 0$ for $j \in \{l,s\}$; standard in related literature

Table 3 summarizes the parameter values we adopt. A standard assumption in models with collateral constraints is that $\beta_b > \beta_h, \beta_l$ (see, for instance, Iacoviello, 2015), which we implement, so that firms' collateral constraints are always binding.[18] Of course, while empirically firms may not always face binding financing constraints over the business cycle, our main objective is to explore the cyclical unemployment implications of improving firms'

[18] We experiment and find that our conclusions do not hinge on other plausible values for β_b, β_h, and β_l.

access to credit relative to a baseline, more constrained economy. As such, our quantitative analysis abstracts from occasionally binding constraints as these are not central to our focus.[19]

Table 3: Parameter Assumptions

Parameter	Value	Notes
α_l	0.320	Epstein and Finkelstein Shapiro (2017)
α_s	0.270	Epstein and Finkelstein Shapiro (2017)
β_b	0.985	Binding collateral constraint; Iacoviello (2015)
β_h	0.885	Binding collateral constraint; Iacoviello (2015)
β_l	0.885	Binding collateral constraint; Iacoviello (2015)
δ	0.025	Standard in related literature
η_j	2.000	$j \in \{l, s, o\}$; Merz and Yashiv (2007)[20]
ξ	0.500	Petrongolo and Pissarides (2001)[21]
ϕ_a	0.700	Benchmark; Epstein and Finkelstein Shapiro (2017)[22]
ρ^l	0.030	Bosch and Maloney (2008)
ρ^s	0.070	Bosch and Maloney (2008)
ρ^o	0.040	Bosch and Maloney (2008)
ϱ_z	0.950	Aguiar and Gopinath (2007)
σ	2.000	Standard in related literature
$\overline{z}_s$	1.000	Normalization; see Appendix for details
$\overline{z}_l$	2.219	Busso, Fazio, and Levy (2012); see Appendix for details

Table 4 summarizes the calibrated parameters used in our benchmark simulation. We use Mexico as a reference DEME given its rich labor market data. We note that $\overline{\eta}_s > \overline{\eta}_l$ may initially seem at odds with the well-known severity of financing constraints among small firms. However, we stress that firms also differ in their steady-state levels of internally-accumulated capital. In particular, small firms have less capital and it is the *total borrowing*

[19] Of note, a related segment of the literature on financial frictions focuses on the misallocation and total-factor-productivity implications of these constraints as part of the development process (see Buera, Kaboski, and Shin, 2011; Buera, Fattal-Jaef, and Shi, 2014; among others). Since our focus is not on misallocation or micro-level differences in firm productivity, we stay close to well-known studies on business cycles and financial frictions.

[20] Our value implies that the total resource cost from vacancy posting in the benchmark calibration is around 1 percent of output, in line with the literature (Boz, Durdu, and Li, 2015).

[21] In line with related literature, the bargaining power of all types of workers is $\chi = 0.5$. Our conclusions do not change if we assume that ξ and/or χ differ at the sectoral level.

[22] This value implies a relatively high degree of imperfect substitutability between sectoral output (other reasonable values, whether higher or lower, do not change our conclusions).

capacity, $\overline{\eta}_l k_l$ for large firms and $\overline{\eta}_s k_s$ for small firms, that ultimately matters for the relative sensitivity of firms to shocks. Indeed, controlling for firms' differential internal capital levels, the *total* borrowing capacity of large firms is much higher than the one for small firms. That is, in the steady state, $\overline{\eta}_l k_l > \overline{\eta}_s k_s$. Thus, the calibrated values for $\overline{\eta}_l$ and $\overline{\eta}_s$ are consistent with large firms having better access to formal financing relative to small firms as suggested by existing empirical evidence.

Regarding employment shares, according to Mexico's National Survey on Urban Employment and National Survey on Occupation and Employment, the share of self-employment in Mexico is close to 23 percent (a lower bound). Around 30 percent of those self-employed work in firms with more than one worker (that is, in salaried firms). Hence the share of small firm owners we use in our benchmark calibration. In the model, the self-employed are accounted for in the share of workers in small firms since, similar to small-firm salaried workers, self-employment is countercyclical. Also, as noted in Epstein and Finkelstein Shapiro (2017), the fact that $M_s > M_l$ should not be taken as implying that large firms are less efficient at hiring than small firms, but instead may reflect aspects of the economic environment that we are not explicitly modeling (institutional or regulatory factors that affect the matching process, for example). Moreover, the values for these matching parameters imply higher job-finding probabilities for small-firm employment relative to large-firm employment, which is consistent with evidence from Bosch and Maloney (2008) (where informal employment is mainly concentrated in small firms).

Table 4: Calibrated Parameters

Parameter	Value	Notes
$\overline{\eta}_l$	0.291	Match Mexico empirical average domestic credit-to-GDP ratio (=0.20; World Bank Development Indicators)
$\overline{\eta}_s$	0.614	Match share of credit to small firms in sample of DEMEs (= 0.10; OECD, 2012)
γ_k	0.650	Match Mexico distribution of capital stock across firms Busso, Fazio, and Levy (2012) for Mexico.
b^*	0.673	Match Mexico (steady-state) foreign debt-to-GDP ratio (= 0.30; Aguiar and Gopinath, 2007)
M_l	0.076	Match $n_l = 0.40$ in Mexico (statistical agencies)
M_s	0.448	Match $n_s = 0.48$ in Mexico (statistical agencies)
M_k	0.027	Match $o_s = 0.07$ in Mexico (statistical agencies)
ψ_l	0.034	Vacancy cost is 3.5 percent of sectoral wages (Levy, 2007)
ψ_s	0.011	Vacancy cost is 3.5 percent of sectoral wages (Levy, 2007)
ψ_k	0.320	Capital-search cost equals 3 months of sectoral wages (McKenzie and Woodruff, 2008)
γ_a	0.341	Match $(p_l \cdot y_l)/y$=0.55 in Mexico (Busso, Fazio, and Levy, 2012 , and Enterprise Surveys)
η_b	0.010	Stationary debt holdings without affecting aggregate dynamics (Schmitt-Grohé and Uribe, 2003)
φ_k	32.140	Match investment volatility relative to output in Mexico (1993:Q1-2007:Q4)
σ_z	0.017	Match output volatility in Mexico (1993:Q1-2007:Q4)
ϱ_η	0.900	Persistence of output in Mexico (1993:Q1-2007:Q4)
σ_η	0.028	Cyclical correlation between output and wages in Mexico (1993:Q1-2007:Q4)

Given the large number of state variables, global solution methods become highly intractable. Therefore, we log-linearize the model around the non-stochastic steady state and use a first-order approximation to the equilibrium conditions. The model is simulated for 2100 periods. The first 100 periods are discarded, and an HP filter with smoothing parameter 1600 is applied to the remaining series.

3.2 Business Cycle Moments

Business cycle fluctuations in the benchmark model are driven by productivity and borrowing capacity (financial) shocks, only. Table 5 shows business cycle statistics for Mexico ("Data") and compares them to results from our benchmark economy ("Model"). The model performs well in quantitatively capturing the cyclical properties of the data on all fronts, except the volatility of unemployment. Of note, the benchmark model: successfully generates standard deviations of consumption and wages higher than the standard deviation of output, which is a well-known feature of DEMEs (Boz, Durdu, and Li, 2015); generates a countercylical trade balance-output ratio;[23] generates a factual autocorrelation of unemployment. and generates factual correlations with output of both large- and small-firm employment.[24]

The limited ability to generate overall high unemployment volatility is a well-known and well-documented reflection of the "Shimer puzzle" (Shimer, 2005). Addressing this common limitation of search models lies outside the scope of our work as we are interested in *differences in unemployment volatility* across different financial development equilibria. As such, not being able to exactly match the volatility of unemployment is of entirely second order for our purposes.

[23] Removing the wage bill from firms' collateral constraints improves the countercyclicality of the trade balance-output ratio, but reduces the volatility of wages somewhat. However, it is still the case that both wages and consumption remain more volatile relative to output, as in the data. Results available upon request.

[24] The majority of formal salaried workers are in large firms and the majority of informal workers are in small firms (Busso, Fazio, and Levy, 2012). This explains why, given our mapping between the data and the model, small firm employment is countercyclical (for empirical evidence, see Bosch and Maloney, 2008; Fernández and Meza, 2015). Within the context of our model with formal financing, this mapping is an approximation as many small firms (which are generally informal) may not have *full* access to formal financing, though this fact is reflected in the collateral constraint (adjusted for the level of capital) for small firms. The mapping we use is not problematic since a share of small firms do indeed have access to formal financing (World Bank Enterprise Surveys). As shown in Table 5, it is worth highlighting that the model is consistent with specific second moments of the labor market that we do not target, which adds considerable validity to our framework.

Table 5: Business Cycle Statistics, Data vs. Model

A. Targeted moments				
Statistic	σ_{y_t}	$\sigma_{i,t}$	$\rho(y_t, y_{t-1})$	$\rho(w_t, y_t)$
Data	2.390	6.644	0.750	0.560
Model	2.390	6.644	0.745	0.566

B. Non-targeted moments								
Statistic	$\sigma_{c,t}$	$\sigma_{w,t}$	$\sigma_{\mathbf{u}_t}$	$\rho(n_{l,t}, y_t)$	$\rho(n_{s,t}, y_t)$	$\rho(\mathbf{u}_t, y_t)$	$\rho(\mathbf{u}_t, \mathbf{u}_{t-1})$	$\rho(tb_t/y_t, y_t)$
Data	3.011	4.701	20.66	0.740	−0.470	−0.780	0.840	−0.750
Model	2.814	3.441	0.764	0.645	−0.168	−0.549	0.874	−0.333

Notes: σ_x refers to the standard deviation of variable x. $\rho(x, y)$ refers to the correlation of x with y. All second moments for the model are obtained using filtered series to make them comparable to the data. The empirical moments for large-firm and small-firm employment are based on data from Mexico's employment survey (ENEU). The empirical volatility of consumption and wages, the cyclicality of unemployment, and the persistence of output and unemployment are from Boz, Durdu, and Li (2015).

3.3 Financial Development

In order to study the link between financial development and unemployment volatility, we focus on three parameters: $\bar{\eta}_l$ (the large firm's steady-state borrowing capacity); $\bar{\eta}_s$ (the small firm's steady-state borrowing capacity); and γ_k (which determines the relative importance of matched capital obtained via input credit in the production function of small firms).[25] Recall that a higher γ_k implies that, all else equal, small-firm production is more intensive in input credit; that is, small firms rely relatively more on informal external finance.[26]

Figure 3 plots the economy's steady-state bank credit-GDP ratio and unemployment volatility for different combinations of $\bar{\eta}_l$ and γ_k (top two panels) and of $\bar{\eta}_s$ and γ_k (bottom two panels), respectively.[27] In each graph the benchmark calibration point is highlighted

[25] See Dabla-Norris et al. (2015) for a related approach that studies financial development.

[26] Of note, as part of our robustness analysis below, we show that having differences in borrowing capacity between large and small firms (that is $\bar{\eta}_l \neq \bar{\eta}_s$ as opposed to $\bar{\eta}_l = \bar{\eta}_s = \bar{\eta}$), *which reflect small firms' more constrained status relative to large firms as in the data*, is important for quantitatively explaining the link between financial development and unemployment volatility.

[27] For consistency with Table 5, Figure 3 is generated using simulated data at quarterly frequency. We

with a white dot. Note that, all else equal, a higher borrowing capacity among large or small firms ($\bar{\eta}_l$ or $\bar{\eta}_s$) is associated with a higher steady-state bank credit-GDP ratio. In contrast, all else equal a higher share of input-credit-capital in production (γ_k) is associated with a lower steady-state bank credit-GDP ratio.

Note from Figure 3 that the parameter combinations for $\bar{\eta}_l$, $\bar{\eta}_s$, γ_k generate the range of steady-state bank credit-GDP ratio that matches the empirical range of this variable as shown in Figure 1.

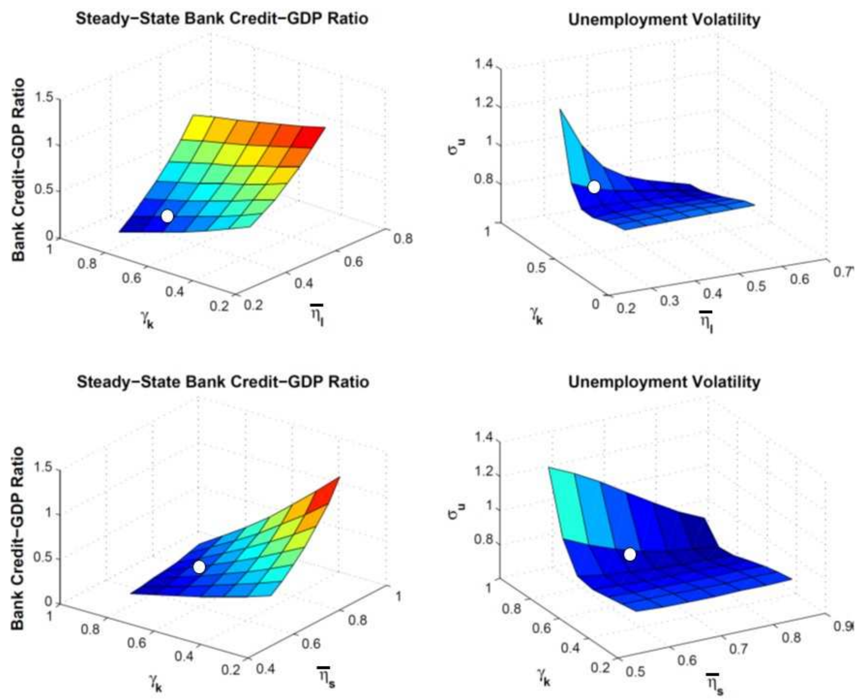

Figure 3: Impact of changes in key parameter values on the steady-state bank credit-GDP ratio and unemployment volatility (benchmark model).

Also, per Figure 3 unemployment volatility is decreasing under, all else equal, higher $\bar{\eta}_l$ and, all else equal, higher $\bar{\eta}_s$, but only at high values of γ_k (i.e., when interfirm input credit is a relatively important component among small firms, as is the case in DEMEs). For low values of γ_k, improvements in firms' borrowing capacity have virtually no impact

note that the main results are qualitatively identical if we consider simulations at a yearly frequency.

on unemployment volatility, as is the case in AEs. So, unemployment volatility is always rising in γ_k, but the rate at which unemployment volatility is decreasing in $\bar{\eta}_l$ and $\bar{\eta}_s$ is decreasing in γ_k. Similarly, from the perspective of financial development reflected in firms' domestic external financing structure, unemployment volatility is rising in γ_k (which itself is negatively correlated with the steady-state bank credit-GDP ratio), but only for low levels of firms' borrowing capacity $\bar{\eta}_l$ and $\bar{\eta}_s$.

Keeping Figure 3 in mind, recall from the facts in the Introduction that, all else equal, there exists a markedly negative and statistically significant relationship between unemployment volatility and financial development in DEMEs, and a slightly positive though statistically insignificant relationship between financial development and unemployment volatility in AEs (even after controlling for other potential factors that may influence the volatility of unemployment). Furthermore, recall that interfirm input credit is a key characteristic of small firms' external financing structure in DEMEs but plays a less significant role in AEs, where firms rely relatively more on more formal sources of external financing.

All told, we conclude that the model can successfully generate both the factual negative relationship between domestic financial development and unemployment volatility in DEMEs and also the factual disconnect between domestic financial development and unemployment volatility in AEs documented in Figure 1. In doing so, the model suggests that the statistically significant negative correlation between unemployment volatility and financial development observed in DEMEs can be traced back to increases in firms' borrowing capacity occurring amid a high degree of input-credit relevance in production. In contrast, the statistically insignificant relationship between unemployment volatility and financial development observed in AEs can be traced back to increases in firms' borrowing capacity occurring amid a low degree of input-credit relevance in production.

Of course, taken together these results suggest that an endogenous negative relationship between financial development and input-credit relevance in production (or, more broadly, firms' external-financing structure) may exist, which is intuitive. However, as noted earlier, we have purposefully taken an agnostic modeling approach to pinpoint in a disciplined and transparent way the key features of an economy's domestic firm-external-financing structure that can rationalize the stylized facts observed in the empirical data.

3.4 Economic Mechanisms

Figure 4 sheds light on the driving forces behind our main results. This figure shows: the volatility of large-firm and small-firm employment and wages (top 4 panels); the volatility of the share of large-firm capital devoted as input credit to small firms, ω (bottom left panel); and the volatility of unemployment (bottom right panel). (Similar patterns are observed for all of these variables when we change $\bar{\eta}_l$ and γ_k the interpretation for which is entirely akin to that stated further below—recall that changes in $\bar{\eta}_l$ and $\bar{\eta}_s$ have the same qualitative impact on unemployment volatility; so, without loss of generality we focus on financial development equilibria based on changes in $\bar{\eta}_s$ and γ_k.) The volatility of all variables depicted in Figure 4 is: decreasing in γ_k; and decreasing in $\bar{\eta}_l$ only at relatively high values of γ_k.

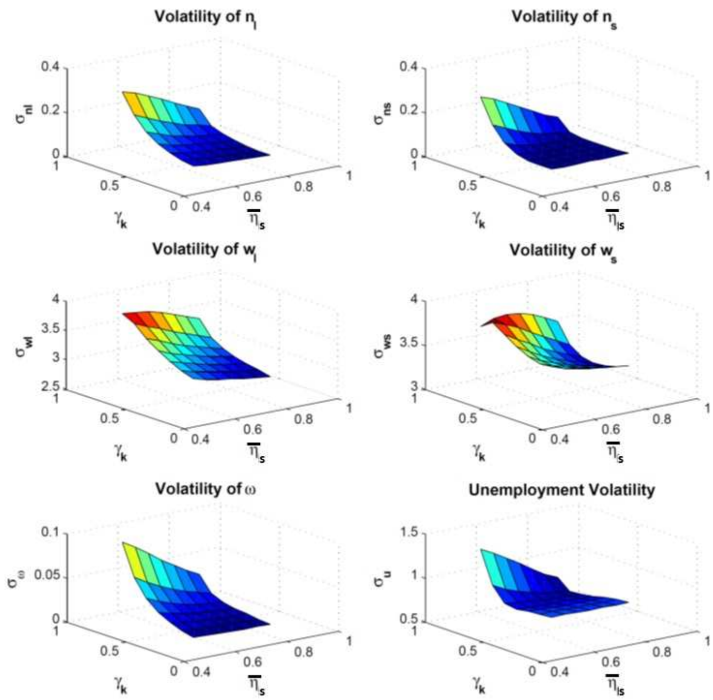

Figure 4: Impact of changes in key parameter values on: sectoral employment volatility; sectoral wage volatility; fraction of large-firm capital devoted to input-credit volatility; unemployment volatility (benchmark model).

To understand the results shown in Figure 4, note that an improvement in small firms' borrowing capacity $\bar{\eta}_s$ amid productivity and financial shocks boosts the accumulation of capital. This higher capital stock, all else equal, makes firms more resilient to credit disruptions, in turn making vacancy postings less volatile for a given set of shocks. Therefore, small-firm employment becomes more stable. Critically, this greater employment stability also stabilizes the demand for input credit, which leads to a fall in the volatility of ω. All else equal, this fall in the volatility of ω stabilizes large firms' profits and vacancy postings and, as a result, large-firm employment as well. So, both large-firm and small-firm employment, and ultimately aggregate unemployment, become less volatile amid financial development. This mechanism is always at play, regardless of the degree of input credit in an economy (as captured by γ_k). However, the greater the degree of input credit in an economy, the greater the explicit linkages between large and small firms. Therefore, input credit is the key amplification channel by which financial development can lead to lower unemployment volatility.

Importantly, note that a reduction in unemployment volatility tied to financial development is not due to an increase in sectoral (and aggregate) real-wage volatility. In fact, as shown in Figure 4, both wage and unemployment volatility fall as a result of financial development. This result consistent with the evidence in Boz, Durdu, and Li (2015), who document that advanced economies have, on average, lower real wage volatility relative to emerging economies.

In sum, our results suggest that both financial development as reflected in a higher aggregate bank credit share and firms' domestic external financing structure—especially as it relates to the degree of dependency on interfirm input-credit relationships among small firms—are critical to shed light on the link between domestic financial development and unemployment volatility.

3.5 Nested Models and Robustness Analysis

In what follows, we present evidence that supports our framework and assumptions on heterogeneity across firm categories in their financial structure and borrowing capacity by showing that simpler models either underperform in matching important facts compared to our benchmark specification or fail to replicate the empirical relationship between financial development and unemployment volatility. In particular, we consider (1) a version of our model with the same borrowing capacity parameter across firm categories (that is, $\bar{\eta}_l = \bar{\eta}_s = \bar{\eta}$) ("Model $\bar{\eta}_l = \bar{\eta}_s = \bar{\eta}$"); (2) a version of our model without input credit linkages (i.e., $\omega = 1$ for all t) and therefore no small firm owners o_s ("No ω and No o_s") (without loss of generality, we show the results under a change in $\bar{\eta}_s$ for nested model (2), but the same results hold under a change in $\bar{\eta}_l$); and (3) a standard one-sector model with collateral constraints ("One Sector Model").[28] All of these models are nested within our benchmark framework.

First, Table 6 compares business cycle moments across models to our benchmark model. Second, Figures 5 and 6 plot equilibrium bank credit-GDP ratio and unemployment volatility for different $\bar{\eta}_l$, $\bar{\eta}_s$, and γ_k, $\bar{\eta}$ ($= \bar{\eta}_l = \bar{\eta}_s$) and γ_k, or $\bar{\eta}$, depending on whether nested model (1), (2), or (3), respectively, is under consideration. For reference, the top panel of Figure 5 plots outcomes for the benchmark model.

Table 6: Business Cycle Statistics, Data vs. Benchmark Model and Nested Models

	A. Targeted moments			
Statistic	σ_{y_t}	$\sigma_{i,t}$	$\rho(y_t, y_{t-1})$	$\rho(w_t, y_t)$
Data	2.390	6.644	0.750	0.560
Model	2.390	6.644	0.745	0.566

	B. Non-targeted moments							
Statistic	$\sigma_{c,t}$	$\sigma_{w,t}$	$\sigma_{\mathbf{u}_t}$	$\rho(n_{l,t}, y_t)$	$\rho(n_{s,t}, y_t)$	$\rho(\mathbf{u}_t, y_t)$	$\rho(\mathbf{u}_t, \mathbf{u}_{t-1})$	$\rho(tb_t/y_t, y_t)$
Data	3.011	4.701	20.66	0.740	−0.470	−0.780	0.840	−0.750
Benchmark Model	2.814	3.441	0.764	0.645	−0.168	−0.549	0.874	−0.333
Model $\bar{\eta}_l = \bar{\eta}_s = \bar{\eta}$	3.045	3.667	0.912	0.632	−0.287	−0.512	0.838	−0.263
No ω and No o_s	1.768	3.868	1.196	0.426	0.025	−0.132	0.486	0.658
One Sector Model	1.768	3.911	0.748	0.664	–	−0.446	0.835	0.671

Notes: σ_x refers to the standard deviation of variable x. $\rho(x, y)$ refers to the correlation of x with y. All second moments for the model are obtained using filtered series to make them comparable to the data. The empirical moments for large-firm and small-firm employment are based on data from Mexico's employment survey (ENEU). The empirical volatility of consumption and wages, the cyclicality of unemployment, and the persistence of output and unemployment are from Boz, Durdu, and Li (2015).

[28] Nested model (2) is a simple two-sector model where the only differences between "small" and "large" firms are differences in exogenous sectoral productivity and steady-state borrowing capacity. Both firm categories have the same production technology (with internally-accumulated capital and labor as inputs).

Per Table 6, the model under identical borrowing capacity parameters across firm categories does well in replicating key second moments but, importantly, as shown in the bottom panel of Figure 5, this model cannot generate the relationships between financial development and unemployment volatility observed in the data. In fact, counter to the data, unemployment volatility is actually rising in borrowing capacity regardless of the level of γ_k.

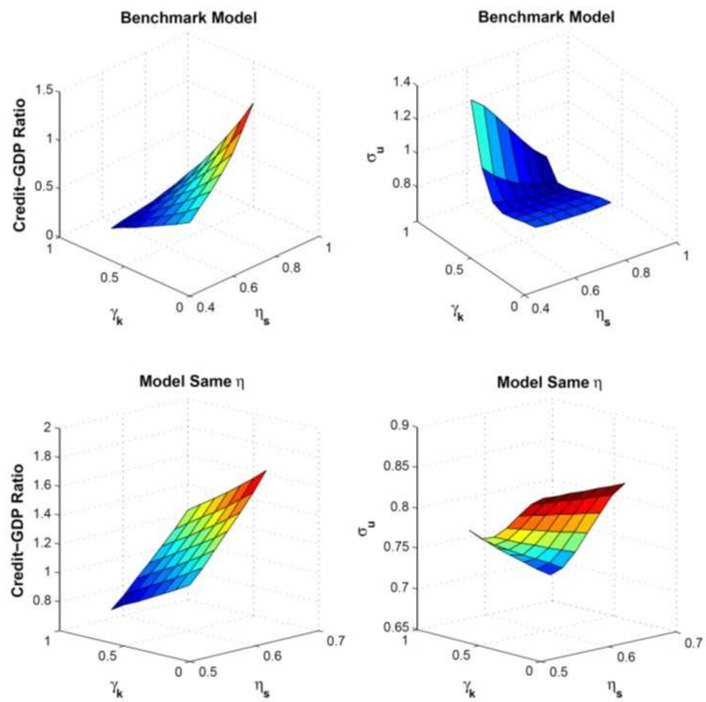

Figure 5: Impact of changes in key parameter values on the steady-state bank credit-GDP ratio and unemployment volatility (benchmark model and alternative model with common borrowing capacity).

This counterfactual result is also observed in Figure 6 resulting from the one-sector model and the model that abstracts from input credit. As shown in Table 6, these models also perform worse in matching key second moments for Mexico compared to the benchmark model. (*Note that Figure 6 presents results in 2 dimensions only since the models presented in this figure abstract from input credit, and therefore from the parameter* γ_k).

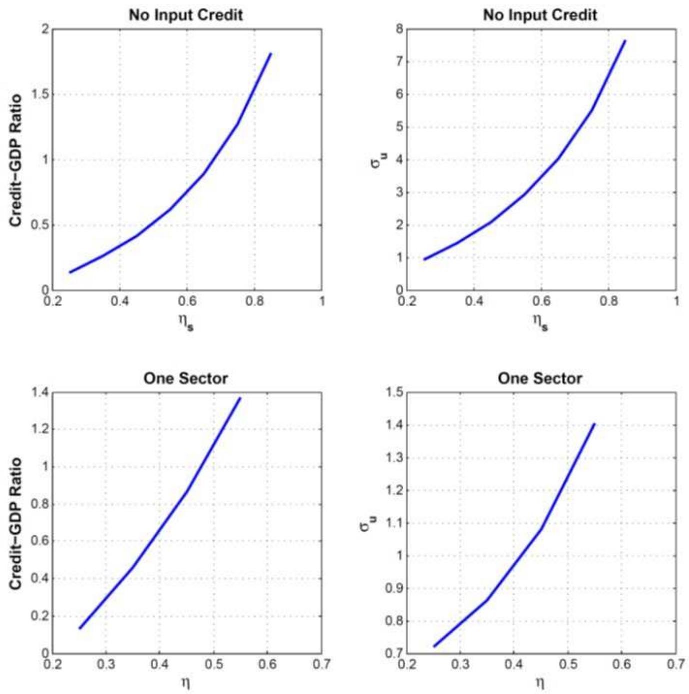

Figure 6: Impact of changes in key parameter values on the steady-state bank credit-GDP ratio and unemployment volatility (no-input-credit and one-sector models).

Taken together, these results stress the importance of heterogeneity in domestic external financing structure and borrowing capacity in order to successfully replicate the cross-country patterns in the data, as is the case with the benchmark model.

Table A4 in the Appendix presents additional results that compare business cycle moments from the benchmark model under the baseline calibration to: (1) the benchmark model with productivity and foreign interest rate shocks but no borrowing capacity (financial) shocks; (2) the benchmark model with only productivity shocks; (3) the benchmark model with linear vacancy posting costs; (4) the benchmark model where input credit can be pledged as collateral as well;[29] and (5) the benchmark model with costly financial inter-

[29] Campello and Larrain (2014) document how a number of countries implemented reforms that expanded the set of assets acceptable as collateral. This set included movable assets. Love, Martínez Pería, and Singh (2013) document that a number of countries have improved collateral registries, which facilitates the use of movable assets for collateral and relaxes the constraints imposed by existing collateral requirements.

mediation that gives rise to lending-deposit spreads as in Cúrdia and Woodford (2010) (see the Appendix for more details). All of these model variants are able to match key second moments for Mexico.[30] These alternative specifications of the benchmark model also generate the factual changes in unemployment volatility under financial development, *except for the models where business cycles are driven by TFP shocks only or by TFP shocks and foreign interest rate shocks* (see Figures A1 through A4 in the Appendix). Therefore, these results suggest that in order to match the facts regarding unemployment volatility, the presence of domestic financial shocks plays an important role when financial development is driven by improvements in bank borrowing.

4 Conclusions

Using a sample of advanced economies (AEs) and developing and emerging economies (DEMEs), we document a novel and robust significant negative relationship between improvements in bank credit-GDP ratios—which is a defining characteristic of domestic financial development—and unemployment volatility in DEMEs, but not in AEs. In order to better understand the potential linkages between financial development and labor-market dynamics, we develop a business cycle search model with firm heterogeneity, external financing structure, and sectoral collateral constraints.

Analysis of the model shows that an improvement in firms' borrowing capacity boosts the accumulation of capital, which makes firms more resilient to credit disruptions and

[30] However, while financial shocks help in generating a relative volatility of wages greater than 1, standard foreign interest rate shocks cannot. This stands in contrast with Boz, Durdu, and Li (2015) and is a consequence of our two-sector structure and the presence of financial frictions.

stabilizes the demand for input credit. These dynamics make vacancy postings, and therefore, unemployment, less volatile for any given set of shocks. The quantitative magnitude of this mechanism is increasing in the degree of input credit in an economy. Therefore, input credit represents a key amplification channel by which financial development can lead to lower unemployment volatility. In fact, for a sufficiently low degree of input credit the relationship between financial development and unemployment volatility is for all purposes mute.

Input credit is, empirically, a much more important characteristic of firm structure in DEMEs compared to AEs. Therefore, the model suggests that the lack of a statistically significant relationship between financial development and unemployment volatility in AEs owes to the fact that in these economies input credit is much less prominent than in DEMEs, and the reverse logic applies to DEMEs. This backdrop may have important implications for credit-market stabilization policies across economies that differ in their firms' financing structure. We plan to explore these issues in future work.

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