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SUDDEN STOPS, OUTPUT DROPS, AND CREDIT COLLAPSES

JIHAD C. DAGHER
International Monetary Fund

This paper proposes a tractable sudden stop model to explain the main patterns in firm-level data from a sample of Southeast Asian firms during the Asian crisis. The model incorporates trend shocks and financial frictions, features that have so far been used separately in the literature on emerging markets. A negative shock to trend productivity growth can account, in our model, for the drop in output and its swift recovery together with the sizable and persistent downward adjustment in firms' Tobin's Q and debt levels. These patterns are broadly shared by most sudden stop episodes as documented in the literature. Trend shocks can also generate, in our model, strong leverage effects in line with the firm-level data and other observations from the literature.

Keywords: Sudden Stops, Financial Frictions, Trend Shocks, Creditless Recovery, Leverage

1. INTRODUCTION

In recent decades, a number of emerging markets have experienced episodes of sudden stops in international capital flows that were followed by severe economic crises. The far-reaching consequences of these sudden stop episodes have prompted a large body of research that seeks to explain some of the main patterns displayed by economic aggregates during these crises [see, e.g., Caballero and Krishnamurthy (2001); Chari et al. (2005); Mendoza (2010)]. This literature has made significant progress in improving our understanding of the economic mechanisms at play and has highlighted the importance of financial frictions. Nevertheless, the current models of sudden stops remain at odds with some of the patterns in the data from these episodes. Calvo et al. (2006) show that the recovery from these episodes is typically uneven, in that output's swift recovery is coupled with a persistent contraction in credit and investment. This dichotomy poses a challenge for existing models, which typically rely on total factor productivity (TFP) level shocks that create a strong procyclicality between economic aggregates.

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This paper takes a disaggregated approach to the so-called "Phoenix miracle" and examines the recovery from a sudden stop episode using firm-level data on Southeast Asian firms during the Asian crisis.[1] It then proposes a tractable firm-financing model that can account for the main features in the data. This approach allows a straightforward comparison between the model and the data. It also allows us to focus on an important and relatively homogeneous sector of the economy, particularly in regard to access to financing, while making use of reliable data to compute key variables such as Tobin's Q and leverage ratios.

The main findings from firm-level data are as follows. At the onset of the Asian crisis, firms in our data experienced a sizable and persistent collapse in market value, which within two years contracted by more than 60% for the median firm. At the same time, the crisis put firms' debt levels on a downward trend. Five years after the crisis the debt level for the median firm was still falling and was more than 40% below its precrisis level. This significant downward readjustment in firms' market value and debt was coupled with a V-shaped contraction and recovery in output. These overall patterns are broadly shared by most firms in the sample. Quantitatively, however, there is significant heterogeneity in the performance of firms. We find that precrisis leverage is an important predictor of a firm's performance during the crisis.

The model proposed in this paper features firms with access to both debt and equity financing, each of which is subject to frictions. A firm's debt financing is subject to an endogenous limit that is a function of the firm's expected market value in the next period. This collateral constraint is along the lines of the frictions found in the literature on the financial accelerator in macroeconomic models and is similar to the collateral constraint in Mendoza (2010). When this constraint binds, shocks that affect the market value of firms generate an adjustment in firms' debt level. Thus, shocks that affect the market value of firms also have a direct effect on their ability to borrow. Borrowing constraints are a central feature of sudden stop models. Without such frictions, even large movements in the market value of firms in our model will not have a direct impact on the firms' production decisions. The model also features frictions on equity financing by firms in the form of a convex issuance cost à la Jermann and Quadrini (2006, 2012). The convexity of this cost function is consistent with evidence from Altínkílíç and Hansen (2000) that shows that the implied equity issuance costs are increasing and convex in the size of the offering. Note that when the cost of issuance is sufficiently large, the model becomes similar to models with no equity financing, which are common in the macro literature. We nevertheless allow equity issuance because we study patterns from publicly listed firms, and also because this friction allows us to explore explicitly the relation between financial frictions and output drops.

A central feature of our model is the presence of trend shocks. That is, the productivity of firms is subject to shocks to the random walk component implying permanent changes in the level of the aggregate variables. Aguiar and Gopinath (2007) show that emerging market economies, unlike advanced economies, are subject to substantial volatility in trend growth, which can explain the large

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fluctuations in current accounts as well as the high volatility of consumption in these economies.

To understand the main mechanisms of the model, consider a simple example of the effect of an unexpected one-time permanent downward shift in trend productivity on the detrended variables. Even a small unexpected decline in the trend can lead to a substantial drop in the market value of firms because of its persistent effect on the level of expected future dividends. The drop in market value would then translate into tightened borrowing constraints on firms. The shift in trend productivity has, however, no impact on the detrended optimal production level in the new steady state, as we show. Variations in the trend level only affects the long-term growth rate of output. Thus, the combination of trend shocks with endogenous borrowing constraints can create a dichotomy in the long-term response of output on one hand, and that of the market value and the debt level on the other. How does the trend shock affect output in the short run? The answer, as we show, depends on the degree of friction in equity financing. In the absence of such friction, i.e., when the only cost from equity financing is the forgone utility from dividends, firms are able to substitute equity financing for debt financing, leaving their production unaltered. When equity financing is costly, however, the financial squeeze due to the obligation of debt repayment by the firm is likely to generate a temporary drop in the firm's output. This is because firms will face a tradeoff between using equity financing, and selling capital in order to pay down a fraction of their debt. The more costly is equity financing, the more important is the drop in output. The drop in output is only temporary, however, as firms are able to rebuild their capital stock over time.[2] Standard level TFP shocks in this model, and in the canonical sudden stop model, cannot generate this dichotomy because they induce a strong procyclicality in the variables in the model. A permanent TFP shock in the model creates a permanent drop in all the variables in the model, whereas a short-lived shock also generates a short-lived response from the variables.

The paper parameterizes the model to match key features in the data. The permanent trend shock that is fed to the model imitates the persistent decline in growth rates after the Asian crisis in the three countries that we study: Indonesia, Malaysia, and Thailand. The borrowing constraint is set to match the precrisis leverage of firms. We find that the parameterized model generates responses from output, debt, and the market value that are comparable both qualitatively and quantitatively with the data. We compare the impact of trend shocks with that of TFP level shocks in the model to show that the latter cannot generate the dichotomous response that is observed in the data. We also show that, just as in the data, the precrisis leverage of firms is a strong predictor of the performance of firms in our model. This is because when sudden stops are generated by trend shocks, the fall in output is tightly linked to the deleveraging process by firms.

This paper can be classified as an event study [see, e.g., Christiano et al. (2003), Cole and Ohanian (2004)] because it focuses on one particular crisis episode.

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This aspect sets the paper apart from a literature that aims to account for business cycle features in emerging markets [see, e.g., Aguiar and Gopinath (2007), Chang and Fernandez (2010), Garcìa-Cicco et al. (2010), Mendoza (2010), Yue (2010)]. The model in the paper does, however, provide insight that could help explain similar episodes in other countries. A conspicuous novelty in this paper is the combination of trend shocks and financial frictions, features that have so far been found separately in the literature. Aguiar and Gopinath (2007) show the importance of trend shocks in explaining the business cycle in emerging markets. Their model is, however, void of financial frictions. Sudden stop models, on the other hand, although they are rich in financial frictions [see, e.g., Mendoza (2010)], rely on standard shocks to the level of TFP. We show in our model simulation how trend shocks are essential to break the strong procyclicality in the variables of the model and how they are a likely candidate to explain the features in the data.

A second novelty in this paper is the focus on firm-level dynamics in both the empirical and theoretical analysis. The paper makes use of a parsimonious theoretical model that builds on existing firm finance literature [see, e.g., Cooper and Ejarque (2003), Hennessy and Whited (2007), and Jermann and Quadrini (2006, 2012)], which it uses in the context of a sudden stop episode.

The rest of this paper is organized as follows: Section 2 discusses the main empirical findings from the data; Section 3 presents the model, followed by simulations from quantitative exercises, and a discussion; and Section 4 concludes.

2. EMPIRICAL MOTIVATION

Southeast Asian economies enjoyed a long period of high and uninterrupted growth before a financial crisis, which started with the devaluation of the Thai Baht, hit the region during the second half of 1997. Following this devaluation, these economies experienced large losses in their output in 1998, and for some, these losses continued in 1999, before economic activity started a strong recovery in 2000. Aggregate data from Indonesia, Malaysia, and Thailand show that these economies have exhibited to a great extent the main stylized facts of a sudden stop. This motivates the study of this sample in our paper.[3]

The three countries experienced a strong reversal in current account. Following this reversal, real GDP contracted by more than 10% in Indonesia and Thailand, and by around 7% in Malaysia (see Figure 1). Among the three countries, Indonesia's recovery was the slowest; its real GDP recovered to its precrisis level only by the end of 2003. The recovery of the GDP took place without a recovery in credit, as shown in Figure 2. Furthermore, the collapse in the market value of firms below the precrisis levels, as shown in Figure 3, was also very persistent, lasting more than 10 years.[4] Another intriguing feature in the aggregate data is the decline in growth rates following the crisis. Table 1 shows a comparison of average growth rates for the three countries before and after the crisis. For example, whereas Malaysia's real growth rate averaged around 9.5% between

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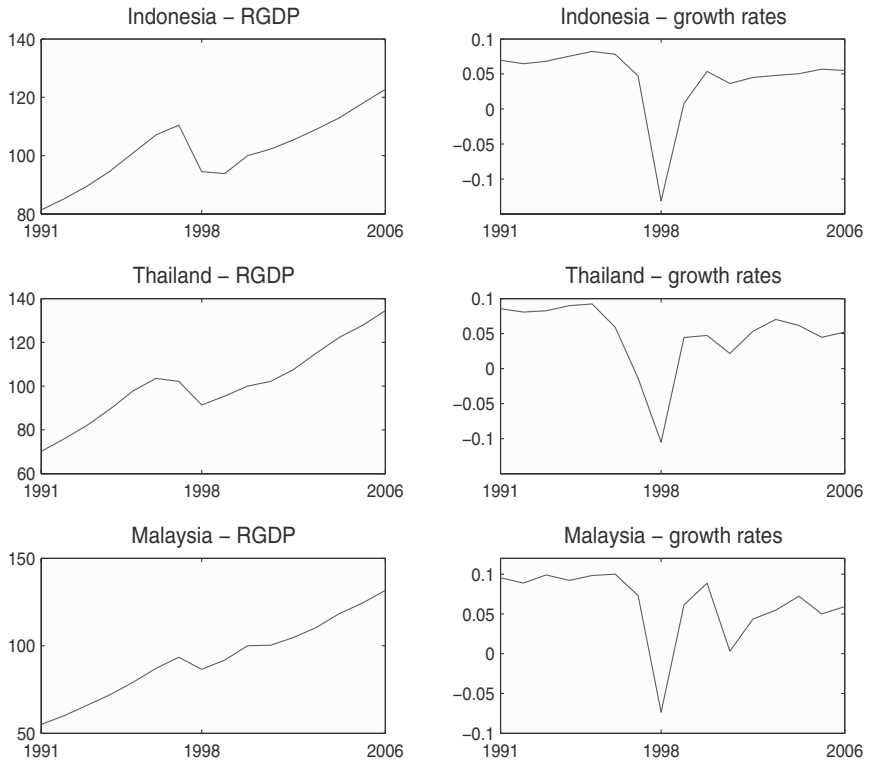


FIGURE 1. Real GDP indices and growth rates. The left-hand panels in this figure plot an index of the real GDP in Indonesia, Malaysia, and Thailand between 1991 and 2006. The right-hand panels plot the growth rates in real GDP during this period. The three countries experienced their largest losses in output in the year 1998. *Data source:* IFS.

1990 and 1996, it fell to an average of 4.2% between 2000 and 2006. The decline is statistically significant, and sizable, and can be observed in Figure 1. This is in line with findings from other empirical studies [see, e.g., Barro (2001) and Cerra and Saxena (2008)] that show a persistent decline in GDP growth rates following financial crises.

2.1. Micro Evidence

2.1.1. Sample selection. The sample consists of 480 nonfinancial firms listed on the stock markets in Indonesia, Malaysia, and Thailand. The focus is on the period 1996–2003, a period that extends from the precrisis year to the year in which output recovered to its precrisis level in all three countries. Because the interest is in understanding the recovery of these firms, only surviving firms are selected, making the sample a balanced panel. This also eases the interpretation of the results (as well as the figures), which become independent of firm entry and

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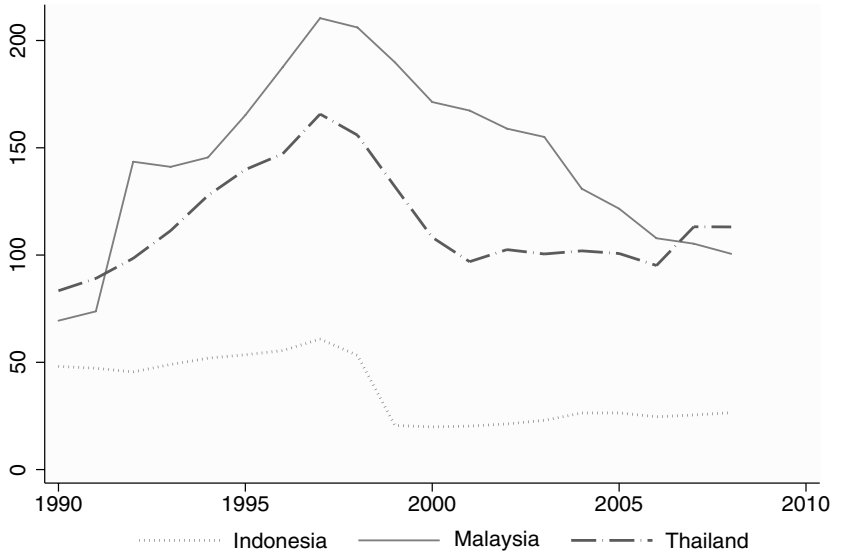


FIGURE 2. The ratio of credit to GDP. *Data source:* World Development Indicators, World Bank.

exit.[5] The data are obtained from Worldscope (Thomson Financial) and include information on firms' balance sheets, income statements, and flow of funds, as well as other information. Only companies for which the main balance sheet items are available are included. In particular, the main inclusion criterion is the availability of data on sales, assets, liabilities and market value. Of the 480 firms in the sample,

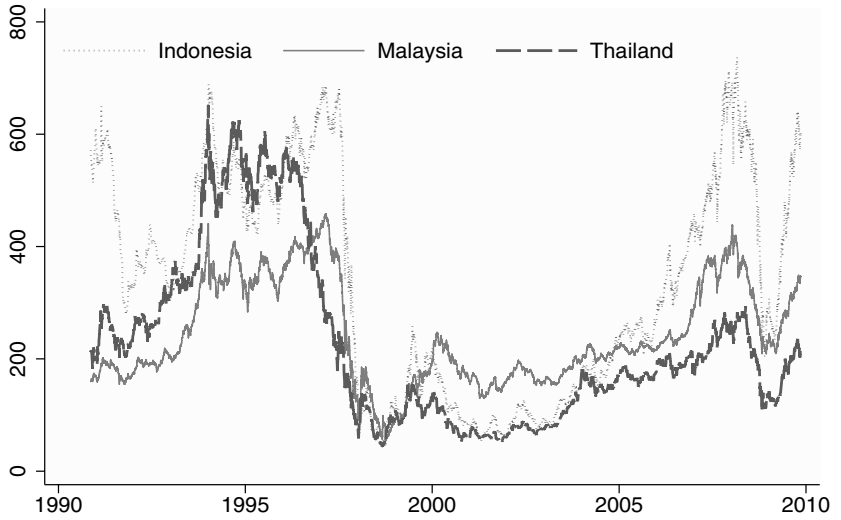


FIGURE 3. MSCI market indices. *Data source:* MSCI Global Equity Indices.

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TABLE 1. Average growth rates before and after the crisis

	Indonesia	Malaysia	Thailand
Annual: 1985–1996	0.068	0.084	0.092
Standard errors	*0.009*	*0.027*	*0.023*
Annual: 1990–1996	0.072	0.095	0.086
Standard errors	*0.006*	*0.004*	*0.015*
Annual: 2000–2006	0.049	0.055	0.051
Standard errors	*0.0067*	*0.025*	*0.015*
Annual: 2000–2008	0.052	0.055	0.048
Standard errors	*0.008*	*0.022*	*0.015*

Notes: The data are taken from the IFS. The table shows the simple average of growth rates before and after the crisis. The standard errors are shown in italic. A *t*-test rejects the equality of the means between the two samples.

102 firms are listed in Indonesia, 220 are listed in Malaysia, and 158 are listed in Thailand.

2.1.2. The collapse in credit and asset prices. Figure 4 shows the average and median cumulative growth rates of the main variables of interest in the sample over the sudden stop episode. The upper left panel shows the growth rate in firms' sales. We can see that sales dropped by around 7% in the first year of the crisis, in 1998. Average sales also declined in 1999 and started a strong recovery as of 2000. The average firm recovered its precrisis sales by 2001. The recovery was slower for the median firm; nevertheless, the median firm did recover its precrisis sales as of 2003. This difference between the mean and the median is driven by the underlying heterogeneity in the data. The upper right panel shows the growth rates of firms' debt levels. In both the median and the mean, we see a continued collapse in debt levels, which is, however substantially more severe for the median firm. Whereas in the first year debt declined by around 20%, it continued declining and had contracted by more than 40% by 2003 for the median firm (always in comparison with the 1997 level). Indeed, even by 2003, the debt levels of firms showed no signs of recovery. The market value of firms is shown in the lower left panel. We find that it collapsed fast, both in mean and in median, to a level that is more than 50% below the precrisis level.[6] Despite a small rebound, which ended in being only temporary, as of 2003, the market value of firms was between 50% and 60% below its precrisis level. The last graph in the lower right panel shows the growth of investment, which collapsed both in mean and median and was relatively stable at around 60% below its 1997 level.

2.1.3. The leverage effect. These patterns of collapse and creditless recovery are quite uniform across firms of different characteristics. The magnitude of the impact of the crisis, however, varies substantially across firms. We find that a firm's leverage, among other factors, is an important predictor of its performance. This

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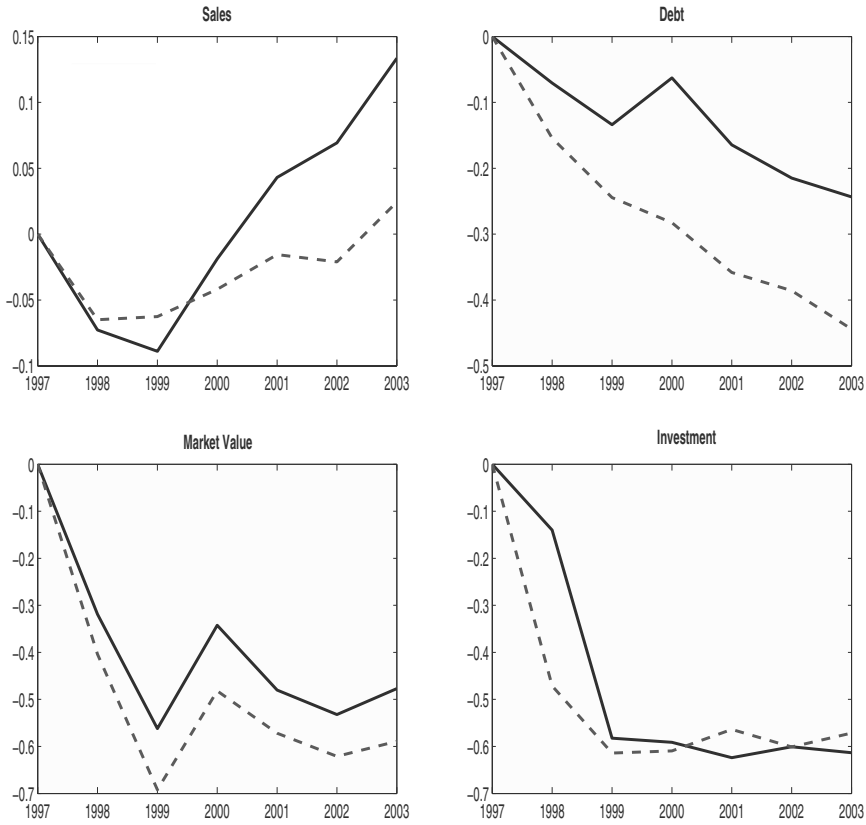


FIGURE 4. Mean (—) and median (- - -) growth in sales, debt, market value, and investment. Except for *Value,* which is a beginning-of-year index because it precedes the drop in other variables, other indices are end-of-year values. *Data source:* Worldscope, Thomson Financial.

is illustrated in Figure 5, which compares the performance of firms with different precrisis leverage during the crisis. The two left panels of Figure 5 compare the performance of firms with leverage below 0.2 (below the 10th percentile) to that of the average firm in the sample (average leverage in the sample is 0.52). Although the market value collapse is also strong in that sample, the fluctuations in their output do not necessarily suggest an economic crisis. This pattern is not very surprising and has been emphasized in earlier studies [see, e.g., Claessens et al. (2000) and Mitton (2002)]. What is particularly interesting, and will give credence to the modeling strategy in Section 3, is the fact that firms with the lowest leverage ratios experienced little to no setback to their sales, despite the fall in their market value. Further evidence, which this paper argues could be brought to support the central role of firm leverage in determining performance, comes from data in Paulson and Townsend (2005). These data cover rural and semirural family

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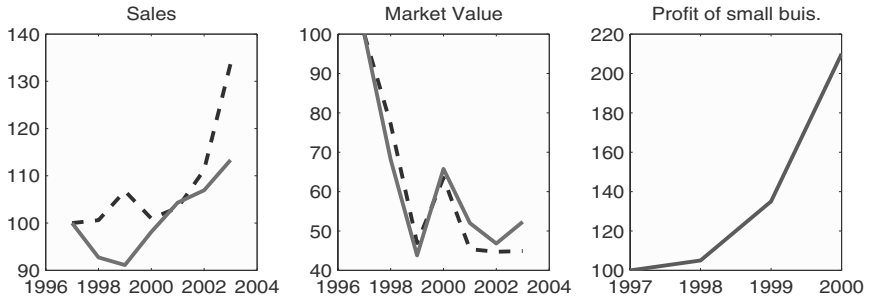


FIGURE 5. The impact of the crisis on low-leverage firms. The left and center panels contrast the performance of low-leverage firms (dashed line), defined as firms with a leverage below the tenth percentile, which corresponds to 0.2, and that of the average firm in the sample. The panel on the right shows the median profits for household businesses in Thailand during the crisis [see Paulson and Townsend (2005) for a more detailed description of the sample].

businesses in Thailand. Paulson and Townsend (2005) found that these small businesses in Thailand did not experience any significant decrease in their income and profit levels. The right panel in Figure 5 shows that the incomes of these small businesses were relatively resilient to the financial crisis. These small businesses are, indeed, very different from the firms studied in this paper. Nevertheless, one of their important characteristics, the fact that they carried virtually zero debt because of severe financial constraints, makes them relevant to our later discussion on the leverage effect.

2.1.4. Regressions. To further explore the precrisis characteristics of firms that predicted the performance during the crisis, and in particular the role of precrisis leverage, we estimate simple ordinary least squares regressions. Two measures of performance are used as endogenous variables: the change in sales and the change in the market value of a firm between peak (end of 1996) and trough (end of 1998).

The results from these regressions are shown in Table 2. The explanatory variables are from the end of 1996 and they are listed in the table. The first and second columns show regressions where the dependent variable is the change in log sales and the change in log market value, respectively, between the end of 1996 and the end of 1998. The results suggest that larger firms, exporters, and lower leverage firms had better performance during the crisis by both measures. The exporter effect is well documented and understood in the empirical and theoretical literature and is mainly due to the large devaluations associated with the Asian crisis and other sudden stops and financial crises. Unsurprisingly, firms that were more likely to be profitable at the end of 1996 (based on our profitability measure) performed better in terms of sales, and firms that had a higher investment ratio also did significantly better in terms of sales. The change in the market value is

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TABLE 2. Determinants of firms' performance during the crisis

	(All) Δ Sales	(All) Δ Value	(NT) Δ Sales	(NT) Δ Value	(T) Δ Sales	(T) Δ Value
Size	0.0468**	0.0760**	0.0697***	0.113***	0.0483**	0.0183
	(2.15)	(2.46)	(3.06)	(2.90)	(2.49)	(0.48)
Export	0.193***	0.222**			0.129**	0.102
	(2.93)	(2.38)			(2.18)	(0.89)
Leverage	−0.309*	−0.818***	−0.339*	−1.096***	0.110	−0.604*
	(−1.82)	(−3.39)	(−1.90)	(−3.49)	(0.68)	(−1.92)
Profit.	0.583*	0.603	−0.900*	2.192***	−0.767**	0.820
	(1.78)	(1.30)	(−1.94)	(2.68)	(−2.09)	(1.59)
Interest	−0.431	−1.128	−1.510	1.002	−2.389**	−3.956*
	(−0.37)	(−0.69)	(−1.28)	(0.49)	(−1.99)	(−1.72)
Dividends	−0.109	0.0179	−0.0543	0.0127	0.0859	0.213
	(−1.13)	(0.13)	(−0.52)	(0.07)	(0.90)	(1.08)
W. Capital	−0.215	−0.172	−0.387**	−0.745**	−0.00257	−0.655*
	(−1.19)	(−0.66)	(−2.18)	(−2.39)	(−0.01)	(−1.94)
Investment	0.659**	−1.002**	0.856**	−1.079*	−0.0400	−0.899
	(2.09)	(−2.26)	(2.59)	(−1.90)	(−0.12)	(−1.45)
Thailand	−0.107	0.254**	0.00795	0.317**	0.00969	0.458***
	(−1.37)	(2.28)	(0.10)	(2.31)	(0.13)	(3.25)
Indonesia	0.0182	0.0470	−0.0406	−0.114	0.205**	0.0639
	(0.17)	(0.31)	(−0.43)	(−0.70)	(2.44)	(0.38)
Indust.	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−0.455*	−1.629***	−0.570*	−2.101***	−0.609**	−1.236**
	(−1.68)	(−4.24)	(−1.97)	(−4.20)	(−2.48)	(−2.57)
R^2	0.186	0.206	0.164	0.208	0.164	0.150

Notes: The sample is formed by merging data from Indonesia, Malaysia, and Thailand after converting all values to the U.S. dollar of 2000. The dependent variables are the changes in log sales and log market value between end 1996 and end 1998. The last four columns exclude the nontradable (NT) sector and the tradable (T) sector, respectively. The table shows the output of simple OLS regressions. The explanatory variables are from end 1996. *Size* is a measure of firms' fixed assets. *Export* is a dummy that takes the value one for exporters. *Leverage* is the ratio of total liabilities to total assets. *Interest* is the ratio of the total interest payments to total liabilities. *Profitability* is the ratio of net income to total assets. *Dividends* is a dummy that takes the value one for firms that paid dividends in 1996. *Investment* is the ratio of investment to total assets at end 1996. The regression also includes a dummy for Thailand, a dummy for Indonesia and dummies based on the SIC codes to capture the industry effects. *t* statistics in parentheses. *Data source:* Worldscope, Thomson Financial.
$^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

negatively correlated with investment, on the other hand, suggesting that expectations from these investments were higher in the precrisis period than following the crisis. Similar regressions are separately run in the tradable and nontradable firms' subsamples and shown in columns (3)–(6) in Table 2. We find a more important leverage effect in the nontradable sector, where leverage has a negative impact on the change in sales and the market value.

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3. MODEL ECONOMY

This section presents a dynamic model of firm financing in a small open economy. It first describes the general environment, next discusses the financial frictions in the model, and then shows simulations from an event shock characterized by a decline in the productivity trend.

3.1. General Environment

The economy is populated by a continuum of identical firms indexed by j, where $j \in [0, 1]$. Firms decide on production and financing plans to maximize the lifetime value of dividends,

$$V_{j,t} = E_t \sum_{k=t}^{\infty} \beta^{k-t} d_{j,k}. \tag{1}$$

Entrepreneurs discount time at a rate $\beta < 1$. We henceforth focus our analysis on a representative firm, dropping the index j, for simplicity. Firms are endowed with a decreasing-returns-to-scale production technology,

$$y_t = a_t k_t^{\alpha} \Gamma_t^{1-\alpha}, \tag{2}$$

where $\alpha \in (0, 1)$.[7] The parameter Γ_t represents the stochastic trend in the economy, which is the cumulative product of growth shocks. In particular, $\Gamma_t = \prod_{j=1}^{t} g_j$. The growth factor g is stochastic and follows a first-order Markov process with transition probability $\Lambda(g, g')$ with a mean $\overline{g}$. We assume that this growth factor takes values that are greater than 1, making the economy experience unbounded growth with fluctuations around a stochastic trend.

3.2. Firm Financing and Frictions

At the beginning of each period t, firms start with a level k_t of capital and b_t of debt accumulated from the previous period. After observing the aggregate productivity level Γ_t, and after discovering its new technology level $a_{j,t}$, each firm decides on its investment, borrowing, and dividend payments. The budget constraint of a representative firm is given by

$$f(k_t, a_t, \Gamma_t) + (1 - \delta)k_t - k_{t+1} - b_t + \frac{b_{t+1}}{1 + r} = \varphi(d_t), \tag{3}$$

where d_t is the net equity payout of the firm, and $\varphi(d_t)$ is the cost associated with this payout. In particular, we assume that the actual cost for the firm is given by

$$\varphi(d_t) = \begin{cases} d_t + \frac{\kappa}{\Gamma_{t-1}}(d_t - \Gamma_{t-1}\overline{d})^2 & d_t \leq \Gamma_{t-1}\overline{d} \\ d_t & d_t \geq \Gamma_{t-1}\overline{d}. \end{cases}$$

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Because d_t is allowed to be negative, firms are allowed to raise funds through equity issuance. This function formalizes the frictions on equity financing in a way similar to that of Jermann and Quadrini (2006, 2011). Implicitly, this function can capture not only the cost of issuing equity but also the nonmonetary cost of a dividend payout that is below the long-run payout target.[8] Unlike Jermann and Quadrini (2006, 2011), we assume that this cost function is asymmetrical. We do so motivated by the fact that the total cost partly reflects direct issuance costs, and by the premise that managers are significantly more reluctant to make payouts below the long-term payout plan than above it [see, e.g., Lintner (1956)]. Using a symmetrical cost function instead would lead to similar results. In fact, the results shown later hinge only on equity financing being costly. Note that a model that does not allow for equity issuance is in essence a special case of the preceding model in which $\kappa \to \infty$. The presence of Γ_{t-1} in the denominator in the equation ensures that the cost remains constant in the steady state.

Firms face endogenous borrowing constraints that limit their borrowing to a fraction of their expected market value in the next period. The borrowing constraint is written as

$$\phi b_{t+1} \leq EV(k_{t+1}, b_{t+1}, a_{t+1}, \Gamma_{t+1}). \tag{4}$$

This constraint imposes standard restrictions on firms' borrowing, limiting it to a fraction of their value. Most theoretical papers that study linkages between the financial sector and the real economy postulate that the availability of collateral imposes a constraint on firm financing. This constraint is also thought to bind harder in less financially developed countries.[9] In this paper, the collateral available for the firm ise its assets evaluated at their expected market value. Hence a decline in a firm's market value will automatically decrease its borrowing capacity. This constraint can be interpreted as the incentive compatibility constraint from a bargaining problem between creditors and firms (see, e.g., Jermann and Quadrini (2006)). Under this interpretation, $1/\phi$ would represent the bargaining power of the creditor. The higher is ϕ, the lower is the degree of enforceability of the debt contract and the tighter is the constraint.

3.3. The Firms' Maximization Problem

The growth in the aggregate level of technology Γ_t implies that the variables in the model are nonstationary. To solve the model, we detrend all the variables by the factor Γ_{t-1}, which is the compounded growth up to $t-1$.[10] We denote by $\hat{x}$ and $\hat{x}'$ the detrended counterparts of x_t and x_{t+1}, respectively. We also denote by $s = (a_t, g_t)$ the state variable of aggregate productivity. We can now write the maximization problem of the firm recursively, with all variables detrended. The firm chooses the equity payout, $\hat{d}$, the new capital level, $\hat{k}'$, and the new debt

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level, $\hat{b}'$, to solve

$$\hat{V}(\hat{k}, \hat{b}, s) = \max_{\hat{k}', \hat{b}', \hat{d}} \{\hat{d} + \beta g E \hat{V}(\hat{k}', \hat{b}', s')\}$$

subject to

$$f(\hat{k}, s) + (1 - \delta)\hat{k} - \hat{b} - \hat{k}'g + \frac{\hat{b}'g}{1 + r} = \hat{\varphi}(\hat{d})$$

$$gE\hat{V}(\hat{k}', \hat{b}', s') \geq \phi g \hat{b}',$$

where

$$\hat{\varphi}(\hat{d}) = \begin{cases} \hat{d} + \kappa(\hat{d} - \overline{d})^2 & \hat{d} \leq \overline{d} \\ \hat{d} & \hat{d} \geq \overline{d}. \end{cases}$$

Taking the firm's interest rate as exogenous, and denoting by μ the Lagrange multiplier associated with the enforcement constraint, the first-order conditions are

$$\hat{\varphi}_{\hat{d}}(\hat{d})(\beta + \mu)E\hat{V}_{\hat{k}}(\hat{k}', \hat{b}', \hat{s}') = 1, \tag{5}$$

$$(\beta + \mu)E\hat{V}_{\hat{b}}(\hat{k}', \hat{b}', s') = \mu\phi - \frac{1}{\hat{\varphi}_{\hat{d}}(\hat{d})(1 + r)}. \tag{6}$$

The detailed derivations are shown in the Appendix. Substituting the envelope condition with respect to $\hat{b}'$ in (6) gives

$$\mu = \frac{\dfrac{1}{\hat{\varphi}_{\hat{d}}(\hat{d})} - \beta(1 + r)E\left[\dfrac{1}{\hat{\varphi}_{\hat{d}}(\hat{d}')}\right]}{(1 + r)\left(\phi + E\left[\dfrac{1}{\hat{\varphi}_{\hat{d}}(\hat{d}')}\right]\right)}. \tag{7}$$

The interpretation of equation (5) is simple. It equates the marginal utility of an increase in dividends with the marginal cost in terms of forgone future dividends due to the resulting decrease in capital. Equation (7) determines the multiplier on the borrowing constraint as a function of the interest rate, the discount factor, the marginal cost of dividends, and the tightness of the constraint, ϕ.

To understand this relation, it is useful to study the special case where $\kappa = 0$. In that case, the cost function on dividends can be written as $\hat{\varphi}(\hat{d}) = \hat{d}$, implying that $\hat{\varphi}_{\hat{d}}(\hat{d}) = 1$ for all $\hat{d}$. Under this assumption, (7) reduces to

$$\mu = \frac{1 - \beta(1 + r)}{(\phi + 1)(1 + r)}, \tag{8}$$

meaning that $\mu > 0$, i.e., the borrowing constraint will be binding at the steady state, if $\beta(1 + r) < 1$, which is a common assumption in the literature that

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ensures a well-defined equilibrium in a small open economy context [see, e.g., Schmitt-Grohe and Uribe (2003)].[11]

3.4. The Model Dynamics

This section studies the dynamics of the model and the features that help us account for the stylized facts from the data. To simplify the exposition, we first explore the model in the steady state, abstracting from any shocks or uncertainty.

PROPOSITION 1. *In a deterministic steady state, the detrended capital level is independent of g.*

Proof. Under these conditions, we know that $\hat{d}_t = \bar{d}$ for all t and therefore (8) holds at all times, and is independent of g. From (5) and the envelope condition we know that $\hat{f}_{\hat{k}}(\hat{k}', s' = s) + (1 - \delta) = \frac{1}{\beta+\mu}$; that is, $\alpha(\frac{k}{g})^{\alpha-1} = \frac{1}{\beta+\mu} - (1 - \delta)$. This implies that $\hat{k}/g$, the detrended capital with the trend at time t, is independent of g. ■

Proposition 1 is important for understanding the mechanism through which trend shocks allows us to break the strong procyclicality that is usually created by shocks to the level of TFP. The proposition implies that the level of detrended capital, and thus output, is independent of the growth rate of the trend in the steady state. Because the detrended output is constant, this means that even permanent changes to the trend would affect the growth rate of output in the new steady state but not its detrended level. Indeed, this finding is intuitive, because trend productivity growth is what drives the growth of output in the model. This is not the case, however, for the market value of a firm, as can be seen from equation (1). For simplicity, let us assume that detrended dividends are constant and independent of the trend growth rate; i.e., $d_t/\Gamma_t = \overline{d}$, in which case we can rewrite equation (1) as

$$\frac{V_t}{\Gamma_t} = \frac{\overline{d}}{1 - \beta g}, \tag{9}$$

which clearly shows that the detrended market value is very sensitive to changes in g, the growth rate, as they determine the discounted value of future dividends.[12] Indeed, although the detrended dividends are not independent of the trend, we will see that this simplified case can capture quite faithfully the reaction of the detrended market value to changes in the trend. Therefore, trend shocks in this model create a dichotomy in the response of the output on one hand, and the market value on the other. Figure 6 illustrates how these two variables are affected by a permanent break in the trend. In the upper left graph we see the break happening at $T = 20$, the period in which trend growth rate switches from 6% to 2%. All graphs in the upper panel show a logarithmic transformation of the variables. The upper middle graph shows how the market value instantaneously adjusts to a lower trend. The detrended market value adjusts permanently into a lower value, as is shown in the lower middle graph. As for output, we know from Proposition 1 that its steady state detrended value is constant. This is clearly

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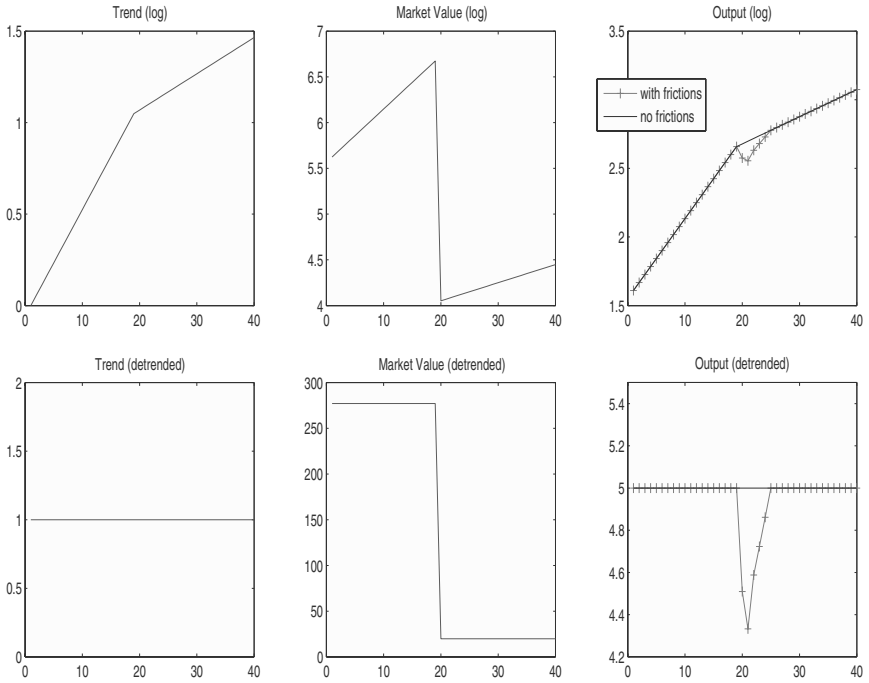


FIGURE 6. Illustration of the impact of a trend shock in the model and the role of frictions in the response of output to the trend shock.

shown in the lower right graph in the figure. The upper and lower graphs on the right differentiate between a scenario with no frictions on equity financing and one with frictions. They illustrate another important mechanism in the model: When equity financing is frictionless, the transition of output adjusts automatically to the new trend. The following proposition formalizes this.

PROPOSITION 2. *In the absence of financial frictions on equity financing, the detrended capital level is constant and independent of g.*

Proof. In the absence of financial frictions $\kappa = 0$ and thus from (7) we have $\mu = \frac{1-\beta(1+r)}{(\phi+1)(1+r)}$. From (5) and the envelope condition we have $\hat{f}_{\hat{k}}(\hat{k}', s') + (1-\delta) = \frac{1}{\beta+\mu}$. Similarly to Proposition 1, this implies that the detrended capital is constant and independent of g. ■

The intuition behind this result is simple. When firms are able to decrease their equity payout at no additional cost (i.e., cost in addition to the foregone utility from decreasing dividends), it is always optimal to smooth capital through the use of equity financing. This is due to the fact that the marginal return on dividends is equal to one when $\kappa = 0$, whereas the marginal return on capital is higher than one at any point below the steady state.[13] Note that a decrease in capital affects not

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only the next period's production but also the market value of the firm, which in turn also has an impact on the firm's ability to borrow. Thus, following a negative shock to the trend, which brings down the market value and forces the firm to decrease its stock of debt, the firm is able to substitute equity financing for debt financing without altering its production decisions.

Although the case with no frictions on equity financing is useful in understanding the dynamics of the model, the more relevant case is the one that takes these frictions into account. In the presence of these frictions, and following a shock to the trend, the firm now faces a tradeoff between equity financing and selling some of its capital in order to "deleverage" and repay some of its debt stock. This choice is determined at the margin, by comparing the relative costs of the two options. When equity financing is costly, the firm will opt to decrease both in a way to equalize the marginal cost. This mechanism thus leads to a short-lived contraction in output that is followed by a recovery to the optimal level of production, even when the market value and the debt levels are still below their precrisis levels. Note that to keep the solution and exposition simple, we abstract from adjustment costs for capital.

3.4.1. Numerical Exercise and Quantitative Properties. The model is parameterized on an annual basis to match the main characteristics of the median firm in the sample in the year 1996. The growth rate is set to 5%, which is the observed growth rate of sales of the median firm in 1996. In this model, and similarly to models that incorporate a stochastic trend in a business cycle model, βg is equivalent to the discount factor in stationary models. Therefore β is set to 0.94, so that $\beta g = 0.98$. The interest rate is set equal to the ratio of interest payments to total debt adjusted for inflation in 1996. For the parameterization of the production function, α is set to 0.71, which is the outcome of the regression of sales on the log of assets. This parameter is relatively stable over time in our sample. Furthermore, a value of 0.7 is standard in models without labor.[14] The borrowing constraint parameter is set to $\phi = 9.85$ in order to match the median of the leverage ratios of firms in 1996 which was around 0.52.[15] Firms' leverage increased significantly in 1997, when the median leverage reached 0.6. This increase is partly due to the devaluation that took place in 1997. Arguably, therefore, the benchmark value does not reflect the liability dollarization in the sample, and a higher value for leverage could be warranted. However, because the higher the leverage, the stronger is the amplification of a negative shock on output, it is better to start with a conservative value and then show simulations for higher and lower leverage values. As for the parameter κ, which determines the financial frictions on equity financing, it does not affect the steady state values, because $\bar{d}$ is set so that $\hat{\varphi}(\hat{d}) = \hat{d}$ in the steady state. Without guidance from the data on κ, it is better to use a conservative value, one that allows firms to use significant equity financing. For this purpose, it is important to note first that κ also determines the lower bound on equity payouts. In particular, $\hat{d}$ cannot be smaller than $\hat{d}^*$, which is the equity payout for which $\hat{\varphi}_{\hat{d}}(\hat{d}) = 0$. It is easy to see that any equity payout smaller than or equal to $\hat{d}^*$ will be counterproductive, leading to an increase in costs by an equal or larger amount

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TABLE 3. Benchmark calibration

Description	Parameter values
Discount factor	$\beta = 0.94$
Growth factor	$\bar{g} = 1.05$
Interest rate	$r = 0.041$
Depreciation rate	$\delta = 0.062$
Share of capital	$\alpha = 0.71$
Borrowing constraint parameter	$\phi = 9.85$
Cost of equities parameter	$\kappa = 0.5$

of the issuance. This lower cutoff point is directly determined by κ. If $\kappa = 0$, then this cutoff point goes to $-\infty$, for which case there are no frictions on the equity payout function. For $\kappa = 0.5$, the benchmark value that will be used here, $\hat{d}^* \approx -1$, which is, in absolute value, slightly larger than the steady state market value of the firm under the chosen parameters. Therefore this conservative value is used at first, while it is noted that $\kappa = 50$ is the value for which $\hat{d}^* = 0$. The parameters from the benchmark calibration are shown in Table 3.

Regarding the growth process g, the numerical exercise consists of choosing the high and low growth factors, g_{H} and g_{L}, respectively, as well as the transition probability between the two. Regarding the levels of the growth factors, what will matter for the results is the magnitude of the fall. The high growth factor is set to 1.05 to match the growth rate observed in the firm-level data in the precrisis year. The new low growth factor is set to 1.03, implying a decline of 2% in the growth rate. This magnitude of the fall is more conservative that the macro data from before and after the crisis would imply (see Table 1 and Figure 1, which show a decline of around 3% on average). Regarding the probabilities of transition between the high and low growth states, it is assumed that the state with low growth rate is an absorbing state. This is done for two main reasons. First, one would like to check the robustness of this model against the precautionary savings argument, and the permanence of the shock only enhances this effect. Second, this is also motivated by the persistent lower growth rates observed in the region after the crisis. The probability of transitioning from the high to the low growth state is set to 1.5%. This probability is hard to gauge from the data, but the accelerating growth in stock market returns and credit before the crisis suggests that this probability must be very low. The closest counterpart for this probability in the literature is the probability of sudden stops that was targeted in the calibration in Mendoza (2010), where it is set to 3.3% to match the frequency in the cross-country data in Calvo et al. (2006). Arguably, given that the crisis under study in East Asia was a first of its kind in the region, a lower frequency is justified in our case.[16]

Response to a negative shock to g. This section studies the impact of a permanent negative shock to the growth rate of the trend. The upper panels of Figure 7

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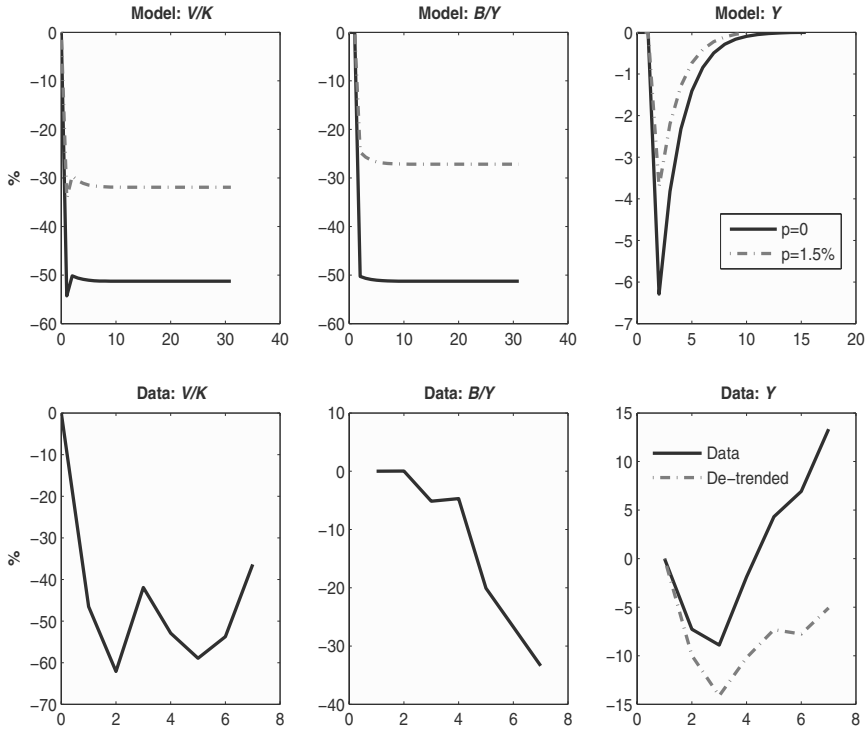


FIGURE 7. The benchmark parameterization. The top panels in the figure show the response of the ratio of the market value to capital, the ratio of debt to output, and the detrended level of output to a trend shock under the benchmark parameterizations while p, the transition probability, is varied. The lower panels show the responses of these variables to the crisis in the firm-level data.

show the response of the variables in the model to the trend shock. whereas the lower panels show median values from the data. The model simulations are shown for two different assumptions on the transition probability between the high state and the low state, 1.5% and 0%.

The results from the model are shown in detrended form, and therefore in comparing the output performance one has to take into consideration that sales in the data are not detrended. For this reason, the figure also includes a graph (a dashed line) of sales detrended by a trend with a growth rate of 3%. The results show that a trend shock does a good job of generating the patterns in the data, even in the context of a simple model. First, qualitatively, the model generated a dichotomy between assets prices and credit on one hand, and output on the other, similar to the one observed in the data. Hence, the creditless recovery is a direct outcome of this model. Quantitatively, a drop of 2% in the growth trend does generate, under the benchmark parameterization, a fall in V/K and B/Y of magnitudes similar to that in the data. When the sudden stop is fully unexpected,

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i.e., the probability of transition from the high-growth state to the low-growth state is zero, the fall in all variables is larger. This is because, when agents internalize the possibility of a sudden stop, the market values of firms adjust downward in the precrisis steady state and fall by less at the news of the new growth state. Note that under the current and similar parameterizations, the borrowing constraint is always binding, even when agents expect a sudden stop with a probability as high as 3%. In this model, because of the form of the borrowing constraint (becoming tighter the higher the expectation of a negative shock) and the mere possibility of debt–equity substitution, firms find it optimal to borrow to the limit almost always, as long as $\beta(1 + r) < 1$. The fall in output generated by the model is smaller than what is observed in the data. However, conservative values have been used for both the leverage and κ, and the effect of varying these assumptions will be discussed shortly.

Discussion. The simulations suggest that a simple model that incorporates trend shocks à la Aguiar and Gopinath (2007) together with financial frictions à la Mendoza (2010) can explain some of the seemingly striking features in firm level data from the Asian crisis episode. The patterns are also displayed during other sudden stop episodes. The dynamics of this simple model are tractable. Following a permanent decline in trend productivity growth, the detrended market value of firms is abruptly and permanently adjusted downward. This simply reflects the fact that the discounted sum of future dividends declined because of the decline in productivity growth. The model has two financial frictions. The first is a limit on debt, exogenously set by creditors so that a firm's debt does not exceed its expected market value. This constraint is binding in the steady state because we assumed that $\beta(1 + r) < 1$ (see the earlier related discussion). Thus a drop in the market value of the firm leads to a drop in its borrowing limit, and thus the firm faces margin calls and has to repay some of its stock of debt. This creates a financial squeeze on the resources of the firm. The second friction in the model follows from the assumption that equity financing is costly. In the absence of such friction, and as discussed earlier, firms can simply substitute equity financing for debt financing without having to alter their production decisions. When equity financing is costly, however, the deleveraging by the firm could impact its production, as the firm might be forced to sell some of its assets to repay its debt. Note, however, that the trend shock does not decrease the level of productivity of the firm; it instead affects its growth rate. Thus, although the firm decreases its capital, its detrended unconstrained optimal production is unaffected by the trend shock, regardless of the persistence of this latter. Therefore, after the initial disinvestment, the firm rebuilds its capital slowly during a period of low equity payout, or, in other words, high equity financing. Thus the recovery in output can take place despite a sustained period of depressed asset prices and debt financing.

3.4.2. Comparison with Total Factor Productivity Level Shocks. We stress the role of trend shocks in allowing us to break the strong procyclicality that is

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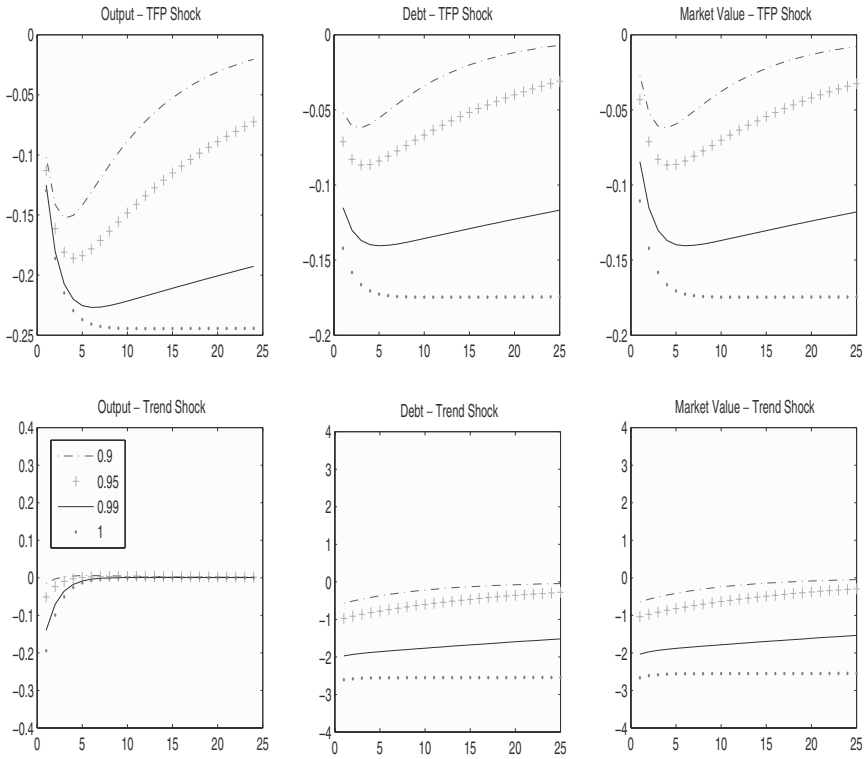


FIGURE 8. Comparison with TFP shocks. This figure compares impulse responses of output, debt, and the market value between TFP level shocks and trend shocks.

typical in the standard model with TFP level shocks. It is useful to compare the effect of these shocks in the context of the model presented here. We thus introduce transitory shocks to the model by replacing a_t by $a_0 e^{z_t}$ in equation (2), which is now written as

$$y_t = a_0 e^{z_t} k_t^{\alpha} \Gamma_t^{1-\alpha}. \tag{10}$$

It is straightforward to see that shocks to the level of the productivity, i.e., shocks to z_t, directly affect the optimal level of capital and production decisions of the firm (even in detrended form). More importantly, shocks to z_t affect the market value only through their impact on the *level* of output, whether this is a transitory or a permanent shock. This creates a simple financial multiplier effect, in that declines in the market value of the firm will subsequently affect the production level because of the financing constraints. This tight relation between the level of output and the firm's market value will, however, make it impossible to generate the observed dichotomy in the data.

Figure 8 compares impulse responses of output, debt, and the market value to TFP level shocks vs. trend shocks. This is done under the parameterization shown in Table 3 for one-standard-deviation shocks. We vary the persistence of

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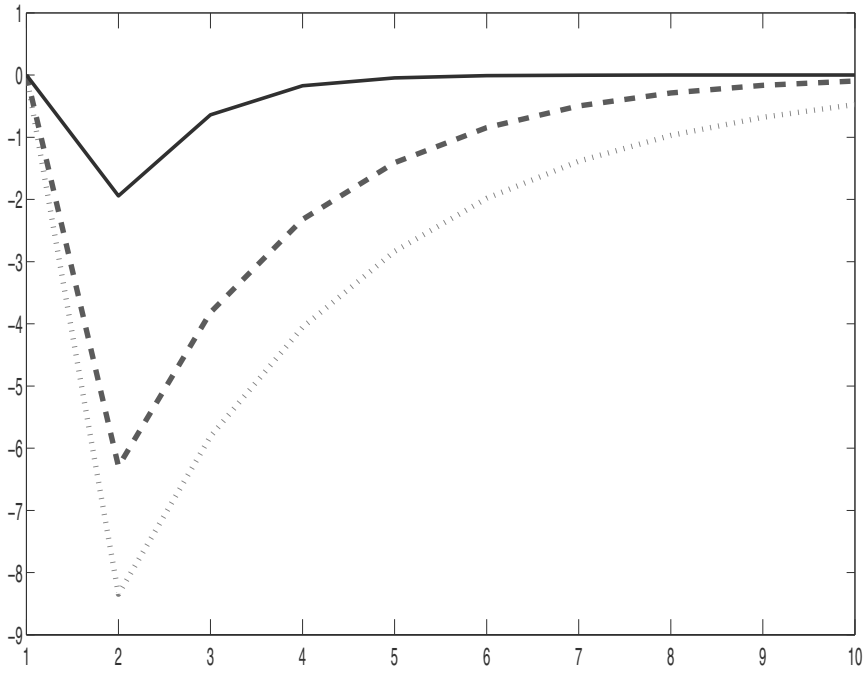


FIGURE 9. Varying the cost of equity financing. This figure compares the impact of a trend shock on output under different assumptions on frictions. The higher the κ, the higher are the frictions facing firms. (—) $\kappa = 0.1$, (- - -) $\kappa = 0.5$, (...) $\kappa = 1.0$.

the shocks to show that although persistent shocks best highlight the differential impact of these shocks, this can also be observed in the response of variables to less persistent shocks. TFP level shocks create, as shown in the upper panel, a strong procyclical movement between output and the firm's debt stock and its market value. This is true because any changes in the market value are driven by expected movements in output. On the other hand, a trend shock has a direct effect on the market value of the firm and thus subsequently on its debt level. Its impact on output is indirect and takes place because of the presence of financial frictions. Note that more persistent shocks do not create necessarily more persistence in output, but instead cause a larger drop in magnitude because of the substantial adjustment needed in the debt level.

3.4.3. Financial Frictions and Leverage. Just as in most sudden stop models, financial frictions are central in generating drops in output in the model. They are partly captured at the equity payout level in this setting. These frictions are meant to formalize costly adjustment in financing and reflect more than just the cost of issuance, as explained earlier. The parameter κ, which determines the degree of friction, was set to a conservative value, as explained earlier. Figure 9 shows the

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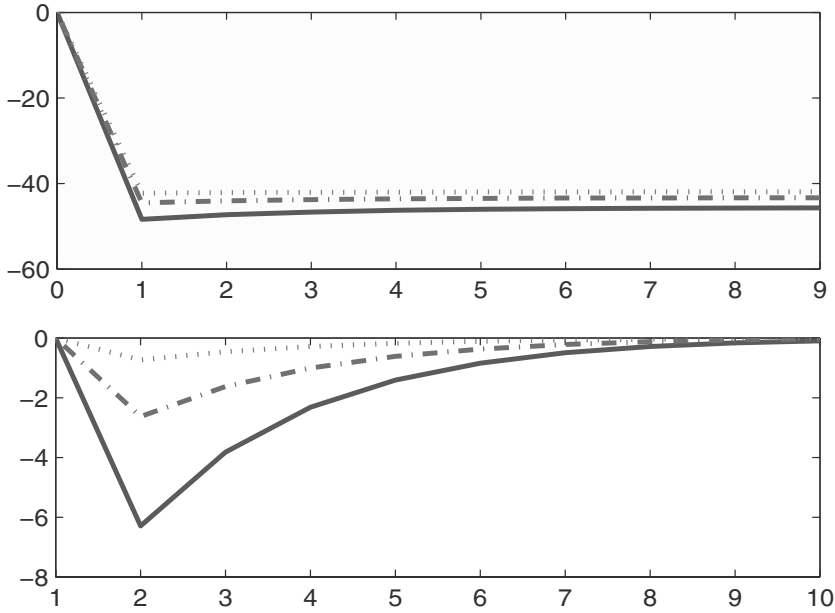


FIGURE 10. The leverage effect. This figure compares the impact of trend shocks on the market value (upper graph) and output (lower graph) under different assumptions on leverage (generated by varying the coefficient ϕ). (...) $B/K = 0.1$, (– –) $B/K = 0.25$), (—) $B/K = 0.5$.

impact of the same shock discussed earlier for varying levels of κ. The results show a stronger impact on output for higher levels of κ.

In this model, output drops occur solely because of financial frictions, triggered by the need to decrease debt levels. The leverage effect is therefore very strong and, as shown in Figure 10, lower values of leverage significantly reduce the impact of the shock on output.

4. CONCLUSION

This paper studied firms' recovery from a sudden stop in a sample of publicly listed firms in Southeast Asia. The data show an unambiguous dichotomy between the behavior of sales, which recover relatively swiftly, and that of Tobin's Q, debt levels, and investment, which show a persistent collapse and remain well below their precrisis levels. These patterns are shared with other sudden stop episodes, as documented in Calvo et al (2006).

We formulate a model that can account for these patterns. The model incorporates trend shocks and financial frictions in the form of an endogenous borrowing constraint and costly equity issuance. The trend shocks are motivated by a very

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persistent decline in postcrisis growth rates and in asset prices. Standard TFP shocks cannot generate these patterns. Once trend shocks are taken into account, the model shows that they can rationalize the main observations as well as the leverage effect that we observe in the data.

The paper models trend shocks as an exogenous factor, and remains silent about the factors that could lead to this sudden downward shift in the trend [as in Aguiar and Gopinath (2007)]. Despite the recent literature on the role of these shocks in emerging markets' business cycles, they remain largely unexplained and therefore a subject for future research. The results in this paper also call for further research into whether a combination of trend shocks and financial frictions could improve the explanatory power of sudden stop models.

NOTES

1. Calvo et al. (2006) dubbed these episodes of creditless recovery from sudden stops "Phoenix miracles."

2. One can interpret the sale of capital as a fall in capital utilization. We keep the model simple, not allowing for variable capital utilization, however, partly because this would significantly complicate the nonlinear solution method we use, as well as because of the modest added value from such a feature.

3. Although South Korea was also severely affected by this episode, the data suggest that it had an atypically strong recovery in all economic aggregates, including credit. Because we are interested in understanding the Phoenix miracle episodes by taking a closer look using firm-level data, we do not include South Korea in our analysis.

4. The indices shown in Figure 3 do not show a sign of recovery to their precrisis level until recently, in 2008, particularly in Indonesia and Malaysia, as the MSCI index of the Thai market is still, as of the end of 2009, significantly below its end-of-1996 level.

5. The use of balanced panels is also common in the literature that studies firms' performance in emerging markets during a crisis, because data on bankruptcies are not always readily available, and firms could delist for a host of other reasons. Given that the purpose of our study is not a systematic empirical analysis of the determinants of firms' performance during the crisis, a balanced panel is well suited for our analysis. We are also confident that the leverage effect is not tainted with a survivorship bias in view of its significance, the relatively small number of bankruptcies, and the other citations that we provide in support of such correlations.

6. Note that the market value, unlike other variables in Figure 4, is shown as of the beginning of the period in order to capture the complete fall in the value of firms that started during 2007.

7. The production function can be interpreted as a standard Cobb–Douglas function incorporating trend productivity, as in Aguiar and Gopinath (2007), except that it abstracts from labor by setting $L = 1$. This gives a production technology with decreasing returns to scale in capital, as is common in firm financing models with one factor of production [see, e.g., Cooper and Ejarque (2003)].

8. See, e.g., Chen and Ritter (2000) for a discussion on issuance costs. There is a growing evidence in the finance literature that managers prefer to smooth dividends, as first shown by Lintner (1956). A theoretical literature rationalizes dividend smoothing. See, for example, Miller and Rock (1985), Allen et al. (2000), and Guttman et al. (2007).

9. Recently, Liberti and Mian (2010) have shown, using data on loans in 15 emerging markets, that the collateral cost is higher in less financially developed economies. They have also shown that with an increase in financial development, firms are more able to pledge firm-specific assets instead of non-firm-specific assets such as land. Interestingly, they also find that with increased risk, the composition of collaterizable assets shifts toward non-firm-specific assets.

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10. We detrend using the lag of the productivity trend so that the variables at time t that are in firms' information set at time $t-1$ remain in this set. This choice does not affect the solution of the problem [see, e.g., Aguiar and Gopinath (2007)].

11. Instead of making this assumption, one could, in line with some of the firm financing literature, assume a tax shield on debt due to tax-deductible interest payments, which would lead firms to prefer debt over equity financing, in line with the pecking order theory.

12. Note that we assume that $\beta\overline{g} < 1$, as is common in models with a stochastic trend.

13. See equation (5) evaluated in the steady state.

14. See, e.g., Cooper and Ejarque (2003) and Henessey and Whited (2006).

15. When the transition probability is increased from 0% to 1.5% the parameter ϕ is set to 6.2 to match the leverage ratio of 0.52.

16. When a transition probability of 3.3% is used in our case, the qualitative results are unaffected, but quantitatively the model generates smaller amplifications of a given shock under the banchmark conservative parameterization.

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APPENDIX

A.1. FIRST-ORDER CONDITIONS

Let λ and μ be the Lagrange multipliers on the budget constraint and the borrowing constraint, respectively. Taking the derivatives, we get

$$\hat{d} : 1 - \lambda \varphi_{\hat{d}}(\hat{d}) = 0, \tag{A.1}$$

$$\hat{b}' : -\mu\phi + \frac{}{1+r} + (\beta + \mu) E V_{\hat{b}'}(\hat{k}', \hat{b}', s') = 0, \tag{A.2}$$

$$\hat{k}' : (\beta + \mu) E V_{\hat{k}'}(\hat{k}', \hat{b}', s') - \lambda = 0. \tag{A.3}$$

The envelope conditions are

$$V_{\hat{k}}(\hat{k}, \hat{b}, s) = \lambda[f_{\hat{k}}(\hat{k}, \hat{b}, s) + (1 - \delta)], \tag{A.4}$$

$$V_{\hat{b}}(\hat{k}, \hat{b}, s) = -\lambda. \tag{A.5}$$

A.2. NUMERICAL PROCEDURE

The numerical procedure solves the model nonlinearly to allow for the possibility that the borrowing constraint does not bind under certain parameterizations and during the transition following the shock. The approach consists of approximating the conditional expectations in (A.2) and (A.3) and in the objective function as functions of the state variables through a finite-element representation that interpolates linearly between the grid points of the state space. For the case of homogeneous firms, we first solve for the steady states for each value

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of g and set the space of the grids accordingly. We then make a guess about the value function and its derivatives with respect to the state variables. For these guesses, one can solve for all the variables, assuming the borrowing constraint binds. If μ, the Lagrange multiplier on the borrowing constraint, is positive, this means the borrowing constraint is indeed binding. Otherwise, we solve the problem again, setting $\mu = 0$, because this means that the constraint does not bind. This is done at every grid. The grid points are joined with bilinear functions so that the approximate functions are continuous. We update the initial guesses until convergence. Note that the problem with heterogeneous firms is solved in a similar way; however, the steady state values are computed simultaneously during the iteration procedure, with the homogeneous steady state results for each firm's parameterization being taken as an initial guess.

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