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Cheap labor meets costly capital: the impact of devaluations on commodity firms

Kristin J. Forbes*

*MIT-Sloan School, 50 Memorial Drive, Cambridge, MA 02142, USA
1050 Massachusetts Avenue, Cambridge, MA 02138, USA*

Abstract

This paper examines how devaluations affect the relative costs of labor and capital and, therefore, influence production, profitability, investment and stock returns for firms in the “crisis” country, as well as competitors in the rest of the world. After developing these ideas in a small, open-economy model, the paper performs a series of empirical tests using information for about 1100 firms in 10 commodity industries between 1996 and 2000. The empirical tests support the model’s main predictions: (1) immediately after devaluations, commodity firms in the crisis country have output growth rates about 10–20% higher than competitors in other countries; (2) immediately after devaluations, commodity firms in the crisis country have operating profit growth rates about 15–25% higher than competitors in other countries; (3) the effect of devaluations on fixed capital investment and stock returns (and, therefore, expected long-run output and profits) is determined by capital/labor ratios and changes in the cost of capital. For example, crisis-country firms have higher rates of capital growth and better stock performance after devaluations if they had lower capital/labor ratios and there was no substantial increase in their interest rates.

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1. Introduction

In 1997, Indonesia abandoned its pegged exchange-rate regime and allowed the rupiah to depreciate substantially. In 1998, Indonesia’s economy contracted by about 14%. Several companies and industries, however, increased production and profits improved

* Tel.: +1-617-253-8996; fax: +1-617-258-6855.

E-mail address: kjforbes@mit.edu (K.J. Forbes).

URL: <http://web.mit.edu/kjforbes/www>.

significantly. For example, in 1998, the plantation sector (which includes coffee, cocoa, rubber, palm oil and tea) grew by 6.5%. One of the largest plantations in the country reported that profits increased by a multiple of four.¹ Over the same period, however, numerous firms complained about a “credit crunch” and their inability to obtain financing to increase productive capacity and take advantage of lower dollar export prices. Many firms even claimed that they were unable to obtain enough working capital to purchase inputs necessary to continue producing at predevaluation levels.

Financial crises not only affect firms in the devaluing country, but can also impact competitors around the world. After Brazil devalued the real in January of 1999, Argentine companies were forced to reduce their export prices for soya beans in order to compete with cheaper Brazilian exports. During the Asian and Russian crises, stock returns for firms that competed with devaluing country exports were significantly lower than for other firms in the same countries.² This suggests that the Asian and Russian devaluations negatively impacted expected earnings and profits for firms that competed with exports from the crisis countries.

This paper examines how devaluations affect relative costs, production decisions and profitability for firms within a “crisis” country, as well as competitors in other countries (where a “crisis” country is defined as a country that devalues its currency). More specifically, it analyzes how devaluations influence firms’ output, profitability, capital investment and stock returns, as well as industry prices and quantities, in the short and long run. In the theoretical model, firms use two variable inputs (labor and materials) and one fixed input (capital). Labor is priced in domestic currency. Materials and capital are priced in “dollars”, and the price of capital also incorporates any domestic capital market developments. The immediate impact of devaluations is to lower the relative cost of labor in the crisis country. Firms in the devaluing country increase output and profits, while competitors decrease output and profits. In the longer term, however, devaluations raise the cost of capital for firms in the crisis country (potentially by more than the exchange-rate movement). If this increase in the cost of capital is large enough and the firm’s capital/labor ratio is high enough, more expensive capital could outweigh the benefits of relatively cheaper labor. Therefore, in the long run, devaluations could decrease output, profits and investment for firms in the devaluing country, and increase these variables for competitors in other countries.

The empirical section of the paper uses data for over 1100 firms in 10 commodity industries to test the model’s main predictions during a series of devaluations between 1997 and 2000. Results show that immediately after devaluations, commodity firms in the crisis country have output growth rates about 10–20% higher and profit growth rates about 15–25% higher than competitors in other countries. These growth effects are short-lived and tend to disappear within a year, although the levels of output and profits remain higher indefinitely. Moreover, investment growth and stock returns (both of which signal changes in expected long-term output and profitability) are correlated with capital/labor ratios and changes in the crisis country cost of capital. For example, crisis-country firms have larger increases in capital investment and better stock performance after devaluations

¹ Statistics from the McCarthy (1999).

² Forbes (2000).

if they had lower capital/labor ratios and their interest rates did not increase substantially. Therefore, although the empirical analysis is not a formal test of the theoretical model, the estimates agree with the model's central predictions. Even though crisis-country firms may benefit from cheaper labor immediately after devaluations, they may not benefit in the longer term if they use capital intensively and/or their capital becomes more costly.

This paper focuses on firms that produce commodities (or any undifferentiated product) for three reasons. First, commodity exports are a large share of GDP in most countries that abruptly devalue their currency. Moreover, many of these countries rely heavily on commodity exports for tax revenues and foreign currency. Second, although there has been a substantial amount of research on the impact of currency movements on differentiated-goods firms (such as the pricing-to-market literature), there has been relatively little analysis for homogenous goods. Third and finally, the production structure for most commodities is extremely useful in isolating some of the key effects of devaluations. For example, many commodities require a large, fixed investment (such as planting trees or drilling mines) that must be made several years before the resulting output is sold. This structure helps differentiate between the short- and long-run impact of devaluations. In addition, the production of most commodities requires imported inputs and capital, as well domestic labor, so that it is possible to capture how devaluations interact with relative input intensities and input costs to affect output, profits and investment. These factors appear to have played an important role in determining how recent devaluations affected firms around the world.

The remainder of this paper is divided into four sections. Section 2 reviews several branches of related literature. Section 3 presents a theoretical model of how devaluations affect firms in the crisis country and the rest of the world in the short and long term. It establishes several conditions under which devaluations are more likely to increase firms' output, profitability and investment levels. Section 4 uses firm-level data for a series of devaluations between 1997 and 2000 to test four central predictions of the model. Section 5 concludes.

2. Literature overview

This paper is related to six diverse branches of literature, each of which is so extensive that this overview does not make any attempt to discuss all of the relevant work. Instead, it simply highlights the key questions and refers to recent surveys and closely related articles.³

The first branch of literature examines how devaluations affect exports. Ghei and Pritchett (1999) provide a detailed summary of why devaluations may or may not improve export performance, as well as the empirical challenges in measuring these effects. They conclude that exports typically increase after a devaluation, and that most of this response occurs rapidly. A second and closely related branch of literature examines how devaluations and crises affect not only exports, but also other variables such as output, investment

³ Forbes (2002) also provides a more detailed review of related literature.

and inflation. Agénor and Montiel (1996) develop a general-equilibrium model exploring these effects and survey related work. They conclude that the evidence on whether devaluations are contractionary is mixed.⁴

While these branches of literature focus on the domestic impact of devaluations and crises, a more recent and rapidly growing body of work examines “contagion” and how crises affect other countries. Claessens and Forbes (2001) include recent surveys of this literature, as well as case studies and empirical analyses. While almost all of this empirical work uses macroeconomic data, one exception closely related to this paper is Forbes (2000), who examines how the Asian and Russian crises affected stock returns for over 10,000 companies around the world. A fourth relevant branch of literature also focuses on stock returns and measures the extent of exchange-rate exposure for various companies. Most papers estimate reduced-form, market models of how exchange-rate movements affect stock returns. Dominguez and Tesar’s (2001) work is one of the most recent and thorough examples of this literature. They conclude that about 12–23% of firms are significantly exposed to exchange-rate movements.

A fifth literature related to this paper examines how exchange-rate movements affect output prices. This literature includes the work on pricing-to-market and pass-through and emphasizes the role of industrial structure.⁵ Dornbusch (1987) develops these ideas theoretically, and Goldberg and Knetter (1997) survey the empirical evidence of pricing-to-market in specific industries.⁶ A final literature is the extensive work on commodities. This work includes everything from the analysis of how commodity price movements affect macroeconomic statistics, to the role of cartels and impact of El Niño. Cashin et al.’s (1999) work is a recent paper that surveys much of this work and analyzes commodity-price cycles.

Despite the range of theoretical frameworks and empirical tests used in these six branches of literature, none of these papers has explicitly addressed the key question explored in this paper: how do devaluations affect output, profitability and investment decisions of firms around the world? The majority of this literature focuses on macroeconomic relationships and country-level evidence. The literature on exchange-rate exposure and pricing-to-market uses firm-level models and data, but focuses on how exchange-rate movements affect stock returns or product prices. The pricing-to-market literature focuses on differentiated goods in developed countries. Moreover, none of these branches of literature has focused on the key tradeoff analyzed in this paper: how devaluations give firms a relative cost advantage in terms of cheaper labor and disadvantage in terms of more expensive capital. This tradeoff generates a number of interesting predictions for firms in the devaluing country, as well as competitors in the rest of the world.

⁴ Edwards (1989) also provides literature surveys and detailed empirical studies.

⁵ Several papers have extended this framework to examine how exchange-rate movements affect micro-level variables for example, Campa and Goldberg (1999) examine the effect on sectoral investment.

⁶ One study that combines this approach with the work on exchange-rate exposure is that of Allayannis and Ithrig (2000). They examine how market structure, including export and import competitiveness, affects the exchange-rate exposure of a large sample of U.S. firms.

3. The theoretical model

This section develops a model to show how devaluations affect firms' output, profits and capital investment in the short and long run. Section 3.1 models firms' decisions in the short run when their level of capital is fixed. Section 3.2 models the long run when firms can adjust their capital levels. Section 3.3 examines the short- and long-run impact of devaluations. This model and framework form the basis of the empirical tests in Section 4. Before developing the model in detail, the next few paragraphs highlight its key components and central predictions.

Each firm uses three inputs (labor, materials and capital) to produce the same commodity. Firms are located in two "countries", the crisis country (that devalues its currency) and the rest of the world (r.o.w.). Each firm produces a small share of global output and has no impact on global prices. There are no trade barriers or transportation costs. As a result, the commodity's price is determined by global supply and demand. Firms make their production decisions in two stages. In the short run, each firm's level of capital is fixed. This fixed investment could include anything from planting rubber trees to drilling mines. Given this fixed capital, each firm chooses its optimal mix of labor and materials to maximize short-run profits. Labor is priced in domestic currency and can be interpreted as any local component of production, while materials are priced in r.o.w. currency and can be interpreted as imported inputs. Firms have company-specific productivity parameters. In the long term, each firm can also adjust its capital level. Capital is priced in r.o.w. currency and includes a country-specific component (to capture differences in domestic risk and local capital markets).

Each firm chooses its level of capital expecting relative prices and exchange rates to remain constant (at least until the next chance to invest). Then the crisis country devalues its currency. In the short run, the devaluation reduces the relative cost of labor in the crisis country. This causes crisis-country firms to increase output, lowering the global price of the commodity. Firms in the r.o.w. respond by decreasing production, although by less than the total increase by crisis-country firms. Therefore, the aggregate short-run impact of the devaluation is to increase global production and decrease the output price. The magnitude of these effects is determined by the crisis country's share of global production and the share of labor in production. The devaluation also decreases profits for firms in the r.o.w. and increases profits for firms in the crisis country.

Over longer periods, however, firms can adjust their capital levels and the above predictions can be reversed. Since capital is priced in r.o.w. currency, devaluations increase the cost of capital for firms in the crisis country, possibly by even more than the exchange-rate movement if there is a simultaneous increase in domestic risk or contraction in lending. More specifically, if the firm's capital/labor ratio is large enough, or the increase in the cost of capital is large enough, the devaluation could raise the total cost of production for crisis-country firms and outweigh the benefits of relatively cheaper labor. Crisis-country firms would decrease output, investment and profits, raising the long-run price of the commodity and causing competitors to increase production, investment and profits. Therefore, although the model's short-run

predictions of how devaluations affect output and profits are fairly clear, the long-run predictions depend on firm's capital/labor ratios and relative changes in input costs.

Before developing this model in detail, it is worth mentioning what the model does not consider. First, it does not allow for any sort of strategic pricing behavior. Firms are assumed to take the global output price as given and are unable to affect this price by adjusting production or forming cartels. Similarly, exchange-rate movements are fully passed through into material input prices. Second, although exogenous shocks can affect global demand for the commodity in each period, the model assumes that firms export most of their output, so there is no direct impact of the devaluation on global demand. Finally, all prices are in real terms and the real impact of the devaluation on relative prices is not eroded by differences in inflation rates across countries.

3.1. The short-run with a fixed level of capital⁷

In order to produce most commodities, firms must make a large, upfront investment in fixed capital. After making this initial investment, there is often a substantial time lag before the first unit of output is sold. For example, there is about a 6-year lag after coffee is planted until the beans can be sold. To capture this, I model firms' decisions in two stages. In the short run, defined as the periods from $t = 1, \dots, T$, a firm's level of capital is fixed. In the long run when $t > T$ (which is modeled in Section 3.2), a firm is able to choose its level of capital.⁸

Beginning with this short-run scenario, each firm i has a fixed level of capital $k_i > 0$. Output in each period t is determined by the choice of two variable inputs: domestic labor ($l_{i,t}$) and imported materials ($m_{i,t}$). Firm output is given by a Cobb–Douglas production function that has decreasing returns to scale⁹:

$$q_{i,t} = A_i k_i^\alpha l_{i,t}^\beta m_{i,t}^\gamma \quad \text{with } \alpha + \beta + \gamma < 1. \quad (1)$$

A_i is a technology parameter (which varies across firms). The cost of labor is w_t and of materials is s_t . The firm chooses variable inputs to maximize short-run profits ($\pi_{i,t}^{\text{SR}}$) in each period:

$$\max_{l,m} \pi_{i,t}^{\text{SR}} = P_t q_{i,t} - w_t l_{i,t} - s_t m_{i,t}, \quad (2)$$

where P_t is the sale price per unit of output.

Each firm produces identical goods and there is no differentiation between markets (i.e. no barriers to trade or transportation costs). Therefore, the global price of the good can be

⁷ This short-run version of the model is loosely based on [Dornbusch \(1987\)](#).

⁸ Although the model does not explicitly include entry and exit, firms can set output and capital to zero in the long run and, therefore, "exit". Entry is captured by allowing firms to increase their capital levels.

⁹ Decreasing returns to scale ensures that the most efficient firm does not produce all of global output.

expressed as a function of global output (Q_t), and to simplify the model’s solution, assume that this global price is determined by a constant-elasticity demand function:

$$P_t = Z_t Q_t^{-\varphi} \tag{3}$$

where Z_t is any period-specific shock to global demand and $1/\varphi$ is the elasticity of demand.¹⁰ In addition, assume that each firm produces a relatively small fraction of global output and, therefore, takes input costs and the industry price as given. These assumptions are fairly accurate descriptions of competition in most commodities.

Without loss of generality, assume that firms are located in two “countries”: the crisis country (which devalues its currency) and the rest of the world (r.o.w.). In the notation that follows, all variables for the crisis country that differ from the r.o.w. are written with a “~”, and firms in the crisis country are indexed by j . The output price (P) and cost of imported materials (s) are both expressed in r.o.w. currency, which can be interpreted as dollars. In the short run, the only price that differs between the two countries is the domestic wage. The exchange rate is the relative cost of labor in the two countries,

$$e_t = \frac{\tilde{w}_t}{w_t}, \tag{4}$$

so that a devaluation in the crisis country is a decrease in e .

For a fixed investment and given output price, each firm chooses its optimal combination of the two variable inputs in order to maximize profits in period t . If the r.o.w. wage is normalized to equal one, then the optimal output levels for firms in the r.o.w. and crisis country are:

$$q_{i,t}^{SR} = \left[P_t^{\beta+\gamma} A_i k_i^\alpha \left(\frac{\beta}{w_t} \right)^\beta \left(\frac{\gamma}{s_t} \right)^\gamma \right]^{\frac{1}{1-\beta-\gamma}} \quad \text{and} \\ \tilde{q}_{j,t}^{SR} = \left[P_t^{\beta+\gamma} A_j \tilde{k}_j^\alpha \left(\frac{\beta}{e_t} \right)^\beta \left(\frac{\gamma}{s_t} \right)^\gamma \right]^{\frac{1}{1-\beta-\gamma}}. \tag{5}$$

Next, assume that there are n firms in the r.o.w, and \tilde{n} firms in the crisis country. Global output can be expressed as:

$$Q_t = \int_{i=1}^n q_{i,t} + \int_{j=1}^{\tilde{n}} \tilde{q}_{j,t}. \tag{6}$$

Appendix A presents the full solutions for the global price and quantity.

3.2. The long-run with variable capital

In periods longer than T , firms can adjust their capital levels. Capital is priced in r.o.w. currency, but prices vary across countries due to factors such as domestic risk, capital market liquidity, capital controls, etc. Firms chose their optimal levels of capital ($k_i \geq 0$ and

¹⁰ The commodity is a normal good, so that $\varphi > 0$.

Table 1
Model predictions for the impact of devaluations

	Sign	Magnitude	Caveats
<i>Short-run predictions</i>			
$\frac{dQ_t^{SR}}{de_t}$	<0	$-\Gamma \frac{\beta}{e_t} \frac{\hat{Q}_t^{C,SR}}{(\hat{Q}_t^{W,SR})^{\frac{\phi(\beta+\gamma)}{1-\beta-\gamma+\phi(\beta+\gamma)}}}$	
$\frac{dP_t^{SR}}{de_t}$	>0	$\Gamma \frac{\beta}{e_t} \frac{\hat{Q}_t^{C,SR}}{(\hat{Q}_t^{W,SR})^{\frac{1-\beta-\gamma+\phi}{1-\beta-\gamma+\phi(\beta+\gamma)}}}$	
$\frac{dq_{i,t}^{SR}}{de_t}$	>0	$\left(\frac{q_{i,t}^{SR}}{1-\beta-\gamma}\right) \left(\frac{(\beta+\gamma)}{P_t^{SR}} \frac{dP_t^{SR}}{de_t}\right)$	
$\frac{d\tilde{q}_{j,t}^{SR}}{de_t}$	<0	$\left(\frac{\tilde{q}_{j,t}^{SR}}{1-\beta-\gamma}\right) \left(\frac{(\beta+\gamma)}{P_t^{SR}} \frac{dP_t^{SR}}{de_t} - \frac{\beta}{e_t}\right)$	
$\frac{d\pi_{i,t}^{SR}}{de_t}$	>0	$\left(\frac{\pi_{i,t}^{SR}}{1-\beta-\gamma}\right) \left(\frac{1}{P_t^{SR}} \frac{dP_t^{SR}}{de_t}\right)$	
$\frac{d\tilde{\pi}_{j,t}^{SR}}{de_t}$	<0	$\left(\frac{\tilde{\pi}_{j,t}^{SR}}{1-\beta-\gamma}\right) \left(\frac{1}{P_t} \frac{dP_t^{SR}}{de_t} - \frac{\beta}{e_t}\right)$	if $(1/\phi) > 1$ and/or $\frac{\hat{Q}_t^{C,SR}}{\hat{Q}_t^{W,SR}} < \frac{1-\beta-\gamma+\phi(\beta+\gamma)}{\phi}$
<i>Long-run predictions</i>			
$\frac{dQ_t^{LR}}{de_t}$?	$-A \left(\frac{\beta}{e_t} + \frac{\alpha}{\tilde{r}_t} \frac{d\tilde{r}_t}{de_t}\right) \frac{\hat{Q}_t^{C,LR}}{(\hat{Q}_t^{W,LR})^{\frac{\phi(\beta+\gamma+\alpha)}{1-\beta-\gamma-\alpha+\phi(\beta+\gamma+\alpha)}}}$	< 0 if $\frac{\beta}{e_t} > \frac{\alpha}{\tilde{r}_t} \frac{d\tilde{r}_t}{de_t}$
$\frac{dP_t^{LR}}{de_t}$?	$A' \left(\frac{\beta}{e_t} + \frac{\alpha}{\tilde{r}_t} \frac{d\tilde{r}_t}{de_t}\right) \frac{\hat{Q}_t^{C,LR}}{(\hat{Q}_t^{W,LR})^{\frac{1-\beta-\gamma-\alpha+\phi}{1-\beta-\gamma-\alpha+\phi(\beta+\gamma+\alpha)}}}$	> 0 if $\frac{\beta}{e_t} > \frac{\alpha}{\tilde{r}_t} \frac{d\tilde{r}_t}{de_t}$
$\frac{dq_{i,t}^{LR}}{de_t}$?	$\left(\frac{q_{i,t}^{LR}}{1-\beta-\gamma-\alpha}\right) \left(\frac{(\beta+\gamma+\alpha)}{P_t^{LR}} \frac{dP_t^{LR}}{de_t}\right)$	> 0 if $\frac{\beta}{e_t} > \frac{\alpha}{\tilde{r}_t} \frac{d\tilde{r}_t}{de_t}$
$\frac{dk_{i,t}^{LR}}{de_t}$?	$\left(\frac{k_{i,t}^{LR}}{1-\beta-\gamma-\alpha}\right) \left(\frac{1}{P_t^{LR}}\right) \left(\frac{dP_t^{LR}}{de_t}\right)$	> 0 if $\frac{\beta}{e_t} > \frac{\alpha}{\tilde{r}_t} \frac{d\tilde{r}_t}{de_t}$

Table 1 (continued)

	Sign	Magnitude	Caveats
$\frac{d\pi_{i,t}^{LR}}{de_t}$?	$\left(\frac{\pi_{i,t}^{LR}}{1-\beta-\gamma-\alpha}\right)\left(\frac{1}{P_t^{LR}}\frac{dP_t^{LR}}{de_t}\right)$	> 0 if $\frac{\beta}{e_t} > \frac{\alpha}{\tilde{r}_t} \frac{d\tilde{r}_t}{de}$
$\frac{d\tilde{q}_{j,t}^{LR}}{de_t}$?	$\left(\frac{\tilde{q}_{j,t}^{LR}}{1-\beta-\gamma-\alpha}\right)\left(\frac{(\beta+\gamma+\alpha)}{P_t^{LR}}\frac{dP_t^{LR}}{de_t} - \frac{\beta_t}{e_t} - \frac{\alpha}{\tilde{r}}\frac{d\tilde{r}}{de}\right)$	< 0 if $\frac{\beta}{e_t} > \frac{\alpha}{\tilde{r}_t} \frac{d\tilde{r}_t}{de}$
$\frac{d\tilde{k}_{j,t}^{LR}}{de_t}$?	$\left(\frac{\tilde{k}_{j,t}^{LR}}{1-\beta-\gamma-\alpha}\right)\left(\frac{1}{P_t^{LR}}\frac{dP_t^{LR}}{de_t} - \frac{\beta}{e_t} - \frac{(1-\beta-\gamma)}{\tilde{r}}\frac{d\tilde{r}}{de}\right)$	< 0 if $\frac{\beta}{e} > \frac{\alpha}{\tilde{r}} \frac{d\tilde{r}}{de}$ and $\left(\frac{1}{\varphi} > \Theta$ and/or $\frac{\hat{Q}_t^{C,LR}}{\hat{Q}_t^{W,LR}} < \Theta'\right)$
$\frac{d\tilde{\pi}_{j,t}^{LR}}{de_t}$?	$\left(\frac{\tilde{\pi}_{j,t}^{LR}}{1-\beta-\gamma-\alpha}\right)\left(\frac{1}{P_t}\frac{dP_t^{LR}}{de_t} - \frac{\beta}{e_t} - \frac{\alpha}{\tilde{r}}\frac{d\tilde{r}}{de}\right)$	< 0 if $\frac{\beta}{e} > \frac{\alpha}{\tilde{r}} \frac{d\tilde{r}}{de}$ and $\left(\frac{1}{\varphi} > \Omega$ and/or $\frac{\hat{Q}_t^{C,LR}}{\hat{Q}_t^{W,LR}} < \Omega'\right)$

Notes: $\hat{Q}_t^{R,SR} = n\left(\frac{\bar{A}\bar{k}^\alpha}{w^\beta s^\gamma}\right)^{\frac{1}{1-\beta-\gamma}}$, $\hat{Q}_t^{C,SR} = \tilde{n}\left(\frac{\bar{A}\bar{k}^\alpha}{e_t^\beta s^\gamma}\right)^{\frac{1}{1-\beta-\gamma}}$, $\hat{Q}_t^{W,SR} = \hat{Q}_t^{R,SR} + \hat{Q}_t^{C,SR}$, $\hat{Q}_t^{R,LR} = n\left(\frac{\bar{A}}{w^\beta s^\gamma r^{1-\beta-\gamma}}\right)^{\frac{1}{1-\beta-\gamma-\alpha}}$, $\hat{Q}_t^{C,LR} = \tilde{n}\left(\frac{\bar{A}}{e_t^\beta s^\gamma \tilde{r}^\alpha}\right)^{\frac{1}{1-\beta-\gamma-\alpha}}$, $\hat{Q}_t^{W,LR} = \hat{Q}_t^{R,LR} + \hat{Q}_t^{C,LR}$ and $\Gamma, \Gamma', A, A', \Theta, \Theta', \Omega, \Omega' = f(\alpha, \beta, \gamma, T, Z, \varphi, e, \tilde{r}, d\tilde{r}/de)$.

$\tilde{k}_j \geq 0$) at cost r_t and \tilde{r}_t to maximize long-run profits (π_T^{LR}) until the next opportunity to invest. To simplify the algebra, assume that there is no discounting. The profit-maximization equation for r.o.w. firms is:

$$\max_k \pi_{i,t}^{LR} = E \left[\int_{t=1}^T (P_t q_{i,t} - w_t l_{i,t} - s_t m_{i,t}) - rk_i \right]. \tag{7}$$

Next, assume that companies expect input prices and demand shocks to be constant (so that $E[w_t] = w$, $E[e_t] = e$, $E[s_t] = s$ and $E[Z_t] = Z$). Then prices from $t = 1$ to T are expected to be constant and $E[P_t] = P$. Substituting the short-run solutions into the long-run profit-maximization equation, the optimal capital investment for firms in the r.o.w. and crisis country are:

$$k_i = \zeta \left(\frac{A_i P}{w^\beta s^\gamma r^{1-\beta-\gamma}} \right)^{\frac{1}{1-\beta-\gamma-\alpha}} \text{ and } \tilde{k}_j = \zeta \left(\frac{A_j P}{e^\beta s^\gamma \tilde{r}^{1-\beta-\gamma}} \right)^{\frac{1}{1-\beta-\gamma-\alpha}} \tag{8}$$

with $\zeta = f(\alpha, \beta, \gamma, T)$. As a result, firms will chose higher capital levels if: they are more productive, the expected output price is higher, or any of the input prices are lower.

Using Eq. (8), it is possible to solve for each firm's optimal long-run output. As long as the price realizations are equal to their expected values, the long-run output solutions are:

$$q_{i,t}^{\text{LR}} = \Psi \left(\frac{A_i P^{\beta+\gamma+\alpha}}{w^\beta s^\gamma r^\alpha} \right)^{\frac{1}{1-\beta-\gamma-\alpha}} \quad \text{and} \quad \tilde{q}_{j,t}^{\text{LR}} = \Psi \left(\frac{A_j P^{\beta+\gamma+\alpha}}{e^\beta s^\gamma \tilde{r}^\alpha} \right)^{\frac{1}{1-\beta-\gamma-\alpha}} \quad (9)$$

with $\Psi = f(\alpha, \beta, \gamma, T)$. Appendix A reports the long-run global quantity and price solutions.

3.3. The impact of devaluations on firms around the world

Using the model developed above, it is possible to predict the impact of devaluations on firms in the crisis country and r.o.w. in both the short run (when capital is fixed) and the long run (when capital is adjustable). Assume that there is an unexpected devaluation that has no impact on global demand for the commodity (i.e. that $dZ_t/de_t = 0$).¹¹ In the short-run, the main impact is to reduce the relative cost of labor in the crisis country. The top of Table 1 reports the predicted impact of devaluations on global output and prices and shows that devaluations (a decrease in e) cause global output to increase and prices to fall. These effects are proportional to the share of labor in production and the share of global output produced by crisis-country firms.

The next section of Table 1 shows the short-run effect of devaluations on firm output and profits.¹² Exchange-rate movements affect firms in the r.o.w. only through movements in the global commodity price. Therefore, devaluations cause r.o.w. firms to reduce output and profits. On the other hand, exchange-rate movements affect crisis-country firms through two channels in the short run: the global commodity price and the relative cost of labor. The first effect is the same as for firms in the r.o.w. Counteracting this “output price” effect, however, is an “input price” effect. Devaluations reduce the cost of labor in the crisis country relative to the cost of other inputs, as well as relative to firms in the r.o.w. Algebraic manipulation shows that this second “input price” effect always dominates the first “output price” effect, so that devaluations unambiguously cause crisis-country firms to increase output in the short run. Finally, since global output increases and output by the r.o.w. decreases, output by the crisis country must increase by even more than the increase in global production. Therefore, firms in the crisis country will sell to customers/markets that were previously serviced by firms in the r.o.w.

Devaluations will also increase short-run profits for firms in the crisis country, with one additional caveat: if the global elasticity of demand for the product is greater than one and/or if the crisis country has a small enough share of global output. In other words, if the price decline leads to a large enough increase in global demand, or if the impact on global prices is fairly small (since the crisis country only produces a small fraction of global

¹¹ This assumption is realistic for commodity firms in most emerging markets since the majority of production is exported to developed countries, and most devaluations have minimal impact on their demand. In select cases, such as the 1998 Russian crisis, this assumption may not apply. It is straightforward to extend the model and allow exchange-rate movements to affect global demand.

¹² Short-run profits do not include the cost of capital investment and are defined in Eq. (2).

output), then devaluations increase short-run profits for crisis-country firms. There is a lengthy debate in the development literature on whether the elasticity condition ($1/\varphi > 1$) holds for most commodities. Estimates of the price elasticity of demand are highly dependent on an individual commodity's characteristics, how narrowly it is defined, and the length of time constituting "short run". In most cases, however, the output-share condition ($\hat{Q}_t^{\text{Crisis,SR}}/\hat{Q}_t^{\text{World,SR}} < X$) is satisfied because the production of most commodities is widely dispersed across countries.¹³ Moreover, even for commodities with extremely low price elasticities of demand, this condition should be satisfied.¹⁴ Therefore, devaluations are expected to increase short-run profits for firms in the crisis country.

Over the longer term, however, the short-run impact of devaluations on output and profits can be reversed. Devaluations also affect the relative cost of capital, and when $t \geq T$, firms can adjust their investment accordingly. More specifically, assume that:

$$dr_t/de_t = 0 \quad \text{and} \quad d\tilde{r}_t/de_t < 0. \quad (10)$$

In other words, devaluations have no impact on the cost of capital for r.o.w. firms but increase the cost for crisis-country firms. This increase could occur because if capital investment is financed in r.o.w. currency and/or imported, then the crisis-country interest rate would move in proportion to the devaluation. If devaluations also raise domestic interest rates by increasing the country risk premium, contracting bank lending, and/or decreasing property and collateral values, then interest rates in the crisis country could increase by significantly more than the exchange-rate movement.

The middle of Table 1 shows the predicted long-run impact of an exchange-rate movement on global output and prices. Devaluations can either increase or decrease global output and prices based on two conditions: the relative share of labor and capital in production and the impact on the crisis-country's cost of capital. If labor is a more important component of production than capital and/or if the impact of the devaluation on interest rates is small, then the devaluation is more likely to increase global production and decrease global prices. The equations also show the intuitive result that the impact of devaluations on global output and prices is greater when the crisis country produces a larger share of global output.

The long-run impact of devaluations on firm output, capital and profits is shown at the bottom of Table 1. Exchange-rate movements continue to affect output and profits for r.o.w. firms, as well as investment levels, only through movements in the global commodity price. Therefore, a devaluation could cause r.o.w. firms to either increase or decrease their output and investment, based on whether the devaluation leads to a long-run increase or decrease in the global price as determined by the above criteria. If production is relatively more capital intensive, or if the devaluation causes a large increase in interest

¹³ Even when a country is heavily specialized in a specific commodity, it rarely has a dominant share of global production. Agénor and Montiel (1996) make this point and document that only 16 developing countries have as much as 10% of the world market for any commodity (based on three-digit SITC groups).

¹⁴ For example, if $\varphi = 5$ so that the price elasticity of demand for the commodity is 0.2 (which is unrealistically low), and $\beta + \gamma = 0.5$ (which is also unrealistically low for an emerging market), then $X = 0.60$. In other words, even using extreme parameter values which make it more difficult to satisfy this condition, a country would have to produce over 60% of global production in order for $\hat{Q}_t^{\text{Crisis,SR}}/\hat{Q}_t^{\text{World,SR}} < X$.

rates, then there is a greater chance that the global price increases and r.o.w. firms subsequently increase output and investment.

Finally, as shown at the bottom of Table 1, devaluations affect output, profits and capital for crisis-country firms through the same global price effect as for r.o.w. firms, as well as through changes in the relative costs of labor and capital. Algebraic manipulation, however, shows that the sign of the impact depends on the same two criteria: capital–labor ratios and changes in the crisis-country cost of capital. Devaluations only increase output, investment and profits for crisis-country firms in the long run if: labor’s share is relatively larger than capital’s share and the increase in the cost of capital is not too large.¹⁵ This is intuitive. Devaluations only cause crisis-country firms to increase output, investment and profits if the cost advantage gained from cheaper labor is greater than the cost disadvantage from more expensive capital. Therefore, in the long run devaluations have the opposite impact on firms in the crisis country than firms in the r.o.w.

4. Empirical tests

This section tests four of the model’s key predictions. Section 4.1 describes the data set, devaluation episodes and commodity groups used for the analysis. Sections 4.2 and 4.3 examine how devaluations affect output growth and profit growth, respectively. Sections 4.4 and 4.5 assess the expected long-run impact by examining changes in firms’ investment and stock returns. These two sections also consider how capital/labor ratios and changes in the cost of capital determine the impact of devaluations on different groups of firms. Although this empirical analysis is not a formal test of the full theoretical model, the results support the model’s central predictions for how devaluations impact output, profitability and investment for firms around the world.

4.1. The events, data and commodity groups

The empirical analysis focuses on “major devaluations” in eight countries between January 1997 and January 2000.¹⁶ “Major devaluations” are defined as episodes where the local currency/U.S. dollar exchange rate increased by 15% or more within any 4-week period. Table 2 lists the countries with major devaluations in chronological order, as well as the month of the devaluation.¹⁷ This list of devaluation episodes includes the standard events typically analyzed in the currency-crisis literature: several Asian countries in 1997–1998, South Africa and Russia in 1998 and Brazil in 1999.

¹⁵ The impact of devaluations on capital and profits in crisis-country firms also depends on the elasticity and/or global output share criteria. As discussed above, however, these conditions are expected to be satisfied since commodity production is rarely concentrated in an individual country.

¹⁶ This period was chosen to correspond with the available firm-level data. Exchange-rate data is from *Datastream*.

¹⁷ After a devaluation, the next 4 weeks are excluded so that there can be, at most, one devaluation event within any 4-week period. The only major devaluation that is not included in this analysis is for Ecuador starting in January of 1999. This event is excluded because there is no firm-level data for Ecuador and Ecuador exports less than 1% of global exports for each of the commodity groups in the sample.

Table 2
Major devaluation events^a

Country ^b	Devaluation period
Thailand	7/97, 12/97, 1/98
Indonesia	10/97, 12/97, 1/98, 5/98, 6/98, 1/99
Philippines	12/97
South Korea	12/97, 1/98
Malaysia	1/98
South Africa	7/98
Russia	8/98, 10/98, 12/98, 1/99
Brazil	1/99

^a “Major devaluations” are episodes when the country’s local currency/U.S. dollar exchange rate increased by 15% or more within a 4-week period. After a devaluation event, the next 4 weeks are excluded so that there can be, at most, one devaluation event within any 4-week period. Exchange rate data is from *Datastream*.

^b Countries in the sample which do not have any major devaluation events are: Argentina, Australia, Austria, Bahrain, Bangladesh, Belgium, Britain, Canada, Chile, China, Colombia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Ireland, Israel, Italy, Japan, Jordan, Kuwait, Lebanon, Luxembourg, Malta, Mexico, Morocco, Netherlands, New Zealand, Norway, Poland, Portugal, Saudi Arabia, Singapore, Slovakia, Spain, Sri Lanka, Sweden, Switzerland, Taiwan, Turkey, United Arab Emirates, Uruguay and Venezuela. Ecuador is the one country that has a major devaluation but is not included in the list since firm-level data is not available for the country and Ecuador exports less than 1% of global exports for each of the commodities studied.

The empirical tests focus on 10 commodity groups: natural rubber and related forest products; mining for silver and gold ores; natural gas and crude petroleum; preserved fruits and vegetables; edible oils and fats; cigarettes; industrial inorganic chemicals; plastics, materials and synthetics; industrial organic chemicals; and fertilizers.¹⁸ The firm-level information includes data for over 1100 firms and is from the *Worldscope* database published by Disclosure (2001). Table 3 shows the distribution of firms (and average firm size) by country and region. Although the sample includes information from 51 countries and 9 regions, coverage of many developing economies is extremely limited. Table 4 provides additional information on the distribution of firms by commodity group in the devaluing countries, as well as corresponding three-digit SIC codes.

The remainder of this section uses the 10 commodity groups listed in Table 4 to examine the impact of the devaluation events listed in Table 2 on output, profits, investment and stock returns in firms around the world. It focuses on the model’s predictions for firms, rather than industries, because global production and prices are affected by numerous shocks to supply and demand (other than devaluations) that are extremely difficult to measure. For example, an unusually cold winter in the Northern hemisphere can increase demand for natural gas and oil; a severe monsoon in Asia could decrease the global supply of edible oils; and technological advances (such as fiber optics) can reduce the demand for specific minerals (such as copper). By focusing on within-

¹⁸ These commodity groups were chosen based on three criteria: (1) firm-level data existed for at least 20 companies in the three-digit industry; (2) at least 5% of the firms in the industry were located in devaluing countries; (3) the industry roughly fits the characteristics of a commodity as described in the model. Several of the resulting industry groups are not typical commodities, but as shown in the sensitivity tests, results are robust to excluding different commodities.

Table 3
Firm sample information

Region	Country	No. of firms	Average asset value ^a
Africa	Egypt	2	106,735
	Morocco	1	884,222
	South Africa	51	936,165
	Zimbabwe	1	30,146
Australasia	Australia	66	392,031
	New Zealand	3	893,242
East Asia	Hong Kong	5	347,789
	Japan	140	1,799,298
	Korea	43	1,094,628
	Malaysia	49	313,508
	Singapore	10	174,846
Eastern Europe	Taiwan	26	719,444
	Czech Republic	9	221,110
	Hungary	2	365,357
	Poland	3	229,511
	Russia	10	3,802,581
Latin America	Argentina	9	2,529,668
	Brazil	26	2,700,113
	Chile	4	584,754
	Colombia	2	62,207
	Mexico	8	1,403,361
	Peru	1	389,694
Middle East	Venezuela	2	11,820,064
	Israel	6	1,177,402
	Jordan	1	481,423
	Turkey	5	75,959
North America	Canada	170	621,109
	United States	151	3,940,778
South and West Asia	China	9	1,138,498
	India	71	349,866
	Indonesia	11	528,264
	Pakistan	20	71,352
	Philippines	13	272,038
	Thailand	18	560,326
	Western Europe	Austria	3
Belgium		8	3,192,222
Denmark		5	497,253
Finland		3	1,376,643
France		15	3,593,548
Germany		13	9,909,534
Greece		15	99,360
Ireland		7	139,395
Italy		10	8,175,550
Luxembourg		1	8,643,201
Netherlands		7	2,933,540
Norway		8	3,812,535
Portugal	4	91,514	
Spain	7	1,046,979	

Table 3 (continued)

Region	Country	No. of firms	Average asset value ^a
Western Europe	Sweden	5	1,368,383
	Switzerland	6	3,371,978
	United Kingdom	63	2,782,784
Total sample		1128	1,777,259

^a Assets measured in thousands of U.S. dollars in 1996 (or the closest year available).

industry differences in firm performance, rather than on aggregate industry trends, it is possible to control for these exogenous shocks to global supply and demand and better identify the direct impact of devaluations on firms around the world.

4.2. Test of prediction 1: the short-run impact of devaluations on firm output

Prediction 1: Immediately after devaluations, commodity-exporting firms in the devaluing country increase output and competing firms in other countries decrease output.

To test this prediction, Table 5 begins by listing average output growth for firms in countries that devalued (in that year) compared to competitors in countries that did not devalue. Output growth is measured as the annual percent change in net sales and revenues (measured in local currency) for each year from 1996 through 2000.¹⁹ The first row of the table reports mean output growth for the entire sample. The lower rows disaggregate average output growth into the 10 commodity groups in Table 4. The table also reports standard deviations of output growth (in parentheses) and *z*-statistics from a Wilcoxon Rank–Sum Test of the null hypothesis that the two independent samples of firms are from populations with the same distribution.

Table 5 shows that average annual output growth for firms in devaluing countries was 21%, while output growth for firms in nondevaluing countries was 8%. When output growth is disaggregated by commodity, firms in devaluing countries have higher output growth in all 10 industries. For example, in the edible oils and fats industry, output growth for firms in devaluing countries averaged 16%, while output growth for firms in nondevaluing countries averaged only 4%. Moreover, the *z*-statistics are significant (at the 10% level) for the entire sample of firms and for 9 of the 10 commodity groups. These tests indicate that output growth rates for firms in devaluing countries are significantly higher than for firms in nondevaluing countries.

Next, in order to formalize this analysis and control for inflation, annual shocks to output, and any forward and/or lagged impact of devaluations, I estimate the model:

$$\Delta q_{i,t} = \theta_0 + \theta_1 \text{Devalue}_{i,t-1} + \theta_2 \text{Devalue}_{i,t} + \theta_3 \text{Devalue}_{i,t+1} + \theta_4 \text{Inflation}_{i,t} + \eta_t + \varepsilon_{i,t} \quad (11)$$

where $\Delta q_{i,t}$ is output growth for firm *i* in period *t*; $\text{Devalue}_{i,t-l}$ is a dummy variable equal to 1 if the country where firm *i* is located will have a devaluation in the

¹⁹ More specifically, net sales and revenues are defined as gross sales and other operating revenues less discounts, returns and allowances.

Table 4
Sample information for devaluing countries

Industry and SIC code	Natural rubber and gums/ forest products 083		Mining for silver and gold ores 104		Natural gas and crude petroleum 131		Preserved fruits and vegetables 203		Edible oils and fats 207	
	No. firms	Percent of total	No. firms	Percent of total	No. firms	Percent of total	No. firms	Percent of total	No. firms	Percent of total
Brazil	0	0.0	0	0.0	1	0.4	1	1.2	2	2.7
Indonesia	2	8.7	0	0.0	0	0.0	0	0.0	1	1.4
Korea	1	4.3	0	0.0	0	0.0	2	2.5	1	1.4
Malaysia	12	52.2	1	0.5	0	0.0	1	1.2	21	28.4
Philippines	0	0.0	4	2.2	7	3.0	1	1.2	0	0.0
Russia	0	0.0	1	0.5	9	3.9	0	0.0	0	0.0
South Africa	0	0.0	40	21.5	1	0.4	1	1.2	0	0.0
Thailand	0	0.0	0	0.0	1	0.4	4	4.9	2	2.7
Total crisis firms	15	65.2	46	24.7	19	8.2	10	12.3	27	36.5
Total firms in sample	23	100.0	186	100.0	233	100.0	81	100.0	74	100.0
Industry SIC code	Cigarettes 211		Industrial inorganic chemicals 281		Plastics, materials and synthetics 282		Industrial organic chemicals 286		Fertilizer/agricultural chemicals 287	
	No. of firms	Percent total	No. of firms	Percent total	No. of firms	Percent total	No. of firms	Percent total	No. of firms	Percent total
Brazil	1	2.4	1	0.8	4	2.3	7	7.0	9	10.6
Indonesia	3	7.3	0	0.0	2	1.1	2	2.0	1	1.2
Korea	1	2.4	4	3.1	19	10.8	8	8.0	7	8.2
Malaysia	4	9.8	3	2.3	4	2.3	2	2.0	1	1.2
Philippines	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0
Russia	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
South Africa	1	2.4	3	2.3	4	2.3	1	1.0	0	0.0
Thailand	0	0.0	2	1.6	7	4.0	1	1.0	1	1.2
Total crisis firms	10	24.4	14	10.9	40	22.7	21	21.0	19	22.4
Total firms in sample	41	100.0	128	100.0	177	100.0	100	100.0	85	100.0

Crisis firms are firms in countries with a major devaluation event between 1996 and 2000 as defined in Table 2.

Table 5
Trends in firm output growth^a: devaluing countries versus rest of world

		Firms in devaluing countries ^b	Firms in rest of world	z-statistic for difference in output growth ^c
Full sample	Mean output growth	0.21	0.08	−6.50**
	Standard deviation	(0.50)	(0.46)	
Rubber plantations and forest products	Mean output growth	0.22	−0.02	−2.41**
	Standard deviation	(0.30)	(0.34)	
Silver and gold ores	Mean output growth	0.37	0.08	−0.80
	Standard deviation	(1.00)	(0.76)	
Natural gas and crude petroleum	Mean output growth	0.41	0.21	−2.20**
	Standard deviation	(0.96)	(0.66)	
Preserved fruits and vegetables	Mean output growth	0.13	0.06	−1.80*
	Standard deviation	(0.44)	(0.21)	
Edible oils and fats	Mean output growth	0.16	0.04	−3.69**
	Standard deviation	(0.40)	(0.24)	
Cigarettes	Mean output growth	0.23	0.09	−2.36**
	Standard deviation	(0.20)	(0.19)	
Industrial inorganic chemicals	Mean output growth	0.10	0.04	−1.97**
	Standard deviation	(0.13)	(0.17)	
Plastics, materials and synthetics	Mean output growth	0.13	0.03	−3.76**
	Standard deviation	(0.34)	(0.35)	
Industrial organic chemicals	Mean output growth	0.24	0.02	−2.80**
	Standard deviation	(0.34)	(0.24)	
Fertilizer	Mean output growth	0.22	0.10	−2.10**
	Standard deviation	(0.23)	(0.32)	

^a Output growth measured as percent change in net sales and revenues measured in local currency.

^b Devaluing countries are countries with a major devaluation (as defined in Table 2) in the current year.

^c z-statistic from a two-sample Wilcoxon Rank–Sum Test if the two groups of firms are from populations with the same distribution.

* Significance at the 10% level.

** Significance at the 5% level.

next period; $Devalue_{i,t}$ is a dummy variable equal to 1 if the country where firm i is located devalued in period t ; $Devalue_{i,t+1}$ is a dummy variable equal to 1 if the country where firm i is located devalued in the previous period; $Inflation_{i,t}$ is the inflation rate for the country where firm i is located in period t ; η_t is a vector of period dummy variables (for 1996 through 1999, with 2000 the excluded year); and $\varepsilon_{i,t}$ is an error term. The $Devalue_{i,t-1}$ variable captures whether firms had higher or lower output growth in the year before a devaluation, while $Devalue_{i,t}$ and $Devalue_{i,t+1}$ capture whether firms had significantly different output growth in the year of the devaluation or year immediately following. The inflation variable captures any impact of changes in the price level on reported output growth.²⁰ The period dummy variables capture any global shifts in supply or demand that affect all firms in the sample in any period.

²⁰ Inflation is measured as the annual percent change in the consumer price index as reported in line 64..xzf of International Monetary Fund (2001).

Table 6
Regression results: growth in firm output

	Devaluation dummies			Inflation	No. of observations	R^2
	$t-1$	t	$t+1$			
Pooled cross-section	-0.106** (0.054)	0.109** (0.038)	-0.069 (0.078)	0.005** (0.001)	3079	0.03
Fixed industry effects	-0.082** (0.040)	0.133** (0.037)	-0.048 (0.051)	0.005** (0.001)	3079	0.02
Random industry effects	-0.106** (0.040)	0.109** (0.036)	-0.069 (0.051)	0.005** (0.001)	3079	0.03
Rubber plantations and forest products	0.108* (0.065)	0.266** (0.095)	0.125 (0.317)	0.009** (0.002)	72	0.24
Silver and gold ores	-0.081 (0.135)	0.359 (0.272)	0.145 (0.272)	0.006 (0.008)	388	0.02
Natural gas and crude petroleum	-0.950* (0.503)	0.164 (0.296)	-0.939 (0.594)	0.001 (0.003)	613	0.10
Preserved fruits and vegetables	0.117 (0.074)	0.036 (0.121)	-0.220** (0.081)	0.007** (0.001)	230	0.14
Edible oils and fats	0.131** (0.043)	0.129* (0.077)	0.041 (0.051)	0.008** (0.001)	227	0.14
Cigarettes	0.029 (0.047)	0.030 (0.060)	-0.167** (0.042)	0.006** (0.002)	128	0.16
Industrial inorganic chemicals	0.098** (0.034)	0.056 (0.038)	0.039 (0.066)	0.004 (0.003)	395	0.03
Plastics, materials and synthetics	0.036 (0.046)	0.078 (0.054)	0.061 (0.042)	0.005** (0.001)	508	0.04
Industrial organic chemicals	-0.089* (0.054)	0.150** (0.050)	0.076 (0.059)	0.009** (0.002)	271	0.13
Fertilizer	0.001 (0.049)	0.114* (0.063)	-0.063 (0.130)	0.006** (0.001)	247	0.09

Standard errors are in parentheses and are White-adjusted for heteroscedasticity. R^2 is the within- R^2 for the fixed-effects estimates and the overall R^2 for the random-effects estimates. Period dummy variables are included in each specification and are always jointly significant at the 1% level.

* Significance at the 10% level.

** Significance at the 5% level.

Table 6 reports estimates of Eq. (11). The first row shows results when the model is estimated as a pooled cross-section of firms in all 10 commodity groups. The second and third rows report results when the model is estimated with fixed or random industry effects. The bottom part of the table reports estimates when Eq. (11) is estimated separately for each of the commodities. When the model is estimated for the entire sample, $\text{Devalue}_{i,t}$ is always positive and significant at the 1% level. This suggests that when a country devalues its currency, domestic firms have significantly higher output growth (in that year) than firms in nondevaluing countries. The size of this effect can be large. The pooled cross-section estimates indicate that annual output growth is 11% greater, on average, for firms in the devaluing country. Moreover, when Eq. (11) is

estimated separately for each of the 10 commodity groups, the coefficients on $Devalue_{i,t}$ remain positive for each of the industries (and are significant at the 10% level in 40% of the industries). This suggests that within most industries, firms in devaluing countries had higher output growth than competitors in nondevaluing countries. For example, estimates for the first commodity group indicate that output growth for rubber plantations was 27% greater in devaluing countries than for competitors located elsewhere.

When the model is estimated for the entire sample, the coefficients on the forward and lagged devaluation variables are always negative. The estimates in the lower section of the table, however, show that the sign of these estimates fluctuates across industries. Moreover, coefficient estimates for the natural gas and crude petroleum group are such large negative outliers that they could be driving the large negative coefficients for the entire sample.²¹ To test this, the first row of Table 7 repeats the base results (using random effects) from the top of Table 6 and then row 2 excludes firms in the natural gas and crude petroleum industry. The coefficients on $Devalue_{i,t-1}$ and $Devalue_{i,t+1}$ are now positive and insignificant, while the coefficient on $Devalue_{i,t}$ remains positive and highly significant. Next, to examine if any other industry groups affect these estimates, I reestimate the model excluding one commodity group at time (both with and without the natural gas and crude petroleum industry). In each case, the coefficient on $Devalue_{i,t}$ is positive and highly significant, and the signs and significance of the coefficients on $Devalue_{i,t-1}$ and $Devalue_{i,t+1}$ depend on the industries included in the analysis.

The remainder of Table 7 reports a sample of additional sensitivity tests. Row 3 adds a control variable for firm size and row 4 measures inflation using an index of producer prices instead of consumer prices. Rows 5 and 6 include regional and country dummy variables, respectively. Row 7 excludes OECD countries. Rows 8 and 9 report results for only middle- or low-income countries, as defined in World Bank (2001). Row 10 only includes Asia. Row 11 reports results when the equation for output growth is jointly estimated with the equation for profit growth (discussed in Section 4.3) using a seemingly unrelated regressions model in order to control for any correlation in the error terms across models. The top of Table 8 reports results when the devaluation dummies are interacted with the size of the exchange-rate movement in the given period (including squared terms to capture any nonlinearities). These results suggest that the impact of devaluations on sales growth is nonlinear and increases (at a decreasing rate) with the size of the depreciation. I also examine the impact of including controls for interest rates, as well as excluding each country, each region, each devaluation event, the inflation variable, the period dummy variables, and/or the forward and lagged effect of devaluations.

²¹ The natural gas and crude petroleum industry is frequently an outlier in the range of tests reported below. This could partially reflect the unique aspects of this industry (such as the power of OPEC and the concentration of supply in a turbulent region). This may also reflect the unusual price volatility during 1997 and 1998. Rapid increases in production, an increase in OPEC quotas, a mild winter and then an unexpected decrease in global growth, all generated an unusually rapid decline in oil prices during the period when most of the countries in the sample experienced major devaluations.

Table 7
Sensitivity analysis: growth in firm output

	Devaluation dummies			Inflation	No. of observations	R^2
	$t-1$	t	$t+1$			
Base estimates (random effects)	-0.106** (0.040)	0.109** (0.036)	-0.069 (0.051)	0.005** (0.001)	3079	0.03
Exclude natural gas and crude petroleum ^a	0.014 (0.035)	0.115** (0.032)	0.037 (0.045)	0.007** (0.001)	2466	0.03
Control for firm size ^b	-0.108** (0.040)	0.108** (0.036)	-0.072 (0.051)	0.005** (0.001)	3074	0.03
Inflation based on producer-price index ^c	-0.117** (0.041)	0.142** (0.036)	-0.067 (0.051)	0.002** (0.000)	2949	0.02
Include regional dummy variables ^d	-0.088** (0.042)	0.136** (0.038)	-0.067 (0.053)	0.005** (0.001)	3079	0.04
Include country dummy variables	-0.116* (0.061)	0.107* (0.066)	-0.069 (0.072)	0.005** (0.002)	3079	0.05
Only non-OECD countries	-0.084 (0.052)	0.125** (0.051)	-0.082 (0.070)	0.004** (0.001)	945	0.03
Only middle-income countries ^e	-0.102* (0.060)	0.108* (0.062)	-0.154* (0.087)	0.004** (0.001)	666	0.04
Only low-income countries ^e	0.076 (0.138)	0.209** (0.095)	- -	0.004* (0.002)	347	0.08
Only Asia ^f	-0.074* (0.042)	0.115** (0.036)	-0.090* (0.050)	0.005** (0.001)	1277	0.04
SUR joint estimation with profit growth ^g	-0.056* (0.033)	0.096** (0.030)	-0.017 (0.045)	0.005** (0.001)	2814	0.06

Standard errors are in parentheses and are White-adjusted for heteroscedasticity. All estimates are random (industry) effects. R^2 is the overall R^2 . Period dummy variables are included in each specification.

^a Excludes natural gas and crude petroleum (SIC group 131).

^b Firm size measured as total assets in U.S. dollars.

^c Producer-price index based on line 63..zf in [International Monetary Fund \(2001\)](#). Monthly data corresponds to company's reporting period.

^d Regional dummy variables are based on the nine regions listed in [Table 3](#).

^e Definitions of middle- and low-income countries are based on classifications in [World Bank \(2001\)](#).

^f Includes East Asia and South West Asia, as defined in [Table 3](#).

^g Results from a seemingly unrelated regressions model including both output growth and profit growth.

Coefficient estimates for the profit growth equation are reported in [Table 11](#).

* Significance at the 10% level.

** Significance at the 5% level.

In each of these sensitivity tests, the central results do not change. In the year of devaluations, crisis-country firms have output growth rates about 10–20% higher than competitors in other countries. On the other hand, the negative coefficients on the forward and lagged devaluation variables are not robust. This suggests that firm output growth in the years preceding and following devaluations is not significantly different. Therefore, devaluations appear to generate a one-time increase in firm output growth during the year of the devaluation and, therefore, a permanent increase in firm output levels.

Table 8
Sensitivity analysis: devaluation dummies interacted with exchange rate movements

	Devaluation dummies interacted with exchange rate movements ^a					Inflation	No. of observations	R ²
	$t-1$	t	t^2	$t+1$	$(t+1)^2$			
<i>Dependent variable: sales growth</i>								
Pooled cross-section	0.113 (0.110)	0.368 (0.242)	-0.367 (0.266)	0.068 (0.263)	-0.015 (0.266)	0.005** (0.001)	3079	0.02
Fixed industry effects	0.024 (0.165)	0.536** (0.242)	-0.596** (0.301)	0.084 (0.181)	-0.067 (0.155)	0.006** (0.001)	3079	0.02
Random industry effects	0.113 (0.161)	0.368 (0.243)	-0.367 (0.302)	0.068 (0.180)	-0.015 (0.155)	0.005** (0.001)	3079	0.02
<i>Dependent variable: operating income growth</i>								
Pooled cross-section	0.009 (0.256)	0.447 (0.301)	-0.374 (0.331)	0.243 (0.233)	-0.080 (0.271)	0.005** (0.001)	2814	0.02
Fixed industry effects	-0.134 (0.200)	0.680** (0.292)	-0.689** (0.359)	0.266 (0.223)	-0.149 (0.189)	0.006** (0.001)	2814	0.02
Random industry effects	0.009 (0.194)	0.447 (0.292)	-0.374 (0.360)	0.243 (0.222)	-0.080 (0.188)	0.005** (0.001)	2814	0.02

^a The devaluation dummy variables are interacted with the movement in the U.S. dollar exchange rate of the relevant crisis country for the year of the crisis (t). For the year after the crisis ($t+1$), the exchange rate movement is the cumulative movement in the U.S. dollar exchange rate in the year of the crisis and year after the crisis.

** Significance at the 5% level.

4.3. Test of prediction 2: the short-run impact of devaluations on firm profits

*Prediction 2: Immediately after devaluations, commodity-exporting firms in the devaluing country have higher operating profits and competitors in other countries have lower profits.*²²

To test this prediction, I use the same strategy as used above to analyze how devaluations affect firms' output growth. Table 9 begins by listing average growth in operating profits for firms in countries that devalued (in the given year) versus firms in countries that did not devalue. Average growth in operating profits is measured as the annual percent change in net sales and revenues minus the cost-of-goods sold.²³ Operating profits do not include interest expense, depreciation, amortization or taxes and are, therefore, directly comparable to the definition of short-run profits used in the theoretical model.

²² Note that the first part of the prediction (for firms in the crisis country) assumes that the devaluing country produces a small share of global output and/or the global price elasticity of demand for the commodity is greater than or equal to 1.

²³ Net sales and revenues are defined above. The cost of goods sold is the specific or direct manufacturing cost of materials and labor in the production of finished goods.

Table 9
Trends in firm operating profits^a: devaluing countries versus rest of world

		Firms in devaluing countries ^b	Firms in rest of world	z-statistic for difference in profit growth ^c
Full sample	Mean profit growth	0.23	0.08	− 5.54**
	Standard deviation	(0.56)	(0.54)	
Rubber plantations and forest products	Mean profit growth	0.08	− 0.02	− 0.88
	Standard deviation	(0.66)	(0.57)	
Silver and gold ores	Mean profit growth	0.33	0.02	− 0.82
	Standard deviation	(1.09)	(0.81)	
Natural gas and crude petroleum	Mean profit growth	0.18	0.24	− 0.86
	Standard deviation	(0.91)	(0.66)	
Preserved fruits and vegetables	Mean profit growth	0.30	0.06	− 1.67*
	Standard deviation	(0.53)	(0.34)	
Edible oils and fats	Mean profit growth	0.17	− 0.01	− 2.22**
	Standard deviation	(0.49)	(0.55)	
Cigarettes	Mean profit growth	0.30	0.11	− 2.82**
	Standard deviation	(0.29)	(0.25)	
Industrial inorganic chemicals	Mean profit growth	0.10	0.02	− 0.88
	Standard deviation	(0.19)	(0.28)	
Plastics, materials and synthetics	Mean profit growth	0.25	0.01	− 3.87**
	Standard deviation	(0.37)	(0.50)	
Industrial organic chemicals	Mean profit growth	0.37	0.04	− 3.60**
	Standard deviation	(0.37)	(0.43)	
Fertilizer	Mean profit growth	0.23	0.08	− 1.66*
	Standard deviation	(0.45)	(0.47)	

^a Operating profits measured as percent change in net sales and revenues less cost of goods sold (measured in local currency).

^b Devaluing countries are countries with a major devaluation (as defined in Table 2) in the current year.

^c z-statistic from a two-sample Wilcoxon Rank–Sum Test if the two groups of firms are from populations with the same distribution.

* Significance at the 10% level.

** Significance at the 5% level.

Table 9 shows that mean annual profit growth for firms in devaluing countries was 23%, compared to 8% for firms in nondevaluing countries. The z-statistic indicates that this difference is highly significant. When average profit growth is disaggregated by industry, firms in devaluing countries have higher profit growth in 9 of the 10 industries. For example, in the edible oils and fats industry, profits increased 17%, on average, for firms in devaluing countries, while profits decreased by 1% for firms in the rest of the world. The z-statistics show that these differences are significant (at the 10% level) in 6 of the 10 industries.

Next, I estimate the model:

$$\Delta\pi_{i,t} = \theta_0 + \theta_1 \text{Devalue}_{i,t-1} + \theta_2 \text{Devalue}_{i,t} + \theta_3 \text{Devalue}_{i,t+1} + \theta_4 \text{Inflation}_{i,t} + \eta_t + \varepsilon_{i,t} \quad (12)$$

where $\Delta\pi_{i,t}$ is growth in operating profits for company i in period t , and the other variables are defined after Eq. (11). Results are reported in Table 10 and support the patterns in

Table 10
Regression results: growth in firm operating profits

	Devaluation dummies			Inflation	No. of observations	R^2
	$t-1$	t	$t+1$			
Pooled cross-section	0.067 (0.049)	0.146** (0.043)	-0.076 (0.072)	0.005** (0.001)	2814	0.02
Fixed industry effects	0.114** (0.048)	0.183** (0.044)	-0.026 (0.065)	0.005** (0.001)	2814	0.02
Random industry effects	0.098** (0.048)	0.170** (0.044)	-0.043 (0.065)	0.005** (0.001)	2814	0.02
Rubber plantations and forest products	0.097 (0.196)	0.079 (0.232)	0.026 (0.347)	0.013** (0.003)	68	0.09
Silver and gold ores	0.293 (0.179)	0.193 (0.290)	-0.332 (0.392)	0.005 (0.010)	300	0.03
Natural gas and crude petroleum	-0.034 (0.154)	-0.243 (0.275)	0.723** (0.297)	0.006** (0.003)	565	0.09
Preserved fruits and vegetables	0.169 (0.141)	0.247* (0.145)	-0.197 (0.133)	0.007** (0.002)	210	0.12
Edible oils and fats	0.251 (0.155)	0.201* (0.106)	0.067 (0.169)	0.012** (0.002)	213	0.10
Cigarettes	-0.102 (0.113)	0.139 (0.114)	0.006 (0.135)	0.003 (0.002)	124	0.08
Industrial inorganic chemicals	0.131** (0.044)	0.135** (0.063)	0.094 (0.102)	-0.005 (0.007)	377	0.04
Plastics, materials and synthetics	0.140 (0.090)	0.194** (0.067)	-0.040 (0.083)	0.002 (0.002)	477	0.04
Industrial organic chemicals	0.037 (0.062)	0.248** (0.082)	-0.046 (0.076)	0.011** (0.002)	251	0.11
Fertilizer	-0.012 (0.073)	0.177 (0.127)	0.014 (0.170)	0.005** (0.002)	229	0.05

Standard errors are in parentheses and are White-adjusted for heteroscedasticity. R^2 is the within- R^2 for the fixed-effects estimates and the overall R^2 for the random-effects estimates. Period dummy variables are included in each specification and are always jointly significant at the 1% level.

* Significance at the 10% level.

** Significance at the 5% level.

Table 9. When the model is estimated using a pooled cross-section, fixed- or random-industry effects for the entire sample, operating profit growth for devaluing-country firms is significantly higher than for competitors. Moreover, this effect can be large. The random-effects estimates suggest that operating profit growth was 17% higher for firms in devaluing countries. This impact of devaluations on profit growth, however, is not significant in the following year.

When Eq. (12) is estimated separately for each of the 10 commodity groups, the coefficients on $Devalue_{i,t}$ remain positive for nine of the industries (and significant at the 10% level for half the groups). The natural gas and crude petroleum industry continues to be an outlier. Equally important, the magnitude of the coefficient estimates continues to suggest that the impact of devaluations can be large. For example, profit growth in firms producing edible oils and fats was 20% higher in devaluing countries than the rest of the

world. The coefficients on the forward and lagged devaluation variables continue to have mixed signs and significance.

To test the robustness of these results, Table 11 repeats the same series of sensitivity tests performed in Table 7. The bottom of Table 8 reports results when the devaluation dummy variables are interacted with the size of the exchange-rate movement. I also repeat the extensive series of tests outlined in Section 4.2 but not reported in the tables. In each of these tests, the central results do not change (although the magnitude of the estimates fluctuates). Immediately after devaluations, firms in the crisis country have profit growth about 15–25% higher than firms in the r.o.w. There is, however, no consistently significant difference in profit growth for firms in the crisis country and r.o.w. in the years immediately before or after devaluations.

4.4. Test of prediction 3: the impact of devaluations on firm investment

*Prediction 3: After devaluations, commodity-exporting firms in the devaluing country increase investment and competing firms in other countries decrease investment if: labor's share in output is large relative to capital's share and the increase in the crisis-country's cost of capital is small.*²⁴

Since changes in capital investment signal expected changes in future output, and since the model's conditions for firms to increase or decrease long-run output are identical to the conditions for firms to increase or decrease investment, tests of this prediction can also be interpreted as signaling the long-run impact of devaluations on output.²⁵ For comparability with the previous two sections, and as a preliminary analysis, Table 12 reports mean growth in capital investment for firms in devaluing and nondevaluing countries. Growth in capital investment is measured as the annual percent change in net plant, property and equipment.²⁶ In contrast to Tables 5 and 9 (which perform this comparison for output and profit growth), there is no clear pattern for firms in devaluing countries versus firms in the r.o.w. Capital growth is virtually identical for the two groups of firms, and there is no consistent pattern across industries when the analysis is disaggregated by commodity. The z-statistics suggest that any difference across the two groups of firms is never significant at the 5% level. Moreover, if I estimate the regression model of Eqs. (11) and (12) with growth in capital investment (instead of output or profits) as the dependent variable, the devaluation dummies predicting capital growth are highly insignificant.

These patterns are not surprising. The model's predictions for how devaluations affect short-run output and profits were unambiguous; devaluations would increase short-run output and profits for firms in the devaluing country, and decrease short-run output and

²⁴ The first part of the prediction also assumes that the devaluing country produces a small share of global output and/or the global price elasticity of demand for the commodity is greater than or equal to 1.

²⁵ Unfortunately, since the long run in the model is the amount of time before any new investment affects production (which can be several years for commodities), data is not yet available to directly analyze the long-run impact of the devaluations listed in Table 2. Moreover, the firm-level dataset does not have sufficient historical coverage to examine devaluations that occurred before 1996.

²⁶ Gross plant, property and equipment (PPE) is defined as tangible assets with an expected useful life greater than 1 year which are expected to be used to produce goods for sale or for distribution of services. Net PPE excludes accumulated reserves from depreciation, depletion and amortization.

Table 11
Sensitivity analysis: growth in firm operating profits

	Devaluation dummies			Inflation	No. of observations	R^2
	$t-1$	t	$t+1$			
Base estimates	0.098** (0.048)	0.170** (0.044)	-0.043 (0.065)	0.005** (0.001)	2814	0.02
Exclude natural gas and crude petroleum ^a	0.115** (0.046)	0.174** (0.042)	-0.049 (0.062)	0.006** (0.001)	2249	0.03
Control for firm size ^b	0.066 (0.048)	0.145** (0.044)	-0.07 (0.065)	0.005** (0.001)	2812	0.02
Inflation based on producer-price index ^c	0.064 (0.049)	0.192** (0.044)	-0.050 (0.065)	0.002** (0.001)	2693	0.02
Include regional dummy variables ^d	0.120** (0.050)	0.201** (0.046)	-0.020 (0.067)	0.005** (0.001)	2814	0.03
Include country dummy variables	0.174** (0.075)	0.268** (0.083)	0.066 (0.092)	0.006** (0.002)	2814	0.04
Only non-OECD countries	0.180** (0.063)	0.189** (0.063)	-0.053 (0.089)	0.006** (0.002)	847	0.04
Only middle-income countries ^e	0.123* (0.069)	0.168** (0.071)	-0.106 (0.103)	0.006** (0.002)	616	0.04
Only low-income countries ^e	0.205 (0.169)	0.221* (0.116)	- (-)	0.006** (0.003)	303	0.07
Only Asia ^f	0.090* (0.047)	0.148** (0.040)	0.021 (0.056)	0.005** (0.002)	1170	0.03
SUR joint estimation with profit growth ^g	0.114** (0.048)	0.183** (0.044)	-0.026 (0.065)	0.005** (0.001)	2814	0.04

Standard errors are in parentheses and are White-adjusted for heteroscedasticity. All estimates are random (industry) effects. R^2 is the overall R^2 . Period dummy variables are included in each specification.

^a Excludes natural gas and crude petroleum (SIC group 131).

^b Firm size measured as total assets in U.S. dollars.

^c Producer-price index based on line 63..zf in [International Monetary Fund \(2001\)](#). Monthly data corresponds to company's reporting period.

^d Regional dummy variables are based on the nine regions listed in [Table 3](#).

^e Definitions of middle- and low-income countries are based on [World Bank \(2001\)](#).

^f Includes East Asia and South West Asia, as defined in [Table 3](#).

^g Results from a seemingly unrelated regressions model including both output growth and profit growth. Coefficient estimates for the output growth equation are reported in [Table 7](#).

* Significance at the 10% level.

** Significance at the 5% level.

profits for firms in the r.o.w. On the other hand, the model's predictions for how devaluations affect investment were ambiguous and depended on capital/labor ratios and changes in the cost of capital. Therefore, unless all industries had similar capital/labor ratios and devaluations had the same effect on interest rates in all of the crisis countries, there is no reason to expect devaluations to have the same effect on capital growth in these diverse countries and firms.

To explore whether capital/labor ratios and the crisis-country cost of capital are related to changes in investment as predicted in the model, the left side of [Table 13](#) compares capital growth rates for different firms in the devaluing countries. The first two lines divide the sample based on whether the interest rate in the crisis country increased by more or less

Table 12
Trends in capital investment growth^a: devaluing countries versus rest of world

		Firms in devaluing countries ^b	Firms in rest of world	z-statistic for difference in capital growth ^c
Full sample	Mean capital growth	0.14	0.13	– 0.81
	Standard deviation	(0.43)	(0.61)	
Rubber plantations and forest products	Mean capital growth	0.11	0.25	– 0.78
	Standard deviation	(0.40)	(0.71)	
Silver and gold ores	Mean capital growth	0.29	0.20	– 0.60
	Standard deviation	(1.12)	(1.16)	
Natural gas and crude petroleum	Mean capital growth	0.28	0.22	– 1.01
	Standard deviation	(0.28)	(0.58)	
Preserved fruits and vegetables	Mean capital growth	0.04	0.08	1.00
	Standard deviation	(0.24)	(0.26)	
Edible oils and fats	Mean capital growth	0.07	0.06	– 0.56
	Standard deviation	(0.29)	(0.27)	
Cigarettes	Mean capital growth	0.16	0.10	– 1.73*
	Standard deviation	(0.11)	(0.23)	
Industrial inorganic chemicals	Mean capital growth	0.08	0.08	– 0.36
	Standard deviation	(0.28)	(0.24)	
Plastics, materials and synthetics	Mean capital growth	0.09	0.09	0.82
	Standard deviation	(0.33)	(0.47)	
Industrial organic chemicals	Mean capital growth	0.13	0.06	0.18
	Standard deviation	(0.28)	(0.50)	
Fertilizer	Mean capital growth	0.20	0.10	– 1.73*
	Standard deviation	(0.30)	(0.29)	

^a Growth in capital investment measured as percent change in net plant, property and equipment.

^b Devaluing countries are countries with a major devaluation (as defined in Table 2) in the current year.

^c z-statistic from a two-sample Wilcoxon Rank–Sum Test if the two groups of firms are from populations with the same distribution.

* Significance at the 10% level.

than 15% after the devaluation.²⁷ Firms in countries with a larger increase in interest rates have slightly lower capital growth (as expected), although the difference is insignificant. The next two lines divide the sample based on whether the firm's capital/labor ratio was greater or less than 400.²⁸ Firms with higher capital/labor ratios have slower capital growth than firms with lower capital/labor ratios (as also expected). Finally, the last four lines compare capital growth for firms with different combinations of capital/labor ratios and changes in interest rates. The results support the model's main predictions. Devaluing

²⁷ The cost of capital is measured by the lending interest rate from line 60P..zf of *International Monetary Fund* (2001). Data is not available for Brazil, so I substitute the money market rate (line 60B..zf).

²⁸ A capital/labor ratio of 400 is close to the mean ratio for all firms in devaluing countries. Capital/labor ratios are calculated as the ratio of total assets (in US dollars) to total employees. Total assets are the sum of total current assets, long-term receivables, investment in unconsolidated subsidiaries, other investments and net PPE. For several firms, information on employees was not available. For these companies, I substitute the average capital/labor ratio for all firms in the same three-digit industry for the same country. If no data is available for that industry and country, I substitute the average capital/labor ratio for firms in the same industry for the closest comparable country (based on per capita income and geographic location).

Table 13

Capital investment and stock returns in devaluing countries: trends based on interest rates and capital/labor ratios

	Mean growth in capital investment ^a	No. of firms	Mean 3-month return ^b	No. of firms
$\Delta r < 15\%^c$	0.14	144	-0.08	168
$\Delta r \geq 15\%^c$	0.13	58	-0.32	53
K/L ratio $< 400^c$	0.15	143	-0.13	171
K/L ratio $\geq 400^c$	0.11	59	-0.17	50
$\Delta r < 15\%$ and K/L ratio $< 400^c$	0.15	110	-0.06	127
$\Delta r < 15\%$ and K/L ratio $\geq 400^c$	0.11	34	-0.12	41
$\Delta r \geq 15\%$ and K/L ratio $< 400^c$	0.13	33	-0.28	44
$\Delta r \geq 15\%$ and K/L ratio $\geq 400^c$	0.10	25	-0.29	9

^a Growth in capital investment measured as percent change in net plant, property and equipment.

^b Returns are based on local currency and are calculated from the first day of the month prior to the devaluation to the last day of the month after the devaluation.

^c Δr is the change in the lending interest rate as reported in the IFS. K/L ratio is total US dollar assets to employees.

country firms with low capital/labor ratios and no significant increase in interest rates had the highest investment growth (15%), while firms with high capital/labor ratios and a large increase in interest rates had the slowest investment growth (10%).

4.5. Test of prediction 4: the long-run impact of devaluations on firm profits

*Prediction 4: After devaluations, commodity-exporting firms in the devaluing country have higher long-run profits and competing firms in other countries have lower long-run profits if: labor's share in output is large relative to capital's share and the increase in the crisis-country's cost of capital is small.*²⁹

If firms' stock prices are based on the total present value of expected future earnings, then the impact of devaluations on firms' stock prices should capture the expected impact of devaluations on firms' future earnings. Therefore, in order to test how devaluations are expected to affect firms' long-run profits (for which data is not yet available), this section examines how devaluations affect different companies' stock market returns. Granted, stock returns are an imperfect measure since they can be affected by numerous factors other than a devaluations—such as changes in the discount rate or any sort of investor overreaction. On the other hand, stock returns have the advantage of being widely available at a high enough frequency that it is possible to isolate the impact of different devaluations that occur near each other in time.

As an initial test, Table 14 reports mean stock returns for firms in each of the devaluing countries. Returns are calculated as the total return over the 3-month period starting on the first day of the month prior to the devaluation and ending on the last day of the month after

²⁹ Note that the first part of the prediction (for firms in the crisis country) assumes that the devaluing country produces a small share of global output and/or the global price elasticity of demand for the commodity is greater than or equal to 1.

Table 14

Stock returns in devaluing countries^a: trends based on capital/labor ratios

		Low K/L ^b	High K/L ^b
Brazil, January 1999	Mean 3-month return	–0.08	–0.17
	Standard deviation	(0.57)	(0.29)
Indonesia, October 1997	Mean 3-month return	–0.08	–0.30
	Standard deviation	(0.19)	(0.40)
Korea, December 1997	Mean 3-month return	–0.09	–0.30
	Standard deviation	(0.33)	(0.41)
Malaysia, January 1998	Mean 3-month return	0.10	0.26
	Standard deviation	(0.31)	(0.24)
Philippines, December 1997	Mean 3-month return	–0.47	–0.33
	Standard deviation	(0.27)	(0.40)
Russia, August 1998	Mean 3-month return	–0.74	–1.30
	Standard deviation	(1.10)	(1.42)
South Africa, July 1998	Mean 3-month return	–0.17	–0.30
	Standard deviation	(0.30)	(0.29)
Thailand, July 1997	Mean 3-month return	–0.12	–0.29
	Standard deviation	(0.59)	(0.54)
Unweighted mean ^c		–0.21	–0.34
Weighted mean ^c		–0.15	–0.20

^a Returns are based on local currency and are calculated from the first day of the month prior to the devaluation to the last day of the month after the devaluation. The devaluation month is listed next to the country.

^b Division based on the median K/L for the given year and country. K/L is the ratio of total US dollar assets to total employees.

^c Unweighted is the average across countries. Weighted is the average weighted by the number of firms in each country.

the devaluation.³⁰ For each devaluation, the sample is divided into two groups: firms with low capital/labor ratios and firms with high capital/labor ratios. The cutoff between the two groups is the median ratio for that country (so that the two groups are approximately equally sized). Finally, the rows at the bottom of the table report average stock returns for the entire sample of low capital-intensive and high capital-intensive firms.

Most of the patterns in Table 14 agree with the model's predictions. For the entire sample of crisis countries, as well as for six of the eight devaluations, firms with higher capital/labor ratios had worse stock performance than firms with lower ratios. For example, the unweighted estimates suggest that the average 3-month stock return for firms with higher capital/labor ratios was –34%, while the return for firms with lower capital/labor ratios was –21%. Although the majority of firms experienced negative returns during this period, these statistics suggest that investors expected profits for more labor-intensive firms to be less adversely affected by the devaluations than the profits of more capital-intensive firms.

As discussed in Section 4.4, however, the model predicts that it is not only firms' capital/labor ratios, but also changes in their cost of capital that determine how devaluations affect long-term profits. Therefore, the right side of Table 13 examines stock returns for different groups of devaluing-country firms divided based on these two criteria. Firms in countries

³⁰ I focus on 3-month returns to control for any unexpected movements directly before the devaluation, as well as to allow enough time for investors to fully incorporate information after the event.

with a larger increase in interest rates or higher capital/labor ratios have substantially worse stock performance. Firms with lower capital/labor ratios located in countries with no substantial increase in interest rates had the best stock performance (an average 3-month return of -6%), while firms with higher capital/labor ratios located in countries with a large increase in interest rates had the worst performance (an average return of -29%).³¹

5. Conclusions

When a country devalues its currency, some firms and countries generally benefit from any resulting changes in relative prices, while other firms and countries are relatively unaffected or suffer a loss in competitiveness. This paper explores a number of conditions determining the impact of devaluations on commodity firms around the world. It focuses on how devaluations affect relative input costs and, therefore, competitiveness in global markets. In the theoretical model, the immediate impact of devaluations is to lower the relative cost of labor in the crisis country. This improves the competitiveness of firms in the devaluing country, so that they increase output and have higher profits. Devaluations also reduce the relative competitiveness of firms in nondevaluing countries, so that they reduce output and have lower short-run profits.

Devaluations also raise the relative cost of capital for firms in the crisis country, however, potentially by even more than the exchange-rate movement if there is an increase in domestic risk or lending contraction. In fact, if this increase in interest rates for crisis-country firms is large enough, or if firms use capital intensively, then the disadvantage from more costly capital could outweigh the benefits of relatively cheaper labor. Devaluations could cause crisis-country firms to decrease output and profits, while noncrisis firms would increase output and profits. On the other hand, if firms in the devaluing countries have lower capital/labor ratios and there is little impact of the devaluation on the domestic cost of capital, the benefits from cheaper labor will outweigh the disadvantage of more costly capital. Devaluing-country firms would increase output and profitability in the long run, and firms in other countries would decrease output and profitability.

After developing these theoretical concepts, this paper uses data for over 1100 firms in 10 commodity groups to test four of the model's key predictions. Although the empirical analysis is not a formal test of the full model, estimates support the main conclusions. Immediately after devaluations, firms in crisis countries have output growth rates about 10–20% higher and profit growth rates about 15–25% higher than competitors in nondevaluing countries. These effects are short-lived, however, and disappear within 1 year (although output and profit levels remain higher indefinitely). On the other hand, the impact of devaluations on capital investment and stock returns (and, therefore, expected long-run output and profits) is correlated with changes in interest rates and capital/labor ratios in the crisis country. More specifically, crisis-country firms with lower capital/labor ratios in countries without a large increase in interest rates have higher investment growth

³¹ Forbes (2002) also provides evidence that firms in nondevaluing countries that competed with more labor-intensive goods had worse stock performance after devaluations than firms which competed with more capital-intensive goods.

rates and better stock performance after devaluations. These results are intuitive. Firms are more likely to lose competitiveness after devaluations and, therefore, decrease their productive capacity and have lower stock returns, if they are more reliant on capital, and/or if capital becomes significantly more expensive.

Therefore, although devaluations appear to unambiguously benefit this group of crisis-country, commodity firms in the short run, the long-term effects are ambiguous. The critical determinants of whether crisis-country firms benefit from devaluations are whether the cost advantage from cheaper domestic labor outweighs the cost disadvantage from more costly capital. Although this paper does not attempt to aggregate these firm-level effects to the macroeconomic level, the results could provide important insights on why some devaluations boost exports, improve economic growth, and spread to other countries, while other devaluations have little effect on the trade balance, are contractionary, and have minimal impact on the rest of the world.

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Appendix A. Model solutions for aggregate prices and quantities

This appendix reports the solutions for the aggregate variables in the model developed in Section 3 in both the short and long run. Define \bar{q} and \tilde{q} as the average quantity produced by each firm in the r.o.w. and crisis country, respectively. Then the total quantity produced and industry price can be written as:

$$Q_t = n\bar{q}_t + \tilde{n}_t$$

Substituting the short-run solutions from Section 3.1:

$$Q_t^{SR} = \zeta_t \left[n \left(\frac{\bar{A}\bar{k}^\alpha}{s_t^\gamma w_t^\beta} \right)^{\frac{1}{1-\beta-\gamma}} + \tilde{n} \left(\frac{\tilde{A}\tilde{k}^\alpha}{s_t^\gamma e_t^\beta} \right)^{\frac{1}{1-\beta-\gamma}} \right]^{\frac{(1-\beta-\gamma)}{(1-\beta-\gamma)+\varphi(\beta+\gamma)}}$$

$$P_t^{SR} = \zeta_t' \left[n \left(\frac{\bar{A}\bar{k}^\alpha}{s_t^\gamma w_t^\beta} \right)^{\frac{1}{1-\beta-\gamma}} + \tilde{n} \left(\frac{\tilde{A}\tilde{k}^\alpha}{s_t^\gamma e_t^\beta} \right)^{\frac{1}{1-\beta-\gamma}} \right]^{\frac{-\varphi(1-\beta-\gamma)}{(1-\beta-\gamma)+\varphi(\beta+\gamma)}}$$

where $\zeta_t = (Z_t^{\beta+\gamma} \beta^\beta \gamma^\gamma)^{\{1\}/\{1-\beta-\gamma+\varphi(\beta+\gamma)\}}$ and $\zeta_t' = [Z_t^{-\beta-\gamma}/(\beta^\beta \gamma^\gamma)^\varphi]^{\{1\}/\{1-\beta-\gamma+\varphi(\beta+\gamma)\}}$.

\bar{A} , \bar{k} , $\bar{\bar{A}}$ and $\bar{\bar{k}}$ are the productivity parameters and investment levels for the mean-quantity producing firm in the r.o.w. and crisis country, respectively.

In the long run, capital levels can be adjusted and the global quantity and price is:

$$Q^{LR} = \Phi \left[n \left(\frac{\bar{A}}{w^\beta s^\gamma r^\alpha} \right)^{\frac{1}{1-\beta-\gamma-\alpha}} + \bar{n} \left(\frac{\bar{\bar{A}}}{e^\beta s^\gamma \bar{r}^\alpha} \right)^{\frac{1}{1-\beta-\gamma-\alpha}} \right]^{\frac{(1-\beta-\gamma-\alpha)}{(1-\beta-\gamma-\alpha)+\phi(\beta+\gamma+\alpha)}}$$

$$P^{LR} = \Phi' \left[n \left(\frac{\bar{A}}{w^\beta s^\gamma r^\alpha} \right)^{\frac{1}{1-\beta-\gamma-\alpha}} + \bar{n} \left(\frac{\bar{\bar{A}}}{e^\beta s^\gamma \bar{r}^\alpha} \right)^{\frac{1}{1-\beta-\gamma-\alpha}} \right]^{\frac{-\phi(1-\beta-\gamma-\alpha)}{(1-\beta-\gamma-\alpha)+\phi(\beta+\gamma+\alpha)}}$$

where:

$$\Phi = \left[Z^{\beta+\gamma+\alpha} (\beta^\beta \gamma^\gamma \zeta^\alpha)^{\frac{1-\beta-\gamma-\alpha}{1-\beta-\gamma}} \right]^{\frac{1}{1-\beta-\gamma-\alpha+\phi(\beta+\gamma+\alpha)}}$$

and

$$\Phi' = \left[\frac{Z}{(\beta^\beta \gamma^\gamma \zeta^\alpha)^{\frac{\phi}{1-\beta-\gamma}}} \right]^{\frac{1-\beta-\gamma-\alpha}{1-\beta-\gamma-\alpha+\phi(\beta+\gamma+\alpha)}}$$

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