Cheap Labor Meets Costly Capital: The Impact of Devaluations on Commodity Firms

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Abstract: This paper examines how devaluations affect the relative cost of labor and capital and therefore influence production levels, profitability, investment decisions, and stock returns for firms in the "crisis" country as well as competitors in the rest of the world. The paper develops these ideas in a small, open-economy model and then performs a series of empirical tests using information for about 1,100 firms in 10 commodity industries between 1996 and 2000. The empirical tests support the model's main predictions. 1) Immediately after devaluations, firms in the crisis country have higher rates of output growth than competitors in other countries; 2) Immediately after devaluations, firms in the crisis country have higher rates of operating-profit growth than competitors in other countries; 3) The effect of devaluations on fixed capital investment and stock returns (and therefore expected long-term 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. Even though crisis-country firms may benefit from cheaper labor immediately after devaluations, competitors in other countries may benefit in the long run if firms in the devaluing country used capital intensively and/or their capital becomes more costly.

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I. INTRODUCTION

In 1997 the rupiah was devalued and then allowed to depreciate. In 1998, Indonesia's economy contracted by about 14 percent. Several companies and industries, however, increased production and profits improved substantially. For example, in 1998 the plantation sector (which includes coffee, cocoa, rubber, palm oil and tea) grew by 6.5 percent. One of the largest plantations in the country reported that profits increased by a multiple of four in the same year.[1] Over the same period, however, numerous firms complained about a "credit crunch" and their inability to obtain financing to increase their 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 production at pre-devaluation 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.[2] 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.[3] 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 loosely 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 are assumed to 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 domestic risk and any local developments in capital markets. 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 competing firms 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 relative 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

[1] The previous statistics on Indonesia are from the *Asian Wall Street Journal* (1999).
[2] United Nations Conference on Trade and Development (1999).
[3] Forbes (2000).

expensive capital could outweigh the benefits of relatively cheaper labor. Therefore, in the long run, devaluations could decrease output, profits, and capital investment for firms in the devaluing country, and increase output, profits and capital investment for competitors in other countries.

The empirical section of the paper uses data for over 1,100 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, firms in the crisis country have higher rates of output growth and profit growth 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 rates 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 if they had lower capital/labor ratios and their interest rates did not increase substantially. Firms in non-crisis countries had worse stock performance after devaluations if they competed with more labor-intensive firms (and better stock performance if they competed with more capital-intensive firms). Therefore, although the empirical analysis is not a formal test of the theoretical model, the results agree with the model's central predictions. Even though crisis-country firms may benefit from cheaper labor immediately after devaluations, competitors in other countries may benefit in the longer-term if firms in the devaluing country used capital intensively and/or their capital becomes more costly.

This paper focuses on firms that produce commodities (or any undifferentiated product) mainly for export. Although it is possible to extend this framework to other industries, the paper maintains this narrow focus for three reasons. First, commodity exports are a large share of GDP in most countries that abruptly devalue their currency (including many countries that had crises in the late 1990's). 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 firms. 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 in capital (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. Also, 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 relative input costs to affect output, profits, and investment. These factors appear to have played an important role in the impact of recent devaluations on firms around the world.

The remainder of the paper is divided into four sections. Section II briefly reviews several branches of related literature. Section III presents a theoretical model of how devaluations affect firms in the crisis country and 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 IV uses firm-level data for a series of devaluations between 1997 and 2000 to test four central predictions of the model. Section V concludes.

II. LITERATURE REVIEW

This paper is related to six diverse branches of literature: the impact of devaluations on exports; the effect of financial crises on domestic production; contagion and the international transmission of currency crises; the importance of exchange-rate exposure to stock returns; the extent of pass-through from currency movements to goods prices; and the determinants and effects of fluctuations in commodity prices. Each of these branches of literature is so extensive that this survey does not make any attempt to discuss all of the relevant papers. Instead, it simply highlights the key questions and approaches and refers to recent surveys and articles that are closely related to this paper.

The first branch of literature examines how devaluations affect export growth. A standard argument justifying devaluations is that they should reduce the relative cost of exports on international markets and therefore improve export growth. There are, however, a number of reasons why devaluations may not have this desired effect, such as if demand for exports is relatively inelastic or imported inputs are a large component of production. Ghei and Pritchett (1999) provide a detailed summary of why devaluations may or may not improve export performance, as well as why it is difficult to measure these effects. After a review of the empirical work on this subject, they conclude that exports typically increase after a devaluation, and that most of this response occurs rapidly (in about one or two years).[4]

A closely related branch of literature examines how devaluations affect not only export growth, but also other macroeconomic variables such as output, income levels, investment, and

[4] Rose (1991) uses more formal time-series techniques and finds little impact of exchange-rate movements on trade balances. Several papers have also examined specific examples of how devaluations affect export growth. For example, Duttagupta and Spilimbergo (2000), Higgins and Klitgaard (2000), and Barth and Dinmore (1999) examine the impact of the 1997-98 devaluations on Asian exports.

inflation. Agénor and Montiel (1996) provide an excellent summary of this literature and develop a general-equilibrium model showing the various channels by which devaluations can affect the macroeconomy. They also survey empirical work on this subject and conclude that the evidence on whether devaluations are contractionary is mixed.[5] More recently, several papers extend this line of research to examine the impact of "crises" (which are generally defined to include movements in interest rates and/or foreign reserves, as well as exchange rates) on macroeconomic variables. Gupta, Mishra and Sahay (2000) is one of the most recent papers on this subject. Their results suggest that about 40 percent of the currency crises between 1970 and 1990 have been expansionary.[6]

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. Many of these papers focus on "real" linkages between economies, such as trade competition or shifts in the demand for exports. Other papers focus on financial linkages, such as bank lending or mutual fund investment, or on changes in investors' beliefs and behavior. Claessens and Forbes (2001) include recent surveys of this literature, as well as a number of case studies and empirical tests of different cross-country linkages.[7] While almost all of the empirical work on this subject uses macroeconomic data, one exception that is closely related to this paper is Forbes (2000). She examines how the Asian and Russian crises affected stock returns for a sample of over 10,000 companies located around the world. Her results suggest that trade linkages are important determinants of how crises are transmitted internationally.

A fourth relevant branch of literature also focuses on stock returns and measures the extent of exchange-rate exposure for various types of companies. This literature argues that exchange-rate movements can affect stock returns through a number of channels, such as import prices, export prices, and shifts in demand. Rather than estimate each of these channels separately, most of these papers estimate reduced-form, market models of how exchange-rate movements affect stock returns. Dominguez and Tesar (2001) is one of the most recent and

[5] Edwards (1989) also provides an excellent survey of this literature and detailed evaluation of the historical evidence on how devaluations impact a variety of macroeconomic variables. Kamin (1988) is another detailed study and shows that the impact of devaluations on macroeconomic variables fluctuates over time. Calvo and Reinhart (2000) compare the impact of currency crises on macroeconomic variables for emerging markets versus developed countries.

[6] Calvo and Reinhart (2000) compare the impact of currency crises on macroeconomic variables for emerging markets versus developed countries.

[7] In particular, Claessens, Dornbusch, and Park (2001) is an excellent survey of this literature. Glick and Rose (1999) and Forbes (2001) provide evidence of the importance of trade in transmitting crises internationally. Van Rijckeghem and Weder (2001) discuss the role of bank lending, and Kaminsky, Lyons and Schmukler (1999) discuss the role of mutual funds.

thorough examples of this literature.[8] They perform an extensive series of tests to determine the percentage of firms affected by exchange-rate movements, as well as the importance of different firm characteristics. They conclude that about 12-23 percent of firms are significantly exposed to exchange-rate movements. Their estimates of a fairly low level of exposure agree with most work on this subject.

A fifth literature closely 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 and the form of competition.[9] In certain situations, exchange-rate movements may be wholly absorbed in a firm's price-cost margins and have no impact on product prices. Dornbusch (1987) develops these ideas in several simple models, and numerous papers have found evidence of pricing-to-market in specific industries. Goldberg and Knetter (1997) is an excellent survey of the empirical literature on this subject. They conclude that the impact of exchange-rate movements on local currency prices of foreign products varies widely by industry, and that for products shipped to the U.S, the average price response is about one-half the exchange-rate movement.[10]

A final branch of literature related to this paper is the extensive work on various issues related to commodities. For over 150 years economists have tracked commodity prices and attempted to explain their determinants as well as predict future prices. Cashin, McDermott, and Scott (1999) is a recent paper that surveys much of this work and analyses commodity-price cycles. Other papers have focused on the importance of commodities to various countries, and the impact of commodity price movements on a variety of macroeconomic statistics. For example, Edwards (1986) examines how coffee export prices affect Colombia's real exchange rate. Other papers in the industrial organization literature or agricultural economics literature have performed detailed analyses of numerous issues—from cartels to the adoption of new technologies to the impact of El Nino--for specific commodities, countries and/or events.

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:

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[8] Also see Bodnar and Wong (2000) for an overview of empirical issues in estimating exchange-rate exposure. Jorion (1990) is a classic example of this literature.

[9] More recently, several papers have extended this framework to examine how exchange-rate movements affect micro-level variables other than prices. For example, Campa and Goldberg (1999) examine the impact of exchange-rate movements on sectoral investment. Klein, Schuh and Triest (2000) and Goldberg and Tracy (1999) examine the impact on wages and employment.

[10] Knetter (1993) and Marston (1990) are two examples of this literature. One noteworthy study that combines this approach with the work on exchange-rate exposure is Allayannis and Ihrig (2000). They examine how market structure, including export and import competitiveness, affects the exchange-rate exposure of a large sample of U.S. firms.

how do devaluations affect output growth, 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. Moreover, the pricing-to-market literature focuses on differentiated-goods industries in developed countries, undoubtedly due to data limitations for developing countries and its motivation from yen-dollar exchange-rate movements in the 1980's. Moreover, none of these branches of literature has focused on the key tradeoff analyzed in this paper: how devaluations simultaneously give exporters a relative cost advantage in terms of cheaper labor and a cost 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.

III. THE THEORETICAL MODEL

This section develops a model to show how devaluations affect firms' output decisions, profits, and capital investment in the short and long run. It describes firms that produce commodities for export (or any undifferentiated product where the firm has no pricing power), and considers the impact of devaluations on not only firms in the crisis country, but also competing firms located in the rest of the world. Part A of this section models firms' decisions in the short run when their level of capital investment is fixed. Part B models firms' decisions in the long run when they can adjust their levels of capital investment. Part C examines the short-run impact of devaluations, and part D considers the long-run impact. This model and framework form the basis of the empirical tests in Section IV. Before developing the model in detail, the next few paragraphs briefly 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 (hereafter refereed to as r.o.w.). Each firm produces a small share of global output and has no impact on global prices.[11] There is no differentiation between any firms' output, nor any trade barriers or transportation costs. As a result, the commodity's price is determined by global supply and demand and all firms expect the same output price. Firms make their production decisions in two stages. In the short-run, each firm's level of capital is fixed. This

[11] Duttagupta and Spilimbergo (2000) provide empirical support for this assumption during the Asian crisis. They find that export supply prices are insensitive to own quantities but very sensitive to nominal exchange-rate movements.

fixed investment could include anything from planting rubber trees to exploring for natural resources and drilling mines. Given this fixed level of capital, each firm chooses its optimal level 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, so that firms in the same country can have different levels of output and profits. In the longer term, each firm can also adjust its level of capital. Capital is priced in r.o.w. currency and includes a country-specific component (to capture differences in domestic risk and 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, and the increase in total production lowers the global price of the commodity. Firms in the r.o.w. respond by decreasing production, although by less then the aggregate increase by crisis-country firms. Therefore, the aggregate short-run impact of the devaluation on the commodity is to increase global production and decrease the global price. The magnitudes of these effects are determined by the crisis country's share of global production and the share of labor in output. The devaluation also decreases profits for firms in the r.o.w. and increases profits for firms in the crisis country (as long as the price elasticity of global demand is not too small and/or the crisis country's share of global production is not too large).

Over longer periods, however, each of these effects of the devaluation can be reversed. Firms can adjust their levels of capital investment to compensate for the changes in output prices and relative input prices. Since capital is priced in r.o.w. currency, the relative cost of capital increases for firms in the crisis country and can increase by even more than the exchange-rate movement if there is a simultaneous increase in domestic risk or a contraction in lending. If this increase in the cost of capital for crisis-country firms is large enough, it could outweigh the benefits of relatively cheaper labor. 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 actually raise the total cost of production for crisis-country firms so that they decrease output. This would raise the long-run price of the commodity and cause r.o.w. firms to increase production (although by less than the aggregate decrease by crisis-country firms.) In the long run, the devaluation could increase profits for r.o.w. firms and decrease profits for crisis-country firms.

On the other hand, if the cost advantage for crisis-country firms from relatively cheaper labor after the devaluation outweighs the cost disadvantage from relatively more expensive

capital, then the key predictions from the short-run model will also apply in the long run. More specifically, if the firm's capital/labor ratio is small enough or the increase in the cost of capital is fairly small, crisis-country firms would increase output and r.o.w. firms would decrease output. The global commodity price would fall. Profits would increase for firms in the crisis country and decrease for firms in the r.o.w. Therefore, although the model's short-run predictions of the impact of devaluations on output and profits are fairly clear, the long-run predictions depend on capital/labor ratios and the 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 by firms. Firms are assumed to take the global output price as given and are unable to affect this price by adjusting production levels or forming cartels. Similarly, material inputs are priced in r.o.w. currency and exchange-rate movements are fully passed through into the price of these imported inputs. Second, although exogenous shocks can affect global demand for the commodity in each period, the model does not incorporate any direct impact of the devaluation on global demand. More specifically, it assumes that firms export most of their output, so that any domestic contraction resulting from the devaluation will not affect demand. Fourth and finally, all prices are in real terms and there is no allowance for inflation differentials across countries. Therefore, the model assumes that the real impact of the devaluation on relative prices is not eroded by changes in inflation rates.

III.A. The Short-Run with a Fixed Level of Capital[12]

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 firm can begin production and the first unit of output is sold. For example, there is about a six-year lag after coffee is initially planted until the beans can be harvested and sold. To capture this aspect of commodities, I model firms' decisions in two stages. In the short-run, defined as the periods from $t = 1 \ldots T$, a firm's level of capital is fixed. In the long run when $t>T$ (which is modeled in part B) a firm is able to choose its level of capital.[13]

Beginning with this short-run scenario, each firm i has a fixed level of capital $k_i>0$. A firm's output in each period t is determined by its choice of two variable inputs: domestic labor

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

[13] Although the model does not explicitly include entry and exit, firms can set output and capital investment to zero in the long run and therefore "exit" the industry. Entry is captured by allowing firms to increase their level of capital investment in the long run.

($l_{i,t}$) and imported materials ($m_{i,t}$). Output is given by a Cobb-Douglas production function that has decreasing returns to scale[14]:

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

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

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

where P_t is the sale price per unit of output.

Each firm produces identical goods and there is no differentiation between markets (such as barriers to trade or transportation costs). In other words, there is one global market for the good and the price is determined by global supply and demand. Therefore, the global price of the good can be expressed as a function of total global output (Q_t), and to simplify the model solution below, assume that this global price is determined by a constant-elasticity demand function:

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

where Z_t is any period-specific shock to global demand and $1/\varphi$ is the elasticity of demand. The commodity is a normal good, so that $\varphi>0$. Moreover, assume that each firm produces a relatively small fraction of global output and therefore takes input costs and the industry price as given. In other words, each firm assumes that any changes in its own input demands or output quantities will have no affect on input costs or the global output price. These assumptions are fairly accurate descriptions of competition in most commodity industries.

Without loss of generality, assume that firms are located in two "countries": the crisis country (which will devalue its currency) and the rest of the world (hereafter called 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*. Crisis-country and r.o.w. firms face the same price of output (P) and cost of imported materials (s), both of which are expressed in the

[14] Decreasing returns to scale ensures that the most efficient firm does not produce all of global production.

r.o.w. currency that 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 can be expressed as the relative cost of labor in the two countries:

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

so that a devaluation in the crisis country is a decrease in *e*. Equation (2) therefore refers to the profit function for firms in the r.o.w. If the r.o.w. wage is normalized to equal one, then the production function and profit-maximization equation for firms in the crisis country (corresponding to equations 1 and 2 for firms in the r.o.w) are:

(5) $$\tilde{q}_{j,t} = A_j \tilde{k}_j^{\alpha} \tilde{l}_{j,t}^{\beta} \tilde{m}_{j,t}^{\gamma} \qquad \text{and}$$

(6) $$\underset{\tilde{l},\tilde{m}}{Max}\, \tilde{\pi}_{j,t}^{SR} = P_t \tilde{q}_{j,t} - e_t \tilde{l}_{j,t} - s_t \tilde{m}_{j,t}$$

Combining equations (1) through (6), it is straightforward to solve each firm's short-run profit-maximization problem. For a fixed level of investment and given output price, each firm chooses its optimal combination of the two variable inputs and output quantity in order to maximize profits in period *t*. The optimal output levels for firms in the r.o.w. and crisis country are:

(7) $$q_{i,t}^{SR} = \left[P_t^{\beta+\gamma} A_i k_i^{\alpha} \left(\frac{\beta}{w_t} \right)^{\beta} \left(\frac{\gamma}{s_t} \right)^{\gamma} \right]^{1/1-\beta-\gamma}$$

(8) $$\tilde{q}_{j,t}^{SR} = \left[P_t^{\beta+\gamma} A_j \tilde{k}_j^{\alpha} \left(\frac{\beta}{e_t} \right)^{\beta} \left(\frac{\gamma}{s_t} \right)^{\gamma} \right]^{1/1-\beta-\gamma}$$

Next, in order to obtain the global output price and quantity produced, assume that there are *n* firms in the r.o.w, and *ñ* firms in the crisis country. Total global output can be expressed as:

(9) $$Q_t = \int_{i=1}^{n} q_{i,t} + \int_{j=1}^{\tilde{n}} \tilde{q}_{j,t}$$

If $\bar{q}$ and $\tilde{\bar{q}}$ are the average quantity produced by each firm in the r.o.w. and crisis country, respectively, the total quantity produced and industry price can be written as:

(10) $$Q_t = n\bar{q}_t + \tilde{n}\tilde{\bar{q}}_t \ , \qquad \text{so that}$$

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

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

where $\xi_t = \left(Z_t^{\beta+\gamma} \beta^{\beta} \gamma^{\gamma} \right)^{1/1-\beta-\gamma+\varphi(\beta+\gamma)}$ and $\xi_t' = \left[\frac{Z_t^{1-\beta-\gamma}}{\left(\beta^{\beta}\gamma^{\gamma}\right)^{\varphi}} \right]^{1/1-\beta-\gamma+\varphi(\beta+\gamma)}$

and $\bar{A}, \bar{k}, \tilde{\bar{A}},$ and $\tilde{\bar{k}}$ are the productivity parameters and investment levels for the mean-quantity producing firm in the r.o.w. and crisis country, respectively. The equation for Q_t^{SR} yields the intuitive result that global output of the commodity is greater for: a lower cost of either variable input; a greater number of firms in either country; or a larger average output for firms in either country (which is, in turn, determined by average productivity levels and the amount of fixed capital investment.) The equation for P_t^{SR} shows that the global price is greater for a higher cost of either variable input or lower aggregate output from either country. The formula also has the appealing result that in the short-run, price is determined by the variable cost of production in each country weighted by total output in each country.

III.B. The Long-Run with Variable Capital

In periods longer than *T,* firms can adjust their level of capital investment. The cost per unit of capital investment is r_t and $\tilde{r}_t$ in the r.o.w. and crisis-country, respectively, and is fixed at the start of the period. Capital is priced in r.o.w. currency, but can vary across countries due to factors

such as domestic risk, capital market liquidity, capital controls, etc. Firms chose their optimal level of capital ($k_i \geq 0$ and $\tilde{k}_j \geq 0$) to maximize long-run profits (π_T^{LR}) until the next opportunity to adjust their capital levels. To simplify the algebra, assume that there is no discounting and the profit-maximization equations for firms in the two countries are:

(13) $$\underset{k}{Max}\,\pi_{i,T}^{LR} = E\left[\int_{t=1}^{T}\left(P_t q_{i,t} - w_t l_{i,t} - s_t m_{i,t}\right) - rk_i\right]$$

(14) $$\underset{\tilde{k}}{Max}\,\tilde{\pi}_{j,T}^{LR} = E\left[\int_{t=1}^{T}\left(P_t \tilde{q}_{j,t} - e_t \tilde{l}_{j,t} - s_t \tilde{m}_{j,t}\right) - \tilde{r}\tilde{k}_j\right]$$

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 $E[Z_t]=Z$.) As a result, prices from t=1 to T are expected to be constant and $E[P_t]=P$. Substituting the short-run solutions from equations (7), (8), (11), and (12) into equations (13) and (14), the optimal levels of capital investment for firms in the r.o.w. and crisis country are:

(15) $$k_i = \zeta\left(\frac{A_i P}{w^{\beta} s^{\gamma} r^{1-\beta-\gamma}}\right)^{\frac{1}{1-\beta-\gamma-\alpha}} \quad \text{and}$$

(16) $$\tilde{k}_j = \zeta\left(\frac{A_j P}{e^{\beta} s^{\gamma} \tilde{r}^{1-\beta-\gamma}}\right)^{\frac{1}{1-\beta-\gamma-\alpha}}$$

with $$\zeta = \left(\frac{T\alpha\left[\left(\beta^{\beta}\gamma^{\gamma}\right)^{\frac{1}{1-\beta-\gamma}} - \left(\beta^{1-\gamma}\gamma^{\gamma}\right)^{\frac{1}{1-\beta-\gamma}} - \left(\beta^{\beta}\gamma^{1-\beta}\right)^{\frac{1}{1-\beta-\gamma}}\right]}{1-\beta-\gamma}\right)^{\frac{1-\beta-\gamma}{1-\beta-\gamma-\alpha}}$$

As a result, firms will chose a greater level of capital investment if: they are more productive; the expected output price is higher; or any of the input prices are lower.

Next, using equations (15) and (16) it is possible to solve for each firm's optimal long-run output level at each time *t*. As long as the realization of each input price and the global

demand shock are equal to their expected values, the solutions for firms in the r.o.w. and crisis-country are:

(17) $$q_i^{LR} = \Psi\left(\frac{A_i P^{\beta+\gamma+\alpha}}{w^{\beta} s^{\gamma} r^{\alpha}}\right)^{1/1-\beta-\gamma-\alpha}$$

(18) $$\tilde{q}_j^{LR} = \Psi\left(\frac{A_j P^{\beta+\gamma+\alpha}}{e^{\beta} s^{\gamma} \tilde{r}^{\alpha}}\right)^{1/1-\beta-\gamma-\alpha}$$

with $$\Psi = \left(\beta^{\beta}\gamma^{\gamma}\zeta^{\alpha}\right)^{1/1-\beta-\gamma}.$$

As a result, firms will chose a higher output level if: they are more productive; the output price is higher; or any input prices are lower. Finally, the global quantity and price in the long run is:

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

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

where: $$\Phi = \left[Z^{\beta+\gamma+\alpha}\left(\beta^{\beta}\gamma^{\gamma}\zeta^{\alpha}\right)^{1-\beta-\gamma-\alpha/1-\beta-\gamma}\right]^{1/1-\beta-\gamma-\alpha+\varphi(\beta+\gamma+\alpha)}$$

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

The equation for Q^{LR} yields the intuitive result that global output is greater for: a lower cost of any of the three inputs; a greater number of firms in either country; or a larger average output level in either country (which is, in turn, determined by average productivity levels.) The equation for P^{LR} shows that the global price is greater for a higher cost of any input or a lower aggregate output level in either country. The formula also has the appealing result that in the long run, the global price is determined by the total cost of production in each country weighted by total output in each country.

III.C. The Short-Run Impact of Devaluations on Firms around the World

The remainder of this section uses the model developed above to predict the impact of devaluations in the crisis country on firms in the crisis country and the r.o.w. This subsection examines the short-run impact of devaluations (when capital is fixed) and the next subsection examines the long-run impact (when firms adjust their level of capital.) In the short-run, the main impact of devaluations is to reduce the relative cost of labor in the crisis country. To simplify notation and clarify intuition, I use the abbreviations:

$$\hat{Q}_t^{Row,SR} = n\left(\frac{\bar{A}\bar{k}^{\alpha}}{w^{\beta}s^{\gamma}}\right)^{1/1-\beta-\gamma}, \quad \hat{Q}_t^{Crisis,SR} = \tilde{n}\left(\frac{\tilde{\bar{A}}\tilde{\bar{k}}^{\alpha}}{e_t^{\beta}s^{\gamma}}\right)^{1/1-\beta-\gamma}, \quad \text{and } \hat{Q}_t^{World,SR} = \hat{Q}_t^{Row,SR} + \hat{Q}_t^{Crisis,SR}$$

to represent functions of the total quantity produced in the r.o.w., crisis country, and entire world in the short run.

To begin, assume that firms have already chosen their level of investment (so $0<t<T$) and there is an unexpected devaluation in the crisis country. Also assume that there are no exogenous shocks to global demand for the commodity (i.e. there is no impact of the devaluation on Z_t in equation (3).)[15] The immediate impact of the exchange-rate movement on global output and prices is:

$$(21) \qquad \frac{dQ_t^{SR}}{de_t} = -\Gamma\frac{\beta}{e_t}\frac{\hat{Q}_t^{Crisis,SR}}{\left(\hat{Q}_t^{World,SR}\right)^{\varphi(\beta+\gamma)/1-\beta-\gamma+\varphi(\beta+\gamma)}} < 0$$

[15] 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 growth, incomes and/or demand in these developed countries. In select cases, such as the Russian devaluation in August of 1998, this assumption is less realistic. For these situations, it is straightforward to extend the model and allow exchange-rate movements to affect global demand.

(22) $$\frac{dP_t^{SR}}{de_t} = \Gamma' \frac{\beta}{e_t} \frac{\hat{Q}_t^{Crisis,SR}}{\left(\hat{Q}_t^{World,SR}\right)^{1-\beta-\gamma+\varphi \,/\, 1-\beta-\gamma+\varphi(\beta+\gamma)}} > 0$$

where $$\Gamma = \frac{\xi}{1 - \beta - \gamma + \varphi(\beta+\gamma)} \quad \text{and} \quad \Gamma' = \Gamma\varphi .$$

In the short run, devaluations in the crisis country (a decrease in *e*) cause global output of the commodity to increase and the global price to fall. The impact of devaluations on *Q* and *P* is proportional to the share of labor in production and the share of global output produced by firms in the crisis-country. Since the only impact of devaluations on input prices in the short-run is to reduce the relative cost of labor in the crisis country, it is intuitive that the impact of devaluations is proportional to the share of the relatively cheaper input in global production.

The effect of devaluations on short-run output quantities for firms in the r.o.w. and crisis country are:

(23) $$\frac{dq_{i,t}^{SR}}{de_t} = \left(\frac{q_{i,t}^{SR}}{1-\beta-\gamma}\right)\left(\frac{(\beta+\gamma)}{P_t^{SR}}\frac{dP_t^{SR}}{de_t}\right) > 0$$

(24) $$\frac{d\tilde{q}_{j,t}^{SR}}{de_t} = \left(\frac{\tilde{q}_{j,t}^{SR}}{1-\beta-\gamma}\right)\left(\frac{(\beta+\gamma)}{P_t^{SR}}\frac{dP_t^{SR}}{de_t} - \frac{\beta}{e_t}\right) < 0$$

Movements in the exchange rate affect output quantities for firms in the r.o.w only through movements in the global commodity price. Therefore, a devaluation in the crisis country causes firms in the r.o.w. to reduce output in the short run. On the other hand, movements in the exchange rate affect firms in the crisis country through two channels in the short run: changes in the global commodity price and changes in the relative cost of labor (captured in the last term of equation (24).) 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 the other inputs, as well as relative to firms in the r.o.w., and causes crisis-country firms to increase production. Some algebraic manipulation shows that this second "input-price" effect always dominates the first "output-price" effect. In other words, devaluations unambiguously cause crisis-country firms to increase output quantities in the short run. Finally, since global output increases and output by r.o.w. firms decrease, output by crisis-country firms must increase by even more than the increase in global production. In other words,

after the devaluation, firms in the crisis country will sell to customers/markets that were previously serviced by firms in the r.o.w.

In order to more fully examine the impact of devaluations on individual firms, it is also useful to consider the effect on short-run profits. If short-run profits are defined in equations (2) and (6), which do not include the cost of capital investment, then the short-run impact of devaluations on profits for firms in the r.o.w. and crisis country are:

(25) $$\frac{d\pi_{i,t}^{SR}}{de_t} = \left(\frac{\pi_{i,t}^{SR}}{1-\beta-\gamma}\right)\left(\frac{1}{P_t^{SR}}\frac{dP_t^{SR}}{de_t}\right) > 0 \quad \text{and}$$

(26) $$\frac{d\tilde{\pi}_{j,t}^{SR}}{de_t} = \left(\frac{\tilde{\pi}_{j,t}^{SR}}{1-\beta-\gamma}\right)\left(\frac{1}{P_t}\frac{dP_t^{SR}}{de_t} - \frac{\beta}{e_t}\right) < 0 \text{ if } 1/\varphi > 1 \text{ and/or } \frac{\hat{Q}_t^{Crisis,SR}}{\hat{Q}_t^{World,SR}} < X \text{ ,}$$

where $$X = \frac{1-\beta-\gamma+\varphi(\beta+\gamma)}{\varphi}.$$

Therefore, devaluations unambiguously decrease short-run profits for firms in the r.o.w. This is not surprising because devaluations have no effect on r.o.w. input costs, while devaluations will lower r.o.w output quantities and the global price (as shown in equations (23) and (22), respectively). On the other hand, devaluations increase short-run profits for firms in the crisis country 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 of the devaluation on global prices is fairly small (since the crisis country only produces a small fraction of global output), then devaluations increase short-run profits for firms in the crisis country.

There is a lengthy debate in the development literature on whether the elasticity condition $(1/\varphi > 1)$ in equation (26) holds for most commodities. Estimates of the price elasticity of demand are highly dependent on characteristics of the individual commodity, how narrowly it is defined, and the length of time constituting "short run". In most cases, however, the output-share condition $\left(\hat{Q}_t^{Crisis,SR}/\hat{Q}_t^{World,SR} < X\right)$ is satisfied because the production of most commodities is widely dispersed across countries. Even for commodities with extremely low price elasticities of demand and extremely low output shares for labor and materials, this condition should be

satisfied.[16] Moreover, 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 percent of the world market for any commodity (based on 3-digit SITC classifications). Most countries have little control over the prices at which they sell their commodity exports. Therefore, devaluations are generally expected to increase short-run profits for firms in the crisis country. Devaluations unambiguously decrease short-run profits for firms in the r.o.w.

III.D. The Long-Run Impact of Devaluations on Firms around the World

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 in the crisis country, and when $t \geq T$, firms can adjust their capital investment accordingly. More specifically, assume that:

$$(27) \qquad \frac{dr_t}{de_t} = 0 \qquad \text{and} \qquad \frac{d\tilde{r}_t}{de_t} < 0 \ .$$

In other words, devaluations in the crisis-country have no impact on the cost of capital for firms in the r.o.w., but increase the cost of capital for firms in the crisis country. The cost of capital could increase in the crisis country for a number of reasons. For example, if capital investment is financed in r.o.w. currency and/or imported from abroad, then the crisis-country interest rate would move in proportion to the devaluation. If devaluations also raise domestic interest rates, such as 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 initial exchange-rate movement.

To simplify notation and clarify intuition in the remainder of this section, I use the abbreviations:

$$\hat{Q}_t^{Row,LR} = n\left(\frac{\overline{A}}{w^{\beta} s^{\gamma} r^{\alpha}}\right)^{1/1-\beta-\gamma-\alpha}, \ \hat{Q}_t^{Crisis,LR} = \tilde{n}\left(\frac{\overline{\tilde{A}}}{e_t^{\beta} s^{\gamma} \tilde{r}_t^{\alpha}}\right)^{1/1-\beta-\gamma-\alpha}, \text{ and } \hat{Q}_t^{World,LR} = \hat{Q}_t^{Row,LR} + \hat{Q}_t^{Crisis,LR} .$$

[16] For example, if φ=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, especially for an emerging market), then X=.60. In other words, even using extreme parameter values which make it more difficult to satisfy this condition, a country would have to export over 60 percent of the global share of a commodity in order for $\hat{Q}_t^{Crisis,SR} / \hat{Q}_t^{World,SR} > X$.

These are functions of long-run output in the r.o.w., crisis country and world, respectively, and correspond directly to the short-run abbreviations in the last section. The long-run impact of a one-time exchange-rate movement on global output and the commodity price is:

(28) $$\frac{dQ_t^{LR}}{de_t} = -\Lambda\left(\frac{\beta}{e_t} + \frac{\alpha}{\tilde{r}_t}\frac{d\tilde{r}_t}{de_t}\right)\frac{\hat{Q}_t^{Crisis,LR}}{\left(\hat{Q}_t^{World,LR}\right)^{\frac{\varphi(\beta+\gamma+\alpha)}{1-\beta-\gamma-\alpha+\varphi(\beta+\gamma+\alpha)}}} < 0 \quad \text{if} \quad \frac{\beta}{e_t} > \frac{\alpha}{\tilde{r}_t}\frac{d\tilde{r}_t}{de_t}$$

(29) $$\frac{dP_t^{LR}}{de_t} = \Lambda'\left(\frac{\beta}{e_t} + \frac{\alpha}{\tilde{r}_t}\frac{d\tilde{r}_t}{de_t}\right)\frac{\hat{Q}_t^{Crisis,LR}}{\left(\hat{Q}_t^{World,LR}\right)^{\frac{1-\beta-\gamma-\alpha+\varphi}{1-\beta-\gamma-\alpha+\varphi(\beta+\gamma+\alpha)}}} > 0 \quad \text{if} \quad \frac{\beta}{e_t} > \frac{\alpha}{\tilde{r}_t}\frac{d\tilde{r}_t}{de_t}$$

where $$\Lambda = \frac{\Phi}{1 - \beta - \gamma - \alpha + \varphi(\beta+\gamma+\alpha)} \quad \text{and} \quad \Lambda' = \Lambda\varphi \ .$$

In other words, devaluations can either increase or decrease global output and prices in the long run based on the relative shares of labor and capital in production and the impact of the devaluation 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. This result directly follows from the fact that relative prices remain constant in the r.o.w., while the relative cost of labor decreases and the cost of capital increases in the crisis country. If the cost advantage from cheaper labor outweighs the cost disadvantage of more expensive capital, then the total cost of production for crisis-country firms will decrease and cause the global price to fall (and demand for the commodity to increase.) Equations (28) and (29) also show the intuitive result that the impact of devaluations on global output and prices is greater (in either direction) when the crisis country produces a larger share of global output.

Next, the long-run impact of devaluations on output quantities and capital investment for firms in the r.o.w. is:

(30) $$\frac{dq_{i,t}^{LR}}{de_t} = \left(\frac{q_{i,t}^{LR}}{1-\beta-\gamma-\alpha}\right)\left(\frac{(\beta+\gamma+\alpha)}{P_t^{LR}}\frac{dP_t^{LR}}{de_t}\right) > 0 \quad \text{if} \quad \frac{\beta}{e_t} > \frac{\alpha}{\tilde{r}_t}\frac{d\tilde{r}_t}{de_t}$$

(31) $$\frac{dk_{i,t}^{LR}}{de_t} = \left(\frac{k_{i,t}^{LR}}{1-\beta-\gamma-\alpha}\right)\left(\frac{1}{P_t^{LR}}\right)\left(\frac{dP_t^{LR}}{de_t}\right) > 0 \quad \text{if} \quad \frac{\beta}{e_t} > \frac{\alpha}{\tilde{r}_t}\frac{d\tilde{r}_t}{de_t}$$

In the long run, exchange-rate movements continue to affect output quantities for r.o.w. firms, as well as investment levels, only through movements in the global commodity price. Therefore, a devaluation in the crisis country could cause r.o.w. firms to either increase or decrease their output quantities (and corresponding investment levels), based on whether the devaluation leads to a long-run increase or decrease in the global price as determined by the criteria to the right of equation (29). If production is relatively more capital intensive then labor intensive, or if the devaluation causes a large increase in the crisis country's interest rates, then there is a greater chance that the global price increases and r.o.w. firms subsequently increase output and capital investment.

For firms in the crisis country, the impact of the devaluation on output quantities and capital investment is:

$$(32) \qquad \frac{d\tilde{q}_{j,t}^{LR}}{de_t} = \left(\frac{\tilde{q}_{j,t}^{LR}}{1-\beta-\gamma-\alpha} \right) \left(\frac{(\beta+\gamma+\alpha)}{P_t^{LR}} \frac{dP_t^{LR}}{de_t} - \frac{\beta_t}{e_t} - \frac{\alpha}{\tilde{r}} \frac{d\tilde{r}}{de} \right) < 0 \quad \text{if } \frac{\beta}{e} > \frac{\alpha}{\tilde{r}} \frac{d\tilde{r}}{de}$$

$$(33) \qquad \frac{d\tilde{k}_{j,t}^{LR}}{de_t} = \left(\frac{\tilde{k}_{j,t}^{LR}}{1-\beta-\gamma-\alpha} \right) \left(\frac{1}{P_t^{LR}} \frac{dP_t^{LR}}{de_t} - \frac{\beta}{e_t} - \frac{(1-\beta-\gamma)}{\tilde{r}} \frac{d\tilde{r}}{de} \right) < 0$$
$$\text{if } \frac{\beta}{e} > \frac{\alpha}{\tilde{r}} \frac{d\tilde{r}}{de} \text{ and} \left(\frac{1}{\varphi} > \Theta \text{ and/or } \frac{\hat{Q}_t^{C,LR}}{\hat{Q}_t^{W,LR}} < \Theta' \right)$$

where $\Theta, \Theta' = f(\beta, \gamma, \alpha, \varphi, e, \tilde{r}, d\tilde{r}/de)$.

Therefore, the devaluation affects output quantities and capital investment for crisis-country firms through the same global price effect as shown for r.o.w. firms in equations (30) and (31). The devaluation also has two additional effects on crisis-country firms in the long run, however, through changes in the relative costs of labor and capital. Algebraic manipulation shows that the criterion for $d\tilde{q}_{j,t}^{LR} / de_t < 0$ is the same as the criterion for $dP_t^{LR} / de_t < 0$. In other words, a devaluation only increases output for crisis-country firms in the long run if: the share of labor in output is relatively larger than the share of capital and the increase in the cost of capital is not too large. This is an intuitive result. Devaluations will only cause crisis-country firms to increase output if the cost advantage that they gain from relatively cheaper labor is greater than the cost disadvantage from relatively more expensive capital.

The criteria for the devaluation to increase capital investment in crisis-country firms are even more stringent. In this case, not only must the condition for a decline in the global price be satisfied, but some combination of two additional conditions must be met: the global price elasticity of demand must be sufficiently large and/or the share of global output produced by the crisis country must be sufficiently small. In other words, if the devaluation lowers the commodity price, crisis-country firms will only increase their capital levels if the price decline leads to a large enough increase in global demand, or if the impact of the devaluation on global prices is fairly small (since the crisis country only produces a small fraction of global output). As discussed at the end of Section III.C, the output-share condition (that $\hat{Q}_t^{Crisis,SR} / \hat{Q}_t^{World,SR}$ is sufficiently small) is usually satisfied because the production of most commodities is rarely concentrated in an individual country.

To complete this analysis of the long-run impact of devaluations, equations (34) and (35) report the effects on long-run profits for firms in the r.o.w. and crisis country, respectively. Long-run profits are defined as short-run profits plus the cost of capital.

$$(34) \qquad \frac{d\pi_{i,t}^{LR}}{de_t} = \left(\frac{\pi_{i,t}^{LR}}{1-\beta-\gamma-\alpha} \right) \left(\frac{1}{P_t^{LR}} \frac{dP_t^{LR}}{de_t} \right) > 0 \quad \text{if} \quad \frac{\beta}{e_t} > \frac{\alpha}{\tilde{r}_t} \frac{d\tilde{r}_t}{de_t}$$

$$(35) \qquad \frac{d\tilde{\pi}_{j,t}^{LR}}{de_t} = \left(\frac{\tilde{\pi}_{j,t}^{LR}}{1-\beta-\gamma-\alpha} \right) \left(\frac{1}{P_t} \frac{dP_t^{LR}}{de_t} - \frac{\beta}{e_t} - \frac{\alpha}{\tilde{r}} \frac{d\tilde{r}}{de} \right) < 0$$

$$\text{if } \frac{\beta}{e} > \frac{\alpha}{\tilde{r}} \frac{d\tilde{r}}{de} \text{ and} \left(\frac{1}{\varphi} > \Omega \text{ and/or } \frac{\hat{Q}_t^{C,LR}}{\hat{Q}_t^{W,LR}} < \Omega' \right)$$

where Ω and $\Omega' = f(\beta, \gamma, \alpha, \varphi, e, \tilde{r}, d\tilde{r}/de)$.

The sign of $d\pi_{i,t}^{LR} / de$ is the same as the sign of dP_t^{LR} / de. Therefore, if the devaluation reduces the global commodity price, as specified in the condition to the right of equation (34), then profits decrease for r.o.w. firms in the long run. On the other hand, the sign of $d\tilde{\pi}_{j,t}^{LR} / de$ is the opposite of the sign of dP_t^{LR} / de if the global elasticity of demand for the commodity is large enough or the crisis country's share of global output is small enough. As discussed above, the output-share condition is satisfied for most commodities. Therefore, in most cases, devaluations will have the opposite impact on long-run profits for firms in the crisis country versus firms in the r.o.w. For example, if capital is used more intensively in production than labor and/or the

devaluation substantially raises interest rates in the crisis-country, then the devaluation will: increase the global output price; increase profits for firms in the r.o.w.; and decrease profits for firms in the crisis country.

To summarize, Sections III.C. and III.D. have used the model developed in Sections III.A. and III.B. to explore the impact of devaluations on firms around the world. In the short-run, when each firm's level of capital investment is fixed, the model's predictions are fairly straightforward. The devaluation reduces the relative cost of labor in the crisis country and firms in the crisis country increase production. Lower input costs reduce the global price of the commodity, and this effect is proportional to the size of the crisis country in global production and the relative share of labor in production. Since the global output price falls and input prices for firms in the r.o.w. remain constant, firms in the r.o.w. reduce production. The increase in output by crisis-country firms is greater than the decrease in output by r.o.w. firms, so that global production increases. Short-run profits unambiguously decrease for firms in the r.o.w. Short-run profits will generally increase for firms in the crisis country (as long as the country's share in global output is relatively small and/or the global elasticity of demand is not too small.)

In the long run, however, firms are able to adjust their levels of capital investment and the impact of devaluations will depend on production parameters and changes in relative input costs. Not only do devaluations reduce the relative cost of labor in the crisis country, but they also increase the relative cost of capital (possibly by more than the initial exchange-rate movement.) Therefore, the long-term impact of devaluations hinges on the relative importance of labor and capital in production and the impact of devaluations on crisis-country interest rates. If the cost advantage for crisis-country firms from relatively cheaper labor outweighs the cost disadvantage from relatively more expensive capital, then the key predictions from the short-run model also apply in the long run. Firms in the crisis country increase output and investment and their profits rise. Firms in the r.o.w. decrease output and investment and their profits decrease. On the other hand, if the cost disadvantage from relatively more expensive capital outweighs the cost benefit from reduced wages in the crisis country, then each of these predictions is reversed. Firms in the crisis country decrease production and investment, and their profits fall. Firms in the r.o.w. increase output and investment, and their profits rise. Therefore, the long-run impact of devaluations hinges on the importance of capital and labor in production and the relative changes in the costs of these two inputs.

IV. EMPIRICAL TESTS

This section tests four of the model's key predictions. Part A describes the data set, devaluation episodes, and commodity groups used for the analysis. Part B examines how devaluations affect output growth for firms in the crisis country and r.o.w. Part C analyzes how devaluations impact profit growth. Parts C and D assess the expected long-run impact of devaluations by examining changes in firms' capital investment and stock returns, respectively. 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 will impact output quantities, profitability, and capital investment for firms around the world.

IV.A. The Events, Data, and Commodity Groups

The empirical analysis focuses on "major devaluations" in 8 countries between January 1, 1997 and December 31, 1999.[17] "Major devaluations" are defined as episodes where the local currency/U.S. dollar exchange rate increased by 15 percent or more within any 4-week period.[18] Table 1 lists the countries with major devaluations in chronological order, as well as the months when the devaluations occurred.[19] This list of major devaluation episodes includes the standard events during this period that are typically analyzed in the currency-crisis literature: several Asian countries in 1997-98; South Africa and Russia in 1998; and Brazil in 1999.

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.[20] The firm-level information includes data for over 1,100 firms and is from the *Worldscope* database on CD-ROM published by Primark (2001). Table 2 shows the distribution of firms (and average firm size) by country and region.

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[17] This time period was chosen to correspond with the available firm-level data.

[18] The exchange-rate data is from the *Datastream* database.

[19] After a major devaluation, the next four 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 Ecuador's crisis starting in January of 1999. This event is excluded because there is no firm-level data for Ecuador and Ecuador exports less than 1 percent of total global exports for each of the commodity groups in the sample.

[20] These commodity groups were chosen based on three criteria: (1) firm-level data existed for at least 20 companies in the 3-digit industry; (2) at least 5 percent 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 theoretical model. Several of the resulting industry groups are not typical commodities, but as shown in the sensitivity tests below, the results are robust across stricter and looser definitions of commodities (except that natural gas and crude petroleum is occasionally an outlier).

Although the sample includes information from 51 countries and 9 regions, coverage of many of the smaller and/or developing economies is extremely limited. (For example, there is only 1 firm in the sample for Jordan, Luxembourg, Morocco, Peru, and Zimbabwe.) Table 3 provides additional information on the distribution of firms by commodity group in the devaluing countries, as well as corresponding 3-digit SIC codes. As shown in the table, many of the commodities are produced by more than one country that devalued its currency between 1997 and 2000.

The remainder of this section uses the 10 commodity groups listed in Table 3 to examine the impact of the devaluation events listed in Table 1 on output, profits, capital 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 the demand for natural gas and oil; a severe monsoon in Asia could decrease the global supply of edible oils; and technological advances (such as fiberoptics) can reduce the demand for specific minerals (such as copper). By focusing on within-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.

IV.B. Test of Prediction 1: The Short-run Impact of Devaluations on Firm Output

Model Prediction 1: Immediately after devaluations, commodity-exporting firms in the devaluing country increase output and competing firms in other countries decrease output. See equations (23) and (24).

To test this prediction, Table 4 begins by listing average output growth for firms in countries that devalued their currencies (in the given year) versus output growth for firms in countries that did not devalue their currencies. 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.[21] The first row of the table reports mean output growth for the two groups of firms for the entire sample. The lower rows disaggregate average output growth into the 10 commodity groups defined in Table 3. 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.

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

Table 4 shows that average annual output growth for firms in countries that recently devalued was 21 percent, while output growth for firms in countries that did not recently devalue was 8 percent. When output growth is disaggregated by commodity group, 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 percent, while output growth for firms in non-devaluing countries averaged only 4 percent. Moreover, the z-statistics reported in the right-hand column are significant (at the 5 percent 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 different than those for firms in non-devaluing 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:

$$(36) \qquad \Delta q_{i,t} = \theta_0 + \theta_1 Devalue_{i,t-1} + \theta_2 Devalue_{i,t} + \theta_3 Devalue_{i,t+1} + \theta_4 Inflation_{i,t} + \boldsymbol{\eta}_t + \varepsilon_{i,t}$$

where $\Delta q_{i,t}$ is output growth for company i in period t; $Devalue_{i,t-1}$ is a dummy variable equal to 1 if the country where firm i is located will have a crisis in the next period; $Devalue_{i,t}$ is a dummy variable equal to 1 if the country where firm i is located had a crisis in period t; $Devalue_{i,t+1}$ is a dummy variable equal to 1 if the country where firm i is located had a crisis 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 in devaluing countries had significantly higher or lower output growth in the year of the devaluation or the year immediately following the devaluation. The inflation variable captures any impact of changes in the price level on reported output growth.[22] The period dummy variables capture any global shifts in supply or demand that affect all firms in the sample in any period.

Table 5 reports estimates of equation (36). 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 equation (36) is estimated separately for each of

[22] Inflation is measured as the annual percent change in the consumer price index as reported in line 64..xzf of the International Monetary Fund's *International Financial Statistics.* The reporting period is adjusted to correspond to the firm's financial year. As shown in the sensitivity analysis, using the producer price index instead of the consumer price index has no significant impact on results (although it decreases the sample size).

the 10 commodity groups. When the model is estimated for the entire sample of firms, using either the pooled cross-section or fixed or random effects, $Devalue_{i,t}$ is always positive and significant at the 1 percent level. This suggests that when a country devalues its currency, domestic firms have significantly higher output growth (in that year) than firms in non-devaluing countries. The size of this effect can be large. The pooled cross-section estimates show that annual output growth is 11 percent greater, on average, for firms in the devaluing country. Moreover, when equation (36) is estimated separately for each of the 10 commodity groups, the coefficients on $Devalue_{i,t}$ remain positive for each of the industry groups (and are significant at the 10 percent level in 40 percent of the industries). This suggests that within most industries, firms in countries that devalued had higher output growth than competitors in countries that did not devalue. For example, estimates for the first commodity group indicate that output growth for rubber plantations in devaluing countries was 27 percent greater than output growth in rubber plantations located elsewhere.

The coefficients on the other devaluation variables also show several interesting patterns. When the model is estimated for the entire sample of firms, the coefficients on $Devalue_{i,t-1}$ and $Devalue_{i,t+1}$ are always negative (and the coefficient on the former is significant at the 5 percent level). The estimates in the lower section of the table, however, show that the sign of these estimates fluctuates across industry groups. The coefficient on $Devalue_{i,t-1}$ is actually positive in 7 of the 10 commodity groups, and the coefficient on $Devalue_{i,t+1}$ is positive in 6 of the 10 commodity groups. 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 of industries.

Table 6 tests for this effect in the first of an extensive series of sensitivity tests. The first row of the table repeats the base results (using random effects) from the top of Table 5. 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. This suggests that when firms producing natural gas and crude petroleum are excluded from the sample, there is no significant relationship between devaluations and output growth in the year before or after the devaluation, although there continues to be a positive relationship in the year of the devaluation. Next, to test if any other industry groups affect these estimates, I reestimate the model and exclude one commodity group at time (both with and without firms in 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 significant of $Devalue_{i,t-1}$ and $Devalue_{i,t+1}$ are highly dependent on the industries included in the analysis.

Therefore, firm profit growth is significantly higher during the year of a devaluation, independent of which industries are included in the sample. It is worth emphasizing that even though devaluations do not appear to have a significant effect on output growth in the year after a crisis, the one-time increase in output growth during the crisis generates a long-term increase in output levels.

The remainder of Table 6 reports a sample of results from an additional series of sensitivity tests. Row 3 adds a control variable for firm size (assets in the current year denominated in dollars). Row 4 measures inflation using an index of producer prices instead of consumer prices. The remaining columns report a subset of tests examining the robustness of the results across regions, countries, and different income groups. Rows 5 and 6 include regional and country dummy variables, respectively. Row 7 excludes OECD countries from the sample. Row 8 and 9 report results for only middle-income and low-income countries, as defined in the World Bank's *World Development Report* (2001). The final row reports results for only Asia. I also examine the impact of excluding: each country, each region, each devaluation event, the inflation variable, the period dummy variables, and/or the forward and lagged effect of devaluations.

In each of these sensitivity tests, the central results do not change. In the year of a devaluation, firms in the crisis country have higher rates of output growth than firms in the rest of the world. On the other hand, the negative coefficients on the forward and lagged devaluation variables are generally not robust. This suggests that output growth in the years preceding devaluations and following devaluations is not significantly different for firms in the crisis country. 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.

IV.C. Test of Prediction 2: The Short-run Impact of Devaluations on Firm Profits

Model Prediction 2: Immediately after devaluations, operating profits for commodity-exporting firms in the devaluing country increase and operating profits for competitors in other countries decrease.[23] *See equations (25) and (26).*

To test this prediction, I use the same strategy as used in section B to analyze how devaluations affect firms' output growth. Table 7 begins by listing average growth in operating profits for firms in countries that devalued their currencies (in the given year) versus firms in countries that did not devalue their currencies. Average growth in operating profits is measured as

[23] 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.

the annual percent change in net sales and revenues minus the cost-of-goods sold.[24] 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. The first row of the table reports mean profit growth in the two groups of firms for the entire sample. The lower rows disaggregate operating profit growth into the 10 commodity groups.

Table 7 shows that mean annual profit growth for firms in countries that recently devalued was 23 percent, compared to 8 percent for firms in countries that did not recently devalue. The z-statistic reported in the right-hand side column indicates that this difference is highly significant. When average profit growth is disaggregated by industry, the differences are even more striking. 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 percent, on average, for firms in devaluing countries, while profits decreased by 1 percent for firms in the rest of the world. The z-statistics show that the differences in profit growth for firms in devaluing countries versus non-devaluing countries are significant (at the 10 percent level) in 6 of the 10 industries.

Next, to control for inflation, annual shocks to profits, and the forward and lagged effect of devaluations, I estimate the model:

$$(37) \qquad \Delta\pi_{i,t} = \theta_0 + \theta_1 Devalue_{i,t-1} + \theta_2 Devalue_{i,t} + \theta_3 Devalue_{i,t+1} + \theta_4 Inflation_{i,t} + \eta_t + \varepsilon_{i,t}$$

where $\Delta\pi_{i,t}$ is growth in operating profits for company i in period t; and each of the other variables are defined after equation (36). Results are reported in Table 8 and support the conclusions from Table 7. When the model is estimated using a pooled cross-section, fixed-industry effects or random-industry effects for the entire sample of commodity firms (as reported in the top of the table), then operating profit growth for firms in the devaluing country is significantly higher than for firms in other countries (during the year of the devaluation). Moreover, the magnitude of this effect can be large. The random-effects estimates suggest that operating profit growth was 17 percent higher for firms in devaluing countries. This impact of devaluations on profit growth disappears after one year, however, although the level of profits remains higher indefinitely.

When equation (37) is estimated separately for each of the 10 commodity groups (in the bottom of Table 7), the coefficients on $Devalue_{i,t}$ remain positive for 9 of the industries (and

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

significant at the 10 percent level for half of 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 on operating profits can be large. For example, profit growth in firms producing edible oils and fats was 20 percent higher for firms in the devaluing country than in the rest of the world (in the year of the devaluation). The coefficients on $Devalue_{i,t-1}$ and $Devalue_{i,t+1}$ continue to have mixed signs and significance (as seen for the analysis of output growth).

To test the robustness of these results, Table 9 repeats the same series of sensitivity tests performed for the analysis of output growth in Table 6. I also repeat the extensive series of tests outlined in the above discussion, but not explicitly reported in the tables. In each of these regressions, the central results do not change (although the magnitude of the coefficients does fluctuate). Immediately after devaluations, firms in the crisis country have higher profit growth 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. Moreover, these results support the assumption discussed in some detail in section III. C. One of the conditions for devaluations to increase short-run profits for firms in the crisis country is that the devaluing country must not export too large a share of global production (and/or the price elasticity of demand must be greater than 1). As mentioned above, the production of most commodities is not concentrated in any one country, so that in most cases, this condition should be satisfied. This series of empirical tests supports this conclusion. Immediately after devaluations, operating profit growth is significantly higher for firms in the devaluing country than competitors in the rest of the world.

IV.D. Test of Prediction 3: The Impact of Devaluations on Firms' Capital Investment

Model Prediction 3: After devaluations, commodity-exporting firms in the devaluing country increase capital investment and competing firms in other countries decrease capital investment if: labor's share in output is greater than capital's share and the increase in the crisis-country's cost of capital is small. See equations (31) and (33).[25]

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 capital investment, tests of this prediction can also be

[25] 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.

interpreted as indicators of the long-run impact of devaluations on output.[26] For comparability with the previous two sections, and as a preliminary analysis of this prediction, Table 10 reports mean growth in capital investment for firms in countries that devalued in the given year versus firms in countries that did not devalue. Growth in capital investment is measured as the annual percent change in net plant, property and equipment.[27] In contrast to Tables 4 and 7 (which performed this comparison for output and profit growth), there is no clear pattern in capital growth rates for firms in devaluing countries versus firms in the r.o.w. In the full sample, capital growth is virtually identical for the two groups of firms. When the analysis is disaggregated by individual commodity groups, mean growth in capital investment is greater for firms in devaluing countries in 6 industries, equal in 2 industries, and smaller in the other 2 industries. The z-statistics suggest that any differences across the two groups of firms are never significant at the 5 percent level.

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 profits for firms in the r.o.w. On the other hand, the model's predictions for the impact of devaluations on capital investment were ambiguous and depended on two factors: capital/labor ratios and how the devaluation affected 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 changes in the crisis-country cost of capital are related to changes in capital investment as predicted in the model, Table 11 compares capital growth rates for different sets of firms in the crisis countries. The first two lines of the table divide the sample based on whether the cost of capital in the crisis country increased by more or less than 15 percent after the devaluation.[28] Firms in countries with a larger increase in interest

[26] Unfortunately, since the "long-run" in the model is the amount of time before any new capital investment affects production (which can be several years for commodities), not enough time has elapsed to directly analyze the long-run impact of the devaluations listed in Table 1. Moreover, the firm-level dataset does not have sufficient historical coverage to examine the long-run impact of devaluations that occurred before 1996.

[27] More specifically, gross plant, property and equipment is defined as tangible assets with an ecpsected useful life greater than 1 year which are expected to be used to produce goods for sale or for distribution of services. Net property, plant and equipment is gross plant, property and equipment less accumulated reserves from depreciation, depletion, and amortization.

[28] The cost of capital is measured by the lending interest rate from line 60P..zf of the International Monetary Fund's *International Financial Statistics* on CD-ROM (2001). Data is not available for Brazil, so I substitute the money market rate (line 60B..zf).

rates have slightly lower rates of 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.[29] Firms with higher capital/labor ratios have slower rates of capital growth than firms with lower capital/labor ratios (11 percent versus 15 percent), as also expected. Finally, the last four lines of Table 11 compare capital growth rates for firms with different combinations of capital/labor ratios and changes in interest rates. The results support the model's main predictions. Devaluing country firms with low capital/labor ratios and no significant increase in interest rates had the highest rate of growth in capital investment (15 percent). Firms with high capital/labor ratios and a large increase in interest rates had the slowest rate of growth in capital investment (10 percent).

IV.E. Test of Prediction 4: The Impact of Devaluations on Firms' Long-Run Profits

Model 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 greater than capital's share and the increase in the crisis-country's cost of capital is small. See equations (34) and (35).[30]

Unfortunately, not enough time has elapsed since the devaluations in the sample to test this prediction directly (and the dataset does not have sufficient historic coverage to examine these questions for earlier devaluations). On the other hand, if firms' stock prices are based on the total present value of their expected earnings, then the impact of devaluations on firms' stock prices should capture the expected impact of the devaluation on firms' future earnings. Therefore, this section examines how devaluations affect different companies' stock market returns as an indication of how devaluations affect long-term profits. 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 important 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.

[29] 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 to total employees. Total assets are the sum of total current assets, long-term receivables, investment in unconsolidated subsidiaries, other investments, and net property, plant and equipment, calculated in U.S. $ using the fiscal year-end exchange rate. 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 3-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 levels and geographic location).

[30] 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.

As an initial test of how devaluations affect stock returns and expected long-term profits, Table 12 reports mean stock returns (and standard deviations) 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 month and ending on the last day of the month after the devaluation month.[31] (Each country's devaluation month is also listed on the table.) Within each country, the sample of firms is divided into two groups: firms with low capital/labor ratios and firms with high capital/labor ratios. The cutoff between low and high capital/labor ratios is the median ratio for that country (so that the two groups are approximately equally sized.) Finally, the shaded rows at the bottom of the table report average stock returns (weighted and unweighted) for the entire sample of low capital-intensity and high capital-intensity firms.

Most of the patterns in Table 12 agree with the model's predictions. For 6 of the 8 devaluation events, firms with higher capital/labor ratios had worse stock performance than firms with lower capital/labor ratios. Moreover, when returns are averaged across the different crises, firms with lower capital/labor ratios had substantially better stock performance than firms with higher capital/labor ratios. For example, the unweighted estimates (where each country counts as 1 observation) suggest that the average 3-month stock return for firms with higher capital/labor ratios was –34 percent, while the 3-month return for firms with lower capital/labor ratios was –21 percent. 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 IV.D., 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 firms' long-term profitability. Therefore, Table 13 examines stock returns for different groups of firms in an analysis similar to that in Table 11 (which focused on changes in capital growth). The first two lines of the table divide the sample based on whether the cost of capital in the crisis country increased by more or less than 15 percent after the devaluation.[32] Firms in countries with a larger increase in interest rates have substantially worse stock performance (-32 percent versus –8 percent.) The next two lines divide the sample based on whether a firm's capital/labor ratio was greater or less than 400. Firms with higher capital/labor ratios have more negative stock returns than firms with lower capital/labor ratios (-17 percent versus -13 percent).

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

[32] See Section IV.D. for variable definitions.

The last four lines of Table 13 compare stock returns for firms with different combinations of interest-rate movements and capital/labor ratios. These statistics also support the model's predictions. Firms with low capital/labor ratios located in countries with no substantial increase in interest rates have the best stock performance (an average 3-month return of –6 percent). Firms with high capital/labor ratios located in countries with a large increase in interest rates have the worst stock performance (an average 3-month return of –29 percent). In other words, firms in the crisis country tend to be most adversely affected by devaluations if they are more reliant on capital and/or interest rates increase substantially.

As a final analysis, Table 14 examines the impact of devaluations on stock returns for firms located outside of the crisis countries. Since many of these devaluations occurred simultaneously, it is difficult to isolate the impact of each event. Therefore, this table focuses on cross-industry differences in capital/labor ratios to help identify how devaluations interact with capital/labor ratios to affect firms around the world. More specifically, the first column lists average capital/labor ratios for all firms in the crisis countries by commodity group, where industry groups are listed in order of increasing capital/labor intensity. The two columns on the far right list annual returns for all firms in non-devaluing countries from June 1997 through June 1998 (the period of the Asian devaluations) and from July 1998 through July 1999 (the non-Asian devaluations). The table also reports standard deviations and sample sizes. Unweighted and weighted averages are reported at the bottom of the table, where "low K/L" firms are the 5 industries with the lowest K/L ratios, and "high K/L" firms are the 5 industries with the highest K/L ratios.

Although the correlation is not perfect, the table indicates that firms which competed with more labor-intensive goods generally had worse stock performance after devaluations than firms which competed with more capital-intensive goods. For example, between June 1997 and June 1998, firms that competed with the most labor-intensive industry (silver and gold mining) had stock returns of –66 percent, while firms that competed with the most capital-intensive industry (natural gas and crude petroleum) had stock returns of –11 percent. These patterns are clearest in the means reported at the bottom of the table. The weighted mean (during the same period) suggests that firms which competed with the most labor-intensive industries had mean annual returns of –37 percent, while firms that competed with more capital-intensive industries had mean returns of –13 percent. These results suggest that firms around the world are more likely to be negatively affected by devaluations if they compete with crisis-country exports that are more labor-intensive.

V. 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 firms around the world. It focuses on how devaluations affect relative input costs and therefore competitiveness on 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 relative 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 non-devaluing countries, so that they reduce output and have lower profits in the short-run.

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 the devaluation causes a large increase in domestic risk or contraction in domestic lending. In fact, if this increase in the cost of capital for crisis-country firms is large enough, or the crisis-country firms use capital intensively in production, then the disadvantage from more costly capital could outweigh the benefits of relatively cheaper labor. 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 so that they decrease output and have lower profits. Firms in non-devaluing countries would increase output and have higher profits. On the other hand, if firms in the devaluing countries use labor relatively more intensively than capital 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 1,100 firms in 10 commodity groups between 1996 and 2000 to test four of the model's key predictions. Although the empirical analysis is not a formal test of the full model, estimates support its main conclusions. Immediately after devaluations, firms in the crisis country have higher growth rates for output and profits than competing firms in non-devaluing countries. These effects are short-lived, however, and disappear within one year (although the level of output and profits remains 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, after devaluations

crisis-country firms with lower capital/labor ratios in countries that do not have a large increase in interest rates have higher investment growth rates and better stock performance. Crisis-country firms with higher capital/labor ratios in countries with a large increase in interest rates have lower capital investment growth rates and worse stock performance. 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. Moreover, firms in non-devaluing countries tend to be most adversely affected by crises if they compete with labor-intensive goods (which become relatively cheaper in the devaluing countries).

Therefore, although devaluations unambiguously benefit crisis-country firms in the short-run, the long-term effects are ambiguous and firms around the world could either gain or lose competitiveness. The critical determinant of whether crisis-country firms benefit from devaluations (and competitors are harmed) is 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 impact on the trade balance, are contractionary, and have little impact on the rest of the world.

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Table 1
Major Devaluation Events

	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

Notes: (a) "Major devaluation events" are episodes when the country's local currency/U.S. dollar exchange rate increases by 15 percent or more within a 4-week period. After a devaluation event occurs, the next four weeks are excluded, so that there can be, at most, one devaluation event within any 4-week period.
(b) Exchange rate data is from Datastream.
(c) 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 of events since firm-level data is not available for the country and Ecuador exports less than 1 percent of global exports for each of the commodities studied.

Table 2: Firm Sample Information

Region	Country	# Firms	Average Asset Value[1]
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
	Taiwan	26	719,444
Eastern Europe	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
	Venezuela	2	11,820,064
Middle East	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 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	$408,174
	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
	Sweden	5	1,368,383
	Switzerland	6	3,371,978
	United Kingdom	63	2,782,784
Total Sample		***1,128***	***$1,777,259***

Note: (1) Assets measured in U.S. dollars in 1996 (or the closest year available).

Table 3: Sample Information for Devaluing Countries

Industry	Natural Rubber & Gums/Forest Products		Mining for Silver & Gold Ores		Natural Gas & Crude Petroleum		Preserved Fruits & Vegetables		Edible Oils & Fats	
SIC Code	083		104		131		203		207	
	# Firms	% Total	# Firms	% Total	# Firms	% Total	# Firms	% Total	# Firms	% 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 r.o.w. firms	***8***	***34.8%***	***186***	***75.3%***	***233***	***91.8%***	***81***	***87.7%***	***74***	***63.5%***

Industry	Cigarettes		Industrial Inorganic Chemicals		Plastics, Materials & Synthetics		Industrial Organic Chemicals		Fertilizer/ Agricultural Chemicals	
SIC Code	211		281		282		286		287	
	# Firms	% Total	# Firms	% Total	# Firms	% Total	# Firms	% Total	# Firms	% 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 r.o.w. firms	***41***	***75.6%***	***128***	***89.1%***	***176***	***77.3%***	***100***	***79.0%***	***85***	***77.6%***

Note: "Crisis" firms are firms in countries with a major devaluation event between 1996 and 2000 as defined in Table 1. "r.o.w" firms are located in the rest of the world.

Table 4
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 & forest products	Mean output growth	**0.22**	**-0.02**	**-2.41****
	Standard deviation	(0.30)	(0.34)	
Silver & gold ores	Mean output growth	**0.37**	**0.08**	**-0.80**
	Standard deviation	(1.00)	(0.76)	
Natural gas & crude petroleum	Mean output growth	**0.41**	**0.21**	**-2.20****
	Standard deviation	(0.96)	(0.66)	
Preserved fruits & Vegetables	Mean output growth	**0.13**	**0.06**	**-1.80***
	Standard deviation	(0.44)	(0.21)	
Edible oils & 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 & 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)	

Notes: (a) Output growth measured as % change in net sales and revenues measured in local currency. Standard errors are in parentheses.
(b) Devaluing countries are countries that had a major devaluation (as defined in Table 1) 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. * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level.

Table 5
Regression Results: Growth in Firm Output

	Devaluation Dummies				#	
	t-1	t	t+1	Inflation	Observs.	R^2
Pooled cross-section	-0.106**	0.109**	-0.069	0.005**	3,079	0.03
	(0.054)	(0.038)	(0.078)	(0.001)		
Fixed industry effects	-0.082**	0.133**	-0.048	0.005**	3,079	0.02
	(0.040)	(0.037)	(0.051)	(0.001)		
Random industry effects	-0.106**	0.109**	-0.069	0.005**	3,079	0.03
	(0.040)	(0.036)	(0.051)	(0.001)		
Rubber plantations & forest products	0.108*	0.266**	0.125	0.009**	72	0.24
	(0.065)	(0.095)	(0.317)	(0.002)		
Silver & gold ores	-0.081	0.359	0.145	0.006	388	0.02
	(0.135)	(0.272)	(0.272)	(0.008)		
Natural gas & crude petroleum	-0.950*	0.164	-0.939	0.001	613	0.10
	(0.503)	(0.296)	(0.594)	(0.003)		
Preserved fruits & vegetables	0.117	0.036	-0.220**	0.007**	230	0.14
	(0.074)	(0.121)	(0.081)	(0.001)		
Edible oils & fats	0.131**	0.129*	0.041	0.008**	227	0.14
	(0.043)	(0.077)	(0.051)	(0.001)		
Cigarettes	0.029	0.030	-0.167**	0.006**	128	0.16
	(0.047)	(0.060)	(0.042)	(0.002)		
Industrial inorganic chemicals	0.098**	0.056	0.039	0.004	395	0.03
	(0.034)	(0.038)	(0.066)	(0.003)		
Plastics, materials & synthetics	0.036	0.078	0.061	0.005**	508	0.04
	(0.046)	(0.054)	(0.042)	(0.001)		
Industrial organic chemicals	-0.089*	0.150**	0.076	0.009**	271	0.13
	(0.054)	(0.050)	(0.059)	(0.002)		
Fertilizer	0.001	0.114*	-0.063	0.006**	247	0.09
	(0.049)	(0.063)	(0.130)	(0.001)		

Notes: * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level. 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 percent level.

Table 6
Sensitivity Analysis: Growth in Firm Output

	Devaluation Dummies				#	
	t-1	t	t+1	Inflation	Observs.	R^2
Base Estimates (Random Effects)	-0.106** (0.040)	0.109** (0.036)	-0.069 (0.051)	0.005** (0.001)	3,079	0.03
Exclude natural gas & crude petroleum[1]	0.014 (0.035)	0.115** (0.032)	0.037 (0.045)	0.007** (0.001)	2466	0.03
Control for firm size[2]	-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[3]	-0.117** (0.041)	0.142** (0.036)	-0.067 (0.051)	0.002** (0.000)	2949	0.02
Include regional dummy variables[4]	-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[5]	-0.102* (0.060)	0.108* (0.062)	-0.154* (0.087)	0.004** (0.001)	666	0.04
Only low-income countries[5]	0.076 (0.138)	0.209** (0.095)	--- ---	0.004* (0.002)	347	0.08
Only Asia[6]	-0.074* (0.042)	0.115** (0.036)	-0.090* (0.050)	0.005** (0.001)	1277	0.04

Notes: * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level. 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 and are always jointly significant at the 1 percent level.

(1) Excludes natural gas and crude petroleum (SIC group 131).
(2) Firm size measured as total assets in U.S. dollars.
(3) Producer-price index based on line 63..zf in the *International Financial Statistics CD-ROM* published by the International Monetary Fund. Monthly data corresponds to company's reporting period.
(4) Regional dummy variables are the based on the 9 regions listed in Table 2.
(5) Definitions of middle- and low-income countries are based on classifications in the *World Development Report* by the World Bank (2000).

Table 7
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 & forest products	Mean profit growth	**0.08**	**-0.02**	**-0.88**
	Standard deviation	(0.66)	(0.57)	
Silver & gold ores	Mean profit growth	**0.33**	**0.02**	**-0.82**
	Standard deviation	(1.09)	(0.81)	
Natural gas & crude petroleum	Mean profit growth	**0.18**	**0.24**	**-0.86**
	Standard deviation	(0.91)	(0.66)	
Preserved fruits & vegetables	Mean profit growth	**0.30**	**0.06**	**-1.67***
	Standard deviation	(0.53)	(0.34)	
Edible oils & 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 & 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)	

Notes: (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 that had a major devaluation (as defined in Table 1) 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. * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level.

Table 8
Regression Results: Growth in Firm Operating Profits

	Devaluation Dummies				#	
	t-1	t	t+1	Inflation	Observs.	R^2
Pooled cross-section	0.067	0.146**	-0.076	0.005**	2,814	0.02
	(0.049)	(0.043)	(0.072)	(0.001)		
Fixed industry effects	0.114**	0.183**	-0.026	0.005**	2,814	0.02
	(0.048)	(0.044)	(0.065)	(0.001)		
Random industry effects	0.098**	0.170**	-0.043	0.005**	2,814	0.02
	(0.048)	(0.044)	(0.065)	(0.001)		
Rubber plantations & forest products	0.097	0.079	0.026	0.013**	68	0.09
	(0.196)	(0.232)	(0.347)	(0.003)		
Silver & gold ores	0.293	0.193	-0.332	0.005	300	0.03
	(0.179)	(0.290)	(0.392)	(0.010)		
Natural gas & crude petroleum	-0.034	-0.243	0.723**	0.006**	565	0.09
	(0.154)	(0.275)	(0.297)	(0.003)		
Preserved fruits & vegetables	0.169	0.247*	-0.197	0.007**	210	0.12
	(0.141)	(0.145)	(0.133)	(0.002)		
Edible oils & fats	0.251	0.201*	0.067	0.012**	213	0.10
	(0.155)	(0.106)	(0.169)	(0.002)		
Cigarettes	-0.102	0.139	0.006	0.003	124	0.08
	(0.113)	(0.114)	(0.135)	(0.002)		
Industrial inorganic chemicals	0.131**	0.135**	0.094	-0.005	377	0.04
	(0.044)	(0.063)	(0.102)	(0.007)		
Plastics, materials & synthetics	0.140	0.194**	-0.040	0.002	477	0.04
	(0.090)	(0.067)	(0.083)	(0.002)		
Industrial organic chemicals	0.037	0.248**	-0.046	0.011**	251	0.11
	(0.062)	(0.082)	(0.076)	(0.002)		
Fertilizer	-0.012	0.177	0.014	0.005**	229	0.05
	(0.073)	(0.127)	(0.170)	(0.002)		

Notes: * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level. 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 percent level.

Table 9
Sensitivity Analysis: Growth in Firm Operating Profits

	Devaluation Dummies				#	
	t-1	t	t+1	Inflation	Observs.	R^2
Base Estimates (Random Effects)	0.098** (0.048)	0.170** (0.044)	-0.043 (0.065)	0.005** (0.001)	2814	0.02
Exclude natural gas & crude petroleum[1]	0.115** (0.046)	0.174** (0.042)	-0.049 (0.062)	0.006** (0.001)	2249	0.03
Control for firm size[2]	0.066 (0.048)	0.145** (0.044)	-0.078 (0.065)	0.005** (0.001)	2812	0.02
Inflation based on producer-price index[3]	0.064 (0.049)	0.192** (0.044)	-0.050 (0.065)	0.002** (0.001)	2693	0.02
Include regional dummy variables[4]	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[5]	0.123* (0.069)	0.168** (0.071)	-0.106 (0.103)	0.006** (0.002)	616	0.04
Only low-income countries[5]	0.205 (0.169)	0.221* (0.116)	--- ---	0.006** (0.003)	303	0.07
Only Asia[6]	0.090* (0.047)	0.148** (0.040)	0.021 (0.056)	0.005** (0.002)	1170	0.03

Notes: * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level. 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 and are always jointly significant at the 1 percent level.

(6) Excludes natural gas and crude petroleum (SIC group 131).
(7) Firm size measured as total assets in U.S. dollars.
(8) Producer-price index based on line 63..zf in the *International Financial Statistics CD-ROM* published by the International Monetary Fund. Monthly data corresponds to company's reporting period.
(9) Regional dummy variables are the based on the 9 regions listed in Table 2.
(10) Definitions of middle- and low-income countries are based on World Bank classification in the *World Development Report* by the World Bank (2000).

Table 10
Growth in Capital Investment[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 & forest products	Mean capital growth	**0.11**	**0.25**	**-0.78**
	Standard deviation	(0.40)	(0.71)	
Silver & gold ores	Mean capital growth	**0.29**	**0.20**	**-0.60**
	Standard deviation	(1.12)	(1.16)	
Natural gas & crude petroleum	Mean capital growth	**0.28**	**0.22**	**-1.01**
	Standard deviation	(0.28)	(0.58)	
Preserved fruits & vegetables	Mean capital growth	**0.04**	**0.08**	**1.00**
	Standard deviation	(0.24)	(0.26)	
Edible oils & 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 & 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)	

Notes: (a) Growth in capital investment measured as percent change in plant, property and equipment. Standard deviations are in parentheses and are listed below the growth rates.
(b) "Devaluing countries" are countries that had a major devaluation (as defined in Table 1) 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. * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level.

Table 11
Growth in Capital Investment in Devaluing Countries[a]: Trends Based on Interest Rates and Capital/Labor Ratios

	Mean growth in capital investment[b]	Number of firms
Δ r < 15%[c]	0.14	144
Δ r ≥ 15% [c]	0.13	58
K/L Ratio < 400 [c]	0.15	143
K/L Ratio ≥ 400 [c]	0.11	59
Δ r < 15% & K/L Ratio < 400 [c]	***0.15***	***110***
Δ r < 15% & K/L Ratio ≥ 400 [c]	*0.11*	*34*
Δ r ≥ 15% & K/L Ratio < 400 [c]	*0.13*	*33*
Δ r ≥ 15% & K/L Ratio ≥ 400 [c]	***0.10***	***25***

Notes:
(a) Devaluation events are listed in Table 11. Only the first event in each country is included.
(b) Growth in capital investment measured as percent change in plant, property, and equipment. Means are calculated such that each firm with available data has equal weight.
(c) Δr is the change in the lending interest rate as reported in the IFS. K/L ratio is the ratio of total assets (denominated in dollars) to employees.

Table 12
3-Month Stock Returns in Devaluing Countries[a]
Trends Based on Capital/Labor Ratios

		Low K/L Ratio[b]	High K/L Ratio[b]
Brazil	Mean 3-month return	**-0.08**	**-0.17**
Jan. 1999	Standard deviation	(0.57)	(0.29)
Indonesia	Mean 3-month return	**-0.08**	**-0.30**
Oct. 1997	Standard deviation	(0.19)	(0.40)
Korea	Mean 3-month return	**-0.09**	**-0.30**
Dec. 1997	Standard deviation	(0.33)	(0.41)
Malaysia	Mean 3-month return	**0.10**	**0.26**
Jan. 1998	Standard deviation	(0.31)	(0.24)
Philippines	Mean 3-month return	**-0.47**	**-0.33**
Dec. 1997	Standard deviation	(0.27)	(0.40)
Russia	Mean 3-month return	**-0.74**	**-1.30**
Aug. 1998	Standard deviation	(1.10)	(1.42)
South Africa	Mean 3-month return	**-0.17**	**-0.30**
July 1998	Standard deviation	(0.30)	(0.29)
Thailand	Mean 3-month return	**-0.12**	**-0.29**
July 1997	Standard deviation	(0.59)	(0.54)
Unweighted Mean[c]		***-0.21***	***-0.34***
Weighted Mean[c]		***-0.15***	***-0.20***

Notes: (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 under the country name.
(b) Sample divided based on median K/L ratio for the given country in the relevant year. K/L ratio calculated as the ratio of total assets (in U.S. dollars) to total employees.
(c) Unweighted is the average across industries. Weighted is the average across industries weighted by the number of firms in each country.

Table 13
3-Month Stock Returns in Devaluing Countries[a]: Trends Based on Interest Rates and Capital/Labor Ratios

	Mean 3-month Return[b]	Number of Firms
Δ r < 15%[c]	-0.08	168
Δ r ≥ 15% [c]	-0.32	53
K/L Ratio < 400 [c]	-0.13	171
K/L Ratio ≥ 400 [c]	-0.17	50
Δ r < 15% & K/L Ratio < 400 [c]	***-0.06***	***127***
Δ r < 15% & K/L Ratio ≥ 400 [c]	*-0.12*	*41*
Δ r ≥ 15% & K/L Ratio < 400 [c]	*-0.28*	*44*
Δ r ≥ 15% & K/L Ratio ≥ 400 [c]	***-0.29***	***9***

Notes:
(a) Devaluation events are listed in Table 11. Only the first event in each country is included.
(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. Means are calculated such that each firm with available data has equal weight.
(c) Δr is the change in the lending interest rate as reported in the IFS. K/L ratio is the ratio of total assets (denominated in dollars) to employees.

Table 14
K/L Ratios and Annual Stock Returns in Non-Devaluing Countries

	Devaluing Countries	Mean Annual Return in Non-Devaluing Countries[b]	
	Mean K/L[a]	06/97-06/98	07/98-07/99
Silver & gold ores	**51**	**-0.66**	**-0.41**
	(16)	(0.65)	(0.72)
	47	118	116
Rubber plantations & forest products	**107**	**-0.15**	**-0.33**
	(173)	(0.29)	(0.27)
	19	7	7
Cigarettes	**139**	**0.13**	**0.31**
	(84)	(0.40)	(0.31)
	17	25	24
Edible oils & fats	**150**	**-0.23**	**-0.03**
	(110)	(0.50)	(0.56)
	32	33	34
Fertilizer	**356**	**-0.10**	**-0.04**
	(170)	(0.45)	(0.39)
	29	60	55
Industrial inorganic chemicals	**382**	**-0.20**	**-0.05**
	(350)	(0.40)	(0.30)
	20	95	96
Preserved fruits & vegetables	**395**	**-0.02**	**-0.02**
	(520)	(0.42)	(0.64)
	16	58	56
Plastics, materials & synthetics	**492**	**-0.13**	**0.01**
	(394)	(0.46)	(0.43)
	70	115	110
Industrial organic chemicals	**592**	**-0.16**	**-0.12**
	(186)	(0.51)	(0.41)
	34	67	63
Natural gas & crude petroleum	**1191**	**-0.11**	**-0.28**
	(1579)	(0.48)	(0.70)
	29	181	174
Unweighted Mean			
Low K/L	***160.4***	***-0.20***	***-0.10***
High K/L	***610.4***	***-0.12***	***-0.09***
Weighted Mean			
Low K/L	***152.1***	***-0.37***	***-0.19***
High K/L	***609.9***	***-0.13***	***-0.12***

Notes: Standard deviations are listed in parentheses. Number of firms is listed below standard deviations.
(a) Capital/labor ratios measured as the ratio of total assets (in U.S. dollars) to total employees.
(b) Non-devaluing countries defined as countries that did not have a major devaluation (as listed in Table 1) in the current year or previous year).
(c) Unweighted is the average across industries. Weighted is the average across industries weighted by the number of firms in each industry.