BANCA D'ITALIA

Temi di discussione

del Servizio Studi

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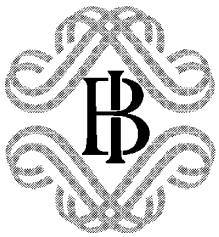

Number 344 - December 1998

The purpose of the "Temi di discussione" series is to promote the circulation of working papers prepared within the Bank of Italy or presented in Bank seminars by outside economists with the aim of stimulating comments and suggestions.

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INVESTMENT AND THE EXCHANGE RATE

by Francesco Nucci* and Alberto F. Pozzolo**

Abstract

This paper investigates the relationship between exchange rate fluctuations and the investment decisions of a sample of Italian manufacturing firms. The results support the view that a depreciation of the exchange rate has a positive effect on investment through the revenue channel, and a negative effect through the cost channel. The magnitude of these effects varies over time with changes in the firm's external orientation, as measured by the share of foreign sales over total sales and the reliance on imported inputs. Consistent with the predictions of our theoretical framework, the effect of exchange rate fluctuations on investment is stronger for firms with low monopoly power and for those facing a high degree of import penetration in the domestic market. We also provide evidence that the degree of substitutability between domestically-produced and imported inputs influences the effect through the expenditure side.

Contents

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1. Introduction[1]

A large body of empirical research in international economics deals with the implications of exchange rate movements for the real economy. Assessing the impact of currency appreciation and depreciation on several key variables, such as those under the firm's control (e.g. prices) and those related to its performance (e.g. the value of the firm), has been the focus of many contributions in the recent literature. This paper investigates the relationship between exchange rate fluctuations and the investment decisions of manufacturing firms.

While the literature has placed considerable emphasis on the study of pricing policies in response to currency fluctuations (see Goldberg and Knetter, 1997, for a survey on the issues of pass-through and pricing-to-market[2]) and also on the study of the exposure of the value of the firm to movements in the exchange rate,[3] fewer authors have analyzed the sensitivity of firms' investment to changes in the currency value. Goldberg (1993), studying the linkage between exchange rate and investment activity in US industry, finds that while during the 1970s a real depreciation (appreciation) of the dollar was likely to generate an expansion (reduction) of capital goods orders, the opposite pattern prevailed during the 1980s. Campa and Goldberg (1995) examine the exposure of US manufacturing firms to foreign

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[1] This paper is based on Chapter I of Francesco Nucci's thesis completed at Columbia University. We are especially grateful to Rich Clarida for his very helpful guidance and constant encouragement during this project. We would also like to thank José Campa, Linda Goldberg, Luigi Guiso, Bob Hodrick, Ron Miller, Giuseppe Parigi, Massimo Roccas, Federico Signorini and in particular an anonymous referee for very useful suggestions and discussions; we benefited from helpful discussions with seminar participants at the Bank of Italy, the University of Southampton and the 1998 European Economic Association Congress in Berlin. We are grateful to Stefania De Mitri for providing valuable research assistance. Any remaining errors are our own. The opinions expressed do not necessarily reflect those of the Bank of Italy.

[2] Influential articles on the subjects include those by Krugman (1987), Dornbusch (1987), Froot and Klemperer (1989), Knetter (1989, 1993) and Marston, (1990).

[3] Among the contributions on this aspect, Jorion (1990), Bodnar and Gentry (1993) and Bartov and Bodnar (1994) try to uncover the relationship between the exchange rate and the asset value of firms, the latter being measured by the rate of return realized in the stock market. Clarida (1997) analyses the effect of the real exchange rate on manufacturing profits by employing an empirical approach where foreign and domestic demand, real unit costs and the relative price of domestically sold products are explicitly accounted for. In a recent paper Bodnar, Dumas and Marston (1998) argue convincingly that the exchange rate pass-through and the responsiveness of firms' profits to exchange rate are closely related phenomena and their analysis examines the two issues together.

competition, concluding that the surprising result of Goldberg (1993) is attributable to a change in the pattern of this exposure; in particular, they show that US firms seem to have progressively increased their reliance on imported inputs.

A cross-country comparison of investment sensitivity to movements in the value of the currency is provided in another work by Campa and Goldberg (1998); controlling for the external exposures of each sector, they report results for Canada, UK and Japan that confirm the conclusions reached in their previous study. Finally, Worthington (1991) documents for US industry that the size of investment responsiveness to real exchange rate fluctuations depends on the exposure to foreign competition.[4]

All the above studies are conducted using data at the industry level, although with a different degree of aggregation. Yet, the recent work on investment behavior underlines the importance of individual specific aspects,[5] which, of course, are difficult to track in aggregate data. Hence, in this paper we analyze the investment responsiveness to exchange rate fluctuations using firm-level data for manufacturing. In particular, we combine data from two high quality sources: The Bank of Italy Survey of Investment in Manufacturing and the Company Accounts Data Service reports (see Appendix II for more details).

The optimal response of a firm's investment policy to movements in the exchange rate depends on a variety of factors, such as the reliance on imported inputs and the share of foreign sales in total sales. After an exchange rate depreciation, the more a firm is dependent on imported inputs, the larger is the increase in variable costs and the reduction in the marginal value of capital, so that the reduction in its level of investment is amplified.[6] By contrast, for a firm with a larger share of revenues from the export markets, the increase in price competitiveness following an exchange rate depreciation is likely to determine a larger increase in the expected value of its capital and therefore in its level of investment. Another prediction of our theoretical framework is that the profitability of firms with weaker market

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[4] Although indirectly, another aspect is related to the issue examined in this paper. In particular, foreign firms' decisions to enter or withdraw from a particular market have a clear effect on the accumulation process and are likely to be largely influenced by exchange rate dynamics (see e.g. Dixit, 1989, and Baldwin and Krugman, 1989; see also Venables, 1990, for a survey).

[5] See e.g. the survey by Hubbard (1998).

[6] The reverse pattern is obviously true in the case of an appreciation.

power is more affected by shocks to the exchange rate. Hence, a testable implication is that their investment decisions are more sensitive to currency value fluctuations than those by firms with a greater ability to adjust their cost-price margins. We also investigate some other aspects in the transmission of exchange rate shocks to investment that may determine a different responsiveness to such shocks. For example, we examine the extent to which firms compete with foreign producers in the domestic market. In particular, we try to characterize the effect of exchange rate fluctuations on investment due to a different degree of import penetration in the domestic market. In addition, we analyze to what extent a different degree of substitutability between domestically produced and imported inputs may amplify or attenuate the effect of exchange rate movements.

All these factors determining the optimal response of a firm's investment policy can be singled out from our data at the firm level. For example, information on the reliance upon imported inputs and the share of export sales in total revenues is directly available for each period; the degree of monopoly power can be approximated by a measure of the price-cost mark-up.

A description of the analytical framework providing theoretical motivation and some testable implications is followed by an empirical specification of the model. Estimations are conducted on a dynamic model from panel data using the generalized method of moments estimator developed by Arellano and Bond (1991). In the empirical equation, exchange rate variations interact with the relevant firm-specific, time-varying explanatory variables. Therefore, the estimated effect of the exchange rate on investment is allowed to vary over time and is shaped by the variables describing the firm's external orientation. Our results confirm the major implications of the theoretical model: a depreciation of the exchange rate has a positive effect on investment through the revenue channel and a negative effect through the cost channel. Moreover, we find that the investment decisions of firms with lower monopoly power are more sensitive to exchange rate variations.

The remainder of the paper is organized as follows. Section 2 outlines a theoretical framework for analyzing the main transmission channels of exchange rate variations to investment and providing some motivation for the empirical model. Section 3 presents the

data, the empirical specification and the methodology used for the estimation. In Section 4 we report and discuss the econometric results. The final section draws some conclusions.

2. Theoretical framework

2.1 A simple model

According to the standard *q* theory of business investment, demand for capital goods depends on the expected present value of a stream of current and future marginal profits. Let $\pi(K_t, e_t)$ be the profit function of a generic firm, where K_t is its capital stock at time *t*, e_t is the real exchange rate computed as units of domestic currency per unit of foreign currency. The firm chooses its optimal level of investment at time *t*, I_t, knowing that the accumulation process is subject to a cost of adjustment, $C(I_t)$, which is increasing and convex in I_t (Hayashi, 1982).

The value of a representative firm is the maximized expected present value of its cash flows, which can be expressed as follows:

$$(1) \qquad V_t(K_{t-1}) = \max_{I_t} \left\{ \left[\pi(K_t, e_t) - I_t - C(I_t) \right] + \beta_{t+1}^{t} E_t \left[V_{t+1}(K_t) \right] \right\},$$

where the cash flow of every period is expressed by $\pi(\cdot)$ net of the overall investment expenditure, β_{t+1}^{t} denotes the firm's discount factor between periods *t* and *t*+1, E_t is the expectational operator conditional on all the information available at time *t* and the price of capital goods is normalized to unity. The capital stock, K_t, is governed by the standard accumulation equation, $K_t = K_{t-1} + I_t$, where depreciation is ignored for ease of exposition. By applying the envelope theorem, the Euler equation characterizing the optimal path of investment can be written as

$$(2) \qquad q_t = \left[\frac{\partial \pi (K_t, e_t)}{\partial K_t} \right] + \beta_{t+1}^{t} E_t (q_{t+1}),$$

where the variable q_t is the marginal valuation of capital, $\partial V_t / \partial K_{t-1}$. If we solve forward the expectational difference equation in (2), the following expression for q_t is obtained:

$$q_t = E_t \sum_{j=0}^{\infty} \beta_{t+j}^{t} \left[\frac{\partial \pi \left(K_{t+j}, e_{t+j} \right)}{\partial K_{t+j}} \right], \tag{3}$$

which implies that q_t is equal to the discounted present value of the net future marginal revenue products of capital. The *j*-period discount factor is $\beta_{t+j}^{t} = \prod_{i=1}^{j} (1 + r_{t+i-1})^{-1}$, with r_t being the firm's nominal required rate of return between periods *t* and *t*+1. Moreover, the first-order condition for maximizing (1) with respect to investment yields the following expression:

$$1 + \left[\frac{\partial C \left(I_t \right)}{\partial I_t} \right] = q_t \, . \tag{4}$$

From the assumption that the cost of adjustment is increasing and convex in the level of investment, the term appearing on the left-hand side of (4), which is the marginal cost of investment, is a positive and increasing function of q_t. Hence, investment can be expressed as an increasing function of q_t, the expected present value of marginal profits; substituting from (3) we then have:

$$I_t = \phi \left\{ E_t \sum_{j=0}^{\infty} \beta_{t+j}^{t} \left[\frac{\partial \pi \left(K_{t+j}, e_{t+j} \right)}{\partial K_{t+j}} \right] \right\}, \tag{5}$$

where $\phi(\cdot)$ is an increasing function due to the properties of adjustment costs.

In order to characterize the effect of the exchange rate on investment, an explicit expression for the marginal profitability of capital has to be derived. We assume that both domestic and foreign markets are imperfectly competitive. In each period the firm maximizes profits, taking as given the quantity of the quasi-fixed factor, capital:

$$(6) \qquad \pi(K_t, e_t) = \max_{p,p^*,L,L^*} x(p_t)p(e_t) + e_t x^*(p_t^*)p^*(e_t) - w_t L_t - e_t w_t^* L_t^*$$

$$s.t. \quad x_t + x_t^* = F(K_t, L_t, L_t^*),$$

where $x(p_t)$ and $x^*(p_t^*)$ denote the demand functions faced by the firm in the domestic and the foreign market, with p_t and p_t^* being the price levels set by the firm in those markets; $w_t L_t$ and $e_t w_t^* L_t^*$ denote the expenditure for domestically-produced and imported inputs, L_t and L_t^*, respectively, and the production function, $F(\cdot)$, is homogeneous of degree one.

Combining the first order conditions derived for this problem and using the envelope theorem yields the following expression for the marginal profitability of capital (see Appendix A and Campa and Goldberg, 1998)

$$(7) \qquad \frac{\partial \pi(.)}{\partial K_t} = \frac{1}{K_t}\left[p_t x_t \frac{1}{\mu_t} + e_t p_t^* x_t^* \frac{1}{\mu_t^*} - w_t L_t - e_t w_t^* L_t^* \right],$$

where μ_t and μ_t^* denote the firm's price-cost margins prevailing in the domestic and the foreign market; these can also be expressed in terms of the price elasticities of demand ($\vartheta_{t,x}$ and ϑ_{t,x^*}), as $\mu_t = (1 + 1/\vartheta_{t,x})^{-1}$ and $\mu_t^* = (1 + 1/\vartheta_{t,x^*})^{-1}$, respectively.

2.2 The effect of exchange rate variations

We assume for simplicity that uncertainty in the model is due exclusively to the exchange rate and that agents perceive any variation in the currency's value as permanent: the level of the exchange rate in future periods is therefore expected to be equal to today's exchange rate, i.e. $E_t(e_{t+1+j} - e_t) = 0 \quad \forall j \geq 0$.

Differentiating expression (5) with respect to the exchange rate and using (7), we can derive an expression for the effect of exchange rate variations on investment:

(8)

$$\frac{\partial I_t}{\partial e_t} = \phi_q(\cdot)\frac{1}{1-\beta}\left[\frac{\partial K_t^{-1}\left(p_t x_t \mu_t^{-1} + e_t p_t^* x_t^* \mu_t^{*-1}\right)}{\partial e_t}\right] - \phi_q(\cdot)\frac{1}{1-\beta}\left[\frac{\partial K_t^{-1}\left(w_t L_t - e_t w_t^* L_t^*\right)}{\partial e_t}\right],$$

where $\phi_q(\cdot)$ is non-negative as stated earlier and, for simplicity, the firm's discount factor is assumed to be constant through time: $\beta^{\,t}_{t+1} = \beta^{\,s}_{s+1} \quad \forall s,t$. This expression shows the dependence of investment on a one-period variation in the exchange rate level, isolating the effect on the revenue side from that on the cost side. It is important to notice that the effect of exchange rate variations on the level of investment at time *t* is not only through the change in current marginal profits but through the change in the whole stream of future expected marginal profits.

2.3 The main channels of transmission

The relevant factors determining the value of the two terms on the right-hand side of equation (8) can be better identified from the following expression for the derivative of marginal profitability of capital with respect to the exchange rate (see Appendix A):[7]

$$(9)\ \frac{\partial I}{\partial e} = \frac{TR}{Ke}\left\{\frac{1}{1+\mu}(1-\chi)\left[\eta_{p,e}\left(1+\vartheta_x\right)-\varepsilon_{\mu,e}\right]+\frac{1}{1+\mu^*}\chi\left[\eta_{p^*e}\left(1+\vartheta_{x^*}\right)+1-\varepsilon_{\mu^*,e}\right]-\frac{1}{\mu}\left(1+\eta_{w^*,e}\right)\alpha\right\},$$

where *TR* denotes total revenues, χ denotes the share of revenues from exports over total revenues; $\eta_{p,e}$ and $\eta_{p^*,e}$ are the elasticities of the prices set by the firm with respect to the exchange rate, respectively, in the domestic market and in the foreign market (pass-through elasticities); $\varepsilon_{\mu,e}$ and $\varepsilon_{\mu^*,e}$ are the mark-up elasticities with respect to the exchange rate, respectively, in the domestic and in the foreign market; α is the share of costs of imported inputs over total variable costs; $\eta_{w^*,e}$ is the exchange rate elasticity of imported inputs prices

[7] To simplify the notation we have dropped all time indices.

(in units of foreign currency) and $\bar{\mu}$ denotes the average of firm's price-cost margins in the domestic and foreign markets.

Equation (9) provides a useful framework for isolating the major determinants of the change in profitability, and hence in investment, induced by a real depreciation.[8]

On the revenue side, the larger is χ, the extent of the firm's exposure to export markets, the more the firm benefits from the increase in competitiveness associated with an exchange rate devaluation.[9] Focusing on the foreign sales side, the positive effect of χ interacts with the foreign pass-through elasticity, $\eta_{p^*,e}$ (ranging from minus one — a complete pass-through to foreign prices of an exchange rate variation — to zero — no pass-through), the (positive) exchange rate elasticity of the mark-up $\varepsilon_{\mu^*,e}$, and the price elasticities of foreign demand, ϑ_{x^*}. If the latter is greater than one in absolute value (i.e. foreign demand is elastic), the effect of a large external orientation is magnified; the opposite is true if foreign demand is inelastic, $|\vartheta_{x^*}|<1$.

On the domestic sales side, the effect on profitability of exchange rate variations clearly depends on $(1-\chi)$, which interacts with the (positive) elasticity of domestic prices with respect to a variation of the exchange rate, $\eta_{p,e}$, the (positive) exchange rate elasticity of the mark-up, $\varepsilon_{\mu^*,e}$, and the price elasticity of domestic demand, ϑ_{x^*}. If domestic demand is elastic, $|\vartheta_x|>1$, the increase in domestic product prices induced by a currency depreciation determines a reduction in the quantity sold, which causes a fall of domestic revenues. The opposite pattern occurs with an inelastic domestic demand curve.

The positive effect of a currency depreciation on revenues from foreign sales is counterbalanced by that on costs, which is clearly non-positive. The magnitude of this latter effect is determined, among other things, by the share of costs of imported inputs in total

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[8] Whilst the discussion below refers to a depreciation, all the considerations are simply reversed in the case of an appreciation.

[9] The effect of a depreciation on revenues from exports is unambiguously positive, regardless of the pass-through behavior of the firm; see Clarida (1997).

variable costs, α, and by the exchange rate elasticity of imported input prices, $\eta_{w^*,e}$, which is non-negative and varies between zero and one. The latter parameter reflects the different pricing policies of foreign exporters in the intermediate inputs market.

An important feature of expression (9) is that the degree of the firm's monopoly power contributes to determining the effect of exchange rate variations on profits, and hence on investment.[10]

When focusing on market power in (9), the effect of exchange rate variations on profits is determined not only by the price-cost mark-ups, but also by the interplay of all the elasticity terms described above. The elasticity of prices in the foreign market with respect to the exchange rate $\eta_{p^*,e}$, and that of foreign demand to prices, ϑ_{x^*}, depend themselves on the degree of each firm's monopoly power. In an influential paper, Dornbusch (1987) shows that when firms are price setters and interact strategically, the absolute value of the pass-through elasticity, $\eta_{p^*,e}$, is inversely related to the price-cost mark-up.[11] Similarly, the monopoly power index μ^* is negatively related to ϑ_{x^*}. Thus, in expression (9), the interaction of $\eta_{p^*,e}$ with $1+\vartheta_{x^*}$ is such that the lower is the firm's monopoly power, the greater is the effect on foreign sales of exchange rate variations.[12] Moreover, the lower is the monopoly power on the foreign market, the less reactive is the firm's mark-up, μ^*, to exchange rate changes;

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[10] Evidence on this fact for US industry is provided by Campa and Goldberg (1998), who argue that firms with high price-cost margins tend to absorb exchange rate swings into their prices, and hence their mark-ups, so that investment by these firms is less sensitive to exchange rate shocks. Consistently with this empirical finding, the model of Bodnar, Dumas and Marston (1998) predicts that the more competitive the industry, the higher the exposure of firms' value to exchange rate changes. In their analysis the degree of competitiveness in each industry is measured by the substitutability in the utility function between the goods exported and those produced locally in the foreign market.

[11] The other element affecting this pass-through elasticity is the ratio between the number of domestic firms in the foreign market and the total number of firms operating therein: the larger this ratio, the higher the elasticity.

[12] Of course, the statement is valid to the extent that ϑ_{x^*} is greater than one in absolute value. However, in models of imperfect competition it is customary to make such an assumption (dealing, for example, with a demand function of the form $X_i = Y(P_i/P)^{-\vartheta}$ with $\vartheta > 1$).

hence, it can be seen in (9) that a low value of $\varepsilon_{\mu^*,e}$ further magnifies the effect of the exchange rate on profitability through the foreign sales.

Dornbusch (1987) also shows that the pass-through of exchange rate changes to domestic prices is itself a decreasing function of monopoly power. For a given exposure to foreign markets, the lower is the market power, the larger is (the absolute value of) the product of the elasticity of domestic price and with respect to the exchange rate, $\eta_{p,e}$, and one plus the price elasticity of home demand, $1+\vartheta_x$, so that the effect of exchange rate variations on total revenues is stronger.[13] As the latter effect is negative for elastic demand functions, it counterbalances the positive effect of a devaluation on foreign sales. In addition, the more competitive is the firm in the domestic market, the higher is the elasticity of the domestic mark-up with respect to the exchange rate, $\varepsilon_{\mu,e}$, so that the effect of an exchange rate shock on revenues from domestic sales is furtherly scaled up in the presence of low market power.

Finally, as both the expressions referring to revenues and costs in equation (9) are multiplied by a decreasing function of the price-cost mark-up, the lower is the monopoly power, the stronger is the effect of the exchange rate on both revenues and costs.

Other aspects, not explicitly captured in our simple analytical framework, support the view that investment by firms with low mark-ups reacts more strongly to exchange rate variations. In particular, the presence of financing constraints in the decision to invest and the possibility of hedging against exchange rate risk.

As concerns the first aspect, there is widespread evidence of imperfections in the capital markets, due to information and incentive problems, which make investment excessively sensitive to the firm's net worth (internal funds), whereas the latter variable would play no

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[13] Strictly speaking, the relevant monopoly power index affecting the pass-through elasticity of domestic prices, $\eta_{p,e}$, is that of the foreign exporters and not that of the domestic producer selling the same product in the home market (Dornbusch, 1987). However, to the extent that their cost structures are similar and the products are not too differentiated, the index for the foreign exporters can be a satisfactory proxy for that of the domestic producer operating in the same industry. Furthermore, $\eta_{p,e}$ also depends upon a measure of import penetration in the domestic market, which is given by the share of foreign firms in the total number of firms selling in the domestic market. We will address this issue later in the text.

role if capital markets were perfect (see Schiantarelli, 1996 for a survey). Conventionally, cash flow is employed as a proxy for internal funds (Hubbard, 1998). In the model illustrated earlier, we focused on current profits as a key determinant of the investment decision and showed, by examining the relevant elasticities, that the profits of a low mark-up firm are more sensitive to the exchange rate than those of a high mark-up firm. Hence, to the extent that current profits display some co-movements with cash flow, it turns out that the latter variable varies more in response to shocks to the exchange rates for firms with low monopoly power. As a consequence, the pool of investment projects that can be financed also varies more, inducing an even stronger relationship between exchange rate variations and investment by low mark-up firms.

With regard to the second aspect, it has been shown that the optimal hedging against currency risk also depends upon the degree of competitiveness in the industry. In particular, von Ungern-Sternberg and von Weizsäcker (1990) investigate the relationship between the hedging decisions of firms and market structure and demonstrate that the extent of optimal coverage against foreign currency fluctuations, as a share of the firms' expected profits, is greater in both Cournot's and monopolistic competition models than in the case of perfect competition. Therefore, since they are hedged to a greater extent, the profits and investment of firms with a higher degree of market power are also less affected by exchange rate variations.[14]

3. Data and estimation

3.1 The data

The empirical analysis has been conducted using data at the firm level drawn from two main sources: The Survey of Investment in Italian Manufacturing and the Company Accounts Data Service reports. A detailed description of these sources and of the variables used is provided in the Appendix B, together with some descriptive statistics. The Survey of

[14] Allayannis and Ofek (1997) document that firms heavily exposed to exchange rate risk through foreign sales and foreign trade are more likely to use currency derivatives. See Hodrick (1998) for insightful discussion on firms' decision to hedge against foreign currency risk.

Investment has been carried out by the Bank of Italy at the beginning of each year since 1984. We believe the data to be of unusually high quality, due to the representativeness of the sample, appropriately stratified by industry classification, firm size and geographical location and to the professional experience of the interviewers. On average, the number of firms in each survey is about 1,000 with the data having a panel structure; in particular, because of attrition, the balanced panel consists of less than 300 firms. The survey collects both quantitative and qualitative information on each firm; the former refers to a considerable number of economic variables, including investment expenditure, total revenues and revenues from foreign sales, the latter to a variety of characteristics that help to define the structure and conduct of each firm.

In order to have information on the cost side of each firm and, specifically, on total expenditure for intermediate inputs, we also employ the Company Accounts Data Service reports. The latter source collects detailed information drawn from the annual accounts of more than 30,000 firms. Merging the information from the two sources resulted in an unbalanced panel of slightly less than 1,000 firms, which was used in the estimation process. Unfortunately, it is not possible to distinguish between domestically produced and imported inputs from the reclassified income statements of each firm. In order to cope with this limitation of our data, we used the most recent 44-sectors input-output table for the Italian economy and singled out for each sector of manufacturing the value of the intermediate inputs imported by each sector. Similarly, we singled out for each sector the value of all the inputs purchased, both imported and domestically produced. We then used economic time series on import demand for each sector and industrial production to update the corresponding figure of the input-output table, which refers, by construction, to a single year only. Finally, in computing the α_{it} for each firm and for each year, we combined this set of information at the industry level with firm-specific information on the total expenditure for intermediate inputs and labor inputs.[15]

[15] Further details on the computation of the $\eta_{p,e}$ are provided in the data appendix; for a similar approach, see also Campa and Goldberg (1997).

In order to measure the degree of a firm's market power, we computed a time-varying measure of profit margins on unit price according to the procedure suggested by Domowitz, Hubbard and Petersen (1986):

$$(10)\quad \overline{mkup} = \left(\frac{Value\ of\ Sales + \Delta Inventories - Payroll - Cost\ of\ Materials}{Value\ of\ Sales + \Delta Inventories} \right).$$

Admittedly, the most appropriate measure of a firm's market power is the Lerner index, which is equal to (*Price-Marginal Cost*)*/Price*. Marginal costs are not directly observable, however, and the mark-up measure as computed in equation (10) is therefore derived from accounting data, a procedure which has a tradition in the empirical literature.[16] In the empirical section of this paper we only deal with one measure of the firm's mark-up, without explicitly distinguishing between its value in the domestic market and the one in the foreign market.[17]

With regard to the choice of e_t, we considered the real effective exchange rate of the lira as computed by the Bank of Italy. It takes into account 14 bilateral exchange rates of the Italian currency, with each weight reflecting Italy's trade with the corresponding country. Real exchange rates are computed using producer price indexes. An increase in e_t means that the currency is appreciating in real terms.

3.2 Estimation

The analytical framework developed in Section 2 provides theoretical motivation for the investment/exchange rate linkage. It also has some testable implications worth investigating on empirical grounds. Hence, we specify the following dynamic investment equation:

$$(11)\quad \Delta I_{ti} = \beta_1 \cdot \Delta I_{t-1,i} + \beta_2 \cdot \Delta S_{ti} + \beta_3 \cdot \chi_{ti} \cdot \Delta e_t + \beta_4 \cdot \alpha_{ti} \cdot \Delta e_t + b' \cdot Z_{ti} + \tau_t + \lambda_i + v_{ti},$$

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[16] For a critique of this measure see, for example, Boyer (1996). Alternative approaches for measuring the intensity of competition in export markets are analyzed in Goldberg and Knetter (1997).

[17] The relationship between $\overline{mkup_t}$ and the index $\overline{\mu_t}$ discussed in the previous sections is the following: $\overline{mkup_t} = (\overline{\mu_t} - 1)/\overline{\mu_t}$.

where Z_{ti} is a vector of dummy variables referring to the sectors of manufacturing industry, the firm's size, the type of ownership (private *vs.* public), the geographical location and the occurrence of a corporate operation such as a merger or an acquisition; S_{ti} denotes total sales and is introduced as an additional control for investment opportunities; τ_t is a time-specific effect introduced to control for movements in the user cost of capital and for variations in the exchange rate not captured by Δe_t. In fact, as the exchange rate varies over time but is the same for all cross-sectional units, we consider its interaction with the firm-specific variables χ_{ti} and α_{ti}, coherently with the theoretical framework summarized by equations (8) and (9). The specification contains an unobservable firm-specific effect, λ_t; the error terms, ν_{ti}, are assumed to have finite moments with $E(\nu_{ti}) = E(\nu_{ti} \cdot \nu_{si}) = 0$, for all $t \neq s$. Finally, in order to account for nonstationarity of the exchange rate we use first differences in the empirical specification. The latter includes a lagged value of the dependent variable to control for autocorrelation: it is often argued that a source of autocorrelation is the adjustment lags typical of investment projects (Caballero, 1997).

The lagged value of the dependent variable in (11) is correlated with the unobservable effect λ_t. In order to account for this endogeneity of regressors, we adopt the generalized method of moments (GMM) estimation procedure developed by Arellano and Bond (1991). This method was shown to be efficient within the class of instrumental variable procedures, as it optimally exploits all linear moment restrictions descending from the assumptions made on the error terms, ν_{ti}. Specifically, the number of instruments employed varies from one cross section to another, growing as we progress throughout the panel: in our estimation, the lagged values of the dependent variable dated *t*-2 and earlier are utilized as instruments.

In addition, the optimal method of Arellano and Bond makes it possible to compute standard errors of the estimated parameters that are asymptotically robust with respect to heteroschedasticity and to derive a set of diagnostic tests for assessing the validity of the empirical specification. Two such tests are considered in our analysis: the Sargan statistic for over-identifying restrictions, which verifies the lack of correlation between errors and

instruments, and the m_2 statistic developed by Arellano and Bond (1991), testing for the absence of second-order serial correlation in the differenced residuals.[18]

4. Results

4.1 Foreign exposure

The evidence from the basic specification of our dynamic model estimated from panel data is summarized in Table 1. The two crucial variables are $\chi_{ti} \cdot \Delta e_t$ and $\alpha_{ti} \cdot \Delta e_t$ referring to the interaction of real exchange rate changes with the firm's exposure to international competition in both the foreign product markets (revenue side) and the foreign inputs markets (cost side). The results of the estimations are consistent with the theoretical predictions: the coefficient associated with $\chi_{ti} \cdot \Delta e_t$ is negative, implying that after an exchange rate depreciation the firm's revenues (and via this channel its investment) tend to grow at a rate which increases with the share of foreign sales in total revenues. The coefficient associated with $\alpha_{ti} \cdot \Delta e_t$ is positive, suggesting that the decrease in firm's costs (and investment) which follows a depreciation increases with the share of the firm's expenditure on foreign inputs in total costs. Both of these effects are statistically significant.[19]

The effects of other variables such as total sales and the lagged change of investment expenditure are also statistically significant. As argued earlier, the latter effect is linked to the time to build and the construction lags that characterize the purchase and installation of

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[18] The limiting distribution of the two test statistics under the null hypothesis are, respectively, χ^2 and standard normal (see Sargan, 1958, and Arellano and Bond, 1991). Estimation and hypotheses testing are conducted with the DPD program written in GAUSS by Arellano and Bond (1988).

[19] As is clear from the theoretical framework presented in Section 2, the exchange rate variations that are relevant for investment decisions are those perceived as permanent. In order to address this issue in more detail, we have also considered empirical specifications where Δe_t is the permanent component of exchange rate changes calculated by applying the Beveridge-Nelson decomposition on annual data from 1970 to 1997. The estimation results obtained using the variation of the permanent component of exchange rate are very similar to those obtained using the actual variation. For example, referring to the basic specification of Table 1, the estimated coefficients for the two key variables $\chi_{it} \cdot \Delta e_t$ and $\alpha_{it} \cdot \Delta e_t$ are -2.22 and 7.18 for the actual change (with *t* statistics of -3.17 and 2.46) and -1.91 and 6.88 for the permanent change (with *t* statistic of -2.88 and 2.57). This similarity reflects the strong correlation between the variation in the actual exchange rate and in its permanent component calculated on annual data.

capital goods (Caballero, 1997), the former constitutes an additional control for investment decisions.

A time-varying, individual-invariant variable such as the real cost of capital enters the specification through the time effects τ_t. Of course, these effects also reflect a variety of other factors, including part of the real exchange rate dynamics not explained by the two interaction terms with Δe_t. The Wald test for the joint significance of these time effects is reported in Table 1, suggesting their importance for the specification. Similarly, dummy variables for each sector of economic activity (17 sectors coherent with the NACE-CLIO classification) and geographical area (North, Centre and South of Italy) turn out to be statistically significant. The effects related to the firm's size are also significant, at a confidence level slightly above the 10 per cent level (*p*-value 0.108).[20] On the contrary, the variables introduced as a control for the type of ownership, distinguishing between private and state-owned firms, and those serving as a control for corporate restructuring operations, such as mergers, acquisitions and break-ups, are not statistically significant.

A confirmation of the validity of our specification comes from the value of the Sargan test for over-identifying restrictions, indicating that the hypothesis of absence of correlation between instruments and residuals cannot be rejected (*p*-value 0.20); similarly, the test statistic for lack of second-order serial correlation of residuals from the first-difference equation does not lead to a rejection of the null hypothesis (*p*-value 0.57).[21]

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[20] Some authors document that firm size is a satisfactory indicator for the presence of financial constraints in the decision to invest, as it reflects unobservable factors that affect the probability of facing difficulties in the access to external funds (see Schiantarelli, 1996, for a survey). Another interpretation for the firm size variables may be related to firms' decisions to hedge foreign currency risk. Géczy, Minton and Schrand (1997) show that larger firms are more likely to pursue hedging policies against foreign exchange risk as firm size is a proxy for economies of scale in the costs of hedging.

[21] In order to further validate our results, in particular as regards the nexus between the exchange rate, profits and investment, we replicated the basic specification presented in this section, using change in profitability as the dependent variable. We intended to verify whether the effect of exchange rate on investment is indeed exerted through its impact on the firm's performance, as measured by information on profit margins drawn from balance sheets. The results confirmed that the effects of the exchange rate change on profit margins through both the revenue and the expenditure side are of the expected sign and statistically significant (*t* statistics are -2.06 and 2.80, respectively).

4.2 Market power

The results reported in Table 2 refer to the basic specification of equation (10), although the sample was split between high and low mark-up firms. The objective of this analysis is to verify on empirical grounds the role of monopoly power in determining the relationship between investment and the exchange rate.

The threshold used to split the sample is the mean of the time-averages of each firm's mark-up. The results lend support to the view that the effect of the real exchange rate on investment is stronger for firms with a low price-cost margin than for firms with a high mark-up. When compared across the two columns in the table, the parameters of the two interaction terms, whilst of the same sign and statistically significant, are of different magnitude, in accordance with our previous conclusions.

Another approach to characterize the role of mark-up is followed in Table 3, where the estimation is conducted on the entire sample and two dummy variables are used: D_{low}, put equal to one when the firm is in the low mark-up category and zero otherwise, and D_{high}, which is constructed in the reverse manner. The splitting criterion for defining the two dummy variables is the mean of the time-averages of each firm's mark-up. These two variables interact separately with each of the two foreign exposure terms; in this case the estimation results also validate the hypothesis that investment activity by firms with low monopoly power is more sensitive to exchange rate variations than that by firms in the high mark-up category. The evidence suggests that the effect operating through the cost side is about 42 per cent higher for low-mark-up firms, that operating through the revenue side is 84 per cent higher. The effect of the interaction terms is always statistically significant at better than the 5 per cent level, although the *p*-values tend to be higher (i.e. the effects relatively less significant) for the coefficients of variables concerning high mark-up firms.

Finally, Table 4 presents the results of a specification which explicitly includes the market power index, $\overline{mkup_{ti}}$, considering its interaction with the product of foreign exchange rate variations and each one of the variables measuring the exposure on the revenue side and the cost side:

$$\Delta I_{ti} = \beta_1 \cdot \Delta I_{t-1,i} + \beta_2 \cdot \Delta S_{ti} + \beta_3 \cdot \left(1 - \overline{mkup_{ti}}\right) \cdot \chi_{ti} \cdot \Delta e_t +$$

(12)

$$+ \beta_4 \cdot \left(1 - \overline{mkup_{ti}}\right) \cdot \alpha_{ti} \cdot \Delta e_t + b' \cdot Z_{ti} + \tau_t + \lambda_i + \nu_{ti}.$$

This specification more closely reflects the expression in the theoretical model developed earlier, where the components related to both revenues and costs are pre-multiplied by a decreasing function of $\overline{\mu_{ti}}$ (respectively, $1/\left(1+\mu_{ti}\right)$, $1/\left(1+\mu_{ti}^{*}\right)$ and $1/\overline{\mu_{ti}}$, see equation 9). Focusing on the revenue side, the model proposed earlier implies that the coefficients multiplying the three interacting variables χ_{ti}, Δe_t, and $(1-\overline{mkup_{ti}})$ mainly reflect the pass-through and price elasticities, and are therefore related to the degree of monopoly power. The estimated coefficient for these interacting variables indicates that the effect of an exchange rate depreciation on investment is positive and increases with the exposure to export markets; on the contrary, it decreases with the market power of the firm, as measured by $\overline{mkup_{ti}}$. This means that for a constant export revenue share (across firms or time or both) and a stable rate of currency depreciation, lower price-cost margins are associated with a more intense accumulation process. On the cost side, the estimated coefficient of the interacting variables α_{ti}, Δe_t and $(1-\overline{mkup_{ti}})$ is positive, suggesting that for a given share of imported inputs in total costs and a constant path of currency depreciation, lower price-cost margins are associated with a larger reduction in investment.

4.3 Extensions

In the previous sections we have emphasized the role of a number of channels that transmit exchange rate variations to investment, operating through changes in firms' revenues and costs. In this section we examine two aspects that may affect such transmission channels, leading to differences across firms in the sensitivity of investment decisions to the exchange rate.

First, a feature that may be important in assessing firms' behavior after an exchange rate shock is the degree of import penetration in the domestic market for the industry to which the firm belongs. In fact, the sensitivity of firms' investment to exchange rate movements is likely to increase with the foreign pressure exerted by import penetration in

the domestic market, and the importance of this channel is likely to be greater for firms whose share of domestic sales in total sales is larger (a high $1-\chi_{ti}$). In order to capture this effect, we supplemented the basic specification in (11) with the following term: $(1-\chi_{ti})\cdot\Delta e_t \cdot IP_{st} \cdot D_s$, where IP_{st} (import penetration for industry *s*) is the share of imports in domestic consumption and D_s is the industry dummy; the other variables are as defined above. The results, reported in Table 5, show that this specificity introduces a degree of difference (at the industry level) in the effect of exchange rate variations on investment, which is statistically significant. The Wald test for the hypothesis that these sector effects are identical is strongly rejected (30.6; *p*-value 0.015). Moreover, the coefficients of the other terms in the model are still significant and of the correct sign, showing the robustness of our earlier results.[22] The sector elasticities of the dependent variable with respect to $(1-\chi_{ti})\cdot\Delta e_t$, controlling for foreign penetration through imports, are reported in Table 5a.[23] We calculated the rank correlation coefficient between sector time-averages of import penetration with the sector estimated elasticities: the value of the coefficient is positive and equal to 0.3, lending some support to the view that the degree of penetration of foreign goods in the domestic market affects investment responsiveness to exchange rate shocks.[24]

The second extension that we consider refers to the effects through the cost channel. In the foregoing sections we saw that the impact of an exchange rate appreciation on investment via this channel is negative and increasing in the share of costs of imported inputs in total costs. Yet, after a depreciation firms may tend to reduce the quantity of intermediate inputs imported from abroad by substituting them with domestic factors. The elasticity of substitution between domestically produced inputs and foreign inputs is not identical for all

[22] It is worth noting that when this term is added to the specification, the industry dummy alone is maintained as in the original equation.

[23] For this sector and for only five others (Metallurgy, Non-metalliferous minerals, Machinery, Leather and clothing) the estimated effect is actually positive.

[24] Some interesting information can be derived from the ranking in Tab. 5a. For example, the Computer and precision instruments industry seems to be among the sectors with the highest sensitivity to import penetration, so that international shocks largely affect firm's performance in the domestic market; the Electrical machinery industry also displays this feature. On the contrary, the Food industry is among the sectors where foreign shocks seem to have the least influence on investment through the import penetration of foreign products in the domestic market.

firms, but is likely to depend on the production technology prevailing in each sector and also on the degree of availability in the domestic market of the primary inputs needed. Hence, there might be an additional degree of specificity at the sector level in the cost-side effects of exchange rate variations on investment. In order to verify this hypothesis we modified our basic empirical model considering the interaction between the term $\alpha_{ti} \cdot \Delta e_t$ and the industry dummy D_s.[25] The results, reported in Table 6, show that differences among the coefficients measuring the industry-specific cost-side effect of an exchange rate variation are statistically significant (Wald test 32.55; *p*-value 0.008).[26]

5. Concluding remarks

This paper proposes a simple theoretical model able to isolate all the channels of foreign exposure through which exchange rate oscillations affect the investment activity of firms.

The channels related to the revenue side of the balance sheet reflect the effects of exchange rate variations on the price competitiveness of firms, both in the internal market (due to the competition of imported substitutes) and in the foreign market (due to the change in export prices). The channels related to the cost side reflect the variation in the price of imported inputs induced by exchange rate changes. These effects increase with the elasticity of the demand for the firm's products, that is to say, the lower is its monopoly power, the larger is the pass-through of exchange rate variations to the prices of imported inputs. The overall effect of swings in the exchange rate on firms' investment is not obvious, as it depends on which of the two opposing effects prevails.

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[25] Another interpretation of the sector effects via the cost side may be related to the different degree of pricing-to-market across sectors undertaken by foreign producers of intermediate inputs. In particular, the more foreign producers of intermediate inputs adjust their mark-ups so as to guarantee price stability for their buyers, the less an exchange rate shock should exert an impact on the cost side of buyers' profitability.

[26] Table 6a reports the sector values of the effects exerted through the cost side and their ranking. For some sectors the results have a straightforward economic interpretation (i.e. the Food and Leather industries are among those displaying a high input expenditure sensitivity to international shocks, whereas the Rubber and Electrical machinery sectors seem to have a more flexible cost structure so that exchange rate fluctuations have less impact on profits and investment though this channel); for others the interpretation is less clear.

Estimation of a dynamic model from panel data for about 1,000 Italian manufacturing firms strongly supports the testable implications of a simple theoretical framework presented in the study. In the empirical specification the effects of an exchange rate variation on the revenue side and the cost side are pinned down through its interaction with the share of foreign sales in total sales, on the one hand, and the share of costs of imported inputs in total costs, on the other. As expected, we found that the coefficient associated with the revenue term is negative (i.e., a depreciation determines an increase in investment through this channel), reflecting the increase in the marginal profitability of capital as a result of the greater price competitiveness; conversely, the coefficient associated with the cost term is positive, due to the increase in expenditure on imported inputs.

An important feature of firms' structure, the degree of monopoly power, turns out to be relevant in determining the relationship between exchange rates and investment. In particular, both the analysis based on sample splitting and on the direct interaction of the mark-up term with changes in the exchange rate show that the investment of firms with lower price-cost margins are more sensitive to exchange rate variations than those of firms with higher margins. Moreover, other aspects such as the different degree of import penetration in the domestic market and the degree of substitutability between domestically produced and imported inputs are shown to cause differences in firms' response to exchange rate shocks.

Appendix I

In order to derive equation (7) in the text, we solve the firm's maximization problem stated in (6). After differentiating the Lagrangian with respect to *p*, *p**, *L* and *L**, and maintaining, as in Campa and Goldberg (1998), that, at the optimum, the marginal revenues in the foreign market are equal to the marginal revenues in the home market, we obtain:

(A.1) $$\lambda_t = p_t(1+\vartheta_{t,x}^{-1}) = e_t p_t^*(1+\vartheta_{t,x^*}^{-1})$$

(A.2) $$p_t(1+\vartheta_{t,x}^{-1})\frac{dF}{dL} = w_t$$

(A.3) $$p_t(1+\vartheta_{t,x}^{-1})\frac{dF}{dL^*} = e_t w_t^*,$$

where λ_t is the Lagrange multiplier. Using the envelope theorem and the expression for the Lagrange multiplier obtained in the first order condition (A.1) we derive the following equation:

(A.4) $$\frac{d\pi(.)}{dK} = p(1+\vartheta_x^{-1})\frac{dF}{dK},$$

where the time index has been suppressed for simplicity. Taking advantage of the first order conditions (A.1) through (A.3), the following expression for the average profits (scaled by the capital stock K) can be obtained:

(A.5) $$\frac{\pi(.)}{K} = \frac{px + ep^* x^*}{K} - p_t(1+\vartheta_x^{-1})\left(\frac{dF}{dL}\frac{L}{K} + \frac{dF}{dL^*}\frac{L^*}{K}\right).$$

Recalling that the firm's technology features constant returns to scale, the application of the Euler's theorem yields to the following reformulation of (A.5):

(A.6) $$\frac{\pi(.)}{K} = \frac{px + ep^* x^*}{K} - p_t(1+\vartheta_x^{-1})\left(\frac{x + x^*}{K} - \frac{dF}{dK}\right).$$

Finally, we derive an expression for $\frac{dF}{dK}$ in (A.6) and substitute it into (A.4). As a result, we obtain the equation (7) in the text.

In order to derive equation (9) in the text, we differentiate (7) with respect to the exchange rate *e*, using the definitions of mark-up in terms of the price elasticities of demand:

(A.7)

$$\frac{d^2\pi(.)}{dK\cdot de}=\frac{1}{K}\left[\frac{dp}{de}x(1+\vartheta_x^{-1})+p\frac{dx}{dp}\frac{dp}{de}(1+\vartheta_x^{-1})-px\frac{d\vartheta_x}{de}\frac{1}{\vartheta_x^2}+p^*x^*(1+\vartheta_{x^*}^{-1})+\frac{dp^*}{de}ex^*(1+\vartheta_{x^*}^{-1})\right]$$
$$+\frac{1}{K}\left[ep^*\frac{dx^*}{dp^*}\frac{dp^*}{de}(1+\vartheta_{x^*}^{-1})-ep^*x^*\frac{d\vartheta_{x^*}}{de}\frac{1}{\vartheta_{x^*}^2}-(w^*L^*+eL^*\frac{dw^*}{de})\right].$$

Algebraic manipulations of the above expressions yield the equation (9) in the text. In the derivation we took advantage of the fact that the exchange rate elasticities of mark-up can be defined as follows: $\varepsilon_{\mu,e}=\frac{d\vartheta_x}{de}\frac{e}{d\vartheta_x}\frac{1}{1+\vartheta_x}$ and $\varepsilon_{\mu^*,e}=\frac{d\vartheta_{x^*}}{de}\frac{e}{d\vartheta_{x^*}}\frac{1}{1+\vartheta_{x^*}}$.

We also used the fact that the firm's mark-up $\overline{\mu_t}$, obtained without distinguishing between the domestic and the foreign market, is equal to the ratio of the total revenues over the total variable costs.

Appendix II

Data sources, definitions of the variables and some descriptive statistics

The main sources used in the present paper are: the Bank of Italy Survey of Investment in Manufacturing (SIM) and the Company Accounts Data Service (CADS).

The SIM database goes back to 1984. The questionnaire is sent to each enterprise at the beginning of each year and the questions refer to the year just past and the previous year (this allows data consistency to be checked over time). Interviewers are officials of the Bank of Italy, who tend to establish long-run relationships with firms' managers and are also responsible for verifying the accuracy of the information collected. The sample is stratified according to three criteria: sector of economic activity, size and geographical localization. With regard to the first, the 3-digit Ateco-81 classification of the Italian Statistical Institute (fully consistent with the international NACE-CLIO classification) is used. Size refers to the number of employees (5 classes) and small firms, defined as those with less than 50 employees, are excluded from the sample. Firm localization refers to the regions (19). The presence of outliers and missing data within the sample is dealt with by means of appropriate statistical techniques.

The Company accounts report is a data service provided by an institution (Centrale dei Bilanci) established and owned by the Bank of Italy and a pool of banks. Information on the annual accounts of around 30,000 Italian firms has been collected since 1982 and data are reclassified to ensure comparability across firms.

Merging the information from the two sources resulted in an unbalanced panel of around 1,000 firms. In particular, the structure of the sample by number of observations per firm is as follows:

Number of annual observation	3	4	5	6	7	8	9	10	11
Number of firms	108	95	127	96	100	153	66	76	142

The sectors of economic activity in manufacturing industry are classified as follows:

1) Metallurgy
2) Transformation of non metalliferous minerals
3) Chemicals
4) Metals
5) Machinery for industry and agriculture
6) Computers, office equipment and precision instruments
7) Electrical machinery
8) Motor-cars
9) Other transport equipment (railway, ship, aircraft and other motor vehicles)
10) Food and tobacco products
11) Textiles
12) Leather and footwear
13) Clothing
14) Wood and furniture
15) Paper and publishing
16) Rubber and plastic products
17) Other manufactures.

Variables are defined as follows.

Investment: Total fixed investment by each firm in structures, machinery and equipment and vehicles. Data are from the SIM source and originally are at current prices. Hence, we have expressed them at constant (1990) prices using the sector investment deflators available from the Italian Statistical Institute.

Sales: Total sales of each firm (source: SIM). Original data are at a current prices; they have been expressed at constant (1990) prices using the sector production price indexes released by the Italian Statistical Institute.

χ: Time-varying share for each firm of foreign sales in total sales. The source for foreign sales is again SIM.

α: Time-varying share for each firm of the expenditure on imported inputs in the total expenditure on inputs. As explained in the text, the variable α is constructed using information at the firm level (source: CADS) and at the sector level. In particular, let *i* denote the generic firm and *j* the sector to which the firm belongs (we use a 44 sector classification); α_{it} is defined as follows:

$a_{it} = \left[\left(IM_{jt}/EM_{jt}\right)EM_{it}\right]/\left(EM_{it} + LC_{it}\right)$, where IM_{jt} is the value of all the materials that sector *j* has imported at time *t*. EM_{jt} and EM_{it} are total expenditure on material by sector *j* and firm *i*, respectively. LC_{it} is the labor cost for firm *i*. Data at the sector level are drawn from the 1988 44-sector input-output table for the Italian economy (source: Italian Statistical Institute) and each item is given a time profile by using the appropriate index (sector industrial production indexes and sector import expenditure indexes; source: Italian Statistical Institute).

Market power index ($\overline{mkup_{it}}$): See text; source: CADS.

Real effective exchange rate: See text; source: Bank of Italy.

The following are some descriptive statistics of the variables used:

Investment	25%	737
	50%	2,368
	75%	7,548
	Mean	11,931
Sales	25%	26,954
	50%	65,781
	75%	162,622
	Mean	226,962
χ	25%	0.05
	50%	0.22
	75%	0.46
	Mean	0.28
α	25%	0.13
	50%	0.17
	75%	0.21
	Mean	0.17
Mark-up	25%	0.05
	50%	0.09
	75%	0.14
	Mean	0.06

Legend: For each variable the first three numbers provided are, respectively, the 25%, 50% and 75% percentiles; calculations are based on the whole sample. Investment and sales are expressed in millions of Italian lire.

Tables

Table 1

GMM ESTIMATES OF A DYNAMIC INVESTMENT MODEL FOR PANEL DATA:
A basic specification
(sample period: 1986-1995; number of firms: 963; number of observations: 5792)

Dependent variable: ΔI_{it}

Variables	
$\Delta I_{i,t-1}$	0.26
	(6.63)
$\Delta S_{i,t-1}$	0.52
	(6.19)
$\alpha_{it} \cdot \Delta e_t$	7.18
	(2.46)
$\chi_{it} \cdot \Delta e_t$	-2.22
	(-3.17)
y_{87}.....y_{95} (time dummies)	
Wald test	103.6 (9; 0.001)
s_2.....s_{17} (industry dummies)	
Wald test	28.31 (16; 0.029)
d_2.....d_5 (firm size dummies)	
Wald test	7.58 (4; 0.108)
own (type of ownership)	
Wald test	1.83 (1; 0.177)
a_2, a_3 (geographical area)	
Wald test	13.40 (2; 0.001)
co (corporate operations)	
Wald test	0.39 (1; 0.532)
Sargan test of over-identifying restrictions	51.74 (44; 0.197)
Test of second-order serial correlation	-0.58 (0.565)

Legend: I_{it}, S_{it}, and e_t are, respectively, the logarithm of investment, total sales and the real effective exchange rate of the lira (an increase in *e* is an appreciation); α_{it} is the share of costs of imported inputs in total costs, χ_{it} is the share of revenues from exports in total revenues. The size dummies *d's* refer are as follows: 50-99, 100-199, 200-499, 500-999, >1000 employees. The dummy *own* distinguishes between public and private firms, *co* refers to merger, acquisitions, etc., *a's* distinguish between North, Center and South.

Notes: Heteroschedasticity consistent asymptotic *t* statistics are shown in brackets below the estimated parameters. Values of the Wald tests for the joint significance of groups of control variables are also reported, with degrees of freedom and *p*-value in brackets. They are asymptotically χ^2. Sargan is a test of the over-identifying restrictions with asymptotic distribution χ^2, degrees of freedom and *p*-value are reported in brackets. The test for second-order serial correlation is distributed asymptotically as a standard normal. The instrument set includes lagged values of the dependent variable dated *t*-2, *t*-3 and earlier.

Table 2

GMM ESTIMATES OF A DYNAMIC INVESTMENT MODEL FOR PANEL DATA: ALLOWING FOR A DIFFERENT DEGREE OF MARKET POWER (*)
(sample period: 1986-1995)

Dependent variable: ΔI_{it}

Variables	(1) low mark-up	(2) high mark-up
$\Delta I_{i,t-1}$	0.23	0.25
	(4.01)	(6.28)
$\Delta S_{i,t-1}$	0.36	0.70
	(4.20)	(6.84)
$\alpha_{it} \cdot \Delta e_t$	14.67	5.11
	(2.85)	(1.56)
$\chi_{it} \cdot \Delta e_t$	-3.11	-1.67
	(-2.49)	(-2.13)
Sargan test of over-identifying restrictions	44.51 (44; 0.450)	51.34 (44; 0.208)
Test of second-order serial correlation	-0.25 (0.801)	-0.92 (0.359)

Legend: I_{it}, S_{it}, and e_t are, respectively, the logarithm of investment, total sales and the real effective exchange rate of the lira (an increase in *e* is an appreciation); α_{it} is the share of costs of imported inputs in total costs, χ_{it} is the share of revenues from exports in total revenues. The following control factors are considered: time year dummies, industry dummies, size dummies (referring to the following breakdown: 50-99, 100-199, 200-499, 500-999, >1000 employees), a dummy distinguishing between public and private firms, a dummy for geographical location (North, Center and South) and a dummy for merger, acquisitions, divestitures, etc. The Wald tests for the significance of each of these control factors are not reported due to space constraints.

Notes: Heteroschedasticity consistent asymptotic *t* statistics are shown in brackets below the estimated parameters. Sargan is a test of the over identifying restrictions. Its asymptotic distribution is χ^2, with degrees of freedom and *p*-value reported in brackets. Finally, the test for second-order serial correlation is distributed asymptotically as a standard normal. The instrument set includes lagged values of the dependent variable dated *t*-2, *t*-3 and earlier.

(*) The sample splitting to distinguish between firms with low market power and those with high market power is based on the *mean* across firms of their time-average mark-ups. 274 firms are within the low mark-up group and 689 within the high mark-up group.

Table 3

GMM ESTIMATES OF A DYNAMIC INVESTMENT MODEL FOR PANEL DATA: ALLOWING FOR A DIFFERENT DEGREE OF MARKET POWER (*)
(sample period: 1986-1995)

Dependent variable: ΔI_{it}

Variables	
$\Delta I_{i,t-1}$	0.26
	(6.65)
$\Delta S_{i,t-1}$	0.53
	(6.19)
$\alpha_{it} \cdot \Delta e_t \cdot D_{low}$	8.99
	(2.42)
$\alpha_{it} \cdot \Delta e_t \cdot D_{high}$	6.34
	(2.02)
$\chi_{it} \cdot \Delta e_t \cdot D_{low}$	-3.32
	(-2.39)
$\chi_{it} \cdot \Delta e_t \cdot D_{high}$	-1.80
	(-2.26)
Sargan test of over-identifying restrictions	51.98 (44; 0.191)
Test of second-order serial correlation	-0.57 (0.566)

Legend: I_{it}, S_{it}, and e_t are, respectively, the logarithm of investment, total sales and the real effective exchange rate of the lira (an increase in e is an appreciation); α_{it} is the share of costs of imported inputs in total costs, χ_{it} is the share of revenues from exports in total revenues. The following control factors are considered: time year dummies, industry dummies, size dummies (referring to the following breakdown: 50-99, 100-199, 200-499, 500-999, >1000 employees), a dummy distinguishing between public and private firms, a dummy for geographical location (North, Center and South) and a dummy for mergers, acquisitions, divestitures, etc. The Wald tests for the significance of each of these control factors are not reported due to space constraints.
Notes: Heteroschedasticity consistent asymptotic *t* statistics are shown in brackets below the estimated parameters. Sargan is a test of the over-identifying restrictions. Its asymptotic distribution is χ^2, with degrees of freedom and *p*-value reported in brackets. Finally, the test for second-order serial correlation is distributed asymptotically as a standard normal. The instrument set includes lagged values of the dependent variable dated *t*-2, *t*-3 and earlier.
(*) In order to distinguish between firms with low market power and those with high market power the dummy variables D_{low} and D_{high} are used. The assignment criterion is based on the *mean* of firms' time-average mark-ups.

Table 4

GMM ESTIMATES OF A DYNAMIC INVESTMENT MODEL FOR PANEL DATA: ALLOWING FOR A DIFFERENT DEGREE OF MARKET POWER
(sample period: 1986-1995)

Dependent variable: ΔI_{it}

Variables	
$\Delta I_{i,t-1}$	0.25
	(6.58)
$\Delta S_{i,t-1}$	0.52
	(6.21)
$\alpha_{it} \cdot \Delta e_t \cdot (1 - \overline{mkup_{it}})$	2.91
	(2.90)
$\chi_{it} \cdot \Delta e_t \cdot (1 - \overline{mkup_{it}})$	-1.73
	(-3.53)
Sargan test of over-identifying restrictions	51.94 (44; 0.192)
Test of second-order serial correlation	-0.52 (0.603)

Legend: I_{it}, S_{it}, and e_t are, respectively, the logarithm of investment, total sales and the real effective exchange rate of the lira (an increase in e is an appreciation); α_{it} is the share of costs of imported inputs in total costs, χ_{it} is the share of revenues from exports in total revenues, $\overline{mkup_{it}}$ is the firm's mark-up. The following control factors are considered: time year dummies, industry dummies, size dummies (referring to the following breakdown: 50-99, 100-199, 200-499, 500-999, >1000 employees), a dummy distinguishing between public and private firms, a dummy for geographical location (North, Center and South) and a dummy for merger, acquisitions, divestitures, etc. The Wald tests for the significance of each of these control factors are not reported due to space constraints.
Notes: Heteroschedasticity consistent asymptotic *t* statistics are shown in brackets below the estimated parameters. Sargan is a test of the over-identifying restrictions. Its asymptotic distribution is χ^2, with degrees of freedom and *p*-value reported in brackets. Finally, the test for second-order serial correlation is distributed asymptotically as a standard normal. The instrument set includes lagged values of the dependent variable dated *t*-2, *t*-3 and earlier.

Table 5

GMM ESTIMATES OF A DYNAMIC INVESTMENT MODEL FOR PANEL DATA: ALLOWING FOR SECTOR DIFFERENCES IN IMPORT PENETRATION
(sample period: 1986-1995)

Dependent variable: ΔI_{it}

Variables	
$\Delta I_{i,t-1}$	0.25
	(6.48)
$\Delta S_{i,t-1}$	0.54
	(6.32)
$\chi_{it} \cdot \Delta e_t$	-2.16
	(-1.42)
$\alpha_{it} \cdot \Delta e_t$	11.51
	(2.23)
$(1-\chi_{it}) \cdot \Delta e_t \cdot IP_{1,t} \cdot s_1, (1-\chi_{it}) \cdot \Delta e_t \cdot IP_{2,t} \cdot s_2, \ldots, (1-\chi_{it}) \cdot \Delta e_t \cdot IP_{17,t} \cdot s_{17}$	
Wald test	30.68 (16; 0.015)
Sargan test of over-identifying restrictions	53.26 (44; 0.16)
Test of second-order serial correlation	-0.69 (0.491)

Legend: I_{it}, S_{it}, and e_t are, respectively, the logarithm of investment, total sales and the real effective exchange rate of the lira (an increase in e is an appreciation); α_{it} is the share of costs of imported inputs in total costs, χ_{it} is the share of revenues from exports in total revenues. The following control factors are considered: time year dummies, industry dummies, size dummies (referring to the following breakdown: 50-99, 100-199, 200-499, 500-999, >1000 employees), a dummy distinguishing between public and private firms, a dummy for geographical location (North, Center and South) and a dummy for merger, acquisitions, divestitures, etc. The Wald tests for the significance of each of these control factors are not reported due to space constraints.

Notes: Heteroschedasticity consistent asymptotic *t* statistics are shown in brackets below the estimated parameters. Sargan is a test of the over identifying restrictions. Its asymptotic distribution is χ^2, with degrees of freedom and *p*-value reported in brackets. Finally, the test for second-order serial correlation is distributed asymptotically as a standard normal. The instrument set includes lagged values of the dependent variable dated *t*-2, *t*-3 and earlier.

Table 5a

SECTOR EFFECT OF EXCHANGE RATE THROUGH IMPORT PENETRATION IN THE DOMESTIC MARKET

Sectors	Elasticities	Ranking
Metallurgy	1.17	14
Transformation of non metalliferous minerals	1.42	16
Chemicals	-0.07	11
Metals	-0.35	8
Machinery for industry and agriculture	0.11	12
Computers, office equipment and precision instruments	-2.51	2
Electrical machinery	-1.86	5
Motor-cars	-1.74	6
Other transport equipment (railway, ship, aircraft, etc.)	-0.21	10
Food and tobacco products	1.31	15
Textiles	-1.89	4
Leather and footwear	2.16	17
Clothing	0.80	13
Wood and furniture	-0.32	9
Paper and publishing	-0.45	7
Rubber and plastic products	-2.76	1
Other manufactures	-2.39	3

Legend: The sector effect of $(1-\chi)\cdot\Delta e$ on investment, controlling for import penetration in the domestic market, are computed on the basis of the estimation in Table 5. The top position in the ranking corresponds to the lowest value. A high negative effect means that, after controlling for import penetration $IP_{s,t}$, an appreciation ($\Delta e_t>0$) associated with a high $(1-\chi_{it})$ makes the firm's products less competitive in the domestic market, and the higher is $IP_{s,t}$, the greater is this effect; this reduced competitiveness is likely to discourage the accumulation process.

Table 6

GMM ESTIMATES OF A DYNAMIC INVESTMENT MODEL FOR PANEL: DATA ALLOWING FOR DIFFERENCES IN SUBSTITUTABILITY BETWEEN DOMESTIC AND FOREIGN INPUTS
(sample period: 1986-1995)

Dependent variable: ΔI_{it}

Variables	
$\Delta I_{i,t-1}$	0.25
	(6.48)
$\Delta S_{i,t-1}$	0.54
	(6.37)
$\chi_{it} \cdot \Delta e_t$	-1.40
	(-1.79)
$\alpha_{it} \cdot \Delta e_t$	15.34
	(3.71)
$\alpha_{it} \cdot \Delta e_t \cdot s_2$,...., $\alpha_{it} \cdot \Delta e_t \cdot s_{17}$	
Wald test	32.55 (16; 0.008)
Sargan test of over-identifying restrictions	52.50 (44; 0.178)
Test of second-order serial correlation	-0.704 (0.481)

Legend: I_{it}, S_{it}, and e_t are, respectively, the logarithm of investment, total sales and the real effective exchange rate of the lira (an increase in e is an appreciation); α_{it} is the share of costs of imported inputs in total costs, χ_{it} is the share of revenues from exports in total revenues; s_j are the industry dummies. The following control factors are considered: time year dummies, industry dummies and size dummies, the latter referring to the following breakdown: 50-99, 100-199, 200-499, 500-999, >1000 employees; moreover, the dummy *own* distinguishes between public and private firms and geographical location dummies distinguish between North, Center and South; the dummy *co* refers to merger, acquisitions, divestitures, etc. The Wald tests for the significance of each of these control factors are not reported due to space constraints.

Notes: Heteroschedasticity consistent asymptotic *t* statistics are shown in brackets below the estimated parameters. Sargan is a test of the over identifying restrictions. Its asymptotic distribution is χ^2, with degrees of freedom and *p*-value reported in brackets. Finally, the test for second-order serial correlation is distributed asymptotically as a standard normal. The instrument set includes lagged values of the dependent variable dated *t*-2, *t*-3 and earlier.

Table 6a

SECTOR EFFECT THROUGH THE COST SIDE ($\alpha \Delta E$)

Sectors	Estimated effect	Ranking
Metallurgy	15.34	4
Transformation of non metalliferous minerals	33.37	1
Chemicals	12.13	5
Metals	5.42	11
Machinery for industry and agriculture	4.95	14
Computers, office equipment and precision instruments	4.03	15
Electrical machinery	3.53	16
Motor-cars	5.16	13
Other transport equipment (railway, ship, aircraft, etc.)	8.63	7
Food and tobacco products	19.08	2
Textiles	5.66	10
Leather and footwear	15.91	3
Clothing	11.31	6
Wood and furniture	6.41	9
Paper and publishing	7.47	8
Rubber and plastic products	0.86	17
Other manufactures	5.42	11

Legend: The sector effect through the cost side is computed on the basis of the estimation in Table 6. The higher the value, the higher the position in the ranking.

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