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Real Exchange Rates, Economic Complexity, and Investment

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Abstract

We show that the response of firm-level investment to real exchange rate movements varies depending on the production structure of the economy. Firms in advanced economies and in emerging Asia increase investment when the domestic currency weakens, in line with the traditional Mundell-Fleming model. However, in other emerging market and developing economies, as well as some advanced economies with a low degree of structural economic complexity, corporate investment increases when the domestic currency strengthens. This result is consistent with Diaz Alejandro (1963)—in economies where capital goods are mostly imported, a stronger real exchange rate reduces investment costs for domestic firms.

JEL Classification Numbers: E22, F31, F41.

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I. INTRODUCTION

The classical Mundell-Fleming model for open economies (Mundell, 1963, Fleming, 1962) suggest that a weaker domestic currency should stimulate investment, as it makes domestic goods cheaper and thus more competitive in foreign markets. This will entice an increase in production and exports, while domestic demand tilts to non-tradable goods. Diaz Alejandro (1963), however, argues that for economies that depend on imported capital goods, investment increases when the domestic currency strengthens—to the extent that purchasing foreign capital goods becomes cheaper. These opposing effects could ultimately reflect different degrees of economic complexity (Hausmann and Hidalgo, 2011).

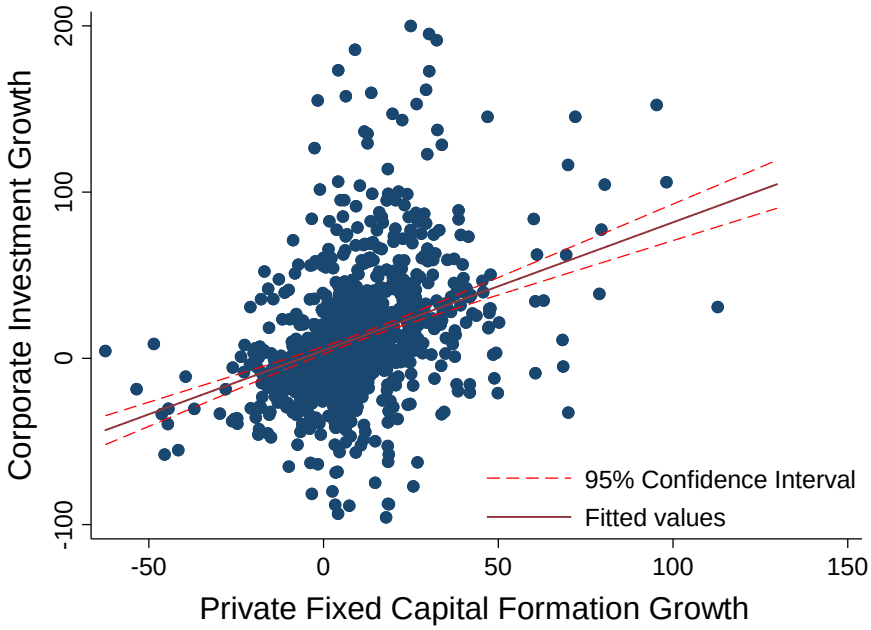
To bridge these two apparently opposing views, we propose a simple theoretical framework that motivates our empirical analysis. We find that the relationship between real exchange rate movements and investment varies across regions and structural economic characteristics. In advanced economies, firms' investment is positively associated with a real exchange rate depreciation. Similar results are found for emerging economies in Asia. By contrast, in other emerging market and developing regions corporate investment is higher when the local currency strengthens in real terms. In short, for corporate investment, the Mundell—Fleming story holds for advanced economies and for emerging Asia. Price competitiveness appears to be a key determinant of firms' investment decisions. By contrast, Diaz Alejandro's argument seems to dominate in all other cases, as the cost of importing capital goods outweighs the positive effects of higher competitiveness. We also show that underlying these findings is the degree of economic complexity. For firms in more complex economies (which generally include most advanced economies as well as emerging Asia), the positive impact of a real exchange rate depreciation on price competitiveness tends to outweigh the negative impact associated with increased cost of imported capital goods. But it is the opposite in firms in economies with a lower degree of complexity, which basically include all other emerging market regions. We also analyze the above exercise for a simple measure of real exchange rate misalignment. Most of the above results carry through, except that advanced economies that are less complex behave as emerging markets other than Asian, in that corporate investment increases when their currencies are overvalued.

We focus on investment at the firm level rather than aggregate investment levels. This has important advantages. The degree of real exchange rate misalignment is totally exogenous to individual firms, regardless of their size. By contrast, using aggregate investment instead of firm-level data could introduce endogeneity issues. Adjustments in the external current account—simply aggregate saving (a typically very slow-moving variable) net of aggregate investment—are tightly associated with movements and misalignments of the real exchange rate. By counting on firm-level data, we mitigate substantially these potential endogeneity issues—as reverse causality is not possible. This approach also prevents potential problems related to investment deflators, as these could be affected by movements in the real exchange

rate.[1] Yet, as Figure 1 shows and Magud and Sosa (2017) document, firm-level investment is highly correlated with aggregate investment.

Figure 1: Corporate Investment and Total Private Investment

(Year-over-year percent change)



Source: authors' calculations based on IMF's International Financial Statistics and Thompson Reuters' Worldscope.

Our paper contributes to a strand of the literature looking at the relationship between the real exchange rate and investment and growth. The closest paper to ours is Alfaro and others (2017). They focus on the impact of real exchange rate movements on firm-level TFP growth and R&D investment. They find that these variables are positively associated with real depreciations in emerging Asia but with real appreciations in other emerging market regions—with no clear relationship in advanced economies. The key transmission channel is given by the relative response of exports and imports. Economies that are more export-intensive (implying a lower dependence on importing capital) increase corporate R&D and TFP growth when the real exchange rate depreciates. Less export-intensive countries do it when the domestic currency appreciates.[2] Dao and others (2017) also study the relationship between the real exchange rate and corporate investment using firm-level data. However, they use a different measure of the real exchange rate, which is not weighted by trade partners—and therefore is more weakly associated with competitiveness[3]—and focus on the labor cost reduction associated with real depreciations. Another key difference is that we split the sample

[1] For a recent study on exchange rate pass-through see Carriere-Swallow and others (2016).

[2] Avellan and Ferro (2018) document similar findings for Ecuador/

[3] Moreover, such a measure is neither a correct measure of competitiveness, nor a measure of real income.

by region or economic structure, allowing us to uncover important differences masked in the aggregate results. Also related to our work is Lanau (2017), who also examines regional differences, but his focus is on the impact of real exchange depreciations on firm-level growth, without analyzing firms' investment.

Avdjiev and others (2017) document how firm-level investment in emerging markets and the U.S. dollar cycle are related, and find that a stronger U.S. dollar is associated with lower firm-level investment in emerging economies, owing to balance sheets' currency mismatches affecting firms' decisions through the financial channel.[4] Similarly, Druck and others (2018), examine the impact of the U.S. dollar cycle on emerging market and developing countries' growth. They show that these effects are more prominently associated to income effects, especially when controlling for financial/currency mismatches effects.

We build on this literature and contribute to it by exploring the relationship between real exchange rate movements and firm-level investment. Our main contribution is to document how this relationship varies across regions, and particularly across economies with different production structures, which to best of our knowledge has not been explored before.[5]

The rest of the paper is structured as follows. Section II sketches the theoretical model, showing that corporate investment can either increase or decrease when the currency strengthens (or weakens)—implying that in the end, it is an empirical issue. Section III describes the data, while Section IV presents the econometric model. Results are shown in Section V, with some robustness checks included in Section VI. Section VII concludes.

II. A THEORETICAL MODEL

We use an augmented Q-model of investment for a price-taking open economy to motivate the empirical analysis below. The problem of a firm *i* in period *t* that produces tradable goods and purchases tradable investment goods over an infinite horizon is to maximize the present discounted value of the flow of dividends, D_t, given by

$$E_t\left\{\sum_{i=1}^{\infty}\frac{D_{t+i}}{R^i}\right\} \quad (1)$$

where *R* stands for the exogenous gross interest rate. In turn, the firms' dividend flows are given by

$$D_t = \pi(K_t, \theta_t, e_t) - e_t I_t - c(I_t, K_t) \quad (2)$$

[4] See also Caballero (2018)

[5] An older literature focused on the contractionary effects of devaluations (e.g., Krugman and Taylor, 1978) and on the contractionary effects of currency mismatches (Krugman 1999, Cespedes and others, 2004).

where π is the firm's profit function, K the stock of capital, θ the level of technology, and e is the real exchange rate. I denotes investment and $c(I_t, K_t)$ represents a function to capture the adjustment cost of investment. The profit function is assumed to be increasing in capital, the level of technology, and the real exchange rate, and it is a concave function. Adjustment costs of installing new capital are an increasing and convex function in the investment-capital ratio, $\frac{I_t}{K_t}$, defined below, and θ_t is a stationary first order Markov process. Given a constant rate of depreciation δ, the stock of capital changes over time as given by

$$K_{t+1} = I_t + (1-\delta)K_t \tag{3}$$

Firms in this economy purchase its capital abroad.[6] The real exchange rate is defined as the number of domestic currency baskets of tradable goods needed to purchase one unit of the foreign currency basket of tradable goods. Thus, an increase in the real exchange rate denotes a real depreciation. When the economy's real exchange rate strengthens, the economy is richer, and thus its purchasing power increases. Therefore, investment (i.e., purchasing capital goods), becomes relatively cheaper. At the same time, however, a weaker real exchange rate increases the country's competitiveness, as its tradable final goods become relatively cheaper for the rest of the world (though more expensive for domestic agents).

Formally, the firm's problem is to maximize (1) subject to (2) and (3). The Bellman equation for the firm's problem is given by

$$V(K_t, \theta_t, e_t) = \max_{I_t, K_{t+1}} \left\{ \pi(K_t, \theta_t, e_t) - e_t I_t - c(I_t, K_t) + \frac{1}{R} E_t[V(K_{t+1}, \theta_{t+1}, e_{t+1})] \right\} \tag{4}$$

Equivalently,

$$V(K_t, \theta_t, e_t) = \max_{I_t} \left\{ \pi(K_t, \theta_t, e_t) - e_t I_t - c(I_t, K_t) + \frac{1}{R} E_t[V(I_t + (1-\delta)K_t, \theta_{t+1}, e_{t+1})] \right\} \tag{5}$$

Optimizing over the control variable I_t, while K_t is the state variable, implies the following first order condition:

$$e_t + c_I(I_t, K_t) = \frac{1}{R} E_t[V(K_{t+1}, \theta_{t+1}, e_{t+1})] = \frac{1}{R} E_t q_{t+1} \tag{6}$$

On the right-hand side of equation (6), as usual in the literature, we define Tobin's q as the discounted shadow price of capital—marginal q—which equals the replacement cost of capital plus the adjustment cost of installing new capital, i.e., the effective price of new capital. Assume a constant-returns-to-scale adjustment cost of capital function given by

[6] Assuming that only a share of the capital stock is imported does not alter the results, this being only a simplifying assumption for ease of exposition.

$$c(I_t, K_t) = \frac{1}{2} b \left(\frac{I_t}{K_t} - \mu\right)^2 K_t \qquad (7)$$

in which μ denotes the investment-capital ratio in steady state, which is associated with no adjustment costs. Intuitively, μK is the level of investment necessary to maintain a constant stock of capital in the steady state. Substituting (7) into (6) we get

$$e_t + b\left(\frac{I_t}{K_t} - \mu\right) = \frac{1}{R} E_t[V(K_{t+1}, \theta_{t+1}, e_{t+1})] = \frac{1}{R} E_t q_{t+1} \qquad (8)$$

Re-arranging (8) we obtain

$$\frac{I_t}{K_t} = \frac{1}{bR} E_t q_{t+1} - \frac{e_t}{b} + \mu \qquad (9)$$

which shows the standard positive association between Tobin's q and investment. As has been shown in the literature, an increase in marginal q (a higher shadow price of capital, implying a larger present discounted value of the flow of dividends, as shown below), makes the firm to optimally increase investment.

The envelope condition implies that

$$V_k(K_t, \theta_t, e_t) = \pi_K(K_t, \theta_t, e_t) - c_K(I_t, K_t) + \frac{1-\delta}{R} E_t[V(K_{t+1}, \theta_{t+1}, e_{t+1})] \qquad (10)$$

Thus,

$$q_t = [\pi_K(K_t, \theta_t, e_t) - c_K(I_t, K_t)] + \frac{1}{R}(1-\delta) E_t[q_{t+1}] \qquad (11)$$

Updating (11) one period, forwarding it, taking expectations as of period *t*, applying the law of iterated expectations and substituting back in (11), and finally iterating forward and using the transversality condition, we obtain:

$$V_K(K_t, \theta_t) = E_t\left\{\sum_{i=0}^{\infty}\left(\frac{1-\delta}{R}\right)^i [\pi_K(K_{t+i}, \theta_{t+i}) - c_K(I_{t+i}, K_{t+i})]\right\} \qquad (12)$$

which shows that the marginal value of an additional unit of capital should equal the discounted flow of marginal profits, net of adjustment costs.

Re-arranging (8) and using the envelope condition (10) results in

$$I_t = \left[\frac{V_k(K_t,\theta_t,e_t) - \pi_K(K_t,\theta_t,e_t) + c_K(I_t,K_t)}{b(1-\delta)} - \frac{e_t}{b} + \mu\right] K_t \qquad (13)$$

Taking the partial derivative of (13) with respect to the real exchange rate yields

$$\frac{\partial I_t}{\partial e_t} = \left[\frac{V_{ke}(K_t,\theta_t,e_t) - \pi_{Ke}(K_t,\theta_t,e_t)}{(1-\delta)} - 1\right] \frac{K_t}{b} \qquad (14)$$

which shows two opposing forces at play. On the one hand, an increase in competitiveness, as given by a higher *e*, stimulates investment by making domestic goods cheaper for the rest of the world. In turn, this increases the continuation value of investment given that $V_{ke}(K_t, \theta_t, e_t) - \pi_{Ke}(K_t, \theta_t, e_t) > 0$. On the other hand, a higher e increases the cost of purchasing capital goods. If the former effect dominates, corporate investment increases when the currency weakens). However, if the latter effect is larger, investment would decline when the domestic currency weakens, as given by

$$\frac{V_{ke}(K_t, \theta_t, e_t) - \pi_{Ke}(K_t, \theta_t, e_t)}{(1-\delta)} - 1 \lessgtr 0$$

Intuitively, in economies where the competitiveness channel is relatively stronger, the impact through this channel will outweigh the negative effect of higher costs of capital goods, implying that a weaker (real) currency should be associated with higher corporate investment. Investment will decrease if the relative strengths of these effects is flipped. Relatedly, the degree of economic complexity should be reflected in these two relative elasticities. In the end, how real exchange rate movements affect investment is an empirical question. We move to this next.[7]

III. DATA AND DESCRIPTIVE STATISTICS

The dataset comprises an unbalanced panel of 40,412 firms from 71 economies for the period 1995—2016, with annual frequency. The source of the firm-level data is Thomson Reuters Worldscope, while the country-specific real effective exchange rate (REER) data comes from the IMF's *International Financial Statistics*, and the global Cboe Volatility Index (VIX) from Bloomberg, L.P. We drop observations with inconsistent data[8] and, to avoid outliers, we truncate the firm-level observations below the 1st percentile and above the 99th percentile.[9] To identify the industry of firms, we use the SIC 4-digit code classification. We restrict the sample to non-financial firms, excluding firms in finance, insurance, real estate, and public administration sectors. Table 1 presents the distributions of firms and observations by industry in the sample. The largest group is manufacturing with close to 52 percent of observations the total sample, followed by services with 14 percent, and transportation, communications, and utilities with almost 10 percent.

[7] Adding a non-tradable sector would only enhance these results as profitability of firms in this sector would not decrease when the currency is overvalued. Adding currency mismatches and the possibility of firms' balance sheet effects would also enlarge these effects—see Magud (2008).

[8] Negative values of total assets; capital expenditure; property, plant, and equipment; common equity; total debt; interest expenses; and depreciations.

[9] For the investment ratio, leverage, and interest expense ratio the data was truncated only for observation higher than the percentile 99th, because the value for the 1st percentile was zero.

Table 1: Sample composition by industry

Industry	No. of firms	Obs.	Percent of obs.
Agriculture, forestry, and fishing	496	4,126	1.2
Construction	2,049	18,511	5.3
Manufacturing	19,345	179,906	51.7
Mining	2,433	15,844	4.6
Nonclassifiable	1,093	9,112	2.62
Retail trade	2,327	20,914	6.0
Services	6,979	48,689	14.0
Transportation, communications, and utilities	3,681	33,143	9.5
Wholesale trade	2,009	17,904	5.1
Total	40,412	348,149	100

Source: Authors' calculations based on data from Thomson Reuters Worldscope.

The countries included in the sample and the number of firms per country are listed in Table A1 in the appendix. The sample includes companies from 39 emerging market and developing economies and 32 advanced economies.[10] The sample is skewed to firms from advanced economies, in a close to two-to-one ratio, with 28,199 firms (69.8 percent of the sample) from advanced economies and 12,213 firms (30.2 percent) from emerging market and developing economies. The top-five countries with the largest shares in the database are the United States (19.1 percent), Japan (10.9 percent), China (7 percent), India (5.7 percent), and the United Kingdom (5 percent). The share of companies in tradable sectors is 66.5 percent in emerging market and developing economies and 61.2 percent in advanced economies.[11]

Table 2 presents summary statistics of variables in the dataset, divided into three sub-samples: full sample, emerging market and developing economies, and advanced economies. The investment-capital ratio (*ICR*) is computed as capital expenditure (i.e., purchase of fixed assets such as property, industrial buildings, or equipment) divided by the total net value of property, plant, and equipment in the previous year. The distribution of this variable is skewed to the right, with a few companies investing more than 100 percent of their previous year's capital stock (Figure 2). For the full sample the mean of *ICR* is 0.27 and the median 0.15, with broadly similar figures for both emerging and advanced economies.

As is standard in the literature, Tobin's q is computed as market capitalization plus total assets minus common equity, divided by total assets (book value).[12] Cash flow is measured as net income plus depreciation and depletion, divided by the previous year's value of property, plant, and equipment. Leverage is the ratio between total debt, net of cash stock, and total common equity. Change in debt is given by the change in the stock of debt since the previous year,

[10] The income classification for 'emerging market and developing economies' and 'advanced economies' are as of January 2015, as defined in the IMF's *World Economic Outlook*.
[11] We define as tradable sectors agriculture, forestry and fishing, manufacturing, mining, and wholesale trade, while all the other industries are classified as non-tradable.
[12] As it is usual in the literature, we approximate marginal q with average q, implicitly taking Hayashi (1982) assumptions to hold.

normalized by property, plant, and equipment. Interest expense is computed as the ratio of each firm's interest bill and the capital stock of the previous period (i.e., the previous year's value of property, plant, and equipment). Sales growth measures the annual growth in net sales or revenues.

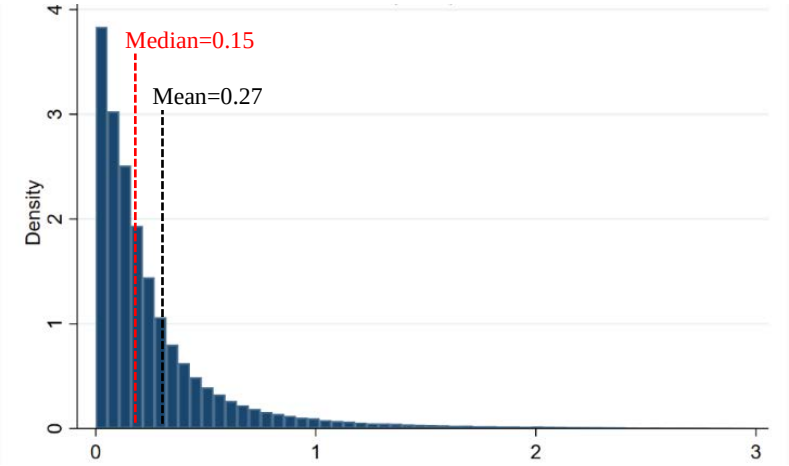
Table 2. Summary Statistics (71 countries, 1995-2016)

Full sample	Obs	Mean	Median	Std. Dev.	Min	Max
Investment-capital ratio (ICR)	348,149	0.27	0.15	0.43	0.00	6.41
Tobin's Q	348,149	1.46	1.13	1.08	0.29	12.51
Cash flow	348,149	0.25	0.22	2.65	-61.60	20.00
Leverage	348,149	0.89	0.50	1.27	0.00	12.70
Interest expense ratio	348,149	0.09	0.05	0.17	0.00	2.61
Change in debt	348,149	0.25	0.01	1.53	-6.31	19.95
Sales growth	348,149	0.14	0.07	0.46	-0.87	6.17
Real Effective Exchange Rate Growth	348,140	0.38	0.43	6.29	-74.07	135.49
Real Effective Exchange Rate Misalignment	348,149	-0.99	-1.04	12.47	-51.50	371.19
Cboe Volatility Index (VIX)	348,149	20.69	22.07	6.07	12.77	32.55
Emerging and Developing Economies						
Investment-capital ratio (ICR)	100,171	0.27	0.15	0.44	0.00	6.40
Tobin's Q	100,171	1.49	1.11	1.16	0.29	12.50
Cash flow	100,171	0.42	0.22	1.39	-61.35	19.91
Leverage	100,171	0.91	0.53	1.25	0.00	12.69
Interest expense ratio	100,171	0.11	0.07	0.18	0.00	2.61
Change in debt	100,171	0.28	0.04	1.35	-6.31	19.91
Sales growth	100,171	0.17	0.11	0.45	-0.87	6.17
Real Effective Exchange Rate Growth	100,171	1.61	1.56	6.72	-74.07	135.49
Real Effective Exchange Rate Misalignment	100,171	2.45	0.17	14.69	-51.50	371.19
Advanced Economies						
Investment-capital ratio (ICR)	247,978	0.27	0.16	0.43	0.00	6.41
Tobin's Q	247,978	1.44	1.14	1.05	0.29	12.51
Cash flow	247,978	0.18	0.22	3.01	-61.60	20.00
Leverage	247,978	0.88	0.49	1.28	0.00	12.70
Interest expense ratio	247,978	0.08	0.05	0.16	0.00	2.61
Change in debt	247,978	0.24	0.00	1.59	-6.31	19.95
Sales growth	247,978	0.13	0.05	0.46	-0.87	6.17
Real Effective Exchange Rate Growth	247,978	-0.12	0.06	6.04	-24.00	16.93
Real Effective Exchange Rate Misalignment	247,978	-2.39	-1.30	11.16	-31.07	54.49

At the country level, the REER index computes the purchasing power (which is at the same time a metric of relative competitiveness) of each economy's currency by factoring in its trading partner and export competitors, weighted by the relative importance in trade. Following the IMF methodology, an increase in the REER index represent a real appreciation of the currency. We also compute a simple, back of the envelope measure of the degree of real exchange rate misalignment, REER_Mis, calculated as the difference between the index at each point in time and its country-specific historical median, as a percentage of its median, for the period 1980-2016. This metric aims at gauging the magnitude of REER overvaluation

(positive gap) and undervaluation (negative gap). However, such a measure of misalignment is not without problems. Some countries have definitely become richer since the 1980s, for which this metric will likely be biased to overvaluation. Despite the simplicity and potential bias of this metric, it is strongly in line with more complex measures, such as IMF's External Balance Assessment's measures of exchange rate misalignment (Figure 3).[13]

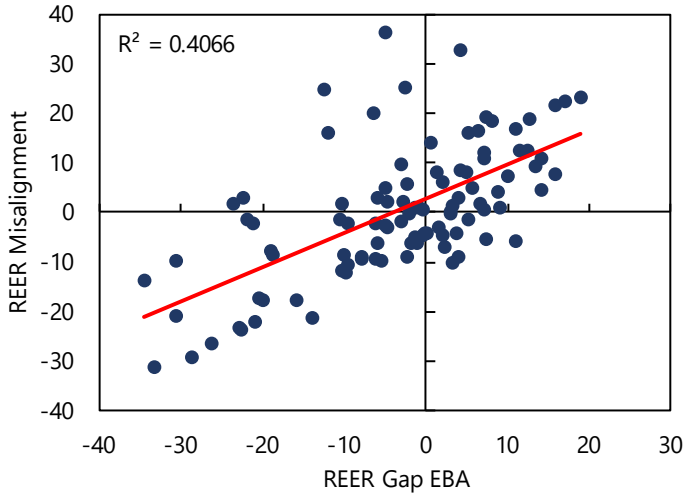
Figure 2: Histogram of Investment-Capital Ratio



Source: Authors' calculations based on data from Thomson Reuters Worldscope.

Figure 3: Alternative Measures of REER Misalignment, 2013-2016

(Percent)



Sources: IMF, External Balance Assessment (EBA) database; IMF, Information Notice System; and IMF staff calculations.

[13] For details on the EBA measure see Phillips and others (2013).

IV. EMPIRICAL APPROACH

The econometric approach is a diff-in-diff firm-level panel regression. We combine firm level variables identified in the literature as determinants of investment with our measure of real exchange rate growth at the country level. The baseline specification is the following:

$$ICR_{j,c,t} = \alpha_{j,t} + \beta * ICR_{j,c,t-1} + \gamma * REER\_gr_{c,t} + \rho * X_{j,c,t} + \sigma * VIX_{t-1} + \mu * T_{i,c,t} + \varepsilon_{j,t}$$

The dependent variable $ICR_{j,c,t}$ denotes the investment-capital ratio for firm j in country c during year t. $\alpha_{j,t}$ represents a vector of firm fixed-effects. We control for the *ICR* of the previous year to take into account the persistence of investment. The variable $REER\_gr_{c,t}$, represents the growth rate of the REER in country *c* during year *t* and varies across countries and not across firms. The main focus of this study is on the effect of the REER growth on firms' investment, given by γ.[14] A negative value of γ means firm-level investment increases when the domestic currency weakens in real terms. On the contrary, a positive coefficient implies investment at the firm level increases when the domestic currency strengthens. We explore if the effect differs across regions and/or economic productive structure. For all specifications we run standard OLS regressions with fixed effects at the firm level and robust standard errors clustered by country, to control for sample heterogeneity. In an alternative specification we replace the growth rate of the real exchange rate by the real exchange rate misalignment.

The vector of firm-level explanatory variables, $X_{j,t}$, includes the determinants of corporate investment standard in the literature (see, for example, Magud and Sosa, 2017; and Li, Magud, and Valencia, 2015). Specifically, we use Tobin's q, cash flow, leverage, change in debt, and sales growth. The VIX is also included to control for changes in global uncertainty and financial volatility. Finally, the vector $T_{i,c,t}$ is a set of year, industry-year, and country-year fixed effects dummies. Including these controls separates the effect of real exchange rate movements from that of other unobserved factors such as fiscal policy, terms of trade shocks, political shocks, etc. at the country level, as well as technological and demand changes at the industry level. To the extent possible, this set of dummy variables controls for omitted macroeconomic variables biases, acting as a control group. Lastly, $\varepsilon_{j,t}$ represents an error term.

V. RESULTS

Table 3 reports the baseline results. Columns 1 and 2 show that the coefficients for the firm-level variables exhibit the expected sign for most variables and are statistically significant for both advanced and emerging market economies. In line with the findings in previous studies,

[14] We follow existing literature in using the current period real exchange rate (see Alfaro and others, 2017). Presumably, the lagged *ICR* and the controls, in particular the set of fixed-effects, capture previous periods' real exchange rate effects.

(continued…)

Tobin's q is positively related to firm's investment. Also consistent with previous studies, we find evidence of financial constraints, as indicated by a positive relationship between firm's cash flow and capital spending, though significant only for advanced economies.[15] Moreover, all else equal, higher leverage reduces firm-level investment, while an increase in debt is associated with higher investment. Previous period sales growth also indicates a higher likelihood of profitability (also in line with accelerator models of investment), as all else equal result in higher investment.

Table 3: The dependent variable is the investment-capital ratio (ICR)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Advanced	Emerging	Dev. Asia	Dev. Europe	LAC	MENA	SSA
ICR (t-1)	0.0645***	0.0770***	0.0744***	0.0711	0.1543***	0.0926***	0.0357
	(0.0096)	(0.0124)	(0.0141)	(0.0554)	(0.0328)	(0.0196)	(0.0129)
Tobin's Q	0.0495***	0.0221***	0.0225***	0.0308	0.0474**	0.0101	0.0301
	(0.0018)	(0.0046)	(0.0054)	(0.0246)	(0.0105)	(0.0136)	(0.0188)
Cash flow	0.0013	0.0402***	0.0459**	0.0365**	0.0324**	0.0192	0.0328***
	(0.0027)	(0.0076)	(0.0125)	(0.0131)	(0.0116)	(0.0303)	(0.0017)
Leverage (t-1)	-0.0190***	-0.0244***	-0.0251***	-0.0132	-0.0234***	-0.0378***	-0.0295**
	(0.0018)	(0.0031)	(0.0043)	(0.0106)	(0.0022)	(0.0046)	(0.0037)
Change in debt	0.0397***	0.0642***	0.0676***	0.0419***	0.0412***	0.0756***	0.0572***
	(0.0045)	(0.0068)	(0.0103)	(0.0037)	(0.0040)	(0.0172)	(0.0023)
Sales growth (t-1)	0.0004***	0.0002**	0.0002*	-0.0001	-0.0000	0.0000	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0001)	(0.0001)
Real Effective Exchange Rate Growth	-0.0053***	0.0010	-0.0010***	0.0049***	0.0005***	0.0274***	0.0080**
	(0.0003)	(0.0828)	(0.0002)	(0.0013)	(0.0001)	(0.0026)	(0.0013)
Cboe Volatility Index (VIX) (t-1)	-0.0019	0.0021	-0.0108***	0.0166***	0.0156	0.0078*	0.0238***
	(0.0011)	(0.2955)	(0.0009)	(0.0041)	(0.0091)	(0.0037)	(0.0013)
Constant	0.2995***	0.1580	0.4139***	-0.1052	-0.1102	0.6270***	-0.3830**
	(0.0277)	(124.0342)	(0.0402)	(0.1463)	(0.1741)	(0.1014)	(0.0615)
Observations	257,663	100,213	61,210	9,549	8,285	6,564	4,231
R-squared	0.0789	0.1265	0.1339	0.1579	0.2074	0.1685	0.1772
Number of firms	29,922	12,547	7,891	1,333	881	827	579
Number of countries	32	39	7	8	6	11	4

Notes: All specifications include firm, year, industry-year, and country-year fixed effects. Robust standard errors (clustered by country) are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The relationship between real exchange rate growth and corporate investment—the focus of this study—varies across regions. Firms in advanced economies tend to invest more when their domestic currencies weaken in real terms (column 1), suggesting that price competitiveness channels play a dominant role. For emerging market and developing economies the coefficient is not statistically significant different from zero. However, this result masks differences across emerging market regions. In fact, the *REER_gr* coefficient is statistically different from zero for all sub-groups of countries, although the sign varies across these sub-groups. Firms in emerging Asia behave as those in advanced economies, increasing investment when their

[15] See Magud and Sosa (2017), Li, Magud, and Valencia (2015), and Love (2004) for evidence on this in emerging market and developing economies, and the references therein for evidence in the U.S.

countries' real exchange rate weakens, pointing to the relative importance of competitiveness as a signal for corporate investment in this region. By contrast, firms in all other emerging market and developing economies invest more when their domestic currencies strengthen in real terms. A plausible explanation for this difference is that these emerging market and developing countries tend to rely heavily on imports of foreign capital goods for domestic production, and these goods become cheaper when the local currency is overvalued.[16] Related to this dependence could be the degree of economic complexity (that is, less complex economies need to import capital goods, as they typically have small and/or low-competitiveness industries). We elaborate on this in the next subsection.

The results are not only statistically but also economically significant. Based on the estimated coefficients, a one-standard-deviation shock to our measure of real exchange rate misalignment shifts the investment-capital ratio by about 3-4 percentage points for all regions. Given the sample *ICR* medians, in the neighborhood of 15 percent for both advanced economies and emerging market and developing economies (Table 2), suggest a non-trivial impact on investment resulting from real exchange rate deviations movements.

Table 4: Baseline results. The dependent variable is the investment-capital ratio (ICR)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Advanced	Emerging	Dev. Asia	Dev. Europe	LAC	MENA	SSA
ICR (t-1)	0.0644***	0.0779***	0.0777***	0.0492	0.1432**	0.0964***	0.0500*
	(0.0105)	(0.0124)	(0.0153)	(0.0470)	(0.0400)	(0.0288)	(0.0206)
Tobin's Q	0.0534***	0.0294***	0.0271***	0.0353	0.0552***	0.0231	0.0402
	(0.0039)	(0.0055)	(0.0057)	(0.0273)	(0.0097)	(0.0179)	(0.0289)
Cash flow	0.0000***	0.0001	0.0004*	0.0001	-0.0000	0.0002	0.0092***
	(0.0000)	(0.0001)	(0.0002)	(0.0001)	(0.0000)	(0.0002)	(0.0005)
Leverage (t-1)	-0.0161***	-0.0235***	-0.0254***	-0.0143	-0.0242***	-0.0331***	-0.0209**
	(0.0016)	(0.0035)	(0.0045)	(0.0110)	(0.0025)	(0.0079)	(0.0046)
Change in debt	0.0401***	0.0662***	0.0720***	0.0361***	0.0456***	0.0795***	0.0506***
	(0.0049)	(0.0080)	(0.0115)	(0.0047)	(0.0043)	(0.0137)	(0.0026)
Sales growth (t-1)	0.0364***	0.0227***	0.0278**	-0.0147	0.0099	0.0026	0.0210*
	(0.0067)	(0.0084)	(0.0111)	(0.0153)	(0.0097)	(0.0085)	(0.0082)
REER Misalignment	-0.0021***	0.0008	-0.0018***	-0.0052***	0.0007***	0.0134***	0.0088***
	(0.0003)	(1.1125)	(0.0001)	(0.0007)	(0.0001)	(0.0013)	(0.0008)
Cboe Volatility Index (VIX) (t-1)	0.0010	-0.0136	0.0005	0.0177***	0.0097	0.0706***	-0.0137***
	(0.0013)	(0.3616)	(0.0031)	(0.0037)	(0.0067)	(0.0076)	(0.0012)
Constant	-0.0870***	0.6120	0.1910*	-0.6500**	0.1715	-1.8090***	0.4387***
	(0.0277)	(79.5654)	(0.0864)	(0.1901)	(0.1979)	(0.1870)	(0.0583)
Observations	224,592	91,154	63,092	8,239	7,522	5,284	3,852
R-squared	0.0876	0.1180	0.1191	0.1314	0.1990	0.2147	0.1717
Number of firms	28,226	12,266	8,052	1,244	852	776	575
Number of countries	32	39	7	8	6	11	4

Notes: All specifications include firm, year, industry-year, and country-year fixed effects. Robust standard errors (clustered by country) are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[16] This has been recently documented in Alfaro and other (2017).

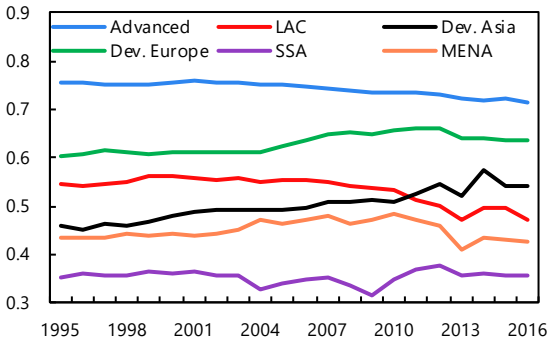
Next, we replicate the above specification using as the main explanatory variable the real exchange rate misalignment (Table 4). Except for countries in emerging Europe, all other results remain the same.

Details matter: The role of economic complexity

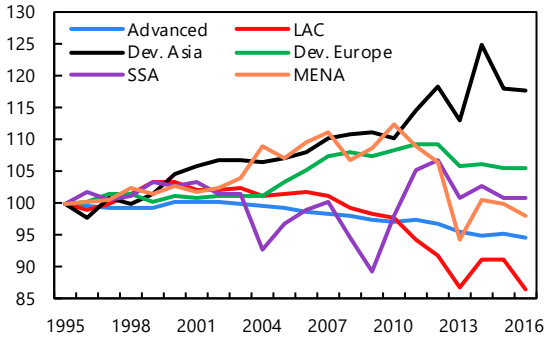
Economic complexity measures the relative knowledge intensity of an economy and it can be used as a proxy for economic diversification and production capabilities to the global market (Hausmann and Hidalgo, 2011). Typically, less complex economies tend to be more commodity oriented and have less competitive manufacturing firms. Consequently, their dependence on imported capital goods is larger, especially given the value added of its exports. To explore this channel, we factor in the index of economic complexity, *ECI* (Hausmann, and others, 2011). Figure 4 presents the *ECI* by region. In panel A (left) the index is standardized from 0 to 1—the original index is estimated from -2.6 to 2.8. The chart shows that the advanced economies and developing Europe have a higher level of economic complexity and Sub-Sahara Africa the lowest. Panel B (right) shows that developing Asia is the region with the highest increase of complexity since 1995.

Figure 4: Economic Complexity Index by Region

A. (Higher index higher complexity)



B. (Index: 1995=100)



Sources: Hausmann, et al., 2011, and IMF staff calculations.
Note: the index was standardized from 0 to 1. The original index is estimated from -2.6 to 2.8.

We run our baseline specification separately on the set of countries that lie in the lower quartile of the *ECI* and on those that lie on the upper quartile. We find that for countries that are less complex, the coefficient of real exchange rate growth is positive, while for those in the upper quartile, which are the most complex and integrated, the coefficient is negative (Table 5). This suggests that for the latter group, having a lower (i.e., weaker) real exchange rate is associated with higher firm-level investment (column 2). On the contrary, for less complex economies (column 1), typically associated to those more dependent on exporting commodities, firm-level investment increases when the domestic currency strengthens.

Countries on the upper quartile of the *ECI* indicator only include advanced economies. Thus, the results in column 2 of Table 5 should not be surprising. The estimated real effective exchange rate growth coefficients are negative for these countries, indicating that a decrease in the REER is associated with higher corporate investment, in line with the results in Table 3 above. For economies in the lower quartile of the *ECI* measure (column 1 of Table 5), the estimated coefficient is positive, suggesting that real exchange rate overvaluation is positively associated with investment at the firm level. This group consists mainly of emerging and developing economies.

Table 5: Economic complexity. The dependent variable is the investment-capital ratio (ICR)

VARIABLES	(1) Sample with ECI lower than percentile 25th	(2) Sample with ECI higher than percentile 75th	(3) Sample with ECI lower than percentile 25th and Advanced	(4) All Countries
ICR (t-1)	0.0603***	0.0097	0.0668***	0.0701***
	(0.0101)	(0.0211)	(0.0110)	(0.0085)
Tobin's Q	0.0385***	0.0470***	0.0486***	0.0427***
	(0.0052)	(0.0057)	(0.0024)	(0.0043)
Cash flow	0.0040	0.0012	-0.0065***	0.0045
	(0.0083)	(0.0054)	(0.0006)	(0.0038)
Leverage (t-1)	-0.0245***	-0.0164***	-0.0271***	-0.0203***
	(0.0036)	(0.0020)	(0.0071)	(0.0018)
Change in debt	0.0652***	0.0426***	0.0478***	0.0455***
	(0.0086)	(0.0022)	(0.0046)	(0.0058)
Sales growth (t-1)	0.0002***	0.0007***	0.0001***	0.0003***
	(0.0001)	(0.0001)	(0.0000)	(0.0001)
REER Growth	0.0014***	-0.0006***	-0.0190***	0.0071***
	(0.0005)	(0.0001)	(0.0022)	(0.0009)
REER Growth X Economic Complexity Index				-0.0084***
				(0.0014)
Cboe Volatility Index (VIX) (t-1)	-0.0058	-0.0003	0.0207***	-0.0193***
	(0.0057)	(0.0029)	(0.0013)	(0.0040)
Constant	0.3918***	0.1391**	-0.3608***	0.6345***
	(0.1391)	(0.0449)	(0.0578)	(0.0857)
Observations	81,298	103,610	21,047	328,168
R-squared	0.1023	0.0904	0.0775	0.0869
Number of firms	12,648	15,971	3,762	39,551
Number of countries	42	10	7	67

Notes: All specifications include firm, year, industry-year, and country-year fixed effects. Robust standard errors (clustered by country) are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

As above, we repeat this specification replacing the real exchange rate growth with the measure of real exchange rate misalignment (Table 6). All the above results hold, except that when using real exchange rate misalignment, less complex advanced economies behave as emerging market and developing economies. In this case, corporate investment needs an overvalued currency to increase (column 3). Thus, this suggests that rather than income, it is the production

structure what matters the most to understand the effect of real exchange rate misalignment on firm-level investment.[17] We also find that higher economic complexity is associated with higher firm-level investment (column 4 of Table 6), as one would have expected. Moreover, economic complexity seems to be related to the competitiveness channel, as shown by the negative and statistically significant coefficient of the interaction of the real exchange rate growth and the economic complexity index.

Table 6: Economic complexity. The dependent variable is the investment-capital ratio (ICR)

VARIABLES	(1) Sample with ECI lower than percentile 25th	(2) Sample with ECI higher than percentile 75th	(3) Sample with ECI lower than percentile 25th and Advanced	(4) All Countries
ICR (t-1)	0.0593***	0.0185	0.0546***	0.0755***
	(0.0107)	(0.0202)	(0.0140)	(0.0110)
Tobin's Q	0.0412***	0.0498***	0.0621***	0.0438***
	(0.0073)	(0.0062)	(0.0040)	(0.0045)
Cash flow	0.0000*	0.0000**	0.0000***	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Leverage (t-1)	-0.0229***	-0.0142***	-0.0209***	-0.0258***
	(0.0039)	(0.0008)	(0.0051)	(0.0027)
Interest expense ratio (t-1)	-0.0003	0.0380***	0.0278***	-0.0072
	(0.0126)	(0.0094)	(0.0039)	(0.0068)
Change in debt	0.0683***	0.0424***	0.0468***	0.0001
	(0.0107)	(0.0015)	(0.0056)	(0.0003)
Sales growth (t-1)	0.0220**	0.0538***	0.0085***	0.0364***
	(0.0101)	(0.0109)	(0.0021)	(0.0064)
REER Misalignment	0.0029***	-0.0009***	0.0034***	0.0299***
	(0.0002)	(0.0001)	(0.0003)	(0.0009)
REER Misalignment X Economic Complexity Index				-0.0702***
				(0.0021)
Economic Complexity Index				1.6894***
				(0.0322)
Cboe Volatility Index (VIX) (t-1)	-0.0126	-0.0063**	-0.0066	0.0133***
	(6.3983)	(0.0024)	(0.0119)	(0.0033)
Constant	0.3631	0.2951**	0.2012	-1.7298***
	(60.3613)	(0.1112)	(0.2156)	(0.0810)
Observations	66,162	95,792	14,505	299,586
R-squared	0.1247	0.0908	0.0938	0.0590
Number of firms	11,520	15,337	3,007	38,790
Number of countries	42	10	7	67

Notes: All specifications include firm, year, industry-year, and country-year fixed effects. Robust standard errors (clustered by country) are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[17] Seven advanced economies are included in this group. The countries and years in this sub-sample are: Australia 1997-2016; Canada 2013-2016; Greece 1997-2016; Hong Kong 1998-2000; New Zealand 1997-2016; Portugal 1997-1999, 2013, 2016; Spain 2016. To check the robustness of this result, we repeated the exercise excluding Portugal and Spain to avoid firms from countries with non-continuous years in the sub-sample. The main results hold.

VI. Robustness Checks

We performed a battery of robustness checks. Among them, we split the sample between manufacturing and non-manufacturing firms and separately for tradable and non-tradable sectors. The results were mostly aligned with those presented above. We also run the above regressions excluding the countries with the largest number of firms in emerging Asia (China and India, accounting for roughly 65 percent of firms in this group of countries) to test whether the differentiated results were driven by firms in these two countries. But they were not as the results were broadly the same when excluding firms from these two countries. We also removed a few countries with a very limited number of firms—and thus observations. Results held.

VII. Concluding Remarks

We use firm-level data to document the impact of real exchange rate movements in corporate investment. The Mundell-Fleming model, a key backbone of open economy macroeconomics, suggests that investment (mainly in the tradable sector) and thus growth, should increase when the currency weakens. When we test for this empirically, we find that for most of the advanced economies, investment in fact increases when the real exchange rate depreciates, in line with this model. For these countries, competitiveness appears to be the channel driving investment. Emerging Asia behaves similarly to advanced economies. However, for all other regions of emerging market and developing economies, as well as for some advanced economies, all being less complex economies, investment increases when the domestic currency appreciates. This evidence lends support to Diaz Alejandro (1963), suggesting that these countries take advantage of the temporary cheaper imported capital goods associated with the stronger real exchange rate and increase investment. Finally, we find that it is precisely economic complexity what determines the relationship between real exchange rates and corporate investment.

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APPENDIX

Table A1: Countries and number of non-financials firms in the sample

Emerging and Developing Economies					Advanced Economies				
Country	No. of firms	Tradable (%)	Manufacturing (%)	% of total the sample	Country	No. of firms	Tradable (%)	Manufacturing (%)	% of total the sample
Argentina	88	61.4	44.3	0.2	Australia	1,506	62.3	18.7	3.7
Bahrain	8	37.5	25.0	0.0	Austria	109	66.1	60.6	0.3
Brazil	345	55.9	48.1	0.9	Belgium	147	59.2	45.6	0.4
Bulgaria	156	76.3	68.6	0.4	Canada	1,557	69.2	25.9	3.9
Chile	187	50.8	39.0	0.5	Czech Republic	55	47.3	40.0	0.1
China	2,845	71.0	62.5	7.0	Denmark	195	59.0	48.2	0.5
Colombia	59	57.6	44.1	0.1	Estonia	14	35.7	35.7	0.0
Croatia	90	46.7	40.0	0.2	Finland	175	62.9	52.6	0.4
Egypt	129	66.7	56.6	0.3	France	1,036	53.6	44.8	2.6
Hungary	47	55.3	48.9	0.1	Germany	945	57.7	51.4	2.3
India	2,284	74.0	69.2	5.7	Greece	287	53.0	39.0	0.7
Indonesia	427	63.2	39.1	1.1	Hong Kong SAR	822	52.7	37.2	2.0
Jordan	107	65.4	59.8	0.3	Iceland	20	50.0	35.0	0.0
Kazakhstan	26	53.8	34.6	0.1	Ireland	78	59.0	37.2	0.2
Kenya	32	65.6	46.9	0.1	Israel	381	59.1	45.7	0.9
Kuwait	93	46.2	29.0	0.2	Italy	335	57.3	51.9	0.8
Lebanon	2	50.0	50.0	0.0	Japan	4,404	49.0	41.2	10.9
Lithuania	36	55.6	47.2	0.1	Korea	1,989	78.2	73.1	4.9
Malaysia	1,073	59.7	46.5	2.7	Luxembourg	31	74.2	45.2	0.1
Mauritius	29	48.3	27.6	0.1	Netherlands	249	54.2	41.0	0.6
Mexico	148	52.0	47.3	0.4	New Zealand	149	45.6	29.5	0.4
Morocco	52	63.5	46.2	0.1	Norway	279	57.0	36.2	0.7
Nigeria	69	75.4	62.3	0.2	Portugal	91	47.3	40.7	0.2
Oman	85	62.4	50.6	0.2	Singapore	709	59.2	44.6	1.8
Pakistan	125	86.4	80.8	0.3	Slovak Republic	16	68.8	68.8	0.0
Poland	452	49.8	40.5	1.1	Slovenia	41	46.3	41.5	0.1
Qatar	25	48.0	32.0	0.1	Spain	205	47.3	39.0	0.5
Romania	111	77.5	67.6	0.3	Sweden	527	55.4	47.2	1.3
Russia	637	49.9	39.1	1.6	Switzerland	249	64.7	59.4	0.6
Saudi Arabia	102	65.7	56.9	0.3	Taiwan Province of China	1,887	83.6	78.0	4.7
Serbia	59	72.9	64.4	0.1	United Kingdom	2,007	45.6	34.4	5.0
South Africa	447	55.0	32.2	1.1	United States	7,704	53.4	43.0	19.1
Sri Lanka	172	64.0	45.9	0.4					
Thailand	604	61.4	51.0	1.5					
Turkey	291	74.9	68.7	0.7					
Ukraine	74	82.4	66.2	0.2					
United Arab Emirates	47	53.2	36.2	0.1					
Venezuela	20	75.0	70.0	0.0					
Vietnam	630	59.5	45.4	1.6					
Total	12,213	66.5	56.5	30.2	Total	28,199	61.2	50.2	69.8