The Lucas Paradox and the Return to Capital in Capital-Scarce Countries

Jennifer Rhee[1]

[1] *University of North Carolina, Chapel Hill*

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Abstract

Neoclassical theory predicts that if two countries share the same constant return to scale production function, and trade in capital goods is free and competitive, due to the law of diminishing returns (a) new investment will occur only in capital-scarce countries since (b) the marginal product of capital should be higher in economies with less capital. This statement at the heart of Lucas paradox, implicitly assumes that cross-country marginal products of capital mirror cross-country financial investment returns. Using firm-level data, I show that although firms in emerging markets enjoy higher marginal products of capital, financial investment returns are roughly equalized across developed and emerging economies. The finding questions the validity of the standard approach that uses differences in marginal products of capital to explain international capital flows. It further suggests that "there is no prima facie support for the view that international credit frictions play a major role in preventing capital flows from rich to poor countries? (Caselli and Feyrer, 2007). Finally, the paper highlights the importance of cross-country differences in capital efficiency to explain the observed patterns of financial returns.

JEL Classification. G00, O16

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1 Introduction

Textbook neoclassical theory predicts that if two countries share identical production functions, and trade in capital goods is free and competitive, new investment will only occur in economies with relatively less capital. It follows from the law of diminishing returns that the marginal product of capital ought to be higher in capital-scarce economies. However, since Lucas (1990) a vast literature devotes itself to explain the observation that capital flows from developed to emerging countries fall short of what theory predicts. In fact, in their 2007 paper, Prasad, et al., document an uphill flow of capital from poor to rich countries in the late 1990s-early 2000s. So, why doesn't capital flow from developed to developing countries?

In this paper, I investigate the link between the marginal product of capital and financial rates of return to provide resolution to the paradoxical patterns of observed international capital flows. In the standard neoclassical model, a firm's first order condition states that the marginal product of capital(MPK_t) and the financial return(r_t) should differ only by depreciation rate(δ), which is assumed constant across countries ($r_t = MPK_t - \delta$). Therefore, theory predicts that high financial returns and high marginal products of capital should go hand in hand. If this link breaks down, i.e., if high marginal product of capital does not translate to high financial returns, it is not clear that the capital ought to flow to countries with high marginal products of capital.

Despite the significance of this first order condition that lies at the heart of the Lucas Paradox, there is little attempt to test its validity. In large part, this is due to the limitations of aggregate data. In this paper, I examine the validity of the link between the marginal product of capital and financial returns using firm-level market and accounting data from a set of developed and emerging countries between 1997 and 2014. Konchitchki and Patatoukas (2014) state, "macroeconomics research has evolved independently from accounting research, which is typically conducted at the firm level" and "the link between accounting earnings and macroeconomy remains relatively unexplored." My paper is part of the growing body of literature that attempts to fill this gap by highlighting macroeconomic insights that can be obtained from the micro-level analysis.

The standard approach in recent work imputes an aggregate marginal product of capital from national income accounts. However, imputed estimates are not the same as computed ones. Imputations rely heavily on underlying assumptions about functional form, raising legitimate questions about the validity of a range of assumptions such as setting parameter values (e.g., technology, capital shares, and elasticities of substitution) equal to those of the US. Specifically, delivering the finding that marginal products of capital are essentially the same across rich and poor countries requires adjustments to the national income accounts for (i) the capital per effective worker and a human capital externality (Lucas, 1990), (ii) non-reproducible capital and the price of capital goods (Caselli and Feyrer, 2005), and (iii) technology catch up and distortions in saving and investment decisions (Gourinchas and Jeanne, 2009).

Imputed estimates are therefore indirect estimates of the aggregate rate of return to capital in developing countries. On the other hand, computed estimates of the return to capital using micro-data may provide a more direct and reliable way forward. Instead of making assumptions about parameters to impute the rate of return to capital from aggregate data, I argue that it is more straightforward to compute firm-level rates of return and to aggregate them to produce estimates of the national rate of return.

The main finding of this paper is that the standard link between the marginal product of capital and the financial return, that is often assumed in the international capital flows literature, does not hold across in a sample of developed and emerging countries between 1997-2014. Consistent with predictions from the neoclassical framework, the results show that firm marginal products of capital are indeed higher in emerging countries relative to their developed-market counterparts. The finding is robust to controlling for firm and industry specific effects and is remarkably consistent across different sample periods and countries.

The neoclassical model implies that the higher marginal product of capital should translate to a high financial return in emerging-markets. However, contrary to this prediction, I find that despite evidence for a downward sloping marginal product of capital curve, the inflation-adjusted financial return is roughly equal across developed and emerging countries. This core finding is significant as it questions the validity of the standard approach that uses differences in the marginal product of capital to explain international capital flow patterns. The firm-level evidence using computed estimates therefore shows that the marginal product of capital may or may not be a valid proxy for financial returns.

Additionally, the results confirm that "there is no prima facie support for the view that international credit frictions play a major role in preventing capital flows from rich to poor countries" (Caselli and Feyrer, 2007). If a high marginal product of capital in emerging countries correctly translates to high financial returns as implied by the standard model, then the shortfall in the capital flow to these countries points international capital market frictions and investment barriers. However, if financial returns are equalized across developed and emerging countries, an alternative hypothesis may be that there is little incentive for capital to flow to the less-developed countries.

These findings further highlight the importance of cross-country capital efficiency differences to explain the Lucas Paradox. Much of the international macro and growth literature, which uses cross-country marginal product of capital differences to explain international capital flow patterns, focuses on productivity differences across countries and the macroeconomic factors that affect productive efficiency, i.e., the level of output that can be obtained from a unit of the capital input. In this paper, I highlight the importance of capital efficiency, i.e., the level of future capital input that can be obtained from a unit investment today. This relationship affects the capital accumulation process within the economy and determines the relationship between the marginal product of capital and financial returns.

The firm's first order condition that links the marginal product of capital and financial returns stems from the standard capital accumulation equation, which suggests that the capital stock tomorrow is the sum of capital stock today and the investment net of the depreciation ($K_{t+1} = (1-\delta)K_t + I_t$ such that K_t and I_t are the capital stock, and investment in period t, respectively). However, if a unit investment does not lead to a unit increase in the capital stock, the standard link between the investment return and marginal product of capital no longer holds, and the cross-country investment return and marginal product of capital patterns can differ. Although models with capital adjustment factors are widely used in the investment literature[1], they have been largely ignored in the international capital flows literature.[2] I find that the quadratic capital adjustment factor introduced in Chirinko(1993) can help model the divergence between the investment return and marginal product of capital observed in the data between 1997-2014.

The paper also uses variables that are commonly employed in the empirical literature investigating the Lucas Paradox to examine macroeconomic factors that may affect the capital efficiency of firms. I find that controlling for per capita output, technology, human capital, financial development, and government efficiency all have a positively significant effect on the capital efficiency of firms. This finding imply that current macroeconomic variables not only affect financial returns today, but also affect future returns by influencing future levels of the capital input. The exact mechanism by which these macroeconomic factors affect the firm productivity and the capital accumulation process is beyond the scope of this paper, but can be a subject for future research.

[1]see Cochrane (1991), Hayashi(1982), Abel and Blanchard (1986)

[2]Keyu Jin (2012) is an exception as she employs a non-standard capital accumulation equation from Abel (2003). However, her analysis focuses on the effect of comparative advantage rather than the effects of within-country distortions.

Since Lucas (1990), an extensive an extensive literature devotes itself to the study of international capital market frictions. Stulz (2005) shows that agency problems in emerging countries can lead to a wedge in the investment returns received by the international and domestic investors. Reinhart and Rogoff (2004) highlight the default history of emerging countries, suggesting that the credit risk can explain the paucity of capital flow to emerging countries. Montiel (2006) proposes an information friction as an important determinant in explaining the paucity of capital flows to Africa.

In their 2005 paper, Banerjee and Duflo outline an exhaustive list of indirect and direct methods used to calibrate the marginal product of capital in the development literature. An indirect method often employed in the literature proxies for the firm return to capital using the interest rate. Therefore a long line of researchers study of lending market in the emerging countries, and they document the extremely high cost of borrowing in these countries even when one adjusts for the risk. For example, Timberg and Aiyar (1984) document a $21-120\%$ interest rate charged by the indigenous-style bankers in India, and Ghate (1992) shows that interest rates in northern Thailand range up to $5-7\%$ per month. More popular and direct estimates of marginal product of capital require one to posit a production function (usually Cobb-Douglas) and derive the expression for marginal product of capital based on the assumed equation. This is the approach employed by Lucas in his 1990 paper, and he shows that marginal product of capital difference across countries fall substantially when one adjust for productivity difference across countries. A more recent paper by Caselli and Feyrer(2007) finds that the return to capital is roughly equal between emerging and developed countries when one adjusts for the relative price of capital, and the complementary factors of production.

Within this extensive literature on Lucas Paradox, there has been a relatively little discussion about the link between the marginal product of capital and the investment return. In large part, this is because in aggregate data, capital is not observed and therefore estimated from aggregate investment using the perpetual inventory method, which requires one to posit a capital accumulation process. Since this process is typically assumed to follow a standard model where a unit increase in investment lead to a unit increase in capital stock[3], the aggregate capital stock estimate itself implicitly relies on the assumption that the standard link between marginal product of capital and the investment return holds. This makes

[3]Cochrane(1991) is an exception in that he uses non-standard capital accumulation process with adjustment cost to estimate capital stock. However, he also sets the adjustment parameter so that the mean aggregate investment and stock returns equate.

it virtually impossible to test the validity of the link using aggregate data. The key advantage of a firm-level data is that unlike aggregate estimates, capital can be directly observed from the accounting and market values. This allows for direct computation of the marginal product of capital and investment returns, which can then be used to empirically test the validity of the standard link between the two variables.

Despite the advantages of firm-level data, there are some drawbacks. For example, firm-level data do not provide any insight into the productivity of self-employed workers or informal sector firms. This is a significant drawback as these types of households and firms constitute a large part of the economy in developing countries. Unlike aggregate data, firm-level market variables are also susceptible to market volatility. Since the period of analysis includes the global financial crisis (2007-2008), I control for year-specific effects in my analysis and also run a robustness test excluding these years. Despite these shortcomings, the firm-level data provide useful insights as they utilize detailed information on the relationship between financial returns and productivity of the firms. This paper therefore provides an alternative lens to complement existing literature that primarily uses macroeconomic data to perform aggregate analysis.

The paper limits the analysis to listed-firms in MSCI emerging and developed countries that have relatively well established stock markets. Although this substantially reduces the number of countries in the sample, as Reinhart and Rogoff (2004) write "roughly twenty five 'emerging markets' account for the bulk of international financial flows." Therefore, the analysis of the firms in these countries ought to provide useful insights into the factors that drive the international capital flows. I also restrict the period of analysis to the post-1996 period due to the limited availability of reliable firm-level data from emerging countries in the early 1990s.

An important concern with using cross-country firm-level data is the difference in the accounting standards used to report data from different countries. For example, the definition of "assets" in the US Generally Accepted Accounting Principles (US GAAP) may differ from the definition in the International Financial Reporting Standard (IFRS). To minimize the effects of the cross-country accounting standard differences, I use the financial and accounting data from the Worldscope Datastream. Datastream not only provides extensive accounting and market data on listed firms across countries, but also aims to "provide the data in a manner that allows maximum comparability between one company and another, and between various reporting regimes" (Worldscope/Disclosure Partners, 1992). Thus, the numbers reported in the firm's annual/quarterly audit reports could differ from the numbers provided by the Worldscope as they make "several adjustments to the data to make the definitions more comparable to their U.S. counterparts." (Wald, 1999) Although extensive measures are taken by Datastream to increase the firm comparability across countries, I further check for the effects of cross-country differences in accounting standards that may remain in the data, by running a robustness test exclusively restricted to firms from countries that adopt the International Financial Accounting Standards (IFRS). I find that the main results remain robust.

The findings in this paper are closely related to Gourinchas and Jeanne (2009), Banerjee and Duflo (2005), and Chirinko and Mallik (2008). Although the approaches differ, these papers all investigate the effect of domestic capital friction on the cross-country marginal product of capital differences. Gourinchas and Jeanne (2009) show that one can reconcile the observed difference between aggregate capital return and the international capital flow using the saving and investment wedge, and Chirinko and Mallik (2008) investigate the role of capital adjustment cost at an aggregate level using a stock market return. Banerjee and Duflo (2005) show that one can partially explain the cross-country difference in marginal product of capital by adjusting for the intra-country heterogeneity in the firm productivity.[4] However, this paper differs from others in that it studies the effect of domestic capital frictions on the relationship between the marginal product of capital and the investment returns rather than the marginal product of capital itself.

The paper proceeds as follows. In section 2, I introduce the basic neoclassical model and its predictions about the relationship between the marginal product of capital and financial investment returns and explain the empirical methodology. Section 3 describes the firm-level data used in the analysis and the summary statistics. Section 4 and 5 present the empirical results. I analyze the cross-country marginal product of capital and investment return patterns in section 4 and investigate the factors that lead to the divergence between the two patterns in section 5. I also perform a robustness test by using only the firms in countries with IFRS accounting standards. Section 6 concludes.

1.1 Benchmark: Neoclassical model

I introduce a standard neoclassical model with perfectly competitive factor markets. This simple, benchmark model delivers useful predictions and illustrates the first order condition that I use to motivate the empirical analysis.

[4] Hsieh & Klenow (2008) and Alfero, et al (2008) also study the domestic capital market imperfection (misallocation of capital within countries), but their analysis focus on TFP and income difference across countries rather than return differences.

Consider a standard neoclassical economy where the representative firm faces competitive factor and goods markets. The firm chooses a capital and labor input ($\{K_t, L_t\}_{t_0}^{\infty}$) to maximize the net present value of the future cash flows, taking the interest rate as given:

$$\max_{l_t, K_t, L_t} \sum_{t \geq t_0} \frac{1}{R_t}(Y_t - I_t - w_t L_t) \tag{1}$$

subject to:

$$\begin{aligned} \text{Production function:} \quad Y_t &= F(K_t, L_t) && (2) \\ \text{Capital accumulation:} \quad K_{t+1} &= G(K_t, I_t) = (1-\delta)K_t + I_t && (3) \\ \text{Definition:} \quad R_t &= (1+r_t)(1+r_{t-1})...(1+r_{t_0}) && (4) \end{aligned}$$

Y_t is the period output of the representative firm, and the w_t is the exogenously determined wage. Note that there is no capital rental market in this economy as the firms own the capital used in the production. R_t is the aggregate compounded investment return from period t_0 to t and δ is the depreciation rate of the physical capital, which is assumed constant. The first order condition yields:

$$\begin{aligned} F_1(K_t, L_t) &= r_t + \delta && (5) \\ F_2(K_t, L_t) &= w_t && (6) \end{aligned}$$

for all periods $t > t_0$. It is evident from equation (5) that the key determinant of the relationship between the period marginal product of capital and the investment return (r_t) is the capital accumulation equation. Thus, if there exists any friction in the capital accumulation process, then the cross-country investment return and marginal product of capital patterns may diverge.

Assuming a constant return to scale Cobb-Douglas production function($Y = AK^{\alpha}L^{1-\alpha}$),

$$\begin{aligned} F_1(K_t, L_t) &= A\alpha K_t^{\alpha-1} L_t^{1-\alpha} && (7) \\ &= \alpha A^{\frac{1}{\alpha}} y_t^{\frac{\alpha-1}{\alpha}} && (8) \end{aligned}$$

such that $y_t = \frac{Y_t}{L_t}$ and A is total factor of productivity or productive efficiency. The capital share of output (α) is assumed less than unity.

Since I assume that all firms in the economy share an identical production function, the output per unit labor should be identical across all entities. It follows from equations (5) and

(8) that both the period investment return and marginal product of capital should decline with increases in output per unit labor. With these simplifying assumptions, the model predicts that firm-level marginal products of capital and investment returns should slope downwards when plotted against the aggregate output per unit labor. In this paper, I test these implications using firm level data.

1.2 Empirical Methodology

In this subsection, I describe the methodology to estimate marginal products of capital and investment returns used in the empirical analysis. To proxy for the two variables of interest, I use accounting and finance measures of profitability with some modifications to better align them with the economic definitions described in the standard model.

From equation (8), one can easily derive the following expression for marginal product of capital.

$$F_1(K_t, L_t) \quad = \quad \alpha\frac{y}{k} \tag{9}$$

Since α is the capital share in output, this expression suggests that the marginal product of capital is the ratio between the portion of earnings that accrue to capital holders (in the model these is simply the firm), and the firm's assets.[5] The empirical estimations use the return on assets(ROA) as a measure of the marginal product of capital as follows:

$$ROA_{c,t,i,f} \quad = \frac{EBITDA_{c,t,i,f}}{(MVA_{c,t1,i,f})(1+infl_{c,t})} \tag{10}$$

$EBITDA_{c,t,i,f}$ is the earnings before interest, tax, depreciation and amortization, and measures the income that accrues to capital holders or the firm f in industry i in period t in country c. I use this measure of earning rather than net income since the model assumes that, the firm owns all of its capital assets, and therefore there are no interest costs. In the analysis, and following accounting practice, I further adjust this measure of income for extraordinary gains/costs. The adjustment is necessary as these costs/gains are often unrelated to business operations, and can increase the volatility of earnings by inflating or deflating the income from the operations. $MVA_{c,t,i,f}$ is the current market value of the firm's assets[6], and is defined as $MVA_{c,t,i,f} = Debt_{c,t,i,f} + MV_{c,t,i,f}$. $Debt_{c,t,i,f}$ is the book value of debt and the $MV_{c,t,i,f}$ is the market value of equity for the firm f in industry i in period t in country

[5]Note that this general expression of the marginal product of capital should hold even if the firms have increasing/decreasing return to scale Cobb-Douglas type production function

[6]note that this is also the replacement value of the asset based on the q-theory of investment

c. Poterba(1998) uses a similar measure to estimate the return to tangible capital at an aggregate level.

This estimate is similar to price-corrected marginal product of capital used in Caselli and Feyrer (2007). In the paper, they define $PMPKL = \frac{\alpha P_y Y}{P_k K}$, where $\frac{P_y}{P_k}$ is a measure of average price of final goods (P_y) relative to the price of capital (P_k) in the respective country. This measure corrects for the fact that "the price of capital relative to the price of consumption goods is higher in poor countries than in rich countries." and should be more relevant to the capital flow analysis as "the physical MPK measures output per unit of physical capital invested, while for the purposes of cross-country credit flows one wants to look at output per unit of output invested." The major deviation from Caselli and Feyrer (2007) is the estimate of K and α. Whereas their aggregate estimate of K only include reproducible capital, I include both non-reproducible and reproducible capital. Therefore, our definition of α also deviates; α in Caselli and Feyrer(2007) is a reproducible capital share, but in this paper it is the total capital share, which accounts for both reproducible and non-reproducible capital.

This measure differs from the standard accounting ROA, which uses the book value of the assets in the denominator as the measure of capital. Although this ratio is widely used in finance and accounting[7], assets on the balance sheet are measured at the acquisition cost. As the market value of an asset can change over time (e.g., the value of buildings or land may appreciate as urban centers develop), the value of assets on financial statements may not correctly reflect current values. Therefore, I replace the denominator of the indicator with the sum of the book value of debt and market value of equity. As total assets necessarily equal the sum of liabilities and equity, this ought to provide a more accurate estimate of the replacement value of an asset in period $t-1$ under perfect capital markets.[8] The value of assets at the end of period $t-1$ is used in the denominator as a measure of what the firm owns entering period t. This is the capital that is employed during period t to generate the income $EBITDA_{c,t,i,f}$. Due to the time discrepancy between the measurement of the capital stock and income, assets are adjusted for inflation using $infl_{c,t}$, which is consumer price inflation in country c during period t.

To derive a testable expression for the investment return, I use equation (3), which can

[7] See Eisenberg, et al (1998), Guenther and Young (2000), Chaney, et al (2004), Bowen, et al (2008)

[8] Debt also enters financial statements at a historical cost, and the interest rate on debt may differ across time. However, the income used in the analysis is income before the interest, and therefore, even if debt is refinanced at a "current" rate of interest, it should not affect the ROA measure used in the analysis.

be rewritten as:

$$\delta = \frac{K_{t+1} - K_t - I_t}{K_t} \tag{3a}$$

If the equation (5) holds true,

$$r_t = \frac{\alpha Y_t - I_t + K_{t+1} - K_t}{K_t} \tag{11}$$

Note that this is the internal rate of return equation commonly used in finance to assess the profitability of an investment [9]. It measures the investment return that capital owners can receive by purchasing one unit of capital at time t, and selling it at period t+1.

Using equation (11) as the benchmark, I derive the following expression to measure the investment return:

$$IRR_{c,t,i,f} = \frac{EBITDA_{c,t,i,f} + [-Adj\Delta Asset_{c,t,i,f} + MVA_{c,t,i,f} - MVA_{c,t-1,i,f}]}{MVA_{c,t-1,i,f}} - infl_{c,t} \tag{12}$$

This definition is similar to a period investment return measure employed by Fama and French (1999) for the US stock market. In their paper, this estimate is termed "internal rate of return on value" and is used as the measure of "the return required by investors," or more precisely, "an estimate of what an investor would have earned during our sample period by passively investing in all corporate securities as they enter the sample" $Adj\Delta Asset_{c,t,i,f} = \Delta Asset_{c,t,i,f} + depreciation_{c,t,i,f}$, such that $\Delta Asset_{c,t,i,f}$ is the change in the book value of assets. This measures the current value of tangible asset investments by firms as financial statements are filed using the historical basis approach, i.e., assets are valued at the acquisition price. I note that this measure of investment does not include a significant portion of the R&D spending by the firm. Due to accounting conservatism and uncertainty about the success of the R&D activity, R& D spending is considered as a cost rather than an asset, and is thus, expensed. If the capital accumulation process outlined in equation (3) accurately describes the data, the values inside the square bracket equals $-\delta MVA_{c,t-1,i,f}$, and $IRR_{c,t,i,f} = ROA_{c,t,i,f} - \delta$, as implied by the model. I also adjust the investment return for inflation in the respective countries.

2 Data and Summary Statistics

Financial and market data used to calculate the firm-level marginal product of capital and investment return are from Worldscope Datastream. Datastream is a preferred source of

[9] see Gordon (1974), Salamon(1985), Fama and French(1999), Graham and Harvey(2001)

data for the cross-country comparison because it not only provides an extensive accounting and market data on listed firms across countries, but also aims to "provide the data in a manner that allows maximum comparability between one company and another, and between various reporting regimes" (Worldscope/Disclosure Partners, 1992). These adjustments by the Worldscope help minimize the potential bias from the cross-country differences in accounting standards.

Although Datastream takes extensive measures to increase the accounting comparability across countries, I further check for the effects of cross-country differences in accounting standards by running robustness test restricting the analysis to the countries that adopted IFRS. Since the mid-2000s there has been increasing attempt led by Euro-zone countries to unify the accounting standards across countries. This has led to a formation of International Accounting Standards Boards (IASB), with the explicit goal "to develop an internationally acceptable set of high quality financial reporting standards." (Barth, et al 2008) Although the United States is yet to adopt IFRS, the standard has been adopted in EU countries by 2005, and majority of MSCI developed and emerging countries by 2011–a list is available in the Appendix. Many other countries that are yet to adopt IFRS have announced their plans for convergence in the near future. For example, India's Ministry of Corporate Affairs released a roadmap for the convergence with the IFRS, and all Indian companies whose securities traded in a public market other than the SME Exchange, will be required to use IFRS by 2017. These efforts may lead to even greater data comparability going forward facilitating firm-level research. In this paper, I find that the main results remain robust to the cross-country differences in accounting standards.

The countries used in the analysis are MSCI emerging and developed countries that have relatively well established stock markets.[10] Exchange floor in developing countries are often very new (e.g., Laos opened its stock exchange in 2011, Syria in 2009, and Somalia in 2012), and in many cases Datastream does not carry data on the firms traded on these exchanges as the market capitalization of these countries is very small (e.g., the Maldives Stock Exchange had only five firms listed as of 2008). Some developing countries do not have a national stock exchange (e.g., Angola, Brunei). Restricting the analysis to MSCI emerging and developed countries reduces the countries in the sample, but as Reinhart and Rogoff (2004) point out "roughly 25 'emerging markets' account for the bulk of the financial flows". Therefore, analyzing the marginal product of capital and the investment return of the firms in MSCI developed and emerging countries can provide useful insights into factors that drive

[10]Saudi Arabia is dropped from the sample due to the limited availability of the firm-level data in early-2000s.

international capital flows.

The period of analysis is 1997 – 2014. A long period is preferred for the analysis as it provides more reliable estimates of ROA and IRR patterns, but unlike macroeconomic aggregate data, which date back to mid-1900s, firm level data for emerging countries are often unavailable before 1995. Even though the estimation period used in the paper is relatively short compared to papers that use macroeconomic data, the period after 1995 is characterized by a large volume of international capital investment following "a series of trade and financial liberalization programs undertaken since the mid-1980s." (Kose, Prasad, and Terrones (2006)). Therefore, the period post-1990 is especially relevant for answering questions related to the marginal product of capital, investment returns and the observed patterns of international capital flows. A major drawback, however, is that the sample period includes the Global Financial Crisis, characterized by high levels of volatility in both earnings and market values. Thus, in the empirical analysis, I control for the time specific effect and also run a robustness check excluding the crisis period.

Within the Worldscope dataset, I exclude firm-years with missing market value, assets, liabilities, depreciation, EBITDA or extraordinary gains/cost. I also drop balance-sheet insolvent firm-years when total liabilities exceed total assets. As period $t-1$ asset values are used to calculate the period t ROA and IRR, firm-years without debt and market value from the previous year are also excluded from the sample.

The remaining data are winsorized at 1% and 99% by country to control for the outliers, following the accounting practice.[11] I repeat the analysis without the winsorization, and the results remain unchanged. To adjust for the industry-specific effects, I sort the firms into the Fama-French 48 industries.[12]. Firms in the financial sector are dropped from the analysis as the paper focuses on the real economy. To test for the robustness of the empirical results to changes in the industry classification schemes, I repeat the exercise using the 2-digit SIC (Standard Industry Classification) codes. After these exclusions, the main analysis uses 335,465 firm-years across 42 countries. Table 1 provides summary statistics for the raw data. An Appendix table provides the number of firm years by industry and country.

[11]Some of the major outliers in the sample are due to merger/acquisitions. Consider a listed firm that merged with another (listed or unlisted) firm in January 2000. The ROA_{2000} will be the ratio between the post-merger EBITDA, and the pre-merger asset value, and the indicator will be highly inflated. Major mergers are highly uncommon, but they can upwardly bias the results.

[12]The actual number of industries used in the analysis is 44, as 4 financial industries are dropped from the sample

Table 1 shows that there is a large variation in the sample size across countries. The US has the largest sample size with 69,400 firm-years, closely followed by Japan with 52,501 firm-years. The sample size is the smallest for Colombia, which has only 365 firm-years. Industry diversity also differs across countries; all 44 Fama-French (FF) industries are observed in Australia, China, Canada, India, United Kingdom and the United States. On the other hand, only 23 FF industries are observed in Hungary. Purchasing power parity (PPP) adjusted real GDP[13], population, employment, and average hours worked per employed are from the Penn World Tables 9.0. In this paper, I use GDP per capita as the measure of output per unit labor, and check the robustness of the result using the GDP per hour worked. Consumer price indices are from the World Bank database.

Table 2 provides summary statistics for the return on assets (ROA) and internal rate of return (IRR) estimates across countries. The data show two idiosyncrasies. First, the mean ROA for Australia is negative during the analysis period (1997-2014). This is due to the significant under-performance of the metal mining industry during and after the financial crisis, and excluding the metal mining companies (SIC 2-digit code: 10), Australia's mean ROA turns positive.

Second, across the MSCI developed and emerging countries the average IRR is greater than the average ROA, a finding which seems at odds with the implications of the standard model ($r = MPK - \delta$). The mean IRR across MSCI developed and emerging countries between 1997 and 2014 is 9.2% and the mean ROA is 7.6%. However, upon further examination this pattern is due to a large rightward skewness in the distribution of IRR, illustrated in Figure 1. The graph shows that compared to the ROA distribution (Figure 1a), which is almost perfectly symmetric across the mean, the IRR distribution (Figure 1b) is skewed to the right.

This pattern is also seen in the difference between the means and the medians in Table 2. The mean and the median ROA almost perfectly align with each other with a less than 1% difference between the two values. On the other hand, the mean and the median IRR differ by 6.4%! Due to the right skewness, even when the mean IRR is higher than the mean ROA, the median IRR is substantially lower than the median ROA. Thus, in the following section, I analyze not only the average cross-country patterns, but also the median trend across countries, to check for the effects of the skewness. The IRR is also substantially more volatile relative to ROA. The aggregate standard deviation for the ROA is 10%, but it is 49% for the IRR.

[13]A detailed discussion about the construction of the PPP adjusted GDP is available on Feestra, et al (2015)

Figure 2 shows the two-way plot between the firm level ROA and IRR against the log(PCGDP). The figure includes the best fit line the 95% confidence interval for the mean trend. Figure 2a is the two-way plot for the ROA and the log(PCGDP); it shows a steep downward sloping best-fit line with a very narrow confidence interval, suggesting a negative correlation between the two variables. On the other hand, the figure 2b, which shows the two-way plot for the IRR and the log(PCGDP), depicts a upward sloping best-fit line with a wide confidence interval suggesting a potential deviation between the cross-country investment return and the financial return patterns. While this positive mean-trend contradicts the predictions of the neoclassical model, it is consistent with the international capital flow pattern. Figure 3 replicates the capital flow analysis conducted by Prasad, et al (2006), for MSCI developed and emerging countries between 1995-2014; the figure shows that "the relative income of [current account] surplus countries has fallen below that of decific countries. Not only is capital not flowing from rich to poor countries, in quantities the neoclassical model would predict–a paradox pointed out by Lucas (1990)– but, in the last few years it has been flowing from poor to rich countries".

Although the two-way plots are highly revealing, the trend may be driven by firm-specific factors; the firms in emerging countries may engage in more risky business, and may face greater financial constraints relative to their peers in the developed markets. Therefore, in the following section, I conduct empirical analysis controlling for the firm and industry specific factors that could have led to the observed results.

3 Cross Country Marginal Products of Capital and Investment Return Patterns

3.1 Firm-Level Return on Assets and Per Capita GDP

To formally assess the relationship between aggregate output per unit labor and the firm level profitability (return on assets), I estimate the following benchmark specification:

$$MPK_{c,t,i,f} = \alpha + \beta_1 log(PCGDP_{c,t}) + \beta_2 D_t + \beta_3 F_i + \boldsymbol{\gamma X_{c,t,i,f}} + \epsilon_{c,t,i,f} \tag{13}$$

$MPK_{c,t,i,f}$ is the return on assets (ROA) for a firm f in industry i in country c in period t, and $PCGDP_{c,t}$ is the purchasing power parity adjusted real per capita GDP in country c in period t in 2011 US dollars that I use as a proxy for labor productivity. Note that I repeat the exercise using labor productivity but the sample of countries with this data is lower. Therefore the main regressions use per capita GDP as a proxy for labor productivity. D_t and F_i are time and industry dummies that are added to control for global macroeconomic shocks that occurred during the period of analysis, or an industry specific trend. $\boldsymbol{X_{c,t,i,f}}$ is the vector of firm specific factors, which includes the log size (the book value of assets denominated in USD; the value is adjusted for the inflation using the CPI index), leverage (book debt to equity ratio), and the equity price-to-book ratio. This vector adjusts for firm-specific factors, which are absent in the standard model. Note that the riskiness of the firm is expected to rise with a decrease in size and an increase in leverage and the price to book ratio.

Table 3 reports the results from the regression model. Column (1) shows the results for the MSCI developed and emerging countries between 1997 and 2014. Size has a statistically significant positive effect on the return on assets, and the price to book ratio and leverage have a negative and significant effect confirming the prediction that firm-level ROA rises with the increase in the firm specific risk. The statistically significant negative relationship between per capital GDP and the firm ROA shows that the implication of the standard neoclassical model holds during the period across firms in MSCI developed and emerging countries and controlling for the firm, industry, and time specific effects. In other words, as the model predicts the firm ROA falls with increases in the proxy for labor productivity. This finding also suggests that if, on average, the first order condition that equates the marginal product of capital and the investment return holds, then investment returns should also be inversely correlated with per capita GDP.

Column (1) shows that, on average, the firm-level ROA declines with increases in per capita GDP, but does not provide any insight on how the pattern differs within the sample. For example, what is the relationship between firm ROA and per capita GDP when we examine high productivity firms with an above average return on assets. Quantile regressions make up for this shortcoming of the OLS regression by modeling the relationship between the specified percentile of the response variable and the control variables, i.e., the median quantile regression portrays the relationship between the median marginal product of capital and the predictor variables, etc. For a more comprehensive analysis, I run a quantile regression for the 25th, 50th (median), and the 75th percentile firms. Also note that this question is particularly important in analyzing the differences between internal rates of return (IRR) and the return on assets, due to the high level of skewness observed in the distribution of the internal rates of return in Table 2.

Columns (2) – (4) show that the coefficient on per capita GDP is consistently statistically significant across the 25th, 50th, and the 75th percentiles. The negative slope is the steepest for the firms in the 75th percentile of ROA, and there is a little difference in the slope between the 25th and the 50th percentile. The finding suggests that the effect of the changes in the aggregate output per unit labor is most acutely felt by the "most productive" firms in the economy.

As the data section mentions, the period of analysis includes the global financial crisis, during which financial systems went through substantial stresses. I repeat the exercise in column (1) for the 2011-2014 post-financial crisis period. Due to the short period of analysis, the values are susceptible to skewness from the market volatility, but the regression results presented in column (5) confirm the findings in column (1). Columns (6) and (7) check for the effect of the cross-country differences in the accounting standards. Column (6) repeats the regression in column (5) using firms from the countries that adopted the International Financial Reporting Standards (IFRS) during the post-financial crisis period, and the column (7) shows the results using firms in MSCI EU countries during 2006-2014– the European Union officially adopted IFRS starting 2005. The results presented in columns (5)-(7) of Table 3 show that the inverse correlation between per capita GDP and firm-level ROA is surprisingly consistent across time, and is robust to cross-country differences in accounting standards.

Table 4 examines the relationship between ROA and per capita GDP with industry-level controls. I estimate the following industry by industry regression for each of the 48-Fama French industry (44 excluding financial industries) using the base sample of firms in the MSCI developed and emerging countries between 1997 and 2014. Table 4 presents the results.:

$$MPK_{c,t,f} = \alpha + \beta_1 log(PCGDP_{c,t}) + \beta_2 D_t + \boldsymbol{\gamma X_{c,t,f}} + \epsilon_{c,t,f} \tag{14}$$

Table 4 shows that the cross-country pattern observed in the Table 3 is not sector-specific. Firm ROAs decline with increases in per capita GDP in almost all 44 non-financial Fama-French industries. Thirty six industries have statistically significant negative coefficients for per capita GDP, and only one industry (aircraft manufacturing) has a statistically significant positive coefficient. The negative coefficient is steepest in the medical and the defense industries, which require high-levels of human capital. The Appendix presents a similar analysis using SIC 2-digit industries. The results remain unchanged. A majority of industries have a statistically significant negative coefficient for per capita GDP, and only a few industries have an insignificant or positive coefficient.

Table 5 further shows that the observed results are not time-specific. It shows the results for the following estimating equation using the base sample:

$$MPK_{c,i,f} = \alpha + \beta_1 log(PCGDP_c) + \beta_2 F_i + \boldsymbol{\gamma X_{c,i,f}} + \epsilon_{c,i,f} \quad (15)$$

Between 1997 and 2014, we observe a statistically significant negative coefficient for all years except 2004 and 2010. The coefficient is most negative during the financial crisis (2007 and 2009). The negative coefficient slowly flattens post-2010, as the developed countries recover. Conversely, the negative slope is relatively flat during the Asian Financial Crisis (1998) and slowly steepens as the Asian tigers move out of their deep recessions.

The results presented in this section show that consistent with the neoclassical model, the marginal product of capital is higher in countries with low per capita GDP. Iin the following subsection, I repeat the exercises using the investment return (IRR).

3.2 Investment Returns and Per Capita GDP

In order to test for the validity of the firm first order condition described in equation (6), I use the following regression specification:

$$r_{c,t,i,f} = \alpha + \beta_1 log(PCGDP_{c,t}) + \beta_2 D_t + \beta_3 F_i + \boldsymbol{\gamma X_{c,t,i,f}} + \epsilon_{c,t,i,f} \quad (16)$$

The predictor variables in the equation are identical to those in equation (13), but the dependent variable is now the internal rate of return ($IRR_{c,t,i,f}$). As in the equation (13), firm-level factors such as size, leverage, and the price to book ratio control for the firm-specific characteristics, and industry and time dummies control for industry and time specific effects. If the standard relationship between the firm investment return and marginal product of capital holds, then the internal rate of return should also be inversely correlated with per czpita GDP.

Table 6 presents the results. Column (1) reports the results for the MSCI developed and emerging countries between 1997 and 2014. Despite the statistically significant negative relationship with marginal product of capital observed in the previous subsection, the coefficient on per capita GDP is not statistically significant when one controls for firm and industry specific factors. This result implies that the cross-country marginal product of capital and investment return patterns do not necessarily mirror each other– as the neoclassical model predicts. This finding questions the validity of the standard approach which uses aggregate marginal product of capital to explain the pattern of international capital flows. The finding also suggests that even accurate measures of marginals product of capital may not explain patterns of international capital flows as the marginal product of capital may be an inaccurate proxy for investment returns.

The finding therefore suggests that "there is no prima facie support for the view that international credit frictions play a major role in preventing capital flows from rich to poor countries." (Caselli and Feyrer, 2007). As Lucas suggests, if investment returns are inversely correlated with per capita GDP, capital ought to flow from developed to emerging countries and any deficiencies in these flows imply international financial market frictions. However, the results in Column (1) suggest that the investment returns are relatively equal across developed and emerging countries and therefore there may not be an incentive for the capital to flow to the emerging markets since opportunities with similar investment returns also exist within developed economies. This empirical evidence does not appear consistent with the claim that international investment barriers play a major role in explaining the lack of capital flow to emerging countries. A potential resolution to the Lucas paradox may therefore lie in the cross-firm or cross-industry variation in internal rates of return within countries.

As in the previous subsection, I run a quantile regression to identify the within sample heterogeneity in response to the changes in the per capita GDP. Given the large rightward skewness in the data from the summary statistics in Table 2, this analysis is particularly important for the internal rates of return. Compared to the results in Table 3, the quantile regression results in Table 6 display a greater variation across percentiles. The regression results presented in Columns (2),(3) and (4) show that the coefficient on per capita GDP is positive and statistically significant at 1% level for the bottom 25th percentile and the median. On the other hand, it is negative and statistically significant for the firms in the 75th percentile. The estimates suggest that although the best performing firms within the emerging countries can successfully translate higher marginal product of capital to higher investment returns, this is not necessarily true for the less-productive firms in the country. One should also note that the counter-intuitive positive coefficient is steeper for the bottom 25th percentile versus the median. This suggests that as Banerjee and Duflo (2005) suggest, the key to Lucas Paradox may not lie so much with 'international' factors, but 'domestic' factors.

Column (5) presents the results for the post-financial crisis period and reaffirms the divergence between the marginal product of capital and the investment return patterns observed in column (1). The coefficient on $PCGDP$ is positive and statistically significant, which implies that the investment return in developed countries is in fact higher than that in emerging countries during the sample period. Column (6) repeats the regression in column (5) using only the firms that adopted IFRS accounting standards during the period, and documents that the cross-country pattern observed in column (5) is robust to cross-country differences in the accounting standards. Column (7) also repeats the exercise in column (1) using the MSCI EU countries that share the streamlined IFRS accounting standard since 2005 and finds that $PCGDP$ is statistically insignificant.

Table 7 shows the results for the following specification to check for any variation in cross-country IRR patterns across industries:

$$r_{c,t,f} = \alpha + \beta_1 log(PCGDP_{c,t}) + \beta_2 D_t + \boldsymbol{\gamma X_{c,t,f}} + \epsilon_{c,t,f} \tag{17}$$

The results confirm the aggregate pattern observed in Table 6. The coefficient on per capita GDP is statistically insignificant or positive and significant in 35 out of 44 industries. Only nine industries have a statistically significant negative coefficient, and the slope is barely significant at the 10% level in the four among the nine industries. This result contrasts sharply with Table 4, in which 36 industries have a statistically significant negative coefficient. It further confirms the finding that the cross-country marginal product of capital pattern does not appear to match the investment return pattern.

Table 8 displays the results of estimating the following regression specification to check for annual variation in the cross-country internal rate of return pattern:

$$r_{c,i,f} = \alpha + \beta_1 log(PCGDP_c) + \beta_2 F_i + \boldsymbol{\gamma X_{c,i,f}} + \epsilon_{c,i,f} \tag{18}$$

Between 1997 and 2014, the coefficient on $PCGDP$ is statistically insignificant or positively significant for 10 years. The negatively significant coefficient is observed for eight years, and four of the eight years occur around the financial crisis (2006-2008, and 2010). The negative slope is also the steepest during this period (2006 and 2010). The finding again confirms that the inverse correlation between the marginal product of capital and per capita GDP does not necessarily translate to an inverse correlation with investment returns as the neoclassical model predicts.

The empirical result in this section documents a divergence between the cross-country investment return and the marginal product of capital patterns, and show that this finding is surprisingly robust across different sets of countries and time periods. This result questions the validity of the traditional approach which uses marginal product of capital to explain the international capital flow patterns. In the following subsection, I check the effect of cross-country difference in the employment and taxes, to further confirm the robustness of the result documented thus far.

3.3 Additional Test and Robustness Checks

3.3.1 Robustness Check: Hourly labor input

In the previous two subsections, I use per capita GDP as the measure of output per unit labor. While this is a widely used measure of economic performance[14], in this subsection, I check the robustness of the results using output per hours worked.

Output per hours worked is estimated using the following equation:

$$PHGDP_{c,t} = \frac{GDP_{c,t}}{AHW_{c,t} * Emp_{c,t}} \tag{19}$$

$AHW_{c,t}$ is the average annual hours worked by person employed, and $Emp_{c,t}$ is the employed population in country c, in time t. $PHGDP_{c,t}$ is a commonly used measure of labor productivity in the macroeconomics literature[15] and is more precise measure of the output per unit labor input relative to $PCGDP_{c,t}$, as it measures the labor input by hour. Another commonly used measure of productivity is GDP per person employed. However, this ratio tend to over-estimate the productivity of workers in emerging countries as it fails to account for the longer working hours in emerging countries. Even in 2014, the average annual hours worked by person employed in Thailand was almost 1.7 times that in Germany. Therefore, ignoring cross-country differences in the average hours worked can bias the results over-estimating the labor efficiency of the workers in emerging countries. One drawback of the output per hours worked measure is that China has to be dropped from the sample due to a lack of data. However, the regression result using the 315,373 firm-years across 41 countries should still provide a reliable estimate of the cross-country return patterns.

To check the robustness of the results presented in sections 4.1 and 4.2, I use the following equations, which replace $log(PCGDP_{c,t})$ with $log(PHGDP_{c,t})$:

$$MPK_{c,t,i,f} = \alpha + \beta_1 log(PHGDP_{c,t}) + \beta_2 D_t + \beta_3 F_i + \boldsymbol{\gamma X_{c,t,i,f}} + \epsilon_{c,t,i,f} \tag{13'}$$

$$r_{c,t,i,f} = \alpha + \beta_1 log(PHGDP_{c,t}) + \beta_2 D_t + \beta_3 F_i + \boldsymbol{\gamma X_{c,t,i,f}} + \epsilon_{c,t,i,f} \tag{16'}$$

Table 9 presents the results. Columns (1)-(4) reports results for the equation (13'), and columns (5)-(8) report results for equation (16'). The columns (1)-(4) show that the findings about the marginal product of capital from section 4.1 remain robust. The coefficient

[14] see Caselli and Feyrer (2007), Banerjee and Duflo (2005), Gourinchas and Jeanne(2009)

[15] see Freeman(1988), O'Mahony and Boer (2002), Prescott (2004)

on per capita GDP is negative and significant for the base sample excluding China (Column 1), post-financial crisis period (Column 2), and in Euro-zone post-2005 (Column 4). The coefficient on per capita GDP is statistically insignificant for post-financial crisis period IFRS countries (Column 3), which may be due to the small sample size. Columns (5)-(8) further highlight the findings on internal rates of return in section 4.2. The coefficient on per capita GDP is positive and significant for the base sample excluding China (Column 5), post-financial crisis period (Column 6), and post-financial crisis period IFRS countries (Column 7). Per capita GDP has a statistically insignificant impact on internal rates of return in Euro-zone countries post-2005 (Column 8).

The empirical results presented in this section confirm the findings of section 4.1 and 4.2, and questions the validity of the standard approach which use marginal product of capital to explain the international capital flow.

This result also rejects the credit friction explanation for the Lucas paradox, and suggests that the key to the paradox lies within the economy and not across.

3.3.2 Robustness Check: Tax adjusted income

In the previous two sections, I use EBITDA as a measure of the capital owner's earnings to calibrate firm ROAs and investment returns. Although EBITDA is a consistent with the standard model, it does not take into account government taxes, which reduce the actual income received by the capital holders. Therefore, in this section, I check the robustness of the main results using the following tax-adjusted estimates of MPK and the investment return:

$$ROA_{c,t,i,f} = \frac{EBITDA_{c,t,i,f}(1-tr_{c,t,i,f})}{(MVA_{c,t-1,i,f})(1+infl_{c,t})} \tag{20}$$

$$IRR_{c,t,i,f} = \frac{EBITDA_{c,t,i,f}(1-tr_{c,t,i,f})+[-adj\Delta Asset_{c,t,i,f}+MVA_{c,t,i,f}-MVA_{c,t-1,i,f}]}{MVA_{c,t-1,i,f}} - infl_{c,t} \tag{21}$$

$tr_{c,t,i,f}$ is the income tax rate on firm f, in industry i in time t, in country c. An alternative expression for tax-adjusted income is $EBITDA_{c,t,i,f} + Tax_{c,t,i,f}$, where $Tax_{c,t,i,f}$ is the actual income tax on firm f. However, $EBITDA_{c,t,i,f}(1 - tr_{c,t,i,f})$ should provide a tax-adjusted income estimate that is more consistent with the model, as the amount of tax imposed on the firm is based on the income after deduction of interest income and expense. Therefore, $EBITDA_{c,t,i,f} - Tax_{c,t,i,f}$, where $Tax_{c,t,i,f}$ is the actual income tax on firm f, and should lead to large variation on the post-tax income based on the capital structure of the specific firm. On the other hand, the estimate based on the tax rate is less affected by the capital structure of the firm, reducing potential bias from the capital structure differences across the firms.

The tax-adjusted measures of ROA and IRR reduce the size of the sample, as they exclude firm-years without tax-rate data. Therefore, the cross-country pattern is estimated using 211,407 firm-years across 42 countries, rather than 315,373 firm-years. Table 10 presrnts the empirical results from equations (13) and (16), using the tax-adjusted ROA and IRR. Columns (1)-(4) report the results from the equation (13), and columns (5)-(8) report the results from the equation (16). Columns (1)-(4) confirm the original finding that $log(PCGDP_{c,t})$ and the marginal product of capital are inversely correlated. The coefficient for $log(PCGDP_{c,t})$ is significantly negative in the base sample (Column 1), post-financial crisis period (Column 2), IFRS countries post financial period (Column 3), and Euro-zone countries post 2006 (Column 4). On the other hand, column (5) shows that the $log(PCGDP_{c,t})$ is a positive and significant predictor of IRR in the base sample. These findings corroborate the evidence about the the differences between the cross-country marginal product of capital patterns and the investment return patterns observed in sections 4.1 and 4.2. These differences are also observed in columns (6) and (7), which document positively significant coefficient for $log(PCGDP_{c,t})$ in post-financial crisis period, IFRS countries post-financial crisis period. $log(PCGDP_{c,t})$ is statistically insignificant in Euro-zone countries post-2006.

These finding shows that the empirical result documented in sections 4.1 and 4.2 are extremely robust across different specifications and samples. There seems to be a non-negligible gap between the cross-country marginal product of capital pattern and the investment return pattern, which suggests that the question "why the capital doesn't flow to emerging countries?" is intricately tied to this gap between the two variables. Based on this finding, in the following section I propose a modification to the traditional neoclassical model, which can potentially model the gap between marginal product of capital and investment return documented in this section. I also investigate alternative macroeconomic variables often used in the Lucas Paradox literature, to find the factors that can potentially affect the size of the observed gap between the marginal product of capital and the investment return.

4 Explaining the gap between Marginal Products of Capital and Investment Returns

4.1 Modelling the Capital Friction

The empirical patterns in the previous sections show that while there exists a statistically significant inverse relationship between per capita GDP and the marginal product of capital, no such relationship exists between per capita GDP and investment returns. This finding suggest that differences in the marginal product of capital across countries do not necessarily translate into corresponding differences in investment returns and the standard link assumed between labor productivity and investment returns, summarized in equation (5), appears not to hold.

The key equation that dictates the relationship between the marginal product of capital and the investment return is the capital accumulation formula. The standard model assumes a costless adjustment of the capital stock, where a unit increase in investment leads to a unit increase in capital stock. This relationship implies that the investment return differs from the marginal product of capital only by the constant depreciation rate δ. However, the empirical findings from the previous sections questions the validity of this standard assumption. Thus, in this section, I propose a modified capital accumulation equation with an adjustment factor which account for the installation/dismantling cost, or potential synergistic gains with the existing capital stock.

I assume the following modified capital accumulation condition:

$$\text{Capital accumulation:} \quad K_{t+1} = (1-\delta)K_t + I_t + \beta \frac{I_t^2}{K_t} \tag{3b}$$

Equation (3b), which is commonly employed in the investment literature, yields the traditional capital accumulation equation if we set $\beta = 0$. In this model, capital cannot be used in production until it has been installed. The adjustment term, which is quadratic in investment, accounts for the non-linear costs incurred in the installation process. This assumption implies, for example that large investments will increase installation costs firms need to set aside more resources for the installation. Moreover, the adjustment costs are inversely proportional to the size of the existing capital stock as firms are less affected by the reallocation of resources when they have a large capital base. Chirinko(1993), Gilchrist & Himmelberg (1995), and Keyu Jin (2010)) assume quadratic adjustment costs while Chocrane (1991) assumes a cubic adjustment cost. In this paper, I use a quadratic adjustment cost term, but the results remain robust even with a cubic adjustment cost.

The investment theory literature assumes that β is negative, as it is the cost incurred in the installation process. However, there also exists an extensive research in the finance literature that studies potential synergies in corporate mergers. [16] Here, the fact that the value of the combined firm can exceed the sum of assets in the individual firms suggests that a unit investment can lead to a more than one unit increase in the aggregate capital stock. Therefore, I do not place any restrictions on the sign of β. If $\beta < 0$ then a unit of investment leads to a less than one unit increase in the aggregate capital stock (a friction) and if $\beta > 0$ a unit of investment leads to a greater than one unit increase in the aggregate capital stock (a synergy).

Replacing (3) with (3b), the firm's FOC now yields:

$$1 + r_t = \left(F_1(K_t, L_t) + \frac{1 - \delta + \beta \left(\frac{I_t}{K_t} \right)^2}{1 + 2\beta \frac{I_t}{K_t}} \right) \left(1 + 2\beta \frac{I_{t-1}}{K_{t-1}} \right) \tag{5a}$$

$$F_2(K_t, L_t) = w_t \tag{6}$$

With the additional quadratic term, the investment return now depends not only on the marginal product of capital but also the investment-capital ratio. This implies that the cross-country investment return pattern may deviate from marginal product of capital pattern depending on the sign and the magnitude of β.

Note that equation (3b) can also be written as

$$\frac{K_{t+1}}{K_t} = (1 - \delta) + \frac{I_t}{K_t} + \beta \left(\frac{I_t}{K_t} \right)^2 \tag{3c}$$

This expression highlights the fact that the modified equation includes a higher order investment-capital ratio to describe the capital accumulation process. Isolating the $\left(\frac{I_t}{K_t} \right)^2$ yields:

$$\frac{K_{t+1} - K_t - I_t}{K_t} = -\delta + \beta \left(\frac{I_t}{K_t} \right)^2 \tag{3d}$$

Using equation ($3d$) as the benchmark, I define the following two variables to test the validity of the quadratic capital adjustment cost described above:

[16] see Brigham (1982), Horne (1983), Chang (1988)

$$qIK_{c,t,i,f} = IKRatio^2_{c,t,i,f} = \left(\frac{adj\Delta Asset_{c,t,i,f}}{(MVA_{c,t-1,i,f})(1 + infl_{c,t})}\right)^2 \quad (22)$$

$$DK_{c,t,i,f} = \frac{-adj\Delta Asset_{c,t,i,f} + MVA_{c,t,i,f} - MVA_{c,t-1,i,f}}{MVA_{c,t-1,i,f}} - infl_{c,t} \quad (23)$$

$qIK_{c,t,i,f}$ is the square of investment to capital ratio ($IKRatio_{c,t,i,f}$), which is calibrated as the ratio between the change in the book value of asset adjusted of depreciation and the market value of an asset. $DK_{c,t,i,f}$ measures the capital accumulation process within the economy. If the standard model is correct, then $DK_{c,t,i,f}$ should have no dependence on $qIK_{c,t,i,f}$. As in the previous sections following accounting practice, I winsorize the $IKRatio_{c,t,i,f}$ at 1% level by country to minimize the effect of the outliers.[17] Table 11 provides summary statistics for the two variables. It shows that the mean and the median for both $DK_{c,t,i,f}$, and $IKRatio_{c,t,i,f}$ are smaller in developed countries relative to their emerging-market peers, and suggests that the effect of adjustment costs, $qIK_{c,t,i,f}$, on the capital accumulation process, $DK_{c,t,i,f}$, may depend on the relative level of aggregate development.

As stated earlier in the paper, $adj\Delta Asset_{c,t,i,f}$ does not include most of the investment in Research and development (R&D), as R&D costs are taken as expenses on financial statements due to the accounting conservatism. This does not affect the measurement of $IRR_{c,t,i,f}$ as both expense and investment are deducted from the period income, but it may downwardly bias the estimate of $IKRatio_{c,t,i,f}$ by underestimating the level of investment in R&D heavy industries or countries. The market value of assets, $MVA_{c,t-1,i,f}$, on the other hand, does include the value of the intangible assets in the firm as the market observes the outcome of R&D activities. However, if omitted R&D investment is the sole driver of the observed gap, then $qIK^2_{c,t,i,f}$ should not be statistically significant in the regression analysis as the effect of omission on $DK_{c,t,i,f}$ should be linear; i.e. omitted R&D investment may affect the level of $IKRatio_{c,t,i,f}$, but it should not affect the curvature of the capital accumulation process.

Using the two variables described above, I test the validity of equation (3d) by using the following two specifications:

$$DK_{c,t,i,f} = \alpha + \beta_1 D_t + \beta_2 F_i + \eta_1 qIK_{c,t,i,f} + \boldsymbol{\gamma X_{c,t,i,f}} + \epsilon_{c,t,i,f} \quad (24)$$

$$DK_{c,t,i,f} = \alpha + \beta_1 D_t + \beta_2 F_i + \boldsymbol{\eta} qIK_{c,t,i,f} \begin{bmatrix} 1 \\ log(PCGDP_{c,t}) \end{bmatrix} + \boldsymbol{\gamma X_{c,t,i,f}} + \epsilon_{c,t,i,f} \quad (25)$$

[17]For robustness, I repeat the exercise without winsorization and the results remain unchanged

Equation (24) analyses the effects of adjustment costs, $qIK_{c,t,i,f}$, on the capital accumulation process, $DK_{c,t,i,f}$, to test the validity of the capital adjustment cost factor. If the modified capital accumulation path described in equation (3d) is correct, then the $qIK_{c,t,i,f}$ ought to be statistically significant. Equation (25) sub-divides the capital adjustment factor into two parts ($qIK_{c,t,i,f}$ and $qIK_{c,t,if} * log(PCGDP)$) based on the observations from Table 11, and tests whether the effect of the adjustment term is heterogeneous across countries based on their relative level of development. If the effect of the adjustment term is homogeneous across countries, the interaction term will be statistically insignificant. To control for industry specific effects, I run the regression using the industry-level dummies. Equations (24) and (25) also include the firm specific factors, and time dummies as in equations (13) and (16).

Column 1 of Table 12 shows that $qIK_{c,t,i,f}$ is positive and statistically significant between 1997 and 2014. This finding implies that equation (3d) describes the capital accumulation more accurately than the standard model, and suggests that the aggregate capital estimates, which rely on a linear capital accumulation process need modification. The positive coefficient for $qIK_{c,t,i,f}$ denotes that, on average, synergies appear to dominate friction in the adjustment process, but the results in column 2 show that the effect of the adjustment term is not homogeneous. When I add interaction of $qIK_{c,t,i,f}$ with log per capita GDP to the regression specification, $qIK_{c,t,i,f}$ is negative and significant between 1997 and 2014. The interaction term, on the other hand, is positive and statistically significant during the period. This finding suggests that the effects of capital adjustment appears to depend on a country's level of development; more developed countries appear to enjoy the beneficial effects of synergies in the capital accumulation process. Column (2) through (7) confirm this pattern for the 25th, 50th and 75th percentile.

The results presented in Table 12 show that the cross-country differences in the relative level of capital synergies created in the capital accumulation process can partly explain the divergence between the cross-country investment/financial returns and the marginal product of capital pattern observed in the data. This finding also highlights the importance of capital efficiency (i.e., the level of future capital input that can be obtained from a unit investment today), and suggests that aggregate capital stock estimates based on the traditional capital accumulation equation may be misspecified. Therefore, in the following section, I investigate potential macroeconomic factors that could lead to frictions/synergies in the capital accumulation process to explain the patterns observed in this section.

4.2 Macroeconomic factors

Numerous macroeconomic factors have been discussed in the Lucas Paradox literature as the sources of inefficiency in the emerging countries. However, most of the analysis focused on their effect on the aggregate productive efficiency, and the effect on the capital efficiency remains relatively uninvestigated. Therefore, in this section I analyse how the commonly cited macroeconomic factors affect capital efficiency at the firm level. Higher level of capital efficiency should increase the future investment income as higher level of future capital stock can be obtained from the unit investment today.

Equation (8) implies that if countries share the identical production function, then the marginal product of capital of firms in emerging countries should fall with increase in per capita output. However, if there exists a systematic difference in the total factor of productivity across countries (i.e. if A differs across countries), then the cross-country marginal productivity pattern can deviate substantially from the standard neoclassical model. Cross-country difference in human capital and the other complementary factors of production should have a similar effect.[18] Therefore an extensive effort has been devoted to identify the macroeconomic factors that affect the aggregate productivity. Table 13 summarizes some of the factors that has been discussed in the development literature. The variables used in the analysis includes labor utilization, human capital, institutional quality, financial development, and technology.

Labor utilization measures the percent of the population involved in the production process[19]. Per capita GDP measures output per total population, implicitly assuming that the entire population is involved in the production process. However, the labor force participation rate, and the unemployment rate varies greatly across countries as shown in the

[18] Consider the following modified Cobb-Douglas function with human capital:

$$Y = AK^{\alpha}(hL)^{1-\alpha}$$

where h is the level of human capital. This modified production function yields the following expression for the marginal product of capital:

$$\frac{\partial Y}{\partial K} = \alpha A^{\frac{1}{\alpha}} h^{1-\alpha+\frac{1}{\alpha}} y^{\frac{\alpha-1}{\alpha}}$$

If the level of total factor of productivity (A) and human capital(h) is identical across countries, then the marginal product of capital should be completely determined by the relative level of per capita output as predicted in the neoclassical model. However, if the assumption is violated cross-country difference in the marginal product of capital may deviate from the predicted values based on the model.

[19] $LU_{c,t} = \frac{LF_{c,t} * (1-UR_{c,t})}{P_{c,t}}$ such that $LU_{c,t}$ is labor utilization, $LF_{c,t}$ is the labor force, $UR_{c,t}$ is unemployment rate and $P_{c,t}$ is population of country c at time t

Table 13. The average labor force participation rate during the analysis period (1997-2014) is 73.9% in China, but is only 47.2% in Turkey. Similarly, average unemployment rate in Thailand is only around 1.5% but it is close to 25% in South Africa. This implies that the per capita GDP underestimates the output generated by a unit of employed labor in the economy, and the cross-country variation in the labor utilization should affect cross-country productive and capital efficiency pattern. Keeping all else constant, smaller labor input decrease the marginal product of capital due to the concavity of the production function.

Human capital is one of the most commonly employed predictor variable in the development literature, and has been suggested as a potential solution to Lucas paradox by Lucas himself. As a measure of the human capital, I use the the human capital index constructed from the years of schooling and the return to education provided in the Penn World Table 9.0[20]. This index should be more accurate measure of human capital than the average years of schooling as the quality of schools also differs across countries. Table 13 shows that human capital based on education is highest in the US (3.63) and the lowest in India(1.76). All MSCI developed countries except Spain and Portugal have human capital index greater than 3, but only a few emerging countries (Czech Republic, Hungary, Poland, Russia, and South Korea) tops this threshold number. One major drawback of this index is that it does not account for the on-the-job learning, highlighted by Lucas (1990). One possible proxy for the on-the-job training is the median age; higher median age should imply more experienced work force. The median age is estimated by United Nations with 5 year interval, and the missing values are linearly interpolated from the data. The average median age during the analysis period is lowest in Philippines, and highest in Japan, and developed countries tend to have higher median age relative to the emerging economies.

As stated in Alfaro, et al (2005) " 'cluster of institutions,' including constraints on government expropriation, independent judiciary, property rights enforcement, and institutions providing equal rights and ensuring civil liberties, are important to encourage investment and growth." Thus, in this paper I construct institution quality measure using the World Governance Indicators by World Bank. The World Governance Indicator measures: Control of Corruption, Government Effectiveness, Regulatory Quality, Rule of Law, Political Stability and Voice and Accountability. I take the average of the five indexes, linearly interpolating the missing values in each index. Within the MSCI developed and emerging countries, the rating is the highest in Finland and the Nordic countries, and the lowest in Russia and China.

The measure of financial development is from the International Monetary Fund (IMF).

[20]see Human capital in PWT 9.0

The financial development index summarizes the accessibility, efficiency and the depth of the financial market and institutions within the economy.[21] Limited access to financial institutions has been discussed as a source of inefficiency in emerging countries by Banerjee and Duflo (2005), where they document a large within-country variance in the interest rate. Hsieh and Klenow(2009) further argues that financial system can lead to a more efficient allocation of capital within the economy, increasing the aggregate productivity. As shown in Table 13, within the MSCI developed and emerging countries, Switzerland (0.97) has the highest level of financial development, and Peru has the lowest level of development.

The number of triadic patent families is used to proxy for the country's ability to innovate. Triadic patents families is a series of corresponding patents filed at the European Patent Office (EPO), the United States Patent and Trademark Office (USPTO) and the Japan Patent Office (JPO), for the same invention, by the same applicant or inventor. It is a better proxy for the R&D level of the firms than the total number of patent applications as triadic patent families is the "database of 'high-quality' inventions" (Popp, 2007) which excludes inventions/innovations with zero commercial value. The average number of triadic patents over the analysis period is the highest in Japan (15,135), and is the lowest in Peru (0.4).

Although literature thus far remained relatively silent on the effect of the macroeconomic factors on the capital efficiency, these factors are likely to have a significant effect on the capital installation process. High labor utilization should lower capital accumulation friction as more workers can be diverted from production to the capital instalment. Similarly, human capital should lead to a greater efficiency, as workers have greater experience/expertise in the capital installation and adjustment process. As loss and damage of goods in the capital transportation/allocation process has often been cited as one of the major sources of the capital frictions in emerging countries, better institutions, and financial development can help minimize the capital adjustment cost through efficient allocation of resources. Technological innovation should increase the possibility of capital synergy as countries with greater innovative power are likely to generate more value from the unit investment.

To test the effect of the macroeconomic variables on the capital efficiency, I use the following equation:

[21] See Svirydzenka(2016)

$$DK_{c,t,i,f} = \alpha + \beta_1 D_t + \beta_2 F_i + \boldsymbol{\eta} qIK_{c,t,i,f} \begin{bmatrix} 1 \\ log(PCGDP_{c,t}) \\ Macro_{c,t} \end{bmatrix} + \boldsymbol{\gamma X_{c,t,i,f}} + \epsilon_{c,t,i,f} \qquad (26)$$

This is a modified version of equation (24), and includes $Macro_{c,t} * qIK_{c,t,i,f}$ to measure the effect of the macroeconomic factors discussed above. If the discussed factors affect installation process, then the effect should be most acutely felt by the firms that engage in intensive capital investment, and therefore $Macro_{c,t} * qIK_{c,t,i,f}$ should be statistically significant.

Table 14 summarizes the regression result for equation (26), which measures the effect of the macroeconomic variables on the capital efficiency of the firms. The table shows that triadic patents, labor utilization, government efficiency, financial development index, and human capital index all have a positively significant effect on the capital efficiency of firms. This finding suggests better utilization of resources, and higher level of education can help minimize the capital adjustment friction. Median age on the other hand, has a negative effect on the capital efficiency. This counter-intuitive sign may be driven by the large population of retired workers who are no longer in the labor force. The result also suggests a substantial multicollinearity between $log(PCGDP_{c,t}) * qIK_{c,t,i,f}$ and $Macro_{c,t}qIK_{c,t,i,f}$ for institutional quality, education, and government efficiency. The inclusion of these variables have a statistically significant effect on the sign of $log(PCGDP_{c,t}) * qIK_{c,t,i,f}$. Therefore, for robustness, I test equation (26) without $log(PCGDP_{c,t}) * qIK_{c,t,i,f}$. I find that the result remain unchanged.

The result presented in this subsection implies that the macroeconomic factors of production discussed in the development literature affect not only the production today, but also the production in the future by increasing 1) the level of output for a given input, and 2) the future capital input that can be obtained from a unit investment today. The exact mechanism behind this effect is beyond the scope of this paper, but should be a subject of the future research.

5 Conclusion

According to the textbook neoclassical theory, if two countries share the identical production function, and the trade in capital good is free and competitive, new investment will only occur in the poorer country since the marginal return to capital should be higher in economies with less capital (due to the law of diminishing return). However, as Lucas pointed out in his seminal paper in 1990, observed capital flow from developed to developing countries fall short of what should be observed according to the theory. This phenomena has been named "Lucas Paradox" and has been one of the major puzzles in the macroeconomic literature.

In this paper, I show using the firm-level data that despite the higher marginal product of capital in emerging countries, financial return are equalized across developed and emerging countries. This finding is significant as it questions the validity of using marginal product of capital in explaining the international capital flow. The empirical result suggest that marginal product of capital trend does not mirror the investment return trend due to the cross-country difference in the capital efficiency. The effect of the capital adjustment cost can be sufficiently large that it can divorce the cross-country financial return pattern from the marginal product of capital pattern. Therefore, the answer to "Lucas Paradox" may simply be that the investment return is equalized across countries, despite the international difference in marginal product of capital. This finding also suggests that the key issues in explaining the international capital flow is not an "international" credit frictions but rather a "domestic" credit frictions which affects the capital accumulation process. Thus, the future research on Lucas Paradox should focus not only on factors that affect productive efficiency, but also those that affect the capital efficiency.

This paper differs methodologically from most others in the literature in that it uses the firm level data instead of an aggregate data to explain the cross country differences in return and marginal product of capital. The firm level data has an advantage over macroeconomic data in that it allows direct computation of marginal product of capital and the financial return. This allows one to test the validity of the firm first order condition that is at the heart of the Lucas Paradox. Despite this major benefits of the firm-level data, it also has some major drawbacks. It restricts the analysis to mid-to large-size firms that are listed in the stock market. One may argue that the return found using only the firm level data is biased upward as it doesn't include self-employed workers, or mom-and-pop stores. This is a plausible argument, and the future research, based on a larger dataset that encompasses both the unlisted firms and the self-employed workers should help increase the understanding of the capital market frictions.

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7 Tables

Table 1: Data Summary Statistics (1997-2014)

The sample includes all non-financial (all SIC codes except 6000∼6999) balance sheet solvent firm-years in the Worldscope database with 1) market value(WC08001), assets(WC02999), liabilities(WC03351), depreciation(WC01151), EBITDA(WC18198), extraordinary credit(WC01253) and extraordinary charge(WC01254) data for the year and; 2) debt and market value data for the previous year in the MSCI developed and emerging countries (excluding Saudi Arabia, Qatar and UAE) between 1997 and 2014. Purchasing Power Parity (PPP) adjusted per capita GDP (PCGDP) is calibrated using the PPP adjusted GDP(rgdpo) and the population (pop) estimate from the Penn World Table 9.0. Employed population (emp), and average hours worked per employed (avh) are also from the Penn World Table 9.0. CPI inflation is from the World Bank

Country	wbcode	Firm-years	Fama French Industries	PPP adjusted PCGDP (2014)	CPI Inflation (2014)	Population (2014, millions)	Employed (2014, millions)	Average Hours Worked per Employed (2014)
Australia	AUS	14,838	44	44,241	0.025	23.6	12.0	1,803
Austria	AUT	1,147	28	45,705	0.016	8.5	4.4	1,629
Brazil	BRA	1,450	35	14,811	0.063	206.1	105.9	1,711
Belgium	BEL	3,250	38	39,950	0.003	11.2	4.9	1,575
Canada	CAN	12,632	44	43,368	0.019	35.6	18.8	1,688
Chile	CHL	2,080	30	21,317	0.044	17.8	7.8	1,990
China	CHN	20,092	44	12,513	0.020	1,369.4	798.4	NA
Colombia	COL	365	24	12,858	0.029	47.8	24.6	1,772
Czech Republic	CZE	436	24	29,187	0.003	10.5	5.1	1,771
Denmark	DNK	1,890	37	44,423	0.006	5.6	2.8	1,438
Finland	FIN	1,929	36	38,343	0.010	5.5	2.6	1,643
France	FRA	8,637	43	38,584	0.005	66.1	27.3	1,473
Germany	DEU	9,037	43	46,507	0.009	80.6	42.5	1,371
Greece	GRC	3,643	37	24,685	-0.013	11.0	4.0	2,042
Hong Kong	HKG	11,342	42	45,134	0.044	7.2	3.7	2,234
Hungary	HUN	423	23	22,750	-0.002	9.9	4.2	1,860
India	IND	17,621	44	5,452	0.064	1,295.3	510.3	2,162
Indonesia	IDN	3,826	37	9,798	0.064	254.5	113.0	2,027
Ireland	IRL	782	26	51,927	0.002	4.7	1.9	1,821
Israel	ISR	3,187	40	31,606	0.005	7.9	3.9	1,880
Italy	ITA	3,141	36	35,324	0.002	59.8	23.6	1,734
Japan	JPN	52,501	44	35,566	0.027	126.8	65.0	1,729
Malaysia	MYS	11,427	42	21,650	0.031	29.9	13.8	2,268
Mexico	MEX	1,470	35	15,520	0.040	125.4	51.4	2,137
Netherlands	NLD	2,120	39	48,178	0.010	16.9	8.7	1,420
New Zealand	NZL	1,385	36	34,066	0.009	4.5	2.4	1,762
Norway	NOR	2,260	33	78,293	0.020	5.1	2.7	1,427
Peru	PER	986	26	10,931	0.032	31.0	14.7	1,790
Philippines	PHL	1,706	33	6,638	0.041	99.1	34.9	2,115
Poland	POL	3,053	40	24,450	0.001	38.6	15.8	2,039
Portugal	PRT	812	30	27,047	-0.003	10.4	4.3	1,857
Russia	RUS	1,869	35	24,056	0.078	143.4	71.9	1,985
Singapore	SGP	7,146	43	66,482	0.010	5.5	3.4	2,263
South Africa	ZAF	3,621	41	12,067	0.064	54.0	18.3	2,215
South Korea	KOR	16,906	43	34,955	0.013	50.1	26.1	2,124
Spain	ESP	1,883	36	32,858	-0.001	46.3	17.6	1,689
Sweden	SWE	4,761	42	42,605	-0.002	9.7	4.8	1,609
Switzerland	CHE	2,936	34	62,637	0.000	8.2	5.0	1,568
Thailand	THA	5,740	41	13,725	0.019	67.7	38.9	2,284
Turkey	TUR	2,907	36	19,675	0.089	77.5	24.6	1,832
United Kingdom	GBR	18,827	44	38,757	0.015	64.3	31.0	1,675
United States	USA	69,400	44	51,959	0.016	319.4	148.5	1,765
Total		335,464	44					

Table 2: Summary Statistics: ROA vs. IRR (1997-2014)

$$ROA_{c,t,i,f} = \frac{EBITDA_{c,t,i,f}}{(PV_{c,t1,i,f})(1 + infl_{c,t})}$$

$$IRR_{c,t,i,f} = \frac{EBITDA_{c,t,i,f} + [-Adj\Delta Asset_{c,t,i,f} + PV_{c,t,i,f} - PV_{c,t-1,i,f}]}{PV_{c,t-1,i,f}} - infl_{c,t}$$

$ROA_{c,t,i,f}$ is the ratio between the firm EBITDA before extraordinary items (sum of EBITDA after extraordinary items (WC18198) and extraordinary cost (WC01254) minus extraordinary credit(WC01253)) and the market value of asset (sum of market value of equity(WC08001)and the book value of liabilities(WC03351)) from the previous year adjusted for CPI inflation. $IRR_{c,t,i,f}$ is the ratio between the sum of EBITDA before extraordinary item, change in the market value of asset less the change in the book value of asset and the market value of asset from the previous year adjusted for CPI inflation

		ROA			IRR		
		Mean	Median	SD	Mean	Median	SD
Australia	AUS	-0.001	0.020	0.183	0.184	0.007	0.920
Austria	AUT	0.098	0.098	0.069	0.065	0.042	0.275
Brazil	BRA	0.093	0.097	0.072	0.060	0.042	0.278
Belgium	BEL	0.139	0.124	0.108	0.102	0.052	0.354
Canada	CAN	0.065	0.084	0.139	0.132	0.037	0.626
Chile	CHL	0.107	0.099	0.085	0.062	0.025	0.303
China	CHN	0.062	0.052	0.061	0.146	0.011	0.577
Colombia	COL	0.132	0.119	0.093	0.062	0.007	0.365
Czech Republic	CZE	0.145	0.134	0.098	0.040	0.021	0.254
Denmark	DNK	0.085	0.092	0.087	0.071	0.032	0.342
Finland	FIN	0.094	0.097	0.070	0.088	0.061	0.313
France	FRA	0.087	0.087	0.076	0.067	0.042	0.303
Germany	DEU	0.080	0.088	0.095	0.063	0.040	0.345
Greece	GRC	0.072	0.069	0.075	0.120	-0.015	0.823
Hong Kong	HKG	0.063	0.064	0.118	0.150	0.011	0.749
Hungary	HUN	0.104	0.109	0.094	0.002	-0.025	0.333
India	IND	0.113	0.104	0.087	0.058	-0.029	0.459
Indonesia	IDN	0.111	0.099	0.105	0.072	-0.019	0.489
Ireland	IRL	0.075	0.084	0.079	0.137	0.065	0.551
Israel	ISR	0.069	0.076	0.102	0.083	0.034	0.424
Italy	ITA	0.079	0.082	0.064	0.030	0.020	0.229
Japan	JPN	0.081	0.077	0.059	0.055	0.027	0.244
Malaysia	MYS	0.090	0.088	0.085	0.044	0.015	0.317
Mexico	MEX	0.107	0.102	0.071	0.066	0.040	0.292
Netherlands	NLD	0.095	0.097	0.063	0.084	0.063	0.305
New Zealand	NZL	0.087	0.100	0.100	0.082	0.060	0.330
Norway	NOR	0.075	0.086	0.108	0.087	0.039	0.454
Peru	PER	0.155	0.137	0.127	0.157	0.074	0.510
Philippines	PHL	0.095	0.089	0.101	0.110	0.022	0.527
Poland	POL	0.085	0.084	0.094	0.073	0.011	0.473
Portugal	PRT	0.090	0.086	0.063	0.037	0.018	0.194
Russia	RUS	0.148	0.123	0.137	0.040	-0.014	0.476
Singapore	SGP	0.085	0.082	0.090	0.068	0.013	0.407
South Africa	ZAF	0.126	0.123	0.118	0.105	0.058	0.422
South Korea	KOR	0.091	0.093	0.113	0.068	0.018	0.391
Spain	ESP	0.090	0.087	0.062	0.077	0.049	0.268
Sweden	SWE	0.040	0.072	0.130	0.092	0.037	0.500
Switzerland	CHE	0.084	0.087	0.064	0.096	0.070	0.302
Thailand	THA	0.116	0.109	0.095	0.125	0.055	0.386
Turkey	TUR	0.108	0.091	0.106	0.016	-0.047	0.566
United Kingdom	GBR	0.066	0.086	0.106	0.085	0.037	0.490
United States	USA	0.063	0.081	0.111	0.110	0.048	0.534
Total		0.076	0.082	0.105	0.092	0.028	0.493

Table 3: MSCI Developed and Emerging Countries: Firm ROA and PCGDP

Purchasing Power Parity (PPP) adjusted per capita GDP (PCGDP) is calibrated using the PPP adjusted GDP(rgdpo) and the population (pop) estimate from the Penn World Table 9.0. Size is the inflation adjusted book value of the firm's asset in US dollar, and leverage is the ratio between the book value of liability and the assets. Price-to-Book measures the ratio between the market and the book value of the firm equity. Time dummies and industry dummies for the 48 Fama-French Industries are included in all regressions. Standard deviation is reported in the parenthesis.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ROA	ROA	ROA	ROA	ROA	ROA	ROA
VARIABLES	97-14	97-14 (25th)	97-14 (50th)	97-14 (75th)	11-14	11-14 (IFRS)	06-14 (EU)
log(PCGDP)	-0.0196***	-0.00897***	-0.00808***	-0.0140***	-0.0165***	-0.0107***	-0.0128***
	(0.000238)	(0.000250)	(0.000207)	(0.000248)	(0.000452)	(0.000788)	(0.00250)
log(size)	0.00990***	0.00960***	0.00604***	0.00308***	0.00855***	0.00874***	0.0141***
	(8.49e-05)	(7.11e-05)	(5.87e-05)	(7.03e-05)	(0.000150)	(0.000188)	(0.000327)
Leverage	-0.0337***	-0.0131***	-0.0294***	-0.0615***	-0.0333***	-0.0189***	-0.0232***
	(0.00181)	(0.000808)	(0.000667)	(0.000799)	(0.00176)	(0.00270)	(0.00360)
Price-to-Book	-2.05e-05**	-0.000304***	-0.000122***	-2.25e-05***	-2.32e-05*	-7.87e-05**	-6.82e-05***
	(8.29e-06)	(2.45e-06)	(2.02e-06)	(2.42e-06)	(1.35e-05)	(3.10e-05)	(1.95e-05)
Constant	0.188***	0.0347***	0.119***	0.272***	0.166***	0.109***	0.0871***
	(0.00409)	(0.00438)	(0.00361)	(0.00432)	(0.00754)	(0.0151)	(0.0296)
Observations	335,465	335,464	335,464	335,464	88,783	46,729	32,130
R-squared	0.127				0.119	0.133	0.063
Time Dummies	Y	Y	Y	Y	Y	Y	Y
Industry Dummies	Y	Y	Y	Y	Y	Y	Y

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4: Non-Financial 48 Fama French Industries: Firm ROA and PCGDP

Purchasing Power Parity (PPP) adjusted per capita GDP (PCGDP) is calibrated using the PPP adjusted real GDP(rgdpo) and the population (pop) estimate from the Penn World Table 9.0. Size is the inflation adjusted book value of the firm's asset in US dollar, and leverage is the ratio between the book value of liability and the assets. Price-to-Book measures the ratio between the market and the book value of the firm equity. Time dummies are included in the regression but are not reported. Financial industries are excluded from the list of 48 Fama-French Industries, leaving 44 industries for the analysis.

Industries	log(PCGDP)	log(size)	Leverage	Price-to-Book	Observations	R-squared
Agriculture	-0.0320***	0.0165**	-0.123**	-0.000202	4,145	0.024
Food Products	-0.128	2.63e-05	0.0168	-0.000608	9,753	0.003
Candy & Soda	-0.0177***	0.00895***	-0.0325	-0.000240**	2,141	0.062
Beer & Liquor	-0.0361**	0.00540***	-0.0766	-0.000840	2,775	0.017
Tobacco Products	-0.0191	0.00472**	-0.00236	-0.000991	481	0.040
Recreation	0.00377	0.00421***	-0.0705***	-0.000108**	2,990	0.009
Entertainment	-0.0169**	0.0117***	0.0102	-0.000122	5,187	0.012
Printing and Publishing	-0.0104***	0.00784***	-0.0542***	-0.000464***	3,758	0.054
Consumer Goods	-0.0200***	0.00743***	-0.0799***	-0.00112**	7,320	0.014
Apparel	-0.0144***	0.00351**	-0.123***	0.000103	4,111	0.024
Healthcare	-0.0177***	0.00964***	0.0735	-0.00172**	3,156	0.015
Medical Equipment	-0.0764***	0.0480**	0.0641	-9.29e-05***	5,607	0.004
Pharmaceutical Products	-0.0601***	0.0217***	-0.0437***	-1.89e-05	10,932	0.158
Chemicals	-0.0361**	0.00742***	-0.0455	-5.67e-05	12,415	0.004
Rubber and Plastic Products	-0.0198***	0.00455***	-0.0891***	-0.000526**	3,569	0.065
Textiles	-0.0248***	0.00310***	-0.0740***	-0.00390***	5,260	0.112
Construction Materials	-0.0144***	0.00577***	-0.0906***	-0.000377***	13,180	0.065
Construction	-0.00404***	0.00357***	-0.0634***	-3.39e-05	17,807	0.020
Steel Works	-0.0156***	0.00482***	-0.0965***	-0.000582***	10,231	0.082
Fabricated Products	-0.0118***	0.00517***	-0.0939***	-0.00526***	1,530	0.119
Machinery	-0.0168***	0.00573***	-0.0553***	-0.000873*	14,795	0.055
Electrical Equipment	-0.0148***	0.00720***	-0.0453***	-0.000988*	5,427	0.054
Automobiles	-0.0196***	0.00631***	-0.0714***	-0.000180***	8,991	0.044
Aircraft	0.0161***	0.000331	-0.00602	-0.000183	1,190	0.056
Shipbuilding, Railroad Equipment	-0.00827	-0.00108	-0.0125	-0.00900	867	0.027
Defense	-0.0768***	0.00725*	-0.0991***	-0.00519*	343	0.136
Precious Metals	-0.0167***	0.0396***	-0.0139	3.52e-05***	5,036	0.127
Non-Metallic and Industrial Mining	-0.0527***	0.0344***	-0.0491	-0.000104*	5,854	0.141
Coal	-0.0377***	0.0268***	0.0158	-9.83e-07	1,902	0.145
Petroleum and Natural Gas	-0.00235	0.0206***	-0.00271	-0.000313	11,788	0.099
Utilities	-0.0197***	0.0126***	-0.0513***	-1.33e-05	9,876	0.006
Communication	-0.0262***	0.0185***	-0.0335**	-1.13e-05	9,327	0.011
Personal Services	-0.0201***	0.0122***	0.000667	-0.000788**	3,388	0.062
Business Services	0.026	0.0190***	0.0582*	-1.35e-05	36,745	0.001
Computers	-0.0231***	0.00925***	-0.0316***	-9.05e-05	8,793	0.053
Electronic Equipment	-0.0141***	0.0106***	-0.0317***	-4.73e-05	15,818	0.028
Measuring and Control Equipment	-0.00854**	0.00985***	-0.0444***	-0.000184*	4,437	0.049
Business Supplies	-0.0177***	0.00354***	-0.103***	-1.83e-05***	5,242	0.105
Shipping Containers	-0.00553*	0.00457***	-0.0791***	-0.000361	1,665	0.091
Transportation	-0.0199	0.00622***	-0.0176	-7.78e-07	12,407	0.003
Wholesale	-0.0144***	0.00779***	-0.0595**	-2.48e-05	17,709	0.004
Retail	-0.00362**	0.00755***	-0.0720***	-4.16e-05	17,315	0.006
Restaurants, Hotels	-0.0141**	0.000117	-0.0378**	-1.87e-05	7,931	0.005
Other	-0.0043	0.0159***	-0.0311*	-0.000246*	1,365	0.109

Robust standard errors in parentheses

*** $p< 0.01$, ** $p< 0.05$, * $p< 0.1$

Table 5: Annual Analysis: Firm ROA and PCGDP

Purchasing Power Parity (PPP) adjusted per capita GDP (PCGDP) is calibrated using the PPP adjusted GDP(rgdpo) and the population (pop) estimate from the Penn World Table 9.0. Size is the inflation adjusted book value of the firm's asset in US dollar, and leverage is the ratio between the book value of liability and the assets. Price-to-Book measures the ratio between the market and the book value of the firm equity. Industry dummies are included in the regression but are not reported.

	log(PCGDP)	log(size)	Leverage	Price-to-Book
1997	-0.00813***	0.00500***	-0.0380***	-1.26e-05*
1998	-0.0102***	0.00703***	-0.0375***	-9.80e-05***
1999	-0.0235***	0.00953***	-0.0517***	-3.00e-05**
2000	-0.0157***	0.00960***	-0.0331***	-6.91e-05
2001	-0.0217***	0.0113***	-0.0350***	-0.000256***
2002	-0.0283***	0.0124***	-0.0387***	-6.44e-06
2003	-0.0169***	0.0128***	-0.0426***	-2.68e-05
2004	-0.0157***	0.0115***	-0.0410***	-1.54e-06
2005	-0.0147***	0.0120***	-0.0340***	-0.000266***
2006	-0.0177***	0.0103***	-0.0159***	-4.59e-05
2007	-0.0235***	0.00976***	-0.0197***	-3.22e-05
2008	-0.0196***	0.00776***	-0.0239***	-2.72e-05**
2009	-0.0257***	0.0129***	-0.0639***	-0.000767***
2010	-0.0273***	0.00968***	-0.0222*	-0.000142***
2011	-0.0160***	0.00872***	-0.0273***	-2.74e-05**
2012	-0.0158***	0.00909***	-0.0384***	-4.93e-05***
2013	-0.0155***	0.00833***	-0.0407***	-1.01e-05
2014	-0.0189***	0.00801***	-0.0251***	-7.43e-05*

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 6: MSCI Developed and Emerging Countries: Firm Investment Return and PCGDP

Purchasing Power Parity (PPP) adjusted per capita GDP (PCGDP) is calibrated using the PPP adjusted GDP(rgdpo) and the population (pop) estimate from the Penn World Table 9.0. Size is the inflation adjusted book value of the firm's asset in US dollar, and leverage is the ratio between the book value of liability and the assets. Price-to-Book measures the ratio between the market and the book value of the firm equity. Time dummies and industry dummies for the 48 Fama-French Industries are included in all regressions. Standard deviation is reported in the parenthesis.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	IRR	IRR	IRR	IRR	IRR	IRR	IRR
VARIABLES	97-14	97-14 (25th)	97-14 (50th)	97-14 (75th)	11-14	11-14 (IFRS)	06-14 (EU)
log(PCGDP)	-0.00200	0.0287***	0.0150***	-0.0144***	0.0305***	0.0210***	-0.0103
	(0.00122)	(0.000858)	(0.000769)	(0.00147)	(0.00199)	(0.00382)	(0.0109)
log(size)	0.000715**	0.0123***	0.00633***	-1.55e-05	3.09e-05	-0.00224***	0.0110***
	(0.000356)	(0.000243)	(0.000218)	(0.000418)	(0.000559)	(0.000689)	(0.00105)
Leverage	-0.120***	0.141***	-0.0333***	-0.279***	-0.0899***	-0.101***	-0.0985***
	(0.00738)	(0.00277)	(0.00248)	(0.00476)	(0.00712)	(0.0107)	(0.0119)
Price-to-Book	0.000212**	1.65e-05**	0.000490***	0.0209***	0.000103	0.000469**	0.000233***
	(8.49e-05)	(8.38e-06)	(7.51e-06)	(1.44e-05)	(8.50e-05)	(0.000187)	(8.42e-05)
Constant	0.153***	-0.652***	-0.187***	0.466***	-0.270***	-0.114*	0.181
	(0.0195)	(0.0150)	(0.0134)	(0.0258)	(0.0347)	(0.0688)	(0.122)
Observations	335,465	335,464	335,464	335,464	88,783	46,729	32,130
R-squared	0.064				0.037	0.037	0.122
Time Dummies	Y	Y	Y	Y	Y	Y	Y
Industry Dummies	Y	Y	Y	Y	Y	Y	Y

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 7: Non-Financial 48 Fama French Industries: Firm IRR and PCGDP

Purchasing Power Parity (PPP) adjusted per capita GDP (PCGDP) is calibrated using the PPP adjusted GDP(rgdpo) and the population (pop) estimate from the Penn World Table 9.0. Size is the inflation adjusted book value of the firm's asset in US dollar, and leverage is the ratio between the book value of liability and the assets. Price-to-Book measures the ratio between the market and the book value of the firm equity. Time dummies are included in the regression, but not reported. Financial industries are excluded from the list of 48 Fama-French Industries, leaving 44 industries for the analysis.

Industries	log(PCGDP)	log(size)	Leverage	Price-to-Book	Observations	R-squared
Agriculture	-0.0172**	0.0110***	-0.104***	0.00124	4,145	0.093
Food Products	-0.00415	0.00250*	-0.157***	0.00190	9,753	0.064
Candy & Soda	-0.0113	-0.00434	-0.0610	-0.000295	2,141	0.092
Beer & Liquor	-0.0375***	0.00625**	-0.198***	0.0204***	2,775	0.142
Tobacco Products	-0.0383	0.0120	-0.00228	0.00355**	481	0.107
Recreation	0.0187	-0.00318	-0.156***	7.76e-05	2,990	0.063
Entertainment	0.000105	0.00265	-0.118***	0.000719	5,187	0.042
Printing and Publishing	0.00829	0.00190	-0.133***	0.000987	3,758	0.096
Consumer Goods	-0.0121*	0.00728***	-0.198***	0.00806**	7,320	0.093
Apparel	0.0152	0.000410	-0.201***	0.00820***	4,111	0.108
Healthcare	-0.00092	0.00866*	-0.188***	0.00849***	3,156	0.078
Medical Equipment	-0.0288	0.00995***	-0.148***	0.000340***	5,607	0.102
Pharmaceutical Products	-0.0183***	0.00686***	-0.158***	0.000364	10,932	0.090
Chemicals	-0.00826*	0.00394***	-0.101***	0.000133	12,415	0.083
Rubber and Plastic Products	0.0113	0.00130	-0.155***	0.00267	3,569	0.091
Textiles	0.0167***	-0.000736	-0.0999***	0.00474*	5,260	0.071
Construction Materials	0.000967	0.00342***	-0.120***	0.00760***	13,180	0.115
Construction	-0.00254	-0.00524***	-0.0769***	0.000518*	17,807	0.088
Steel Works	0.00177	0.000873	-0.103***	0.00627***	10,231	0.120
Fabricated Products	-0.0291**	0.00653***	-0.272***	0.0469***	1,530	0.207
Machinery	-0.0181***	0.00299**	-0.0989***	0.00555**	14,795	0.124
Electrical Equipment	-0.0155*	0.00469**	-0.118***	0.00378	5,427	0.095
Automobiles	-0.00718	0.000143	-0.105***	0.000566**	8,991	0.101
Aircraft	-0.0233	-0.0135***	-0.0547	0.000528	1,190	0.164
Shipbuilding, Railroad Equipment	0.0372**	0.00419	-0.353***	0.0654***	867	0.324
Defense	-0.106*	0.0126	-0.295***	0.0593***	343	0.211
Precious Metals	-0.0251	0.00246	-0.156***	0.000288***	5,036	0.120
Non-Metallic and Industrial Mining	-0.0035	0.00546	-0.330***	0.000881	5,854	0.120
Coal	-0.027	-0.00552	-0.247***	-1.39e-05	1,902	0.110
Petroleum and Natural Gas	0.0105	0.00151	-0.287***	0.00331***	11,788	0.109
Utilities	0.00869	-0.00358*	-0.0825***	0.000178	9,876	0.081
Communication	0.0150**	-0.00246	-0.0697**	6.88e-05**	9,327	0.128
Personal Services	0.00207	0.000821	-0.145***	0.0106**	3,388	0.079
Business Services	-0.00194	0.00488***	-0.0987***	7.51e-05	36,745	0.080
Computers	-0.00299	0.000476	-0.129***	0.00163***	8,793	0.114
Electronic Equipment	0.0103	-0.00122	-0.161***	0.000327	15,818	0.136
Measuring and Control Equipment	0.0122	0.00151	-0.0977***	0.000724	4,437	0.118
Business Supplies	0.0058	0.000816	-0.128***	0.000473***	5,242	0.121
Shipping Containers	0.0247**	0.00307	-0.0878*	0.00512	1,665	0.106
Transportation	0.002	-0.000145	-0.126***	0.000244***	12,407	0.091
Wholesale	-0.00206	0.000249	-0.108***	0.000234	17,709	0.051
Retail	-0.00134	0.00306**	-0.126***	0.00107**	17,315	0.066
Restaurants, Hotels	0.0210***	-0.00471*	-0.0839***	0.000387*	7,931	0.069
Other	-0.0194	0.000250	-0.169**	0.000494**	1,365	0.094

Robust standard errors in parentheses

*** p< 0.01, ** p< 0.05, * p< 0.1

Table 8: Annual Analysis: Firm IRR and PCGDP

Purchasing Power Parity (PPP) adjusted per capita GDP (PCGDP) is calibrated using the PPP adjusted GDP(rgdpo) and the population (pop) estimate from the Penn World Table 9.0. Size is the inflation adjusted book value of the firm's asset in US dollar, and leverage is the ratio between the book value of liability and the assets. Price-to-Book measures the ratio between the market and the book value of the firm equity. Industry dummies are included in the regression but are not reported.

	log(PCGDP)	log(size)	Leverage	Price-to-Book
1997	0.0786***	-0.00267	-0.0655***	8.87e-05*
1998	0.0553***	0.0118***	0.0258	0.00171***
1999	-0.0431***	-0.0202***	-0.442***	0.000586***
2000	-0.0239***	0.00242	-0.0526**	0.000447
2001	0.0223***	0.0154***	-0.0334**	0.00101***
2002	-0.0194***	0.00202	0.0131	0.000163*
2003	0.0840***	-0.00765***	-0.308***	0.000238
2004	0.0494***	-0.0164***	-0.202***	2.64e-05
2005	0.00699	0.0225***	-0.129***	0.000885
2006	-0.0764***	-0.00294**	-0.144***	0.000880***
2007	-0.108***	0.00313*	-0.269***	0.000539**
2008	-0.0244***	-0.00520***	0.156***	5.30e-05
2009	0.00671	0.0273***	-0.334***	0.00956***
2010	-0.0658***	-0.0106***	-0.136**	0.00119**
2011	0.0496***	-0.00447***	0.000452	9.99e-05
2012	0.0234***	0.0111***	-0.0470***	0.000270***
2013	0.0856***	-0.00529***	-0.140***	3.27e-05
2014	-0.0441***	-0.000912	-0.171***	0.000502

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 9: Robustness Check: log(PHGDP) vs. ROA and IRR

Purchasing Power Parity (PPP) adjusted per hour GDP (PHGDP) is calibrated using the PPP adjusted GDP(rgdpo), employment (emp) and the average hours worked (avh) estimate from the Penn World Table 9.0. Size is the inflation adjusted book value of the firm's asset in US dollar, and leverage is the ratio between the book value of liability and the assets. Price-to-Book measures the ratio between the market and the book value of the firm equity. Time dummies and industry dummies for the 48 Fama-French Industries are included in all regressions. Standard deviation is reported in the parenthesis.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ROA	ROA	ROA	ROA	IRR	IRR	IRR	IRR
	97-14	11-14	11-14 (IFRS)	06-14 (EU)	97-14	11-14	11-14 (IFRS)	06-14 (EU)
log(PHGDP)	-0.0225***	-0.0192***	-0.00116	-0.00460**	0.00405***	0.0320***	0.0256***	-0.00713
	(0.000256)	(0.000479)	(0.00133)	(0.00189)	(0.00122)	(0.00199)	(0.00560)	(0.00808)
log(size)	0.00951***	0.00827***	0.00876***	0.0137***	0.000703**	0.000599	-0.000498	0.0117***
	(8.54e-05)	(0.000152)	(0.000206)	(0.000268)	(0.000352)	(0.000553)	(0.000771)	(0.000935)
Leverage	-0.0313***	-0.0330***	-0.00667**	-0.0223***	-0.121***	-0.0969***	-0.121***	-0.0865***
	(0.00184)	(0.00191)	(0.00332)	(0.00322)	(0.00770)	(0.00755)	(0.0129)	(0.0108)
Price-to-Book	-1.97e-05**	-2.11e-05*	-7.50e-05**	-5.69e-05***	0.000198**	8.93e-05	0.000420***	0.000265***
	(7.95e-06)	(1.25e-05)	(3.01e-05)	(1.98e-05)	(8.07e-05)	(7.75e-05)	(0.000160)	(6.86e-05)
Constant	0.0686***	0.0697***	-0.0336*	-0.0269*	0.121***	-0.0430	0.0804	0.0802*
	(0.00357)	(0.00689)	(0.0185)	(0.0148)	(0.0161)	(0.0322)	(0.101)	(0.0474)
Observations	315,373	80,077	35,935	32,130	315,373	80,077	35,935	32,130
R-squared	0.132	0.126	0.140	0.119	0.059	0.028	0.019	0.141
Time Dummies	Y	Y	Y	Y	Y	Y	Y	Y
Industry Dummies	Y	Y	Y	Y	Y	Y	Y	Y

Robust standard errors in parentheses

*** p< 0.01, ** p< 0.05, * p< 0.1

Table 10: Robustness Check: Tax Adjustment

Purchasing Power Parity (PPP) adjusted per capita GDP (PCGDP) is calibrated using the PPP adjusted GDP(rgdpo) and the population (pop) estimate from the Penn World Table 9.0. Size is the inflation adjusted book value of the firm's asset in US dollar, and leverage is the ratio between the book value of liability and the assets. Price-to-Book measures the ratio between the market and the book value of the firm equity. Time dummies and industry dummies for the 48 Fama-French Industries are included in all regressions. Standard deviation is reported in the parenthesis.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ROA	ROA	ROA	ROA	IRR	IRR	IRR	IRR
	97-14	11-14	11-14 (IFRS)	06-14 (EU)	97-14	11-14	11-14 (IFRS)	06-14 (EU)
log(PCGDP)	-0.0129***	-0.00667***	-0.00262**	-0.00388**	0.00252*	0.0322***	0.0119*	-0.0174
	(0.000211)	(0.000381)	(0.00103)	(0.00196)	(0.00144)	(0.00226)	(0.00617)	(0.0114)
log(size)	0.000452***	-0.000223**	-0.000437***	-0.000628***	-0.00387***	-0.00292***	-0.00335***	-0.000911
	(6.00e-05)	(0.000105)	(0.000144)	(0.000199)	(0.000348)	(0.000562)	(0.000923)	(0.00103)
Leverage	-0.0503***	-0.0506***	-0.0525***	-0.0401***	-0.115***	-0.101***	-0.123***	-0.101***
	(0.000736)	(0.00142)	(0.00264)	(0.00266)	(0.00472)	(0.00870)	(0.0172)	(0.0131)
Price-to-Book	-8.42e-05***	-0.000251***	-0.000391*	-1.81e-05	0.00198***	0.00585***	0.00992**	0.000703
	(2.94e-05)	(9.05e-05)	(0.000220)	(2.52e-05)	(0.000542)	(0.00183)	(0.00498)	(0.000568)
Constant	0.226***	0.176***	0.124***	0.154***	0.138***	-0.267***	-0.0476	0.396***
	(0.00319)	(0.00609)	(0.0152)	(0.0223)	(0.0203)	(0.0304)	(0.0879)	(0.127)
Observations	211,407	54,075	21,260	20,556	211,407	54,075	21,260	20,556
R-squared	0.088	0.071	0.062	0.045	0.081	0.071	0.079	0.185
Time Dummies	Y	Y	Y	Y	Y	Y	Y	Y
Industry Dummies	Y	Y	Y	Y	Y	Y	Y	Y

Robust standard errors in parentheses

*** p< 0.01, ** p< 0.05, * p< 0.1

Table 11: Summary Statistics: Capital Friction and Investment-Capital Ratio

$$DK_{c,t,i,f} = \frac{-adj\Delta Asset_{c,t,i,f} + \Delta MVA_{c,t,i,f}}{MVA_{c,t-1,i,f}} - infl_{c,t}$$
$$IKRatio_{c,t,i,f} = \left(\frac{adj\Delta Asset_{c,t,i,f}}{(MVA_{c,t-1,i,f})(1 + infl_{c,t})} \right)$$

$DK_{c,t,i,f}$ is the ratio between the sum of change in the market value of asset less the change in the book value of asset and the market value of asset from the previous year adjusted for the CPI inflation. $IKRatio_{c,t,i,f}$ is the ratio between the change in the book value of asset market value of asset adjusted for the CPI inflation.

		DK			IKRatio		
		Mean	Median	SD	Mean	Median	SD
Australia	AUS	0.180	-0.043	0.922	0.139	0.057	0.487
Austria	AUT	-0.032	-0.050	0.254	0.093	0.070	0.190
Brazil	BRA	-0.033	-0.057	0.262	0.087	0.067	0.179
Belgium	BEL	-0.044	-0.092	0.305	0.147	0.104	0.220
Canada	CAN	0.064	-0.049	0.613	0.155	0.081	0.385
Chile	CHL	-0.045	-0.076	0.271	0.118	0.089	0.206
China	CHN	0.085	-0.050	0.548	0.112	0.071	0.181
Colombia	COL	-0.068	-0.106	0.325	0.187	0.126	0.265
Czech Republic	CZE	-0.101	-0.110	0.234	0.104	0.089	0.171
Denmark	DNK	-0.015	-0.059	0.318	0.087	0.059	0.202
Finland	FIN	-0.007	-0.043	0.288	0.079	0.054	0.185
France	FRA	-0.021	-0.050	0.281	0.096	0.067	0.181
Germany	DEU	-0.018	-0.046	0.319	0.079	0.058	0.212
Greece	GRC	0.046	-0.074	0.775	0.095	0.062	0.225
Hong Kong	HKG	0.085	-0.062	0.730	0.175	0.091	0.507
Hungary	HUN	-0.105	-0.123	0.283	0.117	0.095	0.246
India	IND	-0.059	-0.131	0.397	0.163	0.110	0.250
Indonesia	IDN	-0.039	-0.109	0.418	0.172	0.103	0.324
Ireland	IRL	0.056	-0.025	0.514	0.104	0.071	0.254
Israel	ISR	0.012	-0.046	0.396	0.082	0.056	0.236
Italy	ITA	-0.049	-0.060	0.212	0.092	0.059	0.212
Japan	JPN	-0.025	-0.046	0.229	0.049	0.043	0.124
Malaysia	MYS	-0.045	-0.072	0.291	0.096	0.070	0.211
Mexico	MEX	-0.042	-0.063	0.254	0.113	0.099	0.178
Netherlands	NLD	-0.010	-0.041	0.288	0.089	0.064	0.197
New Zealand	NZL	-0.003	-0.042	0.312	0.086	0.055	0.240
Norway	NOR	0.012	-0.049	0.437	0.134	0.081	0.320
Peru	PER	0.003	-0.066	0.466	0.148	0.093	0.259
Philippines	PHL	0.014	-0.069	0.496	0.121	0.075	0.284
Poland	POL	-0.011	-0.067	0.438	0.133	0.085	0.307
Portugal	PRT	-0.053	-0.069	0.180	0.109	0.068	0.214
Russia	RUS	-0.111	-0.141	0.377	0.192	0.147	0.261
Singapore	SGP	-0.015	-0.069	0.383	0.110	0.074	0.250
South Africa	ZAF	-0.025	-0.070	0.364	0.139	0.095	0.345
South Korea	KOR	-0.023	-0.075	0.364	0.138	0.094	0.284
Spain	ESP	-0.015	-0.044	0.250	0.110	0.069	0.227
Sweden	SWE	0.052	-0.022	0.471	0.100	0.056	0.277
Switzerland	CHE	0.012	-0.021	0.285	0.057	0.044	0.168
Thailand	THA	0.007	-0.056	0.352	0.106	0.078	0.191
Turkey	TUR	-0.085	-0.133	0.423	0.187	0.131	0.257
United Kingdom	GBR	0.018	-0.046	0.468	0.107	0.060	0.296
United States	USA	0.045	-0.036	0.518	0.089	0.059	0.230
MSCI		0.015	-0.055	0.472	0.105	0.065	0.265
MSCI Developed		0.007	-0.048	0.375	0.100	0.064	0.241
MSCI Emerging		-0.034	-0.087	0.386	0.133	0.094	0.243

Table 12: Testing Capital Accumulation Frictions

qIK is the square of $IKratio$, which is the ratio between the change in the book value of asset and the market value of asset adjusted for the CPI inflation. Purchasing Power Parity (PPP) adjusted per hour GDP (PHGDP) is calibrated using the PPP adjusted GDP(rgdpo), and population (pop) estimates from the Penn World Table 9.0. Size is the inflation adjusted book value of the firm's asset in US dollar, and leverage is the ratio between the book value of liability and the assets. Price-to-Book measures the ratio between the market and the book value of the firm equity. Time dummies and industry dummies for the 48 Fama-French Industries are included in all regressions. Standard deviation is reported in the parenthesis.

	(1)	(2)	(3)	(4)
	DK	DK	DK	DK
	97-14	97-14	97-14 (25th)	97-14 (25th)
qIK	0.206***	-0.221**	0.137***	-0.804***
	(0.00872)	(0.0907)	(0.00130)	(0.0238)
qIK*log(PCGDP)		0.0409***		0.0912***
		(0.00902)		(0.00227)
log(size)	-0.00849***	-0.00854***	0.00157***	0.00144***
	(0.000327)	(0.000327)	(0.000219)	(0.000220)
Leverage	-0.0801***	-0.0793***	0.0251***	0.0260***
	(0.00496)	(0.00493)	(0.00250)	(0.00251)
Price-to-Book	0.000227**	0.000227**	0.000927***	0.000924***
	(8.98e-05)	(8.97e-05)	(7.58e-06)	(7.61e-06)
Constant	0.120***	0.121***	-0.103***	-0.102***
	(0.0146)	(0.0146)	(0.0111)	(0.0111)
Observations	335,465	335,465	335,465	335,465
R-squared	0.104	0.104		
Time Dummies	Y	Y	Y	Y
Industry Dummies	Y	Y	Y	Y

	(5)	(6)	(7)	(8)
	DK	DK	DK	DK
	97-14 (50th)	97-14 (50th)	97-14 (75th)	97-14 (75th)
qIK	-0.0663***	-0.850***	0.576***	-0.354***
	(0.00128)	(0.0235)	(0.00237)	(0.0414)
qIK*log(PCGDP)		0.0753***		0.0884***
		(0.00224)		(0.00396)
log(size)	0.00679***	0.00665***	-0.00434***	-0.00446***
	(0.000215)	(0.000217)	(0.000398)	(0.000383)
Leverage	0.176***	0.177***	-0.190***	-0.190***
	(0.00246)	(0.00247)	(0.00455)	(0.00437)
Price-to-Book	3.19e-05***	2.95e-05***	0.0184***	0.0184***
	(7.44e-06)	(7.49e-06)	(1.38e-05)	(1.32e-05)
Constant	-0.374***	-0.371***	0.185***	0.187***
	(0.0109)	(0.0110)	(0.0201)	(0.0193)
Observations	335,465	335,465	335,465	335,465
R-squared				
Time Dummies	Y	Y	Y	Y
Industry Dummies	Y	Y	Y	Y

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 13: Macroeconomic factors and Productive Efficiency

Labor force participation rate and unemployment rate is from the World Bank database. Labor Utilization is calibrated as the product of labor force and (1-unemployment rate). Median age and the triadic patent data is from the UN database, and Human Capital Index is from the Penn World Table 9.0. Financial Development Index is from International Monetary Fund, and Institution Quality is an average of the six World Governance Indicators from the World Bank

		Labor Force (%)	Unemployment Rate (%)	Labor Utilization	Human Capital Index	Median Age	Financial Development Index	Triadic Patents	Institution Quality
Australia	AUS	64.43	5.83	0.61	3.48	36.19	0.86	355	1.59
Austria	AUT	59.55	4.99	0.57	3.21	40.07	0.67	317	1.60
Belgium	BEL	52.60	7.81	0.48	3.04	40.18	0.66	435	1.33
Brazil	BRA	68.77	10.98	0.61	2.30	27.30	0.57	53	0.01
Canada	CAN	66.16	7.33	0.61	3.58	38.33	0.82	579	1.63
Chile	CHL	57.07	7.84	0.53	2.89	30.56	0.47	6	1.14
China	CHN	73.92	4.38	0.71	2.28	32.18	0.48	558	(0.52)
Colombia	COL	66.00	13.13	0.57	2.29	25.41	0.31	3	(0.48)
Czech Republic	CZE	59.54	6.87	0.55	3.60	38.70	0.35	19	0.82
Denmark	DNK	65.09	5.40	0.62	3.38	39.60	0.74	276	1.83
Finland	FIN	60.80	9.49	0.55	3.24	40.76	0.63	332	1.89
France	FRA	55.57	9.83	0.50	2.99	38.87	0.73	2,511	1.21
Germany	DEU	59.01	8.16	0.54	3.61	42.23	0.76	5,802	1.50
Greece	GRC	52.62	13.19	0.46	2.85	40.18	0.57	13	0.61
Hong Kong	HKG	60.71	4.77	0.58	2.98	38.98	0.76	26	1.31
Hungary	HUN	50.05	8.07	0.46	3.13	39.25	0.48	38	0.84
India	IND	57.78	3.96	0.55	1.88	24.34	0.41	166	(0.26)
Indonesia	IDN	67.38	7.72	0.62	2.29	25.77	0.32	2	-0.63
Ireland	IRL	60.50	8.01	0.56	2.95	33.51	0.79	65	1.51
Israel	ISR	62.30	9.85	0.56	3.43	28.96	0.57	333	0.60
Italy	ITA	48.39	9.41	0.44	2.89	41.86	0.77	756	0.66
Japan	JPN	60.90	4.46	0.58	3.43	43.20	0.78	15,135	1.15
Malaysia	MYS	61.56	3.25	0.60	2.75	25.16	0.62	15	0.36
Mexico	MEX	61.12	3.89	0.59	2.52	24.57	0.35	15	(0.11)
Netherlands	NLD	64.00	4.28	0.61	3.21	39.14	0.79	1,158	1.73
New Zealand	NZL	66.73	5.44	0.63	3.26	35.47	0.62	57	1.77
Norway	NOR	65.75	3.56	0.63	3.47	37.85	0.69	108	1.72
Peru	PER	72.05	6.46	0.67	2.68	24.32	0.30	0	(0.30)
Philippines	PHL	65.51	8.70	0.60	2.52	21.44	0.35	3	(0.36)
Poland	POL	55.53	12.85	0.48	3.13	36.73	0.42	24	0.68
Portugal	PRT	60.92	8.31	0.56	2.28	39.50	0.68	14	1.10
Russia	RUS	61.53	8.12	0.57	3.22	37.25	0.43	75	(0.73)
Singapore	SGP	65.78	4.02	0.63	2.87	35.81	0.72	94	1.50
South Africa	ZAF	54.14	24.61	0.41	2.32	24.24	0.55	35	0.32
South Korea	KOR	60.92	3.83	0.59	3.34	35.15	0.79	1,527	0.67
Spain	ESP	56.23	15.78	0.47	2.73	38.96	0.87	195	1.01
Sweden	SWE	63.33	7.22	0.59	3.27	40.12	0.74	784	1.76
Switzerland	CHE	67.81	3.82	0.65	3.59	40.11	0.97	947	1.76
Thailand	THA	73.08	1.52	0.72	2.41	32.65	0.54	7	(0.05)
Turkey	TUR	48.53	9.15	0.44	2.12	26.65	0.44	14	(0.15)
United Kingdom	GBR	62.00	6.10	0.58	3.60	38.76	0.89	1,843	1.49
United States	USA	64.84	6.07	0.61	3.64	36.20	0.87	14,212	1.32

Table 14: Macroeconomic factors and Capital Efficiency

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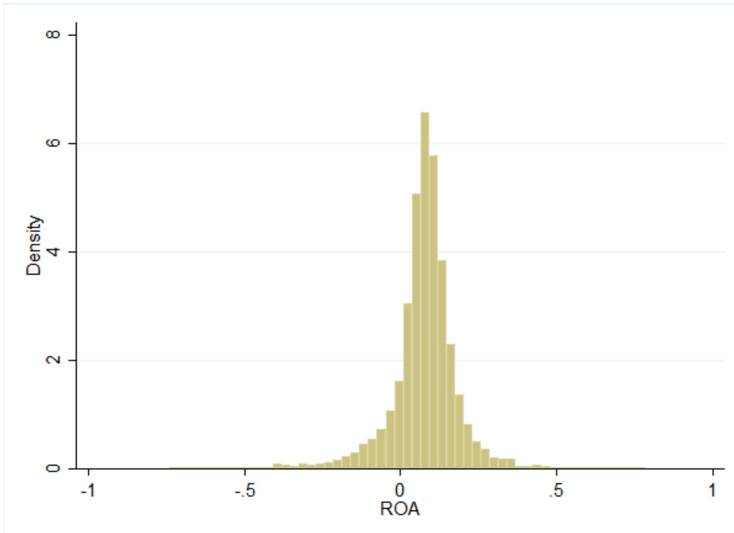
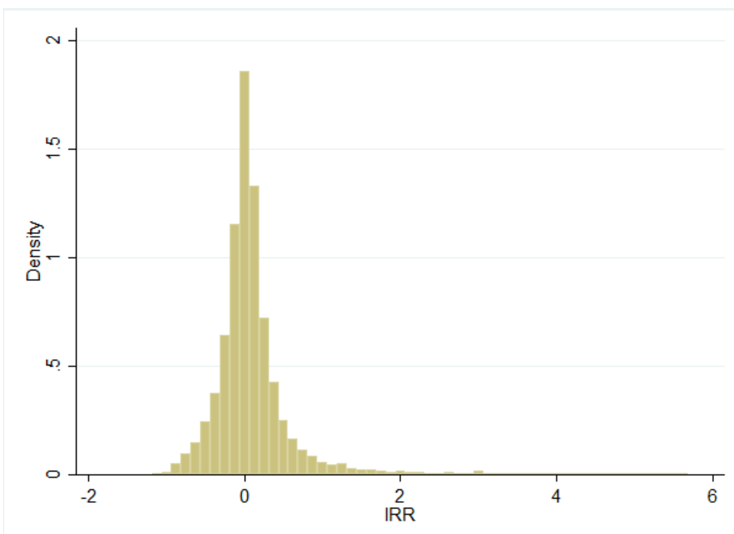
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Years	97-14	97-14	97-14	97-14	97-14	97-14	97-14
qIK	-0.201**	-0.653***	0.439***	0.693***	0.921***	-0.620***	0.473***
	(0.0851)	(0.0991)	(0.102)	(0.200)	(0.149)	(0.115)	(0.119)
qIK*log(PCGDP)	0.0399***	0.00342	-0.0405***	-0.0600***	-0.129***	0.131***	-0.105***
	(0.00844)	(0.00980)	(0.0110)	(0.0220)	(0.0204)	(0.0196)	(0.0187)
qIK*Labor Utilization Rate		1.409***					
		(0.138)					
qIK*Triadic Patents			0.00728***				
			(0.000619)				
qIK*Institution Quality				0.115***			
				(0.0234)			
qIK*FDI					0.813***		
					(0.0900)		
qIK*Median Age						-0.0145***	
						(0.00293)	
qIK*HCI							0.261***
							(0.0279)
Constant	0.115***	0.111***	0.113***	0.109***	0.116***	0.111***	0.113***
	(0.0146)	(0.0145)	(0.0145)	(0.0146)	(0.0146)	(0.0145)	(0.0146)
Observations	335,465	335,465	335,465	335,465	335,465	335,465	335,465
R-squared	0.113	0.116	0.119	0.113	0.116	0.114	0.117
Time Dummies	Y	Y	Y	Y	Y	Y	Y
Industry Dummies	Y	Y	Y	Y	Y	Y	Y

8 Figures

Figure 1: ROA and IRR distribution plot

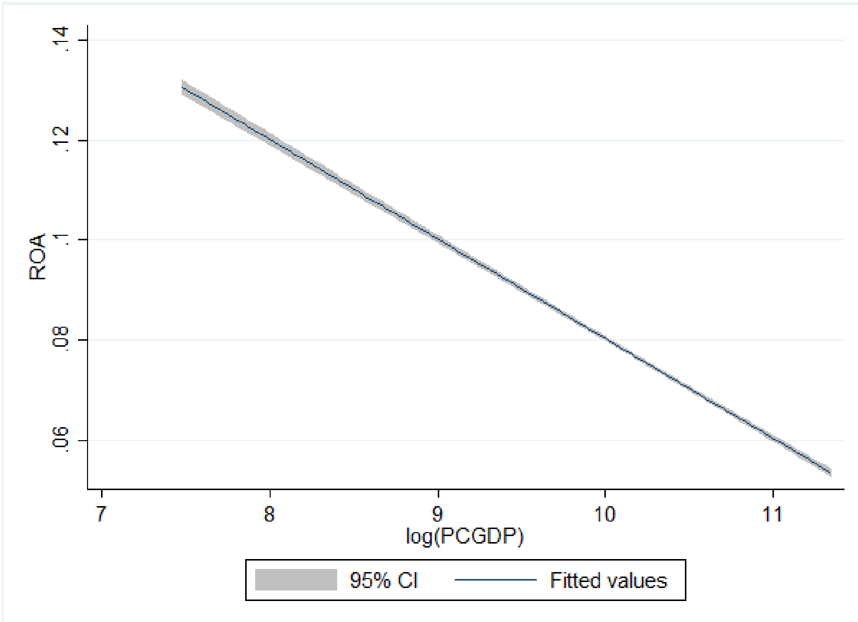


(a) ROA distribution

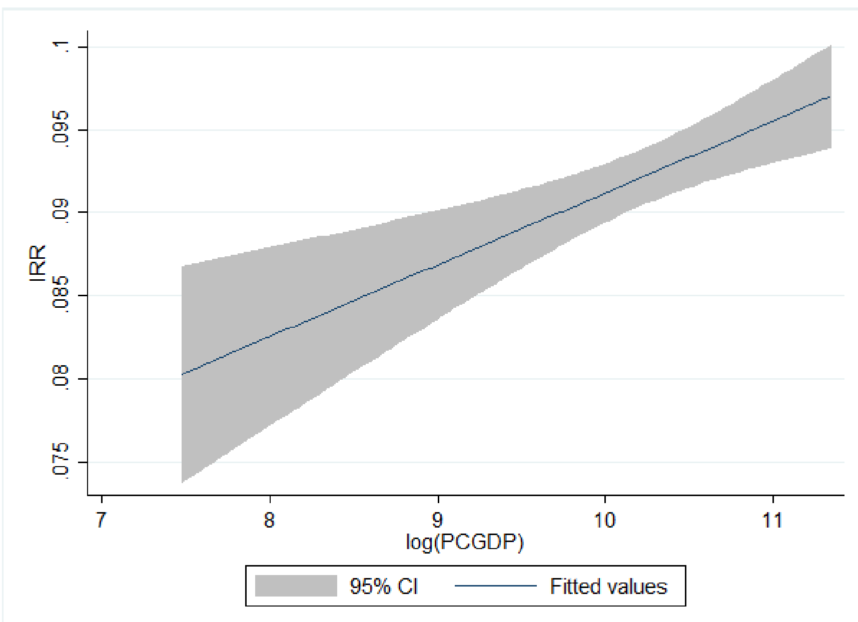


(b) IRR distribution

Figure 2: ROA and IRR two-way plot

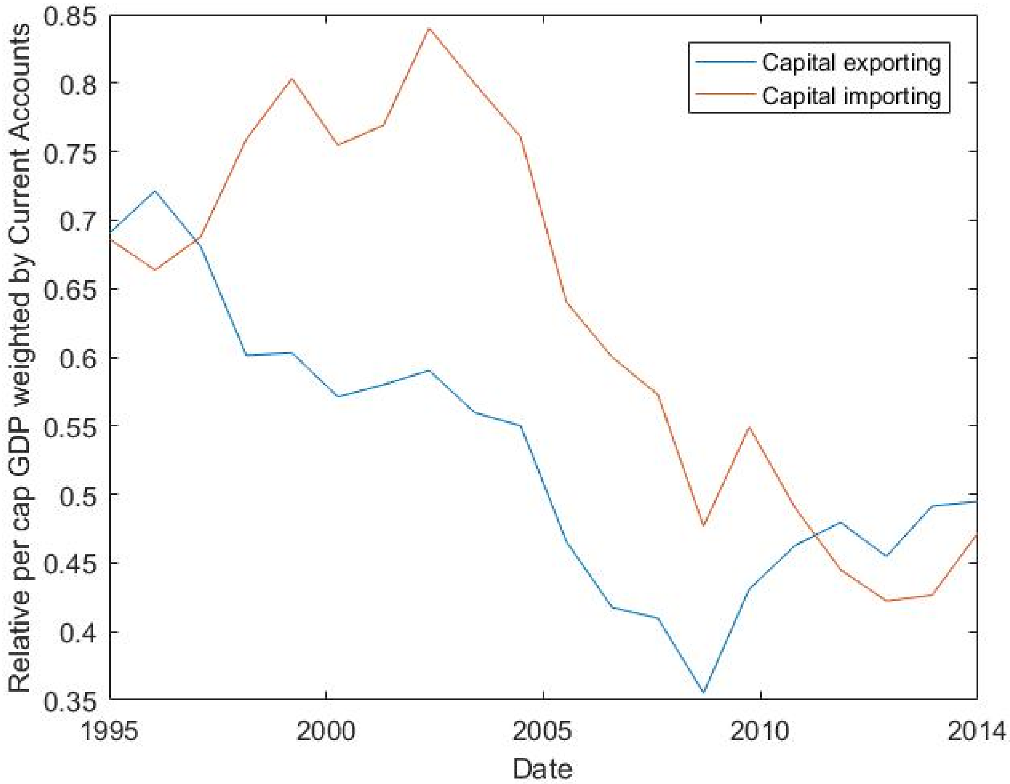


(a) ROA and log(PCGDP) two-way plot



(b) IRR and log(PCGDP) two-way plot

Figure 3: Relative Incomes of Capita-exporting and Capital-importing Countries



Notes: "For each year, we separate our sample of countries into two groupsthose with current account surpluses and those with deficits in that year. For the first group, we then take each countrys share of the total current account surplus accounted for by all countries in that group. We then multiply that share by the relative PPP-adjusted per capita income of that country (measured relative to the per capita income of the richest country in the sample in that year). This gives us a current account-weighted measure of the relative incomes of surplus countries. We do the same for current account deficit countries. This enables us to compare the relative incomes of surplus versus deficit countries in each year." (Prasad, et al (2006)