The Cross-Country Marginal Product of Capital and the Great Recession

By: Logan McGuigan

University of California, Santa Barbara

Advisor: Javier Birchenall

Abstract

Why capital does not flow more heavily into poorer countries with lower capital-labor ratios is a question that development economists have been asking for decades. Caselli and Feyrer (2007) developed adjusted marginal product of capital (MPK) models that are very similar across rich and poor countries, proving that capital is indeed allocated efficiently across the world and there are no major frictions preventing optimal allocation of capital. This paper uses updated and improved national accounts data to replicate the methodology set forth in Caselli and Feyrer (2007), testing the long-term validity of their conclusions as well as the effects of the Great Recession on international capital flows between developed and developing countries. I find that while the Great Recession negatively impacted MPKs in both rich and poor countries, capital flows and output growth have since recovered, and MPKs are still very similar across all countries. This study provides support for Caselli and Feyrer's conclusions on the causes of low capital-labor ratios in poorer countries, as well as the view that capital is indeed allocated efficiently across countries.

I. Introduction

In a world where we have a fully efficient, free-trading and competitive international capital market, standard neoclassical production models imply capital would flow from countries with a lower marginal product of capital (MPK) to countries with a higher MPK, up until all countries have near equal MPKs. This, in theory, would remove deadweight loss in the international capital market and thus increase the gross world product, as capital would be efficiently allocated across countries. Standard assumptions under the neoclassical production model – countries produce the same goods with the same constant to returns scale production function with the same two factors of production (capital and labor) – imply that any difference in production per worker lies in differing levels of capital per worker. As poor and developing countries tend to have far lower capital-labor ratios than do developed countries (as exhibited in the data used in this paper), one would assume those same countries to have higher marginal products of capital as well. If this were the case in our efficient and free-trading market, capital would be invested in poorer countries, until those countries' diminishing marginal returns from capital are equalized with those of more developed countries. Thus, each unit of capital invested across the world is producing maximized output.

Obviously, capital is not solely invested in poorer countries. In fact, most investment occurs in developed countries that are already more productive and have relatively higher capital-labor ratios. If the MPKs do vary substantially between richer and poorer countries, it would seem our global GDP, or gross world product, is indeed experiencing a deadweight loss due to the inefficient allocation of capital. Our neoclassical production model implies MPKs in these richer countries receiving capital investments are lower, and thus we are not producing maximized global output. From this, the question arises if the world would increase its production and become more

efficient by flowing capital from developed to developing countries. If this is not the case, why is it that our production model suggests these poorer countries would produce more output per unit of investment?

Development economists have offered theories as to what factors cause capital flows to fall so far short of what our neoclassical production theory suggests. Many have pointed towards the presence of international capital market frictions that inhibit efficient cross-country allocation. Others have pointed out that poorer countries with lower capital-labor ratios have lower endowments of total factor productivity (TFP), human capital, and other complementary factors to physical capital. These economists suggest that MPKs may be equalized across developed and developing countries with differing capital-labor ratios – it's just that the standard neoclassical model does not account for these important complementary differences. Caselli and Feyrer (2007) attempted to develop a "true" estimate of cross-country MPKs by adjusting the standard MPK equation to account for factors that cause these differences across rich and poor countries. They found that when the MPK equation is adjusted to account for just reproducible capital (i.e. excluding land and natural resources from capital share) as well as the relative price of capital in each country, MPKs across developing and developed countries are nearly equalized. Caselli and Feyrer (2007) concludes that international credit frictions are not the reason for differences in capital-labor ratios – their equalized MPK calculations negated this theory. Instead, they reason capital is indeed efficiently allocated globally, and that wide variances in capital-labor ratios are largely caused by differences between rich and poor countries in both the portion of capital stock that is reproducible, as well as the relative price of capital to consumer goods in a country as two important factors that lead to large variances in capital-labor ratios.

This paper provides an extension to Caselli and Feyrer (2007) to examine the differences in cross-country MPK following the Great Recession. In an exercise to assess whether Caselli and Feyrer's adjusted MPK model still produces near-equalization, I use updated and improved data from the Penn World Tables and the World Bank to run the various adjusted MPK models outlined by Caselli and Feyrer across 114 developed and developing countries. In my results, I find that Caselli and Feyrer's "fully-adjusted" MPK model still produces approximately equal calculations between rich and poor countries in 2014, following deviation in output and capital flows caused by the Great Recession. These results validate and provide longer-term implications to the conclusions in Caselli and Feyrer (2007).

II. Literature Review

In his famed 1990 article "Why Doesn't Capital Flow from Rich to Poor Countries?", Robert Lucas was one of the first economists to raise the puzzle as to why capital doesn't flow from rich to poor countries, even though the poorer countries have lower capital-labor ratios. Lucas highlights how neoclassical economic production theory suggests that capital would flow into these less productive (and poorer) countries with lower amounts of capital per worker, as the Law of Diminishing Returns implies these poorer countries have higher MPKs than do richer countries that already have high amounts of capital per worker. In what has since become known by economists as the "Lucas paradox," he outlines that this is not at all true in looking at international capital flows in global markets. Lucas offers several possible explanations as to why the neoclassical model does not hold true, and what assumptions need to be considered to reflect the true state of the international capital markets.

Lucas argues that there are fundamental differences that affect the production structure of developed and developing countries in varied ways. For example, the gap in human capital between rich and poor countries can lead to differences in capital-labor ratios not reflected in our production model. That is, the labor factor of this model doesn't consider the quality of labor or knowledge of each worker. Richer countries tend to have better-educated laborers that earn higher wages, are more skilled, and thus are more productive. These richer countries also have far higher levels of technology and efficiency, a factor which gives them a higher total factor productivity than poorer countries. Lucas also considers that there are imperfections, or frictions, in the international capital market. For example, poorer countries are much more likely to default on a debt payment, and investing in developing countries comes with a higher level of risk and uncertainty of returns, both of which companies and governments consider when investing internationally. Another issue considered when investing internationally is the higher degree of asymmetric information than when dealing domestically – and this is especially true when money is flowing from a developed country to a developing one. The neoclassical model assumes perfect information, and the lack of it could skew the model's convergence of returns between poor and rich economies.[1]

Caselli and Feyrer (2007) attempt to answer the question posed in Lucas (1990) by developing cross-country estimates of MPKs from macroeconomic data on total income, the value of the capital stock, and the capital share in income in individual countries. Caselli and Feyrer develop a new, simplified but rational method to generate cross-country MPK estimates. Previous methods compared interest rates across countries, regressed ΔY on ΔK for different sets of

[1] Asymmetric information and its relevance to the Lucas paradox are explained in detail in Alfaro, Kalemli-Ozcan, and Volosovych (2008)

countries, or used calibration to assign values to factors complementary to return on capital. Caselli and Feyrer felt these methods (which garnered varying results) often relied on unrealistic and ambitious assumptions, so they developed a more direct approach to arrive at comparable MPK estimates between countries.

This paper applies the methodology employed in Caselli and Feyrer (2007) to new data up to 2014, in an exercise to study the effects of the Great Recession on capital distribution and international marginal products of capital. Their full approach will be explained in further detail in ensuing sections, as their adjustments to the MPK equation will be applied to new and improved data. Broadly, they took the standard neoclassical Cobb-Douglas production function under perfectly competitive capital market conditions, where the rental rate of capital is equal to the MPK, so $MPK \times K$ equals total capital income (where K is the capital stock). Accordingly, the standard MPK calculation, where α is the capital share of GDP and Y is real GDP, is:

$$MPK = a\frac{Y}{K}.$$

Caselli and Feyrer calculate four separate variations of this model using available data on a set of 53 countries. In these different calculations, they adjust the measurement of capital share in GDP, α, from the standard calculation of one minus the labor share in GDP to an estimate of the reproducible-capital share in income. Using one minus the labor share as the "capital share" in GDP includes payments accruing to non-reproducible capital, such as land and natural resources, as well as to reproducible (or physical) capital. Meanwhile, the capital stock, *K*, is usually calculated using the perpetual inventory method from investment flows, which only represents reproducible capital stock. So, Caselli and Feyrer reason that using one minus the labor share in GDP will overestimate the marginal productivity of *K* (which is solely reproducible capital), which in turn will exaggerate all differences in MPK. More importantly, agriculture and

natural resource sectors represent a far larger share of GDP in poorer countries than in rich countries, so the overestimate of MPK would be much higher in those poorer countries.

A second adjustment Caselli and Feyrer make to the standard MPK model is to account for the fact that the relative price of capital compared to the price of normal consumption goods is far higher in poorer countries than it is in richer countries. When both this relative price correction and capital share correction to just reproducible capital stock are made, they found that MPKs across developing and developed countries are quite similar, despite their large difference in capital-labor ratios and "unadjusted" MPKs. In looking at the results from their adjusted model, Caselli and Feyrer concluded that international financial markets are indeed efficient in allocating capital across countries, and there is little deadweight loss in global GDP due to misallocation of capital. Consequently, they dismissed the idea that developing countries are low on capital due to credit-market frictions, and offered a revision to the view in Lucas (1990) that developing countries continue to have lower capital per worker because they are inefficient users of the already low levels of complementary factors they have. While these differences certainly play a role, Caselli and Feyrer conclude that other very important proximate causes in the lack of capital flows to poorer countries are that those countries' shares of reproducible capital in GDP is lower, and their domestic prices of capital goods relative to consumer goods is far higher. These findings held implications in that they suggest increasing aid flows to poorer countries would not necessarily impact their capital stocks and outputs meaningfully.

There have been further applications of the ideas presented by Lucas (1990) and Caselli and Feyrer (2007) to examine capital flows' impact in the growth of a developing country. Gourinchas and Jeanne (2013) takes the Lucas paradox one step further and looks at the allocation of capital flows between developing countries. They find that capital doesn't flow more into

developing countries with higher growth and investment rates, as one would assume from the neoclassical growth model. Dubbing this the "allocation puzzle," they conclude that the allocation of capital flows in developing countries is driven by national saving and international reserves, not an economy's growth or investment rates.

While Caselli and Feyrer concluded that capital is efficiently allocated internationally when adjusting for certain factors, much has changed in the global economy since. The Great Recession caused declines in output and potential deviation in international capital flows. Further, new and improved data on capital stock and labor shares in GDP are available that were not a decade ago. This paper will use this new data and employ Caselli and Feyrer's methodology to assess whether their conclusions still hold true, and what factors have varied over time in cross-country differences in MPK.

III. Theoretical Discussion

The primary motivation behind revisiting the MPK framework laid out by Caselli and Feyrer (2007) with updated and improved data is to examine how the Great Recession affected capital flows between developed and developing economies, how the decline in output along with potential deviations in capital flows affected the validity of Caselli and Feyrer's adjusted MPK models, and whether the adjustments still equalize marginal products of capital following recovery from the Great Recession. The Great Recession directly impacted highly industrialized countries the most, as this is where output declines were most prevalent. Many developing economies were not directly affected in that their real outputs did not fall, at least to the extent in which output fell in many developed countries. However, indirect effects potentially caused many of these countries to lose funding for capital growth.

While the "Lucas paradox" holds true in that poorer, non-industrialized countries do not receive the amounts of international capital inflows as production theory would predict, many developing countries (often the ones with less growth than others) do depend on capital inflows from richer countries to fund economic development.[2] During a recession, Foreign Direct Investment declines, so developing countries can potentially lose money and loans coming from abroad. Developing economies with the highest growth often have their own sovereign wealth fund to use in this event, but many poorer countries do not. Even high-growth emerging markets can be indirectly affected by recession, as they are often highly dependent on export revenues, which fall due to falling prices and lower demand from abroad, thus causing GDP growth to fall.[3] Both lack of capital investment and decline in GDP growth can affect MPK calculations, so it is of interest to look at marginal products of capital during and after the recession.

In an analysis of the Great Recession's effect on the United States, Ohanian (2010) finds that the decline in output and income in the U.S. during the recession was solely due to a drop in the labor input. Deviation from steady state in capital markets was exceptionally small in the U.S. during the recession, while labor markets were affected far more.[4] This suggests that there may exist an MPK decline in highly developed countries impacted by the recession due primarily to decline in output, if the U.S. is reflective of those other countries. Whether this impacts the balance of MPK calculations across countries remains to be seen. The most current calculations using 2014 data will determine if Caselli and Feyrer's MPK adjustments still equalize between rich and poor countries.

---

[2] This is a point stressed in Gourinchas and Jeanne (2013) as a cause of the "allocation puzzle"
[3] Nabli (2011)
[4] Ohanian (2010) uses data on labor, capital, and marginal rates of substitution for both labor and capital during equilibrium times and during the Great Recession to show the U.S. was primarily impacted by distortions in labor supply during the recession

IV. Methodology

The principal models to compare cross-country MPKs using Penn World Table data on GDP, capital stock, price levels of capital and output, and capital shares are based on Caselli and Feyrer's alterations to the MPK equation, $MPK = \alpha\frac{Y}{K}$. Our first, non-adjusted measurement of MPK, dubbed by Caselli and Feyrer as the most "naïve" cross-country measurement, is:

$$MPKN = a_w \frac{Y}{K}.$$

In this formula, *MPKN* is the naïve estimate of MPK, α_w is one minus the labor share, *Y* is real GDP at current PPPs, and *K* is capital stock at current PPPs (more information as to how these numbers are calculated by the Penn World Tables will be provided in the Data section). As previously mentioned, Caselli and Feyrer reasoned that the standard method of obtaining capital share (as done above; one minus the labor share in GDP) overestimated and skewed results between countries. Our capital stock measure, *K*, is calculated in a method that only reflects reproducible capital share and not land and natural capital – both of which one minus the labor share would reflect in capital share. So, our first alteration to this model is to line up the capital share to reflect the calculations of *K*. As the perpetual inventory method creates a calculation for capital stock based on investment data (and thus does not represent capital stock in the form of land and natural resources), the capital share in GDP is adjusted to represent an estimate of just reproducible capital share in GDP. This gives us our second estimate of MPK:

$$MPKL = a_k \frac{Y}{K}.$$

Here, *MPKL* stands for "land and natural resource corrected" MPK, in which only reproducible capital is accounted for in the estimated of marginal product of capital. With an accurate estimate

of the reproducible capital share in GDP, this adjustment in theory corrects the discrepancy between the estimates of capital stock and capital share in GDP.

The *MPKN* and *MPKL* calculations do, however, ignore a second major issue that Caselli and Feyrer (2007) identified as a cause of bias when comparing marginal returns between countries – the relative price of capital varies between countries and currencies. The cost to purchase a unit of capital is generally far more expensive in relativity to domestic consumer goods in poor countries than it is in rich countries. This higher relative cost of installing aggregate capital in poorer countries could be a vital factor as to why capital does not flow to them as much as production models would suggest. Caselli and Feyrer (2007) noted that a perfectly efficient and frictionless capital market would mean all parties have access to an alternative investment with an equal rate of return across the world, and that frictionless international capital markets imply the value of the MPK of any final good, divided by the price of capital, has to be constant across all countries.[5] So to correct for the relative price of final-to-capital goods, they developed a third and fourth estimate of MPK, where the capital prices are calculated in relation to consumer prices in each country. Adjusting the MPK to account for relative capital prices can take away this cross-country price discrepancy of capital and equalize MPK values of final goods across countries. This is done by altering the first two MPK estimators to include P_y/P_k, which is a measure of each country's price level of final goods relative to their price level of capital. Our third estimator of MPK considers this while keeping the "naïve" estimation of the capital share:

$$PMPKN = \frac{a_w P_y Y}{P_k K}.$$

[5] Caselli and Feyrer (2007) illustrate a proof for why this assumption must hold when testing the hypothesis of an efficient and frictionless international capital market

P_yY is therefore real GDP at domestic prices, while P_kK is the capital stock at domestic prices. The prefix "*P*" stands for "price-corrected", as designated by Caselli and Feyrer (2007). Employing both the price adjustment and the previous adjustment of capital share to reflect only reproducible capital, we arrive at our final estimate of MPK, the "fully adjusted" model:

$$PMPKL = \frac{a_k P_y Y}{P_k K}.$$

The *PMPKL* estimate is the one where Caselli and Feyrer found very similar marginal products of capital between developing and developed countries, eliminating the disparity between the two groups of countries under the original *MPKN* estimation. Using new and improved data from 2000-2014 as outlined in the following section, we will see how these assumptions and inputs hold up during and after the period of the Great Recession.

V. Data

The raw input data for the years 2000-2014 is taken from the most recent release of the Penn World Tables, Version 9.0,[6] which has far more expansive data on capital, labor, and output than did the Version 6.1 used by Caselli and Feyrer (2007). All data is in 2011 U.S. dollars, and price levels are relative to the respective 2011 U.S. price level equaling 1. *Y* is output-side GDP in purchasing power parity (PPP). *K*, the capital stock, is also calculated in current PPP. α_w, which represents one minus the labor share in GDP, is calculated from the Penn World Tables (PWT) statistic of shares of labor compensation in GDP at national prices.

It is worth nothing that when Caselli and Feyrer wrote their paper published in 2007, the Penn World Tables did not include information on capital stock or the labor share of GDP. Caselli

[6] Feenstra, Inklaar and Timmer (2015)

and Feyrer calculated the capital stock themselves using the perpetual inventory method (PIM) from time series data on real investment that is included in the PWT Version 6.1 they used, while they got their labor shares of GDP from Bernanke and Gürkaynak (2001). First introduced in Version 8.0, the PWT has since added their own calculations of capital stock and labor share of GDP to their data – largely influenced and motivated by the work of Caselli (2005) and Caselli and Feyrer (2007).

The Penn World Tables also use the PIM to calculate current capital stock, but they differ in their approach in calculating the initial capital stock to arrive at that figure. Briefly, Caselli and Feyrer's approach follows what in the past has been considered standard – they computed initial capital stock using the steady-state relationship from the Solow growth model:

$$K_0 = \frac{I_0}{g + d},$$

where the initial capital stock K_0 is equal to the value of the investment series the first year it is available (as far back as 1950 for some countries), g is the average geometric growth rate for the investment series, and δ is the depreciation rate.[7] The Penn World Tables, the reasoning of which is explained in further detail in Inklaar and Timmer (2013), assume an initial capital/output ratio for each economy to derive their initial capital stock, which they estimate as $K_0 = Y_0 \times k$. Y_0 is GDP in the initial year investment data is available and k is the assumed capital/output ratio, K/Y. This method, they argue, provides more accurate estimates for developing countries whose earlier years may have been tumultuous and where past data is not available for an extended period. Caselli and Feyrer's method to compute initial capital stock assumes the economy was in a steady state at the time investment data became available, which may not hold true for many of these

[7] This method of computing initial capital stock through use of the steady-state relationship in the Solow growth model was first proposed by Harberger (1978)

countries. Further, while Caselli and Feyrer assumed a constant depreciation rate δ at 0.06 across the world (an assumption they admitted could raise potential bias), the new PWT data splits up total investment by asset, which lets them calculate varying depreciation rates on fixed capital across countries and over time. In doing so, the PWT can also calculate a capital PPP to compare capital stocks across countries, which is a more accurate rate of comparison than the investment PPP used in Caselli and Feyrer's model.

In the computation of labor share of income in GDP, the Penn World Table builds on the approach laid out in Gollin (2002), the same work in which Bernanke and Gürkaynak built upon in their computations used by Caselli and Feyrer. The following table, taken from Inklaar and Timmer (2013), outlines all differences in calculations between the new PWT data and that used by Caselli in his 2005 and 2007 papers.

Table 1

Area	PWT8.0	Caselli (2005)
Capital		
Investment	By asset	Only total
Depreciation rate	Varies across countries and time	Common across countries and time
PPP	Capital PPP	Investment PPP
Initial capital stock	Based on initial capital/output ratio	Based on steady-state assumption
Capital measure	Capital stock	
Labor share	Varies across countries and time	Common across countries and time
Labor input		
Employment	Number of persons engaged	
Human capital	Average years of schooling and assumed rate of return	

Source: Inklaar and Timmer (2013)

The Penn World Table, starting with Version 8.0, built upon and improved the cross-country comparability of the calculation methods used by Caselli. The PWT also employed Caselli and Feyrer's ideology behind capital share, and now include a share of gross capital formation in GDP, which is the payments towards fixed, physical assets, while ignoring non-produced assets

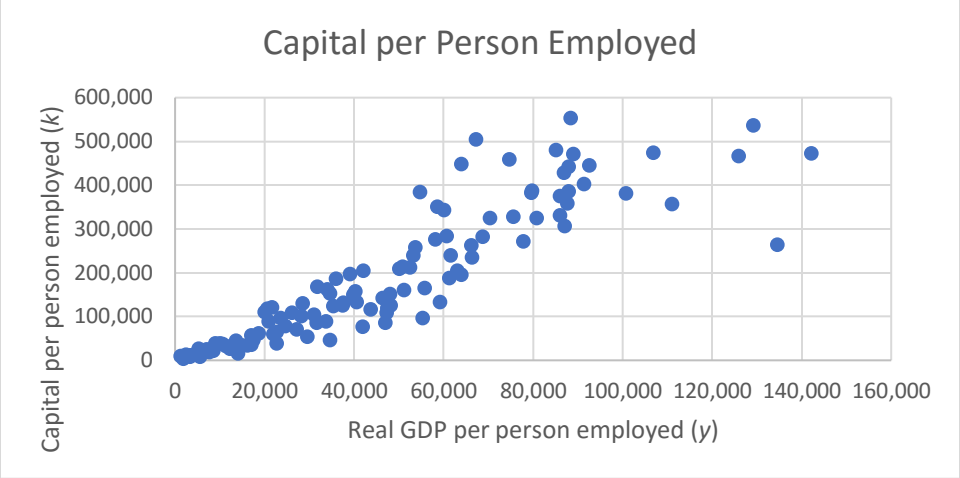
such as land and subsoil assets. This share of GDP can be used as an estimate of the share of reproducible capital in a country's GDP, and utilized as a proxy for α_k. This share in GDP is derived from World Bank Wealth Accounting Data on total and natural wealth, roughly the same approach used by Caselli.[8]

The final piece of data I will be using, P_y/P_k, also comes from PWT 9.0. P_y is the price level of output-side real GDP, while P_k is the price level of capital formation. These are the same measures from the PWT employed by Caselli and Feyrer to eliminate the relative price differences of physical capital between countries in calculating adjusted MPKs.

The Penn World Tables have obviously viewed Caselli's past works as influential and important in development accounting, and have worked to build upon his and others' methodologies to provide more comparable and accurate world data. There is now far more data available than a decade ago, which permits me to utilize a larger sample size of countries in my MPK calculations. My full dataset includes 15 years of data from a total of 114 countries, which is all countries with the necessary available data, less select island nations, city-states, and a few sparsely populated outlier countries. 2014 MPK calculations and input data for each individual country are provided in Appendix Table A1. Summary means and standard deviations of the MPK calculations in all countries (expressed as percentage returns) for all years 2000-2014 are provided in Appendix Table A2. Figure 1 below shows the relationship between 2014 real GDP per person employed and capital per person employed (each dot being a country in the dataset), while Figure 2 plots the relative prices of capital against real GDP per person employed in 2014.

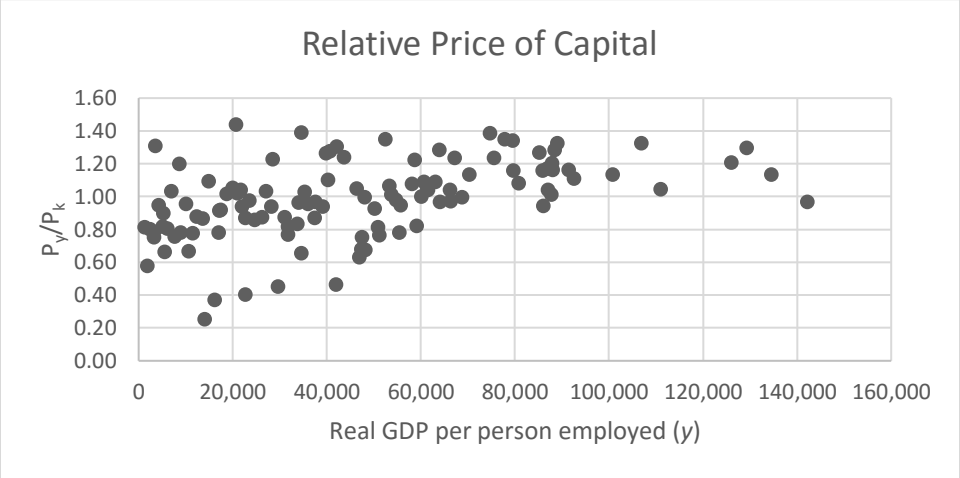
[8] World Bank (2016)

Figure 1



Source: Author calculations using data from Feenstra, Inklaar and Timmer (2015)

Figure 2



Source: Author calculations using data from Feenstra, Inklaar and Timmer (2015) and methodology from Caselli and Feyrer (2007)

As expected, there is a strong positive correlation between real GDP per worker and capital per worker – countries with higher output have more capital per person. The P_y/P_k number becomes higher as the relative price of capital to output declines, so the slight positive correlation between this metric and real GDP per person makes sense in theory and bodes well for our adjusted MPK calculations – capital is relatively cheaper in richer countries.

VI. Results

The MPK calculations using 2014 data largely supports the framework set forth by Caselli and Feyrer (2007). Using data as much as 18 years apart from the data used in their paper, the results prove that the fully adjusted MPK model essentially accounts for all discrepancies in marginal products of capital between rich and poor countries – while poorer countries do tend to have far higher capital to labor ratios (and lower capital to output ratios – see Figure 1), their adjusted MPKs are very close to those of rich countries, with little deviation. Table 2 below shows the average marginal products in 2014 for all 4 MPK models, divided into richer and poorer countries.

Table 2

Average Return to Capital, Poor vs. Rich countries

	Poor countries	**Rich countries**
MPKN (s.d.)	17.22 (8.20)	11.75 (5.94)
PMPKN (s.d.)	14.65 (5.99)	13.21 (6.69)
MPKL (s.d.)	7.13 (2.13)	5.70 (1.73)
PMPKL (s.d.)	6.45 (2.75)	6.43 (2.02)

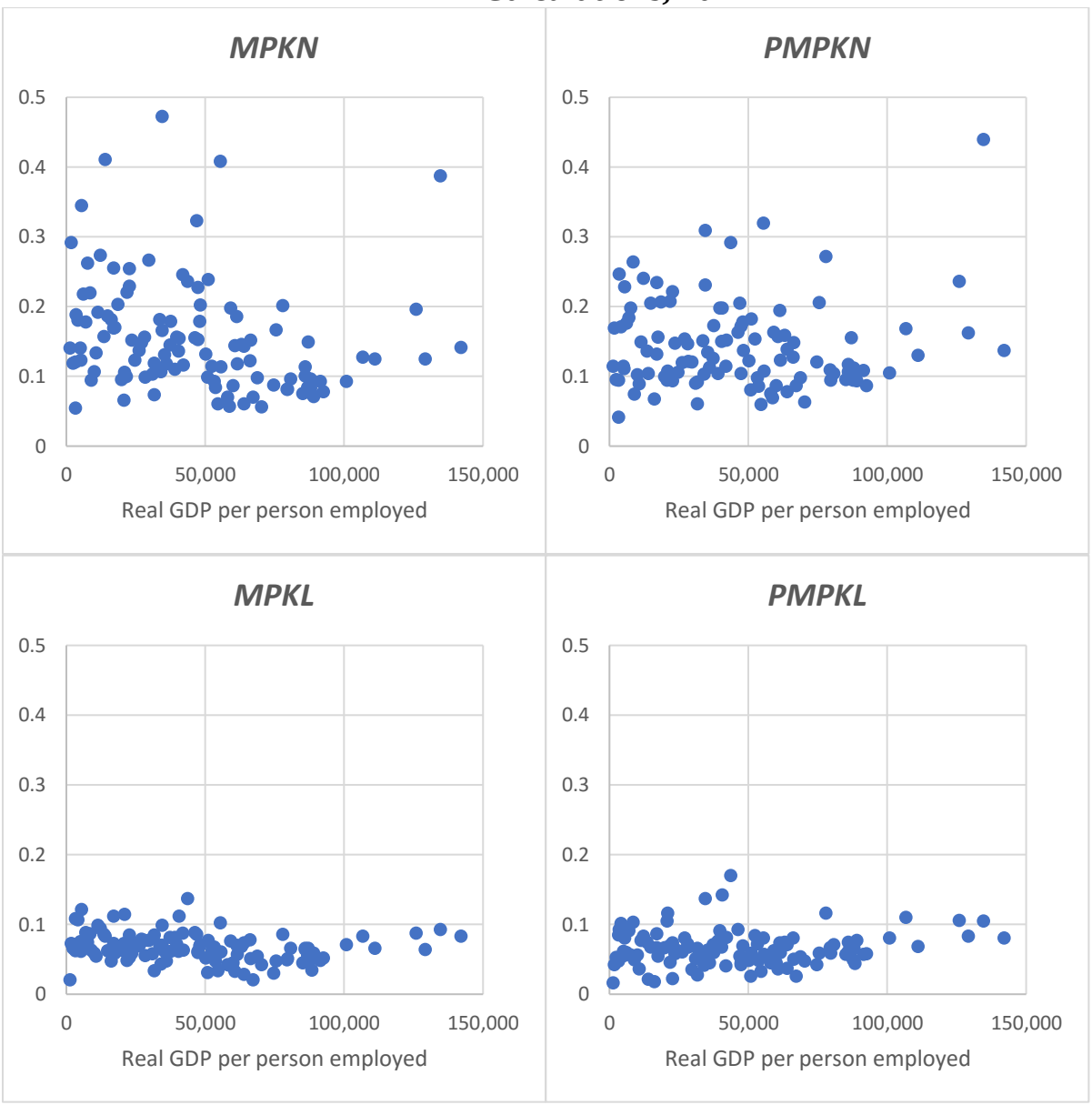
Numbers expressed as percentage returns to capital. "Rich" countries considered all countries in data used with a real GDP per person employed at or above the level of Croatia's (and less than for "Poor" countries). Standard deviations in parentheses.

The price- and capital share-adjusted *PMPKL* model is remarkably similar between poor and rich countries in 2014, while the unadjusted *MPKN* model is significantly higher in poor countries. The two intermediary adjustments bring poor and rich countries' marginal products closer to equal, to varying degrees and deviations. The differences in MPK between these rich and poor countries are significantly different at the 1% for the *MPKN* and *MPKL* calculations, while the *PMPKN* and *PMPKL* calculations are not different at conventional levels of significance.

Figure 3 below plots all four MPK calculations for 2014 against real GDP per person employed, while Appendix Table A1 provides a detailed list of all calculations for 2014 for the 114 countries in the dataset. In Figure 3, the reduced variance with each adjustment in MPK calculation is evident, up until the difference between poor and rich countries is near zero in the *PMPKL* model.

Figure 3

MPK Calculations, 2014



MPKN is "naïve" MPK estimate; *PMPKN* is adjusted for relative price of capital; *MPKL* is land and natural resource corrected; *PMPKL* has both adjustments.

Source: Author calculations using data from Feenstra, Inklaar and Timmer (2015) and methodology from Caselli and Feyrer (2007).

When comparing these 2014 rich vs. poor country results in Table 2 versus the same results in Caselli and Feyrer (2007), there are some findings worth noting. You can see the comparison of my calculations from Table A2 against Caselli and Feyrer's averages between their set of rich and poor countries in Appendix Table A3.

Of course, Caselli and Feyrer used a smaller sample size of countries, didn't split between rich and poor nations exactly where my data splits (due to smaller sample size and different data on GDP per worker), and used statistics that were in part calculated from differing methods, but a few similarities and differences are significant. Their *PMPKL* averages for rich and poor countries were 8.5% and 6.9% respectively, while their *MPKN* calculations have an average of 11.4% for rich countries and 27.2% for poor countries. These numbers differentiate from each other less in my results in large part due to changes in capital-output ratios. Caselli and Feyrer's rich countries had an average capital to output ratio of 2.74, while their poor countries' average was 1.51. My 2014 data (using an updated calculation method for capital stock) has an average of 4.38 for rich countries and 3.29 for developing countries.[9] The 2014 data has numerically higher and proportionally closer capital-output ratios than did the data from Caselli and Feyrer (2007), which helps explain the smaller MPKs in more recent calculations – the larger this ratio, the smaller the MPK (all else the same).

Both the *PMPKN* and *PMPKL* (price-adjusted) models are quite similar between poor and rich countries – more so than in Caselli and Feyrer's calculations. The decrease in relative price of capital to consumer goods in poorer countries has contributed to this – the P_y/P_k metric for rich countries in my 2014 data has an average 1.14, while it averages 0.90 in poor countries. Caselli and Feyrer's average for their rich countries was 1.12, but only 0.60 for their group of poor

[9] Author calculations from Feenstra, Inklaar and Timmer (2015) and Caselli and Feyrer (2007)

countries. As this metric was calculated from the same database under the same method as it was in Caselli and Feyrer (2007), this is a direct reflection of the increase in relative price of capital in poorer economies.

Throughout the 15 years of data collected, capital-output ratio has steadily increased, and with it MPK calculations have steadily declined. The rise in capital-output ratio is illustrated graphically in Appendix Figure A1, and average MPK calculations across all 15 years is shown in Appendix Table A2. During 2009, widely considered the trough of the Great Recession in terms of economic decline, MPK calculations (both adjusted and non-adjusted) sharply decreased from the previous year (as illustrated in Appendix Figure A2, the average fully adjusted *PMPKL* across all countries from 2000-2014). This sharp decline is principally attributable to the lack of GDP growth between 2008 and 2009 – particularly in richer countries.

Average GDP per worker across the entire set of 114 countries declined 3.15%, but when dividing the countries again into richer and poorer countries (based on real GDP per worker), the effect of the recession on output (and consequently marginal product of capital) in developed economies can really be seen. Real GDP per person employed in the set of poorer countries increased by 2.3% from 2008 to 2009, while it dropped by 4.2% in the richer countries. This fall in output led to an 18.7% decrease for richer countries in the fully-adjusted *PMPKL* model (for reference, this MPK model averaged a 0.5% yearly decrease across all countries studied from 2000-2014). Curiously though, the poor countries' *PMPKL* model also dropped 14.9% between 2008 and 2009, just a year after it experienced a slight increase. Much of this decrease for poor countries is not caused by a decrease in output as was the case for the richer countries, but rather due to a 12.7% decrease in the average *reproducible* capital share (α_k) in 2009. The previous year, there was a 5.4% increase in this metric for the same set of poorer countries. Appendix Table A4

illustrates these growth rates for poor and rich countries for the fully-adjusted *PMPKL* calculations along with its data inputs.

The accelerated decreases in our adjusted marginal product of capital models were caused by different underlying factors in richer and poorer countries during the Great Recession, and it is important to take note that the recession directly impacted only developed economies when interpreting why this happened. GDP fell in developed economies which directly led to lower marginal products of capital, and the resulting slowdown in foreign direct investment into many developing countries led to a decline in the reproducible capital share of GDP in poorer countries. It is understandable why this number went down, as this looks to be an indirect trickle effect from investment slowdowns from developed countries.

VII. Conclusions

These results for marginal product of capital calculations both during and after the Great Recession shed some light on to how the recession varied in its impact between developed economies and poorer countries. Caselli and Feyrer's framework of MPK equalization models between rich and poor countries still holds true following the Great Recession, as output and capital flows have returned to their respective growth paths after deviating from the norm during the recession.

The near-equalization of the fully adjusted MPK models across countries speaks to the validity of Caselli and Feyrer's theories that international financial markets are efficient both in capital allocation and in recovery from deviation. The improved data calculations from the Penn World Tables, in part influenced by the work of Caselli, strengthen the assumption that increasing

aid flows to developing countries is not an efficient means to jumpstart those countries' capital stocks and income, as they do not truly have a higher marginal product of capital.

The effects of the Great Recession on our MPK models aligns with the hypothesis that as the recession directly impacted more developed and richer countries, it indirectly hindered capital flows to poorer countries. These results suggest those poorer countries are slightly dependent on flows from richer countries to fund capital formation, although not at the level the neoclassical production model implies. As a result, marginal products of capital declined in poor countries as well as rich countries during the Great Recession, even though there was no decline in output among poorer countries.

These findings open research avenues to extend this study to recessions in the past that contain the relevant data for a wide selection of countries. While the Great Recession is far and away the largest recession that has this relevant data, smaller recessions in the past few decades could be studied to determine the significance of general recessions in Caselli and Feyrer's adjusted MPK calculations and capital flows to developing economies. Doing so could determine the statistical significance of deviations in capital flows and marginal products of capital during recessions.

References

Alfaro, Laura, Sebnem Kalemli-Ozcan and Vadym Volosovych. 2008. "Why Doesn't Capital Flow from Rich to Poor Countries? An Empirical Investigation." *Review of Economics and Statistics*, 90 (2): 347-368.

Bernanke, Ben S., and Refet S. Gürkaynak, "Is Growth Exogenous? Taking Mankiw, Romer, and Weil Seriously." *NBER Macroeconomics Annual 2001*, edited by Ben S. Bernanke and Kenneth Rogoff. (Cambridge, MA: MIT Press, 2002), 11-72.

Caselli, Francesco, 2005, "Accounting for Cross-Country Income Differences," *Handbook of Economic Growth*, Volume 1A, Phillipe Aghion and Steven N. Durlauf (eds.), Amsterdam: Elsevier, 679-741.

Caselli, Francesco, and James Feyrer. 2007. "The Marginal Product of Capital." *Quarterly Journal of Economics* 122(2), 535-68.

Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2015), "The Next Generation of the Penn World Table" *American Economic Review*, 105(10), 3150-3182.

Gollin, Douglas, "Getting Income Shares Right," *Journal of Political Economy*, CX (2002), 458- 474.

Gourinchas, Pierre-Olivier and Olivier Jeanne "Capital Flows to Developing Countries: The Allocation Puzzle," *Review of Economic Studies* 2013; 80(4), 1484-1515.

Harberger, Arnold (1978), "Perspectives on Capital and Technology in Less Developed Countries" in Michael J. Artis and Avelino R. Nobay (eds.), *Contemporary Economic Analysis*, Croom Helm: London.

Inklaar, Robert, and Marcel Timmer, ''Capital, Labor and TFP in PWT8.0,'' unpublished manuscript, University of Groningen, 2013.

Monge-Naranjo, Alexander. "Currency Returns During the Financial Crisis and Great Recession," *Economic Synopses*, No. 4, 2014.

Nabli, Mustapha K. 2011. *The Great Recession and Developing Countries: Economic Impact and Growth Prospects*. Washington DC: The World Bank.

Ohanian, Lee E. 2010. "The Economic Crisis from a Neoclassical Perspective." *Journal of Economic Perspectives*, 24(4), 45-66.

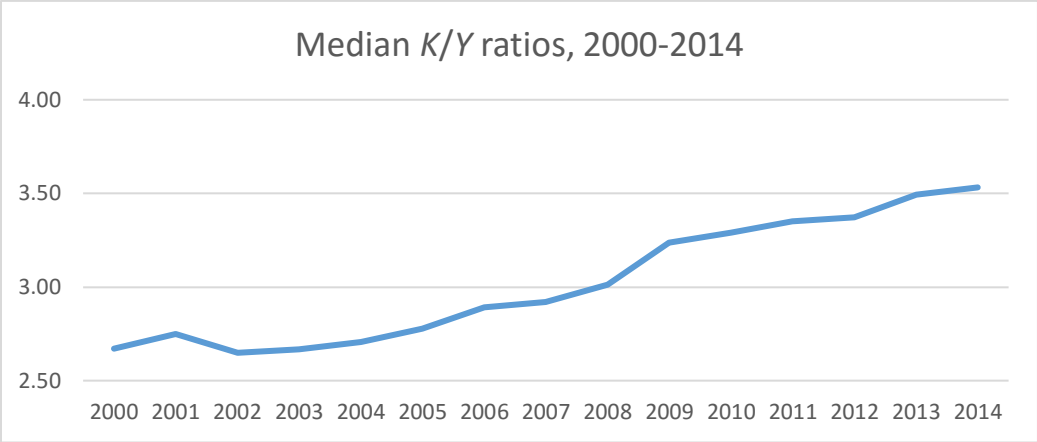
Prasad, Eswar, Raghuram G. Rajan, and Arvind Subramanian, 2007, "Foreign Capital and Economic Growth," *Brookings Papers on Economic Activity*: 1 (Washington, Brookings Institution), pp. 153–230.

The World Bank, Wealth Accounting. Last Updated 03-Jun-2016. Retrieved from http://data.worldbank.org/data-catalog/wealth-accounting.

Appendix

Figure A1

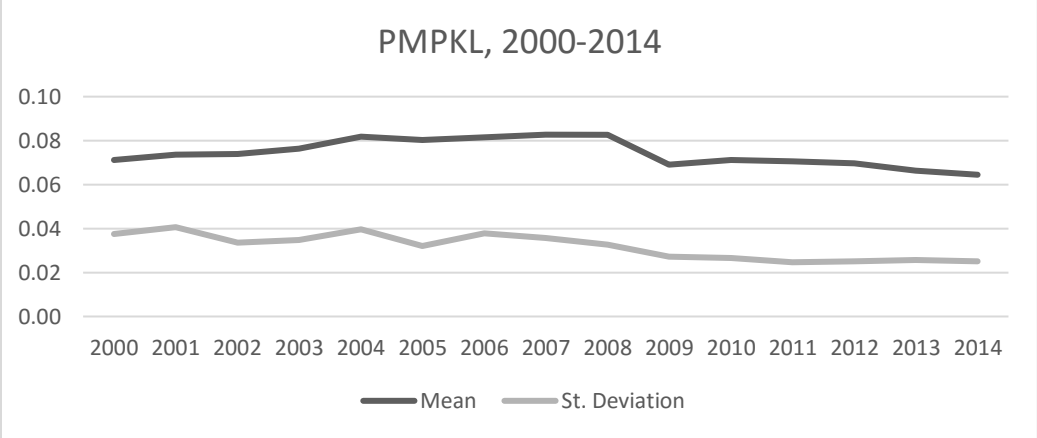
Median Capital-Output Ratio, 2000-2014



Source: Author calculations using data from Feenstra, Inklaar and Timmer (2015).

Figure A2

***PMPKL* Averages, 2000-2014**



Source: Author calculations using data from Feenstra, Inklaar and Timmer (2015) and methodology from Caselli and Feyrer (2007).

Table A1

Data and MPK Estimates, 2014

code	country	y	k	α_w	α_k	P_y/P_k	MPKN	PMPKL	MPKL	PMPKL
ARG	Argentina	47,513	118,698	0.57	0.15	0.75	**0.23**	**0.17**	**0.06**	**0.04**
ARM	Armenia	22,806	36,610	0.37	0.08	0.40	**0.23**	**0.09**	**0.05**	**0.02**
AUS	Australia	86,047	329,659	0.43	0.25	0.94	**0.11**	**0.11**	**0.06**	**0.06**
AUT	Austria	86,996	427,737	0.41	0.27	1.17	**0.08**	**0.10**	**0.05**	**0.06**

BDI	Burundi	1,844	2,482	0.39	0.10	0.58	**0.29**	**0.17**	**0.07**	**0.04**
BEL	Belgium	89,122	469,573	0.37	0.30	1.33	**0.07**	**0.09**	**0.06**	**0.08**
BEN	Benin	5,156	14,165	0.38	0.20	0.82	**0.14**	**0.11**	**0.07**	**0.06**
BFA	Burkina Faso	4,253	10,737	0.45	0.27	0.95	**0.18**	**0.17**	**0.11**	**0.10**
BGR	Bulgaria	33,812	87,474	0.47	0.18	0.83	**0.18**	**0.15**	**0.07**	**0.06**
BHR	Bahrain	75,588	325,867	0.71	0.20	1.23	**0.17**	**0.20**	**0.05**	**0.06**
BIH	Bosnia and Herzegovina	55,800	163,172	0.33	0.17	0.95	**0.11**	**0.11**	**0.06**	**0.06**
BLR	Belarus	41,998	75,329	0.44	0.16	0.46	**0.24**	**0.11**	**0.09**	**0.04**
BOL	Bolivia	12,345	24,397	0.54	0.18	0.88	**0.27**	**0.24**	**0.09**	**0.08**
BRA	Brazil	28,552	128,933	0.44	0.25	1.23	**0.10**	**0.12**	**0.05**	**0.07**
BWA	Botswana	34,638	151,267	0.72	0.43	1.39	**0.17**	**0.23**	**0.10**	**0.14**
CAF	Central African	1,371	8,187	0.84	0.12	0.81	**0.14**	**0.11**	**0.02**	**0.02**
CAN	Canada	80,886	323,837	0.38	0.26	1.08	**0.10**	**0.10**	**0.06**	**0.07**
CHE	Switzerland	100,825	380,357	0.35	0.27	1.13	**0.09**	**0.10**	**0.07**	**0.08**
CHL	Chile	48,151	149,676	0.55	0.21	1.00	**0.18**	**0.18**	**0.07**	**0.07**
CHN	China	21,056	86,902	0.43	0.47	1.02	**0.10**	**0.11**	**0.11**	**0.12**
CIV	Côte d'Ivoire	8,648	20,598	0.52	0.20	1.20	**0.22**	**0.26**	**0.09**	**0.10**
CMR	Cameroon	6,145	14,058	0.50	0.17	0.81	**0.22**	**0.18**	**0.07**	**0.06**
COL	Colombia	24,731	76,397	0.38	0.22	0.86	**0.12**	**0.11**	**0.07**	**0.06**
CRI	Costa Rica	27,165	69,599	0.38	0.20	1.03	**0.15**	**0.15**	**0.08**	**0.08**
CYP	Cyprus	74,784	456,825	0.53	0.18	1.38	**0.09**	**0.12**	**0.03**	**0.04**
CZE	Czech Republic	60,225	341,954	0.49	0.25	1.00	**0.09**	**0.09**	**0.04**	**0.04**
DEU	Germany	87,744	356,784	0.38	0.20	1.01	**0.09**	**0.09**	**0.05**	**0.05**
DJI	Djibouti	20,746	116,846	0.37	0.41	1.44	**0.07**	**0.09**	**0.07**	**0.10**
DNK	Denmark	87,988	384,622	0.36	0.24	1.20	**0.08**	**0.10**	**0.05**	**0.07**
DOM	Dominican	31,121	102,572	0.34	0.19	0.88	**0.10**	**0.09**	**0.06**	**0.05**
ECU	Ecuador	28,334	100,192	0.55	0.27	0.94	**0.16**	**0.15**	**0.08**	**0.07**
EGY	Egypt	34,612	45,624	0.62	0.09	0.65	**0.47**	**0.31**	**0.07**	**0.05**
ESP	Spain	85,241	479,139	0.42	0.25	1.27	**0.07**	**0.09**	**0.04**	**0.06**
EST	Estonia	53,375	238,242	0.41	0.30	1.06	**0.09**	**0.10**	**0.07**	**0.07**
FIN	Finland	79,750	386,086	0.39	0.24	1.16	**0.08**	**0.09**	**0.05**	**0.06**
FRA	France	92,575	443,125	0.37	0.25	1.11	**0.08**	**0.09**	**0.05**	**0.06**
GBR	United Kingdom	79,628	381,478	0.39	0.23	1.34	**0.08**	**0.11**	**0.05**	**0.07**
GEO	Georgia	29,691	51,799	0.46	0.13	0.45	**0.27**	**0.12**	**0.08**	**0.03**
GRC	Greece	67,270	502,747	0.52	0.15	1.23	**0.07**	**0.09**	**0.02**	**0.02**
GTM	Guatemala	21,970	58,348	0.58	0.13	0.94	**0.22**	**0.21**	**0.05**	**0.05**
HKG	Hong Kong	88,039	440,964	0.48	0.28	1.16	**0.10**	**0.11**	**0.06**	**0.06**
HND	Honduras	10,167	36,586	0.38	0.21	0.95	**0.11**	**0.10**	**0.06**	**0.06**
HRV	Croatia	58,174	274,617	0.33	0.20	1.08	**0.07**	**0.07**	**0.04**	**0.04**
HUN	Hungary	53,822	256,327	0.40	0.22	1.01	**0.08**	**0.08**	**0.05**	**0.05**
IDN	Indonesia	21,708	119,061	0.54	0.36	1.04	**0.10**	**0.10**	**0.07**	**0.07**
IND	India	13,672	44,078	0.50	0.27	0.87	**0.16**	**0.14**	**0.08**	**0.07**
IRL	Ireland	129,314	535,436	0.51	0.26	1.30	**0.12**	**0.16**	**0.06**	**0.08**
IRN	Iran	51,190	158,796	0.74	0.24	0.76	**0.24**	**0.18**	**0.08**	**0.06**
IRQ	Iraq	55,443	95,745	0.70	0.18	0.78	**0.41**	**0.32**	**0.10**	**0.08**
ISL	Iceland	70,362	323,873	0.25	0.19	1.13	**0.06**	**0.06**	**0.04**	**0.05**
ISR	Israel	63,162	202,649	0.46	0.22	1.09	**0.14**	**0.16**	**0.07**	**0.07**
ITA	Italy	88,526	552,395	0.46	0.21	1.29	**0.07**	**0.09**	**0.03**	**0.04**
JOR	Jordan	48,284	123,702	0.52	0.18	0.68	**0.20**	**0.14**	**0.07**	**0.05**
JPN	Japan	68,817	280,624	0.40	0.22	1.00	**0.10**	**0.10**	**0.05**	**0.05**
KAZ	Kazakhstan	46,990	85,120	0.58	0.15	0.63	**0.32**	**0.20**	**0.09**	**0.05**
KEN	Kenya	7,784	17,055	0.57	0.16	0.75	**0.26**	**0.20**	**0.07**	**0.06**
KGZ	Kyrgyzstan	14,112	15,037	0.44	0.09	0.25	**0.41**	**0.10**	**0.08**	**0.02**
KOR	South Korea	66,253	261,647	0.48	0.30	1.04	**0.12**	**0.13**	**0.08**	**0.08**
KWT	Kuwait	134,642	262,743	0.75	0.18	1.13	**0.39**	**0.44**	**0.09**	**0.10**
LAO	Laos	11,487	31,934	0.53	0.27	0.78	**0.19**	**0.15**	**0.10**	**0.08**
LBN	Lebanon	42,170	202,506	0.56	0.30	1.30	**0.12**	**0.15**	**0.06**	**0.08**
LKA	Sri Lanka	31,749	85,121	0.32	0.23	0.77	**0.12**	**0.09**	**0.08**	**0.06**

LSO	Lesotho	9,032	36,539	0.38	0.25	0.78	**0.09**	**0.07**	**0.06**	**0.05**
LTU	Lithuania	66,454	234,441	0.53	0.18	0.97	**0.15**	**0.15**	**0.05**	**0.05**
LVA	Latvia	54,762	383,186	0.42	0.23	0.98	**0.06**	**0.06**	**0.03**	**0.03**
MAR	Morocco	20,031	108,620	0.51	0.34	1.05	**0.09**	**0.10**	**0.06**	**0.07**
MDA	Moldova	16,267	33,418	0.37	0.10	0.37	**0.18**	**0.07**	**0.05**	**0.02**
MEX	Mexico	37,617	129,881	0.61	0.21	0.97	**0.18**	**0.17**	**0.06**	**0.06**
MKD	Macedonia	37,479	123,447	0.47	0.26	0.87	**0.14**	**0.13**	**0.08**	**0.07**
MLT	Malta	52,553	211,086	0.46	0.25	1.35	**0.11**	**0.15**	**0.06**	**0.08**
MNG	Mongolia	26,268	107,472	0.56	0.28	0.87	**0.14**	**0.12**	**0.07**	**0.06**
MRT	Mauritania	17,121	55,566	0.55	0.36	0.78	**0.17**	**0.13**	**0.11**	**0.09**
MUS	Mauritius	39,916	148,378	0.58	0.27	1.27	**0.16**	**0.20**	**0.07**	**0.09**
MYS	Malaysia	46,457	140,713	0.47	0.26	1.05	**0.15**	**0.16**	**0.09**	**0.09**
NAM	Namibia	40,703	131,044	0.50	0.36	1.28	**0.15**	**0.20**	**0.11**	**0.14**
NER	Niger	2,443	11,631	0.56	0.31	0.80	**0.12**	**0.09**	**0.06**	**0.05**
NGA	Nigeria	17,176	34,472	0.51	0.14	0.92	**0.25**	**0.23**	**0.07**	**0.07**
NIC	Nicaragua	10,705	35,739	0.44	0.18	0.67	**0.13**	**0.09**	**0.05**	**0.04**
NLD	Netherlands	91,439	401,167	0.40	0.21	1.16	**0.09**	**0.11**	**0.05**	**0.06**
NOR	Norway	142,220	471,054	0.47	0.27	0.97	**0.14**	**0.14**	**0.08**	**0.08**
NZL	New Zealand	64,087	194,353	0.43	0.22	0.97	**0.14**	**0.14**	**0.07**	**0.07**
OMN	Oman	77,914	270,390	0.70	0.30	1.35	**0.20**	**0.27**	**0.09**	**0.12**
PAN	Panama	43,773	115,139	0.62	0.36	1.24	**0.23**	**0.29**	**0.14**	**0.17**
PER	Peru	22,813	62,418	0.69	0.23	0.87	**0.25**	**0.22**	**0.08**	**0.07**
PHL	Philippines	18,732	59,648	0.64	0.20	1.02	**0.20**	**0.21**	**0.06**	**0.06**
POL	Poland	59,202	130,952	0.44	0.17	0.82	**0.20**	**0.16**	**0.08**	**0.06**
PRT	Portugal	64,024	446,211	0.42	0.19	1.29	**0.06**	**0.08**	**0.03**	**0.04**
PRY	Paraguay	17,525	45,155	0.44	0.15	0.92	**0.17**	**0.16**	**0.06**	**0.05**
ROU	Romania	50,225	208,358	0.54	0.21	0.93	**0.13**	**0.12**	**0.05**	**0.05**
RUS	Russia	47,417	107,193	0.34	0.14	0.68	**0.15**	**0.10**	**0.06**	**0.04**
RWA	Rwanda	3,360	6,417	0.23	0.20	0.78	**0.12**	**0.09**	**0.11**	**0.08**
SAU	Saudi Arabia	126,037	465,394	0.72	0.32	1.21	**0.20**	**0.24**	**0.09**	**0.11**
SDN	Sudan	14,998	32,889	0.41	0.13	1.09	**0.19**	**0.20**	**0.06**	**0.07**
SEN	Senegal	7,084	23,944	0.60	0.30	1.03	**0.18**	**0.18**	**0.09**	**0.09**
SGP	Singapore	106,899	472,351	0.56	0.37	1.32	**0.13**	**0.17**	**0.08**	**0.11**
SLE	Sierra Leone	3,663	9,427	0.48	0.18	1.31	**0.19**	**0.25**	**0.07**	**0.09**
SRB	Serbia	50,925	211,983	0.41	0.13	0.81	**0.10**	**0.08**	**0.03**	**0.02**
SUR	Suriname	39,160	195,303	0.55	0.40	0.94	**0.11**	**0.10**	**0.08**	**0.08**
SVK	Slovakia	61,629	237,987	0.45	0.22	1.04	**0.12**	**0.12**	**0.06**	**0.06**
SVN	Slovenia	58,707	349,862	0.33	0.24	1.22	**0.06**	**0.07**	**0.04**	**0.05**
SWE	Sweden	86,008	373,381	0.43	0.28	1.16	**0.10**	**0.12**	**0.06**	**0.07**
SWZ	Swaziland	31,809	166,911	0.38	0.17	0.82	**0.07**	**0.06**	**0.03**	**0.03**
TCD	Chad	5,589	6,568	0.40	0.14	0.66	**0.34**	**0.23**	**0.12**	**0.08**
TGO	Togo	3,367	9,274	0.15	0.17	0.75	**0.05**	**0.04**	**0.06**	**0.05**
THA	Thailand	23,659	95,265	0.61	0.24	0.98	**0.15**	**0.15**	**0.06**	**0.06**
TTO	Trinidad and Tobago	60,715	282,590	0.67	0.15	1.09	**0.14**	**0.16**	**0.03**	**0.04**
TUN	Tunisia	34,098	160,420	0.50	0.20	0.96	**0.11**	**0.10**	**0.04**	**0.04**
TUR	Turkey	61,402	186,852	0.56	0.21	1.05	**0.18**	**0.19**	**0.07**	**0.07**
TWN	Taiwan	87,078	305,469	0.52	0.23	1.04	**0.15**	**0.15**	**0.06**	**0.07**
TZA	Tanzania	5,300	24,351	0.56	0.28	0.90	**0.12**	**0.11**	**0.06**	**0.05**
URY	Uruguay	40,385	156,743	0.53	0.24	1.10	**0.14**	**0.15**	**0.06**	**0.07**
USA	United States	111,077	355,979	0.40	0.21	1.04	**0.12**	**0.13**	**0.06**	**0.07**
VEN	Venezuela	36,089	184,726	0.60	0.24	0.96	**0.12**	**0.11**	**0.05**	**0.04**
ZAF	South Africa	35,364	121,865	0.45	0.21	1.03	**0.13**	**0.13**	**0.06**	**0.06**

y is real GDP per person employed; *k* is capital stock per person employed; α_w is total capital share (one minus labor share); α_k is reproducible capital share; P_y/P_k is price level of final goods divided by price level of capital goods; *MPKN* is "naïve" MPK estimate; *PMPKN* is adjusted for relative price of capital; *MPKL* is land and natural resource corrected; *PMPKL* has both adjustments.

Source: Author calculations using data from Feenstra, Inklaar and Timmer (2015) and methodology from Caselli and Feyrer (2007).

Table A2

Average MPKs of All Countries, 2000-2014

Year	MPKN	PMPKN	MPKL	PMPKL
2000	20.4 (14.2)	17.1 (10.0)	7.9 (3.3)	7.1 (3.8)
2001	19.9 (12.3)	17.0 (9.0)	8.1 (3.9)	7.4 (4.1)
2002	19.8 (10.3)	17.4 (8.4)	8.0 (3.4)	7.4 (3.3)
2003	19.5 (9.9)	17.5 (8.2)	8.1 (3.3)	7.6 (3.5)
2004	19.5 (9.8)	18.0 (8.9)	8.5 (3.4)	8.2 (4.0)
2005	19.2 (9.6)	17.5 (8.2)	8.5 (3.2)	8.0 (3.2)
2006	18.8 (9.4)	17.5 (9.1)	8.4 (2.9)	8.1 (3.8)
2007	18.4 (9.1)	17.0 (8.4)	8.6 (2.9)	8.3 (3.6)
2008	18.0 (9.4)	16.7 (8.9)	8.6 (2.8)	8.3 (3.3)
2009	16.5 (8.2)	15.3 (6.7)	7.1 (2.4)	6.9 (2.7)
2010	16.6 (8.2)	15.3 (6.7)	7.4 (2.4)	7.1 (2.7)
2011	16.4 (8.7)	15.1 (7.0)	7.3 (2.4)	7.0 (2.5)
2012	16.2 (8.7)	14.9 (7.2)	7.3 (2.4)	7.0 (2.5)
2013	15.7 (8.4)	14.5 (6.9)	6.9 (2.3)	6.6 (2.6)
2014	15.3 (7.9)	14.1 (6.3)	6.6 (2.1)	6.4 (2.5)

MPK calculations expressed as percent returns. Standard deviations in parentheses.
Source: Author calculations using data from Feenstra, Inklaar and Timmer (2015) and methodology from Caselli and Feyrer (2007).

Table A3

Average Return to Capital, Rich vs. Poor Countries – 2014 Data versus Caselli and Feyrer (2007)

2014 Calculations

	Poor countries	Rich countries
MPKN (s.d.)	17.22 (8.20)	11.75 (5.94)
PMPKN (s.d.)	14.65 (5.99)	13.21 (6.69)
MPKL (s.d.)	7.13 (2.13)	5.70 (1.73)
PMPKL (s.d.)	6.45 (2.75)	6.43 (2.02)

Caselli and Feyrer (2007)

	Poor countries	Rich countries
MPKN (s.d.)	27.26 (8.96)	11.38 (2.72)
PMPKN (s.d.)	15.69 (5.53)	12.59 (2.58)
MPKL (s.d.)	11.94 (6.89)	7.56 (1.74)
PMPKL (s.d.)	6.87 (3.68)	8.47 (1.95)

MPK calculations expressed as percent returns. Standard deviations in parentheses. 2014 Calculations are those expressed in Table 2; refer to Table 2 for description of methodology. Caselli and Feyrer (2007) are calculations using their data, with Rich countries having a GDP per worker at or above the level of Portugal's, per their specifications.

Source: Author calculations using data from Feenstra, Inklaar and Timmer (2015) and Caselli and Feyrer (2007); replicating methodology employed in Caselli and Feyrer (2007).

Table A4

Poor and Rich Growth Rates, Adjusted MPK Calculation and Inputs, 2007-2009

Poor Countries:

% Change From:	*PMPKL*	*y*	*k*	α_k	P_y/P_k
2007 to 2008	3.34%	5.31%	8.65%	5.42%	1.21%
2008 to 2009	-14.88%	2.30%	7.16%	-12.74%	1.48%

Rich Countries:

% Change From:	*PMPKL*	*y*	*k*	α_k	P_y/P_k
2007 to 2008	-4.23%	1.63%	5.15%	-0.54%	0.28%
2008 to 2009	-18.65%	-4.24%	5.43%	-12.01%	0.26%

PMPKL is the "fully-adjusted" MPK calculation, adjusting for reproducible capital share and relative price of capital; *y* is real GDP per person employed; *k* is capital stock per person employed; α_k is reproducible capital share; P_y/P_k is price level of final goods divided by price level of capital goods.

Rich countries for all three years considered all countries with a GDP per person employed greater than $50,100.

Source: Author calculations using data from Feenstra, Inklaar and Timmer (2015) and Caselli and Feyrer (2007); replicating methodology employed in Caselli and Feyrer (2007).