

Notes on Investment and Investment Prices

Econ 570

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1. Introduction

A very robust finding is that the investment rate is highly correlated with income.

- Mankiw *et al.* find that differences in investment rates account for around half of the income disparity across countries, using the Solow-type model
- Levine and Renelt find the investment rate as the lone robust correlate with growth in income per person, using the standard Barro type regression¹
- DeLong and Summers find that it is machinery investment that is key.²

– in "India, like in Argentina, the savings is relatively high but equipment is expensive...India demonstrates not that boosting investment is unproductive, but that policies that boost saving while simultaneously raising the relative price of investment in equipment and structures are unproductive. We suspect that restrictions on imports of capital goods have ensured that the Indian government's attempts to support investment have had effects not on quantities but on prices: India's policies have managed to enrich *industrialists* instead of encouraging *industry*."

- Richer countries invest more than poorer countries. This is clear from figure 1. Notice that PPP investment rates are 2-3 times higher for US and Norway compared with poor

¹A standard Barro-type regression is a cross-country regression of per-capita income growth over some period, Dy_t , on a host of variables:

$$Dy_t = \alpha + \beta_1 y_{t-1} + \beta_2 h_{t-1} + \gamma_1 x_{1t} + \gamma_2 x_{2t} + \dots + \varepsilon_t$$

where h_t is educational attainment and the x 's are various policy variables, such as the investment ratio, corruption, openness, inflation rate, democracy, rule of law, etc.

²De Long and Summers 1, 396 stress the distinction "between investment effort – share of national product saved, plus capital inflows – and investment – buildings constructed and machines put into productive use. Many of the policies that have been followed in the post-WWII period, especially in the developing world, seem designed to maximize 'investment effort,' while ensuring that each unit of 'investment effort' translates into as little actual investment as possible." Like so many other aspect of economic policy, what was merely a disease in developing countries was a pathology in the socialist world.

countries like Mali and Kenya. Thus both *faster* growing and *richer* countries invest more than slow growing and/or poor countries.

- How does this fit with the finding that TFP is what really matters?

What explains these finding?

- One set of arguments focuses on low-savings rates (and the F-H hypothesis). Classical low savings theories.
- Another set of arguments focuses on distortions to investment. In particular, it is pointed out that the relative price of investment is higher in poor countries. This could be because of taxes or other distortions that make investment more expensive. It could reflect trade policies, barriers to entry, prohibitions, corruption, and all sorts policy distortions that make investment more expensive.
 - the classic reference is to Argentina where the price of capital may have doubled in the Peron era.

1.0.1. Price Distortions and the Lucas Puzzle

Recall the Lucas puzzle – with common technologies and $\alpha = .4$ India has a marginal product of capital that is 58 times that in the US. So capital does not flow. But there is another simple exercise that is informative. If capital is paid its marginal product, then $\alpha = F_K \frac{K}{Y}$. But this means that we can estimate the return to capital across countries by

$$MPK_i = \alpha \left(\frac{Y}{K} \right)_i \quad (1)$$

where i indexes the country. It is rather easy to get data on capital-output ratios across country. Before collecting it, however, we should also take into account the fact that output will be sold at P_i in country i , and that the cost of capital goods is P_{I_i} . Then we should examine the true holding return, MPK^* , defined by

$$MPK_i^* = \frac{P_i}{P_{I_i}} MPK_i = \frac{P_i}{P_{I_i}} \alpha \left(\frac{Y}{K} \right)_i. \quad (2)$$

Rather than measuring the capital-output ratio at world prices, we adjust each for domestic price levels and distortions. This will be important as this ratio will differ dramatically across countries.

Suppose we do this, what do we find? From (1) we can see that much of the conundrum goes away. Without the domestic price adjustment we can already explain a lot. Take India. With $a = 1/3$ the ratio of $\frac{MPK_{India}}{MPK_{US}} = 226$. But using (1) we find $MPK_{India} = 0.55$ compared with 0.37 for the US. Essentially, India uses less capital per unit of output than the US, and this shows up in the ratio. It is due to lower productivity of course. When we do the calculation according to (2) then we have $MPK_{India} = 0.32$ compared with 0.46 for the US. This shows up similarly for most countries. The point being that distortions in domestic prices make the returns to capital across countries look normal.³ Another way to look at this result is with regard to Argentina. With the Lucas calculation its return to capital is 11 times that of the US. At international prices it is about 20% higher than the US (0.43 versus 0.37). But correcting for distortions it is about 30% lower than in the US (0.35 versus 0.46). Hence, correcting for the distortions we see why capital does not flow to Argentina very easily.⁴

These price distortions suggest that at domestic prices poor countries are not investing so much less than rich ones. The problem is that they get less investment for a unit of expenditure. At domestic prices the correlation goes away. Thus while the correlation between y and $\frac{i}{y}$ is 0.50 when measured at PPP, the correlation between i/y at domestic prices and y at PPP is only 0.05. It is well-known that investment rate differences are very small when measured at a common set of prices while very large when measured at domestic prices. Evidently, the domestic price of investment goods is high relative to consumption in poorer countries. Why? Is this due to tariffs and taxes, or is it more fundamental?

³This should not be surprising since capital-output ratios do not vary much across countries. In the Solow model capital labor ratios differ in different steady states, but capital output ratios vary less – one of Kaldor's stylized facts.

⁴This may be the place to point out the importance of studying Argentina (and Latin America) for development. In 1913 Argentina's GDP per-capita was 80% of the OECD average. By 1987 it was 32%. This is quite dramatic, and explaining why a country diverges must be as important as why it converges.

Table 7
Estimated Marginal Product of Capital, 1985-1989

A. Basic Data								
	GDP per worker (1985 int.\$)	P/P	K/Y (intl. prices)	K/Y (domestic prices)	Lucas MPK _t ¹ ($\alpha=0.4$)	Lucas MPK _t ² ($\alpha=1/3$)	Higgins MPK (intl. prices, $\alpha=1/3$)	Higgins MPK (domestic prices, $\alpha=1/3$)
Malawi	1,171	2.60	0.38	0.97	210.3	1252.3	0.88	0.35
Madagascar	1,604	7.00	1.05	7.39	134.4	692.2	0.32	0.05
Kenya	1,990	2.07	0.51	1.05	88.5	394.5	0.65	0.32
Zambia	2,265	1.46	0.69	1.10	114.3	557.6	0.48	0.32
Nepal	2,271	2.55	0.34	0.91	74.5	313.3	0.99	0.37
Nigeria	2,312	1.64	0.38	0.60	86.2	382.5	0.88	0.37
Sierra Leone	2,424	8.71	0.09	0.79	94.1	430.1	3.71	0.43
Zimbabwe	2,760	1.56	1.69	2.66	58.3	226.6	0.20	0.13
India	2,989	1.71	0.61	1.05	58.0	224.6	0.55	0.32
Ivory Coast	3,543	2.00	0.31	0.62	51.0	192.3	1.08	0.34
Philippines	4,479	1.35	0.86	1.16	34.7	113.3	0.39	0.29
Honduras	4,614	1.55	0.94	1.44	44.2	156.2	0.35	0.23
Jamaica	4,933	1.44	0.71	1.06	19.3	51.7	0.47	0.33
Bolivia	5,390	2.17	1.17	2.52	35.9	118.5	0.29	0.13
Thailand	5,549	1.46	0.79	1.19	13.9	33.8	0.42	0.28
Sri Lanka	5,610	1.83	1.52	2.76	25.1	73.5	0.22	0.12
Swaziland	5,689	1.36	0.73	1.21	23.0	65.4	0.47	0.30
Paraguay	6,149	1.32	0.14	0.19	25.7	76.0	2.40	1.77
Morocco	6,706	2.29	0.35	0.81	24.3	70.3	0.97	0.42
Botswana	6,944	1.62	0.68	0.96	17.3	44.9	0.49	0.39
Dominican Rep.	7,300	1.38	0.76	1.00	21.9	61.5	0.44	0.34
Guatemala	7,380	1.71	0.51	0.88	23.9	69.0	0.65	0.38
Turkey	7,835	1.13	0.94	1.01	11.4	25.7	0.35	0.33
Peru	8,197	1.14	1.13	1.29	20.0	55.0	0.30	0.24
Poland	8,353	1.19	1.38	1.68	8.8	18.3	0.24	0.20
Panama	8,963	0.98	1.81	1.72	14.0	34.1	0.19	0.19
Mexico	9,074	2.44	0.32	0.81	5.9	10.8	1.04	0.42
Ecuador	9,288	1.11	1.69	1.87	16.7	42.7	0.20	0.18
Colombia	9,794	1.33	1.30	1.78	13.0	30.6	0.26	0.19
Chile	10,860	0.91	0.72	0.66	8.9	18.5	0.46	0.50
Yugoslavia	11,090	1.14	0.74	0.84	6.5	12.2	0.46	0.42
Iran	11,820	1.18	1.04	1.23	13.4	32.0	0.34	0.30
Korea, Rep.	13,056	1.09	1.12	1.11	5.6	10.1	0.30	0.30
Portugal	13,413	1.50	0.77	1.14	5.1	8.8	0.43	0.29
Argentina	14,909	1.22	0.79	0.96	6.2	11.6	0.42	0.35
Taiwan	15,711	0.95	1.41	1.34	4.1	6.6	0.24	0.25
U.K.	25,317	0.98	0.75	0.76	1.7	2.0	0.44	0.44
Finland	25,652	0.79	1.63	1.32	1.6	1.8	0.20	0.23
New Zealand	26,001	0.91	1.24	1.17	1.8	2.1	0.27	0.29
Sweden	27,620	0.86	1.27	1.11	1.3	1.5	0.26	0.30
Germany, West	28,423	0.85	1.74	1.48	1.4	1.5	0.19	0.23
France	28,693	0.80	1.16	0.95	1.5	1.7	0.29	0.35
Italy	29,061	0.87	1.02	0.90	1.8	2.1	0.33	0.37
Norway	29,238	0.86	1.58	1.38	1.5	1.7	0.21	0.24
Belgium	29,243	0.83	1.18	0.98	1.6	1.9	0.28	0.34
Netherlands	29,589	0.96	1.04	1.00	1.6	1.9	0.32	0.33
Australia	30,066	0.90	1.18	1.08	1.4	1.5	0.28	0.31
Switzerland	31,391	0.84	2.16	1.84	1.1	1.2	0.15	0.18
Canada	33,392	0.79	1.15	0.93	1.1	1.1	0.29	0.26
Luxembourg	34,394	0.90	1.35	1.22	1.3	1.4	0.25	0.27
U.S.A.	35,477	0.78	0.91	0.73	1.0	1.0	0.37	0.46
Mean	14,924	1.49	0.99	1.27	23.5	95.4	0.49	0.34
Std. Dev.	10,380	1.25	0.43	0.90	37.9	203.4	0.53	0.21

Figure 1: Estimated Marginal Products of Capital

Hsieh and Klenow pursue this and show that investment goods are no more expensive in poor than rich prices. The high relative price of capital is primarily driven by lower consumption goods prices. It is not $\frac{P_I^{US}}{P_C^{Malì}}$ that differs so much, but $\frac{P_C^{US}}{P_C^{Malì}}$.

The argument is that in poor countries investment sectors have low productivity relative to their consumption sectors. This is a corollary to the Balassa-Samuelson hypothesis. Tradable investment goods but not all tradable consumption goods. Nontradable consumption goods in poor countries are cheaper than tradable investment goods. That is what causes the relative price difference. But what causes this productivity difference?

2. Model

The Hsieh-Klenow model has two sectors and two tax rates: a nontradable consumption sector, a tradable investment sector, a tax rate on importing investment goods (τ_{I_j}), and a tax rate on capital income, τ_{K_j} . Otherwise it is a standard neoclassical growth model.

Each of L_j workers in j inelastically supply one unit of labor per period. They choose consumption to maximize

$$\sum_{t=0}^{\infty} \beta^t \frac{C_{j,t}^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} \quad (3)$$

subject to

$$K_{j,t+1} = (1 - \delta)K_{j,t} + I_{j,t}, \quad (4)$$

$$P_{C_{j,t}}C_{j,t} + P_{I_{j,t}}I_{j,t} = w_{j,t} + [R_{j,t} - \tau_{K_j}(R_{j,t} - \delta P_{I_{j,t}})]K_{j,t} + T_{j,t} \quad (5)$$

and

$$R_{j,t}(1 - \tau_{K_j}) = [r_{j,t} + \delta(1 - \tau_{K_j})]P_{I_{j,t}}$$

or

$$R_{j,t} = \frac{r_{j,t} + \delta - \delta\tau_{K_j}}{1 - \tau_{K_j}}P_{I_{j,t}} \quad (6)$$

where R is the rental price of capital, and T are transfers from the government, and are rebated tax collections. Expression (6) is just an expression for the rental cost of capital.

Rest is standard.

Key Assumption: Consumption goods cannot be traded internationally but investment goods are tradable.

The pre-tax world price of investment is taken as given, P_I^W . Then

$$P_{I_j} = (1 + \tau_{I_j})P_I^W. \quad (7)$$

In each country firms rent capital and hire labor in competitive spot markets. They sell output in competitive markets to maximize current profits, given by

$$\Pi_C \equiv P_{C_j}C_j - w_jL_{C_j} - R_jK_{C_j} \quad (8)$$

and

$$\Pi_I \equiv P_I^W I_j - w_jL_{I_j} - R_jK_{I_j}$$

because investment goods are tradable. This can be re-written as:

$$\Pi_I \equiv P_{I_j}I_j - \tau_{I_j}P_I^W I_j - w_jL_{I_j} - R_jK_{I_j}. \quad (9)$$

Production technologies in the two sectors are

$$C_j = A_{C_j}K_{C_j}^\alpha L_{C_j}^{1-\alpha} \quad (10)$$

and

$$I_j = A_{I_j}K_{I_j}^\alpha L_{I_j}^{1-\alpha} \quad (11)$$

where A_{I_j} and A_{C_j} are productivity indexes. It is assumed that α is the same across countries and across sectors within countries.

The F.O.C.'s that come from this problem allow us to write

$$R_j = \alpha P_I^W A_{I_j} \left(\frac{K_j}{L_j} \right)^{\alpha-1} \quad (12)$$

and⁵

$$\frac{P_{C_j}}{P_I^W} = \frac{A_{I_j}}{A_{C_j}}$$

⁵Why are the capital labor ratios equal? From the F.O.C. for labor we have

$$w(1-\alpha)P_c A_c k_c^\alpha = (1-\alpha)P_I^w A_I k_I^\alpha$$

so $\frac{k_I^\alpha}{k_c^\alpha} = \frac{P_c A_c}{P_I^w A_I} = \frac{k_I^{\alpha-1}}{k_c^{\alpha-1}}$ where the last equality comes from the F.O.C. wrt to capital. Hence, $k_I = k_c$.

which implies

$$\frac{P_{C_j}}{P_{I_j}} = \frac{A_{I_j}}{A_{C_j}(1 + \tau_{I_j})}. \quad (13)$$

Expression (12) equates the rental price of capital to the marginal product. Expression (13) says that the relative price of consumption goods is inversely related to relative TFP in the two sectors and is decreasing in the tax rate on importing goods. These are the two key factors. The important thing is to separate out the two factors.

To make this tractable they assume that some basic parameters, β , σ , and δ are the same across countries. Moreover, sectoral TFP's grow at the constant rate g_A across sectors and across countries.⁶ The parameter values that can vary across countries are τ_{K_j} , τ_{I_j} , A_{I_j} , and A_{C_j} . Thus TFP grows at similar rates but they can differ across sectors or countries at a point in time.

Variation in the parameters τ_{K_j} , τ_{I_j} , A_{I_j} , and A_{C_j} generate cross-country variations in steady state levels of the investment rate at domestic prices, the domestic price of investment, and the domestic price of consumption. They also yield different levels of PPP levels of y at a point in time across countries.

Notice that because of (7) and the assumption that consumption is nontradable there are no opportunities for international commodity arbitrage. There are also no incentives for international capital mobility because capital is taxed where it is located. After-tax after-depreciation real interest rates are the same in all countries and equal to

$$r_j = r = \frac{(1 + g)^{1/\sigma}}{\beta} - 1 \quad (14)$$

this follows from the consumption Euler equation – it is the Keynes-Ramsey rule – plus the steady state assumption. With no capital flows we have savings equal to investment within countries.

The investment rate at international prices can be written (using (10) and (11)) as:

$$j^{PPP} = \frac{P_I^{PPP} A_{I_j} (k_{I_j})^\alpha \frac{L_{I_j}}{L_j}}{P_I^{PPP} A_{I_j} (k_{I_j})^\alpha \frac{L_{I_j}}{L_j} + P_C^{PPP} A_{C_j} (k_{C_j})^\alpha \left(1 - \frac{L_{I_j}}{L_j}\right)}$$

⁶This latter assumption is not critical.

which can be re-written as:

$$j^{PPP} = \frac{P_I^{PPP} A_{I_j} \frac{L_{I_j}}{L_j}}{P_I^{PPP} A_{I_j} \frac{L_{I_j}}{L_j} + P_C^{PPP} A_{C_j} \left(1 - \frac{L_{I_j}}{L_j}\right)} \quad (15)$$

because the capital-labor ratios in the two sectors are equal. The key implication of this equation is that low TFP in investment relative to that in consumption can cause the investment rate (at PPP) to be lower.

Now consider what happens if A_I falls holding A_C fixed. From (15) it is clear that investment rate falls. This means that the fall in aggregate TFP will be *greater* than just the direct effect (via its size).⁷ The reason is that capital accumulation is also affected. This is important. Not only do poor countries have lower TFP than rich ones, but they have especially low A_I 's. Their low sectoral TFP's contribute to their low aggregate TFP, and their low $\frac{A_I}{A_C}$ ratios contribute to their low physical capital intensity in *PPP* terms.

Figuring out why A_I is so low is very important.

3. Cross-Country Evidence

If the "investment barriers" hypothesis is true then investment prices should be cheaper in rich countries. So if the prices of machinery and equipment are converted to dollar prices at official exchange rates, or using black market premia, then there should be a negative relationship with PPP income. But this does not appear in the data (see figure for official exchange rates).

Suppose that one regresses the price of investment goods (machinery or fixed investment) on the log of y^{PPP} either using official exchange rates or black market rates to convert investment prices. If the "investment barriers" hypothesis is true then the coefficient on y^{PPP} should be negative. But in the data it is insignificant and the R^2 is very low. In some case investment prices appear *more expensive* in rich countries.

⁷The direct effect follows because we can express economy-wide TFP as:

$$TFP_j = P_C^{PPP} A_{C_j} \left(\frac{L_j - L_{I_j}}{L_j}\right) + P_I^{PPP} A_{I_j} \frac{L_{I_j}}{L_j}.$$

The high PPP rates of investment in rich countries is due not to low prices of investment, but high relative prices of consumption. This is consistent with B-S: nontradables are relatively cheap in poor countries. But why are *tradable* consumer goods cheaper in poor countries? Perhaps it is distribution costs.

But why is investment relatively inefficient in poor countries?

- financial underdevelopment leads to bad project selection
- public investment is relatively higher and this is inefficient relative to private

Whatever the explanation, and more later, this implies that poor countries *do not appear to lack investment effort – they lack investment efficiency.*⁸

Of course, this should imply that developing countries should *import* investment goods. In the model there are no tradable consumer goods to export, but surely in practice developing countries import a large share of machinery.

4. Digression: Government Production of Investment

Schmitz (JME, 2001) considers the impact of government production of investment goods. If the government is less efficient at producing investment goods this will have a productivity impact on the economy. He uses a similar framework. He notes that there is a direct and indirect effect.

- *direct effect* is lower output and labor productivity in sector, I .
- *indirect effect* is that on the rest of the economy through lower capital-per worker

⁸To recap, poor countries do not exhibit particularly low investment rates at domestic prices. Nor do they exhibit high investment goods prices. Instead they exhibit low consumption prices. When consumption is valued at common PPP prices in all countries, the investment rates in poor countries are lower than in rich countries. Poor countries do not appear to suffer from low-savings traps brought on by high discount rates or subsistence consumption needs. If they did, we would expect to see much lower domestic-price investment rates in poor countries. Nor do they appear to heavily tax the returns to capital. If they did we would expect to see low domestic-price investment rates in poor countries. Finally, poor countries do not appear to impose high taxes and tariffs on producing and importing investment goods. If they did we would expect to see high investment good prices in poor countries. Poor countries do not appear to lack investment effort, but rather investment efficiency.

Suppose we are in a steady state, then from earlier we know that

$$R = \alpha P_I A_I k_I^{\alpha-1} = \alpha P_c A_c k_c^{\alpha-1} \quad (16)$$

we also know that relative prices satisfy $\frac{P_c}{P_I} = \frac{A_I}{A_c}$ where I have set $\tau = 1$.

Then the steady state capital-labor ratio satisfies:

$$k^* = \left[A_I \alpha \frac{P_I}{R} \right]^{\frac{1}{1-\alpha}} \quad (17)$$

Now suppose that the government produces all investment goods, and that TFP is now given by μA_I ($\mu < 1$). Then

$$\widehat{k}^* = \left[\mu A_I \alpha \frac{P_I}{R} \right]^{\frac{1}{1-\alpha}} \quad (18)$$

so that the effect of this ownership policy is

$$\frac{\widehat{k}^*}{k^*} = \mu^{\frac{1}{1-\alpha}} \quad (19)$$

Just to have an idea, suppose that $\alpha = 1/3$ and that $\mu = 1/2$. Then $\frac{\widehat{k}^*}{k^*} = 0.35$. Steady state capital stocks are 35% of what they would be without this policy. This is the direct effect.

Notice that this policy will also change the relative price of investment goods. This should not surprise given Hsieh-Klenow. Before the policy we had $\frac{P_c}{P_I} = \frac{A_I}{A_c}$, now $\frac{P_c}{P_I} = \frac{A_I}{\mu A_c}$, which implies that the relative price of investment goods doubles.

What happens to aggregate TFP? Let y_i^{PPP} be detrended output under policy i ($i = 1, 2$, where the latter is the policy of government ownership). Then it is straightforward to show that

$$\frac{y_2^{PPP}}{y_1^{PPP}} = [(1 - n_I^*) + \mu n_I^*] \left[\frac{k_2^*}{k_1^*} \right]^\alpha \quad (20)$$

where n_I^* is the share of the labor force that works in the investment sector in the steady state.

Using (19) we can write:

$$\frac{y_2^{PPP}}{y_1^{PPP}} = [(1 - n_I^*) + \mu n_I^*] \left[\mu^{\frac{1}{1-\alpha}} \right]^\alpha = [(1 - n_I^*) + \mu n_I^*] \mu^{\frac{\alpha}{1-\alpha}}$$

Now suppose that 80% of the labor force is in consumption and 20% in the investment sector. And suppose that we continue to let $\mu = 0.5$. Then we obtain

$$\frac{y_2^{PPP}}{y_1^{PPP}} = [0.8 + (0.20)(0.5)] [(0.5)^{0.5}] = [0.9][0.5]^{0.5} = .636$$

which means that the policy of government production of investment would reduce aggregate productivity to 64% of its potential level.

Of course any of these calculations depend on the value of μ . Schmitz cites independent studies for Turkey and Egypt which show that state-owned capital-goods firms are half as productive as private-owned ones. These may seem large, but it is important to note that we are not talking about natural monopoly type industries in this case. These differences perhaps then reflect some of the costs of regulations that the state-owned firms operate under that the private ones do not. Of course, there may also be some selection issues that arise from the definition of industries (too broad categories, for example). More studies needed.

Notice that if you take into account the fact that government ownership is not 100%, then you face some modelling questions. How do private and state firms coexist if the latter are less efficient? Either they produce different goods, which is not too inviting since we would then need to know how substitutable they are. Or you could assume that taxes and subsidies are used to allow coexistence. It may also be the case that the government mandates the share of the sector that will be state-owned.

4.0.2. *General issues*

1. Are government-owned firms inherently less productive?

It would seem so. We know why for planned economies. Some of these factors, however, do not apply to developing economies (relative prices are market determined, there is no central plan, no seller's market). The causes in this case are primarily organizational – absence of free entry and selection, and perhaps rent-seeking that ensues. Could also be extra corruption.

- Indeed, one might think that the reason why governments want investment goods sectors

to be state-owned is that it makes corruption easier to facilitate. It is harder to know the price of capital goods, so kickbacks are easier to conceal. The more frontier the technology the harder to judge the price, so bureaucrats may want to encourage imports of such goods to get kickbacks.

2. Why is the problem of government ownership more important in developing economies?

It could partly be a sectoral priorities issue. Heavy industry is more important. Commanding heights. Although government shares of GDP are similar across countries, government ownership of manufacturing differs greatly. And in countries where there is data, this seems concentrated in investment goods sectors. Rent-seeking opportunities must be a part of this. Also, they may need protection to survive competition from imports from more developed economies. Legacies of import substitution.

4.1. *Specific H-K issues*

Sum up: H&K can explain:

- The cross sectional patterns of correlations (particularly for later years).
- The increasing gap between the two correlations over time. For this, the model should be extended to feature higher growth of A_I/A_C in richer countries.
- Still in need of explanation is the declining correlation of investment rates in domestic prices and income over time.

Conclusions from this exercise:

- Poor countries have low levels of physical capital. The paper claims that this is NOT because they have sacrificed little consumption (or invested little in domestic \$).
 - There is some truth to this. Poor countries did not save necessarily less in the 90's (in domestic \$). However, current levels of capital are the result of decades

of accumulation, and it seems that a few decades ago, poor countries were indeed sacrificing less consumption.

- So, it can still be true that the low levels of capital today are the result of little sacrifice in the past. We need finer development accounting...

Some other implications. The benchmark model has one “tradable.” Investment goods are tradable. Consumption goods are not tradable. Hence, no good is traded in equilibrium. There is no motive for trade, because there is only one tradable.

- What happens when trade is allowed for? I.e., when the poor can produce tradable consumption goods with a comparative advantage.
- With trade, the prediction that $Corr(i^{PPP}, Y) > 0$ weakens. i.e, this correlation is lower with than without trade.

– (This is because the share of tradables in consumption declines with income)

- Since in the data $Corr(\text{IR in PPP prices}, Y) > 0$ is robust, this suggests that in practice trade between developed and developing countries is negligible.
- Why is trade so low?
 - Barriers to trade in DC. (Protection of primary sectors.)
 - Productivity of tradables too low in LDC.
- Suggests another test: $Corr(\text{IR in PPP prices}, Y)$ should be higher for countries that trade little with DC.⁹

Is P_I equal across countries? While measured P_I can be equal, “effective” PI might differ. This could occur due to higher risk in Developing Countries (e.g: risk of expropriation is higher).

⁹If you split the sample into two groups: Low and High Trade, the $Corr(i^{PPP}, Y)$ is higher for low-trade countries (openc<median): $-Corr(i^{PPP}, Y) = 0.71$ if Openness<Median, 1996. $Corr(i^{PPP}, Y) = 0.16$ if Openness>Median, 1996. Good for H&K! But do check other years!

- This higher risk constraints the technology choice set, leading countries to adopt less efficient technologies. This could be behind the choice of less productive technologies.

Why should productivity in nontradables rise slower than productivity in tradables? Two possible explanations are:

- tradables have greater inherent capacity for productivity improvement because more mechanized and capital intensive
- tradable goods have larger scale due to larger markets, so the return to innovations may be greater

Why is the production of investment goods so inefficient in poorer countries? One explanation is government production. Another may relate to scale and markets.

5. Conclusion

Poor countries have low levels of physical capital. In the 90's they did not invest less than the rich (in domestic \$). But they seemed to have invested less in the 60's-80's. So, to some extent, current low levels of capital might still be the result of low sacrifice of consumption early on.

References

De Long, J. Bradford, and Lawrence H. Summers, "How Strongly to Developing Economies Benefit from Equipment Investment?" *Journal of Monetary Economics*, 32, 3, December 1993: 395-416.