ON GROWTH, INVESTMENT, CAPITAL AND THE RATE OF RETURN

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This paper is aimed at introducing economic analysts and other interested parties to some interesting twists and turns that arise as one juxtaposes basic economic theory to real-world data. Readers will, I think, be quite surprised at the insights one gets from some very simple exercises. In addition many may be led to appreciate aspects of a country's economic life of which they previously had little awareness. To give some focus to our story, we will concentrate on the idea that somehow "hidden" in the standard national accounts of a country, lies the basis for measuring the contribution of investment to the growth process, and also an overall "real" rate of return to reproducible capital in the country. In subsequent exercises, we will explore breaking down the capital stock of the country into segments, with different rates of return applying to each segment. In the process we will explore how to build up a series of estimates of the "real" reproducible capital stock of a country; how to deal with land as an additional component of the total capital stock; how to allow for the special attributes of residential housing as a component of the capital stock and as a generator of a stream of real returns; how to handle the contributions of government investments in infrastructural items that yield little or no cash revenues; and finally, how to isolate the real rate of return to what might be called "ordinary business capital" apart from housing.

Expressing Gross Investment in Real Terms

Nearly all national accounts systems present time series on gross investment. Most of them include under this concept both private and public investment, and in this paper we will assume that we are dealing with such a case. Non-economist readers should be aware that the focus of the national accounts is on the flow of goods and services being produced, consumed, or invested in a given period. Under this concept, a country cannot invest in land, except by such actions as clearing, leveling, fencing, etc., and, of course, reclaiming land from rivers, lakes or seas. Thus the private purchase of a farm or residential lot is indeed an investment from the purchaser's point of view, but the national accounts view it as a disinvestment by the seller of same. These two entries cancel from the national accounts point of view. The same goes for the purchase and sale of a manufacturing plant or a truck, or any other pre-existing asset. The gross domestic investment that the national accounts measure consists of the goods and services that were produced in the country and used for domestic investment in the given period, plus imported goods and services that likewise ended up being used for domestic investment in that same period. The sum of these two items is what the national accounts typically label gross investment.

To express investment in real terms, one needs to deflate the gross investment figure by some relevant price index. Most countries develop as part of their national accounting procedures an investment goods price index. For the purposes of the present paper, however, we want to use a more general index, the GDP deflator. The reason for this is that we are headed toward a direct measurement of the rate of return to capital. This consists of a ratio between the "return to capital" in the numerator and the "stock of capital" in the denominator. Obviously, one cannot take such a ratio and call it a rate of return if the numerator and denominator are measured in different units. Our procedure will end up measuring both numerator and denominator in units of "GDP baskets" of constant purchasing power (e.g., in terms of pesos of the year 2000 or some other base year). The "return to capital" in the numerator is obtained simply by summing the various sources of capital income (profits, interest, rents, etc.), usually in nominal pesos, then expressing this income as a fraction of nominal GDP, and then applying this fraction to the country's real GDP. In our numerical exercises, we will operate with alternative assumptions about the fraction of real GDP going to reproducible capital.

Building a Capital Stock Time Series

The simplest method for building a capital stock on the basis of investment data uses what is called the perpetual inventory approach. This applies the following operation:

End of 2006 capital stock

equals

End of 2005 capital stock

plus

Gross Investment During 2006

minus

Depreciation of Existing Stock During 2006

In symbols: $K_t = K_{t-1}(1-\delta) + I_{gt}$

where K_t is the capital stock at the end of period t, I_{gt} is gross investment during period t and δ is the fraction of last year's capital stock that depreciates (in real terms) during period t. The formula provides a rolling evolution of the capital stock, moving from one year to the next by adding the next year's new investment and subtracting the real depreciation of the old capital stock during that same next year.

The question obviously arises, under this procedure, from where do we get an estimate of the initial capital stock (for some past year) from which to start this chain-link process? Here we will describe what is probably the simplest method for doing so. Alternative techniques are outlined in a companion paper.

Our simplest technique is based on a result that characterizes "growth equilibrium" under nearly all approaches to the analysis of economic growth. This result states that in growth equilibrium an "equilibrium capital/output (K/Y) ratio" prevails, which in turn means that the capital stock series (K) and the real GDP (or other output) series grow at the same rate. To get an estimate of K_o (say K at the end of 1969) using the assumption of growth equilibrium, we assume that during 1970 both K and Y grew at the same rate. The increment to K is $\Delta K_{70} = I_{70} - \delta K_{69}$, the rate of increase of capital is $(\Delta K_{70}/K_{69}) = (I_{70}/K_{69}) - \delta = \Delta Y_{70}/Y_{69}$, the rate of increase of output. Since we have data on I_{70}, ΔY_{70}, and Y_{69}, and since our procedure uses an assumed value for δ, the above equation can be solved for K_{69}, which then can be used as the starting point for the chain-link, perpetual inventory method.[1]

We have yet to speak of the depreciation rate, δ. It would be nice if the national accounts would give us an accurate picture of the real depreciation occurring in an economy each year. But in fact the underlying data are distorted by several important factors:

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[1]In my own applications I have tried to use for I_{70} in the above formula an average like $(I_{69}+I_{70}+I_{71})/3$ and for $(\Delta Y_{70}/Y_{69})$ an average of $(\Delta Y_{69}/Y_{68})$, $(\Delta Y_{70}/Y_{69})$ and $(\Delta Y_{71}/Y_{70})$. This helps guard against the chosen year being erratic in the sense of the real capital stock and real GDP growing at substantially different rates. In choosing the starting date for a given country, we also have tried to avoid "abnormal" periods (export booms, cyclical recessions, major inflationary bursts, etc.) Others would be well advised to adopt the same precautions.

a) In most countries, business accounts are kept in nominal terms with no attempt to convert them into real terms. Firms thus deduct as depreciation for each year a specified fraction of the nominal price paid for each asset. When inflation has intervened between the year of purchase of the asset and the year for which depreciation is being calculated, this leads to a significant understatement of depreciation.

b) In many countries, governments permit the accelerated depreciation of assets for tax purposes. In these cases tax depreciation often far exceeds true economic depreciation.

c) Independent of government policy, business firms typically has an incentive to exaggerate depreciation, as this gives them a bigger deduction for tax purposes.

For the above reasons one can have little reliance on national accounts depreciation unless a very explicit effort has been made by the national accounts people themselves to do exercises of the type we are here examining. Hence nearly all economists who engage in the exercise of building time series of the real capital stock make assumptions as to plausible rates of real depreciation. The best way to do this is to build separate capital stock series for buildings, machinery and equipment, vehicles and inventories (plus other categories if and when the data exist and the categories seem relevant). However, to do this using direct data one requires annual national accounts investment to be broken down into these component parts. In the absence of such a breakdown, and/or in studies in which a common methodology is being applied to many countries, the practice has been to make a sensible assumption as to the average rate of depreciation of the country's reproducible capital stock.

Here we will assume the rate of real depreciation on the entire stock of reproducible capital to be 4%. To justify this, we develop a "scenario analysis" showing the coherency and plausibility of the various components of the story.

First, we assume an economy in which real GDP is growing at the rate of 3% per year, and in which real gross investment averages 20% of real GDP. This investment in turn is broken down as follows:

Investment in:

Buildings, roads, bridges, etc.	= 45% of Ig, with a depreciation rate of 2%
Machinery and equipment	= 30% of Ig, with a depreciation rate of 8%
Vehicles	= 22% of Ig with a depreciation rate of 12%
Inventory investment	= 3% of Ig, with a zero depreciation rate (Standard national accounting practice considers inventory investment to represent the net increment to inventories. The depletion of old inventories has thus automatically been deducted in arriving at national accounts investment.)

Table 1 shows data for a typical year in such an economy. Gross investment is taken to be 100 in that year, so GDP is 500. What we do in the table is to build equilibrium stocks of the different types of capital, following the "rule" that the equilibrium stock $K_{j,t-1}$ is equal to $I_{gjt}/(g+\delta_j)$. Where I_{gjt} = gross investment of type j in year t, and g = GDP growth rate.

To these assumptions we add the allocation of annual investment – 45% to buildings, 30% to machinery and equipment, 22% to vehicles (row a of Table 1 below). Three percent of I_g is allocated to inventory investment, but this figure is based not on total investment, but on the growth of GDP. The assumption is that 20% of the increment to GDP is represented by inventory accumulation. This assumption in turn leads to an estimated total stock of inventory capital that is equal to 20% of one year's GDP (= 100, in the units of the table). The assumed depreciation rates for the types of depreciable capital are shown in row b. Then the capital stocks of those three types are estimated by dividing the current gross investment of that type by $(.03 + \delta_j)$, as shown in row c. This assumes that we are in growth equilibrium for each of these classifications of capital. The resulting capital stocks are shown in row d. Together with the estimate of 100 for inventory capital, they add up to a total capital stock of 1420. When we apply the depreciation rate appropriate to each type of capital stock, we get the depreciation amount shown in row d. These add up to 57.5, or almost exactly 4% of the estimated total capital stock of 1420.

TABLE 1

SCENARIO ANALYSIS

CAPITAL STOCKS AND DEPRECIATION AMOUNTS

(by type of capital)

	Buildings	Machinery & Equipment	Vehicles
a) Investment in year t	$.45\ I_{gt}$ = 45	$.30\ I_{gt}$ = 30	$.22\ I_{gt}$ = 22
b) Depreciation Rate (δ_j)	.02	.08	.12
c) Capital Stock (= Investment/ $(.03+\delta_j)$)	900	273	147
d) Depreciation Amount	18	21.84	17.64

Total Depreciation = 57.5

Inventory Investment = 20% of ΔY

$$\Delta Y = .03Y = .03 \times 500 = 15$$

Inventory Investment = $.2\ \Delta Y = 3.0$

If each ΔY leads to inventory investment of $.2\Delta Y$, then the total stock of inventory capital should be .2Y, or 100.

Total Reproducible Capital Stock = 900 + 273 + 147 + 100 = 1420

$$\delta = \text{Depreciation/Reproducible Capital Stock)} = 57.5/1420 \approx 4\%$$

This example is intended to give readers a sense of how this analysis is not just a blatant wave-of-the-hands assumption, but rather a quite "textured" picture of the structure of a growing economy with capital stocks of different economic lives.

In point of fact, we will show later that our main conclusions would not differ much if the average depreciation rate were 3% or 5%. So readers should take from this exercise the reassurance of the seriousness of the framework, and not worry about the precise figure of an average 4% annual depreciation rate.

Economic Growth and the Return to Capital

A standard breakdown of a country's growth rate is the following:

(1) $$\frac{\Delta Y}{Y} = s_L \frac{\Delta L}{L} - s_K \frac{\Delta K}{K} + \frac{R}{Y}$$

Here $(\Delta Y/Y)$ is the rate of growth of GDP, $(\Delta L/L)$ is the rate of growth of the employed labor force, $(\Delta K/K)$ is the rate of growth of the country's reproducible capital stock and (R/Y) represents the amount of real cost reduction accomplished in the economy in the period in question, expressed as a function of GDP. s_L and s_K are the shares of labor and capital in GDP. One can see that the first two terms attribute to the increments of labor and capital, respectively, contributions measured by their respective shares in GDP.

The main objective of this section is to point out that the earnings of capital can be thought of as capital's gross-of-depreciation rate of return $(\rho+\delta)$ times K_{t-1}, the beginning of period capital stock; and the share of capital is therefore $(\rho+\delta)K_{t-1}/Y_t$. Taking the share of capital times $\Delta K_t/K_{t-1}$ we get:

(2) $$\frac{(\rho+\delta)K_{t-1}}{Y_t}\times\frac{\Delta K_t}{K_{t-1}}=(\rho+\delta)\times\frac{\Delta K_t}{Y_t}$$

that is, expressed in words:

$$\text{capital's contribution to growth in year t} = \frac{\text{net investment}}{\text{GDP}}\times \text{gross-of-depreciation rate of return}$$

This is a much more insightful, much more intuitive, and much more readily communicable way of representing capital's contribution to the growth rate than the standard "share of capital" times "rate of net increase in the capital stock". Most business owners and business executives would boggle at the standard definition, but all of them would quickly grasp the meaning (and the common sense) of measuring investment's contribution to growth as being equal to net investment times an appropriate rate of return. [That rate of return is measured gross of depreciation because we are estimating the effect of investment in GDP, and GDP itself is measured inclusive of depreciation.]

The specific point that I want to make in the present section is that, as equation (2) tells us, the relevant rate of return is precisely the rate of return that generates capital's share, as measured in the traditional representation. That is to say, the whole return to reproducible capital divided by the whole reproducible capital stock.

When we divide the GDP of a country into only 2 parts, we pretty much have to aggregate land along with reproducible capital. The easy way to deal with this is to separate "basic land" (call it A) from the rest of capital (what we call reproducible capital, including improvements to land, which are counted as investment in the national accounts). Doing this, we can reformulate the traditional approach as:

(3) $$\frac{\Delta Y}{Y}=S_L\frac{\Delta L}{L}+S_K\frac{\Delta K}{K}+S_A\frac{\Delta A}{A}+\frac{R}{Y}.$$

Here ($\Delta A/A$) is equal to zero, but the term $\Delta A/A$ has meaning because attached to it is the share of GDP (S_A) that goes to the remuneration of the land factor. Here we will take S_A to be .04. We will use three alternative assumptions for the values of S_K and S_L, respectively: (i) S_K = .04 and S_L = .56; (ii) S_K = S_L = .48; or (iii) S_K = .56 and S_L = .40.

Thus, reproducible capital's contribution to growth will be .0144 (=.48×.03) under the first set of assumptions and .012 (= .40×.03) and .0168 (= .56×.03) under the second and third sets of assumptions.

Rates of Return Are Implicit in the Mechanics of Growth

We have already introduced enough component parts to be able to show, quite simply, how a growth process implies (or perhaps better, has hidden within itself, a real rate of return to reproducible capital). Assume an economy that is growing at g percent per year, with reproducible capital receiving a fraction a of its GDP, and with gross investment accounting for the fraction s of GDP. If the depreciation rate is δ, then net investment (=ΔK) is equal to gross investment minus depreciation.

(4) $$\Delta K_t = \underline{s}Y_t - \delta K_{t-1}.$$

That is to say, gross investment ($\underline{s}Y_t$) serves to cover the depreciation of the old capital stock, plus the current increase in that stock.

(4') $$\underline{s}Y_t = \delta K_{t-1} + \Delta K = \delta K_{t-1} + \frac{\Delta K}{K_{t-1}} \cdot K_{t-1}$$

(4'') $$\underline{s}Y_t = (\delta + g)\, K_{t-1}.$$

This last equation builds in the notion of growth equilibrium, with capital growing at the same rate (g) as output. This says that last period's capital stock is this year's gross investment divided by (δ+g).

Here we can get directly to the gross-of-depreciation rate of return (ρ+δ).

(5) $$(\rho+\delta) = \frac{\text{Return to Reproducible Capital}}{\text{Stock of Reproducible Capital}} = \frac{\underline{a}}{\underline{s}} \frac{Y_t}{Y_t/(\delta+g)}$$

(5') $(\rho+\delta) = \underline{a}(\delta+g)/\underline{s}$

(5") $\rho = [\underline{a}(\delta+g)/\underline{s}] - \delta.$

Table 2 elaborates on this result for a range of values of the key parameters. Our baseline case has GDP growth occurring at 3% per year, gross investment equal to 20% of GDP, reproducible capital receiving a return equal to 48% of GDP, with a depreciation rate of 3% in such capital. This package of assumptions yields a gross-of-depreciation rate of return (ρ+δ) of 16.8% (not shown in the table) and a net rate of return – the object of our interest – of 12.8% (middle figure of Panel A).

Panel A explores how this "built-in" rate of return changes as one modifies the assumptions about the rate of depreciation and the share of reproducible capital. This panel reveals that the rate of return is modestly affected as the depreciation rate varies from 3 to 4 to 5 percent per year, becoming higher with higher depreciation rates. The effect of changing reproducible capital's share from .40 to .48 to .56 is somewhat more pronounced. It is interesting to note, however that all but two of the calculated net rates of return in the Panel A lie between 10% and 15.6%.

TABLE 2

RATES OF RETURN IMPLIED BY GROWTH SCENARIOS

Panel A: Varying rates of depreciation and capital's share in GDP

Share of Reproducible Capital in GDP	Rate of Depreciation .03	.04	.05
	Net Rate of Return (ρ) under equilibrium growth		
.40	9%	10%	11%
.48	11.4%	12.8%	14.2%
.56	13.8%	15.6%	17.4%

Gross investment = .20 × GDP
Rate of GDP growth = .03

Panel B: Varying Rates of Depreciation and the Share of Gross Investment in GDP

Gross Investment ÷ GDP	Rate of Depreciation .03	.04	.05
	Net Rate of Return (ρ) under equilibrium growth		
.15	16.2%	18.4%	20.6%
.20	11.4%	12/8%	14.2%
.25	8.5%	9.4%	10.4%

Rate of GDP growth = .03
Return to reproducible capital = .48 × GDP

Panel C: Varying Rates of Depreciation and the Rate of GDP Growth

Rate of GDP Growth g	Rate of Depreciation .03	.04	.05
	Net Rate of Return (ρ) under equilibrium growth		
.02	9.1%	10.4%	11.8%
.03	11.4%	12.8%	14.2%
.04	13.8%	15.8%	16.6%
.05	16.2%	17.6%	19.5%

Return to Reproducible capital = .48 × GDP
Gross Investment = .20 × GDP

Panel B shows the sensitivity of the rate-of-return calculation to changes in the rate of gross investment, together with the rate of depreciation. Here the sensitivity to changes in the depreciation rate is still modest, but the rate or return responds quite strongly to changes in the rate of gross investment. It is pretty obvious that this should be so, since the formula for generating the capital stock as a multiple of GDP shows that capital stock will be proportional to the share of investment in GDP. Note, however, that all but two of the net rates of return shown in panel B lie between 9.4% and 18.4%.

Panel C of Table 2 shows how the results are modified if we change: a) the rate of depreciation and b) the rate of GDP growth. Here the sensitivity appears to be quite strong to changes in g. This is to be expected. Note that the rate of investment is being held constant at 20% throughout this panel. A higher rate of growth coming from a given rate of investment is best explained by a higher rate of real cost reduction (increased total factor productivity). Such increased productivity is known to result in higher overall returns, typically to all factors of production. To conclude on Panel C, note that all but two of the rates of return reported there lie between 10.4% and 17.6%.

What If We Don't Have Equilibrium Growth?

In this tumultuous world, some readers might be troubled by the idea of a set of calculations that are based on the convenient assumption of equilibrium growth – that is, of a situation in which the country's GDP and its stock of reproducible capital are growing at the same rate. Fortunately, it is easy to correct for this situation. From equation (4), we know that

(6) $$\frac{\Delta K_t}{K_{t-1}} = \underline{s}\,\frac{Y_t}{K_{t-1}} - \delta.$$

Previously, we replaced $\Delta K_t/K_{t-1}$ by g (= the rate of growth of GDP), assuming that capital and output were growing at the same rate. Now we simply replace $\Delta K_t/K_{t-1}$ by g + e, which allows for the capital stock to be growing faster (e > 0) or slower (e < 0) than output.

In reality, it is quite plausible that capital will sometimes grow systematically faster than output, and sometimes slower for a substantial period of time. For e > 0, we have the fact that in most low-income countries, the ratio of capital to output is lower than in most advanced countries. Thus it is reasonable to believe that as a long-run tendency in the process of development, the rate of growth of capital might be a point or two higher than that of GDP. On the other hand, when a country is enjoying a spurt of growth due to very rapid real cost reduction (= TFP increase), without a big increase in the saving rate, we can expect output to be growing a point or two or three faster than GDP. Finally, we have cases like those of China and the other "Asian Tigers" (Taiwan, Korea, Thailand, and Malaysia). Here very rapid growth was accompanied by huge investment rates (reaching over 40% of GDP in China's case). Here it is almost certain that, in spite of the high rates of GDP growth of these countries in their growth-boom periods, capital was almost certainly growing significantly faster than output.

Table 3 has the purpose of showing how rates of return respond when we have divergences between the rates of growth of capital and output.

In Panel A of Table 3 we examine the case of the ratio of capital to output gradually rising through the process of development. It seems reasonable that this would entail a higher than "normal" rate of gross investment, so Panel A allows for investment rates varying from 20 to 25 or 30 percent. Again we find a significant concentration of calculated rates of return – all but two cases lie between 9.4 and 15.2 percent.

TABLE 3

RATES OF RETURN WHEN CAPITAL GROWS FASTER OR SLOWER THAN OUTPUT

Panel A: Moderately Higher Investment Rates with "Normal" Growth (long-term trend case)

Investment Rate (s)	.01	.02	.03
	e = "excess" rate of growth of capital stock		
	Net Rate of Return (ρ)		
.20	12.8	15.2	17.6
.25	9.4	11.4	13.3
.30	8.8	10.4	12.0

Assumed: return to reproducible capital = .48 GDP
: Rate of growth of output = 3%
: Rate of depreciation = 4%

Based on the formula:

$$\rho = [a(g+e+\delta)/s] - \delta$$

Panel B: Spurts of Output Growth Driven By Productivity, With "Standard" Investment Rate

Rate of GDP Growth (g)	0	-.01	-.02
	e = "excess" rate of growth of capital stock		
	Net Rate of Return (ρ)		
.03	12.8%	10.4%	8.0%
.04	15.2%	12.8%	10.4%
.05	17.6%	15.2%	12.8%
.06	20.0%	17.6%	15.2%

Assumed: return to reproducible capital = .48 GDP
: Investment rate = .20
: Rate of depreciation = .04

Based on the formula:

$$\rho = [a(g+e+\delta)/s] - \delta$$

Table 3 (continued)

Panel C: High Growth Rates Together With High Investment Rates (Asian Tiger Case)

Rate of GDP Growth	e = "excess" rate of growth of capital stock: 0	-.01	-.02
	Net Rate of Return (ρ)		
.06	9.7%	11.1%	12.5%
.08	12.5%	12.8%	15.2%
.10	15.2%	16.6%	17.9%

Assumed: return to reproducible capital = .48 GDP
: Investment rate = .35
: Rate of depreciation = .04

Based on the formula:

$$\rho = [\underline{a}(g+\underline{e}+\delta)/\underline{s}] - \delta$$

Panel D: Very High Growth Rates Together With Very High Investment Rates (Chinese Case)

Rate of GDP Growth	e = "excess" rate of growth of capital stock: .02	.04	.06
	Net Rate of Return (ρ)		
.08	10.9%	13.1%	15.2%
.10	13.1%	15.2%	17.3%
.12	15.2%	17.3%	19.5%

Assumed: return to reproducible capital = .48 GDP
: Investment rate = .45
: Rate of depreciation = .04

In Panel B we explore the case of rapid output growth largely propelled by real cost reduction (TFP improvement). In this case output grows more rapidly than the capital stock ($\underline{e} < 0$). Note that a declining capital stock (relative to output) implies a lower rate of return. Recall that our table deals with a given share of capital in the nation's GDP. If the capital stock is declining relative to output that means that last period's capital stock is larger relative to today's return to capital, than would be the case with a constant ratio of capital to output. Today's share of GDP going to capital is thus spread over a larger last-period capital stock, resulting in a lower rate of return. Note that in Panel B, we have all but two of the calculated rates of return lying between 10.4% and 17.6%.

Panel C tries to simulate the Asian Tigers case – high growth rates together with a high rate of investment (equal to 35% of GDP). This has a surprisingly moderate effect on rates of return, with all but two of the cells in Panel C lying between 11.1% and 16.6%. I suspect that the Asian Tigers' actual rate of return was higher than is shown here, and that the reason for that was a return to reproducible capital accounting for more than 48% of GDP. But I do not want to exaggerate rates of return in the present paper – the results are high enough to be surprising, even when conservative assumptions are being made. Moreover, later explorations will result in even more surprising rates of return, again under quite conservative assumptions.

Panel D is designed to simulate the case of China, with its enormous ratio of investment to GDP. Under the assumption ($\underline{s} = .45$), it seems reasonable to allow for capital's growth rate to exceed that of GDP by even more than we contemplate in Panel C. Thus, Panel D incorporates the possibility of capital's growth rate being 4 or even 6 percentage points higher than that of GDP. Once again, we find a notable concentration of calculated rates of return. All but two of them lie between 13.1% and 17.3%.

Allowing For Infrastructure Investment

In this section we explore the consequences of taking account of the fact that many public sector investments do not produce an income stream in the form of cash. This is not to say that they are not worthwhile – roads, bridges, the judicial system, the public administration all have important roles to play in a functioning modern society. But their economic benefit lies in increasing the productivity of other factors of production, or adding to the utility of consumers, rather than generating a cash flow of their own.

So when we measure the profits, interest and rents generated by an economy, these returns accrue to (and reflect the marginal productivity of) investments other than these "infrastructure" portions of the capital stock.[2]

It is obviously quite a task to separate out these non-revenue-generating investments from the others that do yield an income stream, but it should be feasible to reach a reasonable division in any given country. (The money-making public enterprises usually keep standard business accounts, publish annual reports, etc.) For our purposes in this section, we are seeking a rough idea of the likely order of magnitude of the share of infrastructure investment in a typical developing country's economy. To do this I draw upon a study by Everhart and Sumlinski,[3] in which they present a breakdown of total investment into "private" and "public" categories for 63

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[2] I am not happy with the term infrastructure in this connection, but have found no easy substitute for it. What I am aiming at is to divide public investments into two big groups -- those that really represent business investment, but with businesses in the public sector (like Chile's Codelco, Mexico's Pemex, plus many public sector electricity, gas and water companies) on the one hand, and on the other hand those that yield absolutely no revenue (like the buildings housing public administration and free public schools) or very minor receipts (like national parks and museums that charge modest admission fees). The first group should be lumped together with private sector investments -- they are the money-making part of the story. The second group should be separated out; and it is to this group that I am referring when I here use the term "infrastructure investments."

[3] Everhart, Stephen and Mariusz A. Sumlinski, 2001, Trends in Private Investment in Developing Countries: Statistics for 1970-2000 and the Impact on Private Investment of Corruption and the Quality of Public Investments, International Finance Corporation Discussion Paper No. 44, Washington, DC: The World Bank.

developing countries. They show shares of public investment in GDP that range to over 20%, and shares of public investment in total investment that range to over 50%. In more than half of the countries covered, public investment ranges between 5 and 10 percent of GDP and between 25 and 50 percent of total investment. Our decision was to consider the lower bounds of these ranges to represent the nonremunerative portion of public investment, the idea being that all countries have roads and schools and public buildings, and that the countries that beyond this also have money-making public enterprises will reveal this in higher fractions of GDP and of total investment being devoted to public investment.

The end result of all of this is that in our "standard" example, where total investment is equal to 20% of GDP, we assign one quarter of this to "infrastructure". This enables us to calculate the average rate of return to reproducible capital in "remunerative" investment (both private and public) simply by dividing our previously calculated rate of return of 12.8% by .75. This reflects that the income we are counting in the numerator is in fact accruing to only 75% of our previously calculated capital stock.

Table 4 replicates two panels from Table 2, calculating the return to remunerative investments rather than the return to the total capital stock. It is easy to see that the "center of gravity" of these estimates moves from the 10-15% range to the 15-20% range. But that is just the beginning. In the next section we turn to the special case of investment in residential housing.

Dealing With Investments in Residential Housing

There are several reasons why residential housing should be treated separately in an exercise like this. In the first place, a goodly share of such housing is owner-occupied; on this portion the makers of a country's national accounts introduce an "imputed rent". Rarely does that rent imply a real rate of return (on housing investment) greater than 6% per annum. Secondly, rates of return implied by the ratio of rents to house values tend to be quite low. A long-time rule of thumb was that monthly rent should equal 1% of house value. This was often

TABLE 4

RATES OF RETURN TO REMUNERATIVE INVESTMENTS

Panel A: Varying rates of depreciation and capital's share in GDP

Share of Reproducible Capital in GDP	Rate of Depreciation .03	.04	.05
	Net Rate of Return (ρ) under equilibrium growth		
.40	12%	13.3%	14.7%
.48	15.2%	17.1%	18.9%
.56	18.4%	20.8%	23.2%

Gross investment = .20 × GDP
Rate of GDP growth = .03

Panel B: Varying rates of depreciation and the rate of GDP growth

Rate of GDP Growth g	Rate of Depreciation .03	.04	.05
	Net Rate of Return (ρ) under equilibrium growth		
.02	12.1%	13.9%	15.7%
.03	15.2%	17.1%	18.9%
.04	18.4%	21.1%	22.1%
.05	21.6%	23.5%	26.0%

Return to Reproducible Capital = .48 × GDP
Gross Investment = .20 × GDP

interpreted as covering 1-2% for taxes, 1-2% for maintenance, 1% for insurance, and 2-3% for depreciation, with 6% representing the net real rate of return. But today one often finds free-market monthly rents in the range of 1/2 percent of the value of the dwelling. This can be rationalized by the owners expecting a good part of their return to come in the form of rising real values of their properties (negative depreciation = appreciation). But the national accounts do not measure this as part of the return to capital (profits, interest, rents). So in this case the measured return turns out to be much less than 6%. Third, in most countries the government engages in special housing projects for the poor and often also the not-so-poor. These units pay rents, but usually at a rate well below a standard market level, implying a real rate of return well below 6%.

The end of this story, for us, is that when we impute a 6% measured real rate of return to residential housing, we are probably erring on the upward side. From the point of view taken in this paper, this is a conservative assumption – if we imputed a 3 or 4 percent rate of real return to housing investment, we would end up with even higher implied rates of return to general business capital than the ones we are about to calculate.

To build a capital stock of residential housing we take housing investment to equal 3% of GDP (typically a conservative assumption) and build its capital stock by the formula $K_h = .03Y/(g+\delta_h) = .03Y/(.03+.02) = .6Y$. A 6% net real return on this capital stock would yield net income equal to .036Y.

To get the implied net rate of return to non-infrastructure, non-housing capital, we go through the following steps:

i) Total Stock of Reproducible Capital

$= .2Y/(.03+.04) \qquad = 2.857Y$

ii) Total Stock of Remunerated Capital

= .75 × 2.857Y = 2.143Y

iii) Total Stock of Housing Capital

= .03Y/(.03+.02) = .600Y

iv) Total Stock of "Business Capital"

2.143Y - 600Y = 1.543Y

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v) Total Return to all Capital = .480Y

vi) Total Depreciation on All Remunerated Capital

.04 × 2.143Y = .086Y

vii) Net Return to all Remunerated Capital

.480Y - .086Y = .394Y

viii) Net Return to Housing Capital

.06 × .600Y = .036Y

ix) Net Return to "Business Capital"

.394Y - .036Y = .358Y

x) Rate of Return on "Business Capital"

.358Y ÷ 1.543Y = <u>23.2%</u>

We can re-use most of the above calculations if we stick to our "standard" assumption of a depreciation rate of 4% on the overall capital stock. <u>Changing the share of reproducible capital in GDP to .40 we get</u>:

v) Total Return to all Capital = .400Y

vi)	Total Depreciation on all Remunerated Capital	= .086Y
vii)	Net Return on all Remunerated Capital	= .314/Y
viii)	Net Return on Housing Capital	= .036Y
ix)	Net Return on "Business Capital"	= .278Y
x)	Rate of Return in "Business Capital"	
	.278Y ÷ 1.543Y	= 18.0%

Now, changing the share of reproducible capital to .56, we get:

v)	Total Return to all Capital	= .560Y
vi)	Total Depreciation on all Remunerated Capital	= .086Y
vii)	Net Return on all Remunerated Capital	= .474Y
viii)	Net Return on Housing Capital	= .036Y
ix)	Net Return on "Business Capital"	= .438Y
x)	Rate of Return on "Business Capital"	
	.438Y ÷1.543Y	= 28.4%

* * * * *

To explore the impact of changing GDP growth on the rate of return to "business capital," we have to go through all ten steps. To remain on the conservative side, we will do so under the assumption that the return to reproducible capital is 40% of GDP. In Table 2, this assumption, with a 4% overall depreciation rate yields a rate of return to all reproducible capital equal to 10%. Our base case here is the one yielding an 18.0% return to "Business Capital". That is built on the assumptions of $\delta = .04$, $g = .03$; return to reproducible capital = .40 × GDP; Investment = .20 × GDP (see first case treated on previous page).

Next, we maintain all of these assumptions but one, making the rate of growth (g) equal to .02. Now we have

i)	Total Stock of Reproducible Capital	
	= .2Y/(.02+.04)	= 3.333Y
ii)	Total Stock of Remunerated Capital	
	= .75 × 3.333Y	= 2.500Y
iii)	Total Stock of Housing Capital	
	= .03Y/(.02+.02)	= .750Y
iv)	Total Stock of "Business Capital"	= 1.750Y
v)	Total Return to all Capital	= .400Y
vi)	Total Depreciation on all Remunerated Capital	
	.04 × 2.500	= .100Y
vii)	Net Return on all Remunerated Capital	= .300Y
viii)	Net Return to Housing Capital	
	.06 × .750Y	= .040Y
ix)	Net Return on "Business Capital"	= .260Y
x)	Rate of Return on "Business Capital"	
	= .260Y ÷ 1.750Y	= <u>14.8%</u>

Now we <u>raise the GDP growth rate (g) to 4%</u>, and repeat the exercise:

i)	Total Stock of Reproducible Capital	
	= .2Y/(.04+.04)	= 2.500Y
ii)	Total Stock of Remunerated Capital	
	= .75 × 2.500Y	= 1.875Y

iii) Total Stock of Housing Capital

= .03Y/(.04+.02) = .500Y

iv) Total Stock of "Business Capital"

1.875%Y - .500Y = 1.375Y

v) Total Return to all Capital = .400Y

vi) Total Depreciation on all Remunerated Capital

.04 × 1.875Y = .75Y

vii) Net Return on all Remunerated Capital = .325Y

viii) Net Return to Housing Capital

.06 × .500Y = .030Y

ix) Net Return on "Business Capital" = .275Y

x) Rate of Return on "Business Capital"

= .275Y/1.375Y = 21.5%

Needless to say, all these rates would be higher if we had assumed that the return to reproducible capital was .48Y or .56Y, (the alternative assumptions we previously explored).

The conclusion to be drawn, which I believe to be inescapable, is that business capital, in most developing countries, receives a very substantial rate of return. This is a fact that, in my opinion, has not been fully "digested" by the economics profession. Obviously, if it were easy for anybody (foreigner or local national, insider or outsider) to put down some capital and readily gain a real rate of return of 20% or more, we would see lots of money flowing into those opportunities and the rate of return would be bid down.

Yet the rate of return is there. The national accounts do not exaggerate returns in capital (even implicitly). If anything, they understate them. So there is something of a mystery here, to be delved into. Surely some of this measured return represents “monopoly profits”, which are not properly part of the true return to capital, but are hard to disentangle from ordinary profits. A further part of the high measured return to business capital surely represents “inframarginal investments” – that is, investments with individually high returns which are exploited in any given time period, but that are not marginal investments. The image here is that there are probably some few investments each year that turn out to have real yields of 50, 40, and 30 percent. These yields contribute to a high average rate of return, but this does not mean that adding to the stock of investible funds would lead to any (or much) of that incremental money being invested in items of super-high yield (these opportunities being so attractive that they are exploited anyway, with or without extra funds being placed in the market). Still, there is evidence that at least in some developing countries, real yields on business capital in excess of 20% prevail year after year after year – suggesting at the very least either that important new “inframarginal” opportunities keep coming onto the scene year after year, or alternatively, that the inframarginal aspect is not a big part of the story, and that a lot of business capital keeps earning very high real rates of return. Finally, there is the possibility that these high rates of return are really there, but require a degree of local knowledge and “savvy” that is hard for outsiders to replicate. Perhaps outsiders do put up money, and it truly yields 20% or more, but foxy locals manage to cream off enough of this return (even quite legally) so that the investment no longer seems very attractive to foreigners.

The above are merely speculations on my part – they are one person’s stab at potential answers to the puzzle of how such high measured rates of return can exist and persist. They are not put forward as the true answers. My main purpose here is to call attention to the facts of the case and to the puzzle that those facts create for us and others to try to answer.

A final word about the facts. The numbers that I used in the examples in this paper delineate what I would consider a very reasonable range. It is hard to imagine a situation in which the real rate of depreciation on the total reproducible capital stock of a sizeable country is outside the range between .03 and .05. Likewise, in most countries the ratio of gross investment to GDP actually does lie within the range of .15 to .25.[4] Finally, it is hard to imagine a sizeable country in which the gross return to reproducible capital was less than 40% or more than 56% of its GDP. (Note that after depreciation a gross return of 40% of GDP turns into a net return of less than a third of GDP, and that a gross return of 48% of GDP turns into a net return of less than 40% of same.) Overall, the assumed "packages" of numbers seem to form a sort of cage which hems us in from all sides.

There is every reason for us and others to proceed down a more time- and resource-consuming route, of building up direct time series on the real capital stocks and real returns to capital of different classifications, for as many countries as we can. These are useful not only in order to generate more precise results for particular countries, but also to reassure people of the reasonableness of the numerical assumptions made in studies like this one. But in the meantime, the exercises carried out in this paper present, I am sure, a broad picture quite similar to the one that will emerge from more careful study.

Dealing With R&D and Other "Hidden Investments"

A pharmaceutical company spends $100 million on research seeking a better treatment for diabetes; a restaurant opens a new campaign by blanketing its neighborhood with advertising about the experience and honors of its new chef; an existing firm manages to disguise as an

[4] In Everhart and Sumlinski's study (op. cit.) the rate of gross investment to GDP lay between .15 and .25 for 37 out of 63 countries, and between .12 and .30 for 53 of them.

expense the costs of leveling and preparing the site for its new headquarters. From an economic point of view all these costs represent investment – outlays in the current period aimed at generating or supporting an income stream that will flow over a number of future periods. Conceptually, they should all be capitalized, with the capital sum then being depreciated over the span of that future income stream. Legally, the first two are legitimately classed as expenses – the first because those expenses qualify as R&D, the second because advertising outlays are always expenses. Only in the third is it illegal to claim the outlays as a current expense.

But to estimate the true economic rate of return one should really reclassify all three outlays as investment, and at the same time augment the income of the firm by the same amount during the investment period. Many such operations occur in any national economy in a typical year, so when we are estimating rates of return, as in this presentation, we should be able to make adjustments so as to properly treat the outlays involved.

The needed adjustment entails three steps: first, to increase the GDP and the income received by capital by the amount of such outlays; second, to increase investment of the year by the same amount; and third, to depreciate that investment over time in an appropriate manner.

Assume that such expenses (of all kinds, legal and illegal) amount to 4% of a country's GDP in a typical year. To recalculate our base case we therefore augment our GDP figure from Y^o to $1.04Y^o$, our investment figure from $.20Y^o$ to $.24Y^o$, and our income from capital figure from $.48Y^o$ to $.52Y^o$. (Note: Y^o should be thought of not as just the GDP of a given year but as a whole time series, in our case growing at the rate of 3% per annum.)

Now we repeat our basic operations. The reproducible capital stock now becomes $.24Y^o/(g+\delta)$, in this case $.24Y^o/(.03+.04)$, and the return to reproducible capital becomes $.52Y^o(1.04)$. The gross rate of return is thus $.52Y^o(1.04)/[.24Y^o/(.03+.04)]$. This works out to a 15.8% rate of return compared with a 16.8% rate in our base case – $.48Y^{o}/ [.20Y^{o}/ (.03+.04)]$. The calculated net rate of return would be 11.8% as compared to 12.8% in the base case.

It is likely, however, that these "new" types of investment depreciate more rapidly than the old, raising, say, the average rate of depreciation from .04 to .0425. This would change the calculated gross rate of return to $.52Y^{o}(1.04)/[.24Y^{o}/(.03+.0425)]$, which equals 16.34%. Its corresponding net rate of return is 16.34% minus 4.25%, or 12.09%.

This exercise should be sufficient to dispel any doubts that making plausible adjustments for R&D and other "hidden investments" would not change the order of magnitude of our results in any important way.