

Chapter 2: Investment and Physical Capital

1. Introduction

Properly conceived, investment is the essence of the process of creating a market economy. Transition is typically thought of as re-writing the rules, and progress in transition is measured by what is still missing among the rules – and now institutions as well. But the big problem for Russia is not what is missing, but rather what is there – as a result of 70 years of misallocation. The real task of transition is to unmake and rebuild that old economy, i.e., investment. All else is prelude.

Analysis of investment decisions can be broken down into two components: the gap between the desired and actual capital stock, and the optimal path in closing this gap. Much of the analysis of investment in Russia implicitly focuses on the latter problem, given the emphasis on corporate governance and corruption as determinants. In the case of Russia, however, there are important misperceptions with regard to both the actual and desired capital stocks, and without understanding this a complete understanding of the problem of investment is unobtainable. In particular the actual capital stock in Russia is over-stated due to a failure to write down to market, and the desired capital stock is underestimated because of an unwillingness to recognize the distance to the market (the competitiveness of Russian capital). In this paper we examine the forces that lay behind these two tendencies.

The ironic situation of the Russian economy is that changing the rules, and even the institutions, of the economy will not make many of these assets profitable to use in a market economy. Yet, as we will see agents still prefer to keep them in operation. This represents an important puzzle about the Russian economy that we address in this chapter. Moreover, it is the continued operation of many of these enterprises that makes the price of investment goods in Russia extraordinarily high when measured at international prices. This means that the increment to productive capacity that Russia gets for its investment effort is low compared with other comparable countries, including transition economies.¹

¹The fact that investment rates measured at world prices is correlated with levels and growth rates of output across countries is a robust result in development economics (8, 15). The critical question is whether

Why is the investment problem under-estimated? One reason is that the inherited capital stock from Soviet times was so large. Since the Soviets over-invested for 70 years, one might logically ask, how could underinvestment be the problem now? Under-investment could, in fact, be a healthy phenomenon. But this misses a fundamental point. The Soviet Union did not just over-invest; it mis-invested. It built and installed the wrong kinds of capital, and it located this capital in the wrong places. As a result, the actual and market value of the inherited capital stock is low. The depreciation of the capital stock caused by liberalization and the transition to the market economy is, in fact, disinvestment.² Hence, the market value of the capital stock at the start of transition was far below its notional value.

Yet when people speak of investment needs, they most often refer to what it would take to make existing physical configurations viable.³ This is not at all the correct way to view the issue, because it takes Soviet investment decisions as the correct base to build on. Yet it is a characteristic way of viewing the problem, and we will focus on this.

2. Is Investment a Problem in Russia?

How important a problem is the investment rate in Russia? The Soviet period demonstrated that very high investment rates were no guarantee against stagnant, and even decreasing growth rates. This has led many observers to de-emphasize the role of investment rates, and to focus instead on organizational improvements and other elements of economic reform as crucial. The implicit assumption is that inherited inefficiency takes the form of production well within efficiency frontiers, and that privatization and other institutional reforms can lead

this is due to distortions that raise the prices of investment goods, or the relative efficiency of the production of consumption goods as in poorer countries. We argue below that in the case of Russia it is primarily problems on the investment side that dominate.

²What is the market value of the capital stock? It is that capital stock's contribution to the expected discounted value of future profits. The historical value of the capital stock, in contrast, is the sum of past investment, less depreciation. Given the regime change implied by transition, the probability that the market value would be within an order of magnitude of the historical value, let alone the same, must be very close to zero. Even in market economies the two quantities don't coincide, but on average they would be close. The problem in Russia is the systematic bias: that the market value is systematically lower than the historical value, and that the difference is at least an order of magnitude.

³That is, these analysts assume that the capital stock itself is fine but the problem is with institutions and organization.

to rapid improvements in productivity growth. A clear example of this view was offered by Palmeda and Lewis:⁴

There are no natural or economic obstacles to high economic growth in Russia, and the current situation need not be tolerated. Russia can rely on a skilled and inexpensive labor force, large and economically attractive energy reserves, and surprisingly, much spare capacity in potentially productive industrial assets. Explicit and targeted social policies combined with balanced and enforceable regulations (mostly at the sector level, involving taxes, energy, land and red tape) would remove the most important market distortions. The payoff would be strong economic growth in Russia (Palmeda and Lewis, 2001: 49).

While organizational improvements are clearly important, this view ignores the fact that the capital stock Russia inherited from the Soviet period – its installed capital – is highly inefficient and may not be competitive even with frontier management. This is partly the result of investment decisions with energy and other inputs that were priced too low, and without regard to the costs of the cold and location. Moreover, the enterprises that produce inefficient producer goods present a continued handicap for the growth process, as outlined below.

2.1. New versus Installed Capital

Especially in transition, it is crucial to distinguish the returns from installed and new capital. Installed capital is critical because inherited capital stocks from the Soviet period are so inefficient. Returns to new investment can be high, however, precisely because they can be appropriate to new economic circumstances.

The problem is how to encourage new investment that does not just replenish depreciated capital stuck in the wrong places. This is difficult due to the need of relational capital.

⁴Although Palmeda and Lewis focus primarily on industry impediments due to lack of competition, rather than macro institutional issues such as corruption, lack of labor mobility, or corporate governance.

3. Growth Models and Russian Growth

Recent literature on the sources of economic growth underscores the importance of investment. In their benchmark study, Ross Levine and David Renelt (1992) concluded that despite the dozens of policy or institutional variables that have been hypothesized to account for growth, the only truly robust correlation they found was that between growth and investment share of GDP. Their work spurred a number of subsequent efforts to analyze the prospects for long-term growth, including in transition countries. Such analyses typically proceed from some form of the Levine-Renelt growth equation (see 11):

$$\hat{y} = \alpha + \beta_1 y_0 + \beta_2 n + \beta_3 \text{sec} + \beta_4 i \quad (1)$$

where \hat{y} is the growth of per-capita GDP over some period, y_0 is initial per-capita GDP, n is population growth over the same period, sec is the secondary school enrollment rate (measured in the beginning period), and i is the investment share of GDP.⁵ This type of specification focuses on the role of catch-up in the growth process. Economies can expect rapid growth when there is a lot of catching up to do. The key policy variable, however, is the investment rate. Estimation of such equations for samples of transition economies shows that the role of investment is critical for growth projections (see, for example, 1). This is especially true when one considers policy and institutional variables. Some fixed effect variables might affect growth but Russian cannot change its climate.⁶

Sutela, 18, 216-7, for example, explores the prospects for Russian economic growth under three different scenarios for investment: a basic scenario which employs the historical average investment rate of 21%, an optimistic scenario which uses 30%, and a pessimistic scenario which uses a rate of 15%. Using a model like (1) Sutela shows that the long-run growth rate more than doubles going from the pessimistic to the optimistic scenario.⁷ The forecasts for \hat{y}

⁵In almost all of the cross-country literature \hat{y} is measured at international prices while i is measured at domestic prices. See 11 for example. The literature does not seem to make notice of this. We discuss the implications of this below.

⁶Though as we discuss in chapter 3 it could change the location of its industry and population.

⁷The forecasting model used by Sutela is the Levine-Renelt equation. In our notation it is:

$$\hat{y} = -0.83 - .35 * y_0 - .38 * n + 3.17 * \text{sec} + 17.5 * i$$

are given in table 1:

	Investment Rate	Per-Capita GDP Growth (\hat{y})
Pessimistic Scenario	15%	2.0%
Baseline	21%	3.0%
Optimistic	30%	4.7%

Table 1: Forecasts for GDP Growth Using the Levine-Renelt Equation

The critical lesson of these and similar exercises – based on the initial studies by Fischer and Sahay (2000) – is that investment is crucial for growth in transition economies. It then becomes important to ask whether Russia can produce the type of investment needed to meet Putin’s goals for growth.

This exercise is further pursued by Crafts and Kaiser (2002). Two important adjustments are made; first, they use additional explanatory variables such as the rule of law to tighten the forecasts. Second, they adjust the initial income variable to measure the gap from the frontier at the start of transition, not earlier.

These exercises are baselines for projections in transition economies. The key result of all these exercises, as the table shows, is that investment is the key variable for growth. A ten percent increase in the rate of investment leads to a 1.75% increase in the growth rate of GDP per-capita. Clearly, these results imply that meeting the Putinesque goals of doubling Russian GDP, will require a very high rate of investment.

4. How High Is Investment in Russia?

During the Soviet period investment rates were very high. The Soviet growth model was extensive, and investment rates exceeded 30% (See 13, 1786 for analysis). Much of this investment was wasted, however, due to the known inefficiencies of the Soviet model. Hence, when transition started there was need for investment to modernize the capital stock even as old capital had to be (or should have been) written off. To what extent did Russia invest in the post-Soviet era and how does this compare to other fast-growing economies.

We can summarize our findings in terms of three comparisons. First, the Russian investment rate is less than those observed in fast growing ("miracle" economies). Second, Russian investment is less than the levels observed in EU accession countries. Third, Russian investment levels are only in the middle of the pack of CIS countries.

4.1. Traditional Comparisons

Measured in the traditional manner — ratio of investment to GDP — Russia's investment rate is not that high by international standards. Figure 1 shows that the investment rate in Russia falls far below historical and current rates in Japan, China, South Korea, and the Czech Republic. Note that Korea's growth takeoff occurred when its investment rate rose above 25%, with so-called miracle periods occurring when the rate is even higher. Russia, in contrast, saw its investment rate drop to below 20% by the mid-1990s, down to under 15% in the post-crisis year of 1999.

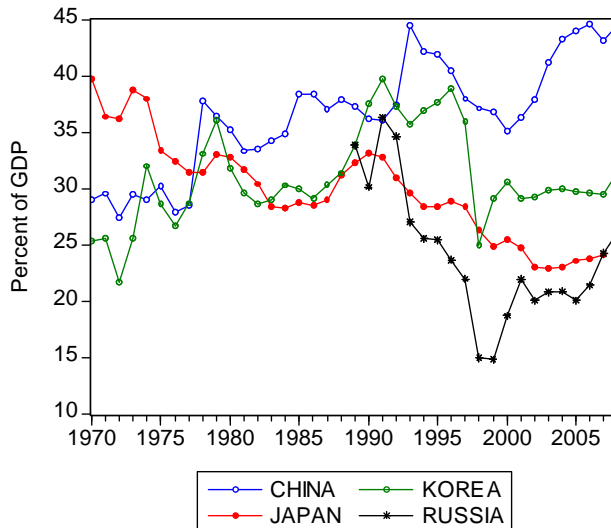


Figure 1: Gross Capital Formation for Selected Economies, Domestic Prices

In figure 1 we note that the investment rate of Russia is below that of Japan, China, Korea, and the Czech Republic. Notice that the takeoff in Korean growth occurs when the investment rate rises above 25%, and that the miracle periods occur when the investment rate

is even higher. Russian investment declined from the beginning of transition until 1999. Since then it has recovered – this is the sharp recovery in investment, and the rapid growth year to year that is talked about quite often. Nonetheless it is apparent that this is still significantly lower than other comparable economies.

	Investment/GDP Ratio %
EU Accession	
Slovakia	28.9
Czech Republic	29.1
Hungary	25.8
Estonia	30.2
Slovenia	25.5
Poland	21.4
Lithuania	22.0
Latvia	24.7
Romania	21.4
Bulgaria	18.2
Ex Soviet Union	
Azerbaijan	34.1
Belarus	25.4
Ukraine	21.5
Tajikistan	16.5
Uzbekistan	22.1
Russia	20.3
Kyrgyzia	17.7
Armenia	21.3
Kazakhstan	22.2
Georgia	25.2

Averages of observations from 1995-2005

Table 2: Investment Rates in Transition Economies

The fact that investment rates in Russia are lower now than in the early 1990's (let alone the Soviet period) may be less important if there has been a significant increase in the efficiency of investment. After all, one goal of economic reform has been to improve the nature of the investment process. Whether efficiency has actually risen is an important question that we discuss below. It is important to note, however, that the investment rate is also low compared not only with fast growing economies but in comparison to slower growing ones too – Czech Republic, Japan in the 1990's.

The obvious, but important, conclusion is that if Russia did not have oil this investment

rate would lead to much slower growth. Russia's GDP level and its growth rate are enhanced by its resource abundance.

4.2. PPP Comparisons

In the previous section we analyzed Russian investment rates measured at domestic prices. Development economists have increasingly turned their focus, however, to measuring investment at international prices. Using international prices allows one to measure the true value of the physical capital obtained as a result of the investment effort. If a country's relative price of investment is high this means that the country gets less increase in capital stock per unit of savings than in a country with a lower relative price.⁸ This is because in many developing economies investment is the focus of many policy distortions. The relative price of investment when measured at international prices is higher in poor countries than in rich countries.⁹ This means that when we measure investment rates at international prices richer countries tend to invest a higher share of GDP than poor countries.¹⁰ In this section, we examine the relative price of investment in transition economies.

For transition economies there is an extra complication. Under the Soviet system the relative price of investment was low due to planners' preferences. Consumption was a residual priority. Hence, liberalization of prices causes a shock to the relative price of investment, pushing it up in the early stages of transition.¹¹ In the ensuing period, however, the relative price of investment declines. Figure 2 shows this decline in Hungary and Poland. In Poland the decrease in the relative price of investment was more immediate – a reflection of the

⁸De Long and Summers 2, 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.

⁹In principle, the concept of high and low is relative to an international benchmark. In practice, the Penn World Tables uses the US as a benchmark. So if the relative price is greater than unity it means that the cost of increasing capital (in terms of foregone domestic consumption) is higher than in the US.

¹⁰This was first noted by 17, 339.

¹¹This has been intensively analyzed by Richard Ericson (1999). Essentially, costs of investment were shifted, under Soviet pricing rules, onto consumption. This was an implicit tax on consumption to finance investment. When price liberalization occurs, investment goods must cover their costs, so their relative price rises.

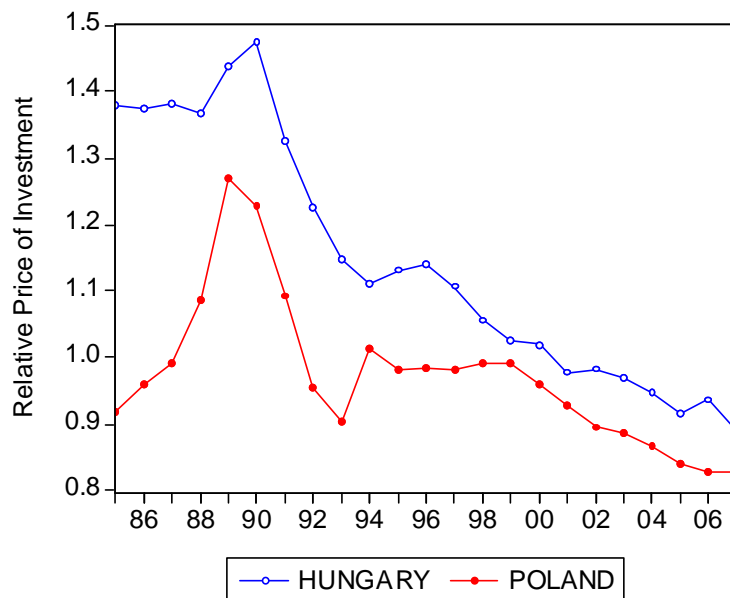


Figure 2: The Relative Price of Investment in Hungary and Poland: The Impact of Liberalization and Transition

quicker pace of price liberalization in general. In both cases, however, the relative price of investment is significantly lower in the second half of the 1990's than in the first half. Hence, transition led to an effectively lower relative price of investment in Hungary and Poland.

In Russia price liberalization also led to a shock to the relative price of investment. Subsequently, however, the relative price of investment has been increasing, significantly. Indeed, the distortion in relative prices (which could be measured as the difference from unity) has more than doubled during transition. A similar tale can be told for Ukraine.

Measured at international prices the relative price of investment is high in transition economies in general, and in Russia in particular (see figure 3). Notice that the dispersion in relative prices has increased over the period, the coefficient of variation increasing from .188 in 1991 to .304 in 2000.¹² This is somewhat surprising. One might expect that market reforms would cause the relative price of investment to converge. At least this would be so if all differences in relative prices were due to planning distortions. These are important, but they are not the only ones. For example, governments may engage in policies that distort

¹²Notice that much of this divergence is caused by Russia and Ukraine.

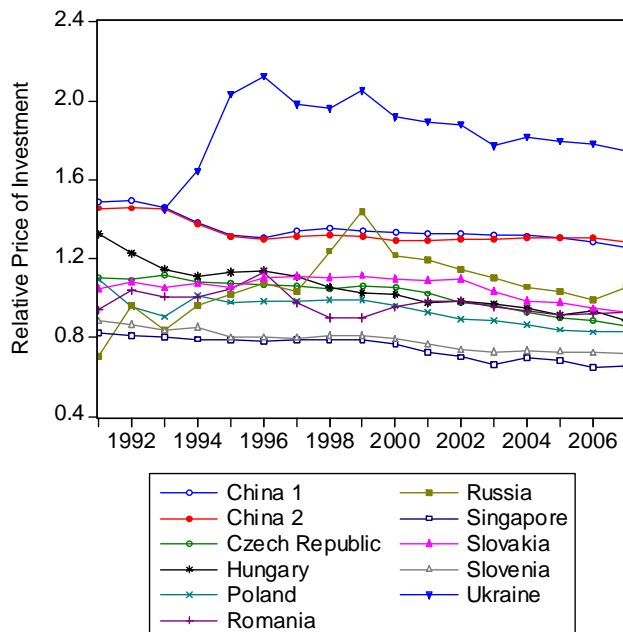


Figure 3: The Relative Price of Investment in Transition Economies

prices. That seems to be what is taking place in Russia and Ukraine in figure 3.

Compare the same countries as in figure 4 above:

Given the high relative price of investment in Russia (and Ukraine) it follows that investment rates are lower when measured at international prices (figure 5). The adjustment is quite dramatic for Russia. Recall from table 1 that Russia invested, on average, about 20% of GDP at domestic prices. At international prices, however, the investment rate falls below 10% after 1998. Adjustment for international prices reduces investment rates for all of the economies displayed in figure 5, but the adjustment is highest for Russia and Ukraine. Moreover, the gap increased during the second half of the 1990's.

The impact of a high relative price of investment on growth is straightforward. It means that for any level of savings, the addition to the capital stock is lower. Hence, when we compare the relative price of investment to growth performance it is not surprising that we find a strong negative relationship for transition economies, as in figure 6. Notice that Russia is a bit of an outlier because of its energy abundance. It is less reliant, in a period of high and rising oil prices, on investment. The negative impact of the relative price of investment

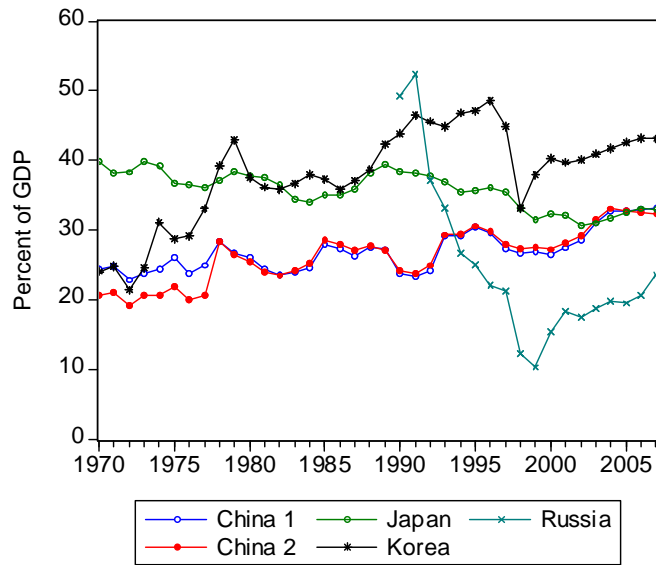


Figure 4: Gross Capital Formation at International Prices

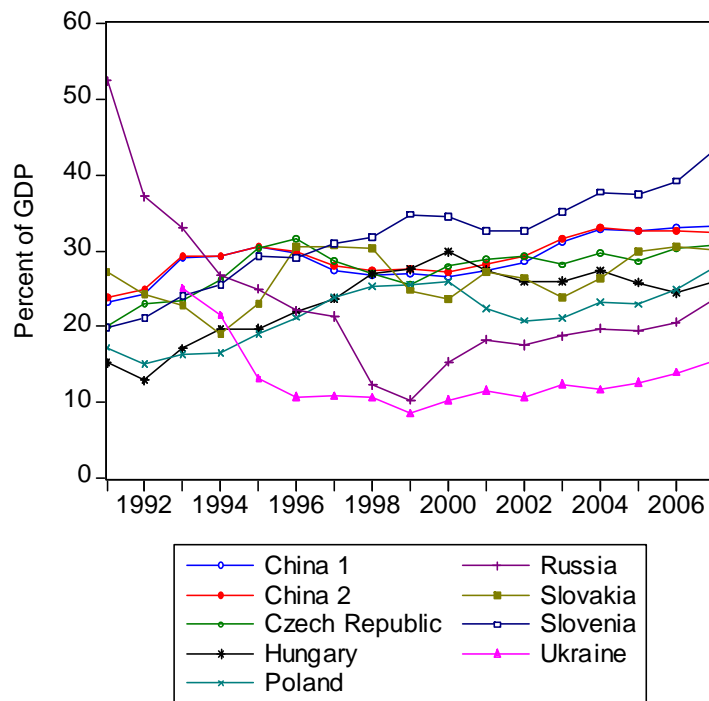


Figure 5: Investment Rates at International Prices

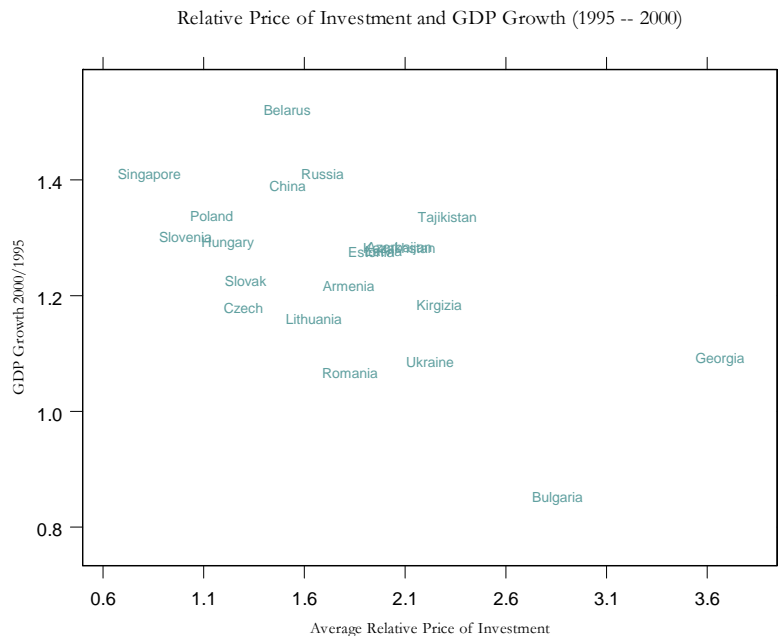


Figure 6: Relative Price of Investment and GDP Growth

is quite apparent.

4.3. Growth Equations Revisited

If measuring investment at international prices confers such a different picture it begs the question how are projections of growth affected? To answer this we return to the Levine-Renelt equations, but use investment at international prices. We estimate the equation using data from 1960-89 to maintain comparability with Levine-Renelt, though we can extend the data period (and do below). In figure 3 we present the Levine-Renelt equation and our alternative, the main difference being that we use investment shares at international prices. Our education variable is also different from Levine-Renelt. We use the share of the population aged 15 and over (as of 1960) that has *attained at least* the level of secondary school (BLSECA).¹³ The data is from Barro-Lee. We also include a squared-term for educational attainment to account

¹³Recall Levine-Renelt use the level of secondary school enrollment. We use instead an attainment measure: the pct of the total population aged 15 and over that has attained some level of secondary education or higher. (In the Barro-Lee education data, appendix A2, it is the sum of "second level, total" and "post-secondary level, total.")

for the non-linear impact of education levels on growth.¹⁴ From figure 3 it is evident that this term is negative and significant.

Variable	Levine-Renelt	Gaddy-Ickes
constant	-0.83 (0.97)	0.87 (1.20)
Y60	-0.35 (2.50)	-0.27 (3.85)
DPOP	-0.38 (1.73)	-0.41 (1.97)
SEC	3.17 (2.46)	
BLSECA		7.83 (2.65)
BLSECASQ		-8.05 (1.99)
Investment	17.5 (6.53)	12.52 (6.13)
R^2	.46	.48
n	101	91

t-statistics in parentheses, White corrected standard errors

Table 3: Growth Equations Compared

It should not be surprising that the two equations in figure 3 are so similar. The key difference, of course, is that the coefficient on investment is lower in our preferred alternative. By using the PPP measure of investment shares we are gauging the impact of actual investment, rather than investment effort as in the Levine-Renelt equation. This suggests that some of the

The good news is that Russia has oil so it does not need to invest 55% of GDP in order to grow at satisfactory rates. But this also points out how misguided is the idea that Russia should diversify out of oil. There are two reasons for this. First, and most obvious, oil is the primary generator of Russian growth. Second, the abundance of oil has raised the relative price of investment compared with countries without oil. The implications of this second point are critical. Because of Russia's high relative price of investment, diversification into manufacturing is likely to result in much less growth than would be the case in a less resource

¹⁴The variable BLSECA is the share of the population aged 15 and over (as of 1960) that has attained at least the level of secondary school. The data is from Barro-Lee.

abundant economy.

5. Why is the Relative Price of Investment so High in Russia?

This is really a manifestation of the Soviet inheritance in all its forms: a legacy of state-owned enterprises, location, and most importantly resource addiction.

One aspect of this is government ownership. Schmitz (2001) studies the impact of government production of investment goods in Egypt and Turkey. He shows that the impact on aggregate productivity of government production of investment can be quite large. Assuming that state-owned capital goods producers are 50% as productive as private-owned producers (the result based on case studies in these countries) he shows that aggregate productivity is only 64% of its potential level. Of course in the case of Russia all investment goods producers were 100% state owned prior to privatization, and little restructuring seems to have taken place in many of these enterprises (see, for example, 14).

	Hungary	Poland	Russia	Singapore	USA	Czech Republic	Ukraine
Construction	1.24	1.23	1.86	1.68	1.15	1.17	2.28
Machinery and Equipment	2.06	1.94	2.74	0.65	0.95	2.52	5.33
Stocks	1.68	2.03	2.31	1.43	1.06	2.05	3.13
Capital Formation	1.55	1.54	2.12	0.89	1.05	1.72	2.95

Source: Penn World Tables and author calculations

Table 4: Investment Price Ratios by Type

A common cross-country observation is that the relative price of investment goods is higher in poorer countries. Hsieh and Klenow (8) show that this is because of higher relative productivity in consumer goods industries in poorer countries. This seems also to be the case in Russia, although, perhaps for different reasons. In the Soviet period consumer goods industries were low prestige and underinvested in. In the post-Soviet period they have received the overwhelming bulk of non-oil FDI. This presumably promotes productivity growth in consumption goods industries. The relative low political weight of consumer goods industries probably also means that these sectors found it harder to resist entry.

In figure 4 we present calculations of the relative price of investment (specifically, the price of investment goods relative to consumption goods, $\frac{P_I}{P_C}$), for capital formation as a whole and by type of investment. The high relative price of investment for Russia stands out (2.12 compared to 1.05 in the US). Even in other transition countries, it is lower, aside from Ukraine. What is even more important, however, is the very high relative price for machinery and equipment. For as we discuss (in section 7.) below, machinery and equipment are the most important component of capital formation for enhancing productivity growth.

The legacy of the Soviet period was low productivity assets. According to one estimate, these were 30% as productive as US assets in 1992 14, 48. Many dinosaur enterprises managed to survive the upheaval at the end of the Soviet period; they did not go extinct. The Soviet legacy in relation to capital was one of hypertrophied machine building and defense enterprises. There was a dual use imperative in the Soviet economy (Gaddy 1996) that lowered productivity.

These problems should become less important through the passage of time. As capital depreciates new enterprises built in the market economy should replace dinosaur enterprises. Russia's problem – its potential bear trap – is that rent addiction serves to sustain the dinosaurs.¹⁵

In a way Russia shares this problem with any country with a history of inward-oriented development. De Long and Summers 2, 399 point out that 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*."

¹⁵The transition to a market economy should have been a cataclysmic event for dinosaur enterprises, just as the K-T event at the end of the Cretaceous Period was fatal for the dinosaurs. Dinosaur enterprises, however, were able to survive by using their relational capital to obtain rents. See Ickes (2003).

But in Russia inward-oriented development was taken to an extreme not witnessed anywhere else. For the Russian case, the contrast is perhaps that attempts to support investment have insured the survival of dinosaurs at the expense of encouraging industry.¹⁶

6. Quantity of Capital

Even if the relative price of investment is correctly measured investment figures may still be inflated due to the standard, but peculiar, method of measuring investment. The standard in national income accounting is to include as investment the cost of adjusting to climate and distance. Thus, extra insulation required for a heating plant in Novosibirsk is counted as extra capital. It is important to note that the impact of cold may in fact overstate investment in Russia. In calculating investment, the PWT explicitly excludes an adjustment for the extra cost of investing in cold climates.¹⁷ A power plant built in Siberia requires extra heating and insulation compared with Mexico. That greater cost is included, however, as output, so it shows up as greater investment. If one were to account for this adjustment investment would be relatively even more expensive in Russia, especially as this applies most to structures and we have seen that the composition of Russian investment is skewed in that direction.

¹⁶Ironically, support for the dinosaurs often comes from the incomes of the oligarchs. One might be tempted to say that in this case rather than enriching them, such policies tax them. Of course, however, the oligarchs participate in these policies precisely because this allows them to indeed "enrich themselves" by exploiting the assets that they obtained. See 6.

¹⁷Kravis, Heston and Summers explicitly discuss this question and explain why they cannot correct for it: "Suppose that in a cold climate a stream power plant had to be built with insulating walls around its boiler room and switchhouse, whereas in a warm climate both can be exposed to the weather. Assuming that all other characteristics are identical, should the inputs and costs required for closed construction in the cold climate be regarded simply as added costs, or as more output?"

One line of reasoning in response to such questions is to regard the future flow of services that each capital good would produce in each country as the basis for evaluating the relative amounts of investment. This implies that an international comparison should be made of the present value of the increases in output — ultimately in the form of consumption goods — that new capital goods would contribute in each economy. In the real world, no dated list is available of consumer goods that will eventually flow from new investment, but only the value of investment and the prices of the capital goods themselves in each country's own currency. Furthermore, knotty problems would arise in isolating the differences in future flow that could be attributed to the input of capital from the differences attributable to other elements, such as other factor inputs and environment. Therefore, it is too difficult to implement the future-flow-of-services approach 10, 29."

6.1. The τ effect.

Capital can be handicapped by location. It may be in extremely remote locations, cold locations, mountainous regions, and so forth. One way to think of such "handicapped capital" – capital in abnormal environment – is that in each period more capital depreciates than would otherwise be the case. Hence, a greater portion of gross investment is really replacement, though this extra replacement is compensating not for wear and tear or even economic obsolescence, but rather to allow capital to function as it would in a normal environment. Failure to account for this depreciation results in overmeasurement of the capital stock.

Suppose that we can index by τ the ratio of the true capital stock to the measured capital stock (τ is thus a mismeasurement index). Now consider the return to capital. The actual return to capital is measured capital net of the handicap. So if the production function is of the customary Cobb-Douglas form, we should write:

$$Y_i = A_i(\tau K_i)^\alpha L_i^{1-\alpha} \quad (2)$$

Ignoring τ the marginal product of capital appears as $\alpha A_i K_i^{\alpha-1} L_i^{1-\alpha}$, but if $\tau < 1$ (if capital is overmeasured) the actual marginal product of capital is $\alpha A_i \tau K_i^{\alpha-1} L_i^{1-\alpha}$. With $\tau < 1$ it is obvious that

$$\alpha A_i K_i^{\alpha-1} L_i^{1-\alpha} < \alpha A_i \tau K_i^{\alpha-1} L_i^{1-\alpha}$$

In other words, the measured marginal product of capital is in fact smaller than the actual marginal product of capital. This means that the impact of investment is understated if measured capital is inflated. Alternatively, the difference in income levels – as in development accounting – overstates the impact of differences in A , as it understates differences in functioning capital stocks across countries. This diverts attention from problems with factor accumulation towards efficiency.¹⁸ Ignoring systematic mismeasurement can lead to lack of attention paid to differences in capital stocks.

¹⁸Caselli notes, "the consensus view in development accounting is that Efficiency plays a very large role. A sentence commonly used to summarize the existing literature sounds something like "differences in efficiency account for at least 50% of differences in per capita income. (p. 2)"

All countries may have instances of inflated capital. Kravis-Heston-Summers recognize the problem:

"Suppose that in a cold climate a steam power plant had to be built with insulating walls around its boiler room and switchhouse, whereas in a warm climate both can be exposed to the weather. Assuming that all other characteristics are identical, should the inputs and costs required for closed construction in the cold climate be regarded simply as added costs, or as more output?"

They are correct to argue that it should be added cost, but as a practical matter they ignore this, and opt to treat it as more output. They recognize that this means:

"The cost of a flat road of a given specification in one country was compared with the cost of a road of the same specification in another country, and likewise for a mountainous road. The effect, of course, was to treat the mountainous road as more output than a flat road; in a sense, an adverse environment in this instance required more production, just as low temperatures necessitated the provision of heat and warm clothing. Similarly, insulating walls for power plants in cold climates were regarded as part of output rather than mere addition to cost."
(Kravis, et al., 1982: 28-9).

But for some countries – Russia, in particular, the problem may be systematic.

For Russia, in particular, problems of cold and size it is likely to have more of these handicaps. The impact is systematic, not random in the case of Russia. So ignoring $\tau < 1$ is likely to be much more problematic in the case of Russia than in almost any other country in the world.

This has important implications for thinking about Russia's relative inability to attract foreign direct investment (FDI). Conventional wisdom is that barriers, restrictions and taxes on investment are the chief culprit preventing capital flows to developing economies. So, the argument goes, if these restrictions are removed FDI will flow to Russia. But if $\tau < 1$ rates

of return may be insufficient to attract investment even if "the chief culprit" is eliminated. Because if $\tau < 1$ is due to geographic burdens as in Russia, then removing the "chief culprits" will not solve the problem. Institutional reforms will not make Russia more compact or warmer.

All countries (except Singapore where $\tau = 1$ – the country is a city, after all) have a $\tau < 1$. But the handicaps that any country faces can be decomposed into a self-imposed part and a fixed effect. The latter is due to irreducible features of the environment optimally adapted to. The former refers to the extra costs imposed due to misallocation.

The Kravis-Heston-Summers approach is to consider $\tau < 1$ as present but measurement error. Their implicit assumption is that differences in τ across countries are not systematic. Hence, they can be ignored in comparative analysis. This may be true in general, but if one were to take their discussion seriously, one would realize that some countries, notably Russia, would have systematic errors.

7. Machinery and Equipment

DeLong and Summers (1993) argued that machinery and equipment is the most important component of capital accumulation in explaining productivity growth.¹⁹ The idea is that ideas may be embodied in capital goods, and it is machinery and equipment where this embodiment takes place. Employing modern machinery and equipment requires skills that are important for growth. Moreover, as it is equipment investment that is associated with growth, not structures, it is much more likely that the former causes the latter than an instance of reverse causation.²⁰ They were also able to show that the effect applies to developing countries: it is not just a rich country effect.

The argument that machinery and equipment is the essential feature of capital accumu-

¹⁹This idea is also consistent with the ideas of Paul Romer. And Mokyr has referred to technology embodied in machinery as the "lever of riches." (Mokyr 1990).

²⁰That is, if growth caused equipment investment then we would expect to see the same association with investment in structures. Higher growth would cause demand for both more machinery and more structures to house them. But given that the association is between equipment investment and growth it is much more likely that the former causes the latter.

lation is even more important when we think about Russia. Lots of capital accumulation in Russia goes towards coping with location and size; for example, transportation investment and insulation. Neither brings new ideas or increases total factor productivity. In Russia a large portion of transportation should really count like insulation in Siberia. Capital formation in Russia consists to a much greater extent than in the US, say, of construction as opposed to producer durables. Moreover, construction is the type of capital formation that lends itself most to corruption in all countries.²¹ Of course, corruption is high in all the post-Soviet countries.

	Share of Construction	Share of Producer Durables	Share of changes in stocks
Belarus	.82	.13	.60
Brazil	.69	.31	0
Czech Republic	.57	.36	.06
Germany	.54	.44	.03
Hungary	.53	.28	.19
Romania	.59	.34	.07
Russia	.62	.22	.15
Singapore	.25	.77	−.02
Slovakia	.66	.30	.03
Ukraine	.73	.20	.08
United States	.48	.50	.02

Source: Penn World Tables

Table 5: Components of Domestic Capital Formation

Given that the relative price of machinery and equipment investment is high in Russia it is not surprising that the share of capital accumulation that takes this form is comparatively low (table 5). Whereas in the US about 50% of capital accumulation goes to machinery and equipment, in Russia it is less than a quarter.

8. Consequences of High Relative Price

The consequences of the high relative price of investment in Russia are several. First, it means that growth is lower than would be expected given Russia's savings rate. Russia obtains

²¹One might argue that construction is such a high portion of Russian investment precisely because it is so susceptible to theft. Another important factor, however, is the impact of cold. Construction is more expensive in cold climates. See chapter 3.

less return that would be expected from its sacrifice due to the "tax" it pays on investment. This effect is masked, to a large degree, by Russia's resource abundance which fuels growth independently.

Second, the high relative price of investment, and consequently the lower level of actual investment (as opposed to investment effort) means that the goal of diversifying the Russian economy out of oil and raw materials is more distant than thought.

9. Conclusion

We used PPP investment rates to get the 55% estimate. But this is not the end of the story because the PPP measures still overvalue investment in Russia. This is because space and cold issues are not taken into account in Summers-Heston data – for fundamental reasons. Russia gets even less per unit of effort than other countries would. So the amount of sacrificed consumption Russia would require to grow at acceptable rates without oil is immense.

In the next chapter we examine aspects of location in detail. Now we briefly consider the implications of space and cold on the measure of investment in national accounting statistics.

We have quoted from Kravis et al (2002) to describe how investment is counted in national accounting statistics. There are two dimensions of this problem to consider. First, since Russia is colder on average, it spends more investment effort on insulation and other geographic hurdles than other countries. So comparatively its relative price of capital is even higher than measured. Second, Russia has located too much economic activity in places that have geographic handicaps, so this reinforces the problem. The first problem cannot be overcome – so mismeasurement relative to other countries is inevitable, the second could be addressed by overturning legacies of past location decisions. That is, if the second problem were addressed the consequences of the first problem would be less severe.

The analysis clearly implies that Russia gets credit for investment that shouldn't be counted. Statistically, it gets rewarded rather than penalized for bad location decisions. To achieve the same flow of capital services a plant in Novosibirsk requires more investment than one in Moscow. But this extra investment is compensation for cold and distance – it adds

nothing to productivity. Hence, poor location decisions make Russia's capital stock look larger than it really is – it makes τ_K smaller. But productivity is still low.²²

Notice that this problem is not just about the initial investment decision. All further investment to maintain that location is similarly mis-measured. We can't adjust statistics for this, but this problem is likely to be very significant.

We turn in the next chapter to the hurdles posed by location legacies.

9.1. *There are two views about investment in Russia.*

- The *conventional* view is that if the financial system is fixed and if corporate governance is straightened out that investment will flow to non-energy sectors of the economy. The idea is that the risk premium is too high right now to invest in non-energy sectors. With tax reform underway, and if new reforms are implemented investment will flow. The barrier to this investment currently are these institutional failures that reforms will fix.²³
- The *alternative* view is that investment in non-energy sectors is constrained by low potential. The problem is that the capital-labor bundles are too inefficient.²⁴ On this theory even if investment in energy is satiated it will not flow to these sectors. Here it is the internal aspects that are critical, not the external, institutional, aspects.

We suggested that agents tend to underestimate investment needs for three systematic reasons.²⁵ We explore them in turn.

²²This is obviously a bigger problem for investment in the regions than for investment in Moscow. So it could explain why returns are lower in regions. Some of the extra return attributed to Moscow location could be due to access to authorities, but the τ -effect implies that this factor may be overstated.

²³Even those that recognize that much of the capital stock is junk assume that there is enough so that with proper institutions productivity increases would occur. What this view ignores is the write-off issue. Alternatively it assumes that because capital has no market value it can be freely disposed (in the economy-wide sense). This ignores the political struggle to give it value.

²⁴Location is an aspect of this as well.

²⁵Note this error occurs as well with natural resources – gold, diamonds, platinum, etc. Just because the resources are in the ground does not mean that their extraction has value once you incorporate the full costs of operating in these regions. All the arguments we make here with regard to capital apply equally to the resource sector, and the territories where they are located. Notice that these sites were often originally founded on the basis of prison labor – e.g., Norilsk – so the cost of production was clearly shifted on to others.

Note that underestimating investment needs is precisely the result of the failure to write-down the capital stock to market valuations. So the operative question is why this write down does not occur in the Russian market economy?

9.1.1. *Scrapping Problem*

What are the policy implications of the two different views of investment? For the conventional view, the main implications are obvious: continue with institutional reforms (tax reforms, corporate governance reforms, financial market reforms, etc.) For the alternative view, the policy implications are more complex.²⁶

The real policy problem of the alternative view is what, if anything, can be done to change the true investment attractiveness of the non-energy sectors? Herein lie some dangers. The critical issue is to distinguish between investments to improve technical efficiency and those to improve allocative efficiency.²⁷

Put simply: Do you encourage investment to make economic activity in Novosibirsk more productive, or do you channel that investment into a Western oblast?

Consider the analogy of the investment dilemma of a business faced with a fundamental technological revolution in its industry. The business has invested heavily in the old technology over the years. Its activity is thoroughly dependent on that old technology. The company must choose between upgrading the old technology or scrapping the old technology entirely

But there is one key difference. Technological advance (or using Canadian methods) can lower the cost of operating in cold regions, etc., so it may be profitable in the future (which is another reason for keeping it in the ground) whereas the dinosaur plant in Perm will never be profitable, and time will only cause d to increase.

²⁶On the surface, it might seem that at a minimum, it is at least fine to continue with the same kind of institutional reforms as dictated by the conventional view. True, those institutional reforms might not solve the problem. But they can't hurt. But in fact, it's never enough to say that an action is worth taking simply because it has benefits. Policy-making is a costly endeavor. One must therefore always consider the alternatives. Prioritizing institutional reforms might divert scarce political as well as monetary resources away from more important and urgent tasks. In Russia, bureaucratic competence is a scarce resource.

A second reason why one should not automatically assume it's OK to push ahead blindly with "good" institutional reforms is that it might sustain false illusions about the outcome.

²⁷See Gaddy and Ickes (2002). Technical efficiency refers to obtaining more output from given inputs. Allocative efficiency is achieving optimal outcomes given available resources; it compares how resources are allocated across activities. They write: "Improvements in [technical] efficiency involve movements from inside the production frontier to the boundary of the frontier. However, the gain implied by this may not be sufficient to overcome the fact that the enterprise produces the wrong thing in the wrong place (p. 49, fn. 10)."

and fully re-equipping with the new.

The two technologies are incompatible. It is an “all-or-nothing” choice. Nothing of the existing capital stock can be re-employed. It also cannot be sold to help finance the new acquisition.

The first path—upgrading—is cheaper and produces results immediately. But it locks the company into a second-rate path. Now matter how much the old technology is upgraded, continuing to depend on it will ultimately doom the company to noncompetitiveness.

The second approach is very costly up-front. It requires shutting down operations for a period. New staffing will be required. A few employees can retrain. Most cannot.

Russia structurally (in types of industries and in location) is a like a corporation that made the “wrong” technology choice long ago. Because of the poor governance of that corporation in the past, it ignored all the signals indicating that the choice was wrong. Rather, over time it concentrated even more on the wrong path.²⁸ In the market economy, when market value falls too far below the historical value you recognize the mistake, and disinvest – write down the investment - because you have no choice. But in the Soviet system this feedback was not there. There was no force correcting the mistakes.

The corporation ended up on the verge of collapse. So new management took over. The new managers correctly recognized that the current disastrous state of the corporation was fundamentally due to the management practices of the past. So they change the governance procedures. These new procedures will ensure that future business decisions are rational and will always be efficiency-enhancing.

The problem is that as they focus on a real problem—the old system of management and decision-making in the company—the new managers ignore the problem of the inherited antiquated technology. They fail to see that they will never be able to rehabilitate the company unless they can successfully rid the company of the single biggest mistake caused by the old

²⁸This is also related to the willingness to write down debts. In Japan worthless debts remain on the books and the debt overhang prevents growth. In the US, after the S&L crisis, debts were written off. The lingering effects of the debt overhang were much smaller in the US.

So in market economies you recognize mistakes and try something else.

management system: the commitment to the wrong technology.

And so, working hard to introduce correct new management practices, they work to “improve” the company’s inherited capital stock—the capital that is all based on the wrong technology. They do the “right” things in the “right” way . . . with the wrong capital. They are doomed to fail.

The question is why would a new owner be unwilling to write down the value of the assets and restructure? Why do they maintain the old technology? The key point is that transparently recognizing that the market value of the enterprise is much lower than what it is believed to be can be disadvantageous to the parties concerned. We develop this point in more detail in our Chapter 4 on the political economy of federalism. Before that, however, we examine the economics of location.

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