The rise and decline of the Soviet economy

Robert C. Allen *Department of Economics, University of British Columbia*

Abstract. The reasons for the rapid growth of the Soviet Union before roughly 1970 and for its subsequent growth slowdown are analysed. The concentration of investment on heavy industry and soft budget constraints explain most of the growth in the 1930s. The growth slowdown was due to disastrous investment decisions following the elimination of surplus labour and the diversion of research and development resources to the military rather than the failure of firms to carry out plans or diminishing returns to capital.

Grandeur et décadence de l'économie soviétique. On analyse les raisons de la croissance rapide de l'Union Soviétique avant 1970 et du ralentissement de sa croissance dans l'après. Il semble que la concentration de l'investissement dans l'industrie lourde et des contraintes budgétaires relativement douces expliquent le gros de la croissance dans les années 1930. Le ralentissement de la croissance est attribuable à des décisions d'investissement désastreuses à la suite de l'élimination du surplus de travail et du détournement des ressources de recherche et développement vers le secteur militaire, bien davantage qu'à l'échec des entreprises dans la réalisation des plans ou aux rendements décroissants sur le capital.

> Western civilisation [has] much to learn from Russia and Russia much to learn from western civilisation.
>
> Harold Innis[1]

In 1945 Harold Innis visited Moscow to attend the 220th anniversary of the Soviet (formerly Russian) Academy of Sciences. He kept a diary of his observations in which he warned against the 'danger of' Russia and the West 'each becoming fanatical and talking about the merits and demerits of the capitalist system.' For Innis,

Innis Lecture delivered at the 35th annual meeting of the Canadian Economics Association, Montreal, June 2001.

1 All quotations are taken from Innis (1981, 23, 47).

Canadian Journal of Economics / Revue canadienne d'Economique, Vol. 34, No. 4
November / novembre 2001. Printed in Canada / Imprimé au Canada

0008-4085 / 01 / 859–881 /

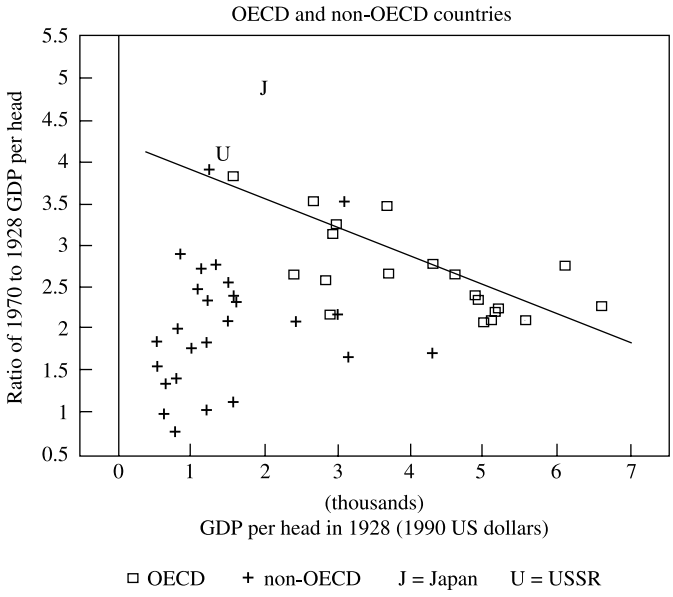

FIGURE 1 Economic growth, 1928–89

'System is a fanatical term' to be avoided. Instead, 'universities' must 'take [the] lead in adopting a neutral position' based on 'the search for truth.'

In this paper I take up Innis's challenge by reconsidering the broad outlines of Soviet economic history. The predominant interpretation today is failure – Soviet socialism could never have worked; it was always a big mistake. Economists, on both the left and the right, point to poor incentives and 'principal-agent' problems (Kornai 1992; Roemer 1994; Bardhan and Roemer 1993). While there were certainly many things wrong with the Soviet economy and – even more so – the Soviet political system, a review of the evidence suggests that the condemnation of the economy is too sweeping: in certain respects and in certain times, it performed well; in others, it did not. The Soviet Union was one of the great experiments of the twentieth century, and it behooves us to analyse its history carefully to see what worked well, what worked badly, and why.

GDP per head is the first indicator that economists usually use in assessing performance, and I begin with it. The growth record divides in two sometime around 1970. Before then, the Soviet economy was one of the most successful in the world using per capita GDP as the measure of performance. Maddison (1995) has estimated GDP in 1991 U.S. dollars for the fifty-six leading economies back to 1820. Figure 1 plots the proportional growth in GDP per head from 1928 to 1970 against the level of 1928 when the first Five Year Plan started. The squares indicate the OECD countries. It should be noted that they were the rich countries in the world in 1928, as, indeed, they had been in 1820. The exception to this generalization is

Japan, which was poor in 1820 and in 1928 and has been the most successful economy in the world since then. Among the OECD countries, the poorer have grown faster than the richer, as countries like Spain, Norway, and Ireland have caught up with the leaders. The 'convergence regression' summarizes this trend.

Convergence, it should be emphasized, has not extended beyond the OECD; the predominant tendency in the world economy has been income divergence (Pritchett 1997). In 1820 western Europe was two and a half times richer than South Asia; by 1989 the lead had grown to fifteen times. The non-OECD countries appear mainly in the lower left hand of the graph with low initial income levels in 1928 and low growth since. A few countries like Argentina had high incomes in 1928 and have shown slow growth since – initial successes that fell off the rails.

Where does the USSR fit into this pattern? Its income was low in 1928, and its growth rate was high. It was the most successful non-OECD country in this period. Even by the OECD standard it did well, since it grew faster than the OECD convergence regression – a stringent standard, since it requires particularly rapid growth for poor countries. From 1928 to 1970 the USSR did not grow as fast as Japan, but was arguably the second most successful economy in the world.

Many scholars of the Soviet Union would disagree in judging Soviet economic performance a 'success' for three reasons: (1) political repression and the famine mortality following the collectivization of agriculture, (2) negligible growth in consumption, and (3) the failure of the Soviet Union to achieve a western standard of living. These objections, however, are not decisive. First, while the repression and famine were certainly deplorable, the issue in an economic assessment is how they were related to economic performance. Simulations discussed later show that the state terrorism accompanying the collectivization of agriculture did increase growth but by only a small amount. Conversely, the Soviet policies that were decisive for increasing growth did not have dire consequences. Second, the view that consumption per head did not rise in the 1930s was propounded by Bergson (1961) using data available in the 1950s. Evidence that has subsequently become available and advances in index number theory suggest that per capita consumption increased by one-quarter in the 1930s.[2] The gains accrued to the urban population and to those who moved to the cities. If the GDP increase were only steel and tanks, one might dismiss the growth record as a failure, but rapid growth in consumption as well as investment was a good performance. Third, the right comparison group for assessing Soviet performance is not the United States, despite the enthusiasm of both communists and Americans for that comparison, but rather other countries with a similar level of income in 1928. The USSR outperformed all of those countries except Japan. Some commentators have speculated that Tsarist Russia would have closed the gap with the West had the 1917 revolution not occurred (Gregory 1994), but the claim is speculation unsupported by modelling.

Growth began to slow down in the 1960s, and success turned to failure after 1970, when the growth rate dropped dramatically. GNP grew in excess of 5 per cent

2 Allen (1998c) provides a detailed discussion. Hunter and Szyrmer's (1992) reassessment of Soviet performance leads to the same conclusion reached in Allen (1998c).

TABLE 1
Inputs, output, and productivity, 1928–85

	1928–40	1950–60	1960–70	1970–75	1975–80	1980–85
GNP	5.8	5.7	5.2	3.7	2.6	2.0
Labour	3.3	1.2	1.7	1.7	1.2	0.7
Capital	9.0	9.5	8.0	7.9	6.8	6.3
Land	1.6	3.3	0.2	1.0	−0.1	−0.1
Total inputs	4.0	4.0	3.7	3.7	3.0	2.5
Productivity	1.7	1.6	1.5	0.0	−0.4	−0.5

NOTE: To emphasize the long-run trends, the figures for the 1940s have been omitted; growth rates in that decade were very low, because of the Second World War.
SOURCE: Ofer (1987, 1778–9)

per year from 1928 to 1970, but the annual rate dropped to 3.7 per cent in 1970–75, then to 2.6 per cent in 1975–80, finally hitting 2.0 per cent in 1980–85 (table 1). The rapid growth before 1970 was due to exceptional growth of the capital stock, a big increase in employment (especially in the 1930s), and some expansion of the cultivated acreage. Productivity grew at a rate similar to that of the East Asian economies during their boom. Indeed, the sources of high-speed growth in the USSR look much like those of South Korea or Taiwan (Young 1995).

The growth slowdown was the result of deterioration in all sources of growth. Employment growth plummeted, and there was a reduction in land under cultivation. The growth of the capital stock declined, although it was still much faster than that of the other inputs. The slowdown in accumulation was not due to a drop in the investment rate, which continued to rise, but to the decline in GDP growth. Most dramatically, total factor productivity growth went negative. This result is quite controversial, as we will see, since it presumes a Cobb-Douglas production function, which is disputed.

This growth record poses the paradoxical questions of Soviet economic history: Why was growth so rapid from 1928 to about 1970? Then, why did performance deteriorate so abruptly? Capital accumulation will be the protagonist in the narrative proposed here. In 1928 the USSR was a capital-scarce, labour-surplus economy. It grew rapidly for half a century as the investment rate was pushed steadily higher. How that was done will be shown. By the 1970s this phase of growth was over – everyone had a job. Growth then slowed down. Here the narrative choices become great. There are three stories to choose from. The usual story among Sovietologists attributes the growth slowdown to technological failure, which, in turn, is attributed to poor incentives to innovate. The second story denies the fall in TFP growth shown in table 1 and, instead, attributes the growth slowdown to diminishing returns to capital. The question turns on the elasticity of substitution between capital and labour. There is no role for policy error in this approach. The third

approach, which I will advance here, attributes the growth slowdown to horrendous investment decisions. It is not a coincidence, in this view, that the economy slowed down when it did. The end of surplus labour posed new challenges. The Communist leadership flubbed them.

Why was growth rapid from 1928 to 1940?

Before considering failure, we will analyse fast growth. How did the USSR succeed in growing so rapidly from 1928 to 1970? In 1928 the country had a small capital stock and a large, ineffectively employed, rural population. The rapid accumulation of capital was the key to rapid growth. The investment rate was pushed up from 8 per cent in 1928 to over 20 per cent in the mid-1930s (Moorsteen and Powell 1966, 364). As a result, the capital stock grew rapidly, as shown in table 1. The central issue is explaining this rise in investment. There are three policies or institutions that need to be analysed.

The first was the allocation of producer goods. In the 1930s the Five Year Plans increased the fraction of producer goods – machinery and construction – allocated to the producer goods sector itself. Steel and machinery output were high priorities, and their output expanded explosively as the ever greater volumes of steel and machines were ploughed back into those sectors. How much of the accumulation was due to this investment policy?

The second was the collectivization of agriculture. In the industrialization debate of the 1920s Preobrazhensky (1926) is famous for having advocated that heavy industry be financed by the state's turning the terms of trade against the peasants. In the 'standard story' Stalin accomplished this by herding the peasants into collective farms where they were forced to hand over a large fraction of agricultural output at low prices dictated by the state (Millar 1970.) While important features of this story have been refuted – for example, agriculture's terms of trade actually improved during the first Five Year Plan, owing to the thirty-fold inflation of food prices on the unregulated farmers' markets (Ellman 1975) – the question remains whether investment could have been increased without impoverishing the rural population. As Alec Nove (1964) put it: Was Stalin Necessary?

The third was the use of output targets and the corresponding provision of soft budgets to direct industrial enterprises. During the New Economic Policy, industry was organized into trusts and directed to maximize profits. Soft budgets first appeared in the mid-1920s, when the state tried to increased agricultural sales by lowering the prices of manufactured goods (Johnson and Temin 1993). In the 1930s soft budgets became general, as firms were given output targets and the bank credits to finance them. Kornai (1992) criticized these practices in the 1980s, when there was full employment. The question is whether employment-creating policies like soft budgets may have accelerated growth under the surplus labour conditions of the 1930s.

I have analysed these policies with a series of simulation models that describe counterfactuals that are further and further removed from actual Soviet experience

TABLE 2
Actual and simulated nonagricultural capital stock (billions of 1937 rubles)

	Collectivized soft budget	NEP soft budget	Capitalist employment hard budget
1928, actual	136.3	136.3	136.3
1939, simulated			
e			
0.07	201.0	192.7	162.9
0.12	237.3	225.1	186.3
0.17	281.1	263.6	215.2
0.23	343.9	318.0	258.7
1939, actual	344.7	344.7	344.7

NOTE: *e* is the fraction of producer goods output reinvested in the producer goods sector.
SOURCE: Allen (1998b) with revisions

(Allen 1998a,b, with revisions). Alternative investment strategies are captured by increasing the fraction of producer goods output reinvested in that sector (e) from 7 per cent in the 1920s to 23 per cent in the mid-1930s; analysing collectivization requires introducing free markets for food, eliminating the 1933–34 famine and altering rural-urban migration functions; modelling soft budgets requires that a hard-budget alternative be created. In the soft-budget model full employment is imposed and the marginal product of labour sinks below the wage; in the hard-budget model the wage equals the marginal product, and unemployment results.

So far as capital accumulation is concerned, the results of the simulations are summarized in table 2. Two factors were of cardinal importance in promoting accumulation – the investment strategy emphasizing heavy industry, and the imposition of high output targets in conjunction with the soft-budget constraint. Consider the following thought experiment. We begin with the economy least like the Soviet Union in the 1930s, that is, with a capitalist employment rule (employment is set so the wage equals the value of the marginal product of labour) and an investment strategy that simply replicates the consumer goods oriented capital stock of the 1920s (i.e., $e = 0.07$). That economy would generate a 1939 capital stock of 162.9 billion rubles – not much above the 1928 starting value of 136.3 and a scant increase on a per capita basis. Now let e rise to 0.23. In that case, the 1939 capital stock equals 258.7 – a jump of 90 per cent. The strategy of investing in heavy industry pays off! Next replace the hard-budget constraint with the soft-budget constraint. The simulated capital stock rises to 318.0 in 1939 – a further gain of 23 per cent. The soft-budget constraint also pays off. Finally, imagine that the free-market relationship between agriculture and industry that characterized the NEP were replaced by the obligatory deliveries and state-imposed prices that characterized collectivization. The simulated capital stock would again rise, but only to 343.9 – an additional gain of 8 per cent. There is little pay-off to collectivization. Since the simulated

capital stock is within 0.2 per cent of the actual 1939 value of 344.7, the thought experiment shows that the investment strategy and the soft-budget constraint comprise a complete explanation of Soviet accumulation; it is not necessary to invoke other factors to account for what happened.

Similar results obtain when GDP, non-agricultural value added, and per capita consumption are analysed. The results for consumption are particularly interesting; for they show that increases in the fraction of producer goods output reinvested in that sector increased consumption per head by 1940. In the totalitarian model of communism (Tucker 1977), increased military power is the motive for expanding heavy industry, but Gosplan economists like Fel'dman promoted the policy in the 1920s on the grounds that a larger capital goods sector would provide the equipment to expand the consumer goods industries (Domar 1957). My simulations of the Soviet economy show that Fel'dman's projections were realized within a decade.

The role of collectivization in Soviet development has been so controversial that it deserves more comment. The simulations show that collectivization had a negative effect on all indicators – GDP, investment, consumption, and, of course, population – in the mid-1930s. However, collectivization pushed up the growth rate enough in the rest of the decade to raise GDP, capital accumulation, and consumption above the 1939 levels they would have realized had the agrarian system of the 1920s been preserved. Collectivization raised growth by increasing rural-urban migration: First, low procurement prices lowered farm incomes below the level they would have otherwise reached. Migration increased in consequence, since it was a function of the ratio of urban to rural income. Second, the deportation of 'kulaks' and state terrorism in general increased the rate of rural-urban migration at every ratio of urban to rural consumption. Terrorism increased economic growth to that small degree.

These findings point towards three important conclusions about institutions and Soviet economic development. First, the New Economic Policy, which involved the preservation of peasant farming and a market relationship between town and country, was a conducive framework for rapid industrialization. Collectivization made little additional contribution to this effort. Stalin, in other words, was not necessary. Second, the autarchic development of the producer goods sector was a viable source of new capital equipment. Exporting wheat and importing machinery – that is, following comparative advantage – was not necessary for rapid growth. Third, the central planning of firm output in conjunction with the soft-budget constraint was effective in mobilizing otherwise unemployed labour. This additional employment made a significant contribution to output as well as distributing consumption widely.

While the development of socialism was conducive to economic growth in the Soviet Union during the 1930s, the barbaric policies of Stalinism added very little to industrial output. In particular, the collectivization of agriculture – perhaps the archetypical Stalinist policy and the one that resulted in the most avoidable death – made only a modest contribution to growth. Modifying the NEP to include central planning, high employment, and the expansion of heavy industry was a program for growth in capital, output, and per capita living standards. Adding collectivization to that recipe contributed little to growth and corrupted socialism.

Why did the growth rate drop? Technological failure

Why did the economy, which grew so rapidly from the 1920s into the 1960s, perform so badly in the 1970s and the 1980s? There are three approaches to this question – technological failure, diminishing returns to capital, and errors in investment. They are prompted by different readings of the figures in table 1.

Technological failure is probably the most common explanation among Sovietologists (e.g., Bergson 1978). The drop in TFP shown in table 1 is variously attributed to the impossibility of planning a large economy, the baleful effects of soft budgets, enterprise managers' stockpiling inputs to ensure meeting targets, and inadequate incentives to promote technical progress. In these accounts, the Soviet decline shows the impossibility of socialism.

There are many difficulties with this line of explanation. One possibility, which emerges from some of the other explanations, is that the TFP series shown in table 1 is erroneous because the Soviet production function was not a Cobb-Douglas function as presumed in conventional growth accounting. Accepting for the moment the reality of the productivity drop, there are three reasons for doubting that it reflects a failure of Soviet R&D institutions.

First, there is a timing problem. The Soviet research and development institutions and the incentives to which they gave rise were long standing. They did not change around 1970. Easterly and Fischer (1995) note that if they did not change, it is hard to see how they can explain the abrupt drop in productivity.

Second, the disincentives to innovate may not have been as strong as is usually believed. The standard critique was developed by Joe Berliner (1976a) 'The general problem with the old economic structure [central planning] is that it gave maximal encouragement to decision makers to favor established products and processes, and to discriminate against innovations "as the devil shies away from incense," in Mr Brezhnev's words.' Berliner (1976b, 437, 444) offers many reasons for this conservatism, including the following: first, research and development was carried out by institutes rather than by the businesses that would use the new products or processes. These institutes either chose their own projects or were assigned projects by higher level authorities. In either case, projects were not suggested by the production or sales departments of businesses and so research was not directed to meeting the needs of business and the new techniques produced by the labs were often of little practical use or were too imperfectly developed to be of immediate value. Second, the pricing of new models tended to pass on the gains of improved performance to consumers rather than benefiting the innovating enterprises. Third, managers were rewarded for meeting output targets, so they had little incentive to innovate. 'The reason is that the changeover to a new product or a new manufacturing process always results in a slowdown in the current rate of output' and that slowdown threatens the manager's bonus for meeting his output target. Consequently, the lack of information flow between producers and designers could not be solved by creating manufacturing departments in firms, since the firm managers found it financially rewarding to transfer the R&D personnel and equipment to current production if that was necessary to meet output targets. For instance, Glavneftemash, which made

two-thirds of the USSR's oil field equipment, assigned its research facilities to current production in order to meet the heavy demand for drilling rigs during Brezhnev's oil and gas offensives (Gustafson 1989, 190).

These considerations do not provide a complete account of Soviet technological performance because there was progressive behaviour as well. Higher productivity required intelligent decisions by planners and spontaneous attempts by enterprises to improve performance, and both occurred. The cement industry, admittedly not the most glamorous, is a case in point (Abouchar 1976). Productivity increased, better processes were introduced, and the geographical balance between production and consumption was improved. Perhaps most important, the character of invention and innovation was very different from that predicted by Berliner. 'The journals in this period contain abundant evidence of experimentation – on the plant sites and not just in central laboratories.' The result was further 'improvements: more efficient heat transfer apparatus and chimney design modifications to reduce stack loss, two-end kiln feeding, and so on.' Despite Berliner's (1976b, 444) conclusion that 'there was very little incentive for self-initiated innovative activity at the enterprise level,' much experimentation went on.

Third, there was an external development that coincided with the drop in Soviet productivity and that may explain it. That development was the arms race with the Americans during the Brezhnev period. The magnitude of Soviet military spending and its impact on the economy were heatedly debated in American defence circles during the 1980s (Adams 1992; Firth and Noren 1998; Jacobsen 1987; Noren 1995; Rosefielde 1982; Rowen and Wolf 1990). After much revision, the CIA concluded that the USSR spent 12 per cent of its GDP on defence in 1966–70 against 16 per cent in 1981–85 (Davis 1992, 193). This increase was probably not large enough to significantly affect the growth rate, since even one-for-one ruble substitution of investment for defence spending would have raised the investment rate by only one-ninth (from 36 to 40 per cent of GDP).

The increase in defence spending may have lowered productivity growth, however, by diverting R&D resources from civilian to military innovation. It is difficult to measure the rate of invention, but the available indicators suggest that it was declining in the USSR, at least for the civilian economy. The Soviets did publish considerable statistics on the number of new prototypes brought into use. While such numbers are always hard to interpret, Kontorovich (1987, 1990) has argued that they indicate the volume of newly available technologies, and Amann (1986) has pressed them into service. They show a decline in the absolute number of new inventions brought into use each year from the 1960s to 1985. Kontorovich (1990, 267) has divided them into civilian and military innovations and argued that the fall was largely confined to the civilian sector.

These shifts in the output of the R&D sector reflected a reallocation of inputs to the military. According to Campbell (1990, 141–2), the defence 'ministries were absorbing the lion's share of the resource increment in R&D' – in particular, technical employees – 'in the decade preceding 1985, starving the civilian R&D function.' Moreover, the defence 'ministries were winning out over the civilian ministries in the struggle for investment resources,' so producing an investment crisis in non-

defence machinery production. Kontorovich (1990, 267) attributed much of the decline to the arms race: 'resources were shifted from civilian to military R&D in 1965–85.' Campbell (1990, 127) agreed: 'resource allocation to the military sector became increasingly burdensome' from 1976 to 1985. 'It was an important contributor to the slowdown in economic growth, primarily through its deleterious impact on the civilian machinery industry and on investment.'

The same conclusion is supported by industry studies that show the lack of investment in civilian machinery and trace it back to resource conflicts between the military and civilian economies. The oil and gas industry is a prime example; for it was the priority civilian activity in the 1970s and 1980s. Soviet efforts to increase production were hampered by inadequate industrial support. Throughout the period, oil field equipment continued to be made in the antiquated plants of Glavneftemash. Investment was not available for reconstruction, let alone expansion. The Soviet gas campaign required six new pipelines, and they, in turn, required 21,000 km of 1420 mm diameter pipe. Virtually all of this pipe was imported, since it would have taken too long to build the mills for the Soviet steel industry to make it. 'In metals as in machinery, the underlying reasons for failure have been abysmal civilian innovation and competition for the best people and the best output from the military-industrial sector (the former obviously aggravated by the latter).' The pipelines also required hundreds of compressors to push the gas from Siberia to Europe. Nevskii Zavod produced a satisfactory 10 MW compressor by the mid-1970s, but never managed to produce a reliable 25 MW model. The most successful large Soviet compressor was one based on a converted jet engine supplied by the Ministry of the Aviation Industry and produced at the Frunze plant. 'The chronic problems at Nevskii Zavod (and the lesser but substantial difficulties at the Frunze plant in Sumy) had little to do with high technology; rather, the case illustrates the debilitating effects of competition from military priorities on civilian programs, even high-priority ones.' Productivity growth in investment as well as in consumer goods industries was stifled by the allocation of resources to the military: 'A major reason for the technological stagnation of the civilian machinery sector was the preferential channelling of resources to the ministries making military machinery.' (Gustafson 1989, 190, 193, 204–8, 212.)

If the Cold War was responsible for the drop in Soviet productivity growth, then it accounts for over half of the Soviet growth slowdown. TFP growth dropped from 1.5 per cent per year to −0.5 per cent between the 1960s and 1980–85. Reversing the productivity slowdown by adding 2 per cent to the 1980–85 GNP growth rate increases the latter from 2 to 4 per cent per year. This is still less than the 5.7 per cent growth of the 1960s, but certainly is a much better performance.

Why did the growth rate drop? Diminishing returns to capital

The Cold War may have been one factor contributing to the fall in Soviet productivity, but there are other approaches to the problem, and they indicate that other factors were at work. Growth deceleration was already apparent in annual data for the 1950s and 1960s, and it was already being attributed to technological failures

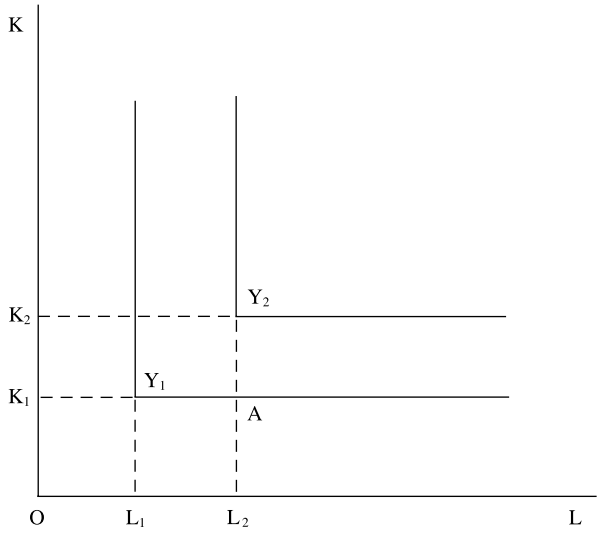

FIGURE 2 Weitzman growth model

manifest as declining TFP growth. Productivity in these arguments was calculated with a standard Cobb-Douglas framework with constant factor shares like those in the West. Weitzman (1970) challenged this interpretation by estimating a production function for the USSR. He concluded that the Cobb-Douglas specification was incorrect, and that the Soviet experience was better represented by a CES function with an elasticity of substitution between capital and labour of .4. In this framework, the growth deceleration is due to diminishing returns to capital; there is not evidence of a fall in TFP growth. The growth slowdown, in other words, does not indicate poor institutional performance. Easterley and Fisher have redone the econometrics with more recent data and confirmed the elasticity of substitution. They have been reluctant, however, to exonerate Soviet institutions.

One of the attractive features of the Weitzman-Easterly-Fischer approach is that it can be extended to provide an integrated account of both the success and failure of the Soviet economy. Figure 2 shows a diagram that allows us to tell the story of Soviet history in a simplified form. The depiction is starker than Weitzman's because the isoquants assume fixed proportions – an elasticity of substitution of zero rather than 0.4 – but the logic is more clearly revealed. In this framework, a rise in the investment rate caused rapid growth in the 1930s and 1940s as surplus labour was put to work. By the 1950s structural unemployment was eliminated and growth slowed down as capital accumulation ran into diminishing returns.

The diagram presupposes that fixed quantities of capital and labour are required to produce a unit of GPD, as indicated by point Y_1. These proportions are preserved along the diagonal OY_2. More labour (L_2) or capital (K_2) yields no extra output so

long as the quantity of the other is fixed. Constant returns to scale is assumed, so that doubling the capital (from K_1 to K_2) and labour (from L_1 to L_2) doubles output (from Y_1 to Y_2).

In 1928 the Soviet Union was at a point like A. Output was limited to one unit (Y_1) by the available capital (K_1) and $L_2 - L_1$ units of labour were in surplus. In this case, accumulating capital increased output by moving the economy upwards along a vertical line from A to Y_2; indeed, in this period output and capital grew at the same rate. Surplus labour was correspondingly reduced. This shift corresponds to the period 1928–70, when the USSR grew rapidly by accumulating capital.

The era of high-speed growth ended, however, when the economy reached Y_2, and surplus labour was exhausted. Thereafter, capital accumulation failed to generate growth. As the economy accumulated capital, it moved upwards along the vertical part of the isoquant where capital was in surplus and labour constrained production. In that case, output failed to grow. Indeed, there was a quick transition from fast growth to stagnation. In real time, the transition occurred in the late 1960s and early 1970s. One indicator of the change is unfilled vacancies on the first shift, which rose from 1 per cent in 1960, to 4.9 per cent in 1970, to 7.3 per cent in 1975, then to 9.9 per cent in 1980, and finally hit 12.2 per cent in 1985 (Rumer 1989, 199–200). In the 1970s a Gosplan research director reported that 10–12 per cent of the increment in real fixed capital was unutilized, owing to a shortage of labour (Rumer 1989, 202), and that proportion could only have increased in the 1980s. The capital stock rose without a corresponding rise in GDP because there was no labour to operate the new capacity.

Weitzman's statistical results support this story in a nuanced fashion. With an elasticity of substitution of 0.4, the isoquant has a curved corner rather than a right angle. As a result, the growth slowdown takes place over a decade or two rather than occurring instantaneously. History is more accurately replicated, but the underlying logic is the same as that shown in figure 2.

To see how Weitzman's statistical results imply rapid growth then an abrupt slowdown, we can embed his production function in a Solow (1956) / Swan (1956) growth model: GDP is a function of the capital stock and labour force, an exogenously given fraction of output is invested, and capital grows as the stock in one year is increased by investment and reduced by depreciation. Production is computed from a CES (constant elasticity of substitution) production function:

$$Y_t = A(hK_t^{-p} + (1-h)L_t^{-p})^{-1/p}, \tag{1}$$

where Y_t is GDP in year t, K_t is the capital stock, and L_t is the labour, which is assumed equal to the population and to grow at its historical rate. The parameter values are those estimated by Weitzman: $h = 0.639$, and $p = 1.481389$, implied by an elasticity of substitution of 0.403. The constant A is chosen to make Y equal its historical value in 1928.

Investment is computed by multiplying GDP (Y_t, as given by equation (1)) by the historical series of investment rates (s):

$$I_t = sY_t. \tag{2}$$

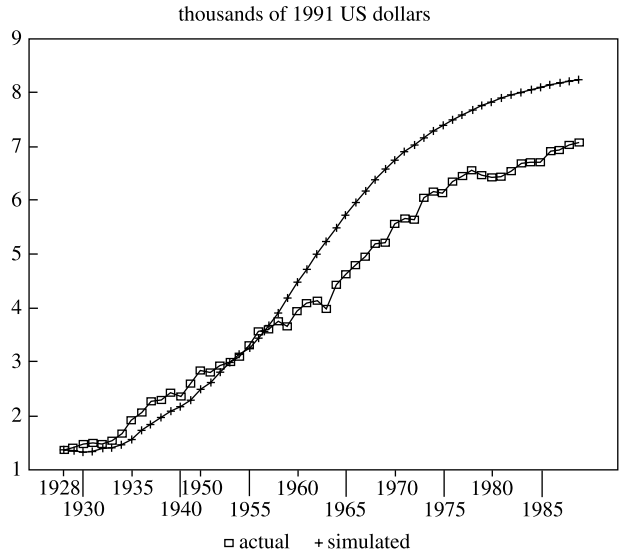

FIGURE 3 Soviet GDP per head, 1928–89

The capital stock is cumulated from investment according to the equation

$$K_t = (1 - d)K_{t-1} + I_t, \tag{3}$$

where d is the depreciation rate applied to the capital stock in the previous year.

The data for this exercise are derived from Maddison (1995).[3] The Second World War is dealt with in a highly stylized way, namely, by leaving it out: GDP was similar in 1940 and in 1948, so the intervening years were omitted, and the capital stock in 1940 was carried over to 1948. The population in the 1930s was interpolated between 1928 and 1948.

Figure 3 contrasts the actual history of real GDP per head in the Soviet Union between 1928 and 1989 with the series implied by equations (1)–(3). The correspondence is remarkably close: The series are within 10 per cent of each other in 1989, despite the simplicity of the model and the cavalier treatment of the Second

3 Maddison's estimate of GDP in 1991 US dollars is the measure of output. The labour force is measured by the population since that indexes the potential labour supply, which is the relevant measure in assessing the impact of surplus labour and its elimination. The capital stock is calculated with equations 2 and 3 from Maddison's GDP series, the historical series of investment rates, and a value of 2 for the capital-output ratio in 1928. This value is slightly higher than the value of 1.68 calculated by (Moorsteen and Powell 1966, 367). For 1960–89 the investment rate was taken from the Penn World Tables. Investment rates for earlier years were extrapolated from the 1960 value using Moorsteen and Powell's (1966, 364) series. The depreciation rate in equation (3) was taken to be 3 per cent, which is consistent with Moorsteen and Powell's work. Applying these assumptions to equations (2) and (3) implies the Soviet capital stock in 1991 U.S. dollars.

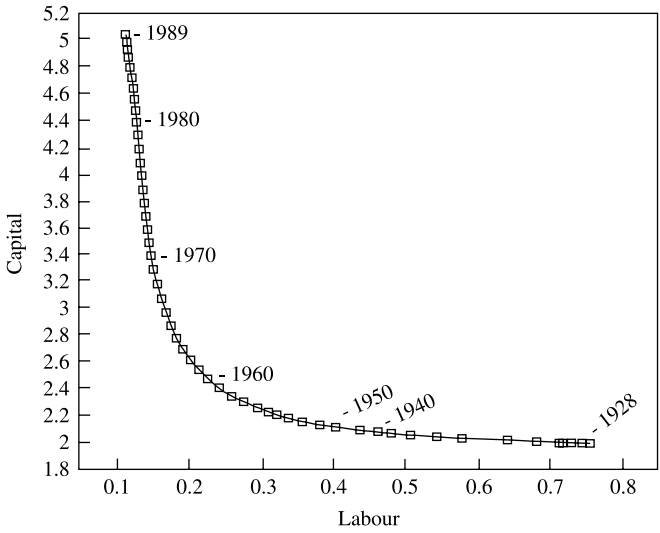

FIGURE 4 Soviet unit isoquant, 1928–89

World War. The simulation mimics the remarkably fast growth of the Stalinist period, and the growth slowdown of the final decades of Soviet power. The import of the simulation is that these facts can be entirely explained by the logic of capital accumulation under the assumption of a low elasticity of substitution between capital and labour.

Figure 4 shows why the model captures the main lines of Soviet history. The former shows the unit isoquant implied by the Weitzman-style production function. The sharp corner is apparent. In 1928 the Soviet Union was at the right end of the isoquant with little capital and lots of labour, and it moved to the left as accumulation proceeded. The dates at which the economy reached various points are shown in the figure, and it passed the corner in the 1960s as growth began to decelerate.

Diminishing returns to capital: can we believe it?

Weitzman's explanation is very elegant. It complements the account of rapid development given earlier by advancing one mechanism by which the elimination of surplus labour would cut the rate of growth. But is a low elasticity of substitution really the explanation for the Soviet climacteric?

Weitzman's theory is hard to credit when seen in international perspective. Japan is an important contrast. It may have been even more devastated than the Soviet Union in 1945, and its recovery in the late 1940s was slower. In 1950 GDP per head was $2834 in the USSR and $1873 in Japan. By that time the Soviets had already raised their investment rate to 22 per cent – higher than levels in the 1930s – and the

Japanese rate was 17 per cent. Both countries grew by pushing their investment rates even higher, reaching 35 per cent and 38 per cent, respectively, in 1989.

With similar investment histories, one would expect similar growth performance if the Weitzman model were the full story. But the growth histories were very different. While output per head flagged in the USSR, it surged upwards in Japan and reached a western European level in 1989 ($17,757 in Japan versus $7078 in the USSR). While the capital stock per head was also lower in Japan in 1950, that figure, too, quickly surpassed the Soviet level, reaching a value almost twice that of the USSR in 1989.[4] If the Weitzman story had applied in Japan, then growth should have been choked off as the capital-labour ratio rose. Why was Japan so different?

One difference was in the elasticity of substitution. Weitzman's econometrics imply a value of 0.403 – a figure confirmed by Easterly and Fischer (1995, 357) for the whole economy. But 0.4 is an unusually low value. Evidence for Japan and other advanced capitalist economies suggests a value of 1.0 or even greater (Easterly and Fischer 1995, 359–61; Duffy and Papageorgiou 2000). While simulations using an elasticity of substitution of 0.403 imply a growth slowdown, simulations with a value of 1.0 do not: With more substitutability between capital and labour, diminishing returns to capital are not substantial enough to cause stagnation, and this is why a high investment rate paid off in Japan but not in the USSR. Why was the elasticity of substitution so low in the Soviet Union? Why was it only the USSR that failed to translate high investment in the 1970s and 1980s into greater output?[5]

Investment policy and productivity slowdown

Weitzman and Easterly and Fischer speculate on reasons why the elasticity of substitution might have been lower in the USSR than elsewhere, without coming to firm conclusions. This is good; for, I will argue, the value of 0.4 is an illusion. The low measured value of the elasticity reflects massive errors in Soviet investment strategy rather than a real difference in technology. It was not purely happenstance that these errors occurred in the 1970s and 1980s; for the end of the surplus labour economy posed new management problems, and the party leadership bungled them.

During the 1960s there were two changes in investment policy that were highly deleterious. First, investment shifted from the construction of new manufacturing facilities to the modernization of old ones. Second, the depletion of old oil fields and mining districts led to a redirection of investment from Europe to Siberia. Both changes involved huge expenditures and these cumulated into a rapid growth in the

4 The capital stock was cumulated from Maddison's output series and Japanese investment rates using the same procedures and depreciation rate as were used for the Soviet series.

5 An alternative approach to the data is to question their reliability. Wolf (1992, 135), for instance, claims that 'much of the growth reported in capital investment in the 1970s and early 1980s did not occur.' The reason is that inflation in investment goods was underestimated by the Soviets, so that their reported series of real investment overstates real growth. However, Rumer (1990, 274) estimated this omitted inflation. Deflating Soviet investment by Rumer's rate of price increase does not change the results in a historically meaningful way.

TABLE 3
Productivity growth (TFP) by industry, 1965–85

	1965–75	1975–85
Moderately successful		
Gas	31%	41%
Electricity	31	8
Chemicals	33	12
Poor		
Machine building	15%	−2%
Construction materials	14	−3
Light industry	10	2
Food	10	−7
Other	1	3
Disasters		
Coal	8%	−24%
Oil	37%	−21%
Ferrous metals	11%	−12%
Overall	19%	−2%

SOURCE: Indices of output, employment, and capital from *Narodnoe Khozyaistvo SSSR*, *Trud v SSSR*, and *Promyshlennost' SSSR*, various years. Productivity calculated from a Cobb-Douglas production function with labour's share being 0.7 and capital's share being 0.3.

capital stock, as shown in table 1. However, the massive accumulation did not lead to more output, since the investment was largely wasted.

Under this circumstance, standard econometric techniques give misleading results when applied to Soviet data. Fitting production functions to the inputs and outputs of capitalist firms is justified by the assumption that they minimize costs, so that the observed data are efficient input choices and lie on the firms' isoquants. The assumption of cost minimization did not obtain for the Soviet Union, however. When output per unit of capital and labour in the USSR are plotted as in figure 4, the result is a sharp vertical movement in what appears to be an isoquant. In terms of the post-1970 aggregate data shown in table 1, there is the rapid growth of the capital stock in conjunction with small growth in employment and GDP. Fitting a production function to the data indicates a low elasticity of substitution. However, this result should be regarded as spurious. Whatever the 'true' isoquant, the data do not reveal it; instead, they are accounted for by a massive misallocation of investment.

We can get at the role of investment policy by examining input and output growth at the industry level, where there was considerable variation in behaviour. Table 3 shows total factor productivity growth for major industries. The average TFP growth of these industries shows roughly the same decline as the aggregate Soviet data in table 1, but the average encompasses some satisfactory performances and some disasters. Generally, the industries with good productivity records had capital-output ratios that were fairly stable. In electricity generation, for instance, output

increased by a factor of 2.3 from 1965 to 1975, while the capital stock grew 2.1 times. From 1975 to 1985, output increased 1.5 times, while the capital stock grew by 1.7 times. In contrast, industries with poor productivity records showed large increases in the capital stock without reductions in employment or increases in output. In ferrous metals, for instance, the capital stock went up by 55 per cent between 1975 and 1985, while employment rose 9 per cent, and output grew by only 10 per cent. As a result, total factor productivity dropped 12 per cent. How could so much capital be poured into the iron and steel industry with such a scant increase in output and no saving of labour?

Two factors explain the difference between steel and electricity. One was the degree of reconstruction investment undertaken: the industries with high levels of reconstruction investment exhibited big increases in capital with little increase in output and, consequently, falling productivity. In 1970, for instance, 20 per cent of the investment in electricity generation went to 'technical reequipping, reconstruction, and expansion of existing production,' while the proportion in ferrous metals was 60 per cent. The fractions jumped to 34 per cent and 80 per cent in the next decade. The second factor was the seriousness of mineral depletion and the investments in Siberian resources that were taken to offset it. The former cut productivity in existing operations, and the latter led to vast investments that maintained output with more expensive inputs. These were not issues in electrical generation, but they plagued the steel industry.

Japan showed the world how to boost productivity in steel making. Between 1960 and 1985, Japanese steel production grew from 26.9 to 105.3 million tons, and Japan was renowned as the most efficient producer in the world (see U.S. *Statistical Abstract*, 1962, 925; 1988, 814). Japan's success was achieved by building nine new integrated steel mills on large coastal sites with an average capacity of 9 million tons (Hasegawa 1996, 81). The minimum efficient size of a steel mill was 6 million tons per year in this period (ibid., 162), and the new Japanese steel mills exceeded that size.

Soviet productivity went up so long as the Soviets acted like the Japanese; otherwise, it declined. From 1960 to 1985 Soviet steel production increased by 90 million tons (from 65.3 million to 155 million.) About 55.8 million tons of the steel smelted in the USSR in 1980 were made in eight 'green field' plants built in the 1960s and 1970s. Those plants accounted for five-eighths of the increase in output from 1960 to 1980. They were large enough to realize scale economies, but – despite frequent complaints about excessive 'giantism' in Soviet industry – they were somewhat smaller than new Japanese steel plants: 7 million tons in the USSR versus 9 million tons in Japan (Rumer 1989, 51–75). These plants pushed up TFP and account for the rise in efficiency in 1965–75 shown in table 3.

Older plants made 58 per cent of general purpose Soviet steel[6] and accounted for the remaining three-eighths of the increase in production after 1960. This group included the famous mills, such as Magnitogorsk and Kuznetsk, constructed in the

6 That is, excluding special steels and the small amount of steel made by machine-building plants. See Rumer (1989, 54).

1930s as well as mills in the Ukraine dating back to the nineteenth century. Although Magnitogorsk had a capacity of 16 million tons, its plant site was highly congested, its equipment was obsolete, and its high-grade ore deposits were exhausted. The rest of the older plants had capacities of 1–5 million tons. Not only were they too small to realize scale economies, but their sites were overcrowded. The post-1960 mills had about 140 hectares per million tons of capacity, while interwar mills had only 90 hectares (Rumer 1989, 56). The smaller mills were often unintegrated. Gosplan studies showed that it cost 55 per cent more to increase capacity in old works than in green-field sites (Rumer 1990, 15; 1989, 211). Furthermore, these investments failed to shake out labour, since there was no agreement on employment norms in re-engineered plants. Plants in the Russian Republic that received reconstruction investment in the early 1970s actually increased their workforces by 18 per cent (Rumer 1989, 202).

In the 1960s and 1970s the Soviets spent their investment budgets wisely in the steel industry. Green-field sites were developed, and they greatly increased output. The shift in emphasis to reconstruction of old sites was disastrous. It resulted in little increase in output or reduction in the use of labour or raw materials. The planners were not able to monitor changes in capacity, nor did they have objective norms to assess employment levels. As a result, the shift to reconstruction investment allowed firm managers to accumulate labour and capital to meet future output targets. A great deal of money was spent for little gain.

Resource depletion

Reconstruction investment was a great waste of funds, but it was not the only fruitless investment. Three industries had TFP falls of more than 10 per cent between 1975 and 1985: coal, oil, and ferrous metals. These were natural resource industries plagued by depletion and burdened by the heavy expense of expanding production in Siberia. Indeed, the development of Siberian natural resources was a vast sink for investment rubles. The Soviet Union is often seen as 'blessed' with abundant natural resources. Before the 1970s this was true in that many of the resources that were being exploited were in European Russia or just east of the Urals, and their exploitation was comparatively cheap. By the 1970s, however, the locus of resource exploitation had shifted to Siberia, where costs were very much higher. By then, the Soviet Union's 'abundant' natural resources had become a curse. Resource development swallowed up a large fraction of the investment budget for little increase in GDP.

The problems were acute in iron mining, which accounted for 30 per cent of ferrous metal investment (Rumer 1989, 205). Between 1960 and 1980 the production of iron ore increased from 142.1 million tons to 502.0 million, making the USSR the world's largest producer. Fifteen open-pit mines accounted for 80 per cent of the growth in production. These were, of course, giant cones that became narrower as they were pushed deeper into the earth. Each year they were driven down another 5–12 m. Between 1976 and 1980 the share of ore from mines of less than 200 m declined from 74 to 58 per cent (ibid., 151). The iron content dropped

from 44.5 to 34.7 per cent, and the overburden to be removed increased. Between 1977 and 1982, alone, the total rock removed to extract one ton of commercial ore increased from 5 to 8 tons (ibid., 152). As the mines became deeper, the routes to the surface became longer and required more equipment. Likewise, the bottom became correspondingly narrower, causing congestion and reduced productivity on the floor of the mine. Costs rose in step with total production. New mines could be opened, but they offered little relief, since the deposits were even more remote.

The problems were even more costly in the energy sector. Coal had traditionally been the most important fuel. The Donbass in the Ukraine was the centre of coal mining until the 1960s. Its production peaked in 1976, and exploitation shifted to the lignite deposits of the Kansk-Achinsk Basin in Krasnoiarsk Province. This move proved hugely expensive and slashed productivity (Gustafson 1989, 27, 33). Between 1975 and 1985 investment raised the capital stock by 62 per cent, but employment increased by a quarter, and output grew by only 4 per cent. As a result, TFP dropped by 24 per cent!

Oil was an even bigger sponge for capital. Before 1975 the situation appeared trouble free, but industry failed to meets its exploration targets and then its production targets, as exploitation was pushed further and further into Siberia. Brezhnev responded with a series of crash programs that brought larger and larger commitments of investment to the oil industry. Between 1975 and 1985 energy as a whole increased its share of the industrial investment budget from 28 to 39 per cent. This rise understates the capital absorbed by energy, since it excludes pipeline investment, which was tallied as transportation. Before 1975 the aggregate statistics of the oil industry were not troublesome, but thereafter they became a nightmare. In 1975–85 the capital stock was increased by a factor of 2.42, employment rose by a quarter, while output fell by 21 per cent. Productivity plummeted. The oil industry sucked in capital at a great rate without yielding up more energy.

The resource constraints in metals and fuels meant that the Soviet Union was caught in a Ricardian trap. The depletion of existing raw material sources implied steeply rising costs – including capital costs in particular – if output was increased from either new regions or already exploited ones. There were two solutions to this dilemma: Replace expensive domestic raw materials with cheap imports or reduce demand for energy and metals.

Soviet trade policy was very different from that of the advanced capitalist countries when it came to raw materials. Japan was at the opposite pole. It had few minerals, no oil, and only a little coal, so it necessarily relied on imports for these key raw materials. However great an obstacle this may have been to Japan's early development (Yasuba 1996), it was a great boon as transport costs fell after the Second World War, since it meant that Japan could shop around the world for the cheapest minerals and fuel. Economic development efforts in the Third World guaranteed abundant supplies at low prices. Even First World governments around the Pacific Rim rushed to supply Japan with subsidized coal. Not having billions of hectares of tundra to develop made the Japanese economy competitive.

Instead, the Soviets tried to be self-sufficient in everything. To a remarkable extent they succeeded. The output of almost every mineral grew, and the USSR was

usually one of the biggest producers in the world. Many of these mines would not have been profitable if they had been evaluated at world prices. But that was not the point in the USSR. There, the objectives were self-sufficiency and the full development of the country's natural resources – not creating a surplus of revenue over cost. Early in the development process, when deposits were accessible, this strategy did not involve great waste, but as the sources of supply became more remote, the costs skyrocketed, and vast quantities of investment were committed to projects that brought little gain. These show up as falling productivity in coal, oil, ferrous metals, and 'other products,' which include non-ferrous metals.

The other approach to rising resource costs would have been to cut consumption. In 1980 the USSR consumed 0.95 tons of oil equivalent per US$1000 of GDP, in contrast to the OECD average of 0.50 tons. Canada, which has a similar climate, consumed 0.74 tons. In the next eight years, conservation measures in the West reduced energy consumption (to 0.41 in the OECD as a whole and to 0.64 in Canada), while consumption in the USSR rose to 0.99 tons per US$1000 (see *A Study of the Soviet Economy*, vol. 33, IMF, World Bank, OECD, and European Bank for Reconstruction and Development, 198).

The rise of Soviet energy consumption did not reflect a lack of concern in planning circles. Since the 1970s conservation had been part of the official rhetoric. Indeed, some improvement had been made: electrification of the railways, more cogeneration, more efficient power plants, and a shift from coal to oil and then to gas (Gustafson 1989, 230–1).

Most Soviet energy is consumed by large industrial customers, which should have made conservation simple, but several obstacles stood in the way. First, there was no agreement as to appropriate norms for energy use. Second, attempts to control energy use by raising its price were hampered by the soft-budget constraints of many customers. Third, and most important, the majority of farms, residences, and factories lacked meters to monitor energy consumption. The problem worsened as gas displaced oil, since gas meters, in particular, were lacking. An energy conservation program of any sort required either the creation of an industry to make meters or their importation on a massive scale (Gustafson 1989, 236–42). The politicians running the economy, however, looked for immediate solutions to the problems they faced, and establishing an industry to make meters, like erecting steel mills to make 1420 mm pipe, would have taken too long to command interest.

Conclusion

The Soviet Union grew rapidly from 1928 to about 1970 because it rapidly accumulated capital and created industrial jobs for people otherwise inefficiently employed in agriculture. The strategy of building up heavy industry and the use of output targets and soft budgets were effective in doing this. The growth rate dropped abruptly after 1970 for external and internal reasons. The external reason was the Cold War, which diverted substantial R&D resources from civilian innovation to the military and cut the rate of productivity growth. The internal reason was the end of the surplus labour economy: unemployment in agriculture had been eliminated and the

accessible natural resources of the country had been fully exploited. A new strategy was needed. The Soviet leaders responded to these changes by squandering vast sums on retooling old factories and by throwing additional fortunes into Siberian development. It was as if the United States had decided to maintain the steel and auto industries of the midwest by retooling the old plants and supplying them with ore and fuel from northern Canada instead of shutting down the Rust Belt and importing cars and steel from brand-new, state-of-the-art plants in Japan supplied with cheap raw materials from the Third World. What the country needed was a policy to close down old factories and shift their employees to new, high-productivity jobs, reductions in the use of energy and industrial materials, and increased involvement in world trade.

The interpretation of the Soviet decline offered here is the reverse of the analyses that emphasize incentive problems and the resulting failure of managers to act in accordance with the plans. On the contrary, the plans were implemented; the problem was that they did not make sense. The strength of Soviet socialism was that great changes could be wrought by directives from the top. The expansion of heavy industry and the use of output targets and soft budgets to direct firms were appropriate to the conditions of the 1930s, they were adopted quickly, and they led to rapid growth of investment and consumption. By the 1970s the ratio of good decisions to bad was falling. President Gorbachev was as bold and imaginative as any Soviet leader was likely to be, but his economic reforms were not aimed in the right direction. Perhaps the greatest virtue of the market system is that no single individual is in charge of the economy, so no one has to contrive solutions to the challenges that continually arise. The early strength of the Soviet system became its great weakness, since the economy stopped growing because of the failure of imagination at the top.

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