MACROECONOMIC EFFICIENCY OF CAPITAL FORMATION IN SOVIET INDUSTRY UNDER LATE STALINISM, 1945–1955

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Introduction

THERE exists by now a vast literature on the related topics of Soviet industrial growth and investment efficiency. The post-1950 emphasis to be found in this literature sometimes results in the blurring of two salient historical facts. First, the tendency of Soviet industrial growth to decelerate is not just a postwar phenomenon but stretches back to the interwar years. Second, the tendency of Soviet industrial capital productivity to decline is not just a postwar phenomenon either; however, the downward trend which was already perceptible in the 1930s was checked during the war, and capital productivity grew almost continuously from somewhere around 1942 until the late 1950s, returning eventually to its 1928 level before peaking and resuming a downward course.

This suggests a set of questions, the answers to which may throw light both on the economics of late Stalinism and on the problems which subsequently beset Stalin's successors. Why was the long term decline in industrial capital productivity reversed in the 1940s and much of the 1950s? Did improved capital productivity under late Stalinism mean that industrial growth had become more efficient? How were the underlying processes of investment mobilisation and capital construction reflected in the formation of new capital assets, and how did capital formation contribute to economic growth?

The historical background

The capital formation process played a decisive role in the expansion of the Soviet economic system in its formative years under the Stalin regime. The large-scale investment mobilisations of 1928–31 and 1934–36 gave rise at first to rapid increases in production, employment and fixed capacity. In each case, however, the mobilisation culminated in an economic crisis, partly the product of unfavourable exogenous trends (for example, in the military, foreign trade or climatic environment), partly also the result of overinvestment (the demands upon the economy arising from the combined investment and consumption plans of government, enterprises and households outran the existing capacity of the economy to supply them). Mobilisation gave way to retreat and rationalisation before further mobilisation could be attempted.

This process was thus marked by an alternation of two tendencies. One was the tendency of the economic system's centralised authorities to excessive ambitiousness, reflected in the designation and multiplication of super-large,

massively expensive capital projects taking years to complete and aimed at recoupment over a very long time horizon. This tendency was reinforced at intermediate and lower levels of the economic system by a permanent state of 'investment hunger' on the part of plant managers and industrial and regional bosses. The tendency to overambitious investment plans was periodically offset, however, by the enforced necessity for centralised authorities to budget investment resources more modestly, to restrict sharply the scale, capital intensity and time horizon of authorised projects, and to concentrate on the completion and commissioning of new capacity at the expense of projects still far from fruition. The quantitative side of this investment cycle was wide fluctuations in macroeconomic investment efficiency, measured by movements in the rate of transformation of investment resources into new productive capacity and in the rate of productivity of new capacity. In the long term, average capital productivity tended to decline.[1]

This cycle was also evident in wartime. The German invasion of June 1941 plunged the Soviet economy into a massive crisis, resolved only by the most determined rationalisation of the resource balance, including the balance of resources for new investment. Investment recovery began in 1943–44 with the renewal of procedures for perspective planning and designation of new capital projects. However, while the war was still on, the principal sources of recovery of output were the recovery and reconstruction of productive assets on recaptured Soviet territory, rather than new capital projects commissioned for the first time.[2]

Accounts of the postwar readjustment of Soviet industrial capacity are few, and they do not attempt a comprehensive assessment of its macroeconomic efficiency. Soviet sources tend to stress increased effectiveness of construction organisation and the declining aggregate capital-output ratio in industry.[3] More critical Western observers stress rising investment costs, leading to downward revision of official estimates of the aggregate volume of public sector investment, and the evidence of fluctuation in the proportions of investment devoted respectively to completion of new capacity and additions to unfinished construction.[4] Timothy Dunmore has also attempted to compile indicators of investment effectiveness relative to the all-Union norm for different regions and for industrial groups 'A' and 'B', based on comparison of investment with incremental output volumes, but without taking into account variations in investment completion rates and, further, without the possibility of making intertemporal comparisons.[5]

We cannot tell from these accounts whether the industrial economy of late Stalinism was more or less efficient than that of the prewar five-year plans at organising either capital formation or capital use, or why industrial capital productivity grew in this period. All that is visible is the superficial outline of a postwar investment cycle. This was reflected in two outlying tendencies of investment policy, representing two sets of competing goals: short-term repair of the wartime damage done to the economic system and its fixed assets, versus the large-scale, long-term capital requirements of transition to a communist society (at any rate as it was perceived at the time). On one side, much investment was

devoted to restoration of war damage to the economic system. To the extent that wartime damage and disruption had resulted in widespread bottlenecks in the supply of materials, transport services and other links in the production, distribution and consumption process, there existed substantial reserves of industrial capacity which could be speedily realised on the basis of investment in capital restoration and reconversion. Such investment could therefore be expected to bring quick and substantial returns.

On the other side was the tendency of the late Stalin period to initiate new large-scale, long-term capital projects with a much more questionable prospectus—for example, the 'Stalin plan for the transformation of nature'. Such projects could be expected to add to the investment burden without adding significantly to productive capacity (in the short term, certainly, and possibly in the long term as well). In between these two extremes there doubtless lay a broad range of intermediate projects. However, we cannot tell whether either of the extreme tendencies dominated, or whether the intermediate range of the spectrum was more representative.

An analytical approach

The capital formation process

The capital formation process can be analysed by adapting an analytical framework proposed by K. C. Yeh for study of long-term economic growth in China.[6] Let us define $\dot{x}$, the proportional time rate of change of capital assets:

$$\dot{x} = \frac{dK}{dt} \frac{1}{K} \tag{1}$$

where K is productive fixed capacity. At this point incremental capacity dK can be redefined in terms of its underlying relationship with investment, output and existing capacity:

$$\frac{dK}{dt} = \gamma I \tag{2}$$

where I is investment and γ is the rate at which investment is converted into completed capital assets, or rate of investment completion. Moreover,

$$I = \beta Y \tag{3}$$

where Y is industrial output and β is the share of output reinvested in industry;[7] and

$$Y = \alpha K \tag{4}$$

where α is the average productivity of the existing capital stock. From equations 1 to 4 it follows that:

$$\dot{x} = \alpha \beta \gamma \tag{5}$$

That is, the growth of capital assets reflects the productivity of existing assets α, the share of their product which is allocated towards reinvestment β and the rate of transformation of investible resources into finished capacity γ.[8]

Efficiency in capital formation and capital use

Yeh suggests that α may be called the index of 'efficiency in the use of capital' and γ the index of 'efficiency in the formation of capital'. There is some intuitive sense in this, but we shall resist it for the simple reason that both α and γ may be expected to change without any alteration in the efficiency relationship between outputs and inputs in either production or capital formation. For example, γ is more than just an index of efficiency in capital formation because, in a growing economy where capital projects take several periods to complete, the volume of newly completed capacity will normally fall below the volume of investment in new and ongoing projects. Normally, therefore, γ will be less than one; an increase in the rate of growth of investment may cause the gap between the volume of new and ongoing projects and the volume of newly completed capacity to widen, and γ to fall, even though efficiency in terms of the relationship between inputs and outputs at each stage of the investment process remains unchanged.[9] However, were we to find a combination of slackening investment effort and falling investment completion, a decline in efficiency of capital formation would certainly be implied (an increase in efficiency could be presumed under converse circumstances).

In the same way α is more than just an index of efficiency of capital use. For example, under conditions of labour scarcity, α might be expected to fall because of rising capital per worker, yet the use of capital would not have become less efficient in a meaningful sense (for greater precision on this score see equation 7 below). Thus the efficiency implications of changing capital productivity can only be assessed in the light of changing factor proportions within a production function approach, to which we now turn.

The role of capital formation in economic growth

Estimation of the contribution of capital formation to economic growth requires use of a production function, the form of which must be assumed but which may also be subject to empirical test. Below I employ a Cobb-Douglas production function of the form:

$$\dot{y} = s_1\dot{x} + s_2\dot{\lambda} + \dot{r} \qquad [6]$$

where $\dot{y}, \dot{x}, \dot{\lambda}$ are the proportional time rates of change of output, capital stock and labour force, and s_1, s_2 are the respective elasticities of output with respect to capital and labour inputs.[10] The expressions $s_1\dot{x}$ and $s_2\dot{\lambda}$ represent the contributions of capital formation and of workforce growth to output growth respectively, and $\dot{r}$ captures the residual contribution of changing efficiency of input utilisation. From equation 5 it also follows that the contribution of capital formation can be rewritten $s_1\alpha\beta\gamma$.

Given the Cobb-Douglas production function as a working hypothesis, what is the appropriate value of s_1, the elasticity of output with respect to capital, for Soviet industry under late Stalinism? Evidence from this period suggests $s_1 \approx 0 \cdot 28, s_2 \approx 0 \cdot 70$. The closeness of the sum of the elasticities to unity is taken to indicate the absence of significant economies or diseconomies of scale.[11]

Although based on a production function approach, this framework is aimed at a lower level of generality than the numerous existing production function studies of Soviet postwar industrial growth efficiency. It is designed in their light in order to supplement them by means of its focus on particular aspects of capital formation. It adopts the simplest possible formulation of the production function in order to carry out this task, and does not consider alternative formulations. However it is worth noting that, in a major recent study of postwar Soviet industrial growth which compared results of the Cobb-Douglas approach with those of its major rival (the constant elasticity of substitution production function), the former outperformed the latter.[12]

Sources of change in capital productivity

Within this framework economic growth is influenced by both the level and rate of change of capital productivity. Its level is important because (as in equation 5) it affects directly the rate of reproduction of capital assets. Its rate of change is also significant, but in a different sense. First, it is a compound indicator of economic processes, some of which bear upon the role of capital formation generally, and some of which represent the role of changing efficiency of resource use. Second, it interacts with the level of capital productivity and therefore also (from equation 5) with the pace of capital formation.

If we write $\dot{\alpha}$ for the proportional time rate of change of capital productivity, then the factors determining it can be accounted approximately from equation 6 as follows:

$$\dot{\alpha} \approx \dot{y} - \dot{\varkappa}$$
$$= \dot{r} + s_2 \dot{\lambda} - (1 - s_1) \dot{\varkappa} \qquad [7]$$

That is, capital productivity growth is explained by exogenous total factor productivity growth plus increased output growth attributable to growth of labour inputs less the offsetting effect of a rising capital stock subject to diminishing returns; under constant returns to scale when $s_1 + s_2 = 1$, the expression for capital productivity growth is reduced to $\dot{r} - s_2(\dot{\varkappa} - \dot{\lambda})$, that is total factor productivity growth less the effect of rising capital per worker.

Capital productivity and composition

Critical to the validity of this approach is the lack of influence of various possible composition effects upon the growth record of Soviet industry; that is, we must be able to treat the industrial capital stock as basically homogeneous across the different vintages laid down at different times, and across the various industrial branches and sub-branches.

Absence of vintage effects is important because, in their presence, the underlying efficiency of resource use will change through time as new vintages of fixed capacity are laid down and old vintages are retired. By making $\dot{r}$ independent of the rate of capital formation, we have assumed this not to be the case. This assumption is to some extent arbitrary, since it is notoriously difficult to test for such effects. If we make no explicit provision for them, capital productivity might appear to increase exogenously when improvement is really due to capital formation. For instance, in equation 7 capital formation appears as a negative factor in capital productivity growth (through the effect of rising capital per worker) whereas capital formation might also carry an unrecognised, positive vintage effect.

Another critical assumption, more accessible to empirical tests, is that capital productivity is similarly independent of the composition of 'industry' by branch and sub-branch. Suppose that different industrial branches are characterised by different levels of efficiency in capacity utilisation; in this case a structural shift towards sectors of high capital productivity would cause measured average capital productivity to increase without any change in technology, organisation or factor proportions at the level of the industrial branch. The increase in capital productivity would be a result of capital formation, but would be attributed to an exogenous increase in input productivity within the production function approach outlined above. When the sectoral composition of industry is changing rapidly, the influence of such a composition effect may be subject to test. The evidence from this period, however, suggests that the changing branch composition of industry does not result in significant distortion. Investment resources were not concentrated on sectors of relatively high or rapidly growing capital productivity, and such sectors did not tend to grow more rapidly than others.[13]

Determinants of fixed capital growth

Table 1[a] shows that, according to official data, under the prewar five-year plans Soviet industrial productive fixed capacity grew at over 19% annually. In war time the supply of investible resources was greatly reduced; rapid growth was checked and some decline was recorded, although when compensation is made for exogenous losses [b] we find that new capital formation was still adding to the fixed capital stock at nearly 5% per year. After 1945 fixed capital growth was resumed at a high and rising rate of 9–12% annually, but this was still much lower than the prewar precedent.

What were the main sources of slower postwar fixed capital growth? Within our framework we may distinguish the ratio α in which fixed capital supplies output, the share of output β which is allocated to reinvestment in productive fixed capital, and the rate of conversion γ of investment into new fixed capacity.

Associated with the changing volume of capital assets, we find [d–e] that in the prewar period fixed capital productivity tended to fall. After 1940 the decline was checked—in fact, apart from a brief period of disruption associated with postwar reconversion in 1945–46, capital productivity now grew continuously

TABLE 1

THE CAPITAL FORMATION PROCESS IN SOVIET INDUSTRY 1928–60

Annual average (%)

Period	Growth of overall productive fixed capacity [a]	Growth of productive fixed capacity through:		Change in average productivity of fixed capacity [d]
		exogenous war losses [b]	new capital formation [c]	
1928–40	19·10	0·00	19·10	−1·91
1940–45	−1·65	−6·37	4·72	0·00
1945–50	9·52	0·00	9·52	3·60
1950–55	11·33	0·00	11.33	1·58
1955–60	11·48	0·00	11·48	−0·97

Period	Index of fixed capital productivity (alpha) [e]	Index of reinvestment share of output (beta) [f]	Rate of public sector investment completion (gamma) [g]
1928–40	1·00	1·00	0·91
1940–45	0·89	0·28	0·91
1945–50	0·97	0·54	0·87
1950–55	1·10	0·56	0·88
1955–60	1·12	0·53	0·92

Notes and sources:
a Calculated from *Promyshlennost' SSSR* (Moscow, 1964), p. 68.
b This represents the share of 1940 fixed capital destroyed over 1941–45 (from Mark Harrison, *Soviet Planning in Peace and War 1938–1945* (Cambridge, 1985), p. 159) converted to an annual average rate of loss.
c [a]–[b].
d Calculated from an index of gross industrial production (see Table 2, note [a]) divided by an index of productive fixed capacity (see note [a] above).
e The procedure given in note [d] yields an index of capital productivity from which midpoints are estimated for each period and then rebased on 1928–40.
f [c]/([e]×[g]), then rebased on 1928–40.
g New public sector capacity commissioned in each period, divided by public sector investment, both measured at constant prices, taken from *Kapital'noe stroitel'stvo SSSR* (Moscow, 1961), pp. 34, 144.

until the late 1950s. On average, capital productivity was barely lower in 1945–50 than it had been before the war, and in 1950–60 it was substantially higher. Thus, rising capital productivity helps to explain why fixed capital growth accelerated between 1945–50 and 1955–60, but not why it remained so much lower than in the prewar period.

The most important cause of slower postwar fixed capital growth was apparently reduced reinvestment of industrial output in industry [f]. The investment share of output was reduced by nearly three quarters in war time, and remained down by nearly one half throughout the three postwar five-year plans.

The third component of the capital formation process, the rate of investment completion [g] remained relatively stable according to this periodisation. It was somewhat lower in the period of postwar reconstruction than in war time or in the prewar period, although it tended to improve subsequently. The low postwar rate of investment completion is surprising. Other things being equal, investment completion should rise when the investment share falls, and fall when the latter rises. This is on the assumption that periods of increased investment mobilisation see particularly intensive activity on new capital projects far from completion; when investment mobilisation is relaxed, the gap between the volume of new starts and the commissioning of new capacities should narrow. Thus, fewer capacities were completed and commissioned in 1945–50 than might have been expected at first sight. Investment resources were being allocated to unfinished construction rather than to finishing new capacity in slightly greater proportion than in the prewar period, in spite of their increased relative scarcity. The investment completion rate realised in 1945–50 (0·87) also fell below that envisaged in the fourth five-year plan (0·94),[14] so the record also represented a shortfall below the perspective plan target. The stability of investment completion over 1945–55, and its improvement up to 1960, are more easily explicable in terms of the behaviour of the investment share of output. However, the overall postwar record of investment completion was no better than in the prewar period, although the investment mobilisation was greatly reduced.

The contribution of capital formation to industrial growth

Table 2[a–c] compares the growth of industrial outputs and inputs. In each case the prewar period saw exceptionally rapid growth, followed by the sharp check administered by war. In the postwar years fixed capital growth accelerated but did not regain its prewar pace; output growth and workforce growth both registered marked retardation. Even so, by 1960 the Soviet industrial economy was still growing rapidly in all major respects.

When input growth rates are weighted by their corresponding output elasticities [d–e] and the residual contribution of increased input productivity calculated [f], the following picture emerges. In the prewar period the contribution of capital formation to output growth was substantial—over 5% annually. In war time capital formation (net of exogenous war losses) made a small contribution to output decline. In the postwar period there was some recovery, although not to prewar levels. Both in war time and under postwar reconstruction, the contribution of workforce growth to output decline and recovery was exceptionally large—more than twice that of capital formation. After 1950, however, as labour shortage became more pressing, the contribution of workforce growth fell back sharply and remained below the prewar benchmark. When capital and labour inputs are reckoned together, the contribution of input productivity growth can be established. After substantial prewar gains, input productivity grew only a little in wartime, although the fact that it grew at all (considering the disorganised state of the Soviet economy in

TABLE 2

<small>INPUTS AND INPUT PRODUCTIVITY IN SOVIET INDUSTRY 1928–60</small>

Annual average growth (%)

Period	Gross output	Productive fixed capacity	Manual workforce
	[a]	[b]	[c]
1928–40	16·82	19·10	8·46
1940–45	−1·65	−1·65	−2·89
1945–50	13·46	9·52	9·57
1950–55	13·09	11·33	4·78
1955–60	10·40	11·48	5·39

Output growth attributable to:

Period	capital formation	workforce growth	increased efficiency of input utilisation	The share of capital formation in output growth
	[d]	[e]	[f]	[g]
1928–40	5·35	5·92	5·55	0·32
1940–45	−0·46	−2·02	0·84	0·28
1945–50	2·67	6·70	4·10	0·20
1950–55	3·17	3·35	6·57	0·24
1955–60	3·21	3·77	3·41	0·31

Notes and sources:
a Calculated from *Promyshlennost' SSSR*, p. 31.
b Table 1[a].
c Calculated from *Promyshlennost 'SSSR*. pp. 84–5 (except for 1945 for which see Harrison, *Soviet Planning . . .* p. 138; I have assumed that between 1940 and 1945 the manual workforce declined in the same proportion as workers and staff as a whole.
d 0·28×[b], where 0·28 is the estimated elasticity of output with respect to new capital formation.
e 0·70×[c], where 0·70 is the estimated elasticity of output with respect to workforce growth.
f [a]−[d]−[e].
g [d]/[a].

1945, stranded as it was between the wartime and postwar eras) may be considered remarkable. After the war there was no spurt of catching up on the lost years of warfare, for in 1945–50 input productivity grew more slowly than under the prewar five-year plans. If there was a period of 'catching up', it was delayed until the early 1950s, when input productivity recorded exceptional growth. In the late 1950s, however, retardation of input productivity growth set in.

The relative share of capital formation in industrial growth [g] shows that in the prewar period up to one third was attributable to fixed capital growth. In the wartime and early postwar periods other factors (that is, mainly workforce growth) increased their significance. But the share of capital formation now tended to creep back to its prewar level. By the late 1950s, Soviet industry once again owed up to one third of its growth to the role of capital formation. At the same time everything (outputs, capital and labour inputs, and input productivity) was growing much more slowly than before.

Why did industrial capital productivity grow?

The last part of the story is to seek to estimate the sources of change in the average productivity of fixed industrial capacity. Table 3 reminds us [a] that after 1940 the prewar downward trend in capital productivity was checked and reversed until the late 1950s. The rest of the table analyses this movement as the residual product of two sets of forces. On the one hand, rising overall input productivity [b] tended to be reflected in rising capital productivity. On the other hand, rising capital intensity [c–d] tended to push capital productivity down. In the prewar period fixed capital growth was so fast that it tended to outweigh everything else; it exceeded workforce growth by such a large margin that, even though overall input productivity grew rapidly, capital productivity still declined. In war time the extent of offset was much smaller: the workforce declined faster than the capital stock so that rising capital intensity still tended to pull capital productivity down, but the net effect was small and, had input productivity grown at peace-time rates, capital productivity would have risen.

In the postwar period a more complicated pattern emerges. While capital productivity grew at a declining rate, the sources of capital productivity growth altered from period to period. Under postwar reconstruction (1945–50), workforce growth was so rapid that the effect attributable to changing capital intensity was insignificant. The main influence on capital productivity growth was the contribution of rising total input productivity. In the early 1950s, in contrast, although input productivity growth increased, capital productivity growth decelerated because rising capital intensity had a sharply increased negative effect. In the late 1950s the increase of capital intensity was maintained;

TABLE 3

CAPITAL PRODUCTIVITY GROWTH IN SOVIET INDUSTRY, 1928–60

Annual average (%)

| Period | Growth of average productivity of fixed capacity [a] | Contributions to capital productivity growth of growth in: | | |
		input productivity [b]	manual workforce [c]	productive fixed capacity [d]
1928–40	−1·91	5·55	5·92	−13·75
1940–45	0·00	0·84	−2·02	1·18
1945–50	3·60	4·10	6·70	−6·85
1950–55	1·58	6·57	3·35	−8·16
1955–60	−0·97	3·41	3·77	−8·27

Notes and sources:
a Table 1[d].
b Table 2[f].
c Table 2[e].
d (−0·72×Table 1[a]), where 0·72 is 1 minus the elasticity of output with respect to workforce growth. Note that the sum of [b]+[c]+[d] is slightly more or less than [a]. This is because of the approximation for capital productivity growth in equation 7.

when combined with the falling trend in input productivity growth, it was sufficient to begin to push average capital productivity downwards.[15]

Conclusions

First, the main cause of slower postwar fixed capital growth in Soviet industry was a decline in the share of investment in industrial output. A less obvious contributory factor was the failure of investment completion to improve on the prewar record, in spite of the relaxation of investment mobilisation and increased relative scarcity of capital goods. If evidence is to be sought of Stalinist disorganisation of the allocation of investment resources in the postwar years, we may look here. After 1950 fixed capital growth tended to increase. The main sources of acceleration were small improvements in overall fixed capital productivity (increasing the supply of goods in general relative to the reproductive needs of the capital stock) and in the rate of investment completion. However, by the late 1950s gains from increased capital productivity had been exhausted.

Second, capital formation played a smaller role in the postwar recovery of industrial output than it had occupied in prewar industrial growth. In 1945–50 the single most important factor in industrial recovery was the contribution of workforce growth. In 1950–55 the most important factor was improved efficiency of input utilisation. This may be seen as a belated recovery of dynamic losses resulting from the years of war and postwar reconstruction. To the extent that this recovery coincided with the transition to a new high-level political leadership, it is tempting to look here for gains from post-Stalin rationalisation of the economy. After 1955 capital formation regained its prewar relative importance as a factor in industrial growth, but this represented the decline of other factors, not a return to the superfast rate of fixed capital growth established under the prewar five-year plans.

Third, the secular decline of capital productivity is explained in terms of both diminishing gains from improved efficiency of input utilisation, and rising capital per worker under diminishing returns. In 1940–55 the secular trend was checked and reversed. In war time the reason was that, although resource utilisation generally became only a little more efficient, capital per worker did not increase much either. In 1945–50 the reason was that with demobilisation from the armed forces capital intensity was still held back, while growth of overall input productivity was resumed. In 1950–55 the reason was different again: capital per worker rose sharply but was offset by accelerated input productivity growth. After 1955 the growth of capital per worker was maintained but input productivity growth decelerated; the average productivity of fixed capital peaked and returned to its long-term downward path.

Finally, in spite of improving capital productivity, the industrial economy of late Stalinism emerges as one of reduced investment effectiveness on two counts. These are the failure of investment completion to improve despite the reduced rate of investment mobilisation; and the failure of input productivity growth to return input productivity anywhere near its prewar trend, until the temporary

surge of the early 1950s. However, there is no real basis for singling out 'late Stalinism (1945–55)' as a distinct phase of development of capital formation in general. Rather, in this period the problems of long-term investment effectiveness which would cause such anxiety to Stalin's successors were already present, but were masked by the process of compensation for war-time disturbance in the long-term trend.

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[1] On the Soviet process of capital formation more generally see David A. Dyker, *The Process of Investment in the Soviet Union* (Cambridge, 1983); Mark Harrison, 'Investment Mobilisation and Capacity Completion in the Chinese and Soviet Economies', *Economics of Planning,* 19, No. 2 (1985); Raymond Hutchings, 'Periodic Fluctuation in Soviet Industrial Growth Rates', *Soviet Studies,* XX, No. 3 (January 1969); Raymond Hutchings, *Soviet Economic Development* (2nd edn., Oxford, 1982), ch. 15 ('Investment planning and practice'); Eugene Zaleski, 'Capital Investment in the USSR, 1929–1937: Plans and Realities', in R. W. Davies, ed. *Soviet Investment for Planned Industralisation, 1929–1937: Policy and Practice* (Berkeley, California, 1984).

[2] Mark Harrison, *Soviet Planning in Peace and War, 1938–1945* (Cambridge, 1985), pp. 133–5.

[3] See, for example, the authoritative *Istoriya sotsialisticheskoi ekonomiki* (7 vols.). Vol. 6, *Vosstanovlenie narodnogo khozyaistva SSSR. Sozdanie ekonomiki razvitogo sotsializma. 1946-nachalo 1960-kh godov* (Moscow, 1980), pp. 58–9.

[4] Naum Jasny, *Soviet Industrialization, 1928–1952* (Chicago, 1961), pp. 297–307; Eugene Zaleski, *Stalinist Planning for Economic Growth, 1933–1952* (London and Basingstoke, 1980), chapter 17 ('Investment and Resource Balances, 1945–1953').

[5] Timothy Dunmore, *The Stalinist Command Economy: The Soviet State Apparatus and Economic Policy 1945–53* (London and Basingstoke, 1980), pp. 69–72, 121–2.

[6] K. C. Yeh, 'Macroeconomic Changes in the Chinese Economy During the Readjustment', *China Quarterly,* No. 100 (December 1984), pp. 714–16.

[7] Not all investment goods produced in industry were reinvested in industry, and some goods invested in industry represented the outputs of agriculture, construction and transport. Strictly, β represents investment in industry from all sources, expressed as a ratio to industrial output.

[8] In a Harrod-Domar framework with a closed economy, α a constant, β interpreted as the savings propensity and $\gamma=1$, $\alpha\beta$ would also give the warranted growth rate of output.

[9] For more discussion see Harrison, 'Investment Mobilisation . . .', pp. 8–10.

[10] In this paper, both analytically and in estimation, I have assumed that labour inputs can be identified with the size of the workforce. This means assuming that the working year represents a fixed quantum of effort. The assumption would probably be invalid for studying year-to-year variations in output, but not so far from reality for comparison of 1940, 1945, 1950 and 1955.

[11] This result is based on the Soviet industrial growth record in the early postwar years, disaggregated by both sector and period and including adjacent periods. Empirical findings rely on the observation of 7–10 industrial branches over 1940–50, 1950–55 and 1955–60. Of the two estimated output elasticities, only the elasticity of output with respect to workforce growth carried significance (at the 7% level). The contribution of input productivity growth in each sub-period was captured by three dummy constants. Across the industrial branches used for estimation, annual average input productivity growth was estimated at 1·4% over 1940–50, 6·9% over 1950–55 and 3·6% over 1955–60. Of the three constants only that for the middle sub-period was significant (at the 1·5% level). Data and results, including F- and t-statistics and significance levels are given in a Technical Appendix (Table A.1 and Regression 1), available upon request from the author.

[12] Padma Desai, 'Total Factor Productivity in Postwar Soviet Industry and Its Branches', *Journal of Comparative Economics,* 9, No. 1 (March 1985), pp. 5–7.

[13] See the Technical Appendix (Table A.2 and Regressions 2–4), available from the author.

[14] *Istoriya sots. ekonomiki . . .,* vol. 6, p. 151.

[15] The onset of declining capital productivity in industry after 1955 is ascribed by the authors of *Istoriya sots. ekonomiki . . .,* vol. 6, p. 316 to its 'saturation' with equipment (*tekhnologiya*) not generating increased production.