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# Trends in Soviet Labour Productivity, 1928–1985: War, Postwar Recovery, and Slowdown\*

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## *Abstract*

Understanding the pattern of postwar slowdown in Soviet productivity growth requires evaluation of the impact of World War II and associated shocks. Continuous productivity series for industry and the whole economy are estimated for the period 1928–85. The pattern of Soviet productivity growth was highly disturbed; by postwar standards its underlying growth was slow. Rapid growth and slowdown from the late 1940s through the 1960s and beyond are explained just by postwar recovery possibilities and their exhaustion. Clear evidence of an adverse break in the productivity trend does not transpire until the 1970s.

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\* Published in the *European Review of Economic History*, 1998, 2(2), 171-200. There are three appendices: A. 'Basic data and sources', B. 'Unit root tests', and C. 'Regression equations and symbols'. They can be downloaded from the *Review* website (URL: <http://www.econ.ku.dk/ereh/>) where they are to be found under 'Abstracts and appendices of published papers'.

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# Trends in Soviet Labour Productivity, 1928–1985: War, Postwar Recovery, and Slowdown

## 1. Introduction

The aim of this article is to review the evidence for a long-run upward trend in Soviet labour productivity series. Since the evidence is not clear-cut, this necessarily involves a reexamination of such issues as the persistence of the impact of turbulent events in the second quarter of the twentieth century, notably the Stalin revolution and World War II, and the timing and degree of postwar Soviet retardation.

Both the productivity time series and the techniques of time series analysis used below are largely established. The Soviet case presents two kinds of special difficulties. First, the basic data are of poor quality, and continue to be subject to revision. Second, the growth patterns they reveal are more than usually disturbed, and call for historical judgement to an uncomfortable extent.

In part 2 I review briefly some issues arising from the existing literature. Part 3 is concerned with hypotheses and a description of the data. In part 4 I present procedures and results; part 5 concludes.

## 2. The issues

In recent work Crafts and Mills (1996) drew attention to an idea originally proposed by the Hungarian economist Ferenc Jánosy (1971).<sup>1</sup> The latter argued that the great European postwar boom was largely a return to the path marked out by extrapolating each country's prewar growth—what he called the 'trendline'. What was being perceived at the time as retardation was merely the end of a prolonged postwar recovery phase. The widespread failure to understand this point, he believed, had led policy makers in both socialist and market economies into misperceptions and mistakes. In the late 1940s and early 1950s some believed that postwar recovery was already complete when the prewar level of output had been restored, or when technical reconstruction of damaged facilities had been completed; they became too pessimistic about subsequent growth prospects because they did not perceive the remaining gap between actual output and a rising trendline which, with the passage of time, was already well above the prewar maximum. Conversely, others believed that the continuing recovery was itself a new permanent peacetime trend. Consequently their long-range plans became overambitious; they then treated the unexpected slowdown, when the trendline was finally regained, with an exaggerated sense of failure.

After World War II measuring and understanding the postwar pattern of Soviet economic growth and slowdown became a significant preoccupation for western economists (for an authoritative survey see Ofer 1987). Often they imposed a Solow-type single-sector growth model with diminishing returns and exogenous technical change. This model leaves unexplained what appear to be the most important determinants of cross-country differences in economic growth as an exogenous

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<sup>1</sup> The late Ferenc Jánosy (1914–1997) made a notable contribution to comparative economics. In postwar Hungary he promoted independent research on comparative trends in economic growth, including the measurement of development levels. In particular, he pioneered a method of indirect physical indicators which first achieved international recognition in the statistical work of the United Nations Economic Commission for Europe in the 1960s, and continues to be useful when applied to economies with poor national accounts (e.g. Marer 1985, pp. 92–99; Ehrlich 1991).

residual in growth accounting—economies of scale, improvements in the allocation and quality of resources, and technological improvements. More recent developments in growth theory have attempted to endogenize the residual by accounting for it in terms of either constant or increasing returns to accumulation, or as scope for catch-up growth, conditional upon accumulation policies, incentives, and international openness (e.g. Barro and Sala-i-Martin 1992; Levine and Renelt 1992; and Mankiw, Romer, and Weill 1992).

Most studies of Soviet postwar growth have failed to find an endogenous explanation for postwar slowdown. Rather, it appears that there was initially high exogenous productivity growth which declined exogenously, or an exogenous restriction (such as a limit on capital-labour substitution) on growth possibilities, or a performance residual which changed exogenously from positive to negative through the postwar decades. Easterly and Fischer (1995, p. 346), expressed the lack of an endogenous explanation for the extent of decline in postwar Soviet growth when they concluded from their own exercise in cross-country growth comparison that, after correcting for the tendency of small, poor countries' growth performance to show greater variance, 'the Soviet economic performance conditional upon investment and human capital accumulation was the worst in the world from 1960 to 1989'.

In western studies the impact of World War II has been given a particular significance for understanding Soviet postwar growth and slowdown. The story presumes, explicitly or implicitly, that growth rates underlying Soviet time series before and after the war were stationary, that the end of the war was followed by a recovery phase of perhaps no more than 3 to 5 years, that from the outbreak of the war to this point the level of output had marked time, that the prewar growth rate was resumed from the moment when the prewar level of output had been regained, and that the years of lost growth associated with the war were never made up.

This idea has featured in various guises, each perceived by its proponents just as a convenient simplification. It was introduced by Gregory Grossman (1958), who computed Soviet historical growth rates of industrial production over 'effective years', i.e. actual years less those taken up by the war and recovery to the prewar level, as a statistical correction for the impact of the war.<sup>2</sup> This correction implicitly

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<sup>2</sup> The original formulation of 'effective years' was a little more subtle than this. Grossman (1958, p. 16), argued: 'To calculate the average annual rate of Soviet industrial growth we cannot simply consider the growth to have taken place over the 28 years that separate 1956 from 1928. First, we must eliminate the eight years (1940–1948) that elapsed until the pre-war (1940) level of industrial production was re-attained. Secondly, although *recovery* in this sense was achieved by 1948, reconstruction of damaged capacity continued on a substantial scale at least until the end of 1950, and indeed ... industrial output rose during 1949 and 1950 at about twice the annual rate that obtained in the more 'normal' years ... therefore we count these two years as four. This gives us altogether 22 'effective years' of growth ...' (emphasis in original). This quotation is noteworthy also for its distinction between reconstruction and recovery. The concept of effective years was subsequently adopted by Bergson (1961, pp. 222–3). As recent analogues see Ofer (1987, pp. 1778–9) for growth rates, 1928–85, 'calculated on the basis of only 50 years, excluding the World War II years'; Gregory and Stuart (1994, p. 234) for growth rates for 1928–84, 'effective years'; and Gregory (1994, p. 129) for growth rates, '1928–85 (1940–50 omitted)'. Such western calculations were introduced to a Russian readership by Gregory and Zoteev (1991) and Harrison (1991), who also discuss whether 1913–28 should be treated similarly in growth comparisons extending back to the nineteenth century.

valued the impact of the war in years of foregone growth. Years of foregone growth have also featured explicitly as a traditional measure of the cost of the war in the work of both Soviet and western historians.<sup>3</sup> A similar idea is brought in through the back door when Soviet growth is evaluated starting in 1950 or 1960, which would seem to require the assumption that in 1950 or 1960 the Soviet economy was *not* still recovering from the war—either the recovery was complete, or else there was to be no further recovery. These procedures all shared the hypothesis of a stationary growth rate unaffected by the war, however much (and however persistently) the level of output had been affected.

The evidence for this hypothesis is at first sight fairly copious. Relevant studies of western estimates for Soviet long-run growth series have been conducted at the aggregate level of population, capital stock, GNP, and GNP per head. Despite variation in techniques and sources used, they tend to tell a mutually consistent story: World War II permanently depressed postwar levels of production and assets below the prewar trend.

First, population. The USSR began 1946 with an overall demographic deficit arising from the war of approximately of 35–36 million (17 per cent of the expected end-1945 population), combining excess war deaths and emigration with the wartime birth deficit. Conventional demographic theory suggests that a postwar demographic deficit should be accompanied by accelerated population growth. For example, war accelerates the mortality of the very old and young, and also results in delayed marriages and births, and an increase in terminations of pregnancy; after the war, at least some of the marriages postponed in wartime are normally celebrated, and there may also be a baby boom, while the mortality of the very old and young diminishes; the population may be smaller than before, but its growth accelerates. Ellman and Maksudov (1994, p. 674), point out that the war was not followed by the increase in fertility rates which might have been expected. On the contrary, fertility rates (which had been falling in the 1930s) continued to decline, and never regained their prewar levels. Therefore, depending on one's assumptions about postwar fertility rates in the absence of World War II, the postwar demographic deficit was either simply not made up, or continued to increase indefinitely throughout the postwar period.

Second, the shock to the fixed capital stock also appears to have been effectively permanent. On the basis of figures comparable with those adopted here, and taking into account prewar and postwar investment and depreciation trends, Moorsteen and Powell (1966, p. 243), found the net stock of fixed capital in 1950 to be approximately 51 per cent of an extrapolation of the prewar log-linear trend; alternatively, the war caused the postwar capital stock to attain a given value some 6–7 years later than it would have done otherwise. They estimated the trend annual rates of growth of the capital stock in the 1930s and 1950s from log-linear regression against time, and found scant evidence of postwar acceleration (4.2 per cent, rising to 4.7 per cent), suggesting again that war losses were never made good, or made good only very slowly.<sup>4</sup>

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<sup>3</sup> Tamarchenko (1967, p. 135) suggested that the war cost the Soviet Union ‘two five-year plans’. Subsequently Millar and Linz (1978) revised this figure down to 3.2 to 7 years’ lost income. In later work Linz (1980) offered a variety of figures in a higher range.

<sup>4</sup> Growth trends were estimated by imposing log-linear regression lines on annual series for 1928–40 and 1950–61; for regression equations and charts, see Moorsteen and Powell (1966, pp. 238n, 240). Extrapolating the prewar growth rate from 1940, and the postwar growth rate from 1950, the prewar path would have been regained in 140 years.

Again, standard economic theory suggests that this shortfall should not have persisted. During the war, the capital stock was damaged or depreciated, and since the destruction of physical assets was proportionately more severe than the demographic loss the capital–labour ratio probably fell; but this makes postwar investments abnormally profitable, so that investment is encouraged and the capital stock grows more rapidly than before, precisely because it is starting from a lower postwar level. The increased return to physical capital should have spurred additional efforts to accumulate it, enabling a return to the prewar trajectory. In the Soviet case the negative effects of the war were much more persistent than the standard argument would have predicted.

Whether the standard argument is applicable to a command economy is a separate question. In the Soviet economy there were no market signals of capital scarcity; however, since Grossman (1953) it has been recognised that in some respects Soviet planners allocated capital as if in response to scarcity indicators.

Third, studies of GNP present the same pessimistic picture. In an appendix to Harrison (1994a), Tony Syme tested a GNP series similar to that employed in the present study for the presence of a stationary trend in the underlying mechanism generating the data, while allowing for endogenously detected breaks in the level and trend of GNP. He found support for growth of GNP along a constant trend from 1928 through to 1973; the trend annual growth rate of GNP over this period, 5.2 per cent, was unaffected by the wartime experience, and persisted until the early 1970s. But allowance had to be made for a sharp break of the GNP level associated with the war, involving a postwar shortfall of some 37 per cent below the extrapolated prewar trend, or nearly seven years' lost growth. This setback was not followed by postwar acceleration allowing a return to the prewar trendline, and so was permanent, not temporary as the Jánosy hypothesis would have suggested.

The development level of the Soviet economy, its productive potential and potential for satisfying consumer needs, is better measured by output per head than by aggregate output. And of course persistence of the effects of World War II in aggregate series does not necessarily imply that GNP per head suffered similarly. In recent work Harrison (1996a, pp. 155–69, 295–305), investigated the behaviour of Russian and Soviet GNP per head over the whole period from 1885 to 1985 (the series are broken between 1914 and 1928, and from 1941 to 1950). The data can be read in different ways, but the most convincing hypothesis suggested a story consistent with historiographical tradition. In the early period (1885–1913), the evidence supports a stationary trend of approximately 1.7 per cent annual growth. The 1914–28 period (including World War I and the civil war) was associated with a once–for–all loss of 27 per cent of prerevolutionary GNP per head, but it also gave a positive shock to the trend, which accelerated; from 1928 to 1974 GNP per head grew at a steady, relatively rapid rate of 3.6 per cent per year. This growth was interrupted by World War II which inflicted a permanent loss of about 11 per cent of GNP per head. In the most recent period (1974–85), growth fell back to no more than one half a per cent per year.

The only exception to this consensus was provided by Jánosy. In his pioneering study (1971, pp. 55–67), he considered the trend of Soviet industrial production. He concluded that Soviet industrial production was on a more rapidly rising trend after the Revolution than before, but that the underlying trend was obscured by repeated overlapping shocks and recovery phases associated with the two world wars. By 1960 the long–run trend of industrial production had been regained. However, it should be noted that Jánosy used only the official Soviet statistics widely recognized to exaggerate long–run growth.

In other words, commentators may speak loosely of the Soviet Union requiring 5, 10, 20, or 30 years to recover from World War II, but the suggestion of existing

studies apart from that of Jánosy is that, although prewar levels of GNP, population, and so on were soon surpassed, the Soviet Union never returned to its prewar economic trajectory. This suggestion may be considered surprising, since, for the reasons given above, a negative shock such as a war may normally be expected to be followed by accelerated growth. On the evidence so far, the fundamental Soviet economic variables do not show this expected postwar acceleration.

On an international comparison, it appears that the Soviet Union was the only one of the victors to suffer such an economic setback from World War II. Tests for trend breaks in GDP per head applied by Crafts and Mills (1996, p. 425), suggest that, for most countries of the present-day OECD, the hypothesis of a negative wartime shock to growth is rejected. Only defeated Austria, Finland, France, Germany, and Japan display marked declines in trend GNP growth over 1940–50 compared with 1920–39. For several countries (neutral Switzerland, and victorious Australia, Canada, and the United States), 1940 initiated an acceleration phase. From this point of view the effects of the war on the Soviet economy appear far more consistent with the experience of the vanquished countries than with the experience of the victors, Britain or the United States.

The focus of the present article is on Soviet labour productivity rather than GNP or GNP per head. GNP per head is of course just GNP per worker multiplied by the rate of participation in employment. Soviet participation (measured by employment in full-time equivalents) was rising steeply from approximately one third of the population in 1928 to 45 per cent in 1940, and then more gradually past 50 per cent during the 1960s. Thus, GNP per worker grew more slowly than GNP per head, and the gap between them widened more rapidly before World War II than after. These trends mean that the present shift in focus from GNP per head to productivity affects research outcomes. I return to this issue below.

### 3. Hypotheses and data

#### 3.1. Hypotheses

In recent years it has become common for economic historians to analyse the statistical properties of basic historical series in order to establish, first, whether they display trend- or difference-stationarity, and, second, if (after Perron 1989) the trend-stationary hypothesis is preferred, whether the trend was homogeneous or segmented by turning points or breaks of level (for discussion see Inwood and Stengos 1991 and 1995, and Evans 1995).

The statistical properties of Soviet productivity series, whether for the whole economy or for industry, per worker or per hour, have not been investigated systematically in previous research. The main task of the present article is to test a number of hypotheses arising from the literature reviewed above.

1. Can we discern a stationary trend in Soviet productivity? The Soviet series are highly disturbed at each end of the long period available for study—by repeated shocks in the early (1928–45) period, then by the postwar tendency to deceleration. Therefore, a unit-root hypothesis (that is, that productivity followed a random walk with upward drift) can usefully be tested against the hypotheses of either a homogeneous or a segmented upward trend.

A trend and a drift may look similar to the eye, especially over short periods. Much careful testing is required to discriminate between them. Where a stationary trend is present, growth series may take anything from 1 to 5, 10, 20, or even 30 years to converge. When shocks persist, it may make little practical difference to those living at the time whether the persistence is measured at 30 years (in the case of a slowly convergent trend) or infinity (in the case of a drift). For economists, however, the difference is fundamental. It decides whether we are living in the

- world of standard economic theory, with diminishing returns and exogenous improvement, or the new world of endogenous growth in which capital accumulation brings constant or increasing returns.
2. Failing the unit–root hypothesis, we can pursue a stationary–trend model by examining the timing, scale, and persistence of shocks. One source of productivity disturbance in the period (but not—as will be shown—the only one) was World War II. Previous western studies have suggested that World War II resulted in permanent losses to Soviet aggregate indicators as well as to GNP per head. Was this also true of productivity? Against the hypothesis of a permanent shock we will compare the ‘Jánosy’ hypothesis, that at least part of Soviet rapid postwar growth and slowdown is attributable to recovery to an historically normal path established before the wartime disturbance.
  3. Finally we will go on to investigate the periodization of the last phase of normal Soviet productivity growth. If the Jánosy hypothesis proves acceptable, we can examine whether Soviet postwar deceleration is fully accounted for by the return to a normal long–run path, or whether exogenous factors additionally depressed late Soviet productivity growth after the normal path had been restored.

### **3.2. The data and their defects**

#### *3.2.1. The basic data*

The productivity series used below show Soviet GNP per worker, and industry value added per worker and per hour worked, from 1928 to 1985. The output measures are the conventional western estimates derived mainly from Moorsteen and Powell (1966), Becker, Moorsteen, and Powell (1968), and after them the US Central Intelligence Agency (1990). Moorsteen and Powell measured Soviet real GNP by sector of origin; the CIA figures involved a more elaborate computation combining supply–side data with deflated final uses. From their work I obtain series for total GNP and industry value added in rubles at fixed factor costs of 1937 (1928–66, supplemented for the war period by Harrison 1996a), and of 1982 (1950–85).

For whole–economy employment (civilian manual and nonmanual employees, collective farmers, artisans, and military personnel), I take figures from Moorsteen and Powell for employment in ‘prevailing man–years’ (1928–50, since after 1950 their estimates were subject to divergence and revision), and from the subsequent estimates of Rapawy (1987) for 1950–85, which also include series for postwar industry. Figures for prewar and wartime industry are pieced together from a variety of disparate sources (Moorsteen and Powell 1966; Zaleski 1980; Barber and Davies 1994; Harrison 1996a). Full detail is supplied in appendix A.

These data contain a number of problems and deficiencies which require acknowledgement. Prior to 1950 they are incomplete by some percentage of the work force held in NKVD–MVD camps, colonies, special labour settlements. Those subcontracted to civilian agencies were enumerated in official employment statistics, but not those employed directly in NKVD–MVD establishments and construction projects. On the estimate of Harrison (1996a, pp. 258, 272), this accounted for just under 2 per cent of the 1940 working population, and half of one per cent of industrial employment. These missing employees are counted separately in my own workforce estimates for 1940–5, but are not included in the western figures for before or after. For present purposes I have preferred consistency to accuracy, and the series which I use below exclude them uniformly.

Average annual hours present greater difficulty, and are only known with both reliability and serial continuity for large–scale industry. For example, series for hours worked are provided for postwar industry by Rapawy, and can be compiled for the pre– and trans–war period from Moorsteen and Powell combined with official



sources. The whole–economy series provided by western authorities are typically based on large–scale industry, however, with hours worked in other sectors (especially agriculture) assumed constant or changing in steps, so they add little or nothing to what can be learnt from industry–only series and are also unsuitable for dynamic tests. It is hard to see how more empirical research could overcome these defects; in collective farming, for example, labour inputs were traditionally calculated in terms of conventional tasks, not actual time expended. In some sectors (e.g. military services) the very meaning of output per hour is unclear. Therefore, for present purposes I don't calculate GNP per hour, only per worker.

Table 1 shows the changing level of labour productivity in the whole economy and in industry at the beginning and end of the available series, and on intervening benchmark dates commonly used in comparative studies of long–run growth. Between 1928 and 1950, industry value added per hour changed little. Industrial output per worker rose by a fifth, almost entirely because of the increase in hours worked across World War II. In the whole economy, GNP per worker rose by about one half, largely because of two influences, the transfer of employment from low–productivity agriculture to high–productivity industry, and the general increase in hours worked. For this period, therefore, 'extensive growth' was an apt label.

The pattern changed in the postwar years. Between 1950 and 1985, productivity growth within industry and across the whole economy was marked. In industry, output per worker trebled while output per hour rose by even more as hours fell back. GNP per worker also more than doubled. Across the postwar decades, however, there was a perceptible slackening of the pace of the increase, and growth rates were lower in the late 1970s and early 1980s than in the 1950s and 1960s. Much like the industrialized market economies, the Soviet economy had experienced a 'golden age' of postwar recovery and sustained expansion, which then turned sour in the age of oil shocks and high inflation, but the deterioration was sharper for the Soviet economy than for the economies of the west (Maddison 1995, pp. 53–86). Bear in mind, however, that these benchmarks are arbitrary; whether they provide the most suitable periodization of Soviet growth is one of the questions to be explored below.

One of the most important defects of the data is the lack of series extending back into the period before World War I. For GNP and industrial production there is a gap between 1913 and 1928, and for employment (whether in total or in industry) there are no annual series prior to 1913, only occasional census figures with more long gaps. This reflects primarily the deficiencies of employment statistics in an agrarian country with a huge informal sector. The result is to bar us from consideration of the productivity impact of shocks prior to 1928, most notably World War I and the civil war which followed it.

It is accepted that in 1928 Soviet GNP per head was still below its 1913 level, perhaps in the range 83–93 per cent suggested by Paul Gregory (1990). However, there is some evidence that GNP per head in the Russian Empire in 1913 was above its trend as a result of an unusual harvest. Further adjustment would bring the 1928 figure up to 100 percent of 1913 (for more detail of sources and methods see Harrison 1994b, p. 42). If we take the 1913 figure and extrapolate it to 1928 on the basis of the 1.5 per cent annual growth of GNP per worker in the Russian Empire over the years 1883–7 to 1909–13 calculated by Paul Gregory (1982, p. 168), then in 1928 Soviet GNP per worker was roughly 20 percent below the prerevolutionary trendline. Thus it has been reasonably inferred that some growth after 1928 may be accounted for by continuing recovery from the warfare of 1914–21. The same calculation may be made for industry. According to Gatrell and Davies (1990, p. 141), output per hour worked in Soviet census (large–scale) industry in 1926/27 was roughly 10 per cent *above* the 1913 level; however, it was also roughly 10 percent

*below* a prerevolutionary trendline extrapolated on the basis of Gregory's 1.8 per cent figure for annual productivity growth in industry before 1913.

We can assert with assurance, therefore, that in 1928 Soviet GNP and industrial production were not above the 'normal' peacetime trend, and were very likely still below it by some margin. This will prove important below.

Greater precision would naturally be desirable. The lack of it must weaken our ability to determine trends after 1928, and to decide whether they were in continuity with the past. However, the intimidating difficulties of computing adequate productivity series for the years prior to 1928 are enough to force me to draw a line at this point. The gap in time series between 1913 and 1928 cannot be bridged on our present knowledge.

### 3.2.2. *The Gerschenkron effect*

The figures for 1928–85 as they stand present a problem in index number relativity. The output series are computed to two different standards of valuation, and the overlap between them (1950–66) reveals that shifting from constant factor costs of 1937 to those of 1982 gives rise to a significant Gerschenkron effect; that is, the factor costs of 1982 give a lower relative valuation to more rapidly growing components of output than the factor costs of 1937, and therefore a lower figure for the growth rate of output as a whole.

In the case of industry the difference is not large, but for GNP it is more substantial. Taking the period of overlap in each case, the figures calculated in late prices can be regressed on the same series in early prices to give an equation which shows the least-squares fit (all series are transformed into natural logarithms). The growth rate of GNP at 1982 factor cost was probably three quarters of the growth rate of GNP at 1937 factor cost, just because of the reweighting. For industry the results are closer, late prices suggesting a trend growth rate 93 per cent of the trend growth of output measured at early prices.<sup>5</sup> I then use the equations and measured output of the early period (i.e. before the overlap) in early prices to predict output of the early period adjusted to late prices. This gives us complete series for 1928–85 on a consistent standard of valuation based on late prices. Late prices are preferred because the 46 primary observations in late prices (1950–85) outweigh the 39 in early prices (1928–66), and are probably also of higher intrinsic quality.

### 3.2.3. *What the adjusted data show*

The adjusted data are plotted for GNP per worker in figure 1, and for industry value added per worker and per hour, together with average hours, in figure 2. These figures illustrate well the dramas, achievements, and reversals of the Soviet-era supply side.

Looking at these figures reminds us just how overcrowded with history were the years between 1928 and 1950. There were several bursts of rapid productivity growth interspersed with episodes of sharply adverse performance. A stylized narrative of the period associates these episodes with both systemic transformations and exogenous developments. The first setback began in 1930 or 1931 and was associated with the transition to a shortage economy under the first five-year plan, mass collectivization in agriculture, and the famine of 1932. There was mass

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<sup>5</sup> With 17 observations in each case, results were as follows (t-ratios in parentheses; all regression variables as listed in appendix C):

$$gnp(82fc) = 0.9078 + 0.7475 \cdot gnp(37fc); \quad R^2 = 0.9937$$

(48.5985)

$$ind(82fc) = -0.8106 + 0.9316 \cdot ind(37fc); \quad R^2 = 0.9980$$

(86.0093)

migration from country to town; in industry, at the same time, enterprises responded dramatically to the imposition of nonprice controls and softer budget constraints by swelling their labour resources as rapidly as possible. The result was that the plan for job creation was one of the few targets of the first five-year plan to be overfulfilled in real terms. At the same time industrial productivity collapsed.

The crisis of 1931–3 was followed by the ‘three good years’ (Jasny 1961, p. 14) of recovery and consolidation between 1934 and 1936; then, a second period of difficulty began. The context of the years after 1936 was formed by the aftermath of the Stakhanov movement and then sweeping purges, greatly increased regimentation of labour, a shift from rapid rearmament to war mobilization, and the outbreak of World War II in Europe. The economy seemed to be trapped in a vicious circle of overstrain and stagnation. GNP per worker declined. In industry hours of work were forced up, so that output per worker was maintained against a fall in output per hour.

Further shocks were associated with World War II. The war with Germany (1941–5) was won by means of great efforts, including a poorly controlled, costly mobilization of resources. War mobilization in 1941–2, especially the conversion of industry to serial production of weapons, resulted in a marked boost to productivity. But the gains were lost at the other end of the war; with demilitarization and reconversion of industry in 1945, output fell sharply, although employment and hours were maintained. One implication is that, if we consider only productivity, and not aggregate flows and stocks, the war itself does not look like a negative disturbance. It was the two transitions, from peace to war, and then from war to peace again, which appear to have been damaging, and the latter was associated with more damage to productivity than the former. Postwar reconversion to peacetime production, fraught with difficulty in itself, was complicated by renewed famine and economic isolation, and the reconversion process was not really completed since the postwar economy remained much more militarized than before.

Despite rapid recovery in 1946–50, the outcome was that across two decades there had been virtually no productivity gain in industry. The achievement of substantial growth in GNP per worker over the same period, when productivity failed to rise in either industry or agriculture, is thus only to be explained by the largescale transfer of resources out of agriculture (where productivity was low and stagnant) into industry (where productivity levels, if stagnant, were higher than in the rest of the economy).

Nonetheless, by the 1950s the Soviet economy had entered calmer waters, and now embarked on many years of relatively uninterrupted but also gradually declining productivity growth.

## **4. Procedure and results**

### **4.1. Can a unit root be rejected?**

The procedure I follow with each productivity series is first to check whether its path can be described as an upward trend, as opposed to an upwardly drifting random walk corresponding to the presence of a unit root. The results are not completely straightforward but what emerges from detailed analysis is that a unit root is clearly rejected for both GNP and industry value added per worker provided that some segmentation of the time trend is allowed for (for detail see appendix B).

This is not unambiguously the case with industry value added per hour, however. A unit root can only be rejected for discrete subperiods (1932–44 and 1945–85), even allowing for segmentation of the trend, and there is no subperiod beginning in 1929 over which a unit root can be rejected. In other words there is somewhat stronger evidence of frequent persistent shocks to this series, causing it to drift rather than follow a trend.

The relationship between the two industry series is quite intriguing. Any divergence between them is accounted for solely by variations in average hours, which in the Soviet case may plausibly be seen as an exogenous policy variable reflecting the degree of coercion applied to the workforce. Calling it coercion is not to deny that Soviet workers sometimes worked longer hours willingly from a sense of duty or patriotism, for example in wartime, but such movements were visibly accompanied by coercion if only to discourage free riders.

It makes sense to suggest that changes in output per hour worked in Soviet industry may have been negatively associated with changes in hours worked. The evidence of western economies in the 1950s and 1960s indicated that, when the working week in industry exceeded 48 hours, output per worker was at a maximum, so that additional hours would be matched by a proportional reduction in output per hour (Denison 1967, p. 59). The working week in Soviet industry in the second half of 1940 was officially 48 hours, and the actual figure had probably risen to nearly 56 hours by 1943 to judge from data cited by Harrison (1996a, p. 259).

We can try to estimate the elasticity of output per hour with respect to hours worked in Soviet industry from the available time series. When the change in the log of output per hour is regressed on the change in the log of hours over the whole sample period, the estimated elasticity has the wrong sign (+0.20) and is not significantly different from zero even at the 10 per cent level.<sup>6</sup>

This failure to find a significant relationship is mostly attributable to the war period. When war broke out both hours and output per hour rose sharply; when the war finished, both collapsed. Some of this was because of structural change—there was a great increase in the output and employment shares of defence industry. In defence industry both average hours and output per hour rose rapidly with the wartime shift to standardized mass production of weapons, while output per hour (but not average hours) fell in civilian branches. At the end of the war, the process was put into reverse.

If we represent each year of the war and early postwar period by a separate dummy variable, then sort and select the dummies by statistical significance, we find a much stronger result. A large and significant exogenous boost to output per hour transpired in 1942 (when average hours were also rising), and large, significant negative shocks were registered in 1946 and 1947 (when hours were falling). When this is taken into account, the data suggest a large and very significant negative elasticity (-0.77) of output per hour to average hours in the short run.<sup>7</sup> Dynamic tests using a variety of lag lengths, not reported here, confirm that this effect was persistent (estimates of the long-run elasticity varied between -0.6 and -1.0). In other words, the normal effect on output per worker of an increase in hours was largely cancelled out by a decline in output per hour which was not reversed until hours were cut back again.

I take this result as no more than suggestive; a definitive treatment of the relationship between hours and productivity probably requires a largescale study of

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<sup>6</sup> With 57 observations, results were as follows (t-statistics in parentheses; all regression variables as listed in appendix C):

$$\Delta ind / hr = 0.0215 + \underset{(0.7195)}{0.2031} \cdot \Delta hours; \quad R^2 = 0.0093$$

<sup>7</sup> With 57 observations, results were as follows (t-statistics in parentheses; all regression variables as listed in appendix C):

$$\Delta ind / hr = 0.0260 - \underset{(-2.867)}{0.7741} \cdot \Delta hours + \underset{(3.355)}{0.2206} \cdot year(42) - \underset{(-4.115)}{0.28326} \cdot year(45) - \underset{(-5.021)}{0.3160} \cdot year(46);$$

$$R^2 = 0.4547$$

Soviet microdata. Still, it may explain why persistent shocks are more in evidence for industry output per hour than for output per worker. Output per hour is being disturbed by an exogenous policy influence and the disturbances appear to be relatively persistent. Output per worker was affected by one less policy variable, and the series is more easily characterized by a stable trend.

#### **4.2. A Jánossy model of the postwar trend**

The general time–trend model which I test below is based on the Jánossy hypothesis that postwar acceleration represented a return to a prewar normal trend. This is more restrictive than a conventional segmented–trend approach because it forces the same long–run trend on the postwar, post–recovery years as on the prewar period. Its advantage lies in its relative simplicity. The wartime disturbance and recovery sequence is modelled by assuming that, once the forces causing the disturbance ceased to act, the economy returned to its previous trend along an asymptotic curve. The persistence of shocks may therefore be defined by the duration of their half–life. The persistence factor is one of the parameters determined endogenously, along with the timing of breaks of trend and level, in the course of maximizing the model’s explanatory power. A persistence factor of 100 per cent would be identical to a conventional break of level in a segmented–trend model.

My approach to modelling recovery is a little different from that originally proposed by Jánossy (1971, pp. 9–11, and revived in that form by Crafts and Mills (1996). Jánossy conceived of recovery as a linear return to the linear trend. This meant he could speak of a clearly defined recovery phase which began and finished within a determinate number of years, instead of (in my approach) a recovery process which never ends, strictly speaking. However, in early trials using the Soviet data an asymptotic recovery model decisively outpointed the linear recovery alternative originally proposed by Jánossy in terms of significance tests.

Subject to this reinterpretation, I prefer the Jánossy hypothesis to a conventional segmented–trend model for three reasons. Statistically, it provides more explanatory power for fewer independent variables. Analytically, it offers the chance to carry our understanding of permanent and transitory components of postwar growth to a deeper level. Philosophically, it links the traditions of western and east European political economy. Therefore, while a segmented–trend model was also calibrated for each of the series under review in preliminary work, for reasons of space I report here only the results of the Jánossy model. A detailed comparison can be found in an earlier draft of this article circulated as Harrison (1996b) and available from the author.

##### *4.2.1. GNP*

Results for GNP per worker are shown in table 2 (col. 1). World War II is modelled as a discrete subperiod of several years when the productivity trend turned temporarily down before beginning postwar recovery, rather than as a single–period break of level. I allow for a trend break later in the postwar period in order to test the hypothesis that all the subsequent deceleration can be explained by the exhaustion of recovery growth. The moments when transwar deceleration (1937), and postwar recovery (1946) began, and when postwar deceleration set in (1973), are selected endogenously, and are all statistically highly significant.

The resulting picture is summarized as in the final rows of the table (see also figure 3). After scaling the trend coefficients to remove the short–run influence of the lagged dependent variable, the underlying trend of productivity growth from 1929 through to 1973 is estimated at 2.1 per cent per year. The productivity trend turned down temporarily, however, in 1937; from then through to the end of the war, productivity fell annually at 1.3 per cent, so that from 1945 onwards much faster growth was required to converge gradually on the earlier trend.

The annual persistence factor of a large adverse shock such as that associated with World War II is estimated at 93 percent, corresponding to a half-life of the shock of around 9 years. In other words, by 1954, with Stalin's corpse already on view in the Red Square mausoleum, recovery from the effects of World War II was only half complete. Effectively a line is drawn between large and small shocks. Small shocks, the endogenous product of the model's white noise function, have an effect which is mostly exhausted within the annual accounting period; the lagged dependent variable's coefficient in the case of GNP per worker is only 37 per cent. On the other hand, large exogenous shocks have consequences which reverberate far into the future.

This model suggests that all the deceleration of productivity growth reported in the 1950s and 1960s is attributable to the diminishing curve of postwar recovery. The peacetime trend does not turn down until 1973, with underlying productivity growth falling then to 0.5 per cent per year. Incidentally, with the assumption of slow, asymptotic convergence, in 1973 postwar recovery was still incomplete as is can be seen in figure 3, so there was still a small element of post-1973 deceleration to be explained by this influence which continued gradually to die away, becoming negligible in the 1980s.

The research preceding this study and already cited above suggested that the adverse effect of World War II on GNP per head was permanent. Why does the effect of the war appear less persistent in GNP per worker than in GNP per head? The answer appears to lie in two things, one statistical and the other real. The statistical factor is that the GNP per head figures used previously were unadjusted for the Gerschenkron effect. This exaggerated prewar growth relative to postwar growth, and made it more difficult to detect a postwar recovery element. The real factor is the participation rate, which rose much more rapidly before World War II than after. The rapid prewar rise in participation gave a boost to the prewar growth rate of GNP per head which could not be sustained in the postwar period. As a result, postwar GNP per head could not catch up with the prewar trend. The war did not cause the slowdown in the rise of participation, it just coincided with it. But this coincidence created the appearance that the war had caused a permanent break in the level of GNP per head.

My support for the Jánossy hypothesis with regard not only to GNP per worker but also to the other productivity indicators reviewed below should be qualified in the light of our inability to carry the series back through the 1920s and World War I to the prerevolutionary period. A glance at figures 3, 4, and 5 below shows just how great a burden of explanation rests upon observations for 1928-30, which effectively anchor the estimate of the 'normal' peacetime trend in its early years. How are results likely to have been affected by truncation of the sample before 1928?

It was argued above (section 3.2.1) that in 1928 Soviet GNP per head and industrial output per worker, although growing rapidly, were certainly still adversely affected by World War I and the civil war and were therefore, if anything, below their true normal peacetime trend paths. Being unable to take this into account *strengthens* my research findings. If we were to fill in the missing years, we would expect to find that the 1928 level of the productivity trendline was higher than estimated in table 4, that its long-term rate of growth was therefore lower, that the impact of each of the Soviet-era productivity shocks identified was also therefore deeper, that the scope for recovery growth was therefore greater and its duration longer in each case, and that even more of the observed postwar deceleration is therefore attributable to the exhaustion of recovery processes than is claimed in this article.

However, if we base ourselves on no more than the series available, we can sum up as follows. First, the events surrounding World War II clearly disturbed the

productivity trend, but the available series for GNP per worker do not support the hypothesis of a permanent negative shock arising from the war. In a plausible interpretation of the figures, the war was followed by recovery to a rising normal long-run trend. This recovery did however take much longer than contemporary observers and historians have commonly allowed. Then, in the mid-1970s (but not before), the underlying productivity trend of the Soviet economy decelerated sharply. In this new phase, productivity growth was significantly slower than what had previously been historically normal.

#### 4.2.2. *How fast is 2.1 per cent?*

As already stated, the underlying trend of annual productivity growth in the period 1929–73 is estimated at 2.1 per cent. Is this fast or slow? The answer appears to be that it was fast for the whole period, but slow for the postwar 'Golden Age'. This judgement is reached as follows.

The Soviet figure of 2.1 per cent trend productivity growth over 1929–73 cannot easily be inserted into international datasets for the same period because, first, most such datasets measure GDP per head, not per worker; second, the Soviet figure has been corrected for index number relativity in a way that other countries' figures are not; third, it is a notional figure for trend growth, not actual growth. For the period 1929–73 the third problem is less important, because in both 1929 and 1973 the Soviet economy was close to its trend (at least as estimated here), and the same is typically the case for other economies. A short-cut procedure would simply compare the unadjusted figure for Soviet annual GNP per head growth (3.4 per cent) corresponding to the productivity estimates used here with the actual GDP per head growth rates of other countries. Two comparisons may be offered. In a sample of 23 countries of the present-day OECD plus the Soviet Union, the Soviet growth rate over 1929–73 is ranked third (after Japan and Portugal). Since the Soviet economy was relatively poor in 1929, this could simply be the result of  $\beta$ -convergence, in which case the Soviet growth rate should not be considered abnormally rapid. A relevant further contrast is therefore against other economies with similar initial levels of GDP per head. In a sample of 15 countries with GDP per head in 1929 between \$1,000 and \$1,999 at 1990 international prices, the Soviet growth rate over 1929–73 is ranked fourth (after Japan, Portugal, and South Korea).<sup>8</sup> By such standards, underlying Soviet growth was rapid.

It is by postwar standards that underlying Soviet growth looks slow. Here comparisons are at least relatively free of index-number difficulties, but are now complicated by the varying degrees of wartime setback and recovery rates with which different economies began the postwar period. Actual growth rates will not tell us what we want to know.

The best that can be done is to compare the 2.1 per cent figure estimated here for Soviet trend annual productivity growth with postwar GDP per head trends estimated for other countries in the study by Crafts and Mills (1996). Their sample comprises 17 OECD economies, and trends are estimated across varying segments from the nineteenth century through to 1989. In their first model, a homogeneous trend is estimated for the postwar segment beginning in 1951 and ending in 1973. Of the 17

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<sup>8</sup> Both samples are taken from Maddison (1995, pp. 194–206). The countries in the OECD sample are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. Those in the low-income sample in addition to the USSR are Brazil, Bulgaria, Colombia, Indonesia, Japan, Mexico, Peru, Philippines, Portugal, Romania, South Korea, Taiwan, Turkey, and Yugoslavia.

countries, 16 grew more rapidly than the Soviet Union, the exception being the United States. Convergence is not a factor in the poor Soviet showing. Only two (Spain and Japan) had lower initial GDPs per head than the USSR, and both had overtaken the level of the Soviet economy by 1973. Thus, 2.1 per cent is certainly slow by the demanding standards of the 'Golden Age'.

At the same time the standards of the 'Golden Age' may be too high, especially if Janossy was right to suppose that much of rapid postwar growth was to be explained by a prolonged recovery from the war. It is not appropriate to select a period beginning in 1951 for comparison of other countries' growth with the Soviet trans-war trend, if in 1951 European and Japanese growth rates were still benefitting from postwar recovery.

Relevant figures may be found in Crafts and Mills' second model, where they force a first postwar trend break in 1950, then find a second break endogenously. This allows comparison of the Soviet trend up to 1973 with OECD trends estimated for a sub-sample of seven countries for which the final postwar segment ending in 1989 is found to have begun between 1955 and 1959 (for the remaining 10 countries, the segment ending in 1989 is found to have begun between 1970 and 1976, in the era of slower global economic growth when the relevant segment of Soviet growth was already at an end). Six of the seven showed more rapid growth than the Soviet Union, only the United States trend being slower.<sup>9</sup> Again, convergence is not a factor, since all the rapid growers began their final growth phase with higher GDPs per head than the USSR. On this basis it is concluded that trend productivity growth of 2.1 per cent should be counted slow by postwar standards.

#### 4.2.3. Industry

In the case of GNP per worker I combined the hypotheses of a normal underlying trend with an early adverse shock to the trend followed by recovery, and then a another break of trend late in the postwar period. Industry is more complicated. When we look at the pattern of exogenous disturbance in the industry productivity series before 1946, it is clear that the sequence of shocks was probably quite complex, and not all shocks were adverse. Rather than model the pre-1946 process as a trend segmented by the war, I search for multiple breaks of level (crashes). Each crash, distributed over two years, is followed by an asymptotic recovery characterized by the same half-life. Since each shock is additive, and each recovery is asymptotic the result is a sequence of what Jánosy (1971, pp. 36-7, called 'overlapping disturbances'. Recovery from the first crash is not complete before the second materializes, and a third crash will interrupt recovery not only from the second but also from the first.

There are some notable differences in the results for industry value added per worker (table 2, col. 2) and per hour (col. 3). However, the similarities deserve prior attention. Small random disturbances in industry are even more short-lived than in the case of GNP per worker, and the lagged dependent variable shows either little or no significant influence (in the case of output per worker it has been dropped from the regression). On the other hand, large exogenous shocks have a uniform persistence factor (92-3 per cent) and a 9-year half life virtually identical with that applying to GNP per worker. Recovery from the sequence of overlapping disturbances affecting industry before 1946 is sufficient to explain an even longer postwar deceleration phase than for GNP per worker; not until 1976 or 1977 can we

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<sup>9</sup> Crafts and Mills (1996, pp. 421-5). The 17 countries (with the sub-sample of seven in italics) are Australia, *Austria*, Belgium, *Canada*, Denmark, Finland, *France*, *Germany*, Italy, Japan, *Netherlands*, *Norway*, Spain, Sweden, Switzerland, the United Kingdom, and the *United States*.



speak confidently about a new downturn in the normal peacetime trend. In each case a 'normal' long-run trend is identified which can be called slow by postwar standards—2.1 per cent annual growth for output per worker, 2.2 per cent for output per hour (after stripping out the influence of the lagged dependent variable), the minor difference reflecting the long-term reduction in average hours worked.

The important differences among all three series relate to the sequence of shocks before 1946. In the case of GNP per worker, the most powerful model described an adverse shock to growth beginning in 1937 and lasting through 1945. The GNP series was tested for different patterns and sequences of shocks prior to 1937 but none achieved statistical significance. In the case of industry value added per worker, however, the normal trend was apparently interrupted more frequently and more violently, by three two-period crashes beginning in 1931, 1942, and 1945 (figure 4). The second of these, moreover, was a *positive* shock which bounced productivity back up to the pre-1931 trend (with the transition to serial production of weapons average hours soared without detriment to output per hour). But the ground gained was lost again in 1945. The next 30 peacetime years were spent recovering from the cumulative adverse outcome.

Industry value added per hour presents a different picture (figure 5). In the Stalin period output per hour, growing at an underlying 2.2 per cent per year, was struck by repeated setbacks (again modelled by two-period crashes) which arrived in 1931, 1939, and 1945, with far greater frequency than the recovery possibilities. Thus when the second shock to output per hour arrived in 1939–40, recovery from the first shock of 1931–2 was only half completed, and the third arrived in 1945–6 on the heels of the second. As a result, each recovery began from further below the rising trend (see again figure 5). Correspondingly, therefore, growth in the first year of each of the second and third recoveries was more rapid than in the previous recovery. By 1947, industry was recovering from the cumulative consequences of all three productivity disasters. The threefold recovery of output per hour continued along a continuously decelerating path until 1976, when the normal trend itself turned down.

## 5. Conclusions

In terms of the three hypotheses presented earlier, I find as follows.

First, the data do not support the view of Soviet productivity growth as a random walk with upward drift. Underlying growth of both GNP per worker and industry value added per worker was relatively stable, and actual growth followed a process of convergence on an equilibrium trend. The trend was affected from time to time by large exogenous shocks. Once allowance is made for these, the unit-root hypothesis is rejected for both series. For industry value added per hour worked there is some ambiguity, and I propose the persistence of shocks arising from an inverse association with changes in average hours as a possible reason.

Second, the productivity record is generally consistent with a trend-stationary hypothesis when allowance is made for exogenous adverse shocks and recovery from them. Previous research tended to concur in the view that World War II resulted in a permanent postwar shortfall in the level of various Soviet long-run series (especially GNP per head) below the prewar trend. Present findings suggest the opposite: these losses did not persist indefinitely, although they were quite long-lasting. Each of the three series investigated converges on the same figure of 9 years for the half-life of a large, exogenous productivity disturbance. Thus, after three decades nearly 90 per cent of the ground lost because of the war had been made up.

However, it is clear that in the Soviet case recovery was from more than just World War II. Stalin as well as Hitler contributed to a long-term productivity burden. The evidence supports the proposition that some of the observed rapid postwar growth was driven by recovery from losses which preceded World War II. Violent

disturbances depressed productivity at the beginning of the 1930s during the first five-year plan and farm collectivization, at the end of the 1930s with purges and accelerating rearmament, and at the end of World War II as reconversion again disrupted the economy. These were separate and additive traumas from which the economy took decades to recover fully.

The way in which I have specified the Jánossy hypothesis does not allow a direct comparison of the Soviet economy's rate of recovery from World War II with recovery rates of the OECD market economies found in other research. However, it emphasises the importance of distinguishing economic recovery to a prewar trendline from technical reconstruction of war-damaged facilities. Technical reconstruction can be over and done with long before economic recovery is approached. It appears that, whatever advantages the Soviet Union displayed in speedy reconstruction of war-damaged facilities, its economic recovery was quite prolonged.

Third, how we understand the process of postwar retardation is sensitive to the way we model the effects of earlier setbacks, especially those associated with World War II. On the hypothesis that there was no postwar return to a prewar trend, or that recovery was already complete when the prewar level of output had been regained in 1948 or 1949, previous observers argued that underlying growth in the Soviet economy was rapid in the 1950s, and declined gradually and steadily in the 1960s, 1970s, and 1980s. But if, as has been argued here, much early postwar growth was driven by recovery to a prewar trendline which had been rising slowly since 1928, then it becomes possible to explain all of the postwar retardation through and even a little beyond the 1960s just by the exhaustion of recovery possibilities.

This has two implications. One is a diagnosis of the problem with Soviet postwar productivity growth. For most of the postwar period, the problem was not that it decelerated, since deceleration is easily explained; the problem was rather that *the underlying trend on which actual productivity growth converged was slow*, if not by the undemanding standards of the world economy between the wars, then certainly in the light of postwar comparisons. There was an appearance of speed from time to time, but this was just the result of episodic setbacks and recoveries.

A further implication concerns late Soviet decline. To find a real adverse break in the productivity trendline it is necessary to look to events and factors much later in the postwar period than would normally be considered, certainly *not* before 1973 or so. For example, on the present interpretation, the growth deceleration of the 1960s—the setting for economic reform discussions and eventually the Kosygin reforms in 1965—was not a systemic slowdown, just a sign that the scope for postwar recovery was diminishing and partly exhausted.

It remains the case that our readiness to sustain this argument depends very much upon the confidence with which we can identify 'normal' productivity growth over the period from the 1920s through to the 1970s. The problem is not so much one of statistical confidence, as of confidence that our results are not distorted by the absence of annual productivity series before 1928. As it is, a lot hangs on data for the initial years 1928–30. As was argued above, in 1928 Soviet productivity was almost certainly still recovering from the years of world war and civil war, which had concluded in 1921 and so were still only 7 years distant. This means our estimate of the peacetime productivity trendline normal for this time has, if anything, too low an initial level, and too high a growth rate. If so, access to the missing data before 1928 would just strengthen the present findings, not overturn them.

Dating the onset of postwar Soviet productivity retardation in the early 1970s has a satisfying aspect, and also poses further problems. The nice thing is that it fits in so well with the widely accepted timing of postwar slowdown in the OECD market economies in or about 1973. The problem is that the Soviet productivity slowdown was so apparently abrupt and severe.

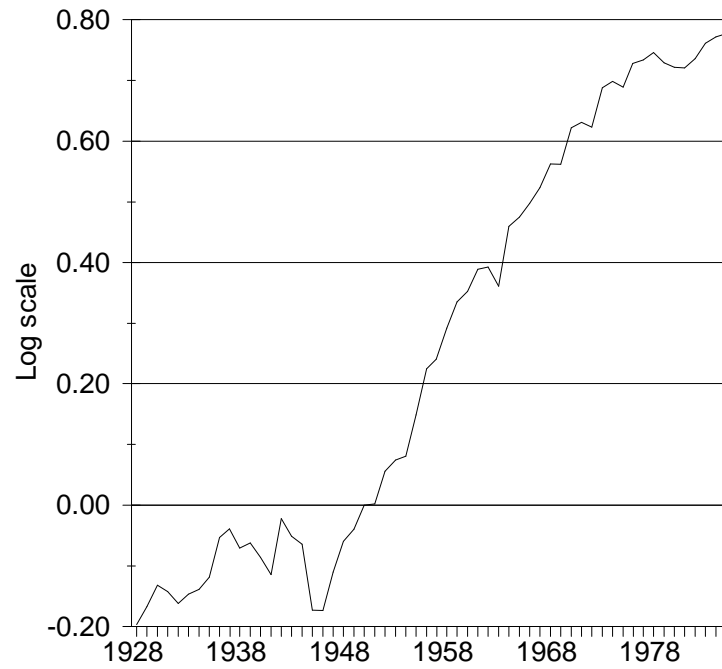
On the face of it an endogenous explanation of late–Soviet slowdown seems unlikely—the Soviet economic mechanism had always been of low dynamic inefficiency, but there was no obvious reason why its efficiency should have taken a sudden and catastrophic turn for the worse. If some indicators (e.g. physical accumulation) were indeed pointing to a slowdown, others (e.g. openness to foreign trade and technology) were gradually improving. The most promising conjectures in the existing literature suggest that attention might be paid to the weakening of planners’ authority in the 1970s, a shift in the balance of power over enterprise resources in favour of insider interests, and declining worker morale.<sup>10</sup> Further research on these issues would appear desirable, and it seems unlikely that answers will be found in the macrodata.

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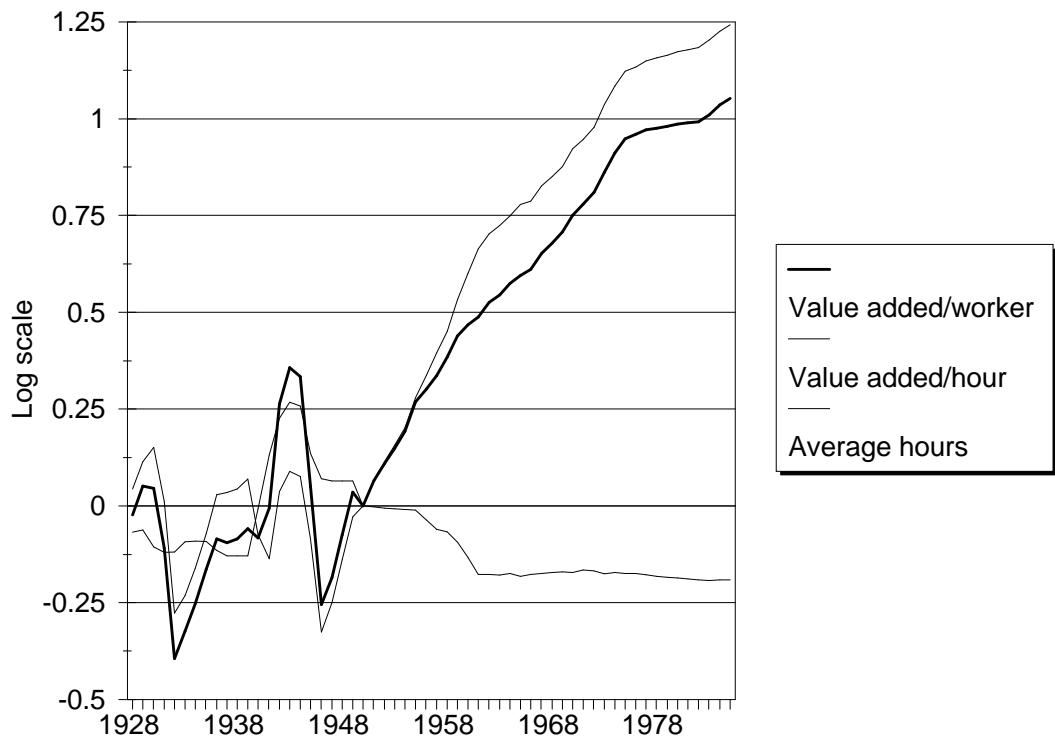
<sup>10</sup> See for example Schroeder (1985). I discount all those conjectures couched in terms of Soviet overcentralisation, agency problems, and poor incentive design, which could have accounted for poor static efficiency at any point in time, and also those (such as production function studies) which have been used to account for a gradual deterioration in dynamic efficiency rather than a break in growth at a particular point in time.

## Figures

Figure 1. GNP per worker, 1928-85

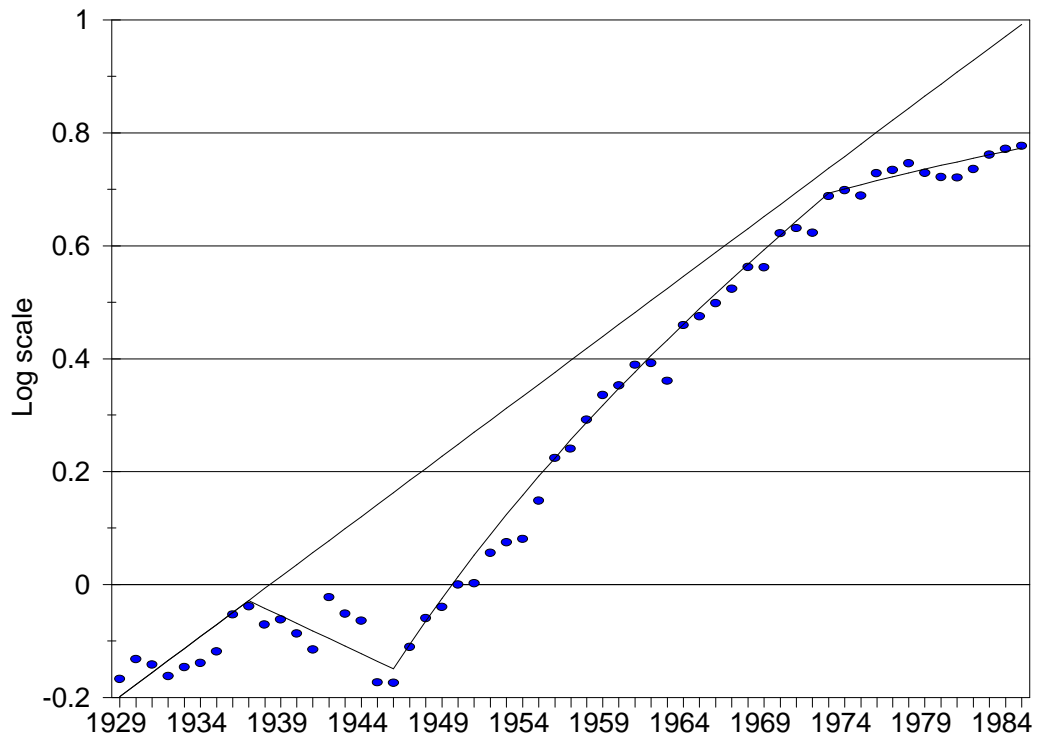


Source: as appendix A.

*Figure 2. Industry, 1928-85*

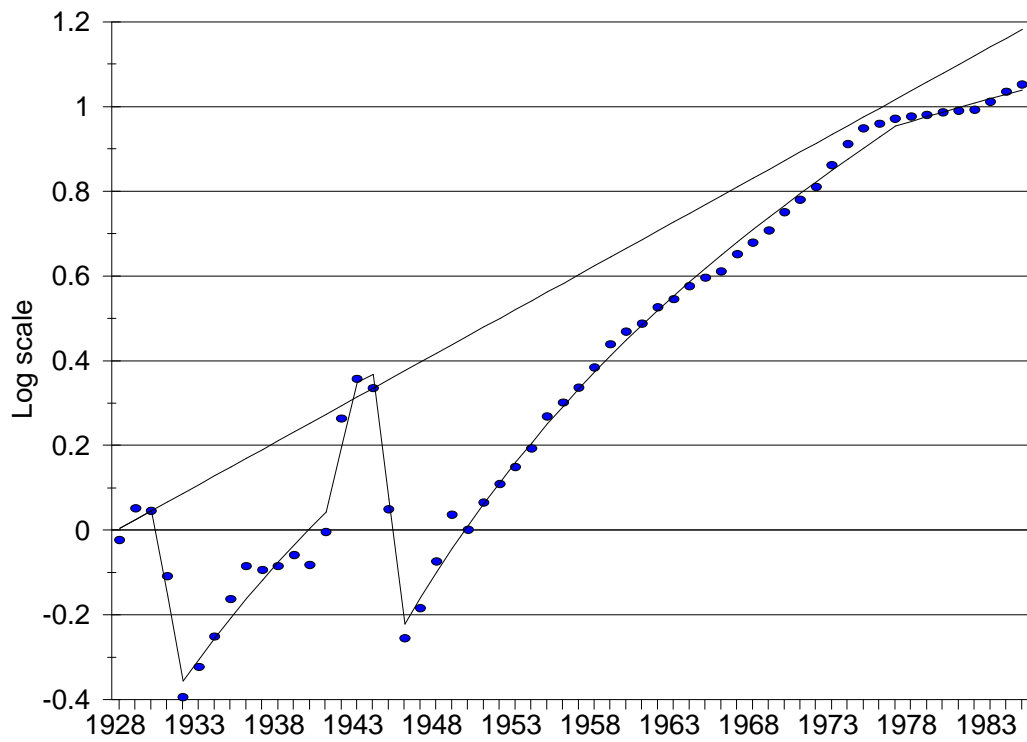
Source: as appendix A.

Figure 3. Trends and shocks in GNP per worker, 1929-85



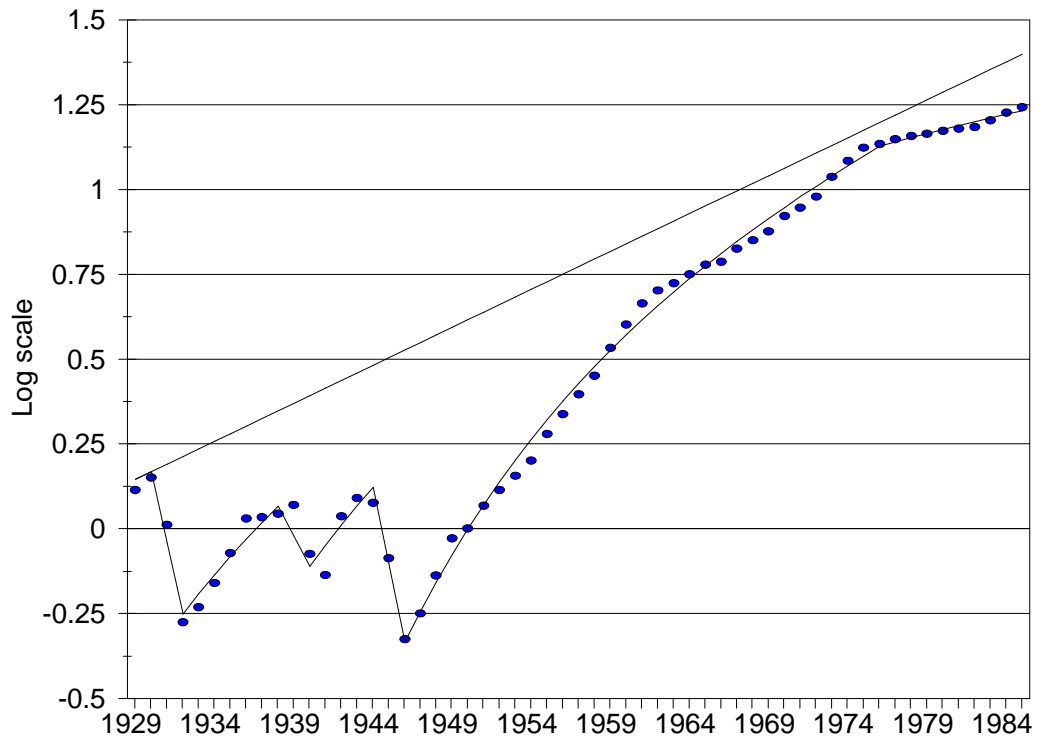
Source: table 2 (col. 1).

Figure 4. Trends and shocks in industry value added per worker, 1929-85



Source: table 2 (col. 2).

Figure 5. Trends and shocks in industry value added per hour, 1929-85



Source: table 2 (col. 3).



## Tables

*Table 1. Soviet labour productivity, 1928–85  
(rubles at constant factor cost)*

	GNP per worker	Industry value added	
		per worker	per hour
	(1)	(2)	(3)
(A) At 1937 factor costs			
1928	2397	5642	2.91
1937	3217	5618	3.08
1950	3538	6880	3.11
(B) At 1982 factor costs			
1950	2162	2063	0.96
1973	4301	4884	2.70
1985	4702	5907	3.31

*Sources:* as appendix A.

Table 2. Trend models of Soviet productivity, 1928–85:  
regression output

	GNP per	Industry value added	
	worker	per worker	per hour
	(1)	(2)	(3)
Dep. var.	<i>gnp/wkr</i>	<i>ind/wkr</i>	<i>ind/hr</i>
R-squared	0.9947	0.9952	0.9964
Obs.	57	58	57
Deg. freedom	52	52	50
F-statistic	2428.8567	2135.9303	2333.2899
Constant	-25.9496	-39.8246	-36.9206
	<i>gnp/wkr-1</i>		<i>ind/hr-1</i>
X-coeff.	0.3701	..	0.1421
SE	0.0975	..	0.0545
t-statistic	3.7973	..	2.6089
	<i>t</i>	<i>t</i>	<i>t</i>
X-coeff.	0.0134	0.0207	0.0192
SE	0.0020	0.0004	0.0014
t-statistic	6.6425	49.1947	14.1666
	<i>trend#(37)</i>	<i>crash#(31)</i>	<i>crash#(31)</i>
X-coeff.	-0.0219	-0.4430	-0.3981
SE	0.0036	0.0237	0.0334
t-statistic	-6.0394	-18.7009	-11.9158
	<i>trend(73)</i>	<i>crash#(42)</i>	<i>crash#(39)</i>
X-coeff.	-0.0105	0.2339	-0.2267
SE	0.0019	0.0222	0.0224
t-statistic	-5.4472	10.5357	-10.1384
		<i>crash#(45)</i>	<i>crash#(45)</i>
X-coeff.	..	-0.6261	-0.4762
SE	..	0.0224	0.0358
t-statistic	..	-27.9525	-13.3044
		<i>trend(77)</i>	<i>trend(76)</i>
X-coeff.	..	-0.0135	-0.0127
SE	..	0.0029	0.0027
t-statistic	..	-4.6022	-4.7120

Continued.

Table 2 continued.

	GNP per worker	Industry value added	
		per worker	per hour
	(1)	(2)	(3)
Summary of long-run trends (per cent per year):			
1929-73	2.1%	..	..
1937-46	-1.3%	..	..
1973-85	0.5%	..	..
1929-77	..	2.1%	..
1977-85	..	0.7%	..
1929-76	..	..	2.2%
1976-85	..	..	0.8%
Year-on-year persistence of large shocks:			
<i>trend#</i> variable:	93%	..	..
<i>crash#</i> variable:	..	93%	92%

Key to variables:

*Dependent variables*

*gnp/wkr* adjusted gross national product per worker  
*ind/hr* adjusted industry value added per hour worked  
*ind/wkr* adjusted industry value added per worker

*Independent variables*

*t* time (calendar year)  
*crash#(T)* break of level in year  $T$  (persistent in degree  $z$ ), followed by exponential return to preceding trend:  
 $crash\#(T_i)_t = 0 (t < T_i), 0.5 (t = T_i), z^{t-T_i-1} (t > T_i); \quad 0 < z < 1$   
*trend(T)* break of trend in year  $T$ :  
 $trend(T_i)_t = 0 (t < T_i), t - T_i (t \geq T_i)$   
*trend#(T)* break of trend in year  $T$  followed after an interval (beyond which the departure from the preceding trend persists in degree  $z$ ) by exponential return to preceding trend:  
 $trend\#(T_i)_t = 0 (t < T_i), t - T_i (T_i \geq t \geq T_j), z \cdot trend\#(T_i)_{t-1} (t > T_j);$   
 $0 < z < 1$

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