THE UNIVERSITY OF WARWICK

Mar 2016 No.276

# Why Did Socialism Fail? The Role of Factor Inputs Reconsidered

Tamás Vonyó and Alexander Klein

## WORKING PAPER SERIES

**(Paper revised and resubmitted May 2017)**

Centre for Competitive Advantage in the Global Economy

Department of Economics

CAGE Competitive Advantage in the Global Economy

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

# Why did socialist economies fail?

## The role of factor inputs reconsidered

Tamás Vonyó[*] Bocconi University

Alexander Klein[†] University of Kent

April 2017

ABSTRACT

We present new investment data and revised growth accounts for three socialist economies between 1950 and 1989. Government statistics reported distorted measures for both the rate and trajectory of productivity growth in Czechoslovakia, Hungary, and Poland. Researchers have benefited from revised output data, but continued to use official statistics on capital input, or estimated capital stock from official investment data. Investment levels and rates of capital accumulations were, in fact, much lower than officially claimed and over-reporting worsened over time. Sluggish factor accumulation, declining equipment investment and labor input, contributed much more to the socialist growth failure of the 1980s than previously thought.

*Keywords:* growth accounting, capital accumulation, Socialism, Eastern Europe

*JEL classification:* N14, N64, O47, P27

ACKNOWLEDGEMENTS

The paper could not have been written without the support of the Economic History Department at the LSE that provided financial assistance for data collection and the Dondena Centre for Research on Social Dynamics and Public Policy at Bocconi University. We owe a debt of gratitude to Lin Ma and Cecylia Leszczyńska for their vital help in data collection. We must also thank Nicholas Crafts, Herman de Jong, Mark Harrison, Leandro Prados, and Nikolaus Wolf for their suggestions and participants of conferences and research seminars in Berlin, Florence, Kyoto, London, Pisa, Prague, and Warsaw for their insightful comments.

[*] Department of Policy Analysis and Public Management, Bocconi University, Via Roentgen 1, 20136 Milan, Italy, Email: tamas.vonyo@unibocconi.it

[†] School of Economics, Keynes College, University of Kent, Canterbury, Kent, CT2 7NP, United Kingdom, Email: A.Klein-474@kent.ac.uk

The relative economic decline of Eastern Europe after 1945 has been linked to institutional failure. The inefficiency of central planning compared to the market economy is well established both theoretically and empirically.[1] The socialist system, it has been argued, was relatively successful in mobilizing resources but stifled innovation and entrepreneurship. Planned economies thus achieved 'a satisfactory productivity performance in the era of mass production, but could not adapt to the requirements of flexible production technology' (Broadberry and Klein 2011, p. 37). Effective in the phase of extensive growth, socialist economies slowed down abruptly as investment reached diminishing returns, which contributed to their collapse in the 1980s. While Eastern European countries seem to have maintained high rates of labor participation and very high levels of investment in physical capital, they were shown to have become increasingly inefficient compared to western market economies in their use of production factors and intermediate inputs (Bergson 1987; Van Ark 1997).

We do not refute that the planned economy was inefficient, but the above characterization of the socialist growth experience is out of date. As the literature review will show, in the majority of existing growth accounts, the inefficiency of the socialist system was manifested in productivity failure. We consider these results biased by the inconsistent use of data on output and factor inputs. Researchers benefited from revised data on national income that yielded more modest growth rates than what government statistics had suggested, but they continued to use official data on capital formation. Under central planning, investment statistics are just as difficult to trust as national accounts. We will show that socialist economies invested considerably less in physical capital than previously claimed. Likewise, employment statistics overstate the growth of labour input as average work hours declined over time. We suggest a greater role for factor inputs and a smaller one for productivity in the relative decline of Eastern Europe than what earlier interpretations advocated. We reveal fundamental differences between the growth experience of small socialist countries and what we know from the accounts of the Soviet economy in the same period.

We construct new investment series for the aggregate economy in Czechoslovakia, Hungary, and Poland from 1950 to 1989 independent from official investment data, and derive rates of capital accumulation from these revised estimates. We adjust employment totals for changes in average work hours as well as educational attainment in order to provide better measures for the growth of labor input. We then use these revised data on factor inputs to establish new growth accounts. Our main findings can be summed as follows. Weighted input growth in all three countries began to slow down in the 1960s and in Hungary and Poland turned negative after 1980. Labor-productivity growth remained respectable until the fall of communism, even though structural change had an adverse effect on productivity during the 1980s. As in many other European economies, average rates of Total Factor Productivity (TFP) growth dropped considerably after the end of the Golden Age. Their continued decline, if any, in the 1980s was less dramatic and can partially be explained by adverse structural shifts. Centrally planned economies ran out of steam not so much because of diminishing rates of productivity growth but mainly because of inadequate factor accumulation.

[1] For summaries see Eichengreen (2007), Ch. 5 and 10, and Berend (1997).

We reconstruct investment series for the aggregate economy in Czechoslovakia, Hungary, and Poland from 1950 to 1989, and derive rates of capital accumulation from these estimates. We adjust employment for changes in average work hours and educational attainment in order to provide better measures of labour input. We then use these data on factor inputs to establish new growth accounts. Weighted input growth in all three countries began to slow down in the 1960s and in Hungary and Poland turned negative after 1980. Labour-productivity growth remained respectable until the fall of communism, even though structural change had an adverse effect on productivity during the 1980s. Average rates of Total Factor Productivity (TFP) growth dropped considerably after the postwar golden age. Their continued decline, if any, after 1980 was much less dramatic. All three economies ran out of steam not so much because of diminishing rates of productivity growth but mainly because of inadequate factor accumulation.

Technological inefficiencies are partly to blame for this growth retardation, but focusing only on them paints an incomplete picture. Insufficient aggregate demand played a very important role, too. This was, in turn, the outcome of austerity policies that ignited public discontent and gradually undermined the economic legitimacy of communism. Two exogenous shocks hit Eastern Europe simultaneously. Firstly, rising oil prices made socialist industries less competitive because they applied energy-intensive technologies, while fuel imports became much more expensive. Secondly, refinancing their external debt, which had grown substantially during the 1970s, was more costly as western creditor nations raised interest rates to combat inflation at home. Governments responded to these shocks by limit imports and by reducing international borrowing. Consequently, even where GDP continued to grow, domestic absorption stagnated or declined. Scarce resources were allocated to consumption and social infrastructure to satisfy popular demands, and thus equipment investment became the victim of austerity. Insufficient machinery investment, in turn, constrained both technological modernization and employment creation. Labour input declined further as a result of shorter official workweeks and popular welfare measures that reduced female labour participation.

Our growth accounts bring the experience of East Central Europe after the postwar golden age closer to what the literature has described for developing regions following their flirtation with import-substituting industrialization. By contrast, it differs from what we know about the Soviet economy, which was hampered by the wasteful allocation of the glut of resources that the boom in hydrocarbons mobilised. The crisis of the 1980s in East Central Europe was not an idiosyncratic phenomenon and did not result from the inefficiencies attributed to the socialist system. This does not mean that technological or allocation inefficiencies can be refuted; indeed there is plentiful evidence for their existence. But, they are not the sole reason for the loss of momentum in socialist economic growth after 1980; insufficient factor accumulation was equally important, if not more.

The paper is structured as follows. After a brief literature review we discuss the available data and describe the methodology that we use to estimate investment and capital stock. The third section reports our new estimates and compares the imputed investment ratios across countries and compares these with available data on Southern European economies. In the fourth section, we reconstruct the aggregate growth accounts of Czechoslovakia, Hungary and Poland, and discuss the

role of structural change in the growth process. The fifth section presents our view on the crisis of the 1980s, before we conclude. Appendix 1 discusses in detail the data used to re-estimate investment. We report investment and capital stock by year in Appendix 2, and robustness checks in Appendix 3.

## LITERATURE REVIEW

The theory of socialist development reaches back to the Marxian model of extended reproduction. Grigory Feldman formalized this concept and argued that the rate of economic growth was limited by the capacities to produce capital goods, and, therefore, it growth could be raised by reinvesting industrial output in expanding these capacities (Feldman 1928, p. 312). Evgenii Preobrazhensky extended this argument by stressing the vital role of the state in accumulating the necessary resources for investment-led growth in a backward country with inadequate domestic savings and underdeveloped capital markets (Preobrazhensky 1926, p. 235). The concept of primary socialist accumulation was often used to justify state intervention in late-developing nations. In the words of Alexander Gerschenkron (1962), it 'provided for lacking prerequisites'.

Robert Allen (1988 and 2003) reinterpreted Soviet industrialization in the 1930s as 'Feldman and Preobrazhensky in action'. Centralized resource allocation with the simultaneous application of output planning and soft budget constraints favoured heavy industry. Allen could draw inspiration from Ragnar Nurkse (1953), who developed an extended version of the Feldman model, according to which capital accumulation in less developed countries generated rapid growth through the reallocation of inefficiently employed farm labour into industry. High rates of investment yielded fast growth as long as this labor surplus was not absorbed. Common to these interpretations is that they did not define the role of technological progress and did not specifically acknowledge the limits of extensive growth. Economic theory has made good on both shortcomings. Branko Horvat (1964) introduced diminishing returns into the theory of socialist economic development by arguing that the stock of complementary factors of production, especially labor, limited the capacity of each economy to absorb new capital.[2]

The falling behind of socialist economies has often been blamed on the neglect of technological progress and inefficient investment (see the works of Michał Kalecki in Osiatyński 1993). These factors were complemented by the relatively high and growing material intensity of production. State enterprises operating with soft budget constraints had the incentive to maximize their use of investment funds and intermediate inputs regardless of the potential returns on them. This evolved into a shortage economy, in which profit maximization was replaced by resource hunger that undermined productivity growth and innovation (Kornai 1992, pp. 140-45). Shortages emerging from inefficient allocation are also believed to have become more disruptive as planned economies modernized, meaning that they operated further and further below their production possibility frontier. Consequently, grey markets emerged to satisfy increasingly complex consumer

[2] The contemporary socialist literature saw capital accumulation as the main driver of development and focused on the capital-output ratio, as in the Harrod-Domar model, and rather than joint factor productivity (see Berend 1985).

demands and to reallocate intermediate inputs between firms (Banerjee and Spagat 1991). Comparative analyses of input-output data confirmed that, on average, the material intensity of production was higher in socialist countries than in western market economies and that this gap widened after the mid-1970s (Gomulka and Rostowski 1988).

Paul Krugman (1994) articulated perhaps most illustratively the predominant view on planned economic growth. He proposed that authoritarian growth models were unsustainable in the long run. Early success came from 'perspiration' (factor accumulation), followed by an inevitable slowdown because of the lack of 'inspiration' (innovation and the creativity of free enterprise). Krugman's characterization of the East Asian growth miracles as the product of neoclassical transition dynamics received support from quantitative research (see Mankiw 1995 and Young 1995, among others), but has since been convincingly refuted. Official statistics exaggerated the rate of capital accumulation; TFP actually made a very substantial contribution to the catching up of newly industrialized nations between 1960 and 1990 (Hsieh 2002).

By contrast, the notion of extensive growth continued to dominate the mainstream view on socialist economic development. Most research conducted on both the USSR and Central Europe reported high productivity growth for the 1950s and, in some cases, the 1960s, followed by considerable slowdown (Balassa and Bertrand 1970; Bergson 1987; Easterly and Fischer 1995; Ofer 1987; Ritschl 1996; Sleifer 2006; Van Ark 1997). For the Soviet economy, most of these studies found negative TFP growth during the late 1970s and 1980s. Josef Brada (1984) applied a frontier production function to examine Eastern European industrial performance between 1960 and 1985 and confirmed the declining rate of TFP growth, especially after 1980. He associated this trend with the deteriorating efficiency of factor utilization rather than regress in technical know-how.

We argue that this conventional story of productivity failure is, at least in part, the product of statistical illusion. Official production and input statistics suggest no such failure; instead constant or increasing rates of TFP growth, at least until the early 1980s.[3] Signs of a productivity meltdown emerged from subsequent research that benefited from downward-revised output data but that continued to use official statistics on factor accumulation or estimated capital stock from official investment data. Our revisions suggest that investment levels in government statistics were inflated, which implies that they overstated the rate of capital formation, too, not only the rate of economic growth. New cross-country evidence has only made good on these shortcomings in part. The last version of the *Penn World Tables* (PWT) to include all socialist countries reported investment ratios of close to or above 30 percent across Eastern Europe in the 1970s and 1980s (Heston et al. 1995). Recent updates of the PWT data (see Feenstra et al. 2015) suggest dramatically lower investment rates for most of the former socialist countries, but still report high rates of capital accumulation and close of zero, or even negative, TFP growth for the 1980s.

We demonstrate that factor inputs played a prominent role, in addition to productivity, in the relative decline of socialist economies. Rather than recording modest growth rates despite very high

[3] On the East German economy, see Ritschl (1996) p. 500, Table 16.1, Column 2. On Czechoslovak and Polish industry, see Rusek (1989) and Kemme (1987) respectively.

levels of investment, Central European countries fell behind, in large art, because they invested much smaller proportions of their national income in productive capital than faster growing market economies, especially in Southern Europe. This finding differs fundamentally from what we know about the retardation of the Soviet economy over the same period.

## DATA AND METHODOLOGY

Socialist data on national income must be treated with more than a modicum of suspicion. Statistics on physical output indicators are considered comparatively trustworthy. Eastern European scholars often used such proxies to account for economic growth and the standards of living (see Bródy 1994 and Ehrlich 1991, among others). By contrast, national accounting aggregates were distorted by unrealistic producer prices, incorrect weighting (inasmuch as industry was assigned higher than actual shares in net material product), and by inappropriate index-number methods (Bródy 1992, 959).[4] Independent western research has established alternative estimates based on the System of National Accounts. These estimates used official data only on physical output indicators in the construction of time series. The Research Project on National Income in East Central Europe under the leadership of Thad P Alton at Columbia University carried out the most substantial work. It reported GNP for several countries including Czechoslovakia, Hungary, and Poland, which have been widely used in empirical research and constitute the main source of the Maddison data for East Central Europe in the period 1950-1989.[5] The same working papers also provide evidence on GNP by sector of origin of product (Alton 1970; Alton et al. 1985a; Alton et al. 1991b; Czriják 1973; Holesovsky 1969; Lazarcik 1968).[6]

Employment data are obtained from official publications.[7] In the absence of comprehensive government statistics on labour hours outside industry, we follow a shortcut method to adjust total employment for changes in average hours worked. If the number of extra hours that employees were required to work did not change dramatically over time, then, for the economy as a whole, the official workweek is a good indication of actual labour hours. We have exact figures on total hours worked in Hungary after 1980, which confirm the accuracy of our approach.[8] Legislation on the official workweek and its implementation are well documented. In addition, for Czechoslovakia and Poland, we assume that in 1989 at least 5 per cent of official labour hours were lost due to the extensive strikes. To adjust labour input for returns to educations, we use the most recent Barro-Lee data on the average years of schooling completed by the adult working-age population.[9]

For investment and capital stock, we generate new data that can be considered more reliable than official statistics or existing scholarly estimates built on them. Socialist investment data are

[4] Net Material Product was the national accounting concept used by COMECON countries. It is conceptually similar to GDP, but excludes services deemed unproductive, especially housing and the government.
[5] For details on data sources see Maddison (2006), pp. 469-71.
[6] The disaggregated series are continuous for Czechoslovakia and Hungary. For Poland prior to 1965, data is only available for benchmark years with five-year intervals.
[7] Employment statistics are generaly considered uncontroversial. See Adam (1985), among others.
[8] See *The Conference Board Total Economy Database* (http://www.conference-board.org/data/economydatabase/).
[9] See Barro and Lee (2013) and the data available at http://barrolee.com/.

unreliable. Under fixed prices and allocations, capital-goods suppliers were incentivised to increase value added by degrading quality, either by changing product specifications or by shifting to less valuable inputs. Prices for new machines were inflated by unsubstantiated claims of major product innovation. Concealed inflation in the investment statistics was extensively discussed in the Soviet context (Nove 1981; Wiles 1982, Bergson 1987; Kontorovich 1989). Gross capital formation was also magnified by additional items, such as the training of personnel, R&D, and inventories, which were fabricated in order for the main components of national accounts to match. Government statistics were often internally inconsistent, for instance when the sum of construction and machinery investment published in one section did not match even approximately the value of gross fixed capital formation reported in the national accounts. Past investment data were frequently revised, especially for the 1950s and for Poland, in order for the current rate of capital formation to appear higher relative to earlier periods, but the procedures of these revisions were rarely explained. Inflated investment figures, in turn, yielded excessively high rates of capital accumulation.

We determine capital stock using the perpetual-inventory method, which has been developed by economists and social accountants to build up stocks of capital from flows of investment after discounting depreciation (see Jorgenson 1973 and 1980, and Hulten 1990).

$$K_1 = \sum_{t=0}^{n} (1-\delta)\, I_t \qquad [1]$$

Following this approach, the stock of fixed capital in a given year evolves according to the value of new investments made in that year and the depreciation of the existing stock.

$$K_t = (1-\delta)K_{t-1} + I_t \qquad [2]$$

The stock of fixed capital (K) in year *t* is derived from the capital stock of the previous year *t-1* after adding investment (I), more precisely gross fixed capital formation, and subtracting capital depreciation. The same method can be applied to estimate past capital stock from more recent levels with retrospective calculation (see Feinstein 1972). The depreciation rate $\delta$ is determined for each type of fixed assets and we take it to be inversely related to the service life of each type of asset,

$$\delta = X/T \qquad [3]$$

where *X* is a parameter (declining balance) that indicates how the usefulness of the asset is distributed over its life and *T* is the average service life for the type of asset. If *X* equals one, then depreciation is linear over the entire service life. This pattern is typically assumed for structures, both residential and non-residential. Geometric depreciation, when *X* equals two, is more suitable for estimating the stock of machinery and equipment, as these assets lose much of their value during the early years of use. Empirical studies often apply the 'modified' geometric depreciation pattern proposed by Jorgenson (1990) that falls between the linear and geometric patterns. We take the depreciation of structures to be linear and assume that *X* equals 1.5 for equipment.

Previous accounts of postwar growth have used a range of values for the service life of different assets. 50-70 years are typical for dwellings, 30-40 years for other structures.[10] We use $T$=50 until the late 1960s and $T$=40 thereafter. Soaring public investment from 1968 in Czechoslovakia and Hungary and from 1971 in Poland shifted resources to transport infrastructure and modern standardized housing using cheap materials that were assumed to have shorter lifespans than traditional buildings. Previous studies have used asset lives of 10 to 25 years for machinery, with road transport vehicles and communications equipment, as well as more modern vintages in general, thought to have faster depreciation. Since command economies frequently used out-of-date machinery, we assume longer service lives of in the early postwar decades and $T$=20 for the second half of the socialist era. These assumptions result in depreciation rates of 2 per cent for structures and 6 per cent for equipment until 1967 (1970 for Poland) and rates of 2.5 per cent and 7.5 per cent respectively thereafter. Our estimates for the rate of capital accumulation are not very sensitive to alternative values of $T$ used in the literature that are plausible for the period and the countries that we study. We report robustness checks in Appendix 3 (Table A3.1).

The perpetual inventory method requires data on the benchmark value of fixed assets and on levels of machinery and construction investment expressed in the prices of the benchmark year. The former cannot be independently established. We must cautiously select the most trustable official sources. For Czechoslovakia and Hungary, we use data from 1990, the first post-transition year, which can be directly linked with our new investment series. The reported values are plausible as they imply capital-output ratios close to three, which is standard globally in this period (see Feenstra et al. 2015, Online Appendix, p. 16). For Poland, this method cannot be used, as the country experienced hyperinflation from the late 1980s through to the early 1990s. The second best benchmark is 1971, when Poland, following the other countries in Central Europe, introduced ambitious economic reforms, which systematically revised official prices. The comprehensive re-evaluation of all fixed assets in the socialist sector aimed at making producer prices better reflect factor costs, since enterprises were subsequently required to pay interest on the value of their assets and were allowed to write off depreciation.[11] These statistics contain the most reliable estimates for the stock of fixed capital during the entire socialist period and the relative prices of the reform year approximate most closely real factor costs.[12]

Both historical and comparative studies on growth accounting have used alternative methods to estimate initial capital stock, especially when official data is not available, or cannot be relied upon to construct plausible benchmarks. The production function approaches originally proposed by Arnold Harberger (1978) determines the initial stock by the steady state relationship between the initial level of investment, the growth of investment, and the rate of depreciation. This method has

[10] See Prados de la Escosura and Roses, 'Capital', table 1, p. 145.

[11] For overviews of the reform process and the working of the New Economic Mechanism in each of the three countries, see Staller (1968), Balassa (1970), Kýn (1970), Portes (1970), Hare and Wanless (1981), and Kornai (1987).

[12] Government statistics of Czechoslovakia and Hungary report net capital stock for both machinery and structures in 1990. Polish data for 1971 only report gross capital stock. We derive net values using the ratio of net to gross stock from the Czechoslovak and Hungarian statistics, but assume somewhat lower ratios, as the Polish capital stock in 1970 had to be considerably older, after decades of very low investment.

been preferred in empirical research on developing countries (Nehru and Dareshwar 1993; Young 1995) and in studies of long-run growth (Prados de la Escosura and Roses 2009, 2010). However, it presents us with the caveats that European economies were far off their steady state during the early postwar period and that it is difficult to establish the steady-state growth rate of investment. Other research, including the recent PWT updates, determine initial stock by assuming plausible capital-output ratios. This approach also becomes problematic in the postwar context, when factor proportions were temporarily dislocated from their norm in war-shattered economies.

Recent advances in estimating capital input used the concept of capitals services (Jorgenson 1989, 1990), which has been applied in historical research (e.g. Prados de la Escosura and Roses 2009, 2010). The usefulness of this approach is that it provides a more direct measure of the value of capital inputs for production and that the imputed ratio of capital input to stock can be used as an indicator of capital quality in the growth accounting formulae. However, crucially, it requires data on the rental price of capital. It is, therefore, inappropriate for centrally planned economies, where capital goods were directly allocated to producers, and thus there were no interest rates on fixed assets. The only solution to circumvent this problem would be to use values estimated for market economies for this period, but this would imply critical assumptions about technologies used in socialist countries. In addition, we believe that computing capital input would not generate rates of capital accumulation radically different from our estimation of stock. Leandro Prados de la Escosura and Joan Roses (2009) found similar rates of net capital formation for Spain in the postwar era using a battery of alternative computations, even in the postwar era of high growth.

We follow two strategies to construct our investment series. For the period 1950-1967, the Research Project published independent estimates for investment in both equipment and structures that reflect the volume of investment goods and construction services (Bandor et al. 1970; Czirják 1968; Holesovsky 1969; Korbonski et al. 1973; Staller 1965a, 1965b). They measure construction investment by gross output in construction that, in turn, is approximated by the availability of building materials. Equipment investment is estimated by the production of machinery and other instruments, adjusted for net imports and disregarding year-to-year changes in inventories.

These are upper-bound estimates of actual investment. Until the mid-1960s, the reported levels of machinery investment can be deemed accurate, as the share of consumer durables in engineering output remained very small, and certain products that we seldom used as capital goods, such as bicycles, motorcycles and some communication equipment were subtracted from machinery output.[13] Military hardware may have carved out more substantial shares in machinery production, but we have no reliable data on the components of military spending for the 1950s and early 1960s. Scholarly estimates using both detailed budgetary figures and proxy methods for the period after 1965 suggest that these shares never surpassed 5 per cent, when adjusting for arms trade (Crane 1988, 530-38), and were likely much smaller as military hardware included some equipment that could be put to productive use, such as transport vehicles. Constructing indexes of construction

[13] Even in Austria, a more developed and more consumer-oriented economy relative to socialist countries, very few private households owned modern appliances before the late 1960s. See Seidel (2005), p. 57, Table 1.13.

investment based on the volume of available building materials can be considered plausible for the entire period, provided that the value-added share of construction output did not increase over time. On the contrary, the literature argued that waste in materials, if anything, increased over time due both to the growing complexity of input requirements and the long duration of building projects (Banerjee and Spagat 1991). To the extent that these arguments hold, we go against our hypotheses by overestimating the growth of investment and thus capital accumulation.

For the period after 1967, the Research Project did not publish similar estimates, since they would have no longer measured the level and structure of investment accurately. Instead, it reported an index for domestic absorption, decomposed into three major items: personal consumption, government consumption (public administration and justice, education, health care, and social services), and a residual (Alton et al. 1991a; Alton et al. 1985a).[14] The later term is dominated by gross capital formation, but it includes several sub-components of public spending not specified in the reports, most notably national defence and R&D, and changes in inventories.

For the period after 1965, we use the index of the Research Project on construction to account for investment in structures, but we derive index numbers for investment in machinery and equipment by decomposing the residual term of domestic absorption.[15] Specifically, we subtract for each year the indexes for military spending and R&D also reported by the Research Project (Alton et al. 1991b; Alton et al. 1985b) from the index of residual final use, weighting each sub-component by its share in total GDP in the benchmark years of the index number series.[16] To determine these weights, we take disaggregate data on research outlays from official sources. The yearbooks of the Stockholm International Peace Research Institute (SIPRI) report total military expenditure as a percentage of GDP in current prices for the three countries in every year from the 1960s (SIPRI, diff. vols.) In light of the controversy about Soviet budgetary figures on national defence, one could question the reliability of this evidence (see Epstein 1990, Davis 2002, and Harrison 2008 among others). However, previous research has shown data on military spending in East Central Europe to be very accurate. Estimates constructed using wage and living-cost data for personnel expenses and input-output as well as trade statistics to determine material costs came very close to budgetary figures (Crane 1988).[17] The lack of transparency in government accounts on defence expenditures was found to be much more serious in the Soviet Union than in the smaller Warsaw Pact countries (Clements 1985; Wiles 1987).

The index for equipment investment is than obtained by subtracting the construction index from the index of fixed-capital investment. We assume that gross fixed capital formation evolved as gross capital formation, disregarding year-to-year fluctuations of inventories, which we cannot establish independently. In order to minimize the impact of aggregation errors and of unobserved swings in actual inventories, we smooth the index-number series for the residual term in domestic

[14] Gross product for domestic use is GDP adjusted for net imports and net foreign payments.
[15] To follow this approach, we have to assume that aggregation errors were random and that the relative size of inventories did not change over time, since we cannot establish these items independently.
[16] We adjust for the difference between GDP and gross product available for domestic use based on detailed benchmark statistics from Alton et al. (1975, 1979), upon which the index for final-use components was constructed.
[17] These estimates are similar to the data collected in Alton et al. (1985b).

absorption, before we decompose this index. The index numbers that we constructed for equipment investment for the period after 1965 are linked to the level estimates of the Research Project for the period 1950-1967. The thus obtained investment levels are converted into prices of the benchmark years for capital stock using official price indexes for investment by asset type. We discuss the methods the Research Project used to estimate the different components of domestic final use in Appendix 1.

## INVESTMENT LEVELS AND INVESTMENT RATIOS

In this section, we present our estimates for equipment and construction investment and compare them to official statistics. We then trace the share of gross capital formation in GDP and contrast these rates with the investment ratios of Southern European countries over the same period. This exercise will demonstrate that slow capital accumulation was instrumental in the falling behind of Central Europe. We report investment and capital stock by year in Appendix 2. Figure 1 and Figure 2 plot investment in Czechoslovakia and Hungary respectively. We compare these newly estimated levels with official data on total investment, since government statistics on gross fixed capital formation did not always distinguish between asset types.

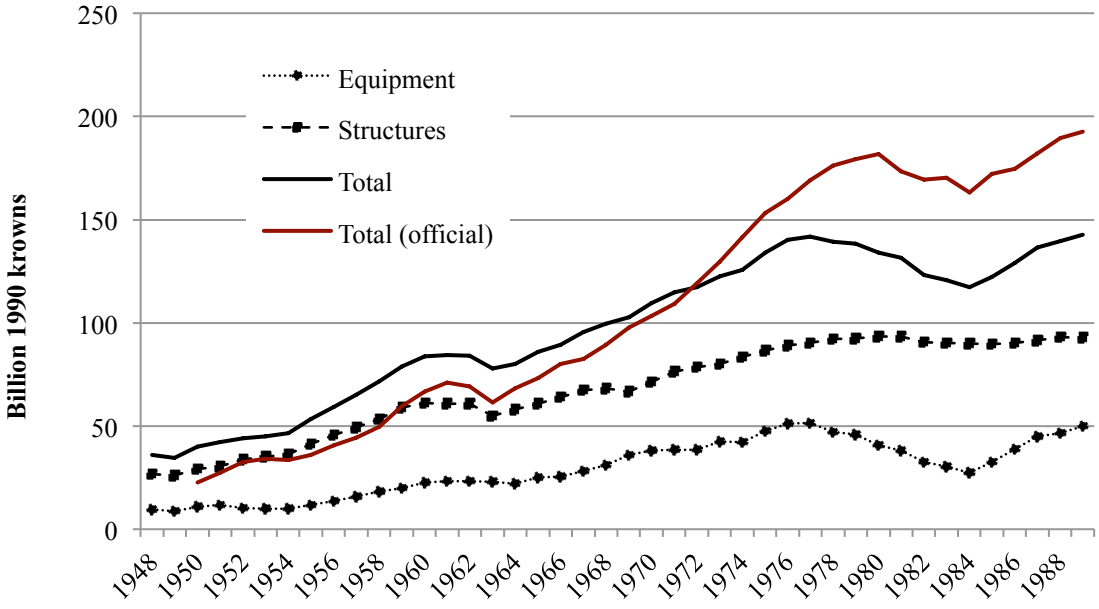


FIGURE 1
ALTERNATIVE ESTIMATES FOR INVESTMENT IN CZECHOSLOVAKIA, 1948-1989

*Sources:* Revised estimates are from Table A2.1 in the appendix. Official statistics are from *Historická statistická ročenka ČSSR*, Tables 8-1 and 8-2, p. 169, *Statistická ročenka Československé socialistické republiky 1986*, Table 8-1, p. 205, and *Statistická ročenka České a Slovenské federatívni republiky 1990*, Table 8-1, p. 220.

In both countries, we see rapid recovery after World War II. Following a temporary setback in the early 1950s, investments continued to grow steadily until about 1970. Thereafter, the two economies walked different paths. The share of equipment in total investment increased further in

Czechoslovakia until the mid-1970s. In Hungary, machinery investment declined from 1971 and in the 1980s fell back to levels achieved already two decades earlier. Construction investment began to diminish after 1978 but remained much higher relative to earlier periods than equipment investment. In Czechoslovakia, construction stabilized after 1978, while machinery investment first plummeted in the early 1980s and then recovered from 1985. Over the last twenty years of communism, capital accumulation focused more strongly on machinery in Czechoslovakia than in Hungary, even if during the 1980s the share of equipment investment fell considerably in both countries. This is not surprising given the difference between the two economies in structural development, which the following section will discuss. The value-added share of the most equipment-intensive sectors, especially industry, was larger in Czechoslovakia and continued to increase moderately even in the 1970s and 1980s, when it was already declining in Hungary.

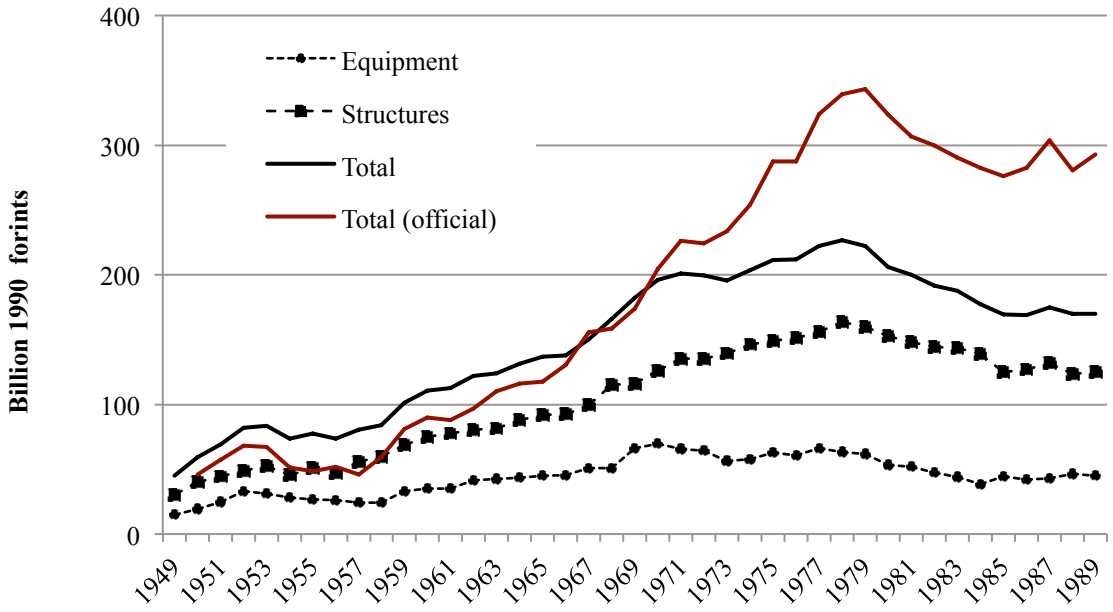


FIGURE 2
ALTERNATIVE ESTIMATES FOR INVESTMENT IN HUNGARY, 1949-1989

*Sources:* Revised estimates are from Table A2.2 in the appendix. Sources of official data, incl. investment prices: KSH, *Beruházási adattár 1950-1977*, p. 32; KSH, *Beruházási évkönyv 1989*, pp. 13-14; KSH, *Beruházási évkönyv 1990*, p. 3.

In both countries, retrospective official accounts underestimated investment during the 1950s and the early 1960s, but the rates of investment growth do not differ much from our estimates. By contrast, official data massively overstate the growth of investment during the 1970s and, therefore, investment levels in the 1980s. Investment at best stagnated and most likely declined from the mid-1970s. The diagrams confirm that the fall of investment during the early 1980s was driven predominantly by machinery investment. Even in Czechoslovakia, investment growth over the last two decades of communism was much less remarkable than officially claimed and resulted mainly from increasing outlays for building projects.

Poland represents a different case (see Figure 3). In the immediate postwar years, levels of investment were very low, so that the stock of fixed capital actually declined until 1952. Investment growth resumed thereafter, but remained modest until the mid-1960s, in contrast to what official statistics suggested. Slow capital accumulation in this period reflected the unique factor proportions that the Polish economy was endowed with after World War II. Due to the colossal wartime casualties and the expulsion of ethnic Germans from the eastern provinces of Prussia after the war, the population of the country declined by 20 per cent between 1939 and 1947. It was not before 1963 that Poland recovered from this demographic shock (see Maddison 2006, 474-75). As a result, the Polish economy faced labour shortage during the 1950s and, therefore, could grow into existing production capacities that were temporarily underutilized. After 1970, investment growth became explosive, both in construction and machinery, but this acceleration proved short lived, and investment levels plummeted in the early 1980s more than in the other two countries.

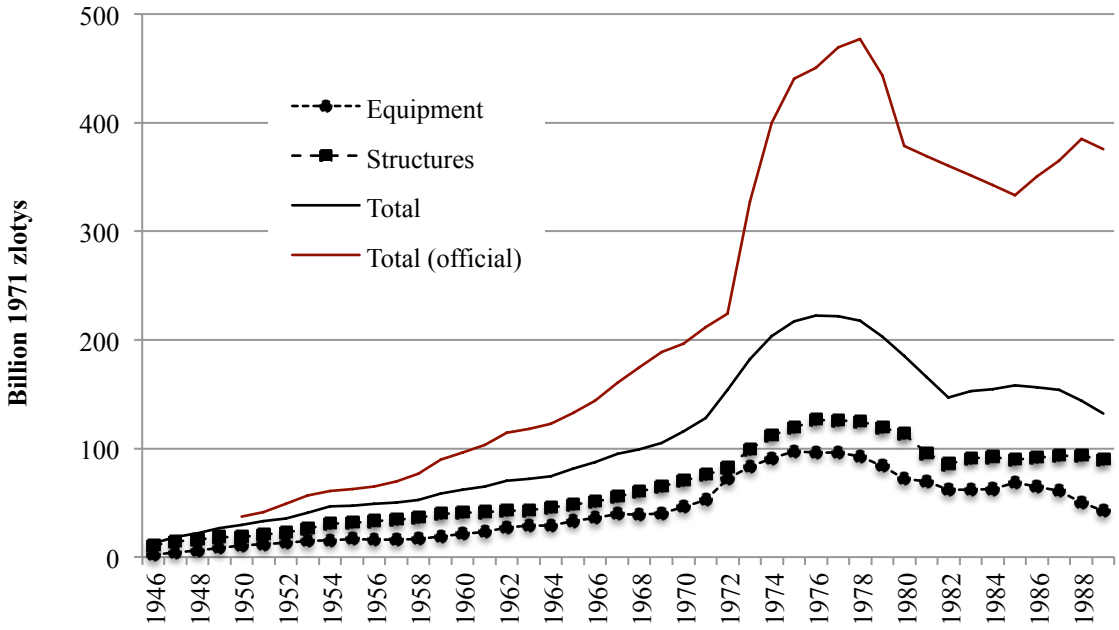


FIGURE 3
ALTERNATIVE ESTIMATES FOR INVESTMENT IN POLAND, 1946-1989

*Sources:* Revised estimates from Table A2.3 in the appendix. The official index is calculated from *Rocznik Statystyczny 1995*, Table I, p. 68, and converted into 1971 prices with additional data from *Rocznik Statystyczny 1968*, Table I, p. 98.

Throughout the 1960s and until the mid-1970s, investment in machinery was catching up to with levels of construction investment. From 1978, both types of investment declined but fell much more dramatically for equipment. The final collapse of investment activity after 1985 was entirely the product of sluggish machinery investment. Official figures report considerably faster investment growth already after 1960, but the overstatement of growth rates in the 1970s was spectacular. It was suggested that investment doubled between 1972 and 1975. This and the apparent recovery 1985 are pure statistical fabrications.

Two core findings stand out from the record of all three economies. Firstly, investment levels during the 1980s were much lower than what official data had suggested and what researchers using these data believed. Secondly, capital formation slowed down in the last decade of communism mainly because of the sharp decline in machinery investment. Still, investment levels alone do not tell much about growth dynamics. Rates of capital accumulation and of economic growth depend more on relative levels of investment, the ratio of gross capital formation to GDP. The PWT are the most commonly used source for investment ratios in cross-country investigations. Vonyó (2017) published a new set of investment rates across Eastern Europe between 1950 and 1989, which reflect continuously increasing ratios until the 1970s and sharply falling rates in the 1980s, except for the Soviet Union. Socialist economies invested considerably smaller proportions of their national income than faster growing nations in Western Europe, except in the 1970s. However, these investment ratios are upper-bound benchmark estimates that may reflect biased relative prices due to hidden inflation in investment goods and that included, in some cases, minor residual items of domestic final use other than investment.

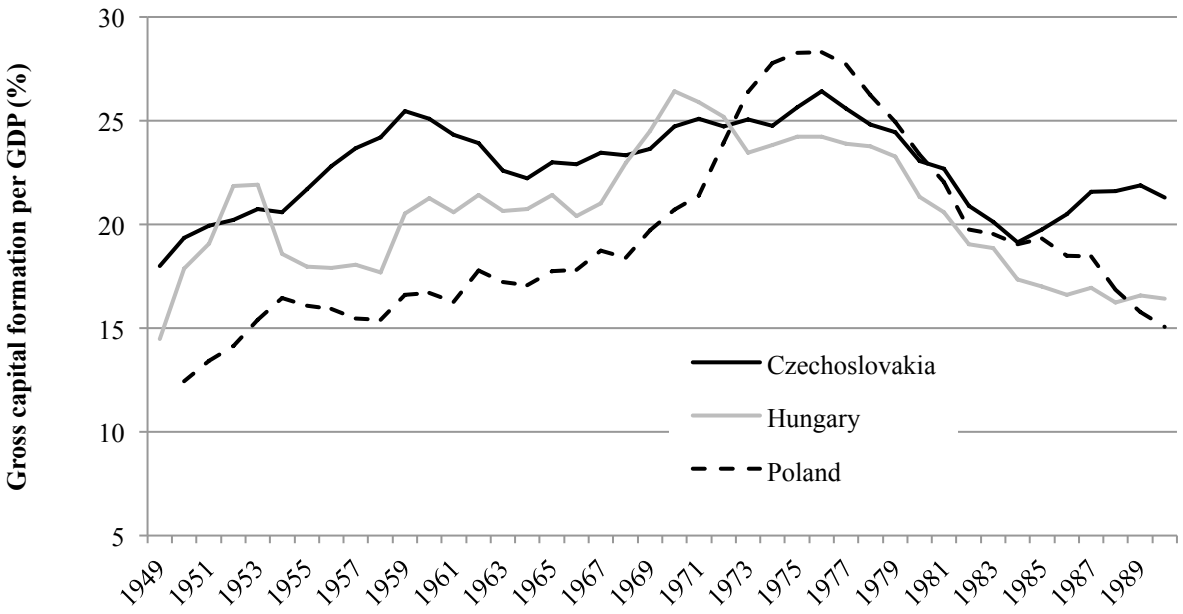


FIGURE 4
INVESTMENT RATIOS IN CENTRAL EUROPE, 1949-1990

*Sources:* Investment levels are taken form Appendix 1, GDP data from Maddison (2006), p. 478. Benchmark rates of gross investment per GDP are established from PWT 5.6 (http://www.rug.nl/research/ggdc/data/pwt/pwt-5.6) and adjusted for the difference between our estimated and official investment levels.

In this paper, we take a different approach. We derive benchmark investment ratios from the last version of the PWT that reported data on all former state socialist countries in Eastern Europe, including Czechoslovakia, and that estimated investment ratios using official investment statistics. We correct these rates for the proportional difference between our estimated levels of investment and government figures, assuming that this ratio for gross fixed capital formation would also hold

for gross capital formation. The investment ratios for all other years are then interpolated using our constant price investment series and the Maddison data on GDP. We again assume that gross capital formation evolved over time in the same way as gross fixed capital formation. The results reported in Figure 4 above are striking. Relative levels of investment in East Central Europe were rather modest, mostly below 25 per cent even in the 1960s and 1970s, and falling closer to or below 20 per cent during the 1980s. In both Czechoslovakia and Hungary, investment ratios surged during the collectivization drives of the early and late 1950s. In the late 1960s and the early 1970s, Hungary and Poland borrowed heavily from international creditors and used cheap money from abroad to scale up investment. Throughout the rest of the socialist era, investment rates in Poland remained well below 20 per cent, and were very modest by the standards of the postwar period.

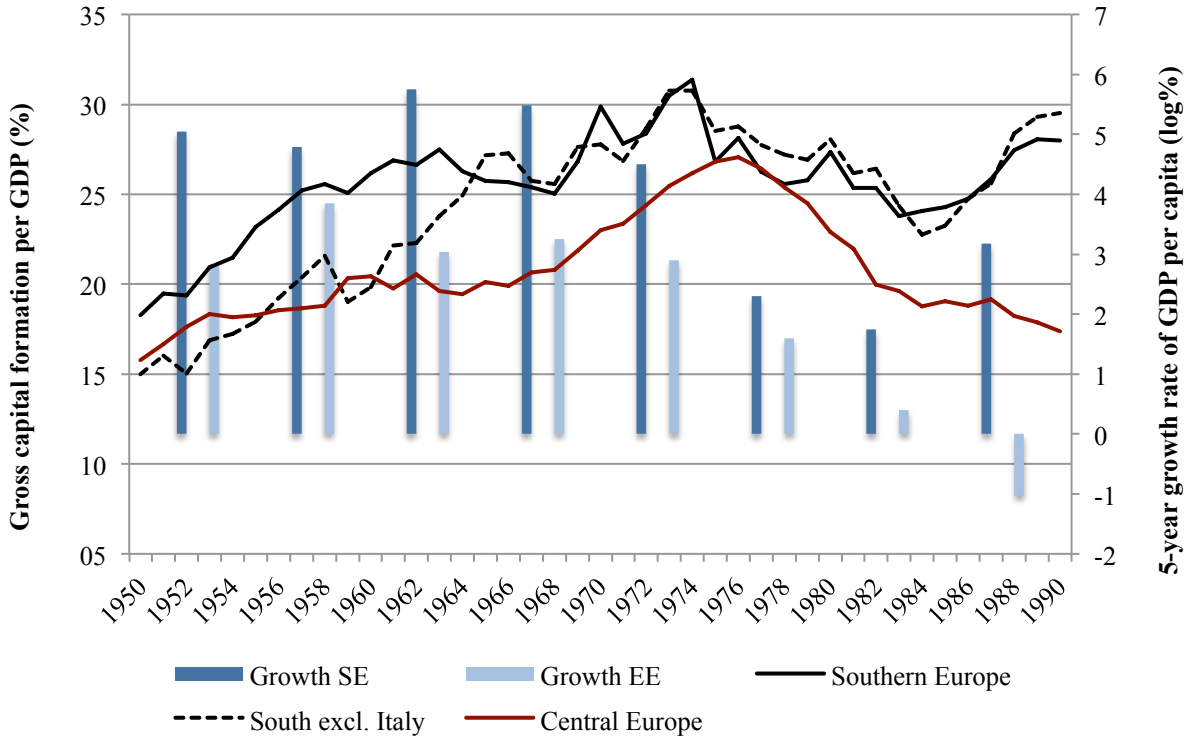


FIGURE 5
INVESTMENT RATIOS AND ECONOMIC GROWTH ON THE EUROPEAN PERIPHERY

*Sources:* Investment ratios are from Figure 4 for Central Europe and from PWT 9.0 (http://www.ggdc.net/pwt), for Southern Europe, weighted with GDP data from PWT 9.0 (output-side real GDP at current PPPs). Growth rates of GDP per capita established form Maddison (2006).

Figure 5 compares investment ratios for the three Central European countries weighted by the size of their GDP with the weighted average rates calculated from the most recent PWT data for Greece, Italy, Portugal and Spain. Since, in terms of total GDP, Southern Europe was dominated by Italy, the most advanced economy in the region and the only one with a democratic political system since the start of the postwar period, we chart two alternative set of investment ratios, one including and one excluding Italy. The line diagrams demonstrate that, except for a few years in the 1970s, socialist countries in Central Europe lagged far behind the market economies in Southern Europe

not just in rates of economic growth, but also in rates of investment. The bar charts measured on the secondary vertical axis also reveal that the largest growth differentials in GDP per capita averaged over five-year periods between 1950 and 1990 typically corresponded with the most substantial gaps in the investment ratios. This finding concurs with Vonyo (2016) in that the growth failure of socialist economies can, to a large extent, be explained within a standard conditional convergence framework. We reveal this to be true even for the 1980s, when the falling behind of Central Europe versus strong growth in Southern Europe coincided with a striking divergence in investment activity between the two regions.

## REVISED GROWTH ACCOUNTS

Table 1 reports average growth rates of national income and factor inputs according to alternative sources and specifications. Previous research benefited from downward-revised estimates for the growth of national income. Official sources reported rapid growth until the late 1970s, followed by a sudden and sharp slowdown. In fact, socialist economies ran out of steam more gradually from the late 1960s. They were falling behind successful modernizers in both Southern Europe and East Asia throughout the socialist period, not only or especially after 1980. The extent to which government statistics overstated the rate of economic growth was drastically reduced during the 1980s. We observe the opposite pattern in the capital-stock data. Our estimates show that retrospective official accounts overstated the rate of capital accumulation only in the second half of the period, and the margin of error increased over time. This finding already suggests that previous research on the relative decline of socialist economies may have been seriously mislead by faulty statistics.

Polish official data were inaccurate even in comparison with the accounts of other socialist governments. Economic growth was much slower than the authorities claimed, but they overstated the rate of capital accumulation even more. Price distortions are mainly to blame for the vast margin of error in the 1980s, when inflation spiralled out of control. Polish statistics on capital stock do not allow us to construct growth rates for the 1950s, meaning that our new estimates not only improve on the existing evidence but also extend it. The common feature in the data for all three countries is that capital accumulation, according to our estimates, accelerated until the early 1970s, but the economic slowdown after 1980 coincided with sharply reduced rates of net capital formation.

This is not the end of the story! Employment figures alone do not measure the growth of labour input accurately. Especially in the 1970s and 1980s, which saw most of the reductions in weekly work hours, the total number of hours grew slower than employment. In Czechoslovakia, the official workweek was already shortened in the late 1950s and again a decade later. In addition, by the end of the 1980s, extensive strikes reduced actual labour input considerably in both Czechoslovakia and Poland. We made the rather conservative assumption that this effect cost only five per cent of contract hours in both countries in 1989. The adjusted growth rates show only modest labour expansion in Czechoslovakia between 1950 and 1970 and practically none after 1980. In both Hungary and Poland, labour input declined sharply during the 1980s. This contraction did not only result from falling average work hours; total employment fell, too.

TABLE 1
ANNUAL AVERAGE GROWTH RATES OF NATIONAL INCOME AND FACTOR INPUTS (LOG %)

| | 1950s | 1960s | 1970s | 1980s |
|---|---|---|---|---|
| | | *Czechoslovakia* | | |
| Net Material Product | 7.3 | 5.5 | 4.5 | 1.9 |
| Gross Domestic Product | 4.6 | 3.1 | 2.5 | 1.3 |
| Fixed capital (official) | 3.4 | 3.8 | 4.2 | 4.3 |
| Fixed capital (revised) | 3.6 | 3.8 | 3.3 | 1.8 |
| Total employment | 0.9 | 1.2 | 0.7 | 0.7 |
| Total hours worked | 0.5 | 0.5 | 0.4 | 0.2 |
| | | *Hungary* | | |
| Net Material Product | 5.7 | 5.3 | 4.4 | 1.1 |
| Gross Domestic Product | 4.5 | 4.1 | 2.4 | 0.9 |
| Fixed capital (official) | 3.5 | 4.2 | 5.5 | 3.9 |
| Fixed capital (revised) | 3.2 | 4.0 | 3.4 | 1.3 |
| Total employment | 1.4 | 0.5 | 0.2 | -0.5 |
| Total hours worked | 1.4 | 0.1 | -0.2 | -1.6 |
| | | *Poland* | | |
| Net Material Product | 7.3 | 7.3 | 5.3 | 1.0 |
| Gross Domestic Product | 4.5 | 4.2 | 3.5 | 0.6 |
| Fixed capital (official) | | 4.1 | 6.1 | 6.4 |
| Fixed capital (revised) | 0.9 | 2.5 | 4.4 | 1.1 |
| Total employment | 1.9 | 2.1 | 1.3 | -0.3 |
| Total hours worked | 1.9 | 2.1 | 0.9 | -1.6 |

*Sources*: GDP from Maddison (2006); NMP, capital stock (official) and employment from statistical yearbooks; capital stock (revised) from Tables A1.1-A1.3 in the appendix. Total hours worked is employment adjusted for changes in official weekly work hours.

We apply the standard growth accounting framework developed by Robert Solow (1957), which assumes a Cobb-Douglas production function with constant returns to scale and constant elasticity of substitution (CES) equal to one between capital and labour.

$$Y_t = A_t(K_t)^{\alpha}(L_t)^{1-\alpha} \quad [4]$$

Value added *Y* in period *t* is the function of the available capital stock (K), the size of the labour input (L) and Total Factor Productivity (A). The coefficients $\alpha$ and $1\text{-}\alpha$ denote the elasticity of output with respect to capital and labour. In a dynamic framework, output growth can arise either from the expansion of factor inputs or from TFP growth.

$$\Delta lnY = \alpha \Delta lnK + (1-\alpha)\Delta lnL + \Delta lnA \quad [5]$$

The terms $\alpha$ and $1$-$\alpha$ stand for the respective shares of capital and labour in gross value added. Equation (5) can be rewritten to express TFP growth as the proportion of labour-productivity growth unexplained by capital deepening, the increase of the capital-labour ratio. This formula is more appropriate to assessing the roles of extensive versus intensive growth under central planning.

$$\Delta lnA = \Delta ln(Y/L) - \alpha[\Delta ln(K/L)] \quad [6]$$

Growth accounts most commonly use the value of 1/3 for $\alpha$, a reasonable approximation of the share of capital in national income in advance market economies. However, it has been argued that a higher capital share is more realistic for socialist command economies (Easterly and Fischer 1995).[18] Following this literature, we assume a constant $\alpha$ of 0.4 in our analysis. In theory, since production factors are paid their marginal products, factor shares can be computed from data on factor prices, but true factor costs are difficult to determine for centrally planned economies. For this reason we report robustness checks using both upper- and lower-bound plausible factor shares in Appendix 3 (Table A3.2).

Martin Weitzman (1970) proposed that socialist economies were better represented by a production function with CES below one. William Easterly and Stanley Fischer (1995) argued the same for the Soviet Union, and Antonin Rusek (1989) for Czechoslovakia. However, we agree with Allen's (2003) rebuttal, supported by Crafts (2009), that the technological possibilities available to planned and market economies did not differ profoundly enough to validate the assumption of radically different underlying production functions. To the extent that Weitzman was correct, the approach we prefer underestimates the contribution of TFP to economic growth, especially towards the end of the socialist period. Since unit CES does not fully account for diminishing returns to capital, it may overstate the contribution of capital deepening to labour-productivity growth. This confirms further that our estimates for the rate of TFP growth are, if anything, lower bound.

In our revised growth accounts, we adjust labour quality for returns to education, even though true returns for education are difficult to determine for centrally planned economies. The extended Solow model that includes education as a labour-augmenting factor was first developed by Edward Denison (1962), but we follow the specification proposed by Robert Hall and Charles Jones (1999).

$$Y_t = A_t(K_t)^{\alpha}(H_t)^{1-\alpha} \quad [7]$$

Human capital-augmented labour (H) is defined as the product of labour input and the efficiency of labour with $E$ years of schooling relative to the efficiency with no schooling. The derivative $\phi'(E)$ is the actual return to education and is estimated in a Mincerian wage regression.

$$H_t = e^{\phi(E_t)}L_t \quad [8]$$

Hall and Jones (1999) take the rate of return to be piecewise linear, 13.4 per cent for each of the first four years of education, 10.1 per cent for each of the next four years, and 6.8 per cent per

[18] Higher capital shares were also used for developing countries as in Benhabib and Spiegel (1994).

year after the eighth year of schooling (the underlying estimates come from Psacharopoulos 1994). Previous research using the wage grid of socialist economies computed substantially lower returns to education, but these findings are biased by strong wage compression applied by central planners (Münich et al. 2005; Jolliffe and Campos 2005). Low rates, thus, reflect not so much the poor efficiency derived from education, but the low rewards that socialist governments offered for these efficiency gains. To the extent that the true returns to education in socialist economies were smaller than the global average rates, our refined estimates of TFP growth can also be considered lower bound. Letting *h* denote human capital per worker (H/L), TFP growth is computed as the residual of labor-productivity growth after subtracting the contributions of capital deepening and education.

$$\Delta lnA = \Delta ln(Y/L) - \alpha[\Delta ln(K/L)] - (1-\alpha)\Delta lnh \qquad [9]$$

We first present growth accounts that can be constructed using official data on factor inputs in Table 2. Government statistics suggest remarkably high labour-productivity growth until the 1970s, but a sharp slowdown after 1980. Capital intensity seems to have grown not only rapidly but also at increasing rates, at least until the 1970s. Capital deepening appears to have driven labour-productivity growth throughout the socialist period. Rates of TFP growth calculated from official data on both output and factor inputs are high, albeit gradually decreasing, until the 1970s. By contrast, all three economies seem to have experienced sharply worsening productivity after 1980. Western data on GDP did not make the Central European growth record look profoundly different. It made planned economic development appear even more capital intensive. Productivity growth slowed down after 1970; TFP first stagnated, and then declined. Based on existing data, Poland represents the most extreme case of productivity failure. According to official statistics, capital intensity increased rapidly in both the 1970s and the 1980s. The annual rate of labour-productivity growth fell off the cliff after 1980. TFP growth declined alarmingly fast, and productivity fell by almost two per cent annually during the 1980s. Although the other two countries seem to have performed better, productivity also appears to have worsened in Czechoslovakia and Hungary.

Our revised growth accounts in Table 3 paint a different picture. Past research underestimated labour-productivity growth from the 1960s, and overestimated capital deepening. The growth of labour productivity and TFP slowed down after the early postwar era, but we obtain higher rates of TFP growth than what the previously available data suggested. The upward revision of productivity growth is most notable after 1970, especially for the 1980s. Hungary and Poland both recorded respectable rates of labour productivity growth until the end of the communism, and while TFP growth slowed down after the golden age, it did not decline further between the 1970s and the 1980s. Czechoslovakia posted comparatively modest rates of productivity growth from the 1960s, but TFP growth remained positive and it slowed down gradually. These results do not refute previous findings that socialist countries performed poorly relative to western market economies, but they have important implications for our understanding of their growth failure during the 1980s and of the economic forces behind the fall of communism.

TABLE 2
GROWTH ACCOUNTS USING OFFICIAL DATA ON FACTOR INPUTS (LOG %)

| | 1950s | 1960s | 1970s | 1980s |
|---|---|---|---|---|
| | | *Czechoslovakia* | | |
| NMP per worker | 6.4 | 4.3 | 3.8 | 1.2 |
| GDP per worker | 3.7 | 1.9 | 1.9 | 0.6 |
| Capital intensity | 2.5 | 2.7 | 3.5 | 3.6 |
| Capital deepening | 1.0 | 1.1 | 1.4 | 1.5 |
| TFP (NMP) | 5.4 | 3.2 | 2.4 | -0.3 |
| TFP (GDP) | 2.7 | 0.8 | 0.5 | -0.9 |
| | | *Hungary* | | |
| NMP per worker | 4.3 | 4.8 | 4.2 | 1.6 |
| GDP per worker | 3.1 | 3.6 | 2.1 | 1.4 |
| Capital intensity | 2.1 | 3.7 | 5.3 | 4.4 |
| Capital deepening | 0.8 | 1.5 | 2.1 | 1.8 |
| TFP (NMP) | 3.5 | 3.3 | 2.1 | -0.2 |
| TFP (GDP) | 2.3 | 2.1 | 0.0 | -0.4 |
| | | *Poland* | | |
| NMP per worker | 5.4 | 5.3 | 4.0 | 1.3 |
| GDP per worker | 2.6 | 2.1 | 2.2 | 0.9 |
| Capital intensity | | 2.0 | 4.8 | 6.7 |
| Capital deepening | | 0.8 | 1.9 | 2.7 |
| TFP (NMP) | | 4.5 | 2.1 | -1.4 |
| TFP (GDP) | | 1.3 | 0.3 | -1.8 |

*Note*: Capital intensity is the stock of fixed capital per employee. Capital deepening is the weighted contribution of the growth of capital intensity to labor-productivity growth. NMP refers to the official data, GDP to the estimates provided by the Research Project and taken from Maddison (2006).
*Source*: Table 1.

Poland represents a unique case. In total contradiction with the standard models of socialist industrialization, its growth in the early postwar period was driven entirely by labour expansion, not capital deepening. Capital intensity was markedly reduced during the 1950s and then stagnated until the late 1960s. This is *prima facie* evidence for increasing capacity utilization and for the existence of a vast capital surplus in the early days of communism. After the war and the expulsion of ethnic Germans from the country, the most pressing challenge for Polish governments was not how to build up new capital, but how to make use of existing capacities. There was little need for additional investment, which explains why the capital stock grew so slowly before 1970. With less investment in new equipment, labour-productivity growth was modest relative to other socialist countries. Soaring investment in the early 1970s and the sharp contraction of labour input during the 1980s made labour-productivity growth more and more investment driven. Still, TFP growth remained positive, and slowed down gradually from the 1960s, not abruptly after 1980.

TABLE 3
GROWTH ACCOUNTS USING REVISED DATA ON FACTOR INPUTS (LOG %)

| | 1950s | 1960s | 1970s | 1980s |
|---|---|---|---|---|
| | | *Czechoslovakia* | | |
| GDP per work hour | 4.1 | 2.6 | 2.1 | 1.1 |
| Capital intensity | 3.2 | 3.3 | 2.8 | 1.7 |
| Capital deepening | 1.3 | 1.3 | 1.1 | 0.6 |
| TFP I | 2.8 | 1.3 | 1.0 | 0.5 |
| Education | 0.3 | 0.3 | 0.3 | 0.3 |
| TFP II | 2.5 | 1.0 | 0.7 | 0.2 |
| | | *Hungary* | | |
| GDP per work hour | 3.1 | 4.0 | 2.6 | 2.5 |
| Capital intensity | 1.8 | 3.9 | 3.6 | 2.9 |
| Capital deepening | 0.7 | 1.6 | 1.4 | 1.2 |
| TFP I | 2.4 | 2.4 | 1.2 | 1.3 |
| Education | 0.2 | 0.4 | 0.5 | 0.0 |
| TFP II | 2.2 | 2.0 | 0.7 | 1.3 |
| | | *Poland* | | |
| GDP per work hour | 2.6 | 2.1 | 2.6 | 2.3 |
| Capital intensity | -1.0 | 0.4 | 3.5 | 2.7 |
| Capital deepening | -0.4 | 0.2 | 1.4 | 1.1 |
| TFP I | 3.0 | 1.9 | 1.2 | 1.2 |
| Education | 0.4 | 0.8 | 0.4 | 0.4 |
| TFP II | 2.6 | 1.1 | 0.8 | 0.8 |

*Notes:* TFP (I) and TFP (II) are the residuals of growth accounts not accounting and accounting for educational attainment respectively. 'Education' refers to human-capital deepening and is the weighted contribution of average improvement in educational attainment to aggregate labour-productivity growth.
*Sources*: Table 1; average educational attainment from http://barrolee.com/.

Surplus capacities also have a role in explaining high TFP growth in Czechoslovakia during the 1950s. Due to the expulsion of ethnic Germans from the Sudetenland, the steep population decline after 1945 combined with robust capital accumulation during the war left Czech industry with surplus capital. Subsequent investment was used to adopt more capital-intensive production technology (which had its beginnings in the interwar years) and to substitute capital for scarce labour in agriculture, which released a quarter of its workforce in the late 1950s. The reallocation of farm workers into industry, in turn, erased surplus capacity in manufacturing (Teichova 1988, 88-102). The failure of the Polish economy to replicate this process was most likely the consequence of an initially weaker industrial base, especially in capacities to produce steel-based capital goods, and the failed attempts at collectivizing the farming sector.

Our main quantitative findings hold, at large, when we adjust for returns to schooling. Improvements in education and vocational training are among the least doubted achievements of socialism. Even when at the expense of teaching quality, educational standards clearly increased,

especially in primary schooling and technical education. However, since the growth of educational attainment was rather smooth over the socialist period, accounting for labour quality does not alter the trajectory of productivity growth; except for Poland in the 1960s and Hungary between the 1970s and the 1980s. As Poland recovered from the demographic shock it had suffered in the 1940s, the best educated young cohorts born after 1945 and entering the labour force in the late 1960s made up a large share of the working age population. Demographics were also responsible for the slow growth of labour qualifications in Hungary after 1980, when the youngest cohorts of the labour force carried less weight in average attainment levels than the oldest workers, whose schooling had been disrupted during the war and the immediate postwar years (see the Barro-Lee data for details: http://barrolee.com/).

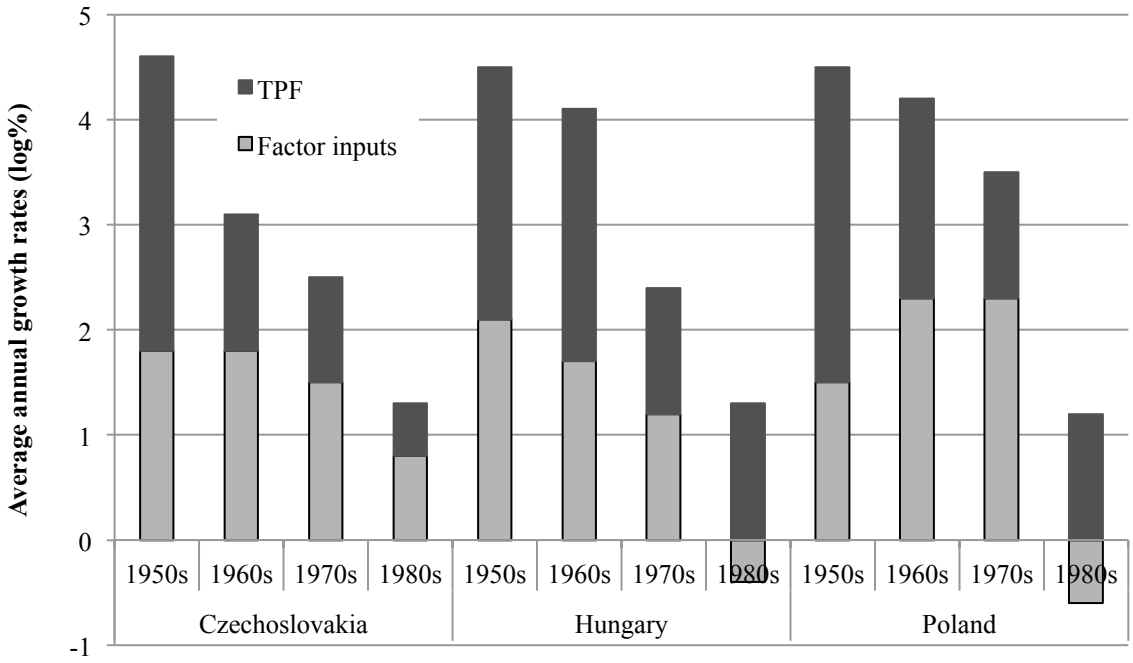


FIGURE 6
THE PROXIMATE SOURCES OF GROWTH IN EAST CENTRAL EUROPE, 1950-1989

*Sources and methods:* Rates of factor accumulation and GDP growth from Table 1. $\Delta lnTFP = \Delta lnGDP - \Delta lnTFI$ (total weighted factor input). Factor shares are 0.4 for capital and 0.6 for labour (see TFP I in Table 3).

Figure 6 above summarizes the core results. As in many other regions of postwar Europe, the gradual slowdown of economic growth reflected declining rates of productivity growth.[19] However, the socialist growth failure of the 1980s was mainly or exclusively input driven. This conclusion becomes even stronger, when we recognize that structural change did not contribute to aggregate productivity growth after 1980. Given the emphasis that the literature on planned economies placed on labour reallocation between agriculture and industry, our study of the socialist growth record cannot be complete without some discussion of structural development.

[19] For comparisons, see Crafts and Toniolo (1996, 2010), Maddison (1997), and Toniolo (1998) among others.

TABLE 4
GDP BY SECTOR OF ORIGIN OF PRODUCT (% SHARE)

| | 1950 | 1960 | 1970 | 1980 | 1989 |
|---|---|---|---|---|---|
| | | | *Czechoslovakia* | | |
| Agriculture | 32.4 | 23.6 | 17.7 | 16.3 | 17.0 |
| Industry | 25.5 | 32.2 | 37.5 | 39.8 | 40.0 |
| Construction | 6.6 | 9.4 | 8.7 | 8.6 | 7.6 |
| Transport and communications | 4.0 | 7.2 | 7.7 | 8.2 | 8.3 |
| Trade | 5.5 | 6.3 | 7.9 | 8.5 | 8.7 |
| Non-material services | 25.0 | 21.3 | 20.5 | 18.4 | 18.4 |
| | | | *Hungary* | | |
| Agriculture | 36.6 | 30.0 | 23.2 | 23.4 | 24.3 |
| Industry | 22.5 | 28.1 | 33.4 | 32.7 | 32.4 |
| Construction | 4.5 | 5.8 | 7.5 | 7.0 | 5.3 |
| Transport and communications | 5.1 | 7.8 | 8.3 | 9.0 | 8.2 |
| Trade | 3.4 | 4.3 | 6.1 | 7.0 | 7.0 |
| Non-material services | 27.8 | 23.9 | 21.7 | 20.9 | 22.8 |
| | | | *Poland* | | |
| Agriculture | 49.5 | 42.4 | 32.3 | 24.1 | 28.9 |
| Industry | 15.5 | 23.1 | 30.7 | 33.7 | 29.1 |
| Construction | 2.5 | 4.5 | 5.5 | 6.6 | 5.0 |
| Transport and communications | 3.2 | 4.3 | 5.7 | 9.2 | 8.3 |
| Trade | 3.7 | 4.3 | 5.2 | 6.5 | 6.5 |
| Non-material services | 24.5 | 21.3 | 20.6 | 19.9 | 22.3 |

*Notes*: Agriculture includes farming, fishing and forestry. Industry includes mining, manufacturing and electrical power. Trade includes both wholesale and retail. Non-material services include water and gas utilities, government services, catering, and personal services. All shares are expressed in 1976/77 prices.
*Sources*: Own calculations from Alton (1970), Alton et al (1991b), Alton et al. (1985a), Czirják (1973), Holesovsky (1968), and Lazarcik (1969).

Unfortunately, the available data are not sufficient to estimate the structural components of labour-productivity or TFP growth. We do not have reliable data on capital input at the sector or industry level. The industry classification used in the official employment statistics is not perfectly consistent across the three countries, and it differs from the industry coverage of our sources for GDP data, especially in the service sector. In addition, we do not have any way of estimating hours worked at the sector level outside of mining and manufacturing. Therefore, the measures of labour productivity that we could construct at the industry level would not only be inaccurate and hard to compare across countries; they would also be inconsistent with our estimates for the economy as a whole. Nonetheless, we can trace structural shifts in the growth of national income.

Table 4 reports the share of six major sectors of the economy in GDP in constant prices. The share of industry ceased to increase by the late 1970s, but deindustrialization after the oil shocks was not as dramatic as in western market economies. Structural modernization dominated the 1950s

and 1960s, but not the next two decades. In Hungary, the relative decline of agriculture came to a halt already in the 1970s, and after 1980 the importance of the farming sector increased in all three countries. The argument that central planning was not flexible enough to support a successful transition from an industrial to a more service-based economy also needs to be more nuanced. Modern services, such as trade, transport and communications, actually made a great leap forward during the 1970s, but contracted more than any other sector in the 1980s, most drastically in Poland. By contrast, the relative decline of non-material services, including the government, was reversed after 1980. As the following section will explain, this reversal in the structural development of socialist economies was a response to exogenous aggregate demand shocks.

## THE CRISIS OF THE 1980S

If the growth failure that undermined socialism in East Central Europe during the 1980s was input driven, then what caused sluggish factor accumulation, especially the sharp fall in investment and the diminishing rate of capital accumulation? Answers to this question need not be invented. We can draw inspiration from the literature on developing regions and from contemporary observers in the three countries that we study. Parallels with the experience of Latin America are particularly strong, where the 'lost decade' of growth has often been linked to poor investment in physical and human capital, which in turn was explained by the debt overhang and the payments crises of the 1980s (see Ocampo 2004, Astorga 2010, and Astorga et al. 2011, among others). However, these factors were overlooked in most theoretical and empirical studies that sought to interpret the failure of planned economies as the consequence of technological and allocation inefficiencies above all else (Snell 1970; Brada and Montias 1984).

'Worst things come in pairs', says the old adage, and they certainly did in Eastern Europe at the turn of the 1970s and 1980s. Firstly, the oil shocks were more detrimental than elsewhere. Until 1975, COMECON countries imported crude oil, natural gas, and petroleum products from the Soviet Union at prices fixed every five years, typically well below the world market price. The existence of this practice prompted some scholars to argue that the USSR subsidized the economic development of her satellites (Marrese and Vanous 1983). As the first oil shock radically improved the Soviet terms of trade *vis-à-vis* western markets and Soviet industry was in grave need to import western machinery, the fixed-price regime was abandoned. COMECON prices for raw materials were thereafter determined as five-year moving averages of the world market price. Thus the ensuing increase of import bills in East Central Europe was initially smoother and somewhat delayed, but lasted longer, than elsewhere, until the mid-1980s (Beckmann and Fidrmuc 2012, p. 36).

Rising fuel prices made socialist industries less competitive because they applied relatively material-intensive technologies. This was not the outcome of technical backwardness but of rational choice. Due to the vast fossil-fuel deposits of the COMECON, energy prices were both nominally and relatively lower than in the West until the late 1970s. As a result, it paid to employ relatively fuel-inefficient technologies. Indicators derived from input-output matrices indicate remarkably similar manufacturing technologies in terms of natural-resource use between Eastern Europe and

OECD countries. Only their consistently higher energy intensity made the input-output ratios of socialist economies notably higher (Drábek 1988; Gomulka and Rostowski 1988). After the oil shocks, this meant loss of competitiveness, sharply worsening terms of trade, and the need for massive investments to replace the existing stock of fuel-inefficient equipment.

Secondly, public debt in Eastern Europe soared during the 1970s, thanks to cheap credit and urged by popular demands for investment in public infrastructure. In the early 1980s, refinancing their external debt became more costly for socialist countries as western creditor nations raised interest rates in an attempt to combat inflation at home. In the context of the Cold War, autarky was the logical, albeit self-destructive, policy response. Both the Soviet politburo and the COMECON council called upon socialist countries to limit their imports and to drastically cut back on international borrowing.[20]

This had negative consequences for economic growth and productivity. In aggregate terms, even though GDP continued to increase, domestically disposable income effectively stagnated from the mid-1970s. As governments struggled to satisfy public demands to expand government services, increase the availability of consumer goods, and improve housing, investment in machinery became the prime victim of austerity (Alton et al. 1991a; Bálek 2007). Our estimates have shown that the shrinking share of national income available for investment was shifted from equipment towards construction. Paradoxically, as communist regimes were nearing their collapse, they disbursed record sums for building projects. Social housing programs are partly to blame, but equally hurting was the construction of nuclear power plants in Czechoslovakia and Hungary precisely with the aim of reducing the dependence of both countries on imported hydrocarbons.

External demand shocks and the policy response they invoked limited the expansion and modernization of production capacities. The need to improve their balance of trade forced socialist countries to promote exports at all cost. To achieve this, they diverted resources to low-productivity sectors with relatively strong export potential in hard-currency markets. Thus, austerity adversely affected the structure of production, too. Deflationary policies (most notably in Czechoslovakia) seeking to dampen the impact of rising energy prices and to improve trade balances also hampered investment and productivity growth (Brada 1989). The need to curtail imports from hard-currency areas may have also contributed to slower productivity growth by making it harder to implement advanced western technologies (Whitesell 1985).

Low levels of equipment investment implied slow growth in productive capacity and sluggish technological progress as well as employment creation. Thus, austerity affected both input growth and productivity negatively. This argument is supported by previous research on the importance of machinery investment, in particular, for productivity growth (De Long 1992; De Long and Summers 1991). It also corresponds with recent evidence pointing to the conditionality of technological gains on sufficiently high levels of capital intensity, and thus investment (Kumar and Russel 2002; Allen 2012). Labour input declined further because of the shortening of the official workweek and popular welfare measures that diminished female labour participation after it had

[20] See Berend (1997), from p. 195 for further details.

increased robustly for decades.[21] The most influential among these measures were the generous maternity benefits that allowed young mothers to stay at home for several years after childbirth and increased pensions for the elderly with a low retirement age for women.

Although the economic meltdown of the 1980s demonstrated these common features in most socialist economies, the extent of the crisis varied precisely because the severity of the external shocks was not uniform either. In Poland, GDP per capita fell between 1980 and 1989. After lavish borrowing during the 1970s, the Polish government was the first to declare insolvency in the wake of the second oil shock, before the avalanche of Latin American defaults began. Extreme austerity and the return to a repressive style of government under General Jaruzelski spurred popular dissent from the Solidarity movement. Recurrent strikes diminished manufacturing output, which further curbed resources for investment (for details see Berend 1997). Czechoslovakia, by contrast, recorded the highest growth rates among socialist economies after the Soviet Union.[22] Because of limited borrowing in the 1970s, leaders in Prague did not need to tighten the belts as much as their counterparts in other countries and, therefore, could maintain relatively high levels of investment. Machinery investment declined less drastically than in Hungary and Poland. Hungary represents a somewhat special case within the Soviet Bloc. It managed to ease the pressure of austerity to some extent by maintaining access to western credit after it joined the IMF and the World Bank in 1982 in a secret operation conducted behind the backs of unsuspecting Soviet leaders.

## CONCLUSIONS

Why did socialist economies fail? The falling behind of Eastern Europe in income per capita and productivity in the period of the Cold War has been subject to a myriad of studies. Most blamed it on the intrinsic inefficiencies of central planning. The extensive nature of the investment-driven development model is well established both in the theoretical and empirical literature. Most of the existing growth accounts for Eastern Europe confirm this view. The inefficiencies of the socialist system were manifested in the productivity failure that brought economic growth to a standstill by the 1980s and undermined the viability of communism. Planned economies, it has been argued, failed because they were bound to. By construction, they were incapable of a successful transition from an extensive growth model to one driven by innovation and rising productivity.

While we accept that socialism was relatively inefficient, we argue that existing accounts of the socialist growth experience require revision. Official statistics did not only overstate the growth of national income but also the rate of capital accumulation. Planned economic development was not as capital intensive as previous research has suggested. Productivity growth never came to a standstill and certainly did not turn into reverse. The growth retardation of the 1980s in East Central Europe did not result from the failure to sustain productivity growth but mainly from the failure to

[21] See Adam (1987) for a discussion of employment policies in Eastern Europe.

[22] As a main exporter of hydrocarbons, the USSR could investment levels after 1980 and, thanks to that, achieved the highest growth rates in Easter Europe in both GDP and GDP per capita (Maddison 2006). Within the union, Russia, which benefited more from the new export opportunities than most other republics, recorded considerably faster growth than the Soviet economy as a whole, as long as oil prices remained high (compare with Ponomarenko 2002).

sustain factor accumulation. As in many other late-developing regions, this was the outcome of powerful exogenous demand shocks rather than an inefficient supply side. Unlike in the Soviet Union, the oil shocks and the payments crises that emerged in their aftermath invoked austerity, and investment in new machinery became the prime victim thereof. This caused growing technological backwardness, structural sclerosis, and employment contraction with worsening capacity utilization in the capital goods industries. By reducing investment in new equipment, austerity also contributed to the lack of innovation after the era of mass production, and thus the widening technological gap with advanced market economies, that the literature has emphasised. The policy response to the crisis undermined the legitimacy of the socialist system and brought it to collapse, or at least accelerated its downfall.

## REFERENCES


Adam, Jan. "Employment Policies in Selected East European Countries: Poland, Czechoslovakia, and Hungary." In *East European Economies: Slow Growth in the 1980*, U.S. Congress Joint Economic Committee, vol. 1, 226-248. Washington, DC: U.S. Government Printing Office, 1985.

——. *Employment policies in the Soviet Union and Eastern Europe*. 2nd Rev. Ed. Houndmills, Basingstoke, Hampshire: Macmillan, 1987.

Allen, Robert C. "Capital Accumulation, the Soft Budget Constraint and Soviet Industrialization." *European Review of Economic History* 2, no. 1 (1998): 1-24.

——. *Farm to Factory: A Reinterpretation of the Soviet Industrial Revolution*. Princeton, NJ: Princeton University Press, 2003.

——. "Technology and the Great Divergence: Global Economic Development Since 1820." *Explorations in Economic History* 49, no. 1 (2012): 1-16.

Alton, Thad P. "Economic Structure and Growth in Eastern Europe". In *Economic Developments in Countries of Eastern Europe*, U.S. Congress Joint Economic Committee, 41-67. Washington, D.C.: U.S. Government Printing Office, 1970.

Alton, Thad P., Krzysztof Badach, Robert J. Bakondi, et al. *Eastern Europe: Domestic Final Uses of Gross Product, 1975-1990*. Research Project on National Income in East-Central Europe, OP-112. New York, NY: L. W. International Financial Research, Inc., 1991a.

Alton, Thad P., Krzysztof Badach, Robert J. Bakondi, et al. *Economic Growth in Eastern Europe 1975-1990*. Research Project on National Income in East-Central Europe, OP-117. New York, NY: L. W. International Financial Research, Inc., 1991b.

Alton, Thad P., Krzysztof Badach, Elisabeth M. Bass, and Gregor Lazarcik. *East European GNP by Origin and Domestic Final Use of Gross Product*. Research Project on National Income in East-Central Europe, OP-89. New York, NY: L. W. International Financial Research, Inc., 1985a.

Alton, Thad P., Krzysztof Badach, Elisabeth M. Bass, and Gregor Lazarcik. "East European Defense Expenditures, 1965-1982." In *East European Economies: Slow Growth in the 1980*, U.S. Congress Joint Economic Committee, vol. 1, 475-501. Washington, DC: U.S. Government Printing Office, 1985b.

Alton, Thad P., Elisabeth M. Bass, László Czirják, and Gregor Lazarcik. *Statistics on East European Economic Structure and Growth*. Research Project on National Income in East-Central Europe, OP-48. New York, NY: L. W. International Financial Research, Inc., 1975.

Alton, Thad P., Elisabeth M. Bass, and Gregor Lazarcik. *The Structure of Gross National Product in Eastern Europe: Derivation of GNP Weights for 1975 – 1977*. Research Project on National Income in East-Central Europe, OP-64. New York, NY: L. W. International Financial Research, Inc., 1981.

Alton, T.P., Elisabeth M. Bass, Gregor Lazarcik, Gregor J. Staller, and W. Znayenko. *Czechoslovakia, Hungary, and Poland: Domestic Final Uses of Gross Product, Structure and Growth, Selected Years, 1965-1978*. Research Project on National Income in East-Central Europe, OP-55. New York, NY: L. W. International Financial Research, Inc., 1979.

Astorga, Pablo. "A Century of Economic Growth in Latin America." *Journal of Development Economics* 92, no. 2 (2010): 232-43.

Astorga, Pablo, Ame R. Berges, and Valpy Fitzgerald. "Productivity Growth in Latin America Over the Long Run." *Review of Income and Wealth* 57, no. 2 (2011): 203-23.

Balassa, Béla. "The Economic Reform in Hungary." *Economica*, New Series, 37, no. 1 (1970): 1-22.

Balassa, Béla and Trent J. Bertrand. "Growth Performance of Eastern European Economies and Comparable Western European Countries." *American Economic Review* 60, no. 2 (1970): 314-20.

Bálek, Alexei. "Československá ekonomika v osmdesátých letech 20. Století." [The Czechoslovak Economy in the 1980s] *Acta Oeconomica Pragensia* 15, no. 1 (2007): 45-53.

Banerjee, Abhuit V. and Michael Spagat. "Productivity Paralysis and the Complexity Problem: Why Do Centrally Planned Economies Become Prematurely Grey?." *Journal of Comparative Economics* 15, no. 4 (1991): 646-60.

Bandor, Frank, László Czirják, and George Pall. *Hungary: Extension of Growth Indexes to 1967*. Research Project on National Income in East Central Europe, OP-33. New York, NY: Economic Studies, Riverside Research Institute, 1970.

Barro, Robert and Jong-Wha Lee. "A New Data Set of Educational Attainment in the World, 1950-2010." *Journal of Development Economics* 104 (September 2013): 184-98.

Beckmann, Elisabeth and Jarko Fidrmuc. "Oil Price Shock and Structural Changes in CMEA Trade: Pouring Oil on Troubled Waters." *Journal of European Comparative Economics* 9, no. 1 (2012): 31-49.

Benhabib, Jess and Mark M. Spiegel. "The Role of Human Capital in Economic Development: Evidence From Aggregate Cross-Country Data". *Journal of Monetary Economics* 34, no. 2 (1994): 143-73.

Berend, Iván T. *Capital Intensity and Development Policy*. Budapest: Akadémiai Kiadó, 1985.

——. *Central and Eastern Europe 1944-1993: Detour From the Periphery to the Periphery*. Cambridge: Cambridge University Press, 1997.

Bergson, Adam. "Comparative Productivity: The USSR, Eastern Europe, and the West." *American Economic Review* 77, no. 3 (1987a): 342-57.

——. "On Soviet Real Investment Growth." *Soviet Studies* 39, no. 3 (1987), pp. 406-24.

Brada, Josef C., 'Technological Progress and Factor Utilization in Eastern European Economic Growth', *Economica* 56, no. 308 (1989): 433-48.

Brada, Josef C. and John M. Montias. "Industrial policy in Eastern Europe: A three-country comparison', *Journal of Comparative Economics* 8, no. 4 (1984): 377-19.

Broadberry, Stephen N. "How Did the United States and Germany Overtake Britain? A Sectoral Analysis of Comparative Productivity Levels, 1870-1990." *The Journal of Economic History* 58, no. 2 (1998): 375-407.

Broadberry, Stephen N. and Alex Klein. "When and Why Did Eastern European Economies Begin to Fail? Lessons from a Czechoslovak/UK Productivity Comparison, 1921–1991." *Explorations in Economic History* 48, no. 1 (2011): 37-52.

Bródy, András. "A GDP mérése proxyk segítségével." [Measuring GDP by Proxies] *Közgazdasági Szemle* 41, no. 11 (1994): 949-66.

——. "Gazdaságunk az ezredfordulón: Előrejelzés az 1992-2004 évekre." [Our Economy at the Turn of the Millennium: Forecast for the Years 1992-2004] *Közgazdasági Szemle* 39, no.10 (1992): 954-70.

Central Intelligence Agency (CIA). *Measures of Soviet Gross National Product in 1982 Prices*. Report prepared for the United States Congress Joint Economic Committee. Washington, D.C.: U.S. Government Printing Office, 1990.

Clements, T. W. 'The costs of defense in the Warsaw Pact: a historical perspective', In *East European Economies: Slow Growth in the 1980*, US Congress Joint Economic Committee, vol. 1, 451-74. Washington, DC: U.S. Government Printing Office, 1985.

Crafts, N. F. R. "Solow and Growth Accounting: A Perspective from Quantitative Economic History." *History of Political Economy* 41, Supplement 1 (2009): 200-20.

Crafts, N. F. R. and Gianni Toniolo. "Postwar Growth: An Overview". In *Economic Growth in Europe Since 1945*, edited by N. F. R. Crafts and Gianni Toniolo, 1-37. Cambridge: Cambridge University Press, 1996.

——. "Aggregate growth." In *The Cambridge Economic History of Modern Europe*, vol. 2: 1870 to the present, edited by Stephen N. Broadberry and Kevin H. O'Rourke, 296-332. Cambridge: Cambridge University Press, 2010.

Crane, Keith. "Military Spending in Czechoslovakia, Hungary, and Poland." *Journal of Comparative Economics* 12, no. 4 (1988): 521-45.

Czirják, László. *Hungarian Investment, 1938 and 1949-1965: Trends in Fixed Capital, Inventories and Net Foreign Investment*. Research Project on National Income in East Central Europe, OP-17. New York, NY: Columbia University, 1968.

——. *Hungarian GNP by sectors of origin of product and end uses, 1938 and 1946-1967*, Research Project on National Income in East Central Europe, OP-43. New York, NY: Economic Studies, Riverside Research Institute, 1973.

Davis, Christopher. "The Defense Sector in the Economy of a Declining Superpower: Soviet Union and Russia, 1965-2001." *Defense and Peace Economics* 13, 2 (2002): 145-77.

De Long, J. Bradford. "Productivity Growth and Machinery Investment: A Long-Run Look, 1870-1980." *Journal of Economic History* 52, no. 2 (1992): 307-24.

De Long, J. Bradford and Lawrence H. Summers. "Equipment Investment and Economic Growth." *Quarterly Journal of Economics* 106, no. 2 (1991): 445-502.

Denison, Edward F. *The Sources of Economic Growth in the United States and the Alternatives Before Us.* New York, NY: Committee for Economic Development, 1962.

Drábek, Zdenek. "The Natural Resource Intensity of Production Technology in Market and Planned Economies: Austria vs Czechoslovakia." *Journal of Comparative Economics* 12, no. 2 (1988): 217-27.

Easterly, William and Stanley Fischer. "The Soviet Economic Decline." *World Bank Economic Review* 9, no. 3 (1995): 341-71.

Ehrlich, Éva. "Contest between countries, 1937-1986." *Soviet Studies* 43, no. 5 (1991), pp. 875-96.

Eichengreen, Berry. *The European Economy Since 1945: Coordinated Capitalism and Beyond*. Princeton, NJ: Princeton University Press.

Epstein, David F. "The Economic Cost of Soviet Security and Empire." In *The Impoverished Superpower: Perestroika and the Soviet Military Burden*, edited by Henry S. Rowen and Charles Wolf Jr., 127-54. San Francisco, CA: ICS Press, 1990.

Feenstra, Robert C., Robert Inklaar, and Marcel P. Timmer. "The Next Generation of the Penn World Table." *American Economic Review* 105, no. 10 (2015): 3150-82.

Feldman, Grigory A. "On the Theory of Growth Rates of National Income." [1928] Reprint in translation in N. *Foundations of Soviet Strategy for Economic Growth: Selected Essays, 1924-1930*, edited by N. Spulber, 174-99, 304-31. Bloomington IN, Indiana University Press, 1964.

Gerschenkron, Alexander. *Economic Backwardness in Historical Perspective: A Book of Essays*. Cambridge, MA: Belknap Press of Harvard University Press, 1962.

Gomulka, Stanislaw and Jacek Rostowski. "An International Comparison of Material Intensity". *Journal of Comparative Economics* 12, no. 4 (1988): 502-20.

Hall, Robert I. and Charles I. Jones. "Why Do Some Countries Produce So Much More Output per Worker than Others?" *Quarterly Journal of Economics* 114, no. 1 (1999): 83-116.

Harberger, Arnold. "Perspectives on Capital and Technology in Less Developed Countries." In *Contemporary Economic Analysis*, edited by Michael J. Artis and Avelino R. Nobay, 15-40. London: Croom Helm, 1978.

Hare, P. J., and P. T. Wanless. "Polish and Hungarian Economic Reforms: A Comparison." *Soviet Studies* 33, no. 4 (1981): 491-517.

Harrison, Mark. "Secrets, Lies, and Half-Truths: The Decision to Disclose Soviet Defense Outlays". PERSA Working Paper No. 55, University of Warwick, Department of Economics, September 2008. http://www2.warwick.ac.uk/fac/soc/economics/staff/mharrison/archive/persa.

Heston, Alan, Robert Summers, and Bettina Aten. *Penn World Table*. Center for International Comparisons of Production, Income and Prices, University of Pennsylvania, 1995. http://www.rug.nl/research/ggdc/data/pwt/pwt-5.6.

Holesovsky, Vaclav. *Czechoslovakia: I. Extension of Growth Indexes to 1965. II. Personal Consumption Index, 1937 and 1948-1965*. Research Project on National Income in East-Central Europe, OP-25. New York, NY: Columbia University, 1968.

Horvat, Branko. *Towards a Theory of a Planned Economy*. Belgrade: Yugoslav Institute of Economic Research, 1964.
Hsieh, Chang-Tai. "What Explains the Industrial Revolution in East Asia? Evidence from the Factor Markets." *American Economic Review* 92, no. 3 (2002): 502-26.
Hulten, Charles R. "The Measurement of Capital." In *Fifty Years of Economic Measurement. The Jubilee of the Conference on Research in Income and Wealth*, edited by Ernst R. Berndt and Jack E. Tripplett, 119-152. Chicago, IL: University of Chicago Press/NBER, 1990.
Jolliffe, Dean and Nauro F. Campos. "Does Market Liberalisation Reduce Gender Discrimination? Econometric Evidence from Hungary, 1986-1998." *Labour Economics* 12, no. 1 (2005): 1-22.
Jorgenson, Dale J. "The Economic Theory of Replacement and Depreciation." In *Econometrics and Economic Theory*, edited by Willy Sellekaerts, 189-221. NewYork: Macmillan, 1973.
——. "Accounting for Capital." In *Capital Efficiency and Growth*, edited by George von Furstenberg, 251-319. Cambridge MA: Ballinger, 1980.
——. "Capital as a Factor of Production". In *Technology and Capital Formation*, edited by Dale J. Jorgenson and Ralph Landau, 1–35. Cambridge, MA: MIT Press, 1989.
——. "Productivity and Economic Growth". In *Fifty Years of Economic Measurement. The Jubilee of the Conference on Research in Income and Wealth*, edited by Ernst R. Berndt and Jack E. Tripplett, 19–118. Chicago, IL: University of Chicago Press/NBER, 1990.
Kemme, David M. "Productivity Growth in Polish Industry." *Journal of Comparative Economics* 11, no. 1 (1987) 1-20.
Kontorovich, Vladimir. "Inflation in the Soviet Investment and Capital Stock." *Soviet Studies* 41, no. 2 (1989), pp. 318-29.
Korbonski, Andrzej, Alexej Wynnyczuk, and Wassyl Znayenko. *Poland: Index of Gross Investment*. Research Project on National Income in East Central Europe, OP-41. New York, NY: L. W. International Financial Research, Inc., 1973.
Kornai, János. "The Hungarian Reforms Process: Visions, Hopes and Reality." *Journal of Economic Literature* 24, no. 4 (1986): 1687-737.
——. *The Socialist System: The Political Economy of Communism*. Oxford: Oxford University Press, 1992.
Krugman, Paul. "The Myth of the Asian Growth Miracle: A Cautionary Fable." *Foreign Affairs* 73, no. 6 (1994): 62-78.
Kumar, Subodh, and R. Robert Russel. "Technological Change, Technological Catch-up, and Capital Deepening: Relative Contributions to Growth and Convergence." *American Economic Review* 92, no. 3 (2002): 527-48.
Kýn, Oldřich. "The Rise and Fall of Economic Reform in Czechoslovakia." *American Economic Review*, Papers and Proceedings 60, no. 2 (1970): 300-306.
Lazarcik, Gregor. *Czechoslovak Gross National Product by Sector of Origin and by Final Use, 1937 and 1948-1965*. Research Project on National Income in East-Central Europe, OP-26. New York, NY: Columbia University, 1969.
Maddison, Angus. *The World Economy: Historical Statistics.* Paris: OECD, 2006.
——. "Macroeconomic Accounts for European Countries." In *Quantitative Aspects of Post-War European Economic Growth*, edited by Bart van Ark and N. F. R. Crafts, 27-83. Cambridge: Cambridge University Press, 1997.
Mankiw, N. Gregory. "The Growth of Nations." *Brookings Papers on Economic Activity*, no. 1 (1995): 275-310
Marrese, Michael and Jan Vanous. *Soviet Subsidization of Trade with Eastern Europe: A Soviet Perspective*. Berkeley, CA: Institute of International Studies, University of California, 1983.
Münich, Daniel, Jan Svejnar, and Katherine Terrell. "Returns to Human Capital Under the Communist Wage Grid and During the Transition to a Market Economy." *Review of Economics and Statistics* 87, no. 1 (2005): 100-23.
Murrell, Peter and Mancur Olson. "The Devolution of Centrally Planned Economies." *Journal of Comparative Economics* 15, no. 2 (1991): 239-65.
Nehru, Vikram, and Ashok Dhareshwar. "A New Database on Physical Capital Stock: Sources, Methodology and Results." *Revista de Analisis Economica* 8, no. 1 (1993): 37–59.
Nove, Alec. "A Note on Growth, Investment, and Price-Indices." Soviet Studies 33, no. 1 (1981): XX.

Nurkse, Ragnar. *Problems of Capital Formation in Underdeveloped Countries*. Oxford: Blackwell, 1953.
Ocampo, José A. "Latin America's Growth and Equity Frustrations During Structural Reforms." *Journal of Economic Perspectives* 18, no. 2 (2004): 67-88.
Ofer, Gur. "Soviet Economic Growth: 1928-1985." *Journal of Economic Literature* 25, no. 4 (1987): 1767-833.
Osiatyński, Jerzy, ed. *Socialism: Economic Growth and Efficiency of Investment*. Collected Works of Michał Kalecki, Vol. IV. Oxford: Oxford University Press, 1993.
Ponomarenko, Alexey N. *Retrospektivnye Natsional'nye Scheta Rossii: 1961-1990* [Retrospective Russian National Accounts: 1961-1990]. Moscow; Finansy i statistika, 2002.
Portes, Richard D. "Economic Reforms in Hungary." *American Economic Review*, Papers and Proceedings, 60, no. 2 (1970): 307-13.
Prados de la Escosura, Leandro and Joan R. Rosés. "The Sources of Long-Run Growth in Spain, 1850-2000." *The Journal of Economic History* 69, no. 4 (2009): 1063-91.
——. "Capital Accumulation in the Long Run: The Case of Spain, 1850–2000." *Research in Economic History* 27 (2010): 141-200.
Preobrazhensky, Evgenii A. "On Primary Socialist Accumulation." [1926] Reprint in translation in *Foundations of Soviet Strategy for Economic Growth: Selected Essays, 1924-1930*, edited by N. Spulber, 235-56. Bloomington IN, Indiana University Press, 1964.
Psacharopoulos, George. "Returns to Investment in Education: A Global Update." *World Development* 22, no. 9 (1994): 1325-43.
Rusek, Antonin. "Industrial Growth in Czechoslovakia 1971–1985: Total Factor Productivity and Capital-Labor Substitution." *Journal of Comparative Economics* 13, no. 2 (1989): 301-13.
Ritschl, Albrecht O. "An Exercise in Futility: East German Economic Growth and Decline, 1945-89." In *Economic Growth in Europe Since 1945*, edited by N. F. R. Crafts and Gianni Toniolo, 498-540. Cambridge: Cambridge University Press, 1996.
Seidel, Hans. *Österreichs Wirtschaft und Wirtschaftspolitik nach dem Zweiten Weltkrieg*. Vienna: Manz'sche Verlags- und Universitätsbuchhandlung, 2005.
Sleifer, Jaap. *Planning Ahead and Falling Behind: The East German Economy in Comparison with West Germany, 1936–2002*. Berlin: Akademie Verlag, 2006.
Snell, Edwin M. "Economic Efficiency in Eastern Europe." In *Economic Developments in Countries of Eastern Europe*, US Congress Joint Economic Committee, 240-96. Washington, DC: Government Printing Office, 1970.
Solow, Robert M. "Technical Change and the Aggregate Production Function." *Review of Economics and Statistics* 39, no. 3 (1957): 312-20.
Staller, George J. *Czechoslovak Index of Investment, 1937-1962: Machinery and Equipment*. Research Project on National Income in East-Central Europe, OP-3. New York, NY: Columbia University, 1965a.
——. *Czechoslovak Index of Construction, 1937-1962*. Research Project on National Income in East-Central Europe, OP-4. New York, NY: Columbia University, 1965b.
——. "Czechoslovakia: The New Model of Planning and Management." *American Economic Review*, Papers and Proceedings, 58, no. 2 (1968): 559-67.
Stockholm International Peace Research Institute (SIPRI). *Yearbook of World Armaments, Disarmament and International Security*. Diff. vols. London: Taylor & Francis, 1968/69 onwards.
Teichova, Alice. *The Czechoslovak economy 1918-1980*. London: Routledge, 1988.
The Conference Board, *The Conference Board Total Economy Database*™ (May 2015) http://www.conference-board.org/data/economydatabase/.
Toniolo, Gianni. "Europe's Golden Age, 1950-1973: Speculations from a Long-Run Perspective." *Economic History Review* 51, no. 2 (1998): 252-67.
Timmer, Marcel P., Robert Inklaar, R., M. O'Mahon, and Bart van Ark. *Economic Growth in Europe: A Comparative Industry Perspective*. Cambridge: Cambridge University Press, 2010.
Van Ark, Bart. "Convergence and Divergence in the European Periphery: Productivity in Eastern and Southern Europe in Retrospect." In *Quantitative Aspects of Post-War European Economic Growth*, edited by Bart van Ark and N. F. R. Crafts, 271-326. Cambridge: Cambridge University Press, 1997.

Vonyó, Tamás. “War and Socialism: Why Eastern Europe Fell Behind Between 1950 and 1989.” *Economic History Review*, published online in early view (2016).

Weitzman, Martin L. “Soviet Postwar Economic Growth and Capital-Labor Substitution.” *American Economic Review* 60, no. 5 (1970): 676-92.

Wiles, Peter J. D. “Soviet Consumption and Investment Prices, and the Meaningfulness of Real Investment’, *Soviet Studies* 34, no. 2 (1982), pp. 289-95.

——. “How Soviet Defense Expenditures Fit into the National Income Accounts.” In *The Soviet Defense Enigma: Estimating Cost and Burden*, edited by Carl G. Jacobsen, 59-94. Oxford and New York, NY: Oxford University Press, 1987.

Whitesell, Robert S. “The Influence of Central Planning on the Economic Slowdown in the Soviet Union and Eastern Europe: A Comparative Production Function Analysis.” *Economica* 52, no. 2 (1985): 235-44.

Young, Alwyn. “The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience.” *Quarterly Journal of Economics* 110, no. 3 (1995): 641-80.

## APPENDIX 1: DATA SOURCES USED IN RECONSTRUCTION OF INVESTMENT

We used a combination of index-number series for construction and equipment investment to reconstruct levels of investment in fixed capital. Construction investment is taken from the occasional papers of the Research Project on National Income in East Central Europe (Alton et al. 1991b; Alton et al. 1985a; Czirják 1973; Holesovsky 1969; Korbonski et al. 1973; Staller 1965b). Equipment investment is reported in the same sources for up to 1965 (Czirják 1968; Holesovsky 1969; Korbonski et al. 1973; Staller 1965a). For the period 1965-1990, we derive indexes of equipment investment by decomposing data on the domestic final use of gross product (Alton et al. 1991a; Alton et al. 1985a). Here, we explain in detail how each subcomponent is estimated in the sources that we used.

Construction investment: is defined as the gross output of the construction industry, which for the economy as a whole is assumed to equal the total value of investments in new buildings and repairs on existing structures. Construction output, in turn, is taken to evolve according to the availability of construction materials. The sources make two critical assumptions, namely that both the value-added ratio and the share of material waste in the building trades remained constant over time. The weights of construction investment in GDP in the benchmarks are established as the sum of industry value-added and of material purchases from other sectors using official prices.

Equipment investment: until 1965 calculated by constructing and index of machinery available for domestic investment purposes. The Research Project built this index from disaggregated data on industrial production that it had complied and later published in other papers. Items believed to be used as consumer durables, such as bicycles, motorcycles, and all communications equipment, were excluded from the product sample. The index of machinery output was constructed from five aggregate production indexes for machine tools, agricultural machinery, prime movers and other equipment, transport vehicles, and electrical instruments incl. power generating equipment. To arrive at domestic availability, output was adjusted for net imports from official foreign-trade statistics. Values in foreign-exchange currencies were converted into domestic producer prices using a basket of goods that were included in the production indexes and were listed in both domestic and international prices in official sources. Adjustments were made for net foreign investment, whenever possible, but the ratio of these transfers to total investments was found to be small. Official data indicated inventories to be highly volatile, and thus changes in inventories were assumed to be random.

Fixed-capital investment: up to 1965 was computed by the Research Project from the index of construction and equipment investment, weighted by using current prices for machinery items from official sources. Thereafter, we derived investment from total domestic absorption. The research project reported indexes of three final-use components: personal household consumption, government services, and a residual composed of gross investment, R&D expenditure and defence spending. We constructed a provisional index of gross investment by subtracting from residual final use the indexes on defence and R&D spending. We assume inventories to be random and, therefore, that fixed-capital investment evolved according to gross investment. We finally subtract from this provisional index the construction index to arrive at investment in machinery.

> *Indexes of final-use subcomponents*: The index of personal consumption was constructed by aggregating indexes for several categories of consumer goods and services using official data from representative consumer surveys. Indexes of public consumption, disaggregated into administration and justice, health care, education, and social services, were the same as indexes for government services in the computation of GNP by sector of origin of product. These indexes, in turn, were

derived from employment data, weighted using both wage returns and the value of materials and services purchased from other sectors of the economy.

*Index of R&D expenditure*: The occasional papers on GNP by sector of origin also report indexes for science and research, using the same approach as for other government services. We establish the weight of total R&D spending in GDP from official data in the benchmark years that the Research Project used in the construction of indexes on final use.

*Index of military spending:* The Research Project collected data on defence expenditures in East Central Europe (Alton et al. 1985b). Based on this work, they established an index of military services in the occasional papers on GNP by sector of origin. As opposed to other government services, this index was based both on personnel and purchases of goods and services. Spending levels are similar to what we could derive from Crane (1988) up to 1984. We adhered to the Research Project data for three reasons: (i) consistency with the sources on other indexes, (ii) the lack of an appropriate prices index to deflate the constant-price estimates of Crane, and (iii) that these data suggest the largest drop (in Poland the slowest rise) in military spending over time, which makes us, if anything, overestimate investment growth and within that the share of equipment investment. The take the weight of defence expenditure in GDP from cross-country data published by SIPRI.

## APPENDIX 2: NEW ESTIMATES FOR INVESTMENT AND CAPITAL STOCK

TABLE A2.1
GROSS INVESTMENT AND GROSS CAPITAL STOCK IN CZECHOSLOVAKIA, 1948-1990
(BILLION 1990 KROWNS)

| | Investment | | Capital Stock | | | |
|---|---|---|---|---|---|---|
| | Equipment | Structures | Equipment | Structures | Total | Index |
| 1948 | 9.5 | 26.5 | 168.8 | 575.6 | 744.5 | 96.0 |
| 1949 | 8.6 | 26.0 | 167.3 | 590.1 | 757.4 | 97.6 |
| 1950 | 10.8 | 29.3 | 168.1 | 607.6 | 775.7 | 100.0 |
| 1951 | 11.8 | 30.3 | 169.8 | 625.7 | 795.5 | 102.6 |
| 1952 | 10.2 | 33.9 | 169.8 | 647.1 | 816.9 | 105.3 |
| 1953 | 9.9 | 35.2 | 169.5 | 669.4 | 838.8 | 108.1 |
| 1954 | 10.1 | 36.5 | 169.4 | 692.4 | 861.8 | 111.1 |
| 1955 | 11.9 | 41.3 | 171.1 | 719.9 | 891.0 | 114.9 |
| 1956 | 13.6 | 45.7 | 174.4 | 751.2 | 925.6 | 119.3 |
| 1957 | 16.0 | 49.3 | 179.9 | 785.5 | 965.4 | 124.5 |
| 1958 | 18.4 | 53.4 | 187.5 | 823.2 | 1,010.7 | 130.3 |
| 1959 | 19.9 | 58.9 | 196.2 | 865.7 | 1,061.9 | 136.9 |
| 1960 | 22.6 | 61.1 | 207.0 | 909.4 | 1,116.4 | 143.9 |
| 1961 | 23.3 | 60.9 | 217.9 | 952.2 | 1,170.1 | 150.9 |
| 1962 | 23.4 | 60.7 | 228.2 | 993.8 | 1,222.0 | 157.5 |
| 1963 | 23.1 | 54.8 | 237.6 | 1,028.8 | 1,266.3 | 163.3 |
| 1964 | 22.0 | 58.2 | 245.4 | 1,066.3 | 1,311.7 | 169.1 |
| 1965 | 25.3 | 60.7 | 255.9 | 1,105.7 | 1,361.6 | 175.5 |
| 1966 | 25.4 | 64.0 | 265.9 | 1,147.6 | 1,413.6 | 182.2 |
| 1967 | 28.3 | 67.2 | 278.3 | 1,191.9 | 1,470.2 | 189.5 |
| 1968 | 31.1 | 68.3 | 292.7 | 1,236.4 | 1,529.1 | 197.1 |
| 1969 | 36.0 | 66.6 | 306.7 | 1,272.1 | 1,578.8 | 203.5 |
| 1970 | 38.1 | 71.4 | 321.8 | 1,311.6 | 1,633.4 | 210.6 |
| 1971 | 38.6 | 76.3 | 336.3 | 1,355.1 | 1,691.4 | 218.1 |
| 1972 | 38.6 | 78.6 | 349.6 | 1,399.8 | 1,749.4 | 225.5 |
| 1973 | 42.6 | 80.1 | 366.0 | 1,444.9 | 1,810.9 | 233.5 |
| 1974 | 42.2 | 83.4 | 380.7 | 1,492.1 | 1,872.9 | 241.5 |
| 1975 | 47.5 | 86.5 | 399.7 | 1,541.3 | 1,941.0 | 250.2 |
| 1976 | 51.2 | 89.0 | 421.0 | 1,591.8 | 2,012.8 | 259.5 |
| 1977 | 51.6 | 90.3 | 441.0 | 1,642.3 | 2,083.3 | 268.6 |
| 1978 | 47.2 | 92.0 | 455.1 | 1,693.3 | 2,148.4 | 277.0 |
| 1979 | 45.8 | 92.5 | 466.8 | 1,743.5 | 2,210.3 | 284.9 |
| 1980 | 40.7 | 93.4 | 472.5 | 1,793.3 | 2,265.8 | 292.1 |
| 1981 | 38.1 | 93.3 | 475.2 | 1,841.8 | 2,316.9 | 298.7 |
| 1982 | 32.6 | 90.6 | 472.2 | 1,886.4 | 2,358.5 | 304.1 |
| 1983 | 30.4 | 90.2 | 467.2 | 1,929.4 | 2,396.6 | 309.0 |
| 1984 | 27.4 | 89.9 | 459.5 | 1,971.1 | 2,430.6 | 313.4 |
| 1985 | 32.6 | 89.5 | 457.7 | 2,011.3 | 2,469.0 | 318.3 |
| 1986 | 38.6 | 90.4 | 462.0 | 2,051.4 | 2,513.4 | 324.0 |
| 1987 | 44.9 | 91.7 | 472.2 | 2,091.8 | 2,564.0 | 330.6 |
| 1988 | 46.6 | 93.1 | 483.4 | 2,132.6 | 2,616.0 | 337.3 |
| 1989 | 50.1 | 92.6 | 497.3 | 2,171.9 | 2,669.2 | 344.1 |
| 1990 | 47.0 | 88.0 | 507.0 | 2,205.6 | 2,712.6 | 349.7 |

*Sources and methods:* See text and footnotes in the section 'Data and Methodology'.

TABLE A2.2
GROSS INVESTMENT AND GROSS CAPITAL STOCK IN HUNGARY, 1949-1990
(BILLION 1990 FORINTS)

| | Investment | | Capital Stock | | | |
|---|---|---|---|---|---|---|
| | Equipment | Structures | Equipment | Structures | Total | Index |
| 1949 | 14.7 | 30.3 | 93.4 | 1,125.7 | 1,219.1 | 97.5 |
| 1950 | 19.1 | 40.0 | 106.9 | 1,143.2 | 1,250.1 | 100.0 |
| 1951 | 24.9 | 44.3 | 125.3 | 1,164.6 | 1,290.0 | 103.2 |
| 1952 | 33.0 | 48.9 | 150.8 | 1,190.2 | 1,341.1 | 107.3 |
| 1953 | 31.3 | 52.3 | 173.1 | 1,218.7 | 1,391.9 | 111.3 |
| 1954 | 27.9 | 45.5 | 190.6 | 1,239.9 | 1,430.5 | 114.4 |
| 1955 | 26.7 | 50.7 | 205.9 | 1,265.8 | 1,471.7 | 117.7 |
| 1956 | 26.0 | 47.6 | 219.6 | 1,288.1 | 1,507.7 | 120.6 |
| 1957 | 24.4 | 56.0 | 230.8 | 1,318.4 | 1,549.2 | 123.9 |
| 1958 | 24.3 | 59.8 | 241.3 | 1,351.8 | 1,593.0 | 127.4 |
| 1959 | 32.9 | 68.5 | 259.7 | 1,393.2 | 1,652.9 | 132.2 |
| 1960 | 35.3 | 75.3 | 279.4 | 1,440.6 | 1,720.0 | 137.6 |
| 1961 | 34.8 | 77.7 | 297.5 | 1,489.5 | 1,786.9 | 142.9 |
| 1962 | 41.4 | 80.5 | 321.1 | 1,540.2 | 1,861.2 | 148.9 |
| 1963 | 42.5 | 81.4 | 344.3 | 1,590.8 | 1,935.1 | 154.8 |
| 1964 | 43.6 | 87.9 | 367.3 | 1,646.9 | 2,014.2 | 161.1 |
| 1965 | 44.9 | 92.0 | 390.1 | 1,705.9 | 2,096.0 | 167.7 |
| 1966 | 45.4 | 92.4 | 412.1 | 1,764.2 | 2,176.4 | 174.1 |
| 1967 | 51.1 | 99.0 | 438.5 | 1,828.0 | 2,266.5 | 181.3 |
| 1968 | 60.5 | 115.2 | 472.7 | 1,906.6 | 2,379.3 | 190.3 |
| 1969 | 63.8 | 116.3 | 501.0 | 1,975.2 | 2,476.3 | 198.1 |
| 1970 | 61.6 | 126.1 | 525.0 | 2,051.9 | 2,576.9 | 206.1 |
| 1971 | 63.3 | 135.2 | 548.9 | 2,135.8 | 2,684.7 | 214.8 |
| 1972 | 61.7 | 135.4 | 569.5 | 2,217.8 | 2,787.3 | 223.0 |
| 1973 | 60.1 | 139.1 | 586.8 | 2,301.4 | 2,888.2 | 231.0 |
| 1974 | 55.5 | 146.1 | 598.3 | 2,390.0 | 2,988.3 | 239.0 |
| 1975 | 60.3 | 149.0 | 613.7 | 2,479.3 | 3,092.9 | 247.4 |
| 1976 | 58.6 | 151.3 | 626.2 | 2,568.5 | 3,194.8 | 255.6 |
| 1977 | 63.8 | 156.2 | 643.1 | 2,660.5 | 3,303.6 | 264.3 |
| 1978 | 61.0 | 163.3 | 655.8 | 2,757.3 | 3,413.2 | 273.0 |
| 1979 | 59.6 | 160.2 | 666.3 | 2,848.6 | 3,514.9 | 281.2 |
| 1980 | 51.3 | 152.6 | 667.6 | 2,930.0 | 3,597.6 | 287.8 |
| 1981 | 49.9 | 148.1 | 667.4 | 3,004.9 | 3,672.3 | 293.8 |
| 1982 | 45.7 | 144.1 | 663.0 | 3,073.9 | 3,736.9 | 298.9 |
| 1983 | 42.3 | 144.0 | 655.6 | 3,141.0 | 3,796.6 | 303.7 |
| 1984 | 37.0 | 138.9 | 643.5 | 3,201.4 | 3,844.8 | 307.6 |
| 1985 | 42.9 | 125.0 | 638.1 | 3,246.4 | 3,884.5 | 310.7 |
| 1986 | 40.4 | 127.0 | 630.7 | 3,292.2 | 3,922.9 | 313.8 |
| 1987 | 41.5 | 131.9 | 624.9 | 3,341.8 | 3,966.6 | 317.3 |
| 1988 | 44.7 | 123.7 | 622.7 | 3,381.9 | 4,004.7 | 320.4 |
| 1989 | 43.3 | 125.0 | 619.4 | 3,422.4 | 4,041.8 | 323.3 |
| 1990 | 42.7 | 112.5 | 615.6 | 3,449.4 | 4,064.9 | 325.2 |

*Sources and methods:* See text and footnotes in the section 'Data and Methodology'.

TABLE A2.3
GROSS INVESTMENT AND GROSS CAPITAL STOCK IN POLAND, 1946-1990
(BILLION 1971 ZŁOTYS)

| | Investment | | Capital Stock | | | |
|---|---|---|---|---|---|---|
| | Equipment | Structures | Equipment | Structures | Total | Index |
| 1946 | 2.1 | 10.5 | 128.5 | 1,263.2 | 1,391.7 | 102.5 |
| 1947 | 4.1 | 14.2 | 124.9 | 1,252.1 | 1,377.1 | 101.4 |
| 1948 | 6.1 | 15.9 | 123.6 | 1,242.9 | 1,366.5 | 100.6 |
| 1949 | 8.3 | 18.2 | 124.5 | 1,236.3 | 1,360.8 | 100.2 |
| 1950 | 10.9 | 18.5 | 127.9 | 1,230.1 | 1,357.9 | 100.0 |
| 1951 | 12.2 | 20.9 | 132.4 | 1,226.4 | 1,358.8 | 100.1 |
| 1952 | 13.2 | 22.4 | 137.7 | 1,224.3 | 1,361.9 | 100.3 |
| 1953 | 14.8 | 26.3 | 144.1 | 1,226.1 | 1,370.3 | 100.9 |
| 1954 | 15.5 | 30.9 | 151.0 | 1,232.5 | 1,383.5 | 101.9 |
| 1955 | 16.4 | 31.2 | 158.4 | 1,239.0 | 1,397.4 | 102.9 |
| 1956 | 15.9 | 33.3 | 164.8 | 1,247.5 | 1,412.3 | 104.0 |
| 1957 | 15.9 | 34.4 | 170.8 | 1,256.9 | 1,427.7 | 105.1 |
| 1958 | 16.5 | 36.0 | 177.0 | 1,267.8 | 1,444.9 | 106.4 |
| 1959 | 18.8 | 39.4 | 185.3 | 1,281.9 | 1,467.1 | 108.0 |
| 1960 | 21.2 | 40.6 | 195.3 | 1,296.8 | 1,492.1 | 109.9 |
| 1961 | 23.4 | 41.6 | 207.0 | 1,312.5 | 1,519.5 | 111.9 |
| 1962 | 27.2 | 42.8 | 221.8 | 1,329.0 | 1,550.8 | 114.2 |
| 1963 | 29.0 | 42.9 | 237.5 | 1,345.3 | 1,582.8 | 116.6 |
| 1964 | 29.0 | 45.5 | 252.2 | 1,363.9 | 1,616.1 | 119.0 |
| 1965 | 33.2 | 48.4 | 270.3 | 1,385.0 | 1,655.3 | 121.9 |
| 1966 | 36.0 | 51.1 | 290.1 | 1,408.4 | 1,698.6 | 125.1 |
| 1967 | 39.5 | 55.5 | 312.2 | 1,435.7 | 1,747.9 | 128.7 |
| 1968 | 38.8 | 60.2 | 332.2 | 1,467.2 | 1,799.5 | 132.5 |
| 1969 | 40.1 | 64.9 | 352.4 | 1,502.8 | 1,855.2 | 136.6 |
| 1970 | 45.9 | 70.0 | 377.1 | 1,542.8 | 1,919.9 | 141.4 |
| 1971 | 52.6 | 75.7 | 407.1 | 1,587.6 | 1,994.7 | 146.9 |
| 1972 | 71.9 | 82.3 | 448.5 | 1,630.2 | 2,078.6 | 153.1 |
| 1973 | 83.5 | 99.0 | 498.3 | 1,688.4 | 2,186.8 | 161.0 |
| 1974 | 91.2 | 112.3 | 552.1 | 1,758.5 | 2,310.6 | 170.2 |
| 1975 | 97.4 | 119.5 | 608.1 | 1,834.0 | 2,442.1 | 179.8 |
| 1976 | 96.3 | 126.2 | 658.8 | 1,914.4 | 2,573.2 | 189.5 |
| 1977 | 96.3 | 125.7 | 705.7 | 1,992.2 | 2,697.9 | 198.7 |
| 1978 | 92.7 | 125.1 | 745.4 | 2,067.6 | 2,813.0 | 207.2 |
| 1979 | 83.8 | 119.3 | 773.3 | 2,135.1 | 2,908.4 | 214.2 |
| 1980 | 72.1 | 113.4 | 787.4 | 2,195.2 | 2,982.6 | 219.6 |
| 1981 | 70.0 | 95.6 | 798.3 | 2,235.9 | 3,034.2 | 223.4 |
| 1982 | 61.9 | 85.3 | 800.3 | 2,265.3 | 3,065.6 | 225.8 |
| 1983 | 62.1 | 90.7 | 802.4 | 2,299.4 | 3,101.8 | 228.4 |
| 1984 | 62.4 | 92.0 | 804.7 | 2,333.9 | 3,138.6 | 231.1 |
| 1985 | 68.8 | 89.6 | 813.1 | 2,365.2 | 3,178.3 | 234.1 |
| 1986 | 64.8 | 91.5 | 816.9 | 2,397.6 | 3,214.5 | 236.7 |
| 1987 | 60.7 | 93.1 | 816.4 | 2,430.8 | 3,247.1 | 239.1 |
| 1988 | 50.2 | 93.6 | 805.3 | 2,463.6 | 3,268.9 | 240.7 |
| 1989 | 42.5 | 89.9 | 787.4 | 2,491.9 | 3,279.3 | 241.5 |
| 1990 | 35.2 | 79.0 | 763.5 | 2,508.5 | 3,272.1 | 241.0 |

*Sources and methods:* See text and footnotes in the section 'Data and Methodology'.

## APPENDIX 3: ROBUSTNESS CHECKS

Table 3.1 reports robustness checks for our estimation of capital accumulation. The baseline assumptions are explained in the main text in section III. The annual average rates of net capital formation are those reported in Table 1. We run two robustness checks. Firstly, we assume different depreciation patterns for both equipment and structures. Hulten and Wykoff (1981) estimated the values of parameter X econometrically to average 1.65 for equipment and 0.91 for buildings, which have been used in empirical studies and recently in the historical growth accounts of Spain by Prados de la Escosura and Roses (2010). In the article, we use a 'more linear' depreciation because shortage economies are characterised with capital hoarding, meaning that firms keep some of their new equipment in storage, where they are not worn out as fast as they would in production. The net to gross capital stock ratio in the benchmark year is adjusted accordingly. Since these values deviate proportionally the same from our assumptions for both type of assets but in opposite directions, the combined effect on the annual rates of capital accumulation is minimal and depends on the share of each asset type in the total capital stock. Secondly, we assume that the typical service life for structures remained constant over time despite the inter-temporal changes in the composition of the stock of buildings. Assuming constant service life of 50 years results in lower depreciation rates and thus faster growth in structures in the second half of the period under investigation, but the rates of net capital formation do not differ substantially from our baseline estimates.

Table 3.1. Annual rates (log %) of capital accumulation using alternative depreciation rates

| | 1950s | 1960s | 1970s | 1980s |
|---|---|---|---|---|
| | | *Czechoslovakia* | | |
| Baseline | 3.6 | 3.8 | 3.3 | 1.8 |
| Alternative patterns | 3.2 | 3.5 | 3.1 | 1.8 |
| Longer service life | 3.6 | 3.9 | 3.5 | 2.0 |
| | | *Hungary* | | |
| Baseline | 3.2 | 4.0 | 3.4 | 1.3 |
| Alternative patterns | 3.1 | 4.2 | 3.6 | 1.5 |
| Longer service life | 3.2 | 4.1 | 3.6 | 1.6 |
| | | *Poland* | | |
| Baseline | 0.9 | 2.5 | 4.4 | 1.1 |
| Alternative patterns | 0.9 | 2.5 | 4.4 | 1.1 |
| Longer service life | 0.9 | 2.5 | 4.7 | 1.3 |

Baseline: T = 20-25 years for equipment, 40-50 years for buildings; X = 1.5 for equipment, 1 for buildings
Alternative patterns: X = 1.65 for equipment, 0.91 for buildings; T as in Baseline
Longer service life: 50 for buildings constant over time; all else as in Baseline

Table 3.2 reports robustness checks for our estimates of TFP growth from Table 3. Two sets of alternative rates of productivity growth are derived from lower-bound and upper-bound assumptions for the share of capital in national income, or the elasticity of output with respect to capital. In the main text, we proposed an elasticity of $\alpha = 0.4$, following Easterly and Fischer (1995), but in centrally planned economies factor shares are arbitrary. They cannot be accurately estimated from factor incomes, since factor prices do not necessarily reflect true factor costs. In other words, factors are not necessarily paid their marginal product. Therefore, it is appropriate to provide estimates for TFP growth using a wider range of plausible values for the share of capital.

Table 3.2. Annual rates of TFP growth using alternative factor shares (log %)

| | 1950s | 1960s | 1970s | 1980s |
|---|---|---|---|---|
| | | *Czechoslovakia* | | |
| $\alpha = 0.3$ | 3.2 | 1.6 | 1.2 | 0.6 |
| $\alpha = 0.5$ | 2.5 | 0.9 | 0.7 | 0.3 |
| | | *Hungary* | | |
| $\alpha = 0.3$ | 2.6 | 2.8 | 1.5 | 1.6 |
| $\alpha = 0.5$ | 2.3 | 2.1 | 0.8 | 1.0 |
| | | *Poland* | | |
| $\alpha = 0.3$ | 2.9 | 1.9 | 1.6 | 1.4 |
| $\alpha = 0.5$ | 3.1 | 1.8 | 0.9 | 0.9 |

*Note:* $\alpha$ is the elasticity of output with respect to capital, or the share of capital in national income.