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Capital Utilisation, Output, and Total Factor Productivity in Polish Industry 1990-1993

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Abstract

The economies of Central and Eastern Europe are undergoing a period of rapid structural change. The general pattern confirms to the J-curve anticipated by several observers at the start of transition. This paper conceptualises the J-curve as the result of a combination of two factors. First, real energy price increases render parts of the capital stock obsolete, due to complementarity between capital and energy in the short run. Second, demand shifts and to a lesser extent efficiency improvements induced by increases in competition cause dramatic changes in total factor productivity. The paper shows for the case of Polish industry that 43 per cent of the capital stock was rendered obsolete over the 1990-1993 period. Total factor productivity fell by 11 per cent in 1990 but had increased to 17 per cent above the 1989 level by 1993. As the capital stock is gradually rebuilt, improvements in efficiency will guarantee an output level higher than before the start of transition.

KEYWORDS: capital ultilisation, efficiency, J-curve, Poland

E22, E32, P47

MAKING SENSE OF THE J-CURVE: Capital Utilisation, Output, and Total Factor Productivity in Polish Industry 1990-1993[1]

Introduction:

The economies of Central and Eastern Europe are undergoing a period of rapid structural change. Spurred by shifts in relative prices after the broad based liberalisation of economic activities, production structures are being rebuilt to become more in line with the region's comparative advantage. In the more advanced countries of Central and Eastern Europe, this process is accompanied by economic recovery after the unprecedented falls in output at the start of economic transition. Within the industrial sector, one of the central determinants and vital elements of this process of real adjustment are improvements in energy efficiency induced by the dramatic increase in real energy prices, particularly in those countries previously dependent on cheap imports of Soviet oil and gas.

The above picture generally confirms to the J-curve pattern anticipated by several observers at the start of economic reforms (Gomulka, 1991; Siebert, 1991; Van Long and Siebert, 1992). Thus it was argued that, due to shifts in relative prices (e.g. an increase in real energy prices), existing production lines may no longer operate profitably. With capital fixity in the short run, a relative price shock would render parts of the industrial capital stock obsolete, causing an initial decline in output.[2] Over time, investment in new activities would take place and

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[2] In Van Long and Siebert (1992), the relative price shock is modeled as a change in output prices. The effect on the capital stock in any given enterprise runs via a reduction in the discounted value of future profits, due to lower output price. The same effect can, however, be obtained through an increase in input prices relative to output price. This interpretation of the J-curve is chosen here because it seems more in accordance with the overall decline in output in industry in all Central and Eastern European economies.

overall efficiency and welfare would be enhanced because market prices reflect true economic scarcities. The J-curve interpretation of output developments in Central and Eastern Europe has, however, been subject to repeated criticism (e.g. Brada and King, 1992; Hare and Hughes, 1992). The most prominent critique has come from Keynesians who make excessive stabilisation and the breakdown of CMEA markets responsible for the fall in aggregate demand and hence output. Recovery in this scenario depends on the relaxation of macroeconomic policies and favourable external demand stimuli.[3]

Empirically, this debate centers around two issues. First, Hare and Hughes (1992) have shown for a number of former socialist countries that there is no systematic relationship between output declines in various branches of industry and an indicator of competitiveness at international prices, as would be expected if relative price changes were the cause of the transformation crisis. Second, Berg (1995) has studied inventory data for the Polish case to show that demand declined ahead of output, as inventories of unsold products initially piled up. This paper takes up both issues and presents a new attempt to substantiate the J-curve argument.

Our approach follows the idea that the rise in real energy prices is the crucial catalyst of real adjustment in Central and Eastern Europe. Indeed, the region's inefficiency in the use of energy prior to 1990 is widely documented (e.g. Moroney, 1992) and the underpricing of energy is one of the central determinants of the degree of competitiveness at international prices as calculated by Hare and Hughes. This approach suggests an analytical parallel to the literature on the causes of the productivity decline in market economies after two oil price shocks. In this literature, the assumption of complementarity between energy and physical

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[3] There are a number of alternative interpretations of the output decline, including Calvo and Coricelli's (1992) „credit crunch" hypothesis and the institutional interpretation proposed by Murrell (1992) and Schmieding (1993) among others.

capital in the short run (putty-clay technology) has been used to derive measures of capital utilisation as a direct function of changes in real energy prices (Berndt and Wood, 1986; 1987). Specifically, in Berndt and Wood's model a rise in the price of energy relative to the price of physical capital leads to a reduction in the utilisation of energy inefficient capital vintages and consequently a lower value of capital services in the production process. The conclusion most relevant in our context is that output may decline independently of the energy intensity of production under the assumption of putty-clay technology. For the case of Polish industry, we show that capital utilisation declined by between 10 and 45 per cent during 1990-1993, depending on the empirical assumptions needed to make the model operational. Based on a comparison with changes in electricity consumption, we consider a reduction in capital utilisation of 30 per cent over 1990-1993 as our most plausible estimate. This implies that a reduction in capital inputs due to relative price changes can account for 45 per cent of the decline in output in 1990. The remainder is attributed to changes in labour inputs (12 per cent) and changes in total factor productivity (TFP; 43 per cent).

An analysis of the TFP residual also provides the basis for clarifying the second empirical issue, raised by Berg's review of inventory behaviour. The dominance of supply versus demand factors in the behaviour of TFP has been widely studied in empirical tests of real business cycle models (Shapiro, 1987; Hall, 1988; Roeger, 1995). We show for the case of Polish industry that the output based or „primal" measure of TFP is highly correlated with changes in sectoral output and with aggregate GDP over the 1990-1993 period. The correlations to factor and output prices have the wrong sign in 1990 and 1991, while this is reversed in 1992-1993. Finally, indicators of the degree of competition across the 21 sectors of industry are positively related to TFP growth. These results indicate that, once the impact of relative price changes on capital utilisation is accounted for, demand shifts rather than technology shifts are the central determinants of output and TFP in the initial years of transition.[4] The slope of the J-curve in its ascending part is, however, increasingly also influenced by improvements in efficiency.

The paper proceeds as follows. Section 2 briefly reports on the size of the energy price shock for the case of Poland. It also draws the parallel to the oil price shock in Western economies in the 1970s and presents Berndt and Wood's model to account for the evidence. Section 3 derives measures of capital utilisation for Polish industry. Section 4 computes changes in TFP and calculates the contributions of factor inputs and TFP to the 1990 output decline. Section 5 analyses the TFP residual for 1990-1993 at the sectoral level and Section 6 concludes.

Section 2: Energy Prices, Capital Utilisation, and Output Decline in Transition Economies

Energy Prices and the Output Decline in Poland

In January 1990, the Polish government liberalised 90 per cent of all prices at one stroke. Consequently, the producer price index increased by 109 per cent in this month alone and by 193 per cent until the end of the year. In the same month, industrial output fell by over 15 per cent or roughly two thirds of the total decline in this year (Schaffer, 1992). Of all price increases, the highest were recorded in the energy producing sectors, namely 322 per cent, 194 per cent, and 200 per cent in January 1990 in coal, fuel, and power respectively. Over the course of 1990, the real price (deflated by the aggregate industrial price index) of coal increased by 122 per cent, that of fuel by 68 per cent and that of power by 64 per

[4] This does not imply support for Keynesian demand management. Sectoral demand curves may shift as a result of the switch from sellers' to buyers' markets (see Kornai, 1980), as a result of increased search costs for consumers, and due to import competition from the West. We elaborate on this below.

cent. By 1993, real energy prices had increased more than threefold. This makes the energy price shock comparable to the combined impact of the first and second oil price shocks for the US economy, where real energy prices increased by 3.6 time between 1970 and 1981 (Berndt and Wood, 1986).

The large increase in real energy prices has prompted a number of authors to seek for parallels in the output decline following price liberalisation in Central and Eastern Europe and the productivity slowdown observed in most industrialised countries during the 1970s and 1980s. Intuitively, it is plausible to expect a large increase in marginal cost and a reduction in energy inputs as a consequence of energy price increases, both of which would reduce the cost minimising output level (see e.g. Moroney, 1992). However, as noted in the introduction, one of the empirical puzzles associated with an interpretation of the transition crisis in terms of energy price increases is the lack of a correlation between sectoral output declines and energy intensity (Hare and Hughes, 1992; Borenzstein and Ostry, 1992). Figure 1 reports such a correlation of sectoral output declines in 1990 against the share of energy in gross output for the case of Poland. No clear pattern may be detected. At the same time, the share of energy in gross output in 1990 did not exceed 4 per cent for industry as a whole (GUSa, 1991, pp. 84).

What has been neglected in this discussion is the fact that exactly the same puzzle has beset students of the productivity decline in the West. Not only was energy's cost share in Western market economies similarly low, but the functional assumptions on which existing predictions concerning the impact of changes in energy prices rested did not hold empirically.[5] Berndt and Wood (1986; 1987)

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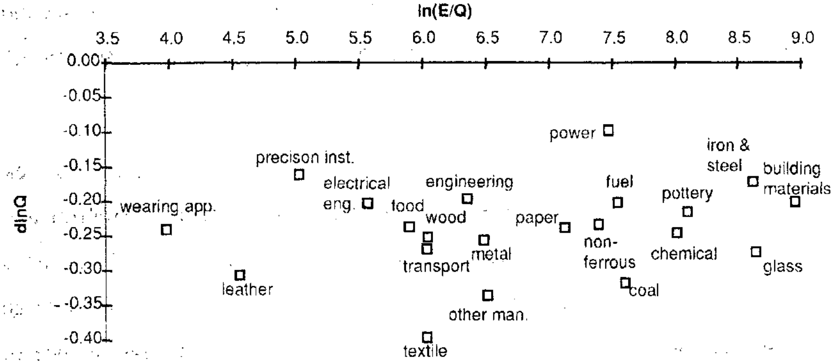
[5] Specifically, the assumed correlation of output declines with the energy intensity of production stems from a Cobb Douglas framework where the contribution of energy to output is exactly equal to its cost share. Berndt and Wood (1986) show that the assumption of substitutability underlying the Cobb Douglas function does not hold empirically, at least in the short run.

Figure 1 – Output Decline 1990 and Energy Intensity, 21 Subsectors of Polish Industry



Source: dlnQ, Q: GUSa, 1992, pp. 18; Energy consumption (E) in tetracalories, GUSa, 1991, pp. 120.

have addressed both issues and presented a model built on capital energy complementarity that allows for a large impact of energy prices on output through changes in capital utilisation. This feature and its empirical tractability suggest an application of the model to the case of a transition economy as one possibility to estimate the degree to which the industrial capital stock might have been rendered obsolete by relative price changes.

Berndt and Wood's Model

The basic argument of Berndt and Wood runs as follows. Assume production is characterised by putty-clay technology in the short run. Thus, there are no substitution possibilities between energy and capital for any capital stock of a given vintage.[6] However, in deciding what kind of capital to invest, a producer

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[6] This assumption is supported in Berndt and Wood (1986) with estimates of a short run own price elasticity of energy demand of only -0.08 for the US and the UK economies. For the case of Poland, a pooled cross sectoral estimate of energy demand for the 1989-1993 period yields a similarly low own price elasticity: (Heteroscedastictiy consistent t-ratios are given

takes into account expected relative prices of energy and capital. The ex ante long run substitution elasticity between energy and capital is thus positive. Other factors of production are assumed to be substitutable in the short run.[7] At any time, the firm will operate with various capital vintages which have a different level of embodied energy efficiency. Berndt and Wood now posit that the firm equates the shadow values of capital inputs across all vintages.[8] This is done by lowering the utilisation of vintages that were bought under the assumption of lower real energy prices, i.e. more energy using capital inputs will be worked less extensively than recently acquired vintages after the price of energy has gone up. relative to that of capital. The authors show (for the constant elasticity of substitution (CES) production function) that, as a result, the elasticity of the utilisation rate of the aggregate capital stock with respect to energy prices will be equal to the negative of the ex ante substitution elasticity between energy and capital. Therefore, the higher the substitution elasticity, the lower the utilisation of capital following an unexpected energy price shock. Empirically, this implies that one can estimate the rate of utilisation of the capital stock directly from information on relative prices, using a microeconomic framework consistent with cost minimisation (see also Morrison, 1992).

$\ln(E/L) = \underset{(2.34)}{-0.09}\ln(PE/PY) + \underset{(6.85)}{0.26}\ln(Q/L) + \underset{(0.66)}{0.002}\,\text{trend};\ R^2 = 0.33$ in parentheses), where E/L is energy per worker, Q/L is gross output per worker, PE/PY is the relative price of energy inputs (for computation see below) to sectoral output prices. The model was estimated allowing for fixed effects across sectors, the time trend (t=1,...,5) was included to ensure stationarity of the exogenous variables.

7 This assumption is crucial for the analysis that follows. If labour inputs are considered fixed in the short run and capital is the limitational factor in production, then there is a directly proportional impact of falling capital utilisation on output. The Economist (11 November, 1995) for instance uses electricity consumption as a proxy for the decline in GDP in Central and Eastern Europe. However, in the face of substantial labour hoarding prior to the start of transition and bearing in mind the remarkable downward flexibility of real wages, the assumption of substitutability between capital and labour does not seem unrealistic.

8 This assumption is indispensable if an aggregate estimate of the value of capital services is to be obtained using Hicksian aggregation. For a different solution to the aggregation problem, see e.g. Atkeson and Kehoe (1994).

Berndt and Wood (1987) compute the effective capital stock by aggregating over vintages and applying a relative vintage specific utilisation rate ($e_{t,t-\tau}$) to the existing capital stock in each year:

1) $$NK_t^* = \sum_{\tau=0}^{\tau} e_{t,t-\tau} * (1-\delta)^{\tau} * I_{t-\tau}$$

NK_t^* adjusted net capital stock

$e_{\tau,\tau-\tau}$ vintage specific relative utilisation rate for all equipment introduced at time t-τ and surviving to time t.

I gross investment at constant prices

δ average annual rate of depreciation

τ lifetime of equipment

t current time

In our case, we cannot aggregate over vintages assuming a constant lifetime of equipment as postulated in Berndt and Wood because of missing capital stock data before the mid-1980s. Instead, we take the real net capital stock in each year as a base, adjust for utilisation, and add real net investment (gross investment minus real depreciation) to arrive at the adjusted net capital stock in the subsequent year:

2) $$NK_t^* = NK_{t-1} * e_{t,t-1} + I_t - \delta NK_{t-1}$$

In Berndt and Wood, the relative utilisation rate is given by the ratio of the utilisation rate of all vintages in place in the preceding year over the utilisation rate of the vintage installed in the current year which in turn is a function of expected relative price changes and the ex ante substitution elasticity:

3) $$e_{t,t-\tau} = \frac{u_{t,t-\tau}}{u_{t,t}} = \left(\frac{PEK_{t-\tau}^*}{PEK_t^*}\right)^{\sigma}$$

$u_{t,t-\tau}$ utilisation rate of capital introduced at time t-τ and surviving to time t

u_t utilisation rate of the most recent vintage

PEK^*_t expected relative price of energy to that of capital at time t (t-τ) respectively

σ ex ante substitution elasticity between energy and capital inputs

Note that the net capital stock in each year will be adjusted for the cumulative impact of relative price changes in all previous years, so that as long as the relative price of energy to capital rises, the effective relative utilisation rate declines. From the adjusted net capital stock thus computed, we can calculate the ratio of utilised to net capital stock, B_t. Our computation starts in 1989, so that by definition the ratio in this year is unity.[9]

$$4)\ B_{t,j} = \frac{NK_{t,j}}{NK_{t,j}}$$

Equation 4) may also be interpreted as a measure of capital obsoleteness under the assumption that the change in relative prices is permanent. The impact on output may be calculated by incorporating Bt as a scalar of capital inputs in the conventional growth accounting framework:

$$5)\ \Delta TFP_{t,j} = \Delta \ln Y_{t,j} - (1-\alpha_j)\left(\Delta \ln NK_{t,j} + \Delta \ln B_t\right) - \alpha_j \Delta \ln L_{t,j}$$

Y a measure of output

L labour inputs

TFP total factor productivity

α the output elasticity of labour

Δ difference operator

j a sectoral subscript

all other variables as defined before.

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9 Potential biases in this starting point are not serious, as we are concerned with changes in capital inputs and not the actual value of the capital stock.

Rearranging equation 5) it may be seen that changes in output can be decomposed into changes in capital and labour inputs, changes in utilisation due to changes in relative energy prices, and changes in total factor productivity. The impact of relative price changes on output is expected to work primarily via a change in B_t. Changes in TFP may include both supply and demand factors and are more closely investigated in Section 5.

Section 3: Estimates of Capital Utilisation for Polish Industry

Turning to the empirical application of this framework, four issues had to be resolved. First, it can be seen from equation 3) that when the ex-ante substitution elasticity between capital and energy is equal to unity, the vintage specific utilisation rate will simply depend on the inverse of the ratio of expected relative prices. Berndt and Wood (1987) present results for three different values of sigma (0.333, 0.667 and 1). Evidently, for a value below unity, the adjustment of capital inputs for a negative energy price shock is lower and, for a given change in output and labour inputs, the change in total factor productivity will be greater. In this paper, we present results for a substitution elasticity of one and 0.667. This is in line with international estimates that show a relatively high substitution elasticity between capital and energy in the long run.

Second, we follow Berndt and Wood (1987, pp. 102) in substituting actual price developments for expected relative prices in equation 3). Alternative expectation formation processes would typically involve forecasts on the basis of historical data which in the case of transition economies with a history of price controls does not seem meaningful. Energy prices were computed as a weighted average of price deflators for six sources of energy (GUSa). Sectoral investment deflators were computed as the ratio of gross investment at current to constant prices (GUSa).

Third, the price of capital is usually given by user costs as:

6) $PK_{t,j} = PI_{t,j} \frac{(i+\delta_j)}{(1-t_j)}$

$PI_{t,j}$ - price deflator of investment goods in sector j.

i – real interest rate

δ_j sector specific depreciation rate

t_j profit tax rate in sector j

In computing user costs according to equation 6) a number of problems had to be solved for the Polish case:

- Capital markets remained segmented in Poland until the banking reform of 1993 (see e.g. Buch, forthcoming) and hence real lending rates are probably not a good measure of the true cost of outside finance. Bond markets are underdeveloped and high and volatile inflation further complicates the calculation of real interest rates. In the face of these problems, we assume that real interest rates were constant over the studied period and given by a social discount factor of 3 per cent per annum. In 1990, close to 90 per cent of industrial production still emanated from the state-owned sector. Given the documented access of state-owned enterprises to credit at preferential conditions at least until recently, it may not be unrealistic to assume no change in the cost of credit (on credit largesse in 1990, see also Raiser, 1993).

- Depreciation rates are also assumed to be constant, in line with the assumptions underlying aggregation over vintages. A constant depreciation rate was computed for each sector as the period average of yearly depreciation rates, 1990-1993. For the years 1992 and 1993 depreciation rates on a sectoral level are given in *Nauka i Technika* (GUSe). For 1990 and 1991, implicit depreciation rates were computed from the difference between gross and net value added at constant prices divided by the net capital stock.

- The tax adjustment factor was computed from sectoral data on effectively paid income taxes and gross profits as published in the *Biuletyn Statystycny* (GUSc). The resulting tax rates are displayed in the Appendix, Table A1. There is a general decline in tax rates, particularly in light industry.

In sum, changes in the price of capital as computed here depend only on the investment goods deflator and changes in sectoral tax rates.

Fourth, Berndt and Wood (1987) suggest to adjust only machinery inputs in the production process for changes in energy prices. In the case of Poland, the share of durable equipment in the total net capital stock fell from 38 per cent in 1989 to 28 per cent in 1990, before rising to 33 per cent in 1993. This share seems unduly small and it may be argued that structures (mainly buildings) could be negatively affected by rising energy prices, too, for instance due to heating costs. We present results for both cases; adjustment of the total net capital stock and of machinery inputs only.[10]

Table 1 presents the ratio of actually utilised capital to the net capital stock, Bt,

Table 1 – Measure of Capital Utilisation, Polish Industry, 1990-93

	1990	1991	1992	1993
Measure:				
B1	0.68	0.55	0.49	0.43
B2	0.90	0.85	0.82	0.78
B3	0.77	0.67	0.62	0.57
B4	0.93	0.89	0.87	0.85
Electricity consumption	0.88	0.82	0.80	0.81

Source: Own calculations.

[10] The distinction is, of course, redundant if only durable equipment counts as capital input into the production process.

for the period of 1989-1993.[11] Four scenarios are distinguished: B1) long run substitution elasticity equals unity and total net capital stock is adjusted for utilisation; B2) long run substitution elasticity equals unity and only machinery inputs are adjusted for utilisation; B3) long run substitution elasticity equals 0.667 and total net capital stock is adjusted for utilisation; B4) long run substitution elasticity equals 0.667 and only machinery inputs are adjusted for utilisation. By assumption, because 1989 is chosen as a base year, the ratio of utilised to net capital is unity in this year in all four cases. The impact of the energy price shock following the liberalisation of prices in January 1990 is clearly evident in Table 1. Utilisation rates fall precipitously in 1990, on average between 32 per cent in scenario a) and 7 per cent in scenario d). Since 1990, utilisation rates have fallen further in all sectors and depending on the assumptions, by 1993 the ratio of utilised to net capital was 43 to 85 per cent. In other words, assuming the new relative price ratios to be permanent, around 17 to 55 per cent of the net capital stock in Polish industry was rendered obsolete by the increase in energy prices.

How plausible are these estimates? One way to check this would be to look at proxies for capital utilisation, such as for instance the consumption of electricity (Costello, 1993). This proxy has the advantage that it is a highly homogenous input and may not be stored. Hence, if capital and energy are complements, electricity consumption might be a relatively reliable measure of capital utilisation. One drawback is that it includes changes in capital utilisation unrelated to relative prices, for instance resulting from changes in aggregate demand. Moreover, a composition effect in total energy consumption could lead to a bias if electricity consumption changes in response to relative energy price changes. According to Meyers et al. (1994) a shift has occurred away from coal towards the use of power as a source energy in Poland since 1989, reflecting the

[11] The computations for the individual sectors appear in Table A2 in the appendix.

much larger increase in coal prices documented above. Bearing these shortcomings in mind, Table 1 also reports indices of electricity consumption for Polish industry over the 1989-1993 period.[12] We can see that in 1990, electricity consumption declined by an average of 12 per cent, putting it between the B2) and the B3) measure of capital utilisation in Table 1 above. In the following analysis, the B3) measure will be adopted as our most plausible estimate, in order to account for the possible upward bias of electricity consumption due to the composition effect, and because we prefer to adjust the net capital stock as a whole and not just the share of durable equipment.

Section 4: Accounting for the Output Decline: The Role of Capital Utilisation and Total Factor Productivity

The preceding section has derived a measure of utilisation adjusted capital stock that may serve as capital input into the calculation of changes in TFP according to equation 5). The other three components needed for the calculation of TFP are a measure of output, a measure of labour inputs, and estimates of the output elasticity of labour. The two factor input production function underlying equation 5) suggests that value added should be used as the measure of output. However, for 1990, data on changes in value added are highly unreliable. We thus prefer to use gross output as our measure of production.[13] With respect to labour inputs, adjustments for working hours and labour quality would be desirable, but cannot be implemented for lack of data at the sectoral level.[14] Labour inputs are

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[12] For sectoral data see Table A3 in the Appendix.

[13] In the sectoral analysis of TFP growth for the US economy, Berndt and Wood (1987) similarly use labour and capital inputs only and gross output as the measure of production. Assuming that the material input intensity of production has remained unchanged and that the production function is weakly separable between material inputs and value added, the changes in real output and real value added should coincide.

[14] Aggregate industrial data suggest that there is no large change in working hours per capita. The index of average employment is 0.95, 0.92, 0.85, and 0.83 from 1990 to 1993, the index of total working hours in industry is 0.95, 0.92, 0.84, and 0.82.

measured by the average number of workers in each sector and year. Finally, output elasticities of labour are measured as labour shares. This implies the assumption of perfect competition on Polish goods markets which is unlikely to hold for the year 1990. Indeed, as Table 2 reveals, labour shares in 1990 were very low on average, suggesting substantial market power in most industries. During 1991-1993, however, labour shares increased to an average level of 0.5 to 0.6. This is much closer to cross-sectional estimates of a combined contribution of human capital and raw labour to output of around 0.7 (e.g. Mankiw, Romer and Weill, 1992). We thus take the average 1991-1993 labour shares as our measure of the contribution of labour to output in calculating TFP growth. Any remaining bias in TFP growth resulting from this approach should be small if changes in capital inputs and labour inputs are positively correlated. An

Table 2 – Labour Shares, 1990-1993, 21 Subsectors of Polish Industry[a]

	1990	1991	1992	1993		1990	1991	1992	1993
Industry	0.31	0.54	0.56	0.56	chemical	0.22	0.44	0.42	0.45
coal	1.68	0.72	1.02	0.88	building mat.	0.29	0.53	0.56	0.56
fuel	0.13	0.28	0.36	0.33	glass	0.39	0.67	0.55	0.69
power	0.22	0.27	0.28	0.32	pottery	0.37	0.68	0.64	0.79
iron and steel	0.21	0.52	0.57	0.60	wood	0.29	0.61	0.56	0.51
non-ferrous metallurgy	0.17	0.36	0.44	0.53	paper	0.25	0.52	0.48	0.53
metal products	0.27	0.56	0.54	0.52	textile	0.51	0.84	0.75	0.77
engineering	0.39	0.65	0.64	0.74	wearing apparel	0.33	0.63	0.56	0.59
precision instr.	0.31	0.66	0.54	0.53	leather	0.40	0.70	0.68	0.73
transport equip.	0.35	0.72	0.67	0.58	food	0.18	0.41	0.46	0.48
electrical engin.	0.34	0.63	0.55	0.53	other manufact.	0.43	0.53	0.51	0.50

[a] Share of total labour costs in gross value added at factor costs.

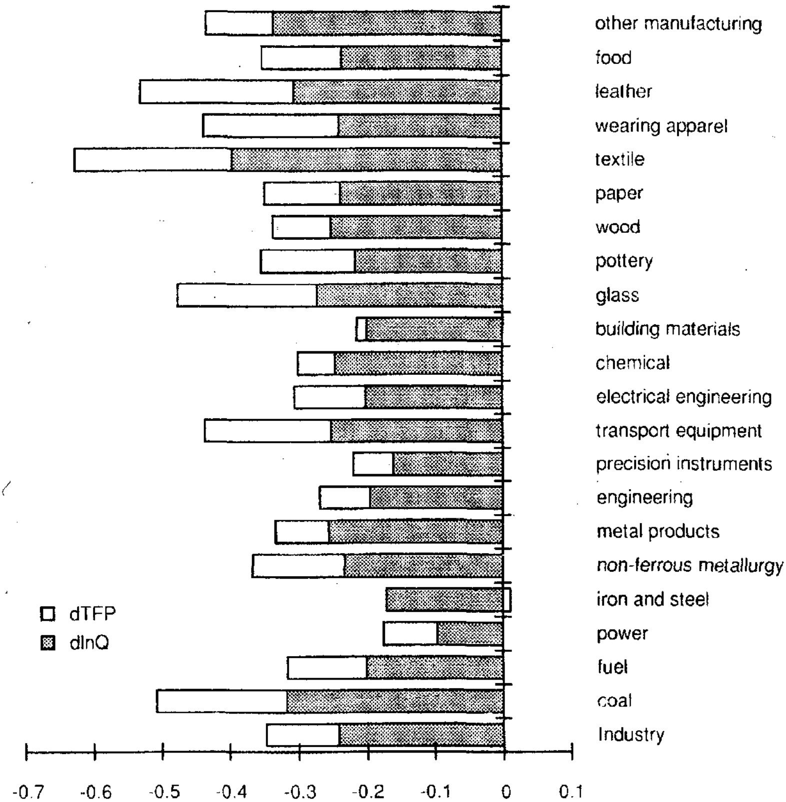
Source: GUSa, own calculations.

underestimate of the output elasticity of labour is then picked up by the capital share which equals one minus the labour share by construction. For the 1991-1993 period, the cross-sectoral correlations of changes in adjusted capital inputs and changes in employment are positive and statistically significant at the 5 per cent level.

Figure 2 displays the changes in output and TFP for industry as a whole and for the 21 sectors in 1990. Generally, the decline in TFP is much less than that in output, confirming the role of relative price changes in the Polish recession of 1990. Nonetheless, changes in TFP are still highly correlated with changes in output, suggesting the existence of a common factor unrelated to relative price changes. Moreover, only in two sectors (iron and steel and building materials) is TFP growth positive or close to zero. Only in these two sectors can the fall in output be fully accounted for by changes in the value of capital and labour services. Thus, while our approach helps to reconcile the expected impact of large changes in energy prices on output with the absence of a correlation of the latter with energy intensity, it also reveals that other factors were at work in causing the transitionary recession. It may be seen from Figure 2 that the decline in TFP is more accentuated in the sectors of light industry, such as textiles, wearing apparel, and leather, and also in transport equipment, glass and coal. This pattern is broadly compatible with a shift in demand away from domestically produced consumer goods and durables in the face of opening the market to foreign competition. The poor performance of the coal industry is a reflection of the composition effect in energy consumption noted before.

Table 3 presents the contributions of changes in factor inputs and TFP to changes in output for the 21 sectors of Polish industry for 1990. The results mirror Figure 2. For industry as a whole, changes in adjusted capital inputs account for 45 per cent of the output decline, reductions in employment for another 12 per cent, and

Figure 2 – Changes in Output and Total Factor Productivity, 21 Sectors of Polish Industry, 1990



Source: GUSa. 1992, pp. 18; own calculations.

Table 3 – The Contribution of Changes in Factor Inputs and Changes in Total Factor Productivity to the Output Decline in Polish Industry

	dlnL	dTFP	dlnNK*		dlnL	dTFP	dlnNK*
Industry	0.12	0.44	0.45	chemical	0.12	0.22	0.66
coal	0.33	0.60	0.07	building mat.	-0.03	0.07	0.96
fuel	0.01	0.57	0.42	glass	0.00	0.74	0.26
power	-0.05	0.81	0.24	pottery	-0.07	0.64	0.43
iron and steel	0.18	-0.06	0.88	wood	0.07	0.34	0.60
non-ferrous metallurgy	0.05	0.58	0.38	paper	0.07	0.47	0.47
metal products	0.09	0.30	0.60	textile	0.19	0.58	0.23
engineering	0.26	0.37	0.37	wearing apparel	0.00	0.82	0.18
precision instrum.	0.11	0.37	0.52	leather	0.15	0.73	0.11
transport equip.	0.13	0.73	0.14	food	0.00	0.49	0.51
electrical engin.	0.07	0.51	0.42	other manufact.	0.22	0.29	0.48

Source: Own Calculations.

the remaining 43 per cent are attributed to a decline in TFP. Again iron and steel and building materials stand out with a share of 88 and 96 per cent of the output decline respectively explained by changes in capital inputs. At the other extreme are those sectors identified above as having recorded large declines in TFP, where reductions in capital inputs explain less than one fifth of the output decline. Employment has been reduced relatively evenly and very moderately across sectors.

If changes in TFP assume such a large role in accounting for the output decline in Polish industry in 1990, an explanation for the behaviour of TFP needs to be provided. This will be attempted below. However, one potential cause shall be presently discarded. It might be argued that the decline in TFP simply results from a misspecification of the production function. We might have failed to consider a factor of production that experienced a large decline in 1990. This omission would thus be reflected in our TFP estimates. For instance, following the credit crunch hypothesis (Calvo and Coricelli, 1992), enterprises in transition economies are dependent on upfront credit for material inputs. The tight monetary policy introduced in Poland in 1990 may have cut existing credit links to the state-owned banks. The resulting reduction in material supplies would have reduced output; the exclusion of material inputs in the production function would mean that this is reflected in a fall of TFP. By implication, the recent increase of TFP (see below) would be due to a relaxation of credit constraints. However, this interpretation is rejected here for a number of reasons. For one, if material inputs are the limitational factor, those sectors producing intermediates should experience a particularly strong fluctuation in output due to credit constraints of their customers, while final producers could smooth out the lack of inputs through inventory dishoarding.[15] In fact, building materials, iron and steel, and power record the lowest declines in output in 1990 and thereafter achieve only slow to moderate recovery (Table 4). Moreover, if credit constraints are the cause of the output decline, then there should be a positive correlation of changes in TFP at the sectoral level to changes in real credit. In fact this correlation is insignificant in 1991-1993.[16]

There are other factors that might have been omitted from our analysis. The most prominent one arguably is the stock of embodied human capital. Thus, due to a sudden change in the institutional environment, managers may face a depreciation of their skills, leading to a reduction in productive efficiency until they have adapted to the rules of market exchange (Bruno, 1992; Schmieding, 1993; Raiser and Nunnenkamp, 1995). It is impossible to directly test for the impact of this factor. In the following, we shall assume that it may be represented as a technology (supply) shock that shifts the production possibility frontier inwards, before gradually pushing in out again as learning processes are initiated. By contrast, in the case of demand shocks, the production possibility frontier remains

15 Note that input inventories in Poland were traditionally very large as a result of the shortage phenomenon (Kornai, 1980).

16 Data on real credit by sector for 1989 and 1990 were unavailable.

fixed but enterprises may temporarily produce off the production frontier. This analytical difference allows us to distinguish between demand and supply factors among the determinants of TFP behaviour in a transition economy both across sectors and over time.

Section 5: What Determines the Behaviour of Total Factor Productivity in Transition?

Table 4 presents indices of TFP (calculated by equation 5) and output for all sectors and for industry as a whole over the 1990-1993 period, starting from a value of 100 in 1989. The most remarkable result is the rapid recovery of TFP in

Table 4 – Output and Total Factor Productivity, 21 Sectors of Polish Industry, 1990-93 (1989=100).

	Output				Total Factor Productivity			
	1990	1991	1992	1993	1990	1991	1992	1993
Industry	75.8	65.0	66.6	74.7	89.4	89.6	102.9	116.6
coal	68.2	67.5	59.2	53.8	81.0	91.3	87.5	93.2
fuel	79.9	67.8	77.6	84.8	88.5	88.1	101.0	94.9
power	90.3	88.6	76.5	73.8	92.1	96.8	86.2	73.7
iron and steel	82.9	56.9	54.6	56.6	101.1	91.4	96.8	111.6
non-ferrous metallurgy	76.7	45.5	40.4	41.8	86.6	69.5	63.1	73.9
metal products	74.4	71.8	78.8	87.3	92.2	104.0	130.6	145.4
engineering	80.4	62.2	46.7	57.8	92.7	89.8	93.5	113.6
precision instruments	83.9	69.3	77.1	98.0	94.1	93.3	125.9	159.1
transport equipment	74.8	49.8	54.9	79.2	81.6	71.4	94.5	122.2
electrical engineering	79.8	64.5	69.3	84.7	89.7	92.7	119.6	140.9
chemical	75.4	65.1	71.5	79.2	94.6	94.9	111.8	124.3
building materials	80.0	77.1	71.8	84.4	98.6	112.3	121.6	142.4
glass	72.7	76.8	80.1	81.1	79.7	91.5	106.7	109.9
pottery	78.4	64.7	61.7	74.2	86.2	89.9	96.0	109.2
wood	74.8	74.9	87.4	100.0	91.5	94.8	119.8	130.4
paper	76.2	72.6	80.4	88.6	88.9	102.9	124.1	131.4
textile	60.4	36.7	36.8	51.8	76.9	78.3	100.2	123.7
wearing apparel	76.0	73.3	87.9	97.4	80.3	84.8	111.6	112.6
leather	69.4	58.3	51.3	47.0	77.6	82.5	98.0	105.6
food	76.3	77.0	79.7	86.1	88.4	88.7	90.6	98.2
other manufacturing	66.4	57.3	79.5	92.4	90.2	95.9	143.9	157.5

Source: GUSa, own calculations.

1992 and 1993, leading the overall industrial index to a value of 116 by 1993. This development coincides closely with industrial output recovery, thereby mirroring the finding of procyclical TFP for Western market economies (Schapiro, 1987). At the same time, Table 4 reveals substantial sectoral variations in economic performance. For instance, metal products or precision instruments record an increase in TFP to a level exceeding the 1989 figure by around one half. By contrast, power and non-ferrous metallurgy by 1993 had not even reached three quarters of the 1989 TFP level. This poses the question whether genuine changes in efficiency (in the sense of shifts of the production possibility frontier) are at the root of TFP behaviour in Poland, or whether it reflects changes in sectoral and aggregate demand.[17]

The behaviour of TFP is at the centre of empirical business cycle models. Real business cycle theorists posit that exogenous shocks to output are always technology shocks. Hence they expect the Solow residual resulting from a simple growth accounting framework such as presented in equation 5) to move procyclically with a measure of output. The overwhelming evidence from Western market economies is that it does. However, critics of real business cycle models have pointed out that such procyclicality of TFP may be due to factors completely independent of technology shocks. A Keynesian interpretation sees output moving procyclically with aggregate demand, while adjustment costs prevent firms from increasing input factors accordingly to meet demand (e.g. Dornbusch and Fischer, 1981; Burnside, Eichenbaum and Rebelo, 1995). Thus, an input based measure of TFP such as given in equation 5) above would also rise procyclically. Hall (1988) expands on this interpretation by arguing that under imperfect competition firms will always choose to keep excess capacity so that

[17] Changes in sectoral demand schedules might arise both from the elimination of previous price and trade distortions and the disappearance of forced substitution, and from different income elasticities of demand across sectors.

marginal cost is below price.[18] Specifically, he derives a formulation of the Solow residual that splits its determinants into a demand factor and a technology factor. This discussion suggests that in distinguishing demand and supply factors in the behaviour of output and total factor productivity in transition economies, the empirical tools of business cycle theorists might present an appropriate point of departure.

Schapiro (1987) has introduced a method to distinguish between supply and demand effects in the behaviour of TFP based on duality theory. He derives a cost based measure of changes in TFP:

7) $\Delta TFPc_t = \alpha(\Delta w_t - \Delta p_t) + (1-\alpha)(\Delta r_t - \Delta p_t)$

TFPc cost based TFP measure
w nominal wage
r user cost of capital (equation 6)
p output price
α Labour share (Table 3)
t time subscript.

Under constant returns to scale and perfect competition, this measure should coincide with the input based measure derived in equation 5). Schapiro's suggestion is to correlate the two measures against each other. The idea is that factor prices reflect the true underlying productivity of all inputs and should be unaffected by short run deviations from the best practise production function in response to demand fluctuations. In other words, while technology shocks that affect the locus of the production possibility frontier have a direct impact on both factor prices and output, demand shocks only affect the latter. As a result, if

18 Enterprise level studies for Poland indicate that both factor hoarding and imperfect competition characterise the operation of Polish state-owned enterprises which until 1993 produced the majority of industrial output (e.g. Belka et al., 1994).

demand shocks predominate as a determinant of TFP, a regression of the input based TFP measure against its cost based dual should yield a coefficient significantly different from unity.

In applying Schapiro's framework, we start with some simple cross-sectional correlations. Table 5 reveals that the input based measure of TFP is positively correlated with sectoral changes in output in all four years, as expected. However, the correlations to real wages and relative prices are insignificant and both have the wrong sign in 1990 and 1991. Negative technology shocks should lead to a reduction in real wages and may cause an increase in price, and therefore the correlation to TFP should be positive and negative respectively. For 1992 and 1993 the correlations do have the right sign, but remain statistically insignificant. This is a first indication that demand factors may overweigh supply factors as determinants of TFP.

The next step is to calculate cost-based measures of TFP, following equation 7). Thereby we can draw on the computations of user costs of capital in Section 2.

Table 5 – Cross-Sectional Correlations of Changes in Total Factor Productivity to Changes in Output, Real Wages and Relative Prices, 1990-1993[a]

	1990 ΔTFP	1991 ΔTFP	1992 ΔTFP	1993 ΔTFP
ΔlnQ	0.64***	0.82***	0.82***	0.73***
Δln(w/P)	-0.23	-0.04	0.19	0.23
Δln(P_i/P)	0.33	0.29	-0.35*	-0.30
ΔTFPc	-0.19	0.11	0.16	-0.02

[a] Three stars indicate significance at one per cent level.

Source: Own Calculations.

The factor shares are the same as for the input based measure used so far. Table 5 also reports the simple correlation of cost-based TFP against the input based measure. The result mirrors the weak correlation to real wages and output prices.[19]

The correlations presented here suffer from two potential shortcomings, however. First, in the original business cycle literature, primal and dual measures of TFP are supposed to be correlated over time but not necessarily across industries. Second, if factor prices deviate from marginal productivities in the short run (which is not unlikely given the imperfect nature of factor markets in transition economies) then the cost based measure of TFP will be biased. Consequently, the use of sectoral output changes as an indicator of demand shifts is unsatisfactory to the extent that sectoral output changes could include supply side factors as well.

There is no entirely satisfactory way around these problems. The subsequent results and their interpretation are thus to be taken with more than the usual grain of salt. We proceed as follows. To overcome the first problem. we pool data over 1990-1993 to obtain sufficient observations to run a regression of the input based Solow residual against its dual and an indicator of aggregate demand (changes in GNP). The possibility of a deviation of factor prices from marginal productivities is incorporated by including a number of supply side variables that are expected to influence factor productivities positively. The following variables were selected:[20]

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[19] It is interesting to note that the correlations become significantly negative, once capital is considered to be fixed in the short run. In this case, equation 7) includes changes in capital productivity instead of user costs as the second determinant of cost based TFP (Schapiro, 1987). It may be concluded that while adjustments to capital inputs reduce the size of the residual that remains to be explained, they do not account for the cross-sectional variation of changes in TFP.

[20] The same variables play an important role in Kennedy's (1994) analysis of structural adjustment in Poland. This author argues that the Polish economy is displaying a dual pattern of adjustment,

GINI - This is the inverse of the conventional GINI measure of concentration (GUSa). It thus reflects market structure in each sector. A high value for GINI indicates little market concentration. The impact on changes in input based TFP is expected to be positive because competition should lead to a more efficient allocation of factor inputs.[21] However, there is a countervailing effect, in that market power allows the firm to benefit from demand shocks without having to reduce price (Hall, 1988). This may have allowed sectors with a high degree of concentration to cushion the impact of an aggregate or sectoral demand shock in the initial transitionary phase. The positive impact of GINI on TFP growth is thus expected to increase over time.

IMPQ - This is the import penetration ratio, computed as the ratio of imports to net domestic sales in each sector (GUSd). The impact on changes in TFP is expected to be positive because of increased competition and access to foreign technology in sectors exposed to imports. Again, there is a time dimension to this effect, as demand for domestic products may initially decline more in sectors exposed to imports, while the positive effect on efficiency may take time to materialise.

QPRIV - This is the share of a sector's industrial output value produced by the private sector (GUSa). As much of private sector activity in industry results from newly set-up private ventures (Belka et al., 1994), a high and increasing private sector share reflects not only a competitive market environment that induces efficiency improvements in existing firms, but also brings in substantial new

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in that light industry, construction and services are adjusting rapidly, while heavy industry is characterised by strong inertia, implying inter alia little improvements in labour productivity, low competition, little foreign direct investment, and low private sector involvement.

[21] This positive effect may not be linear, however. Oligopolies competing on contested markets may be quite efficient. The inclusion of this variable may be justified on historical grounds in that market concentration in Poland was the result of planning decisions rather than competitive forces. Consequently, demonopolisation has occupied an important place among industrial adjustment policies in Poland.

human capital resources. The impact on the Solow residual is expected to be positive.

Table 6 reports the results of pooled cross-section regressions of input based changes in TFP against changes in real Gross National Product (GNP), changes in cost based TFP and the supply side variables introduced above. The reported standard errors were computed from heteroscedastic consistent estimates based on White's variance covariance estimator.

Table 6 reveals that aggregate demand is generally more significant than the supply side factors in explaining the behaviour of TFP. The coefficient on changes in GNP in regressions 1 and 2 indicates that a one per cent increase in aggregate income raises TFP by more than one per cent. This order of magnitude will not persist, however, as Poland approaches steady state growth. Indeed, in regression 3, which also includes two supply variables interacted with a time dummy for 1990, the coefficient on changes in GNP falls to 0.6 which appears more realistic. The cost based TFP measure is positive and marginally significant in regression 1. However, in regressions 2 and 3 ΔTFPc loses all significance, suggesting some collinearity between ΔTFPc and the other supply side variables. Moreover, even in regression 1 the coefficient on ΔTFPc is below unity, which is relatively strong support against an exogenous technology shock. As for the three supply side variables, their impact is positive over the 1991-1993 period, as expected. However, in 1990, the impact of GINI is significantly negative, while the coefficient on import penetration is insignificant. This confirms the ambivalent effect of market power on output based TFP. In latter years, the positive effect of competition on efficiency outweigh the effects of monopolistic behaviour. Finally, the fit of the regressions reveals that a substantial proportion of the variation of TFP across sectors remains unexplained. Clearly, more disaggregated studies and enterprise survey are needed to uncover the determinants of TFP in transition economies. From our results, we may conclude that, once the impact of relative price changes on capital utilisation is controlled for, demand factors have outweighed technology shocks in the initial two years of transition. More recently, efficiency improvements have become an important determinant of TFP and output growth across Polish industry.

Table 6 – Supply and Demand Side Determinants of Total Factor Productivity Growth, Pooled Results 1990-1993

Dependent Variable ΔTFP	1	2	3
constant	0.096***	-0.009	-0.057
	(0.015)	(0.046)	(0.047)
ΔTFPc	0.143**	0.048	-0.055
	(0.058)	(0.069)	(0.089)
ΔlnGNP	1.326***	1.113***	0.624**
	(0.215)	(0.228)	(0.297)
GINI	--	0.029	0.136
		(0.076)	(0.086)
IMPQ	--	0.140**	0.135*
		(0.069)	(0.078)
QPRIV		0.168***	0.165***
		(0.062)	(0.058)
GINI90			-0.272***
			(0.106)
IMQ90			0.009
			(0.115)
$\bar{R}^2$	0.475	0.569	0.61
OBS	84	84	84

[a] Three (two, one) stars indicate significance at one (five, ten) per cent level.

Source: Own calculations.

5. Conclusion

This paper has followed two objectives. The first was to clarify and estimate the impact of the increase in energy prices after price liberalisation on industrial output in a transition economy. Using the assumption of complementarity between energy and capital in the short run, we were able to derive a measure of capital inputs adjusted for utilisation in the face of increased energy costs. As the increase in energy prices mainly reflects their distorted low level before the start of reforms, the negative impact on capital utilisation may be interpreted as an estimate of the extent to which the capital stock in industry has become obsolete. Our results indicate that around 40 per cent of the industrial capital stock in Poland remains idle due to its embodied energy inefficiency. This implies that the increase in energy prices can account for 45 per cent of the output decline in Polish industry in 1990.

The second aim of the paper was to use the estimates of changes in sectoral TFP thus derived to clarify the importance of supply and demand factors in industrial output over the 1990-1993 period. We have found that changes in input based TFP are not significantly correlated to changes in either factor or output prices on a cross-sectional basis, but weakly positively correlated over time. The correlation to aggregate demand is positive and highly significant, suggesting that demand factors have outweighed supply factors as determinants of sectoral TFP growth so far. However, our results also reveal that competitive market conditions, exposure to imports, and private sector involvement are important supply side characteristics that influence TFP growth positively. While all these results are to be interpreted cautiously for lack of time series data and due to remaining distortions in factor prices, the following overall conclusion suggests itself: The J-curve of output in transition results from a combination of capital obsoleteness and demand shifts due to changes in relative prices in its descending part, and improvements in efficiency combined with increases in real income in its ascending part. As adjustment costs are slowly overcome and new capital is installed, these efficiency improvements will guarantee an income level higher than before the start of transition.

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GUSb, Outlay and Results of Industry (Naklady i wyniki przemyl) various issues, Central Statistical Office, Glowny Urzad Statstyzny, Warsawa.

GUSc, Biuletyn Statystyczny, various issues, Central Statistical office, Glowny Urzad Statstyzny, Warsawa.

GUSd, Foreign Trade Statistics (Rocnik statystyzny Handlu Zagranicznego), various issues, Central Statistical Office, Glowny Urzad Statstyzny, Warsawa.

GUSe, Science and Technology (Nauka i technika), various issues, Central Statistical Office, Glowny Urzad Statstyzny, Warsawa.

GUSf, Fixed assets in National Economy (Skrodki trwale w gospodarce Naradownej), various issues, Central Statistical Office, Glowny Urzad Statstyzny, Warsawa.

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Appendix

Description of all Variables and Sources:

Average employment: GUSa 1994, pp. 110 for 1992-93. For 1990-91: GUSa 1992, pp. 33, GUSa 1991, pp. 104 for 1989.

Concentration coefficient: GUSa 1994, tab. 6, pp. 13 for 1989-93.

Depreciation: Gross Value added minus Net value added, GUSa 1991, 1992; For 1992-93: GUSe 1993, pp. 71, GUSe 1994, pp. 75.

Electricity consumption in gigawatthours: GUSa 1994, pp. 180 for 1989-93.

Energy in tetracalories (billions of calories): GUSa 1994, pp. 180; GUSa 1993, pp. 167; GUSa 1992, pp. 153, GUSa 1991, pp. 190, GUSa 1990, pp. 234, GUSa 1989, pp. 274.

Gross capital stock, current prices: GUSa 1994, pp. 157, GUSa 1993, pp. 145, GUSa 1992, pp. 131, GUSa 1991, pp. 160; GUSa 1990.

Gross capital stock, contant prices: GUSa 1994, pp. 159, GUSa 1993, pp. 144; GUSa 1992, pp. 129, GUSa 1991, pp. 154, GUSa 1990. pp. 194.

Gross Investment deflator (Ratio of current to constant gross investment): GUSa 1994, pp. 149. for 1990-93 and GUSa 1994, pp. 150; GUSa 1993, pp. 37; GUSa 1992, pp. 121; GUSa 1991, pp. 147; GUSa 1990, pp. 180.

Gross Profits in bn zlotys, current prices: Value added minus total labour costs.

Gross Output in nominal and constant 1990 bn zlotys: GUSa 1994, pp. 23 for 1993, GUSa 1993, pp. 18 for 1991-92, GUSa 1991, pp. 36 for 1989.

Gross Value added at market prices, nominal and constant 1990 bn zlotys, GUSa 1994, pp. 25 for 1992-93. For 1990: GUSa 1993, pp. 19. For 1991: GUSa 1991 pp. 34.

Import penetration ratio [Imports/(Output-exports+imports)]: GUSd, various issues.

Income taxes in bn zlotys, current prices: GUSa 1990, pp 116. GUSa 1991, pp. 96 for 1989-90. For 1991-1992: GUSc, various issues. For 1993: GUSb 1994, pp. 52.

Indirect taxes and subsidies: See Value added.

Investment outlays at constant 1990 bn Zlotys:GUSa 1994, pp. 149 for 1990-93.

Net capital stock at constant prices (starting value 1989): Calulated from gross stocks.

Price for Energy. Index 1989=100. Annual weighted price deflator for five energy inputs: 1) coal, 2) gas and fuel, 3) coke, 4) gascoke and 5) electricity. The weights are the share of these components in energy consumption in bn of calories for each year. Prices: GUSa 1994, pp. 36, for 1989-93.

Relative producer price (PPI_j/PPI, total industry): GUSa 1994, tabl. 24, pp. 35 for 1989-93.

Share of private sector in sold production: GUSa: 1994, table 17 and 20, various issues.

Total Labour Costs: GUSa 1994, pp. 26, GUSa 1993, pp. 20, GUSa 1992, pp. 22, GUSa 1991, pp. 40, GUSa 1990, pp. 50.

Table A1 – Tax Rates (Income Taxes as a Ratio of Gross Profits), 1989-1993, 21 Subsecotors of Polish Industry

	1989	1990	1991	1992	1993
Industry	0.25	0.21	0.12	0.10	0.12
coal	0.25	0.25	0.25	0.30	0.34
fuel	0.22	0.26	0.09	0.10	0.14
power	0.03	0.23	0.18	0.26	0.31
iron and steel	0.31	0.29	0.12	0.12	0.10
non-ferrous metallurgy	0.31	0.37	0.28	0.25	0.28
metal products	0.24	0.17	0.08	0.08	0.08
engineering	0.22	0.27	0.22	0.15	0.21
precision instruments	0.17	0.20	0.16	0.08	0.08
transport equipment	0.18	0.20	0.12	0.05	0.07
electrical engineering	0.20	0.20	0.16	0.09	0.11
chemical	0.28	0.25	0.19	0.12	0.14
building materials	0.29	0.17	0.14	0.15	0.16
glass	0.27	0.21	0.15	0.09	0.18
pottery	0.25	0.16	0.14	0.17	0.40
wood	0.26	0.10	0.06	0.05	0.06
paper	0.35	0.25	0.11	0.13	0.14
textile	0.27	0.18	0.09	0.06	0.14
wearing apparel	0.27	0.08	0.06	0.05	0.06
leather	0.24	0.10	0.05	0.06	0.08
food	0.23	0.13	0.08	0.05	0.06
other manufacturing	0.03	0.11	0.09	0.06	0.07

Source: GUSa, GUSb, GUSc.

Table A2 – Utilisation Rates for 21 Sectors of Polish Industry, 1990-1993

	B1				B2				B3				B4			
	1990	1991	1992	1993	1990	1991	1992	1993	1990	1991	1992	1993	1990	1991	1992	1993
Industry	0.68	0.55	0.49	0.43	0.90	0.85	0.82	0.78	0.77	0.67	0.62	0.57	0.93	0.89	0.87	0.85
coal	0.78	0.69	0.63	0.67	0.95	0.92	0.90	0.91	0.85	0.78	0.74	0.76	0.96	0.95	0.93	0.94
fuel	0.81	0.57	0.51	0.50	0.96	0.90	0.87	0.87	0.87	0.69	0.63	0.62	0.97	0.93	0.91	0.91
power	0.97	0.83	0.79	0.92	0.99	0.95	0.93	0.98	0.98	0.88	0.86	0.95	0.99	0.96	0.96	0.99
iron and steel	0.60	0.40	0.35	0.28	0.90	0.83	0.81	0.77	0.71	0.55	0.50	0.44	0.93	0.88	0.86	0.84
non-ferrous metallurgy	0.77	0.58	0.48	0.46	0.96	0.91	0.88	0.87	0.84	0.70	0.61	0.60	0.97	0.94	0.92	0.91
metal products	0.60	0.47	0.39	0.33	0.89	0.83	0.79	0.76	0.71	0.61	0.54	0.48	0.92	0.88	0.85	0.83
engineering	0.74	0.58	0.45	0.42	0.93	0.88	0.83	0.82	0.82	0.69	0.59	0.57	0.95	0.92	0.88	0.88
precision instruments	0.71	0.55	0.48	0.40	0.90	0.83	0.80	0.75	0.79	0.67	0.62	0.54	0.93	0.88	0.86	0.82
transport equipment	0.75	0.52	0.41	0.40	0.93	0.84	0.79	0.79	0.82	0.65	0.55	0.55	0.95	0.89	0.85	0.85
electrical engineering	0.74	0.56	0.46	0.42	0.91	0.83	0.78	0.76	0.81	0.68	0.59	0.56	0.94	0.88	0.84	0.83
chemical	0.63	0.53	0.46	0.41	0.88	0.83	0.80	0.77	0.73	0.65	0.60	0.55	0.91	0.88	0.86	0.84
building materials	0.54	0.37	0.33	0.27	0.91	0.86	0.84	0.81	0.66	0.52	0.48	0.42	0.93	0.90	0.88	0.86
glass	0.70	0.57	0.52	0.55	0.90	0.84	0.81	0.83	0.79	0.68	0.65	0.67	0.93	0.88	0.87	0.88
pottery	0.62	0.50	0.59	0.64	0.88	0.83	0.88	0.90	0.73	0.63	0.70	0.74	0.92	0.88	0.91	0.93
wood	0.56	0.47	0.41	0.42	0.87	0.83	0.80	0.80	0.68	0.61	0.55	0.56	0.91	0.88	0.85	0.85
paper	0.69	0.47	0.40	0.41	0.88	0.78	0.74	0.74	0.78	0.61	0.55	0.55	0.92	0.84	0.81	0.81
textile	0.53	0.36	0.30	0.26	0.80	0.69	0.65	0.61	0.66	0.51	0.46	0.41	0.85	0.77	0.74	0.71
wearing apparel	0.71	0.58	0.54	0.55	0.89	0.82	0.80	0.80	0.79	0.69	0.66	0.66	0.92	0.87	0.86	0.86
leather	0.74	0.59	0.52	0.47	0.92	0.86	0.83	0.80	0.82	0.70	0.65	0.60	0.94	0.90	0.88	0.86
food	0.64	0.57	0.54	0.49	0.87	0.83	0.82	0.79	0.74	0.68	0.66	0.62	0.91	0.88	0.87	0.85
other manufacturing	0.58	0.49	0.41	0.42	0.83	0.77	0.72	0.72	0.70	0.62	0.55	0.56	0.87	0.83	0.79	0.79

Source: Own Calculations.

Table A3 – Electricity Consumption in 21 Sectors of Polish Industry, 1990-93 (1989=100)

	1990	1991	1992	1993		1990	1991	1992	1993
Industry	0.88	0.82	0.80	0.81	chemical	0.86	0.72	0.69	0.69
coal	0.86	0.84	0.82	0.81	building mat.	0.78	0.79	0.74	0.77
fuel	0.91	0.86	0.78	0.81	glass	0.94	0.94	0.90	0.90
power	0.95	0.96	0.94	0.95	pottery	0.92	0.83	0.77	0.82
iron and steel	0.93	0.79	0.78	0.79	wood	0.91	0.71	0.74	0.77
non-ferrous metall.	0.91	0.88	0.91	0.94	paper	0.88	0.88	0.87	0.87
metal products	0.80	0.66	0.64	0.71	textile	0.76	0.55	0.52	0.53
engineering	0.83	0.67	0.72	0.66	wearing apparel	0.92	1.05	1.02	1.47
precision instrum.	0.90	0.72	0.63	0.67	leather	0.89	0.74	0.61	0.60
transport equip.	0.72	0.75	0.72	0.72	food	0.92	0.96	0.93	1.00
electrical engin.	0.89	0.69	0.59	0.67	other manufact.	0.82	0.70	0.54	0.52

Source: GUSa.