Driving Factors of Growth in Hungary - a Decomposition Exercise

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Abstract

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Contents

List of Tables

List of Figures

1 Introduction

Relating output to production factors has a long history of more then twohundred years. The exploration of this relationship provides the basis for understanding economic growth or the optimising behaviour of firms. Therfore, a large number of economists have been focusing on estimating production functions and - based on theses estimates - on decomposing aggregate growth into contributions of different factors of production. However, this exercise hides a multitude of difficulties and challenges.

Apart from the search for the most accurate functional form[1], the first issue is the identification of the production function. The seminal contribution of Marschak and Andrews (1944) points out that the OLS estimation of the key parameters may be biased due to the potential correlation between inputs and the unobservable component of the production function, usually refered to as total factor productivity (TFP). In the earliest growth accounting exercises productivity was equated with the Solow residual, which is equivalent to saying that TFP is a set of factors affecting the marginal product of every input factor. As firms can observe individual productivity innovations, their policy functions include not only standard arguments but also their TFP. The main problem of gauging TFP comes from this fact. As it is unobservable to the econometrician, TFP will be part of the unobserved heterogeneity. As TFP and factor decisions are endogenous, a simultaneity problem is generated rendering the identification of production function parameters more difficult.

[1]Some problems with the existence of production function itself even at the firm level, as advocated e.g. in Felipe and Fisher (2003), are present – mainly because of aggregation concerns (Matzkin XXX) – but are generally ignored in empirical research. The argument goes usually that production functions are thought experiments, and the relationships they describe between output and inputs illustrate technology.

One line of the literature got around the simultaneity problem applying conventional GMM techniques in production function estimation (an illustrious example is Blundell and Bond (1999)). However, differencing removes much of the variation in the explanatory variables and instruments are generally only weakly correlated with the differenced explanatory variables (see Wooldridge (2005)). In the absence of good instruments, another set of studies took on a different approach. The idea of these is to find variables that comove with productivity and then use the information in the proxies to non-parametrically "invert out" productivity from the residual of the production function (Olley and Pakes (1996), Levinsohn and Petrin (2003)). These iterative algorithms can be used to at least partly correct for the simultaneity bias but they still suffer from identification problems. The main problem here is that we need to make strict timing assumptions in the decision problem that can be hard to substantiate in some cases (Ackerberg and Caves (2004)). For instance, one has to assume that labour input is more flexible than intermediate inputs or capacity utilisation.

Secondly, there is disagreement in the literature over the question of whether the TFP defined as Solow residual measures technology shocks. Applications tend to ignore that the measured TFP reflects the variation of output that cannot be explained by changes in inputs. Such a change is not necessarily technological; it might be changes in scope efficiency, managerial quality, technological properties or cyclical effects. This implies that measured TFP gaps between firms remain an amalgam of technological, efficiency and other differences in attributes, which calls for further refinement in the treatment of TFP. For instance, Basu and Kimball (1997) and Basu et al. (1998) found that 40-60 percent of the cyclicality of the Solow residual in U.S. manufacturing is accounted for the variable capacity utilisation. Indeed, costs of adjusting inputs, capital and labour, imply variable utilisation rate and, without controlling for this effect, it results in changing the Solow residual and thus the measure of TFP.

The decomposition of growth and the interpretation of the results on macro level give rise to another inevitable difficulty. Obviously, the so-called aggregation problem is as old as economics, but the gap between micro and macro is still wide. Indeed, in nonlinear (as in loglinear) models, we cannot simply add up individual relationships to arrive at the aggregate function. Fortunately enough, the literature propose a large number of possible decompositions. As we will see later, the main challenge in aggregating individual production fuctions is to find an appropriate weighting sheme. In other words, the aggregation problem translates into a weighting problem, where the weights are always specific to the question asked.

The main goal of this paper is twofold: to produce carefully implemented production function estimations on firm-level data and to explain aggregate growth in Hungarian manufacturing from the point of view of the use of different factors of production, paying a particular attention to TFP growth and its contribution to output growth. For this purpose, we use the above mentioned three lines of research as a frame of the paper. The next section is devoted to the production function estimations. First, we briefly introduce the two identification methodologies developed by Olley and Pakes (1996) and Levinsohn and Petrin (2003). Then, we construct firm-level TFP estimates that are clean of cyclical capacity utilisation. Drawing on the work of Basu and Kimball (1997), Basu et al. (1998) and Basu et al. (2004), we construct a new proxy for capacity utilisation. Since some of the variables need to be treated differently in the regressions, we slightly modify the identification procedure.At the end of the section, we present the parameter estimates, comparing the two methods and analysing the effect of capacity utilization. In section 3, we describe the method for aggregating firm-level results and in section 4, we present the different decompositions. We also presents a more detailed analysis of the aggregate TFP. Before concluding, we break down the analysis into sectoral level.

2 Estimating production functions

We applied two procedures developed by Olley and Pakes (1996) (OP) and Levinsohn and Petrin (2003) (LP). LP, described in detail in Petrin et al.

(2004), draws on that of OP in both identification and estimation. In what follows, we briefly present the two estimation methodologies and the way we applied them. For detailed discussion of the two estimation procedures and the remaining issues in these techniques, see Ackerberg and Caves (2004).

2.1 The estimation strategy

We consider a Cobb-Douglas production function (indices i and t were dropped for simplification):

$$y = \beta_0 + \beta_l l + \beta_k k + \omega + \varepsilon \tag{1}$$

where y is log value-added, k is log capital, l is log labour, ω is productivity shock and ε is assumed to be i.i.d. noise. ω is unobservable by the econometrician but known[2] to the decision-maker. Since ω is in the information set of the firm on which it conditions its optimal choices of inputs, there will always be a non-negative correlation between input factors (l and k) and ω. The dependence of factors on ω causes OLS parameter estimates to be biased.

One of the key assumptions in both of the two methods is that capital is a fixed input, that is, its level is chosen before production takes place. In other words capital is decided upon at the beginning of the period. Hence, the orthogonality of k to the innovation in ω can be used to identify β_k.

To solve the endogeneity problem with respect to the freely variable input factor, the labour, both semi-parametric estimation methods make use of a proxy. A common assumption is that the proxy is monotonic in ω. This assumption is necessary because the proxy is used to invert out unobserved productivity shocks in both OP and LP. OP use investment and LP use input materials to control for productivity shocks. Hence, OP assume that the optimal investment is a strictly increasing function of current productivity: $i = i(\omega, k)$. This strict monotonity condition is what allows OP to invert out TFP: $\omega = i^{-1}(\omega, k)$. The inversion here takes the form of a polynomial in i

[2] at least up to an expected future value

and k. Then this polynomial approximation is used to proxy for productivity, namely, this non-parametric function is used to substitute for TFP in the production function.

There are certain drawbacks of the investment proxy. LP criticized using investment as a proxy on several grounds. First, it is well known that capital adjustment is lumpy. The lumpy nature of capital adjustment, that is, the lumpy responsiveness of investment to productivity shocks can violate the strict monotonity condition. Second, the necessary truncation of the database by filtering out non-positive investments would not only lead to efficiency loss, but also to endogenous selection bias that we should control for. LP suggest then to use intermeriate inputs as a proxy instead of investment: $m = m(\omega, k) \Longrightarrow \omega = m^{-1}(m, k)$. As input materials are assumed to be „perfectly variable" inputs, the strict monotonity condition is more likely to hold. Intuitively, a higher level of productivity implies a higher marginal product of capital for price-taking firms. In response, the firm increase its production until the marginal product of capital equals its rental rate. To increase output, the plant increases all inputs including intermediate inputs. Therefore, a high intermediate input usage reveals a more productive firm. Furthermore, intermediate consumption is positive in almost every case.

The first step is regressing value-added on the labour, the cross product and the nonparametric function $m^{-1}(m, k, p^y - p^m)$. For convenience, we think of m as investment in OP and input material consumption in LP, hereafter. Note that we also included the output prices relative to input material/investment prices $(p^y - p^m)$ in the input/investment demand fuction. Firms' input consumption or investment might increase without positive productivity shocks just because output prices might rise faster than prices of input materials or investment. So it might be optimal to adjust the capital stock or increase input consumption even in absence of a productivity shock. Therefore, a more proper specification should incorporate price effects as well. In the original version , both OP and LP assumed that investment/input material and output prices are common across firms.[3] As the investment/input material demand function is indexed by t, changes in relative prices are captured by changes in the form of the function. In the estimation process, we used a third order polinomial approximation of m^{-1} with fixed parameters across firms and time. Consequently, relative prices should also be included in the regression process as a second proxy variable.

Both procedures use a simple OLS as a first step. In this regression $\hat{\beta}_l$ is identified but $\hat{\beta}_k$ is not. This is because the polynomial ϕ contains capital terms so k is colinear with the non-parametric function:

$$y = \beta_l l + \phi\left(m, k, p^y - p^m\right) + \varepsilon, \tag{2}$$

where $\phi\left(m, k, p^y - p^m\right) = \beta_0 + m^{-1}\left(m, k, p^y - p^m\right) + \beta_k k$

In this step, we also obtain an estimate of $\hat{\phi}$.

The second step identifies k's parameter. Here LP assume that ω follows a first order Markov process: $\xi_t = \omega_t - E\left[\omega_t \middle| \omega_{t-1}\right]$, where the predicted values $E\left[\omega_t \middle| \omega_{t-1}\right]$ are obtained from the regression of $\left(\hat{\phi}_t - \beta_k k\right)$ on a non-parametric function of its lagged values in $(t-1)$. In sum, an initial value of $\beta_k k$ permits to obtain ω_t, $E\left[\omega_t \middle| \omega_{t-1}\right]$ and thus $\xi_t\left(\beta_k\right)$. As capital is a fixed input, the orthogonality of this innovation with respect to capital provides a moment condition for identification: $E\left[\xi_t \middle| k_t\right] = 0$. Additional moment conditions are available as innovation should also be uncorrelated to lagged values of labour or itermediate materials. Finally, a bootstrap procedure is used to estimate standard errors.

Implementing OP, a bit stricter assumption regarding the data generating process of productivity allows a simpler algorithm. Assume that a random walk process drives TFP. Now the linear projection of output in excess of freely variable inputs can be written as:

$$E\left[y_t - \hat{\beta}_l l_t\right] = \beta_0 + \beta_k k_t + E\left[\omega_t \middle| \omega_{t-1}\right] = \beta_0 + \beta_k k_t + \hat{\phi}_{t-1} - \beta_k k_{t-1} - \beta_0 \tag{3}$$

[3] This is equivalent to assuming that firms face competitive output and factor markets within an industry.

$$E\left[y_t - \hat{\beta}_l l_t\right] = \beta_0 + \beta_k \left(k_t - k_{t-1}\right) + \hat{\phi}_{t-1} \tag{4}$$

That is, if use the assumption that the forecast of ω_t is nothing else than the observed TFP in period $t-1$ in the case of a random walk, all we need to do to get $\hat{\beta}_k$ is to regress $\left(y_t - \hat{\beta}_l l_t\right)$ on $\left(k_t - k_{t-1}\right)$ and $\hat{\phi}_{t-1}$ without a constant.

However, there are several remaining issues in the above methodologies. First, it is not straightforward that intermediate input material consumption or investment should increase in response to a positive productivity shock at all times. One can think of cases when a positive productivity shock is associated with constant or even decreasing input usage. For instance, firms can improve their productivity by reducing intermediate input consumption by improving the quality control system and thus reducing the number of defective items produced (see Javocik (2004)).

Second, we comment on some of the identification assumptions of the two procedures and possible biases in $\hat{\beta}_l$ that arise from these assumptions. Both procedures assume that the firm decides upon labour having decided about the proxy (input materials or investment). Otherwise – first labour then proxy – labour would be part of the state on which the optimal amount of proxy is determined, that is, l would enter the input materials/investment demand functions. Technically, this imply that function m would contain l as an argument. This implies that the inverse function m^{-1} would also contain l terms meaning labour and the cross product would be colinear with the polynomial approximation $m^{-1}(m, k, l)$. As an obvious consequence, labour and cross-product parameters could not be identified separately from this polynomial. This is the same story LP and OP tells about the capital parameter and this is the reason why the capital parameter can only be obtained through a two-step procedure.

However, this timing requirement is not enough. One needs also to assume that productivity changes between the decisions about the proxy and labour. If TFP remains the same then it is as if the two were determined at the same time and on the same information set. We were facing the previously highlighted problem in this setup. If TFP evolves between the two decisions then labour responds to these shocks but these are not controlled for by the proxy since it is already decided upon. In other words, this uncontrolled productivity innovation feeds into the error term and since labour responds by assumption[4], labour and the cross product are correlated with the error term rendering their OLS parameter estimates upwardly biased.

2.2 A clearer treatment of technology

Although OP and LP are capable of controlling for productivity changes taken up by the proxies, it is an empirical question whether these procedures themselves can control for non-technological cyclical effects in the remaining residual. We do not argue that the TFP should not be cyclical. However, isolating these effects from the error term is crucial as discussions about economic growth most often associate TFP with technical development.

Basu and Kimball (1997) have emphasized the role of intensity of unmeasured factor (capital and labour) utilization, which accounts for a relevant portion of the cyclicality of the TFP. Later, Basu et al. (2004) demonstrated that under some assumptions, changes in both unobserved capital capacity utilization and intensity of labour usage (including overtime work and increased effort) can be expressed as some function of output elasticities and changes in hours worked. In their approach, firms are assumed to be price-takers in input markets and can freely vary average hours worked (H), effort (E) and capital utilization (A). As employees must be compensated with a higher wage for overtime-work and higher effort, wages are strictly increasing in H and E. Moreover, assuming that the major cost of increasing capital utilization is that firms must pay a shift premium to compensate employees for working at night or other undesirable times, employees' wages create a link between H, E and A.

[4] Labor is assumed to be a freely variable input.

We depart from their approach, but since we do not have firm specific hours worked variable in our database, we modify the proxy for capacity utilization. As in Basu et al. (2004), we express total wage as a function of a hourly base wage $\bar{W}$, hours worked H, effort E and shift premium A. $\bar{W}$ is assumed to be determined in a perfectly competitive labour market.[5] Thus, the ratio of wage per worker and effective hourly wage is a function of H, E and A: $\frac{W}{\bar{W}} = g(H, E, A)$. Since H comoves with both E and A[6], the above expression can be simplified to $\frac{W}{\bar{W}} = g(H)$, where $g(.)$ is a convex and continous function. Invering out H yields to $H = g^{-1}\left(\frac{W}{\bar{W}}\right)$. Thus, if firms are price-takers in the labour market, a functional form of the ratio of wage per worker and effective hourly wage can be interpret as average effective hours worked and can be used to control for capacity utilization.[7] For simplicity, we used a simple linear function in our regressions, a possibly more appropriate functional form is to be tested in further work.

In the original OP and LP estimation strategies, labour was assumed to be freely variable and capital was quasi-fixed. Now, introducing capacity utilisation, it makes no sense to assume that labour is a freely variable input. In short, capacity utilisation can be more plausibly treated as a freely variable

[5] Technically, one can think of $\bar{W}$ as the predicted value of a wage eq., regressing wages on firm-level data and employees' characteristics such as age, experience, gender ...etc. Unfortunately, we do not have detailed information on workers in our database. Therefore, we assume that wages are constant within a specific industry in a specific region.

[6] for demonstration, see Basu et al. (2004)

[7] Certainly, if the assumption of homogenous labor fails empirically, our proxy embodies not only capacity differences but also differences in labor quality. Although this framework built on Basu et al. (2004), we are not worried about this possible second interpretation of our proxy. As proposed by Griliches and Ringstad (1971), several papers make use wage bill to proxy effective labour in production function estimations. Griliches and Ringstad suggested to use the ratio of wage bill and the national minimum wage. However, the Hungarian economy was hit by two salient statutory minimum wage increase, by 57 per cent in January 2001, and by 25 per cent a year later. These hikes had large effect on the wage distribution, which casts doubt on the pertinence of this approach. Calculating effective labor following their methodology, we observe a sharp decrease in effective labor input after 2001. Our proxy is normalized by the average hourly wage (constant within an industry in a year), so wage shocks are controlled for.

input than labour. The reasoning is that if labour adjustment is costly, then it is worth hiring or laying off employees only if these costs are lower than the costs of changing capacity utilisation (the cost of additional work hours and shift premia). If labour adjustment is expensive – or, put it differently, there are rigidities in the labour market, firms will refrain from frequent adjusment in the number of employees. There are several arguments suggesting that labour adjustment costs might exceed the additional expenses of extra work. First, labour market frictions may hamper firms looking for additional employees. Second, the training of new employees can be a lengthy an expensive process, especially if the production process needs skilled work. Third, administrative costs can also discourage firms from hiring. Hence, we treat labour as quasi fixed and capacity utilization as freely variable.

However, this setup does not necessarily violate the timing assumption in the OP procedure. It is reasonable to assume that decision on investment precede decision on labour, even if this latter is not perfectly variable. Therefore, the proxy for capacity utilization can simply be treated as additional "freely input variable", and the parameters of labour and capacity utlilization can be estimated in the first step.

On the other hand, the quasi-fixity of labour input makes the LP identification procedure somewhat more complicated. Obviously, it makes no sense to assume that decision on input materials precede decision on labour. Therefore, we change the timing assumption: capital stock is decided on the information available at the end of time $t-1$. Then, developments in TFP lead the firm to adjust its labour, which is followed by changes in input material usage. As the last step, firms decide on capacity utilization and production takes place in time t. This timing implies that labour would be part of the state space on which utilization is decided on rendering indentification more difficult.[8]

We evite inconsistency the following way. The intermediate input demand functionn changes as labour is included: $m = m\,(\omega, k, l, , p^y - p^m)$, and after

[8] A similar timing problem is present in the original LP (see Ackerberg-Caves for further discussion).

inversion: $\omega = m^{-1}(m, k, l, , p^y - p^m)$. Then, as the polynomial ϕ contains capital and labour, but no capacity utilization, this latter is identified in the first step. In the second step, we identifiy capital and labour parameter simultaneously the same way as in the original LP procedure. Note that capital is still orthogonal to the innovation in productivity, so moment condition for identification remains $E[\xi_t | k_t] = 0$. On the other hand, we do not assume that labour is uncorrelated with the innovation term. In this case, lagged values of labour can be used to identify its parameter: $E[\xi_t | l_{t-r}] = 0$, with $r \geq 1$.

2.3 Estimation results and specification tests

We carried out our estimations using a rich tax database containing balance-sheet information of double entry book keeping manufacturing companies with five or more employees for the years 1993-2002. Once small firms with less then five employees, missing observations and outliers are removed, our sample still covers about 85 percent of total output or value added in manufacturing. We also removed the Office machinery and computers industry (NACE 30) because data on deflated output and value added were unreliable.

Detailed information on the database and the variables used are presented in the Appendix. The total number of observations and the sample size is shown in Table 1.

Estimations were carried out for each industry (2-digit level) separately, however, some consecutive industries (marked in red in Table 1) were merged for the estimations due to small sample size.

2.3.1 Parameter estimates

Parameter estimates are presented in Table 2. The first two columns compare parameter estimates using OP and LP procedures. In both cases, results seem plausible. As expected, textile industry (NACE 17-19) has the highest labour share and lowest capital share, while sectors within machinery (NACE 29-35) have the highest capital share. In most of the industries, the sum of the two parameters is below unity, somewhat lower in case of LP.

As expected, labour shares decreased dramatically when we used the LP-technology. On average, the change was about -.19. The direction of bias in the parameters are hard to predict in general, but there are some clues. It depends on the responsiveness of input factors to TFP and the correlation between labour and capital. A typical case is when $0 < \mathrm{cov}\,(K, \varepsilon) < \mathrm{cov}\,(L, \varepsilon)$ and $\mathrm{corr}\,(K, L) \geq 0$, which biases the labour parameter upwards and the capital parameter downwards. Now, if we have a proxy that correlates more strongly with TFP, these biases might be mitigated. This is exactly what we see with the decrease in labour parameter when LP is used. As investment is known to be lumpy at the micro level, it is likely to take up less amount from TFP development leaving more of it in the residual as the input-to-capital ratio is more likely to closely respond TFP developments. However, we do not see a dramatic increase in the parameter of capital.

The parameter of the capacity utilization is significant in both cases (second and fourth columns). In case of OP, the point estimates are generally higher then in LP. Also, it is seen from Table 2 that the introduction of capacity utilization in the regressions did not change significantly the labour and capital parameters. We also checked how the variance of TFP estimates altered after the control. We found that variances reduced in both cases. Namely, capacity utilisation lead to a roughly 30% drop in TFP variance in OP and from 25% to more than 50% in LP. We assess these as evidence of the capacity utilization effect.

2.3.2 Specification tests

The most important specification test is to verify whether the monotonity condition holds, i.e. whether intermediate input usage or investment is increasing in productivity. To see this, we regressed the proxy variables on a third order polynomial approximation of all variables infuencing the choice of intermediate input consumption or investment. Hence, productivity, capital and output/input relative prices are the explanatory variables in these regressions. Then, we evaluated the first order derivate of the function with respect to the productivity shock for each firm ($\partial m / \partial \omega = f\left(\omega, k, p^y - p^m\right)$). This procedure was carried out for each industry separately. The value of the derivate was negative or zero in less than 1% of the total number of observations for both pocedures. We assess these results as strong evidence indicating that higher productivity leads to higher investment and intermediate input consumption.

A second check consists of testing whether the innovation in productivity is correlated with lagged labour input. This correlation varies between -0.16 and 0.24 depending on industry, and equal to 0.09 for the whole sample in the LP case. We carried out the same test to see if innovation is correlated with lagged input material consumption. The correlation coefficients are all within the interval bounded by -0.11 and 0.27, and equals to 0.11 for the whole sample. In the OP case these correlations were even closer to zero (labour: 0.01 for the whole sample and -.03-0.07 across industries, investment: 0.00 and -0.08-0.06). All in all, these results suggest that proxy levels tend to be uncorrelated with the innovation in productivity.

In the LP case we had an alternative proxy so we tested whether the results change using a more restictive intermediate input materials definition. We performed the same estimations using only raw materials and consumables as a proxy. Although parameter estimates do not change significantly, the monotoneity condition did not seem to hold.

The next step was to test if parameter estimates are affected by structural breaks. We recursively reestimated the same model after discarding obsevations before 1994, 1995, ... 1998, then by dropping observations after 2001, 2000 ... 1997. With few exeption, the LP procedure resulted in parameter estimates falling inside the 95% confidence intervall of the original estimation on the whole sample.

3 The aggregation problem

Our main question is: what drove economic growth in the past years? A natural way to tackle the question is to compute contributions of different production factors. This would lead us to a growth accounting exercise. Firm-level estimations provide us with firm-specific productivity characteristics. These metrics are interesting on their own right but proceeding this way a gap between the micro and macro level would remains. Put it another way, these estimates answer

$$Y_i = f(K_i, L_{i,}CAP_i, \Omega_i), \tag{5}$$

while in the macro sense we would like to see:

$$\sum_i^N Y_i = f(\sum_i K_i, \sum_i L_{i,} \sum_i CAP_i, \sum_i \Omega_i). \tag{6}$$

where K_i, L_i, Ω_i represent respectively capital, labour and total productivity, CAP_i is the capacity utilization, proxied by the ration of wage per worker and efficitive hourly wage.

However, we cannot simply add up individual relationships to arrive at the aggregate function, as most often f_i is some nonlinear function. Also, as models are exhibited in continuous-time, while data is available mostly at a yearly frequency. Therefore we need to approximate and, as we will see in the next section, the aggregation problem translates into a non-trivial weighting problem, where the weights are always specific to the question asked.

The aggregation in the growth accounting framework thus relates aggregate movements to individual movements. It is important to note that these contributions capture individuals' genuine productivity contributions to aggregate growth not that of aggregate employment or capital. By the same token, factor contributions reflect how much each factor added to aggregate value added change and not to aggregate employment or capital change.

The growth account exercise is the first part of our our first analysis. However, from a macroeconomic perspective, genuine growth is not the only driver behind aggregates that deserves attention. If we view marcoeconomic phenomena as aggregate processes that are generated by a continuum of entities within a time period, then the changes in the distributions underlying the aggregates are of similar interest. In other words, reallocation or composition effects can play a key role in aggregate dynamics. This motivates the second part of our analysis.

To get a grip on the aggregation problem, our guide is the statement of Domar, saying that "we have to be able to first decompose the economy to an arbitrary degree and then to reassemble it without affecting the magnitude of the residual" (Domar (1961)). In our exercise, we build on the work of work of Hulten (1978). Here, we only make two remarks regarding his work, the interested reader may found a detailed review of his derivations in the Appendix. First, Hulten's work was intended to show that some correction is needed to account for the cumulative effects of an individual productivity change. The correction accounts for the multiplicative effect of an individual productivity increase. This effect can be summarized as follows. As an individual (firm-level, sector-specific, product-specific, etc) shock causes higher output, this will not only increase final demand, but also will increase intermediate inputs to other individual firms. Then increased intermediate inputs drive other individuals' production higher, which augments others' inputs again, and so forth. Second, Hulten's derivations are based on a model which writes output as a function of primary factor inputs and intermediate inputs, while our estimations are based on value added rather than output. To see what difference it makes, we also briefly review how individual TFPs should be weighted when using value added as the dependent variable, and show that in this case, value added shares shoud be used.

3.1 Growth accounting framework

We start by showing that aggregate productivity should be calculated using value added shares if one estimates the production function using value added as the dependent variable.

Let

$$Y_i = f(J_i, \Omega_i) \quad i = 1...N, \tag{7}$$

where Y_i is real value added of firm i, J_i $(1 \times K)$ is the vector of factor inputs used by firm i, and Ω_i is the Hicks-neutral productivity shock.[9] Intermediaries are dropped as value added is the dependent variable.

Total differentiation of 7 yields:

$$\frac{dY_i}{dt} = \sum_{k=1}^{K} \frac{\partial Y_i}{\partial J_i^k} \frac{dJ^k}{dt} + \frac{\partial Y_i}{\partial \Omega_i} \frac{d\Omega_i}{dt} \Rightarrow \tag{8}$$

$$\frac{\dot{Y}_i}{Y_i} = \sum_{k=1}^{K} \frac{\partial Y_i}{\partial J_i^k} \dot{J}_i^k \frac{J_i^k}{J_i^k} \frac{1}{Y_i} + \frac{\partial V_i}{\partial \Omega_i} \dot{\Omega}_i \frac{\Omega_i}{\Omega_i} \frac{1}{Y_i} = \tag{9}$$

$$= \sum_{k=1}^{K} \left[\frac{\partial Y_i}{\partial J_i^k} \frac{J_i^k}{Y_i} \right] \frac{\dot{J}_i^k}{J_i^k} + \frac{\dot{\Omega}_i}{\Omega_i}, \tag{10}$$

where $\dot{Y}_i$, $\dot{J}_i$ and $\dot{\Omega}_i$ are time derivatives.

This shows how firm level value added growth decomposes into factor input growth and TFP growth. Since we assumed TFP to be Hicks-neutral, the last equality holds. The expressions in brackets are elasticites of value added w.r.t. primary input factors and are captured by production function parameters.

[9] If written in terms of output and factor inputs the above equation would look like $Y_i = \Omega_i f(M_i, J_i)$, where Y_i would denote gross output and M_i intermediaire inputs.

As we have estimated all the elasticities:

$$\frac{\dot{Y}_i}{Y_i} = \sum_{k=1}^{K} [\beta_{ki}] \frac{\dot{J}_i^k}{J_i^k} + \frac{\dot{\Omega}_i}{\Omega_i}. \tag{11}$$

What we have here is a firm-level decomposition, where value added growth is written in terms of TFP growth and weighted input factor growth rates for each firm. The weights are elasticities of value added w.r.t. primary factor inputs.

To arrive at the industry level, write industry value added as

$$Y = \sum_{i=1}^{N} Y_i \tag{12}$$

where N is the number of firms in an industry.

Total differentiation of 12 yields

$$\dot{Y} = \sum_{i=1}^{N} \dot{Y}_i. \tag{13}$$

This aggregate value added growth can be written as

$$\frac{\dot{Y}}{Y} = \sum_{i=1}^{N} s_i \frac{\dot{Y}_i}{Y_i}, \tag{14}$$

with $s_i = \dfrac{Y_i}{Y}$, the share of firm i in total value-added. Thus, change in aggregate value-added equals to the value-added share-weighted average of individual growth rates.

To complete the derivation, 11 is substituted to 14:

$$\frac{\dot{Y}}{Y} = \sum_{i=1}^{N} s_i \left(\sum_{k=1}^{K} [\beta_{ki}] \frac{\dot{J}_i^k}{J_i^k} + \frac{\dot{\Omega}_i}{\Omega_i} \right), \tag{15}$$

which is, in the case of $k=2$, i.e. capital and labour:

$$\frac{\dot{Y}}{Y} = \sum_{i=1}^{N} s_i \left(\beta_l \frac{\dot{L}_i}{L_i} + \beta_k \frac{\dot{K}_i}{K_i} \right) + \sum_{i=1}^{N} s_i \frac{\dot{\Omega}_i}{\Omega_i} = \tag{16}$$

$$\sum_{i=1}^{N} s_i \left(\beta_l \Delta l_i + \beta_k \Delta k_i \right) + \sum_{i=1}^{N} s_i \Delta \omega_i, \tag{17}$$

where we approximated the factor growth rates $\left(\dot{J}^k / J^k\right)$ by logarithmic differences. This formula gives a clear indication as to what kind of weighting scheme should be used.

First, calculate value added shares at the firm level (s_{it}). However, equality 14 does not necessarily hold when we use discrete observations. And if equality 14 is not verified, the decomposition presented in equation 17 is not valid either. Therefore, finding the most appropriate weighting sheme which permit to approximate the logarithmic difference of aggregate value added by the weighted average of individual logarithmic differences is crutial. As shown in Figure 1, we found that using Thornquist idexes gives a good approximation, that is: $\mathrm{dlog}\left(\sum Y_i\right) \approx \sum \frac{s_{it} + s_{i,t-1}}{2} \mathrm{dlog}\left(Y_i\right)$.

Then adding up log-differences of factor inputs multiplied by estimated elasticities leads to input growth contribution. The contribution of TFP to aggregate value added growth is shown by the last term in 17. Note that the above formula "thinks" within a growth accounting framework. That is, it relates the change in aggregate growth to individual growth rates.

3.2 The BHC concept: the role of reallocation

As we noted before, growth accounting exercises do not allow composition effects to be formulated within the analysis. However, reallocation can surely occur in discrete time. We now briefly discuss a way how these factor can be measured. The literature almost exclusively employs some form of the

BHC index (see Baily et al. (1992)). This is says that aggregate productivty change is

$$\sum_i s_{it}\omega_{it} - \sum_i s_{it-1}\omega_{it-1}. \tag{18}$$

It is clear that reallocation effects, entry/exit and genuine growth are mixed here. For a detailed discussion, see section 6.5 in the Appendix. To give these composition effects an explicit role, Levinsohn and Petrin (2003) show that a suitable definition of *change* in productivity growth does introduce a reallocation term (6.6 in Appendix).

We indend to explore what role the genuine growth and reallocation played in the period under investigation. We start with aggregate manufacturing productivity change expressed in terms of individual productivity levels. We use the BHC-concept as it better captures how productivity is viewed in the macro sense. We deem aggregate productivity in time t as a weighted average of individual productivity levels. Consequently, aggregate productivity change is the difference in this metric between two consecutive time periods.

The BHC index can be decomposed to show genuine individual TFP changes and reallocation effects (indices i were dropped for simplification):

$$\sum s_t\omega_t - \sum s_{t-1}\omega_{t-1} = \tag{19}$$
$$\sum \frac{s_t + s_{t-1}}{2}(\omega_t - \omega_{t-1}) + \tag{20}$$
$$+\sum \frac{\omega_t + \omega_{t-1}}{2}(s_t - s_{t-1}) = \tag{21}$$
$$= \sum \bar{s}d\omega + \sum \overline{\omega}ds. \tag{22}$$

The last term can further be decomposed to show more telling reallocation effects (details in Appendix 6.7).

$$\sum \overline{S_k}\overline{\omega} ds_k + \sum_{i=1}^{N} \overline{s_k \omega} dS_k, \ k = 1...J, \tag{23}$$

where the $S_{kt} = \sum_{i=1}^{j} s_{it}$ denote industry k's share in overall manufacturing value added in time t, and s_{ki} is firm i's value added share within an industry.

The first sum in 23 shows the effect of individual share changes within industry k holding TFP and sector weights constant at their means. The second term shows the effect of industry share changes holding TFPs and within-industry weights constant at their means. In other words, these expressions account for the effects of intra- and inter-industry share changes in aggregate TFP change.

4 Driving factors of growth in Hungary

4.1 Determinants of growth

The decomposition of aggregate manufacturing growth using equation 17 is presented if Figure 2.[10] Obviously, the econometric analysis presented in the paper can only show movements in input contributions, in TFP and the size of the reallocation effects, but cannot explain the reasons of the underlying dynamics. In what follows, we try to support our results and describe the underlying dynamics using external sources of information. In addition to our background knowledge emanated from the regular analysis of the Hungarian economy, consultation with experts, firm managers and union leaders provided us detailed and highly valuable information.

[10] We only present the Levinsohn-Petrin estimates here. The results with the Olley-Pakes method is mainly the same.

Overall, our results indicate that the contribution of TFP to growth in manufacturing is definitely higher then in advanced economies (REFERENCE). This result is in line with our expectation, as transition economies usually perform better in terms of efficiency gains as countries where production is already close to the possibility frontier. While the institutional background, the production structure and technology has already approached the currently known optimal level in developed economies, Hungary and other post-socialist countries could benefit a lot from adoption of new technologies and methods of production, privatization, infrastructural investments or the development and enforcement of laws, regulations and institutions that ensured the transition towards the market-oriented economy. However, the contribution of TFP is far from being stable over time. Clearly, the fluctuation of TFP is only partly explained by succeeding changes in regulation or economic events that resulted in production efficiency gains, demand side effects included in the residual appear to be significant. Following the business cycle in Hungary, three episodes seem to emerge from aggregate contributions.

The first period (1994-1997) is characterized by the stabilisation of the economy. Indeed, Hungary and other transition economies suffered from a surprisingly severe and persistent recession during the first few years following the collapse of the socialist regime. In response to the recession and the transforming economic environment, firms gradually decreased employment. Moreover, The Hungarian government introduced a draconian bankruptcy law in 1992, which, coupled with the relatively rigorous accountancy law introduced next year, forced many firms to initiate organisation or liquidation proceedings. The severe legislative shock quickly cleaned the economy from unefficient production and led to particularly severe and painful mass layoffs. As a consequence, the greatest initial reduction in manufacturing employment occurred in Hungary among all transition economies (about 30 percent). To a less extent than in previous years, manufacturing employment continued to decline in 1994-1996 and began to increase only in the second half of the ninetieth. That is, initial drop in employment was much stronger than the decline in value added and, later, economic recovery was coupled with continuing layoffs.

The transformation of socialist firms characterised by over-employment to market-oriented firms resulted in mass layoffs of redundant and not specialised workers, which is in itself efficiency gain and, consequently, TFP growth. Reforms such as price liberalization, privatization, removal of barriers to the creation of new firms, establishment and enforcement of a market-oriented legal system and accompanying institutions catalyzed this transformation. Most of the countries in transition proceeded quickly and surprisingly effectively with the first phase of these reforms, however, in-depth transormation policies differed country by counrty. Hungary opted for case-by-case privatization of individual state-owned enterprises, instead of mass privatization techniques as for example in the Czech Republic, Lithuania and to a lesser extent Slovakia.[11] This method of privatization had the advantage that it assigned clear property rights to the new owners and provided much-needed managerial skills and external funds for investment. Thus, privatization coupled with in-depth institutional reforms generated high TFP growth. As pointed out in Brown et al. (2006), Hungary got off to an early start in ownership transformation and accomplished it relatively quickly. Not only the speed of the privatization was remarkable, but also its sudden and high impact on productivity. In our view, these effects did not die away in the early years of the transition, the high productivity growth till 1997 is largely explained by the transformation of privatized firms.

On the other hand, macroeconomic stabilization lagged behind institutional reforms and privatization. The notorious "Bokros package", named after the Finance Minister of that time Lajos Bokros started in 1995. The fiscal consolidation included cuts in general government expenditures, the devaluation of the Hungarian national currency, the introduction of an exchange rate regime based on a pre-announced crawling peg devaluation aiming at establishing predictable conditions for exporters and cooling speculation, the

[11] Svejnar (2002) distinguish Type I and Type II reforms. See the paper for cross-country comparison.

increase of taxes. The package helped reduce external and internal imbalances as well as the share of general government revenues and expenditures. The decisions also included the speeding up of privatisation with the involvement of foreigners. As a consequence, Hungarian FDI jumped[12], which, in turn, encouraged further growth in productivity. The negative effect of the stabilisation shows up one year later, in 1996, but it promoted macroeconomic growth afterwards.

The three years from 1998 to 2000 were charcterized by opposite shocks. A new wave of FDI inflow reached the country, although its relative size compared to previous foreign investments falls behind excessive inflow experienced in other Eastern and Central European countries. Indeed, until 1997, Hungary was the only transition economy receiving a significant flow of foreign direct investment. But starting in 1998, major foreign investments went to the Czech Republic, Poland and Slovakia.

Nevertheless, the new wave of foreign investments which started in 1997-98 were mainly new greenfield investment project, while aquisition of state-owned firms by foreign investors constituted the major component of the FDI prior to '97 . Thanks to these greenfield investments, capital accumulation boosted growth. The major part of new investments went to machinery (see subsection 4.3 for detailed sectoral analyse). Moreover, newly established plants needed qualified workers and as this time, a new wave of particularly active baby boom generation entered the labour market[13], the sharp raise in labour demand in '97-'98 fortunately coincided with "fresh" qualified labour supply. This phenomena is translated to increasing employment and growing labour contribution. This was, in fact, the only period of considerable total employment growth in Hungary.

While labour contribution to growth peaked in 1998 and capital's contribution was important throughout the period, TFP's contribution turned into

[12] Although not included in our analyse, the most imortant privatization was that of MATÁV, Hungarian telecommunication entreprise, which was announced in 1995.

[13] The so called „Ratkó grandchilds", the second generation of the baby boom caused by the stringent abortion policies of the early fifties. The name "Ratkó" is originated from the infamous minister of social affairs at this period.

negative. The drop in effeciency can be partly attributed to the direct and prolonged effects of the Russian crisis. The financial crisis hit the Hungarian economy on several fronts.

Firstly, Hungarian export to Russia fell by more then 30 percent in 1998 and have stabilized at a relatively low level during 1999. The collapse of the Russian market influenced sectors heterogeneously. In Hungary, the agricultural sector was the most severely hit, as agricultural exports accounted for almost half of overall exports to Russia. Within manufacturing, chemical industry registred the most imortant loss. Despite the serious decline in Russian exports, the direct trade effect of the crisis was limited at aggregate level. By the second half of the nineties, Hungarian firms have already reoriented their exports the EU market, the share of Russia in total exports slightly exceeded 5 percent (agriculture included). On the other hand, the export collapse to Russia coupled with economic slowdown in the EU, especially in Germany, which may have exerted stronger effect on Hungarian industry.

Secondly, the Russian financial crisis fed through international financial markets as well. Investors withrew from all emerging markets, which led to exchange rate pressures, rising risk premia and thus increasing interest rates and falling equity prices. Turbulances calmed down relatively quickly, however, as inflation came down faster then nominal interest rates, increasing real interest rates continued to influence growth via falling investment and private consumption.

Since 2001, productivity seemed to be a driving factor of growth again. However, some caution is needed when evaluating the remarkable TFP contributions of 2001, as this year saw some changes in the accounting legislation. We attempted to control for this bias, but to be on the safe side, we evaluate these numbers as only evidence for positive TFP contribution (see Appendix for details). Moreover, it is clear from Figure 2 that TFP contribution to growth is much smaller after 2001 then before 1997.

In these years, labour has become considerably more expensive. Firstly, because the sudden and significant drop in the inflation rate surprised private enterprises. Consequently, both inflation perceptions and expectations have long exceeded actual price rises which could lead to higher nominal wage agreements. Secondly, even with lower inflation expectations, enterprises could not significantly decrease wages. Labour supply stuck at a low level, the shortage of trained skilled workers, the large rises in minimum wages in 2001 and 2002 and the significant wage increases in the government sector coupled with an increase in employment – further reducing the potential labour force of the private sector – represented a series of shocks to private enterprises.

Most enterprises reacted to the sudden increase in labour costs and tightening market conditions by gradually substituting labour for capital and by rationalize the production process. This process explain the lowering demand for labour and thus the decreasing labour' contribution to growth (in 2002), as well as the increasing TFP contribution. Earlier studies confirm that although the magnitude of the first rise in minimum wages in 2001 was greater than that of the rise in 2002, the first labour market intervention was less effective. (see e.g. Kertesi and Köllõ (2003)). Indeed, the Kaitz index[14] in 2001 slightly exceeded 30 percent, which is very low in international comparison.

However, labour contribution began to increase already in 2003 and seem to play a decisive factor in 2004, while aggregate employment in manufacturing kept on decreasing. Large enterprises with high value added shares expanded their workforce (mainly in communication equipments industry) while mass layoffs were experienced in textile industry, which still employs a large part of the total employment in manufacturing but keep on loosing its importance in terms of contribution to aggregate growth. This structural reallocation of production may explain the opposite movement of employment and labour contribution in 2004.

[14] the minimum wage relative to the average wage

4.2 Aggregate productivity

As the second part of our exercise corresponding to Section 3.2 we present the TFP decomposition results. It is readily seen from Figure 3, that genuine TFP growth, though dominant, was not the only driving factor behind aggregate productivity developments. The positive contribution of reallocation to aggregate productivity reinforces what theory suggests: less productive firms lose weight and eventually exit from the marketplace.

To go deeper into the results we show what drove distibution-dynamics. It is seen from Figure 4 that the period under investigation saw remarkable intra- and inter-industry reallocation. We can infer from these numbers that FDI inflows caused significant interindustry reallocation effect. Figure 5 shows that the quickly increasing importance of machinery contributed to agrregate TFP growth during the whole period, however, the increasing contribution was especially significant during the period of heavy FDI inflow. At the same time, chemical industry, suffering a lot from the Russian crisis, lost its weight. It recovered only by 2001.

Also, by the end of the period, both composition effect contributed to aggregate productivity increase. As can be seen in Figure 5, aggregate production gradually shifts towards capital intensive sectors such as machinery while the share of labour intensive industries (textile industry, food and tobacco) in total value added is decreasing. In the wake of the significant wage level increase in 2001-2003, this sectoral reallocation has intensified and contributed more and more to aggregate productivity growth.

4.3 Sectoral stories

The history of various industries during the transition period and the cach-up process is pretty different. In what follows, we briefly summarize the economic background and the evolution of the most important industries in Hungary, namely: machinery, chemicals, metal products, food and textiles. Figures and tables are presented at the end of the paper.

4.3.1 Machinery

Capital growth has been influential in the first half and in the middle of the 90s. As shown by sectoral decompositions, capital growth was uniformly positive across sectors, of which Machinery was the greatest contributor.

Machinery is important not only because it is the biggest within manufacturing but also from a small-open-economy perspective: this industry is the most closely linked to export markets across industrial branches.

The deepest point of the transformation recession was 1992: output halved compared to 1988. The collapse of previous export markets hit the machinery much harder than the whole manufacturing industry (where the level of production was 60% of that of 1988). From 1992 onwards, machinery experienced dynamic growth and showed significant restructuring at the same time.

In the first years of the nineties, investment in machinery concentrated in motor vehicles: capital inflows to motor vehicles were higher than in others by orders of magnitude. These flows materialized in the form of new and large-scale capacities. This sector is the realm of multinational companies throughout the world and correspondingly, multinationals showed much interest towards Hungary already at the beginning of the transition (GM/OPEL, Audi-Rába, Suzuki). Interestingly enough, anecdotal evidence shows that local firms did not manage to enter upstream industries. It is said that – except for Suzuki – the rate of Hungarian suppliers remains below 10% on average at these multinational companies suggesting that the potential for vertical spillover effects to spread might not have been as great as it is often thought.

From the middle 90s onwards, overall machinery continued to exhibit buoyant investment activity but with the rise of the electrical machinery, motor vehicles has gradually lost its importance. Motor vehicle companies showed another wave of restructuring these years, which is reflected in labour developments. It is clear from capital contributions that capital growth was continuous but labour's positive contribution came to a halt in 1999. Specifically, labour was growth-neutral in motor vehicles that year and its contribution was even negative in 2000, reflecting the huge layoffs.

After the heavy greenfield investments in motor vehicles of the early nineties, electrical machinery caught up in terms of investment and output. In fact, electrical equipment saw the most rapid development across machinery in the period under investigation. After the short period of turbulent transition to market economy at the beginning of the 90s, fresh foreign capital injections by the world's well known manufacturers (Philips, Flextronix, Nokia, Samsung, Sony, etc.) gave rise to competitive capacities. The new establishments were dedicated to produce not only end-products but also intermediate inputs. At the same time, a significant number of new small firms appeared in this industry.

Although not included in our analyse, office machinery and computers was also a significant contributor to manufacturing capital growth and, therefore, value added. It has experienced steep growth fuelled by FDI so it is not surprising that this sector is owned almost completely by foreigners. Production is capital intensive but the ratio of value added to sales is the lowest within machinery showing that several firms are specialized to spare parts and computer components (semicondustors) beside communication equipment.

Contrary to the above, machinery & equipment gradually lost its importance despite the fact that it has exhibited steady growth since the middle 90s. This segment offered ample opportunities for small and medium size firms as huge FDI inflows seemed to keep off investing here. The industry produces mainly agricultural and durable household equipment and shows little restructuring in terms of change in product profiles and portfolios.

To sum up, the main contributors in terms of capital growth were motor vehicles and electrical machinery. In terms of output: while machinery accounted for only 18% of overall industrial output in 1995, its rapid growth inflated this ratio to 43% in 2000. The driving force behind this dynamic growth throughout the 90s has been exports: most industries within machinery have been trading their products in external markets to the extent of 85-95%. Another important stylized fact is that investments were financed through foreign capital more heavily than in other industries. In fact, the third of all foreign capital inflows to overall manufacturing materialized in machinery industries (in 2000).

4.3.2 Metal products

Similarly to machinery, the industry of metal products is also highly export-oriented. Based on CSO data in 2000, about half of the production is exported. Another 25 percent of the production constitute input materials for machinery and for other firms within the same industry. The business cycle of this sector is closely linked to that of machinery, however, some important differences worth mentioning.

The regime change and the shift towards market economy drove most of the firms in the sector into depression for several years. Following the collapse of the CMEA market, the demand for metal products halved. At the same time, the Hungarian metal producers were exposed to increased import pressure coming from neighburing countries. Albeit the sector is dominated by few large enterprises, firms operating in Hungary are relatively small on an international scale. Thus, the sudden decline in demand for products coupled with increased supply provenance from foreign giant firms pushed several enterprises near bankruptcy. Altough the market has stabilized in 1994 and most of the firms in the sector regisred increasing sales during the second half of the nineties, financial difficulties remained one of the main obstacles to development.

The privatization of the industry cannot be viewed as a success story. The first wave took place in the metallurgical centre located in the northern part of Hungary with the privatization of Ózdi Acélművek and Diósgyőri Acélművek, but the state was force to buy back the companies in order to avoid bankruptcy. After several tentatives, Ózdi Acélművek was finally succesfully sold in 1997. On the other hand, the destiny of the other North-Hungarian company was uncertain until 2004, when the group Dunaferr - dominant enterprise in the sector - finally bought it.

Although the entire privatization of the largest enterprise in the sector, Dunaferr took place only late 2003, the firm managed to successfully counterbalance the collapse of the CMEA market with increasing export sales to EU members. In fact, investments of Dunaferr accounted for the major part of the total investment of the sector for several years. Also, the relatively high productivity growth within th group Dunaferr accounts for the major part of the total TFP growth registred in the sector during the first half of the nineties.

By the end of the nineties, new (mainly foreign) investors have entered the market. Altough the domination of Dunaferr has not has not eroded, these new, smaller entreprises contributed more and more to the total productivity growth and capital accumulation within the secor. Financial difficulties continue to characterize the sector, it is viewed nowadays as a propulsive industry.

4.3.3 Chemical industry

Similarly to Machinery, the chemical industry experienced restructuring throughout the transition process. At the beginning of the nineties output dropped significantly and production stagnated up until 1996. Chemical firms seemed set to begin to grow only from 1997 but crisis events in Asia and Russia prevented them from entering a stable growth path and eventually output decreased again.

The chemical industry consists of a continuum of firms ranging from large companies with international ownership structure, up-to-date production technologies and environment-conscious management (Oil refining, Pharmaceuticals, medicinal chemicals and Basic chemicals) to small, low-value-added plastic product manufacturers (Rubber and plastic products).

Across chemical industries, oil refining is the most important (37% of chemical production). Here, firms are soundly capitalized, they are mainly affiliates of international oil companies (except for MOL). There are at least two arguments why oil refining is key to understanding factor and TFP developments in the chemical industry. First, its weight renders it a decisive role. Second, most production technologies in the chemical industry are intensively using energy and a variety of oil products. This second claim is supported by the correlation of TFP contributions across chemical industries: in years when oil refining exhibited negative (positive) TFP contributions, the other industries did so, too.

In fact, the chemical industry shows negative productivity contributions in most of the period, which is unexpected in some sense. Some caution is needed when qualifying these TFP numbers. In general, a negative TFP contribution can be interpreted as an efficiency-loss emanating from scale efficiency, mismanagement, etc. However, some industry-specific factors help explaining why TFP's contribution is often negative in the industry. First, in many cases, old capacities had to be disassembled because they could not serve firms' new market endeavors. Second, competitive capacities had to be first physically developed and then built. Third, this industry is a hazardous business requiring special caution and prudence, which might further elongate the period before new investments begin to yield capital services. On top of that, there have been ongoing takeovers in the industry up until recently, suggesting that technologies might still be changing at these firms. Putting all this together, one would imply that time-to-build lags are probably longer than in other manufacturing industries. It is clear that the econoimetric analysis presented in this paper could not capture this strucutral reorganisation in the chemical industry. Presumably, the capital measured does not reflect its true value, as old, less efficient structures are not depreciated but less and less used in reality. Also, the capacity utilization used in our regression may be baised ass well.

4.3.4 Food and tobacco

Contrary to the Chemical and Machinery industries, Food & tobacco is driven by domestic demand: only 20% of total production goes abroad.

Transition hurt the food industri badly. High inflation, pale economicy activity rendered domestic income to be steadily weak. The worsening economic environment was reflected in the deteriorating domestic demand. As Food & tobacco feeds primarily on domestic spending, industry revenues experienced continuous, year-by-year decreases, showing only slightly higher production level in 2000 than in 1990.

The food industry developed in a heterogenous way. On the one hand, traditional, commodity-type production gradually lost its importance and eventually, was ceased by after-privatisation foreign owners (socio-regional problems). On the other, fresh capital embodied in the form of new and competitive capacities gave rise to high value added segments within the industry (65% foreign share in subscribed capital).

Despite the gradual spread of new technologies, the food industry is still suffers the heritage of planned economy. Although the number of employed decreased dramatically due to continued layoffs, the productivity of labour is still 20% below EU-average (in 2000).

4.3.5 Textile industry

To be competed

5 Conclusion

To be competed

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6 Appendix

6.1 The data

Our database contains balance-sheet information of double entry book keeping manufacturing companies for the years 1992-2002. However, the investment ratio is stable only from 1993 – suggesting that capital revaluations during and after the transition period had still been in process in 1992 – so we did not use data in 1992 for the analysis.

The smallest firms, with number of employees less then five in a given year, were dropped from the analysis because their tax return data appeared to be imperfect and unreliable in many cases.

We filtered out missing or non-positive observations for value added, employees, total wage costs, capital and input materials for the whole database. We also checked for outliers: we eliminated firms for which the capital to value-added ratio, the input material to value-added ratio or the average wage cost is 1.5 times the inter-quartile interval below the first quartile or over the third quartile in a specific year in a specific industry. The number of firms and observations in our database are summarized in Table 1. In certain cases, we merged consecutive industries due to the small sample size.

Capital: The capital stock was constructed following the procedure described in Kátay and Wolf (2004). The construction bears on the assumption that investment occurs at the beginning of each year and disinvestment occurs at the end of each year. If K_t is the real capital stock at the end of the year, investing firms use K_t and disinvesting firms use K_{t-1} for production in a given year t. In other words, the real capital stock at the beginning of each year is given by K_t if the firm invests in t and by K_{t-1} if the firm disinvests in t. Therefore, we used K_t or K_{t-1} in the production function estimation procedure depending on the investment decision of the firm.

Labor: Annual average full-time equivalent employment at the firm, rounded to the nearest integer.

Value added: Value added was calculated by subtracting the value of input material costs from the value of turnover net of indirect taxes, deflated by the 2-digit sectoral GDP deflator. Due to change in accounting legislation in 2001, total turnover includes indirect taxes as well. As we have no information in the database on the magnitude of this latter, we corrected for this bias by subscribing the industry-level mean fraction of indirect taxes from total turnover. The following numbers are provided by the Hungarian CSO, expressed as the ratio of indirect taxes in total turnover and in input material costs:

	NACE	Turnover	Input materials
2001	15	0,0232	0,0044
	16	0,5622	-
	23	0,2239	0,0894
2002	15	0,0233	0,0044
	16	0,5915	-
	23	0,2265	0,0861
2003	15	0,0229	0,0005
	16	0,6713	-
	23	0,2165	0,0791
2004	15	0,0234	0,0005
	16	0,7265	-
	23	0,2520	0,0912

Proxies: We used input material costs including raw materials and consumables, contracted services, other service activities, original cost of goods sold, value of services sold (intermediated)[15], deflated by sectoral input material price deflator. As yet, the Hungarian Central Statistics Office has not published industry specific input material price indices, hence we simply calculated them as the ratio of intermediate input material consumption (the difference between sales and GDP) at current and constant prices. We also used firm-level real investment data in case of OP procedure. For further details on how investment was calculated, see Kátay and Wolf (2004).

[15] terminology is taken from the official translation of the Act C of 2000 on Accounting.

Capacity utilization: Average wage per worker (W) was calculated from within our database for every firm. Average hourly wage $\left(\bar{W}\right)$ is the ratio of average wage bill and aggregate hours worked. We calculated the average wage bill for every region in each year and industry, and used official aggregate hours worked given for each industry-year by the Central Statistics Office.

6.2 Aggregate productivity definition

The key equations in (Hulten (1978)) can be summarized as follows.

Aggregate productivity is thought of as "the expansion in the social production possibility frontier" (Hulten (1978)). Let $f(Y, J, t) = 0$ the social production possibility frontier, where $Y(1 \times N)$ is the vector of final demand (value added, or output of firms, industries), $J(1 \times K)$ is factor input supply (labor and capital). f is assumed to be homogenous of degree zero in both Y and J. This assumption stipulates that, in every point in time, the society cannot extend production possibilites by merely changing the amount of inputs or outputs. However, the frontier can move in the wake of productivity shocks.

Applying Euler's Homogeneous Function Theorem to $f(Y, J, t) = 0$ gives

$$\sum_{i=1}^{N} \frac{\partial f}{\partial Y_i} Y_i + \sum_{k=1}^{K} \frac{\partial f}{\partial J_k} J_k = 0. \tag{24}$$

We assume competitive equilibrium and normalize $Y(1 \times N)$ and $J(1 \times K)$. Using (24) the total differential of f can be written as:

$$-\sum_{i=1}^{N} \frac{\frac{\partial f}{\partial Y_i} Y_i}{\sum \frac{\partial f}{\partial Y_i} Y_i} \frac{\dot{Y} i}{Y_i} + \sum_{k=1}^{K} \frac{\frac{\partial f}{\partial J_k} J_k}{\sum \frac{\partial f}{\partial J_k} J_k} \frac{\dot{J}_k}{J_k} + \frac{\dot{f}}{\sum \frac{\partial f}{\partial J_k} J_k} = 0, \tag{25}$$

from which we have

$$TFP_{aggr} = \sum_{i=1}^{N} \frac{p_i Y_i}{\sum p_i Y_i} \frac{\dot{Y}i}{Y_i} - \sum_{k=1}^{K} \frac{w_k J_k}{\sum w_k J_k} \frac{\dot{J}_k}{J_k}. \tag{26}$$

This says nothing else but that aggregate TFP growth is the difference between weighted value added growth and input factor growth, where the weights are as defined by the above equation.

6.3 Industry productivity definition

Let the industry production function be

$$Q_i = f^i(M_i, J_i, \Omega_i) \quad i = 1...N. \tag{27}$$

where Q_i is sectoral gross output, M_i $(1 \times N)$ is the vector of intermediate inputs and J_i $(1 \times K)$ is the vector of factor inputs used in sector i. (Ω is usually assumed to be a Hicks-neutral productivity shock so that $Y_i = \Omega_i f^i(M_i, J_i)$, but for now, we do not restrict the data generating process of Ω.)

Total differentiation of (27) yields:

$$\frac{\dot{Q}_i}{Q_i} = \sum_{j=1}^{N} \left[\frac{\partial Q_i}{\partial M_i^j} \frac{M_i^j}{Q_i} \right] \frac{\dot{M}_i^j}{M_i^j} + \sum_{k=1}^{K} \left[\frac{\partial Q_i}{\partial J_i^k} \frac{J_i^k}{Q_i} \right] \frac{\dot{J}_i^k}{J_i^k} + \left[\frac{\partial Q_i}{\partial \Omega_i} \frac{\Omega_i}{Q_i} \right] \frac{\dot{\Omega}_i}{\Omega_i} \tag{28}$$

Now, assuming product and factor markets are in equilibrium, marginal revenue products and marginal costs of intermediary and primary factors are equal: $\left(\partial Q_i / \partial M_i^j\right) p_i = p_j$, for intermediaries and $\left(\partial Q_i / \partial J_i^j\right) p_i = w_k$ for factor inputs. Plugging these price ratios into (28) yields:

$$\frac{\dot{Q}_i}{Q_i} = \sum_{j=1}^{N} \left[\frac{p_j}{p_i} \frac{M_i^j}{Q_i} \right] \frac{\dot{M}_i^j}{M_i^j} + \sum_{k=1}^{K} \left[\frac{w_k}{p_i} \frac{J_i^k}{Q_i} \right] \frac{\dot{J}_i^k}{J_i^k} + \left[\frac{\partial Q_i}{\partial \Omega_i} \frac{\Omega_i}{Q_i} \right] \frac{\dot{\Omega}_i}{\Omega_i} \tag{29}$$

It can be seen that if Ω is Hicks-neutral, sectoral TFP growth is the simply the difference the sum of weighted input and factor growth rates in that sector:

$$\frac{\dot{\Omega}_i}{\Omega_i} = \frac{\dot{Q}_i}{Q_i} - \left(\sum_{j=1}^{N} \left[\frac{p_j}{p_i} \frac{M_i^j}{Q_i} \right] \frac{\dot{M}_i^j}{M_i^j} + \sum_{k=1}^{K} \left[\frac{w_k}{p_i} \frac{J_i^k}{Q_i} \right] \frac{\dot{J}_i^k}{J_i^k} \right). \tag{30}$$

6.4 Domar aggregation

Now, we show that aggregate productivity growth is the weighted average of individual sectoral productivity growth rates but only with a non-trivial weighting scheme. The idea here is that the aggregation must account for the multiplicative effects of productivity shocks.

First, in product market equilibrium: $Q_i = Y_i + \sum_{j=1}^{N} X_i^j$ for each i. Then

$$\frac{1}{Q_i}\frac{dQ_i}{dt} = \frac{1}{Q_i}\frac{dY_i}{dt} + \sum_{j=1}^{N} \frac{1}{Q_i}\frac{dX_i^j}{dt}, \tag{31}$$

which can be written as

$$\frac{\dot{Q}_i}{Q_i} = \frac{p_i Y_i}{p_i Q_i}\frac{\dot{Y}_i}{Y_i} + \sum_{j=1}^{N} \frac{p_i X_{ij}}{p_i Q_i}\frac{\dot{X}_i^j}{X_i^j} \tag{32}$$

From this we have an expression for $\frac{\dot{Y}_i}{Y_i}$.Plugging in $\frac{\dot{Q}_i}{Q_i}$ from 29 and rearranging we have an expression for factor contributions and TFP contributions. Now substituting this expression for $\frac{\dot{Y}_i}{Y_i}$ in the aggregate equation 26 yields:

$$TFP_{aggr} = \sum_{i=1}^{N} \frac{p_i Q_i}{\sum p_i Y_i}\frac{\dot{\Omega}_i}{\Omega_i}, \tag{33}$$

where, again, the zero profit condition ($\sum p_i Y_i - \sum w_k J_k = 0$) of competitive equilibrium is used to simplify the resulting expression. This equation says that individual TFP changes should not be weighted by their value added shares when estimated using output data. As $p_i Q_i \geqslant p_i Y_i$, the sum of weights are $\geqslant 1$. The intuition is that as an individual (firm-level, sector-specific, product-specific, etc) TFP shock causes higher output, this will not only increase final demand, but also will increase intermediate inputs to other individuals. Then increased intermediate inputs drive other individuals' production higher, which augments others' inputs again, and so forth. This cumulative effect is reflected in the weighting scheme.

6.5 Decomposing productivity growth - theory

The literature almost exclusively employs some form of the Bailey et al (1992) index. This is says that aggregate productivty change is

$$\sum_i s_{it}\omega_{it} - \sum_i s_{it-1}\omega_{it-1}. \tag{34}$$

Reallocation effects and genuine growth are mixed here. To see this, write aggregate growth as the weighted average of individual TFP growth rates:

$$d\omega = \sum_{i=1}^{N} s_{vi} d\omega_i. \tag{35}$$

This formulation relates genuine growth and aggregate growth. The s_{vi}'s are usually approximated by some fixed shares (average share, base shares etc.), while the $d\omega_i$ denotes instantaneous productivity growth and is approximated by $\Delta\omega = \omega_t - \omega_{t-1}$using discrete data (Thornquist-approach). This is what growth accounting usually uses as a starting point.

In light of these, 34 can be rewritten (i indices are dropped for convenience) and can be decomposed as:

$$\sum \frac{s_t + s_{t-1}}{2}(\omega_t - \omega_{t-1}) + \sum \frac{\omega_t + \omega_{t-1}}{2}(s_t - s_{t-1}) = \tag{36}$$

$$= \sum \frac{s_t + s_{t-1}}{2}\Delta\omega_t + \sum \frac{\omega_t + \omega_{t-1}}{2}(s_t - s_{t-1}) = \tag{37}$$

$$= d\omega + \sum \frac{\omega_t + \omega_{t-1}}{2}(s_t - s_{t-1}) = d\omega + \sum \overline{\omega} ds. \tag{38}$$

The last term in 38 is what is often referred to as the reallocation term. The BHC formulation can be further decomposed to account for entry/exit effects:

$$\sum s_{it}\omega_{it} - \sum s_{it-1}\omega_{it-1} = \tag{39}$$

$$\sum_i s_{it}\Delta\omega_{it} + \sum_i \omega_{it}\Delta s_{it} + \sum_i \Delta s_{it}\Delta\omega_{it} + \sum_i^J s_{it}\omega_{it} - \sum_i^K s_{it-1}\omega_{it-1} \tag{40}$$

The first two terms are the same as the ones in 36. The third is similar to what covariance means: how close share changes follow TFP changes. The last two terms are the contributions of entrants (J) and exiters (K). This equation shows reallocation as an amalgam of share changes and TFP changes.

The problem with the above formulations is that neither of the additional terms – masked by the simple BHC formulation in 34 – can be directly originated from the growth accounting framework. As is shown in 35, there is no reallocation term similar to the last term of 38.

6.6 How to motivate reallocation within the growth accounting framework?

To arrive at a pure reallocation term within the growth accounting framework, Levinsohn and Petrin show that a suitable definition of *change* in productivity growth does introduce a reallocation term.

Write the change in aggregate productivity growth like the BHC concept suggests:

$$\sum \frac{s_{t+2} + s_{t+1}}{2}(\omega_{t+2} - \omega_{t+1}) - \sum \frac{s_{t+1} + s_t}{2}(\omega_{t+1} - \omega_t). \tag{41}$$

Unfolding this measure decomposes into the sum of three terms. The first is genuine TFP growth:

$$\sum \frac{s_{t+2} + 2 * s_{t+1} + s_t}{4}(\frac{\omega_{t+2}}{\omega_{t+1}} - \frac{\omega_{t+1}}{\omega_t}). \tag{42}$$

The second is

$$\sum \left[(\frac{\omega_{t+2}}{\omega_{t+1}} + \frac{\omega_{t+1}}{\omega_t})/2 \right] * (s_{t+2} - s_t), \tag{43}$$

which obviously shows the effect of share changes and is called the "reallocation" term.

The last term looks like this

$$\sum_{i \in t+2,t+1} \frac{s_{t+2} + s_{t+1}}{2}(\omega_{t+2} - \omega_{t+1}) - \sum_{i \in t+1,t} \frac{s_{t+1} + s_t}{2}(\omega_{t+1} - \omega_t), \tag{44}$$

which is interpreted as a net entry effect. The first term adds up observations present in period t+1,t+2 and the second adds up observations present in period t+1,t.

The intuition behind expressions 42, 43 and 44 is that if there is no entry/exit and no change in TFP growth, aggregate productivity changes only if the distribution of shares changes over time. That is, aggregate TFP increases as firms (industries) with faster average TFP-growth chunk more out of aggregate value added. If shares are constant throughout the period under investigation (43 is zero), aggregate TFP growth is generated by share weighted TFP changes of firms. The net entry effect is positive if entrants' aggregate TFP change exceeds exiters' contribution.

6.7 Reallocation

Now we show that reallocation - the last term - can be further decomposed to show intra- and inter-industry reallocation effects. We assume there are $k = 1... J$ industries and there are j firms within each industry. These add up to $J * j = N$ firms in the manufacturing sector.

The last term in 38 can be written as

$$\sum_i^N \overline{\omega_i} ds = \sum_i^N \overline{\omega_i} \left(s_{it} - s_{it-1}\right) = \sum_i^N \overline{\omega_i} s_{it} - \sum_i^N \overline{\omega_i} s_{it-1} = \tag{45}$$

$$= \sum_k^J \left[\sum_i^j \overline{\omega_i} s_{it} - \sum_i^j \overline{\omega_i} s_{it-1} \right]_k, \tag{46}$$

$S_{kt} = \sum_{i=1}^j s_{it}$ denote industry k's share in overall manufacturing value added in time t.

after regrouping observations belonging to the same industry in the second line. Rewriting and multiplying/dividing by industry shares yields:

$$\sum_{k=1}^J \left[\left(\sum_{i=1}^j s_{it} \right) \left(\sum_{i=1}^j \overline{\omega_i} \frac{s_{it}}{\sum_i^j s_{it}} \right) - \left(\sum_{i=1}^j s_{it-1} \right) \left(\sum_{i=1}^j \overline{\omega_i} \frac{s_{it-1}}{\sum_i^j s_{it-1}} \right) \right]_k = \tag{47}$$

$$= \sum_{k=1}^J S_{kt} \left(\sum_{i=1}^j \overline{\omega_i} \frac{s_{it}}{\sum_i^j s_{it}} \right)_k - \sum_{k=1}^J S_{kt-1} \left(\sum_{i=1}^j \overline{\omega_i} \frac{s_{it-1}}{\sum_i^j s_{it-1}} \right)_k, \tag{48}$$

where the $S_{kt} = \sum_{i=1}^j s_{it}$ denote industry k's share in overall manufacturing value added in time t.

Now using the identity showed by 36, with $A_{kt} = \left(\sum_{i=1}^j \overline{\omega_i} \frac{s_{it}}{\sum_i^j s_{it}} \right)_k$:

$$\sum_{k=1}^{J} S_{kt}\left(A_{kt}\right) - \sum_{k=1}^{J} S_{kt-1}\left(A_{kt-1}\right) = \sum_{k=1}^{J} \frac{S_{kt}+S_{kt-1}}{2}(A_{kt}-A_{kt-1}) \tag{49}$$

$$+\sum_{k=1}^{J} \frac{A_{kt}+A_{kt-1}}{2}(S_{kt}-S_{kt-1}), \tag{50}$$

$$=\sum_{k=1}^{J} \frac{S_{kt}+S_{kt-1}}{2}\left(\sum_{i=1}^{j}\overline{\omega_i}\left(\frac{s_{it}}{\sum_i^j s_{it}}-\frac{s_{it-1}}{\sum_i^j s_{it-1}}\right)\right)+ \tag{51}$$

$$+\sum_{k=1}^{J} \frac{1}{2}\left[\sum_{i=1}^{j}\overline{\omega_i}\left(\frac{s_{it}}{\sum_i^j s_{it}}+\frac{s_{it-1}}{\sum_i^j s_{it-1}}\right)\right](S_{kt}-S_{kt-1}). \tag{52}$$

Rearranging this expression yields

$$\sum_{k=1}^{J}\sum_{i=1}^{j} \frac{S_{kt}+S_{kt-1}}{2}\overline{\omega_i}\left(\frac{s_{it}}{\sum_i^j s_{it}}-\frac{s_{it-1}}{\sum_i^j s_{it-1}}\right)+ \tag{53}$$

$$\sum_{k=1}^{J}\sum_{i=1}^{j} \frac{1}{2}\left(\frac{s_{it}}{\sum_i^j s_{it}}+\frac{s_{it-1}}{\sum_i^j s_{it-1}}\right)\overline{\omega_i}(S_{kt}-S_{kt-1}) = \tag{54}$$

$$\sum_{i=1}^{N}\overline{S_k}\overline{\omega_i}ds_{ki}+\sum_{i=1}^{N}\overline{s_{ki}\omega_i}dS_k,\ \ k=1...J. \tag{55}$$

At the equality in 54 we made use of the fact that we first summed within an industry and then over industries, i.e. over the whole manufacturing sector.

Tables and figures

Figure 1: Manufacturing VA growth rates (without computer industry)

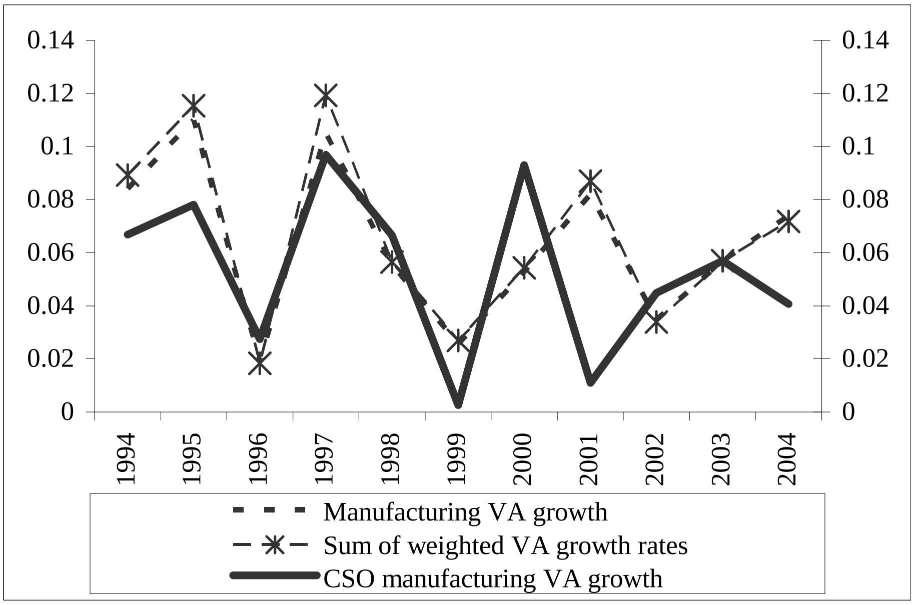

Figure 2: Decomposition of growth

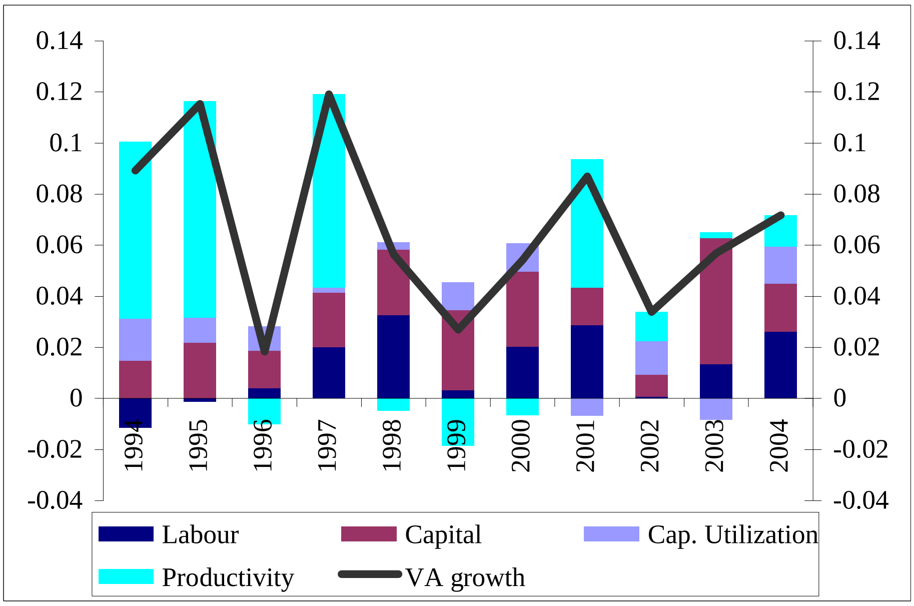

Figure 3: TFP growth and reallocation effect

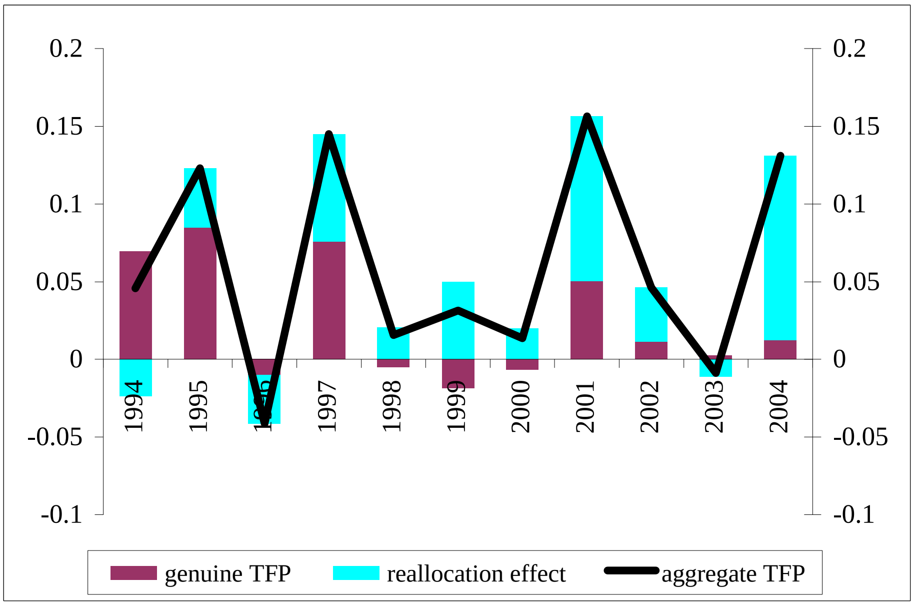

Figure 4: Intra- and inter-sectoral reallocation effects

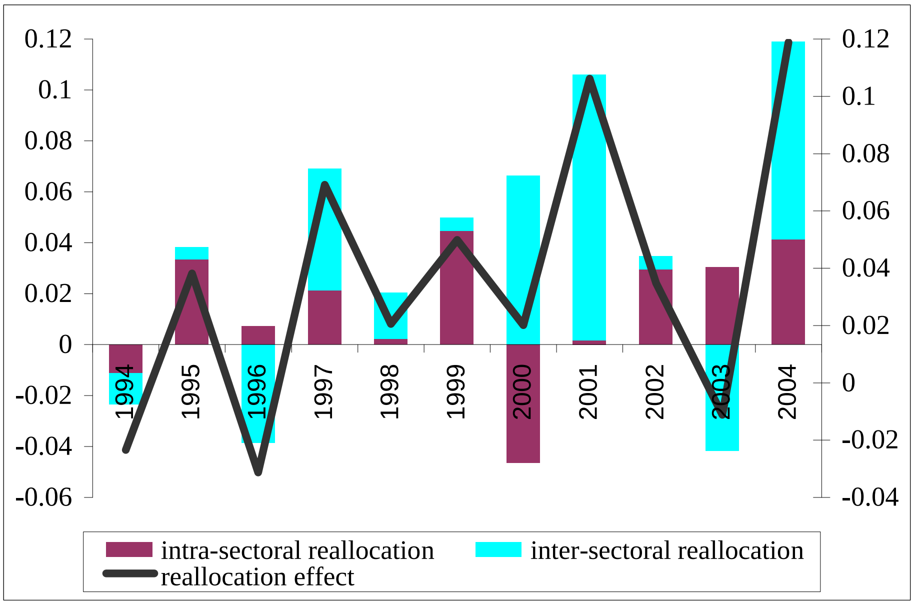

Figure 5: Inter-sectoral reallocation effects by industry

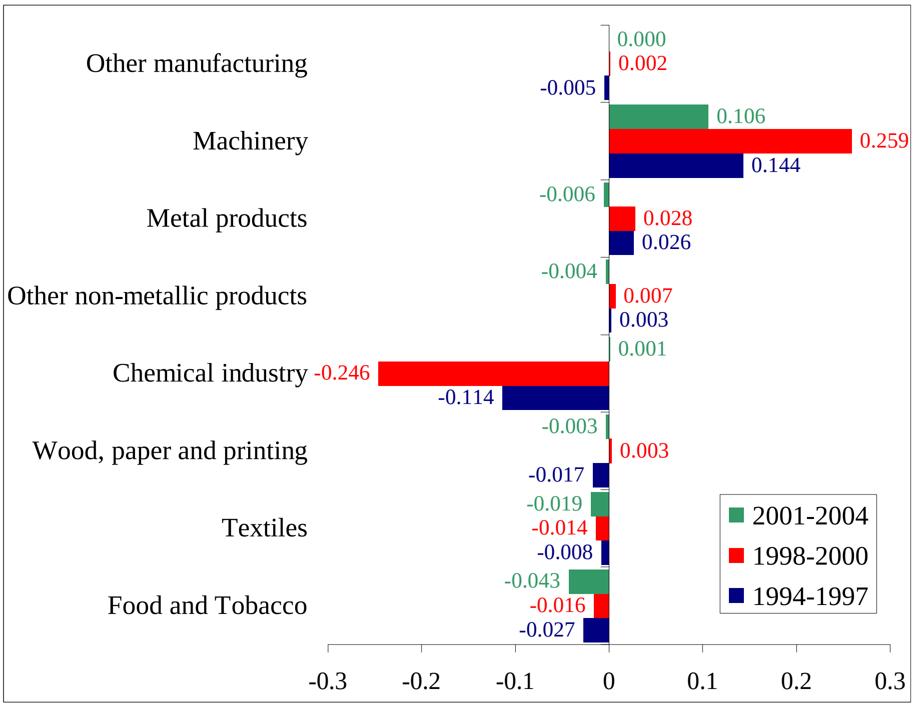

Figure 6: Contribution of industry-level genuine TFP growth to aggregate VA growth

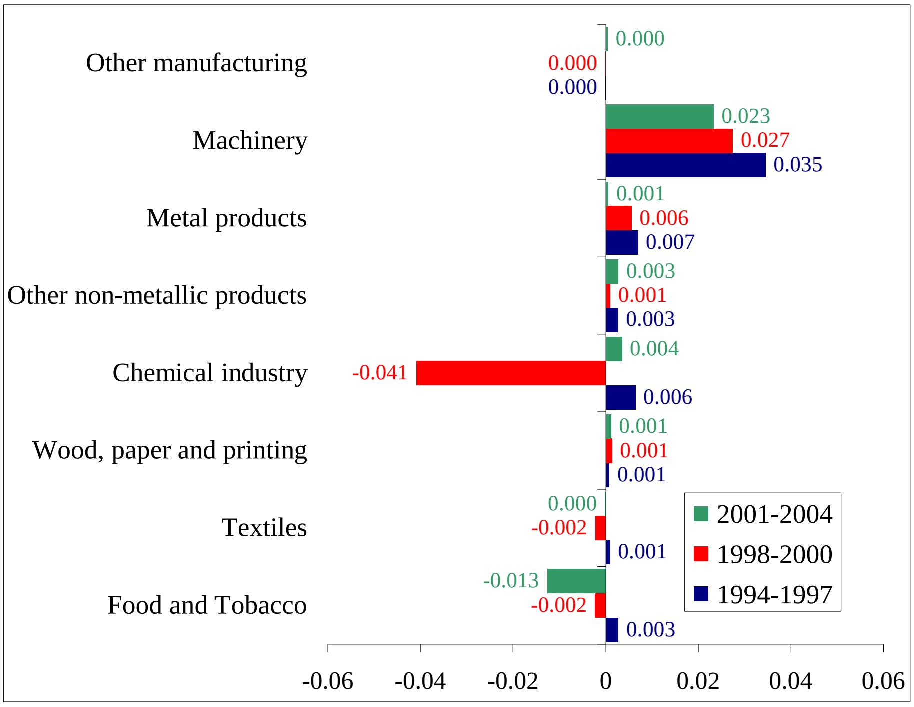

Figure 7: Input contributions by industry (sum to 100%)

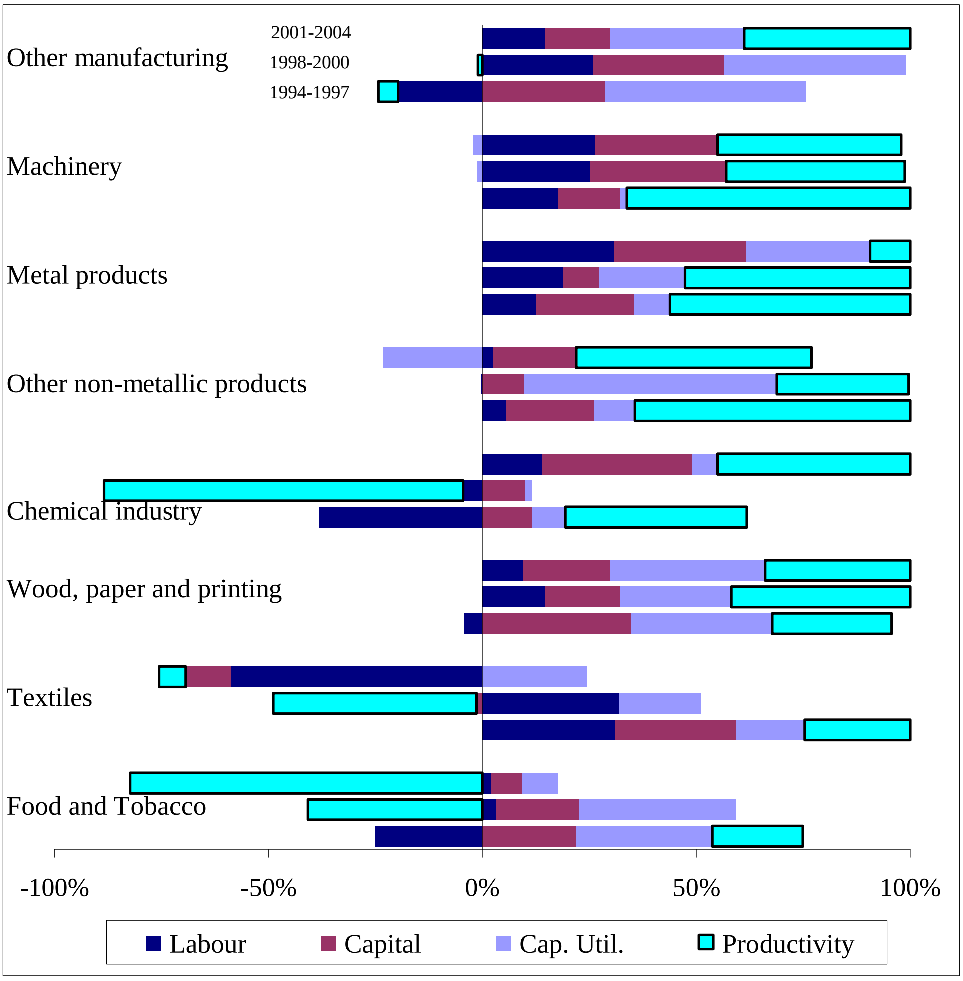

Figure 8: Input contributions in machinery

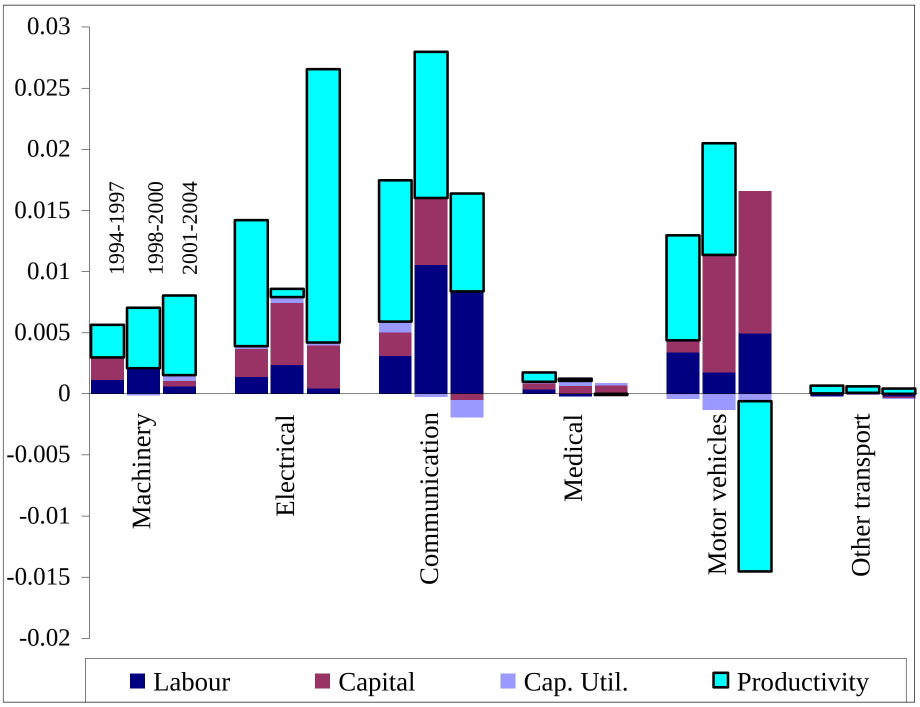

Figure 9: Input contributions in selected chemical subsectors

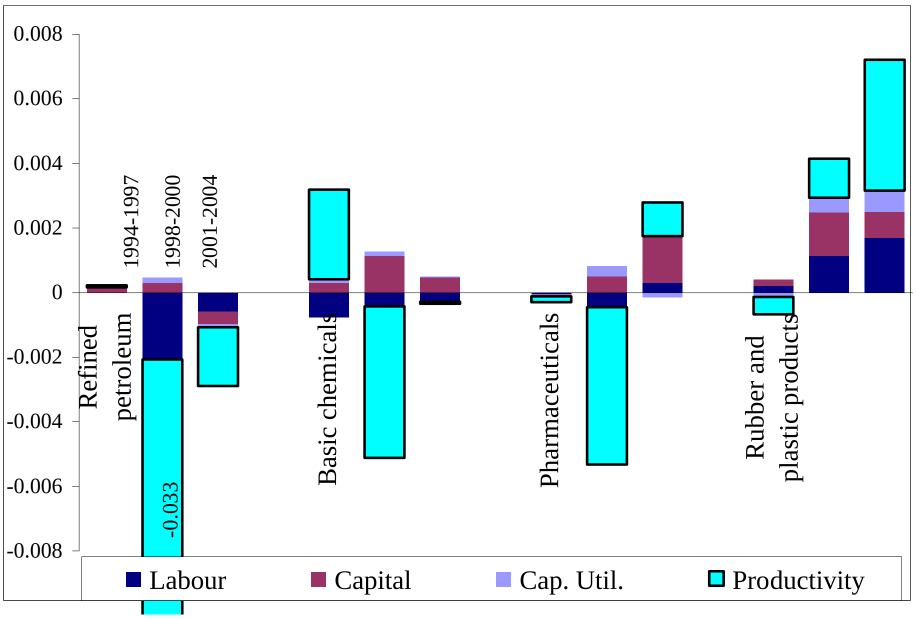

Table 1: Number of observations

NACE	Nb of firms in the database	Nb of firms with emp>=5	Nb of firms in the analysis (missing obs, outliers)	Nb of obs. in the database	Nb of obs. with emp>=5	Nb of obs. in the analysis (missing obs, outliers)
15	8 122	3 984	3 270	38 260	18 914	14 977
16	9	9	8	90	80	55
17	2 355	1 169	1 036	10 833	5 335	4 589
18	3 666	1 617	1 362	14 854	7 524	6 394
19	922	588	510	4 692	2 962	2 560
20	4 267	1 818	1 521	16 872	7 394	5 996
21	712	342	306	3 351	1 763	1 494
22	9 476	2 364	2 059	37 743	10 416	8 994
23	37	15	10	150	66	41
24	1 248	611	552	6 939	3 350	2 922
25	2 714	1 415	1 279	13 563	7 132	6 196
26	3 408	1 468	1 273	11 260	5 275	4 584
27	552	303	255	2 912	1 669	1 394
28	8 312	3 969	3 541	37 498	18 610	16 484
29	6 108	2 816	2 612	29 870	14 077	12 712
31	1 753	795	727	8 830	4 130	3 623
32	1 507	629	573	7 329	3 070	2 667
33	2 362	856	802	11 190	4 345	3 915
34	533	315	272	2 704	1 636	1 427
35	411	163	150	1 718	705	623
36	4 135	1 541	1 331	15 768	6 569	5 571
37	415	129	64	1 378	464	198
TOT	63 024	26 916	23 513	277 804	125 486	107 416

Industry: (15) Food products and Beverages; (16) Tobacco products; (17) Textiles; (18) Wearing apparel, Dressing and Dyeing of fur; (19) Leather and Leather products; (20) Wood and Wood products; (21) Paper and Paper products; (22) Publishing and printing; (23) Coke, Refined petroleum products and Nuclear fuel; (24) Chemical products; (25) Rubber and plastic products; (26) Other non-metallic mineral products; (27) Basic metals; (28) Fabricated metal products; (29) Machinery; (31) Electrical machinery; (32) Communication equipment; (33) Medical, Precision and Optical instruments; (34) Motor vehicles; (35) Other transport equipment; (36) Manufacture of furniture; (37) Recycling

Table 2: Estimation results

NACE	(1) OP without capacity utilization		(2) LP without capacity utilization		(3) OP with capacity utilization			(4) LP with capacity utilization		
	L	K	L	K	L	K	Cap. Util.	L	K	Cap. Util
15 + 16	0.67	0.24	0.48	0.31	0.68	0.22	0.78	0.56	0.35	0.64
17	0.67	0.29	0.60	0.26	0.67	0.26	0.79	0.61	0.25	0.66
18	0.78	0.12	0.72	0.16	0.78	0.12	1.01	0.74	0.17	0.94
19	0.76	0.23	0.74	0.33	0.78	0.19	0.85	0.77	0.34	0.73
20	0.73	0.29	0.50	0.33	0.71	0.29	0.71	0.52	0.34	0.59
21	0.51	0.24	0.36	0.21	0.51	0.21	0.52	0.38	0.20	0.47
22	0.70	0.19	0.41	0.21	0.65	0.20	0.73	0.46	0.23	0.62
23 + 24	0.53	0.23	0.27	0.42	0.60	0.25	0.67	0.39	0.41	0.56
25	0.65	0.32	0.50	0.29	0.64	0.31	0.66	0.53	0.31	0.62
26	0.65	0.25	0.52	0.25	0.68	0.26	0.72	0.58	0.27	0.57
27	0.67	0.19	0.42	0.24	0.65	0.20	0.70	0.46	0.28	0.52
28	0.72	0.27	0.52	0.30	0.69	0.24	0.76	0.55	0.30	0.69
29	0.76	0.22	0.54	0.26	0.71	0.23	0.83	0.57	0.25	0.76
31	0.62	0.33	0.49	0.37	0.61	0.32	0.66	0.50	0.36	0.54
32	0.66	0.28	0.48	0.29	0.68	0.28	0.74	0.54	0.27	0.58
33	0.69	0.27	0.40	0.30	0.67	0.23	0.86	0.48	0.28	0.66
34	0.72	0.32	0.46	0.49	0.69	0.27	0.53	0.46	0.44	0.45
35	0.82	0.13	0.59	0.22	0.81	0.13	0.31	0.55	0.23	0.37
36 + 37	0.75	0.26	0.50	0.27	0.76	0.25	0.86	0.55	0.28	0.71
MEAN	**0.69**	**0.25**	**0.50**	**0.29**	**0.68**	**0.24**	**0.72**	**0.54**	**0.29**	**0.61**

black: significant at 1% blue: significant at 5%; red: non significant

Industry: (15) Food products and Beverages; (16) Tobacco products; (17) Textiles; (18) Wearing apparel, Dressing and Dyeing of fur; (19) Leather and Leather products; (20) Wood and Wood products; (21) Paper and Paper products; (22) Publishing and printing; (23) Coke, Refined petroleum products and Nuclear fuel; (24) Chemical products; (25) Rubber and plastic products; (26) Other non-metallic mineral products; (27) Basic metals; (28) Fabricated metal products; (29) Machinery; (31) Electrical machinery; (32) Communication equipment; (33) Medical, Precision and Optical instruments; (34) Motor vehicles; (35) Other transport equipment; (36) Manufacture of furniture; (37) Recycling