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# JOBS AND GROWTH IN FINLAND: INDUSTRY-LEVEL EVIDENCE FROM THE 1990s

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# Tiivistelmä

Aggregatiivinen kokonaistuotannon ja työllisyyden välisen suhteen tarkastelu osoittaa, että talouskasvun ja työllisyyden välinen suhde on ollut Suomessa 1990-luvulla tavallisuudesta poikkeava. Tämä on näkynyt selvimmin työn tuottavuuden kehityksessä. Poikkeavuus näkyi erityisesti vuosina 1992–94, jolloin työn tuottavuus kasvoi erittäin ripeästi. Nopeaan kasvuun liittyi tuottavuuden kasvu-uran siirtyminen ylöspäin.

Pelkästään kokonaistuotannon ja työllisyyden välistä suhdetta tarkastelemalla on kuitenkin vaikeata päätellä, mitä vuosina 1992–94 tapahtui. Tutkimusselosteessa lisätietoa etsitään toimialakohtaista aineistoa analysoimalla.

Analyysin perusteella ripeä aggregatiivisen tuottavuuden kasvu ja siihen liittynyt tuottavuuden kasvu-uran siirtymä kuvastavat viime kädessä voimakasta tuottavuuden kasvua ja kasvu-uran siirtymää tehdasteollisuudessa – erityisesti metalliteollisuudessa.

Tutkimuksessa käytetyn aineiston avulla ei voi päätellä luotettavasti, mitä nopea tehdasteollisuuden tuottavuuden kasvu ja kasvu-uran siirtymä viime kädessä heijastaa. Olemassa olevat mikroaineistojen käyttöön perustuvat tutkimukset kuitenkin tukevat tulkintaa, jonka mukaan ripeä tuottavuuden kasvu ja siihen liittynyt kasvu-uran siirtyminen kuvastavat ennen kaikkea voimakasta toimipaikkarakenteen muutosta ja työvoiman siirtymistä keskimääräistä korkeamman tuottavuuden tason omaaviin yrityksiin.

Tutkimusselosteen analyysi perustuu yksinkertaisten rakenteellisten VAR-mallien estimoimiseen.

## Abstract

The nature of co-movement between total output and employment during the 1990s indicates that the relationship between employment growth and economic activity has been peculiar in Finland. This has been reflected, for example, in the developments of aggregate labour productivity. In particular, the years from 1992 to 1994 were exceptional. During that period productivity growth was very rapid, and, what is important, the trend of aggregate labour productivity shifted upwards.

By only analysing the relationship between total output and employment it is impossible to say what happened during the period between 1992 and 1994. In this paper the relationship is analysed by utilizing industry-level data. The analysis shows that the rapid growth in aggregate productivity and the upward shift in the productivity trend mainly reflect similar developments in manufacturing, particularly in the metal industry.

Even though the investigation is based on the use of industry-level data, it is still aggregative, which makes the interpretation of the results less clearcut. The existing studies which are based on the use of micro-level (e.g. plant-level) data support the interpretation which emphasizes the role of business restructuring and labour reallocation within manufacturing as the causes of rapid productivity growth and the upward shift in the trend productivity.

The analysis is based on the estimation of simple structural VAR models.

**JEL** Classification: E24, E32, J23, J24

**Keywords:** Labour productivity, jobless growth, technology shocks

# 1. INTRODUCTION

This paper is a straightforward continuation of *Sauramo* (1999). The purpose of that paper was to start to analyse the relationship between employment growth and economic activity in Finland in the 1990s. The motivation for that kind of study is obvious. In Finland, as in many other countries, output growth as a cure for unemployment has been questioned. A major reason for this is that despite relatively strong growth unemployment has fallen, at least apparently, slowly. The years of the recovery have been characterized as the years of "jobless growth".

In organizing the Finnish discussion I distinguished, by following *Gordon* (1993), two interpretations which illustrate the relevant standpoints of the debate. According to the New Era view, the Finnish economy is, as a consequence of rapid technological change, experiencing a new era of rapid productivity growth and, consequently, "jobless growth". On the other hand, according to the Cyclical Rebound view no change in the rate of trend productivity has taken place. The relationship between output growth and employment growth has remained unchanged, and, correspondingly, developments in employment have been consistent with the usual rules of thumb.

In *Sauramo* (1999) I analysed which one, if any, provides the best description of the connection between employment growth and economic activity during the 1990s in Finland. The examination was highly aggregative, utilizing data mainly on GDP and the total number of employees.

I analysed developments in output, employment and productivity by employing a framework which was based on the estimation of simple structural VAR models. When these models are used in modelling dynamic interdependences between output, employment and labour productivity, the main source of fluctuations are shocks which operate through a propagation mechanism. The identification of the relevant shocks, therefore, becomes the crucial task.

Because technological change is a major source of productivity growth, the identification of technology shocks becomes an essential part of the identification of a VAR model which describes fluctuations in productivity. Furthermore, from the two views, the New Era view emphasizes the role of technological change as a factor which has altered the relationship between employment and output growth, i.e. it has increased long-run productivity growth. The discussion about the relative merits of the two views is therefore impossible without a discussion about the role of technological change as a determinant of recent movements in labour productivity in Finland.

If, in the discussion, one wants to utilize results from the estimation of structural VAR models, the identification of technology shocks becomes necessary. A major problem is that, obviously, there does not exist only one way of estimating these shocks . One can, however, rationalize some specific identifying restrictions by utilizing theoretical models which provide the relevant restrictions.

In *Sauramo* (1999) the identification of technology shocks was based on the following identifying assumption: only technology shocks have a permanent effect on the level of labour productivity. This also means that, within the framework, only technological shocks can cause permanent shifts in the productivity trend, which is stochastic.

This restriction can be rationalized by various macro-economic models. *Sauramo* (1999) drew mainly on *Gali* (1999), which utilizes a new Keynesian dynamic general equilibrium model. Essentially the same identifying assumption has also been used, for example, by *Dolado* and *Jimeno (1997)*. (See also *Castillo, Dolado* and *Jimeno,* 1998; *Jacobson, Vredin* and *Warne,* 1997, 1998.)

The use of highly aggregative data is consistent with the use of such models as a theoretical background, because, typically, these models are representative agent models. However, the use of aggregative data makes the interpretation of results difficult. By employing only aggregative data it is difficult, for example, to say anything about the role of various industries as a source of the results obtained. Also, the role of business restructuring and labour reallocation as determinants of aggregate labour productivity cannot be analysed by only utilizing aggregative data. In order to examine the importance of business restructuring, the use of micro data would be necessary.

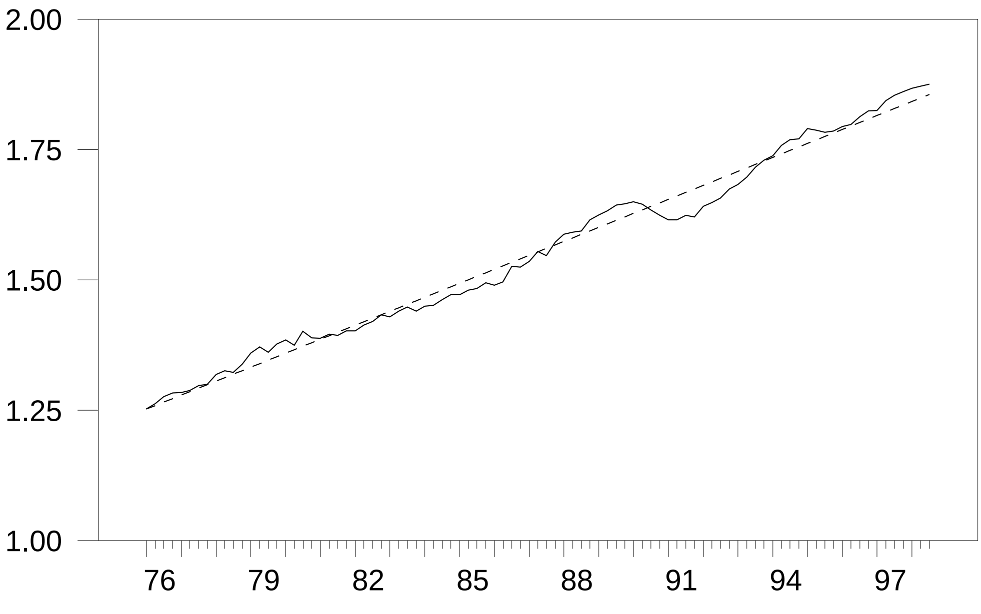
Even though the examination in *Sauramo* (1999) was based on the use of highly aggregative data it provided some interesting results, the main result being as follows. Neither the New Era nor the Cyclical Rebound view provides a telling interpretation about the developments of productivity and the relationship between output and employment growth in the 1990s.

Characterizing the years of the recovery as reflecting a new era which is associated with an increase in the rate of long-run productivity growth is misleading, because that kind of change has not taken place. On the other hand, the movements of productivity are hard to reconcile with the Cyclical Rebound view because the years from 1992 to1994, especially, were exceptional. During that period movements in productivity were not consistent with a pro-cyclical pattern.

The exceptionality of the years from 1992 to 1994 can be seen from Figure 1, which depicts quarterly data on labour productivity with productivity being defined as GDP per the number of employed persons. If a deterministic linear trend is used in the description of the developments in productivity, it is natural to think that an upward shift has taken place in the trend during the exceptional period. It is this shift that makes the period unusual.

**Figure 1. Labour productivity in Finland**

*Seasonally adjusted data in levels:1976:1-1998:3*



The shift is consistent with neither the New Era nor the Cyclical Rebound view. According to the New Era view the slope of the trend should have changed, whereas according to the Cyclical Rebound view no change in the trend should have taken place. Both interpretations give an incomplete description of the developments of productivity.

The way the experiences from different countries for the early 1990s are summarized in OECD’s Jobs study (*OECD,* 1994, 55) illustrates the pecularity of the developments in Finland:"On balance, while the recovery in employment has been slower in some countries than in the past, this would appear to reflect an initially weaker rebound in output rather than "jobless growth" as such." For Finland, the results of *Sauramo* (1999) do not support this kind of interpretation which is consistent with the Cyclical Rebound view.

In Finland productivity growth was "excessive" both during the depression years from 1992 to 1993, when GDP decreased, and in 1994, which was the first year of recovery. Because the period of "excessive" growth lasted for only three years, speaking of a New Era of "jobless growth" is, however, misleading.

In *Sauramo* (1999) the major difficulty turned out to be the interpretation of the causes of the shift in the productivity trend. Within the framework the cause of the shift was a sequence of positive technology shocks which strongly shaped the developments of productivity and employment. Beside accelerating productivity growth they also decreased the demand for labour, and, consequently, were the major cause of the sluggish employment growth at the start of the recovery.

When labour productivity is measured as GDP per employee, it is very difficult to say anything about the role of various industries as a source of exceptional movements in productivity. Furthermore, because changes in an aggregate measure of productivity can reflect a variety of structural changes, for example, business restructuring and not technological changes at the plant level (as suggested by the representative agent model), the possibility for misinterpretations is obvious. The level of aggregate productivity rises if, as a result of births and deaths, the share of firms with a high level of productivity rises.

When interpreting the results, I therefore utilized some results from other recent studies which could help in the interpretation. Of those, Maliranta's study, which is based on the use of micro data, turned out to be invaluable (*Maliranta,* 1997).

Maliranta's study, which deals only with manufacturing, gives support to the following interpretation: the positive technology shocks which dominated the developments of aggregate productivity during the period from 1992 to 1994 reflect, first of all, micro-structural changes like business restructuring and labour reallocation from inefficient to efficient plants and not technological changes at the plant level. Because of such drastic changes, characterizing the depression as the period of creative destruction, a characterization *Schumpeter* (1942) used for recessions, seemed pertinent. According to the results of *Sauramo* (1999), the period of creative destruction in Finland resulted in an upward shift in the path of aggregative trend productivity. Furthermore, according to this interpretatation, the shift mirrors a similar shift in the productivity trend of manufacturing.

The above interpretation is appealing because it highlights the pecularity of the depression. It also gives a reasonable explanation for the counter-cyclical nature of the movements in productivity during the critical years 1992–1993. The interpretation can easily be refined, however.

It is not self-evident that the upward shift in the trend path of aggregate productivity only mirrors an analogous shift in manufacturing. In other industries, too, developments could have been similar.

The interpretation outlined in *Sauramo* (1999) emphasises the role of micro-structural changes at the cost of changes at the plant level. This is mainly due to the influence of *Maliranta'*s (1997) study. Yet, it is reasonable to think that the shift in the trend path of aggregate productivity, and the positive technology shocks, could at least partly reflect shifts in labour demand with shifts reflecting, for example, changes in labour hoarding at the plant level. Recently, Blanchard has argued that the elimination of labour hoarding may have been a major cause for the rise in the share of capital in various countries since the early 1980s (see *Blanchard,* 1997, 1998; *Blanchard* and *Wolfers,* 1999). It is not easy to identify the presence of this factor but in the refinement of the interpretation of *Sauramo* (1999) it is an obvious candidate.

The main purpose of this paper is to refine the interpretation presented in *Sauramo* (1999). The paper aims at analysing whether the upward shift in the trend path of aggregate productivity only reflects a similar shift in manufacturring or whether the shift can be attributed to similar shifts not only in manufacturing but also in other industies. This examination is performed by applying the framework of *Sauramo* (1999) in scrutinizing the developments of output, employment and labour productivity in various industries.

Moreover, in the interpretation of the results I pay special attention to the changes in labour hoarding as a potential determinant of the shifts in productivity trends.

## 2. THE PUZZLE OF 1992–1994: DESCRIPTIVE EVIDENCE FROM VARIOUS INDUSTRIES

A major conclusion drawn in *Sauramo* (1999) was that the shift in the aggregative trend productivity curve in Figure 1 mainly reflects business restructuring and labour reallocation within the manufacturing sector of the economy. The conclusion, which was not based on the analysis of industry-level data, was consistent with studies which utilize micro-data from the manufacturing sector (*Maliranta,* 1997).

The simplest way of analysing the role of various industries as determinants of aggregate productivity is to examine the patterns of productivity developments in these industries. For the purpose of descriptive analysis, the use of annual data would be enough. Because the data should allow one to estimate models which describe dynamic interdependences between output, employment and productivity especially during the critical years of the depression, the use of quarterly data is highly desirable. Even though the construction of reliable quarterly data for various industries is not straightforward, such data can be constructed, albeit not at a very disaggregated level.

Quarterly data on labour productivity for various industries can be constructed by combining data from Quarterly National Accounts and the Labour Force Survey. Labour productivity is measured as real output (real value added) per employed person. It can be argued that the best measure for labour input would be employee-hours and not the number of employed persons. Even though one could construct such data it would most likely be unreliable. (This view is based on the experience I have got from using aggregative data on total employee hours. See *Sauramo*, 1998b.) Furthermore, annual data shows that, for the sake of the argument, it does not make a difference whether one uses data on the number of employed persons or on the number of employees.

The quarterly data for labour productivity cover the period 1976:1–1998:3. The series has one major break (in 1989), which is due to the change in industrial classification. It should not, however, affect the main results of this paper.

The data, which is based on the application of Standard Industrial Classification (SIC) 1995, includes the following industries:

1. Manufacturing (SIC D)
   - wood and paper
   - metal
   - other
2. Energy and water supply (SIC E)
3. Construction (SIC F)
4. Trade (SIC G)
5. Hotels and restaurants (SIC H)
6. Transport and communication (SIC I)
7. Financial intermediation (SIC J).

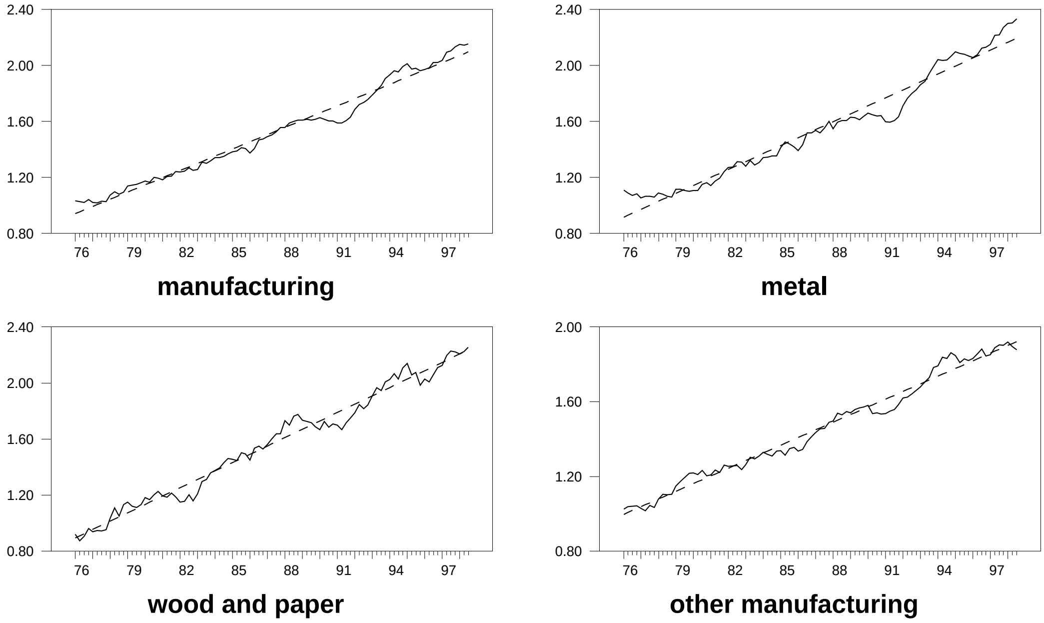
The data comprises major sectors of secondary production and services. It is still highly aggregative but allows one to discuss the patterns of productivity developments in the major sectors of the economy. In particular, it makes possible the comparison of these patterns with that shown by Figure 1.

Figures 2 and 3 summarize the information contained in the data. They depict seasonally adjusted data in logs, and, in addition, linear trends which have been estimated by using all the observations from the period 1976:1–1998:3.

If one compares Figure 1 with Figures 2 and 3, the main conclusion is obvious: the movements in aggregate productivity in the 1990s mirror similar movements in manufacturing. This does not mean that services do not have any role in shaping the pattern of aggregate productivity, but in a somewhat simplified characterization about the pattern of aggregate productivity it can be regarded as a mirror image of the pattern of manufacturing productivity. The developments during the years from 1992 to 1994, for example, are largely explained by similar developments in manufacturing.

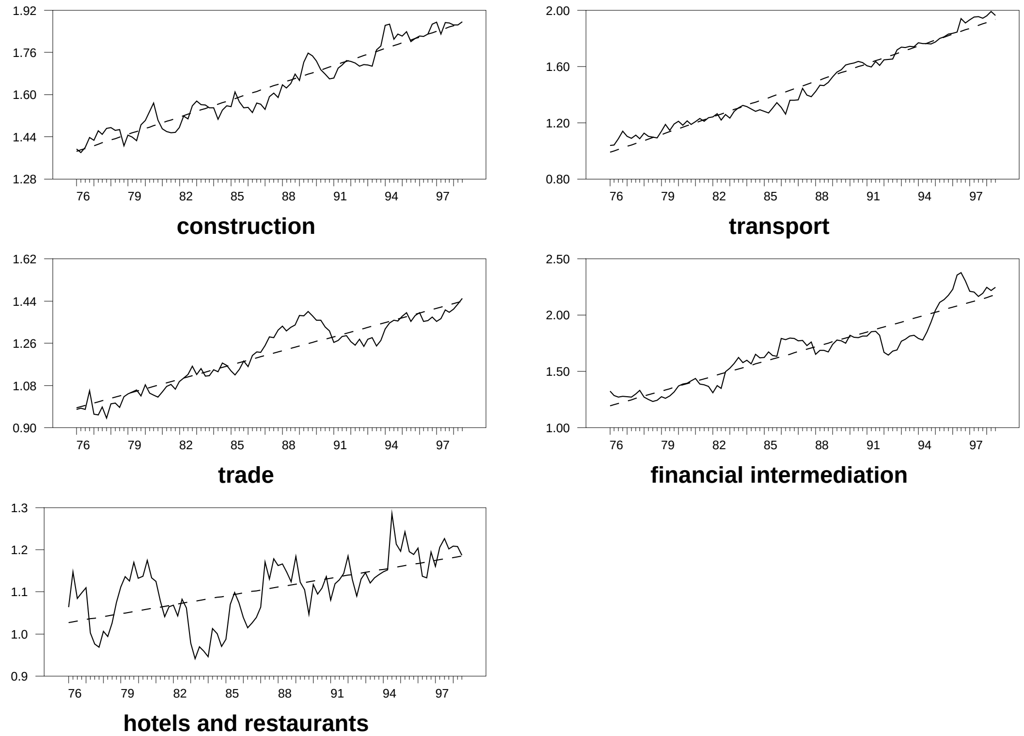
## Figure 2. Labour productivity in manufacturing

*Seasonally adjusted data in levels:1976:1-1998:3*




## Figure 3. Labour productivity in services

*Seasonally adjusted data in levels:1976:1-1998:3*



Futhermore, within manufacturing it is the metal industry in which the shift is seen most clearly, while for the wood and paper industry  it is hard to find a shift. Therefore, the important role which was assigned to manufacturing in *Sauramo* (1999) seems to be justified.

Even though this conclusion, which was based only on descriptive analysis, is worth emphasizing, the use of sectoral-level data enables one to conduct a much richer analysis not only about sectoral developments in productivity but also of the dynamic interdependences between output, employment and productivity. This can be done by applying the same econometric framework which was already used in *Sauramo* (1999). It enables one to compare movements in aggregate and manufacturing productivity in a way which is much more detailed than the way based merely on descriptive analysis.

# 3. THE PUZZLE OF 1992–1994: ECONOMETRIC EVIDENCE FROM VARIOUS INDUSTRIES

The characteristics of productivity developments in various sectors can be seen from the results which are obtained if the econometric analysis which was performed in *Sauramo* (1999) for the whole economy is repeated for each industry separately. The analysis was similar to that of *Gali* (1999), which also discusses the macro-theoretic premises of the approach.

Obviously, not every theoretical model, whether it belongs to the class of Real Business Cycle, new Keynesian or other models, is useful when the issue of "jobless growth" is discussed. The model should have the property that positive technology shocks decrease the level of employment at least in the short run. *Gali's* (1999) model has this property. It is a simple representative agent model with monopolistic competition, sticky prices and variable effort. The basic feature of the model is that predetermined prices imply that aggregate demand and output remain unchanged during the period when the technology shock occurs. If the technology shock is positive, the same output can be produced by less input.

When a bivariate structural VAR model is used, one can identify two shocks. As already mentioned, the critical assumption in the identification of technology shocks is the following: only technology shocks can have a permanent influence on the (reference) level of productivity. (Two additional constraints, which guarantee just-identification, are given by the assumption that shocks are mutually orthogonal and that their variances equal unity.) This means that only technology shocks can shift the productivity trend, which is stochastic, upwards or downwards. The way technology shocks are identified implies that the other type of shocks, non-technology shocks, can have only a transitory effect on the level of productivity. Non-technology shocks, can, however, have a permanent effect on the level of real output, a feature which contrasts with the vertical Phillips curve paradigm. (*Sauramo,* 1998a, discusses – and questions – the relevance of this paradigm in the case of Finland.)

Even though it is not clear in advance whether the non-technology shocks should be interpreted as aggregate demand or aggregate supply shocks, in *Sauramo* (1999) they were regarded as aggregate demand shocks, because within the aggregate demand – aggregate supply framework that was the most convenient interpretation: positive non-technology shocks increased output and the demand for labour while also increasing labour productivity. They were the cause of pro-cyclical movements in productivity.

In *Sauramo* (1999) the bivariate VAR model described joint dependence between productivity and real output. By definition the model also described joint dependence between productivity and labour input.

The most important result was that it was the sequence of positive technology shocks which shifted the aggregate productivity trend upwards between 1992 and 1994 (see Table 4). They also reduced demand for labour and, consequently, were the major cause of the sluggish employment growth in 1994 (Table 5). As already noted, probably the best way of interpreting technology shocks is to regard them as shocks which reflect business restructing and labour reallocation across various establishments within the manufacturing sector of the economy.

If this interpretation is correct, one should be able, by using industry-level data, to produce a similar kind of result. In particular, the results from the use of data on the manufacturing should be consistent with this interpretation.

## Econometric evidence from manufacturing

The consistency is checked by first estimating a bivariate productivity-output model using data on manufacturing (SIC D) and proceeding in a similar fashion as in *Sauramo* (1999). In the comparison of the results I utilize impulse responses, forecast-error variance decompositions and historical forecast-error decompositions. I also make similar considerations for the wood and paper, metal and other manufacturing industries.

According to the standard Augmented Dickey-Fuller tests (log of) manufacturing output (y) and (log of) labour productivity (y-n) are integrated of order one. (This is true for all sectoral-level series represented before). To achieve stationarity, first-differencing is therefore necessary.

The estimation of the unconstrained reduced form is based on the assumption that $x_t = (\Delta y_t - \Delta n_t, \Delta y_t)$ is a covariance stationary process. The model is, therefore, estimated in the first-difference form. Three lags are used, with Schwarz and Hannan-Quinn information criteria being the main decision-making criteria. The estimation period is 1977:1–1998:3.

The identification of the two shocks takes place in a similar fashion as in *Sauramo* (1999).

Figure 4 displays the impulse responses associated with the two shocks together with one-standard error confidence bands. Variables are expressed in levels. The impulse responses for the number of employed persons can be derived after computing impulse responses for productivity and output. Confidence bands for impulse responses were computed by utilizing a Monte Carlo method which is based on sampling from the estimated asymptotic distribution of the VAR coefficients and the covariance matrix of the innovations. In each draw the sample size amounted to 500.[1]

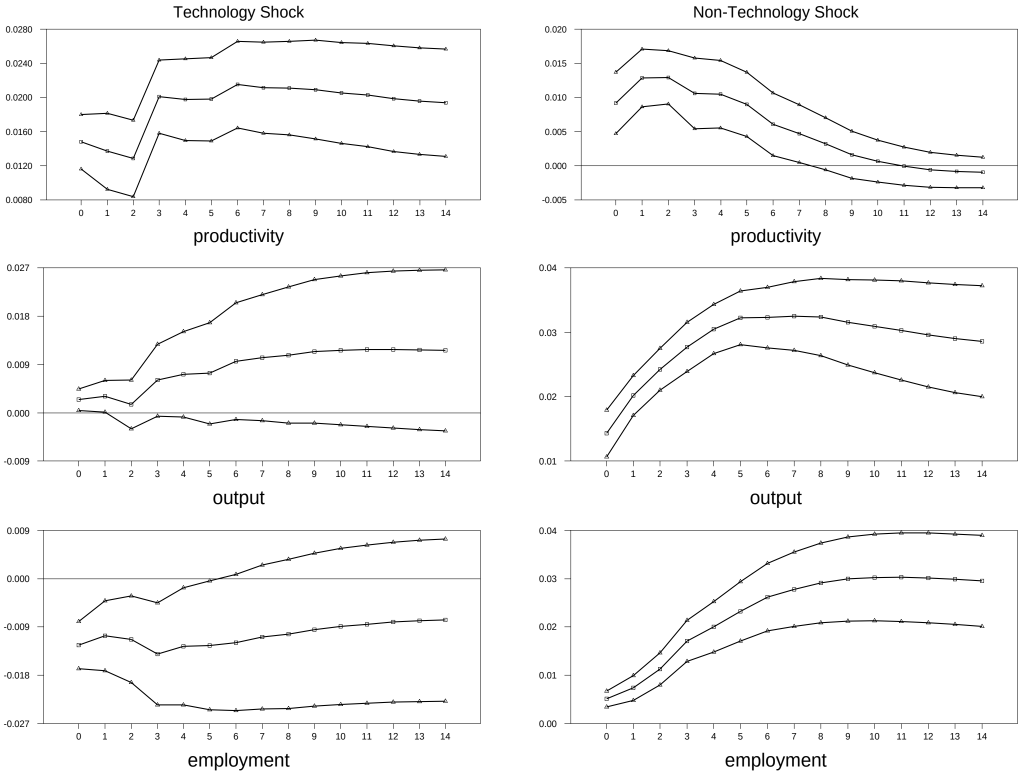
In the figure the left-hand panel depicts the responses to the shock, which is supposed to be a positive technology shock. They are consistent with that kind of interpretation. The positive technology shock increases the level of productivity both in the short and longer run. It has a slightly positive short-run effect on the level of output, but it decreases employment at least in the short run.

The right-hand panel of Figure 4 shows impulse responses which are associated with the non-technology shock. A positive non-technology shock is expansionary. It increases output and employment both in the short and long run. It also has a positive effect on the level of productivity in the short run. By definition, the shock does not affect the level of productivity in the long run. The responses are consistent with the interpretation that the non-technology shock is a demand shock. Impulse responses in Figure 4 are very similar to those in Figure 3 in *Sauramo* (1999). The only minor difference is that, in manufacturing, positive technology

[1] I owe special thanks to Jordi Gali for kindly providing the RATS code for performing the computations.

## Figure 4. Impulse responses: manufacturing

*productivity -output -model*




shocks may be expansionary in the short run while the effect is more clearly ambiguous in the aggregative analysis. This is consistent with the view that supply shocks play a more important role in determining manufacturing output than GDP. Forecast-error variance decompositions also support this view. (They are available upon request.)

Tables 1 and 2, which display the decompositions of eight-quarter forecast errors for labour productivity and employment, illustrate the relative importance of the two shocks as the sources of movements in labour productivity and employment in the 1990s.

The figures are yearly averages calculated by using quarterly observations. Eight quarters were chosen because the forecast errors reflect closely enough cyclical variation in the series. The figures in Table 1 should be interpreted as follows. In 1991 the eight-quarter forecast error for productivity was -9.1 per cent, i.e. the realized level of productivity was 9.1 per cent lower than the forecast by the model. (Owing to the way of computing the forecast errors, they are not exactly the same as relative forecast errors. See the note in Table 1.) Of this error, -1.3

percentage points was due to the technology shock and -7.8 percentage points to the demand shock.

Table 1 is consistent with the interpretation that positive technology shocks in manufacturing were the main causes of the shift in the aggregate productivity trend during the years 1992–94. Positive technology shocks in Table 1 play even a more important role than they played in the corresponding Table 4 in *Sauramo* (1999). The shift in the productivity trend was bigger in manufacturing than it was in the whole economy.

**Table 1.** Decomposition of eight-quarter forecast errors for productivity in manufacturing: productivity – output model (yearly averages for 1990–1998)

| Year | Productivity | Technology shock | Demand shock |
|---|---|---|---|
| 1990 | -9.0 | -6.6 | -2.4 |
| 1991 | -9.1 | -1.3 | -7.8 |
| 1992 | -0.1 | 2.6 | -2.7 |
| 1993 | 6.0 | 6.3 | -0.3 |
| 1994 | 9.2 | 7.2 | 2.0 |
| 1995 | 1.7 | 0.1 | 1.6 |
| 1996 | -3.4 | -3.6 | 0.2 |
| 1997 | 5.3 | 1.6 | 3.7 |
| 1998 | 6.3 | 3.5 | 2.8 |

Note: Forecast errors of the first column are based on the use of the level form of the model. The forecast errors have been obtained by subtracting the forecasts from the logs of the realized levels of productivity. For the year 1998 averages have been calculated by using figures from the first three quarters.

Even though the best way of interpreting technology shocks might be to interpret them as mirroring structural changes in manufacturing, they may at least partly mirror abnormal labour hoarding behaviour. This interpretation is supported by negative technology shocks (in 1991). Within the framework of this paper, the elimination of labour hoarding, which is an example of abnormal behaviour, would be reflected in positive technology shocks. On the other hand, demand shocks should be the source of the normal pro-cyclical pattern of movements in productivity (see Figure 3). The normal pattern is clearly apparent in 1991.

Therefore, if one only utilizes macro and not micro data, one gets support for the view that the elimination of labour hoarding may have been an important factor which has decreased the demand for labour in Finland, especially during the years from 1992–1994. (For a discussion about changes in labour hoarding, see *Blanchard,* 1997,1998; *Blanchard* and *Wolfers,* 1999.) However, the micro-evidence presented by *Maliranta* (1997) does not provide a major role for this factor. Obviously, there is scope for further investigation – not least because of the fact that the last year in Maliranta's study is 1994.

Table 2 also confirms the interpretation of *Sauramo* (1999). During 1993–1994 positive technology shocks, while expanding production, still dampened employment – and were the major cause of "jobless growth".

**Table 2.** Decomposition of eight-quarter forecast errors for the number of employed persons in manufacturing: productivity – output model (yearly averages for 1990–1998)

| Year | Employment | Technology shock | Demand shock |
|---|---|---|---|
| 1990 | 2.5 | 4.2 | -1.7 |
| 1991 | -9.5 | 0.6 | -10.5 |
| 1992 | -14.1 | -2.0 | -12.1 |
| 1993 | -3.4 | -4.4 | 1.0 |
| 1994 | -5.0 | -4.6 | 0.4 |
| 1995 | 6.2 | 0.7 | 5.5 |
| 1996 | 2.8 | 2.0 | 0.8 |
| 1997 | 1.6 | -1.5 | 3.1 |
| 1998 | 5.3 | -2.3 | 7.6 |

Note: See note in Table 1.

Figure 2 suggests that it is the metal industry which has, within manufacturing, played the most important role as a cause of the shift in the trend of manufacturing productivity. The econometric analysis, which is based on the replication of the above analysis by using data on the metal industry, is consistent with this interpretation. This can be seen from Table 3. Rapid productivity growth during the years 1993–94 is almost completely attributed to positive technology shocks. Positive technology shocks have also maintained rapid growth during the latter part of the 1990s.

**Table 3.** Decomposition of eight-quarter forecast errors for productivity in the metal industry: productivity – output model (yearly averages for 1990–1998)

| Year | Productivity | Technology shock | Demand shock |
|---|---|---|---|
| 1990 | -5.5 | -4.5 | -1.0 |
| 1991 | -12.5 | -7.8 | -4.7 |
| 1992 | 0.6 | 1.6 | -1.0 |
| 1993 | 15.8 | 16.7 | -0.9 |
| 1994 | 13.2 | 11.9 | 1.3 |
| 1995 | 3.4 | 0.3 | 3.1 |
| 1996 | -4.1 | -4.6 | 0.5 |
| 1997 | 5.5 | 4.2 | 1.3 |
| 1998 | 12.3 | 11.4 | 0.9 |

Note: See note in Table 1.

On balance, econometric evidence from manufacturing supports the interpretation in which the role of manufacturing, and the role of technology shocks, is highlighted. However, it also illustrated how difficult the interpretation of technology shocks is. Beside reflecting business restructuring and labour reallocation they most likely reflect abnormal labour hoarding behaviour within manufacturing plants. Unfortunately, by only utilizing macro-data it is impossible to assess the relative importance of these factors for productivity developments. In this respect, my analysis has, instead of giving good answers, given rise to some important further questions.

## Econometric evidence from services

Even though the interpretation of technology shocks turned out to be a very knotty task when the data on manufacturing was used, the analysis was rewarding in the sense that both types of shocks, technology shocks and demand shocks, were reasonable. Positive technology shocks, while increasing productivity, decreased the demand for labour at least in the short run - an essential feature, which was consistent with the theoretical model. This result was obtained in every case when the four data sets (manufacturing, wood and paper, metal, other manufacturing industries) were used. Furthermore, in every case the other shocks could be interpreted as demand shocks. Positive demand shocks, while increasing output and employment, also increased productivity, and therefore produced pro-cyclical movements in productivity.

By contrast , when data on service sectors was used, the identification of reasonable shocks was not straightforward. Obviously, this is related to the difficulty in measuring output in certain services. In some sectors the contribution to gross domestic product (GDP) is measured by labour inputs rather than outputs. This kind of procedure is bound to affect the results which are based on modelling dynamic interdependences between output, employment and labour productivity in some service sectors.

In the econometric analysis which was based on the use of five data sets (construction, trade, hotels and restaurants, transport and communication, and financial intermediation) this was reflected in the difficulty in identifying two reasonable shocks. In particular, the identification of relevant non-technology (demand) shocks was difficult. In some cases (trade, transport) a positive non-technology shock could produce a statistically significant negative response to productivity. The increase in employment was bigger than the increase in output. Typically, and not surprisingly, the responses reflect a very close relationship between movements in output and employment.

This does not mean that productivity developments in services have not contributed to producing the special features of the developments depicted in Figure 1. Because of the difficulty in identifying shocks, it is, however, difficult to give a satisfactory shock interpretation for some specific episodes. One way of summarizing the role of services is as follows. As a source of rapid aggregate productivity growth, positive technology shocks in the service sector did not play any role during 1992-93 but may have had some importance in 1994. Furthermore, their role in maintaining the new trend during the latter part of the 1990s is obvious.

Perhaps the best example is given by financial intermediation. As shown by Figure 3, there is a big upward shift in the labour productivity trend in this sector. According to the econometric analysis this shift was caused by positive technology shocks. Obviously, these shocks reflect the drastic reconstruction of the Finnish banking sector. As is well known, the reorganization involved both business restructuring and downsizing (elimination of labour hoarding). The results for this sector support the view that, within the framework of this study, positive technology shocks may mirror both business restructuring and changes in labour hoarding. So far there does not exist micro-evidence which could be utilized in the interpretation of shocks.

## CONCLUSIONS

The main result of my previous analysis (*Sauramo,* 1999) was that the years from 1992 to 1994 constitute a very special period.  During that period the relationship between employment growth  and output growth was exceptional. The pecularity was reflected in rapid productivity growth, which led to an upward shift in the productivity trend. Within the framework of the study, the shift, and the unusual connection between employment and GDP growth, was due to positive technology shocks which dominated the developments of productivity and employment.

The examination was based on the use of a highly aggregative measure of productivity (real GDP per employee), which made the interpretation of the results less clearcut. Drawing on the study by *Maliranta* (1997),  which employs micro-data on manufacturing industries, I interpreted the technology shocks reflecting business restructuring and labour reallocation, mainly in manufacturing, rather than reflecting within-plant improvements in technology.

In this paper I continued the analysis by utilizing industry-level data. The data, even though it was aggregative, allowed me to analyse whether the upward shift in the trend of aggregate productivity only mirrors changes in manufacturing or whether it is apparent in other industries, too. The results show that the shift mainly mirrors a similar shift in manufacturing, and in particular within the metal industry . This is particularly true for the years 1992–93. For 1994, positive technology shocks in some services may also have contributed to the shift. Moreover, upward shifts in some service sectors may have maintained the shift in the aggregative trend in the latter part of the 1990s.

The analysis was based on the estimation of very simple bivariate VAR models, which could be rationalized by a new Keynesian dynamic general equilibium model (*Gali,* 1999). The advantage of the approach was that, by using a very simple econometric model, one could start to discuss the role of technological and structural change as a factor affecting the demand for labour in Finland. The disadvantage, which is inherent when such simple aggregative models are used, was that the interpretation of technology shocks was very difficult.

The analysis conducted in this paper supports, by and large, the interpretation presented in *Sauramo* (1999). However, beside reflecting business restructuring and labour reallocation, technology shocks may also reflect changes in labour hoarding at the plant level. The elimination of labour hoarding is reflected in positive technology shocks.

Without micro-evidence a pertinent interpretation of technology shocks is impossible. For manufacturing there was such evidence but for services that kind of evidence is, at present, not available. Studies which are based on the use of such data would therefore be invaluable (see *Foster*, *Haltiwanger* and *Krizan,* 1998).

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