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THE U.S. EXPANSION: WAS IT DEMAND- OR SUPPLY-LED?

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TIIVISTELMÄ

Tässä tutkimusselosteessa analysoidaan viimeisintä Yhdysvalloissa koettua nousukautta. Voiko sitä pitää kysyntä- vai tarjontajohteisena korkeasuhdanteena? Tähän kysymykseen vastaamisessa kiinnitetään erityishuomio niin sanotun uuden talouden merkitykseen nousukauden luonteen muovaajana. Onhan uutta taloutta pidetty keskeisenä syynä Yhdysvalloissa 1990-luvun jälkipuoliskolla koettuun työn tuottavuuden kasvuvauhdin ripeytymiseen. Ripeää työn tuotavuuden kasvua on puolestaan pidetty osoituksena siitä, että talouskasvu on ollut oleellisilta osiltaan tarjontajohteista. Kysyntätekijöitä korostavissa tulkinnoissa painotetaan talouskasvun velkavetoisuutta.

Tutkimusselosteessa esitetyn analyysin perusteella sekä kysyntä- että tarjontatekijät ovat muovanneet noususuhdannetta. Viime vuosikymmenen puolivälissä alkaneen korkeasuhdanteen alkuvaiheessa kysyntätekijöillä oli keskeinen merkitys. Nousukauden pituutta ja siihen liittynyttä ripeää työn tuottavuuden kasvua on kuitenkin vaikeata selittää pelkästään kysyntätekijöillä. Tarkastelujen perusteella tuottavuuden kasvua kiihdyttäneet tarjontatekijät, muun muassa uuteen talouteen liittyneellä teknologiset edistysaskeleet, pitkittivät voimakasta kokonaistuotannon kasvua. On kuitenkin mahdollista, että uuden talouden tuottavuuden kasvua kiihdyttänyt vaikutus kuvastaa lähinnä ripeätä työn tuottavuuden kasvua uuden talouden toimialoilla (ns. ICT-sektorilla) eikä uuden talouden vaikutuksia talouden muilla toimialoilla. Viime vuonna alkanut korkeasuhdanteen taittuminen johtuu kysynnän kasvun hiipumisesta.

Tarkastelut perustuvat yksinkertaisten rakenteellisten VAR-mallien estimoimiseen. Niiden teoreettisena perustana voi pitää hintajäykkyyksiin ja monopolistiseen kilpailuun tukeutuvia uuskeynesiläisiä malleja.

JEL-luokittelu: E32, E66, J24, J23

Asiasanat: suhdannevaihtelut, työn tuottavuus, uusi talous

ABSTRACT

This paper analyses the nature of the US expansion. Can it be characterized as a demand- or supply-led boom? In answering this question, the paper also analyses the importance of the "new economy" in shaping economic developments in the US during the late 1990s and at the start of the new century.

The analysis is based on the estimation of simple structural VAR models which can be rationalized by a class of New Keynesian models with sticky prices and monopolistic competition. By using data on the nonfarm business sector for the period 1972:1–2001:2, a decomposition of output, labour productivity and hours into technology (aggregate supply) and non-technology (aggregate demand) components is estimated and utilized when the nature of the expansion is analysed.

The paper shows that during the recovery growth in real output in the nonfarm business sector was mainly demand-led until 1998. Thereafter the importance of technology shocks started to increase, and during the latter phase of the expansion the role of technology shocks was dominant. It was most apparent in 2000. On the other hand, aggregate demand shocks have had a strong dampening effect since the beginning of 2000.

Rather than providing evidence of a "new economy", the importance of technology shocks may only reflect very rapid – and supply-led – growth in the manufacture of electronic equipment with no spillover effects on the rest of the economy.

JEL Classification: E32, E66, J24, J23

Keywords: Business cycles, labour productivity, new economy

1. INTRODUCTION

During the late 1990s the US economy surpassed the expectations of most economic forecasters and more ordinary observers, policy makers included. It induced stronger growth, higher employment and lower unemployment without inflation than most other advanced countries. But why?

Typically, economists are unable to reach any agreement in answering questions like that. Nevertheless, in interpreting the causes of the US expansion, their views have differed widely. One explanation for this might be that, during the 1990s, economic developments were viewed through a completely new framework, which is based on the notion of the New Economy.

The proponents of the New Economy revolution argue that information and communications technology (ICT) has, with globalization, created new rules for the US economy. As a consequence of this revolution, the US economy experienced the longest expansion ever, with strong labour productivity growth during the latter part of the 1990s being the most important indication of the New Economy. According to the New Economy view, the US expansion was, by reflecting rapid development in information and communications technology, mainly supply-led. The most enthusiastic proponents of the New Economy even talked about the death of the business cycle, the death being a consequence of permanently strong, "structural" growth.

Even though the New Economy interpretation of the expansion has become very popular it is clearly controversial. At the time of writing (August 2001[1]) it is obvious that the talk about the death of the business cycle is misleading, or simply absurd. Recent economic developments are hard to interpret without taking into account factors which mainly operate, not through aggregate supply, but through aggregate demand.

[1] Actually, this is a slightly revised version of the paper written in February 2001. The most important change is that the most current data on the first and second quarters of 2001 has been utilized in the estimations.

Not surprisingly, major alternative interpretations of the expansion emphasize the role of aggregate demand as the main determinant of economic developments during the latter part of the 1990s. It is simplifying to characterize the discussion about the causes of the expansion by providing only one major alternative to the New Economy view but, anyway, the best way of illustrating the different standpoints of the discussion is to compare the New Economy view with the following interpretation: it was the very strong growth of aggregate demand which caused the expansion. Furthermore, rapid growth of aggregate demand, and therefore of GDP, was to a large extent debt-driven. The private sector of the economy borrowed on an increasing scale, which was maintained by the huge increase in asset prices. Rather than being "structural", strong growth was fundamentally unsustainable, because debt-induced imbalances cannot widen endlessly. This "strong" version of a demand-led expansion also includes a hard landing with a severe financial crisis.

These two interpretations about the causes of the expansion are almost diametrically opposite. But which one is more accurate? In this paper, my main aim is to assess the relative merits of the two interpretations. Obviously, the "best" interpretation of the expansion is given by a synthesis of the two interpretations, because both demand and supply factors have been driving the economy. This does not mean, however, that it is worthless to ask which ones have been more important.

According to the latest economic information, the most enthusiastic advocates of the New Economy view have been wrong in declaring the death of the business cycle. This does not imply that supply factors did not play an important role in the late 1990s, but it does indicate that demand factors have most probably dominated economic developments lately.

In assessing the relative merits of the two basic interpretations of the expansion I attempt to quantify the relative importance of the demand and supply factors in shaping the nature of the boom. I shall pay special attention to analysing developments in labour productivity and employment beside movements in real output.

In order to quantify the relative importance of demand and supply factors, I need an econometric model. The analysis is based on the estimation of very simple structural VAR models, which may be the simplest way of conducting the investigation. The framework I shall utilize is adopted from *Galí* (1999). As far as the framework is concerned, there is

therefore nothing original in my investigation. For my purpose *Galí*'s model is useful because it enables one to analyse the importance of technological progress within a very simple macroeconomic framework.

When structural VAR models are used in modelling the business cycle, a shock interpretation about the causes of economic fluctuations is given. Shocks, which can normally be classified as being either aggregate demand or aggregate supply shocks, are transformed into business cycles through (linear) propagation mechanisms.

Galí's (1999) main aim was to analyse how well technology shocks have explained aggregate fluctuations in the US and other G7 countries. He debates with the proponents of the Real Business Cycle (RBC) theory about the importance of technology shocks as the main source of business cycles. My main aim is clearly different from that of *Galí*'s. Because his analysis covers the period 1948–1994, he does not discuss the causes of the latest economic expansion of the US. Unlike *Galí* (1999) I concentrate solely on the developments of the late 1990s in the US. My aim is not to debate with the advocates of the RBC school even though the results of my analysis may complement Gali's analysis in concerning some parts.

Because an essential ingredient of the New Economy view is the step-up of labour productivity growth which took place after 1995, productivity is, in addition to real output, my main concern of interest. By definition, this implies that I pay special attention to considering movements in employment, too. The appealing feature in Galí's framework is that one does not need more than two variables in order to start to analyse the relative importance of aggregate demand and aggregate supply shocks in explaining the US expansion. But, of course, strong and controversial assumptions have to be made when the shocks are identified.

When structural VAR models are employed in modelling developments in output, employment and productivity, the identification of the relevant shocks which drive movements in these variables becomes the crucial issue. In the identification of his model, *Galí* (1999) utilizes a new Keynesian dynamic general equilibrium model, which gives the necessary identifying restrictions. These are also utilized in this paper.

Even though the framework of this paper is very simple, or even simplistic, it turns out to be useful in assessing the relative merits of the two interpretations of the US expansion. The

main conclusion of the analysis is that neither the New Economy nor the Aggregate Demand view alone provides a telling interpretation of the expansion.

In the mid 1990s, when GDP growth started to accelerate, factors operating through aggregate demand played the major role. These factors shaped movements in GDP up until 1998, when the importance of supply factors, i.e. technology shocks, started to rise. After 1998 technology shocks played an important role in the maintenance of the expansion. Beside dominating movements in labour productivity they also strongly contributed to buoyant output growth.

Interestingly, even in 2000 factors operating through aggregate demand had a strong negative influence on GDP growth.

Even though the New Economy interpretation of the expansion cannot be ignored, the mechanism through which the ICT revolution may have affected the economy remains largely unsolved. The importance of the New Economy may reflect very rapid – and supply-led – growth of electronic equipment with no spillover effects on the rest of the economy. Because of the simplicity of the model, a detailed discussion about the role of the New Economy is impossible. Nevertheless, the New Economy seems to have been a major factor in postponing the end of the expansion.

2. THE U.S. EXPANSION OF THE 1990S: TWO MAIN CHARACTERISTICS

After the Second World War the US economy experienced a period of rapid output and productivity growth, which, however, slowed down at the start of the 1970s. In this paper, I shall not discuss the causes of the slowdown. For the investigation of this paper it is essential to recognize that the mid 1990s clearly marked the end of the period of slow growth in output and productivity. This can be seen from Figures 1 and 2, which depict

developments of output and labour productivity in the nonfarm business sector. In 1996 it accounted for about 76 per cent of GDP.

The data in Figures 1 and 2 is quarterly data which is constructed by the Bureau of Labor Statistics. It is seasonally adjusted index data with 1992=100. (Figures 1 and 2 display logs of the data.) Labour productivity is defined as the real output produced per hour. The data covers the period 1972:1–2001:2.

The choice of the year 1972 as the starting year is not arbitrary nor is it imposed by the availability of the data. The statistics could cover a longer period: 1948:1–2001:2. Because my aim is to analyse the expansion of the 1990s by comparing it with the most relevant path of trend growth, a natural choice for the starting year of that period is the year 1972. It can be regarded as the starting year of the period of slow growth.

Figures 1 and 2 clearly show that the period since 1995 creates a structural break with the years 1972–95, and, consequently, the acceleration of both GDP and productivity growth are the two main characteristics to be explored in this paper. Even though the US economic history preceding 1972 will not be discussed in this paper, it must be remembered that, if the whole postwar economic history had been taken into account, the expansion of the 1990s would look less remarkable and strong (see, for example, *Zarnowitz*, 2000).

Looking only at Figures 1 and 2, it is tempting to argue that, since 1995, output has mainly been productivity-led. It would imply that the New Economy view provides a telling interpretation of the expansion. This conclusion is too hasty, however. For example, productivity is normally procyclical. During expansions, when output grows faster than the trend, productivity also grows faster than normally, since hours do not adjust completely to movements in output. Therefore, Figures 1 and 2 may only reflect procyclical productivity growth. Furthermore, one has to carefully analyse comovements between output, productivity and also hours before any conclusion about the nature of output growth can be drawn. (Figure 3 illustrates changes in hours during 1972:1–2001:2.)

Because mere visual inspection may lead to false conclusions, econometric analysis may provide invaluable additional information. In what follows, I analyse comovements between output, hours and productivity by estimating simple structural VAR models which utilize *Galí*'s (1999) framework.

3. THE FRAMEWORK

If one wants to assess the validity of the two interpretations of the expansion by estimating structural VAR models, one should be enable to identify shocks which can be classified as being aggregate supply and aggregate demand shocks. Furthermore, within the class of aggregate supply shocks one should be able to identify technology shocks, because the New Economy view is based on the important role of those shocks.

Galí's (1999) model fulfils these requirements in a most economical way because it leads to the estimation of two-variable VAR models. If one uses VAR models in investigating the importance of the New Economy, the identification of technology shocks becomes the crucial issue. Of course, there does not exist a unique way of estimating these shocks. One can rationalize some specific identifying restrictions by utilizing alternative theoretical models which provide the relevant restrictions.

In this paper I follow *Galí* (1999) and identify technology shocks by using the following critical assumption: only technology shocks have a permanent effect on the level of labour productivity. In the econometric analysis, this also means that only technology shocks can cause permanent shifts in trend productivity.

A wide class of theoretical models fulfills this restriction. It includes both real business cycle (RBC) models and new Keynesian models, of which *Galí*'s model is one example. 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 model is a representative agent model with monopolistic competition, sticky prices and variable effort. The basic feature of the model is best seen in the special case when money supply is assumed to be exogenous. In that case a constant money supply and predetermined prices imply that real balances and, consequently, 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.

This kind of response is not consistent with predictions of the conventional RBC models. In those models positive technology shocks, by shifting demand for labour schedules, have an immediate positive effect on the level of employment.

Gali's (1999) model is only one alternative among various models which can be used when the central identifying restriction is rationalized (for a discussion, see also *Basu*, *Fernald* and *Kimball* 1998). Its attractiveness is in its simplicity, which is achieved by some strong assumptions, however. It will be seen that one has to pay for the simplicity: if the economy is assumed to be driven by only two shocks, it is obvious that they may reflect various factors, some of which have not been captured by the theoretical model under consideration.

When a two-variable model is used, one can identify two types of shocks. The way technology shocks are identified means that the other type of shocks, non-technology shocks, can have only a transitory effect on the level of productivity. Non-technology shocks, which can be aggregate demand shocks, can, however, have a permanent effect on the level of real output. In their pioneering work *Blanchard* and *Quah (1989)* separated aggregate supply shocks from aggregate demand shocks by assuming, in the spirit of the vertical long-run Phillips curve paradigm, that only aggregate supply shocks could have a permanent influence on real output. The assumption is stronger than the one used in this paper.

The identification of technology shocks can be based on the estimation of bivariate models which utilize data on real output and labour input. For example, *Galí* (1999) estimates models with labour productivity and labour input being the two variables. I will estimate bivariate models which describe joint dependence between productivity and real output. By definition, the models also describe joint dependence between productivity and labour input.

4. THE U.S. EXPANSION OF THE LATE 1990S: THE ROLE OF THE NEW ECONOMY

Within the framework of this paper, the assessment of the two interpretations is based on answering the following central question: what has been the role of technology shocks in explaining movements in real output since 1995? The more important the role they have played, the more relevant is the New Economy interpretation of the expansion.

The answer is based on the results from the estimation of a two-variable productivity-output model. Figures 1, 2 and 3 depict the data in the level form (in logs). According to the standard Augmented Dickey-Fuller tests (log of) output (y) and (log of) labour productivity (y-h) are integrated of order one. To achieve stationarity, first-differencing is therefore necessary.

The unconstrained reduced form of the model is estimated in the first-difference form assuming that $x_t = (\Delta y_t - \Delta h_t, \Delta y_t)$ is a covariance stationary process. Three lags are used, with Schwarz and Hannan-Quinn information criteria being the main decision-making criteria. The estimation period is 1972:1–2001:2.

The identification of the two shocks takes place in a similar fashion as in numerous recent studies which utilize long-run identifying restrictions. In the two-variable case three constraints are needed for just-identification. As described earlier, the two types of shocks, technology shocks and non-technology shocks, are separated by the long-run restriction: only technology shocks have a permanent influence on the level of productivity (or its trend). Two additional constraints are given by the assumption that shocks are mutually orthogonal and that their variances equal unity.

The manner in which technology shocks are defined implies that only technology shocks can cause shifts in the productivity trend, which is stochastic. Since the equations of the unconstrained reduced form contain constants, the productivity trend has a deterministic drift component, however. It describes the average growth rate over 1972:1–2001:2.

Even though the other shock, the non-technology shock, affects the level of productivity only temporarily, it can have a permanent effect on the level of real output. In *Gali*'s (1999)

theoretical model the other shock was a monetary shock, i.e. an aggregate demand shock. Within the empirical two-variable framework of this paper it is impossible to say in advance whether the other shock is best regarded as an aggregate demand or aggregate supply shock. I illustrate the nature of the shocks by impulse responses and forecast-error variance decompositions.

Figure 4 displays the impulse responses associated with the two shocks together with one-standard error confidence bands.[2] Variables are expressed in levels even though the model was estimated in the difference form. The impulse responses for hours are easy to derive 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.

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. A positive technology shock increases the level of productivity both in the short and longer run. It also leads to an immediate, and permanent, increase in output. Its short-run effect on hours appears to be negative, albeit almost immediately statistically insignificant (see also *Galí*, 1999, Figure 2).

The right-hand panel of Figure 4 depicts 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 an aggregate demand shock.

For the argument of this paper it is important that the other shock could be regarded as an aggregate demand shock. In order to get more information about the nature of the shocks, I estimated a three-variable productivity-output-prices model (with producer price index of the nonfarm business sector being the price variable), identified the shocks in an analogous

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

manner and checked how prices (or inflation) responded to the technology shock and to the shock which was supposed to be an aggregate demand shock.

The responses were consistent with the standard aggregate demand - aggregate supply framework. A positive technology shock was deflationary. Furthermore, of the two other shocks the relevant one (corresponding to the non-technology shock in the two-variable case) could be regarded as an aggregate demand shock, i.e. positive shocks were inflationary. (The results are available upon request.)

In what follows, I will therefore regard the non-technology shock as an aggregate demand shock.

However, in a fresh paper *Francis* and *Ramey* (2001) argue, within the RBC framework, that the other shock could be interpreted as a shock to the marginal rate of substitution between goods and leisure. If that were the proper interpretation, the story about the expansion would change drastically. Obviously, more research is needed in examining the nature of the shocks within *Galí*'s framework.

Tables 1 and 2 illustrate how the two shocks shape fluctuations in output and productivity. Aggregate demand shocks are the most important source of fluctuations in output.

In particular, most of the short-run variation of real output is accounted for by these shocks. The role of technology shocks becomes more important when the time horizon lengthens.

By contrast, technology shocks are clearly the most important source of movements in productivity also in the short-run. By definition, they explain all of the long-run variation.

Analogous decomposition for hours would show that changes in employment are almost completely attributable to aggregate demand shocks. (The table is available upon request.)

Even though most of the short-run fluctuations in output are attributable to aggregate demand shocks, this does not mean that technology shocks have not had any role in affecting GDP growth since 1995. Within the VAR framework, the importance of the two shocks in explaining the causes of the expansion can be evaluated with the help of a historical decomposition, which describes the contribution of three factors, the two stochastic shocks and a deterministic drift term, to GDP growth.

Table 1. Forecast-error variance for output in the nonfarm business: productivity-output model

Horizon in quarters	Technology shock	Demand shock
Contemporaneous	19	81
4	17	83
8	28	72
12	32	68
16	34	66
20	35	65
24	35	65
100	38	62

Note: In the table the forecast error variances have been decomposed to two sources. For instance, of the 4-step forecast error variance of output 17 per cent is accounted for by the technology shocks and 83 per cent for demand shocks.

Table 2. Forecast-error variance for productivity in the nonfarm business: productivity-output model

Horizon in quarters	Technology shock	Demand shock
Contemporaneous	80	20
4	85	15
8	92	8
12	94	6
16	96	4
20	97	3
24	97	3
100	99	1

Note: See note in Table 1.

The idea of this decomposition is based on Herman Wold's famous Decomposition Theorem: every stationary stochastic process x_t can be expressed as the sum of two uncorrelated processes y_t and z_t, $x_t = y_t + z_t$, where z_t is a deterministic process and y_t is a process with the moving average representation

$$y_t = \sum_{i=0}^{\infty} \Phi_i u_{t-i},$$

where Φ_0 is an identity matrix, and u_t a white noise process (see, for example, *Lütkepohl*,1993, p. 20).

This theorem can be applied to vector-valued processes, and it can be used when realizations of processes are analysed. Accordingly, it can be utilized when moving average representations of VAR processes are analysed.

Output growth 1995:1–2001:2: the importance of technology and demand shocks

Figure 5 depicts the historical decomposition of output series for the period 1995:1–2001:2 and, accordingly, illustrates the contributions of technology and demand shocks, and the deterministic part to movements in GDP. Because the decomposition, although it is represented in levels, is based on the difference form of the model, the initial level of output at 1994:4 is set to zero.

The figure consists of four series: the actual output series (with the above scaling), the deterministic part (the forecast of the model for output in the absence of shocks during 1995:1–2001:2), the deterministic part in combination with the contribution of technology shocks to output, and the deterministic part in combination with the contribution of aggregate demand shocks to output.

It is Figure 5 which shows the relative importance of the two shocks in shaping fluctuations in output in the nonfarm business sector since 1995. The closer the series which depict the

contributions of the two shocks (with the deterministic part) follow the actual output series the more important has the shock been in affecting output. Figure 5 illustrates, within the framework of this paper, the relative merits of the two interpretations of the expansion.

Figure 5 can be interpreted as follows. At the start of the expansion of the late 1990s output was almost completely determined by aggregate demand shocks. Up until 1998 the role of technology shocks was only modest. The New Economy interpretation is therefore useless in the explanation of the early phase of the expansion. However, since 1998 the importance of technology shocks has started to increase. In 1998, when GDP rose by 4.4 per cent, aggregate demand shocks clearly dampened output growth. During the latter phase of the expansion the role of technology shocks has been dominant. This was most apparent last year, when aggregate demand shocks already had a strong dampening effect. Towards the end of the year it even became negative.

The main conclusion to be drawn from Figure 5 is obvious. Both the New Economy interpretation and the interpretation emphasizing the importance of aggregate demand give a simplified explanation about the nature of the boom.

The New Economy view seems to overemphasize the role aggregate supply factors and, in particular, the role strong productivity growth. Even though productivity growth has accelerated, which has marked the end of the period of very slow growth, and, consequently, has contributed to strong GDP growth, it is only a part of the story. The step-up of productivity growth has not been so strong that it could alone explain developments of GDP. But, anyway, it has played an important role during the past two years. The last year, especially the first half of the year, may be the best example. Had GDP growth been based mainly on factors operating through aggregate demand, it would have been much lower.

On the other hand, it is difficult to explain the length of the expansion by factors operating only through aggregate demand. It can be said that nowadays, when households are able to borrow more heavily than earlier, debt-driven booms can last surprisingly long until the inevitable end comes (see, for example, *Palley*, 1999). However, what seems to have made the US expansion different from a "pure" demand-led boom is that the expansion is associated with faster- than-normal productivity growth. This can be combined with a demand-led expansion only if one supposes that the fast productivity growth reflects

procyclicality of productivity growth. This aspect has, of course, been present in the debate (see *Gordon*, 1999, 2000, 2001). In what follows, I analyse more closely developments in productivity, and especially the role of procyclicality of productivity.

Productivity growth 1995:1–2001:2: the role of technology and demand shocks

In the interpretation of the expansion the role of productivity is the key issue. It was already seen from Table 2 that technology shocks also played the dominant role in shaping fluctuations in productivity in the short run. On the other hand, Figure 4 shows that aggregate demand shocks are a source of procyclical movements in productivity. Positive demand shocks, while increasing output and employment, also increase labour productivity. The response of output is stronger than the response of hours. (Figure 4 also shows that technology shocks contribute to procyclicality of productivity, but for the discussion about the nature of the expansion demand induced procyclicality is more important.) But to which extent has demand-led procyclicality explained movements in productivity since 1995?

Within the framework of this paper, the answer is given by a historical decomposition of productivity. This is provided by Figure 6, which is analogous to Figure 5. It illustrates how important technology and aggregate demand shocks have been as sources of fluctuations in productivity. Figure 6 shows that most of the fluctuations are attributable to technology shocks. For most of the time aggregate demand shocks have had only a minor influence on productivity. Their importance as a source of procyclicality is best seen in 1996-1997 and during the current slowdown. During the early phase of the expansion, positive aggregate demand shocks, while boosting output growth, also sped up productivity growth. Last year negative aggregate demand shocks dampened productivity growth but positive technology shocks more than offset their negative effects.

Procyclicality of productivity is not the factor which explains rapid productivity growth since 1995. If one takes into account how technology shocks are defined within the framework of this paper, the outcome should not be surprising. Unlike aggregate demand shocks, only technology shocks can shift productivity trend. If the step-up of productivity growth is

considerable and permanent, this will be attributed to positive technology shocks. Because aggregate demand shocks cannot shift productivity trend permanently, its effects are bound to be small in the case when productivity trend is shifting. Figure 6 is a good illustration of this.

Technology shocks and the discussion about the New Economy

The best interpretation of the expansion is given by a synthesis in which both aggregate demand and aggregate supply factors have a role. If the importance of technology shocks reflects the New Economy, it cannot be ignored when the story of the expansion is told. Unfortunately, there is at least one major problem in working out the story. Even though technology shocks may reveal some essential features of the New Economy, one still have to analyse what these features are.

Even if one accepts the view that the ICT revolution has been a major source of the rebound in labour productivity growth during the late 1990s, it does not mean that one should accept the most enthusiastic version of the New Economy vision. The critical question is: which are the channels by which ICT innovations have increased productivity growth?

Three channels are normally distinguished. The first one is the contribution ICT industries make through aggravated productivity performance in the production of ICT goods and through an increase of their weight in the economy. Although their share of total production may be, even if increasing, still relatively small, they may make a considerable contribution to overall productivity growth, if productivity growth accelerates strongly in these industries. The other two channels relate to the use of the products of ICT sectors in other sectors of the economy. Investment in ICT goods can boost productivity through capital deepening, i.e. by increasing the capital-labour ratio. The third channel relates to the positive spillover effects which are reflected in total factor productivity (TFP) outside ICT sectors.

There exists a fast growing literature on the effects of ICT on output and productivity growth in the US (see, for example, *Bassanini* et. al, 2000, *Council of Economic Advisors*,

2000, *Gordon*, 1999, 2000, 2001, *Jorgenson* and *Stiroh*, 2000, *Nordhaus*, 2001, *Oliner* and *Sichel*, 2000).

So far it is too early to try to form a kind of consensus view from the results of various studies. Practically all of the researchers agree that ICT has driven overall productivity growth by boosting productivity growth in ICT sectors, i.e. nobody denies the importance of the first channel as a cause of productivity pick-up in the US. Nor is the importance of the role of capital deepening questioned. As to the third channel, there exists a disagreement. *Gordon* (2001), for example, argues that only a trivial revival in TFP has taken place in the economy outside the durable manufacturing.

Even if the results of this paper show that ICT has boosted output and productivity growth since 1990s, the analysis does not give strong support to any of the various interpretations characterizing the relative importance of the three channels by which ICT may have enhanced output and productivity growth. Procyclicality of productivity may play a more important role in Gordon's interpretation than in the analysis of this paper, but this aspect alone does not give a reason to question the validity of his interpretation.

The exploration was conducted by using a highly aggregative measure of productivity, and, accordingly, the definition of a technology shock was rationalized by a theoretical model which was a representative agent model. In the model households and, what is important, firms were assumed to be identical. Obviously, the use of such a model is problematic when the results of an empirical model should be interpreted. In an empirical model positive technology shocks may, for example, reflect the rising share of ICT sectors in the economy and not technological progress at the plant level.

Even if one could get additional information for interpreting technology shocks by estimating analogous models for various sectors of the economy, one would still not be able to distinguish between the importance of the second and the third channel as the sources of acceleration of output and productivity growth. Because of the simplicity of the model the effects of capital deepening cannot be separated from spillover effects. Positive technology shocks may reflect both capital deepening and increases in TFP.

Because the notion of "technology shock" does not necessarily reflect technological improvements at the plant level, it can be highly misleading. Beside capital deepening, technology shocks may also reflect unusual use of labour input.

Nevertheless, the role that technology shocks play in the analysis of this paper may still give an idea about the importance of ICT as a source of supply-led growth in the US since 1995. Even though the analysis reveals nothing about the relative importance of the various channels through which ICT has affected the economy, it provides one means of assessing the validity of the New Economy interpretation of the expansion.

5. CONCLUDING COMMENTS

The analysis of this paper has shown that overly simplified interpretations about the US expansion may be highly misleading. It cannot be characterized either as a demand- or a supply-led boom. Both aggregate demand and aggregate supply shocks, which were identified by using a very simple structural VAR model, have had a major role in driving the economy.

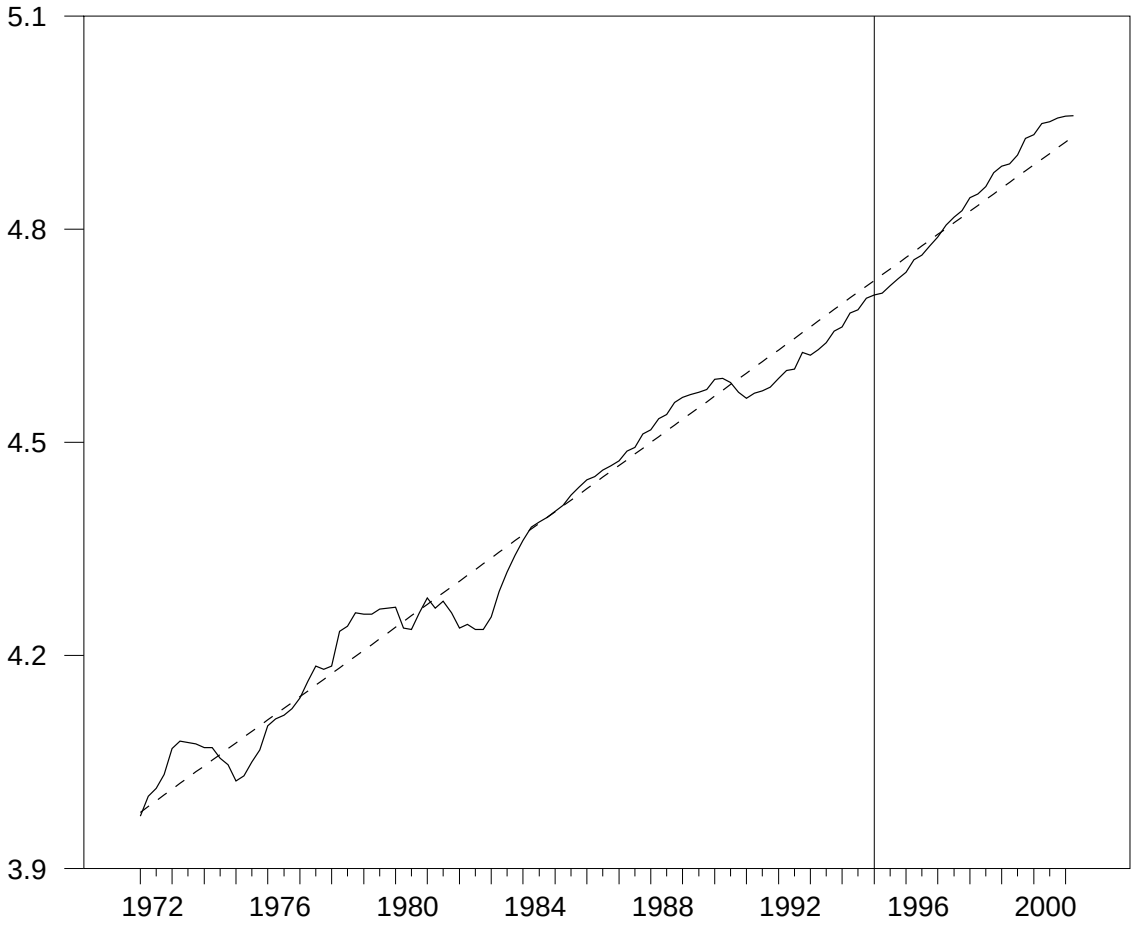
At the start of the expansion of the late 1990s output in the nonfarm business sector was almost completely determined by aggregate demand shocks. Up until 1998 the role of technology shocks (aggregate supply shocks) was only modest, but thereafter the importance of technology shocks started to increase. During the latter phase of the expansion their role in sustaining rapid output growth was dominant.

The analysis shows that it is hard to explain the length of the expansion by factors operating mainly through aggregate demand. The basic reason for this was that strong output growth was associated with a step-up of labour productivity growth. Within the framework of the paper, rapid productivity growth could not be attributed to demand-induced procyclicality of labour productivity. Buoyant productivity growth was caused by positive technology shocks.

Even though it is a simplification to think that the effects of ICT operate only through aggregate supply, the New Economy view which emphasizes the role of rapid productivity growth in combination with low inflation is, as a first approximation, characterized best as a view emphasizing the role of aggregate supply factors.

The factors operating mainly through aggregate demand played a major role both during the early phase of the expansion, in 1995–1997, and at the end of the expansion. The current economic situation is the most convincing proof of the defectiveness of the New Economy view as the main interpretation of the expansion. Demand factors had a contractionary influence on GDP growth even during the first half of last year. Therefore one can even ask if the rise of the federal funds rate last May was justified. During the past twelve months, the dampening aggregate demand effects may have been stronger than Mr. Greenspan and his colleagues have thought.

Figure 1. Output in Nonfarm Business 1972:1–2001:2



Note: A vertical line has been attached to 1995:1 in order to emphasize the starting point of the period 1995:1–2001:2, which comprises the years to be analysed more thoroughly.

Figure 2. Productivity in Nonfarm Business 1972:1–2001:2

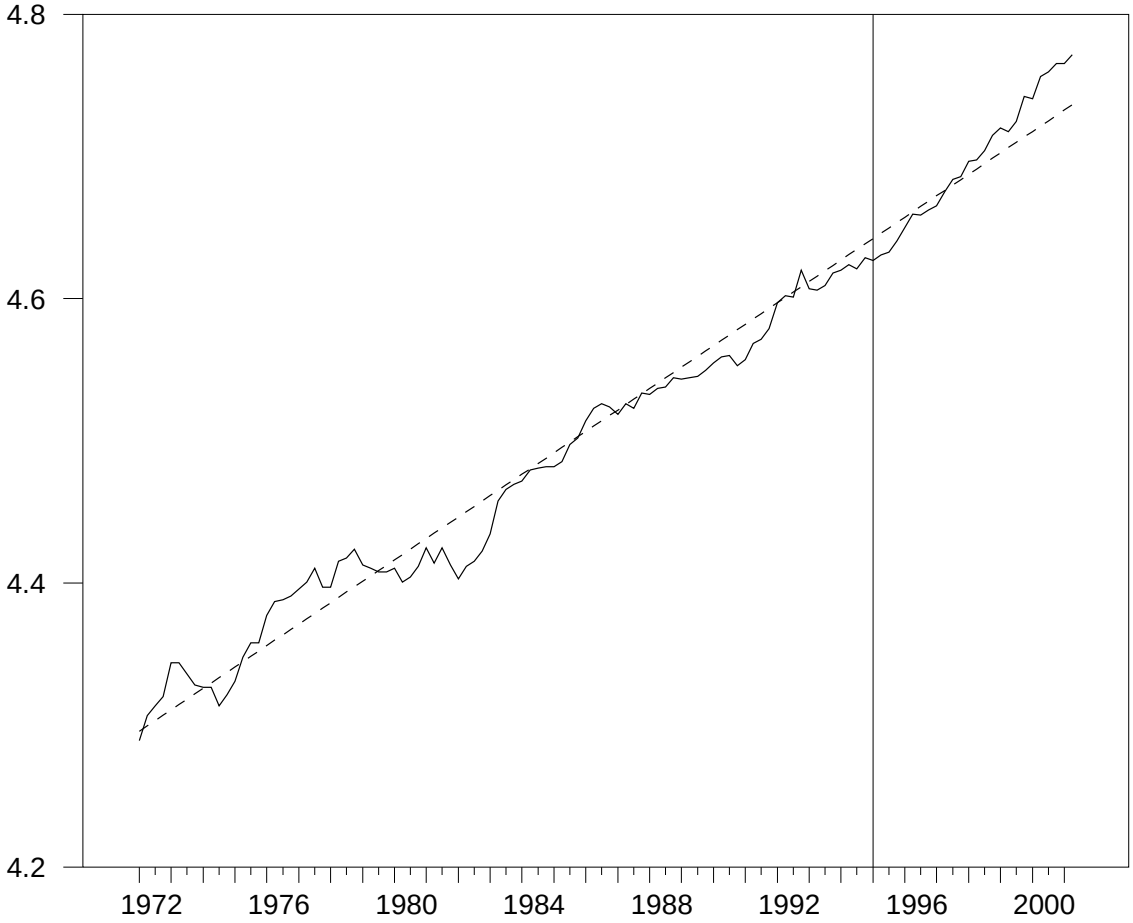


Figure 3. Hours in Nonfarm Business 1972:1–2001:2

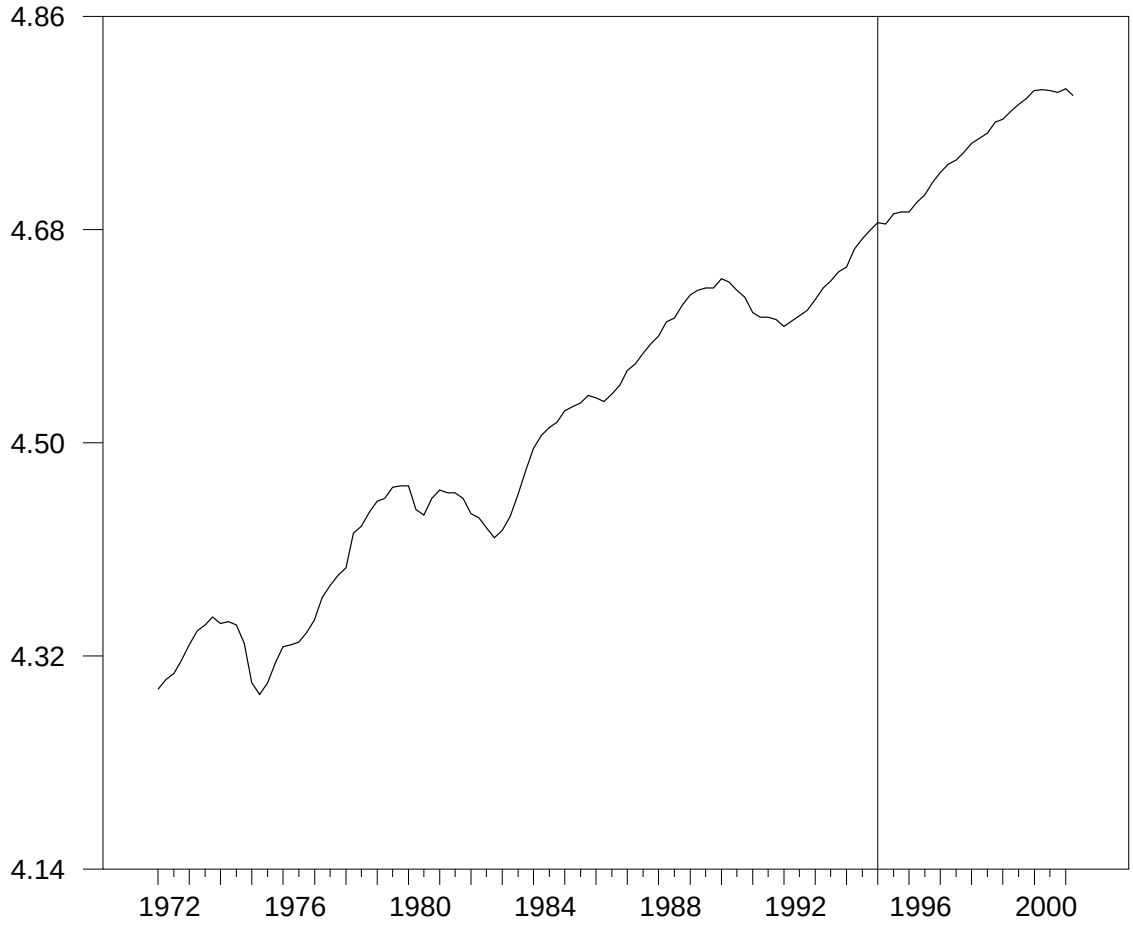


Figure 4. Impulse Responses: Nonfarm Business

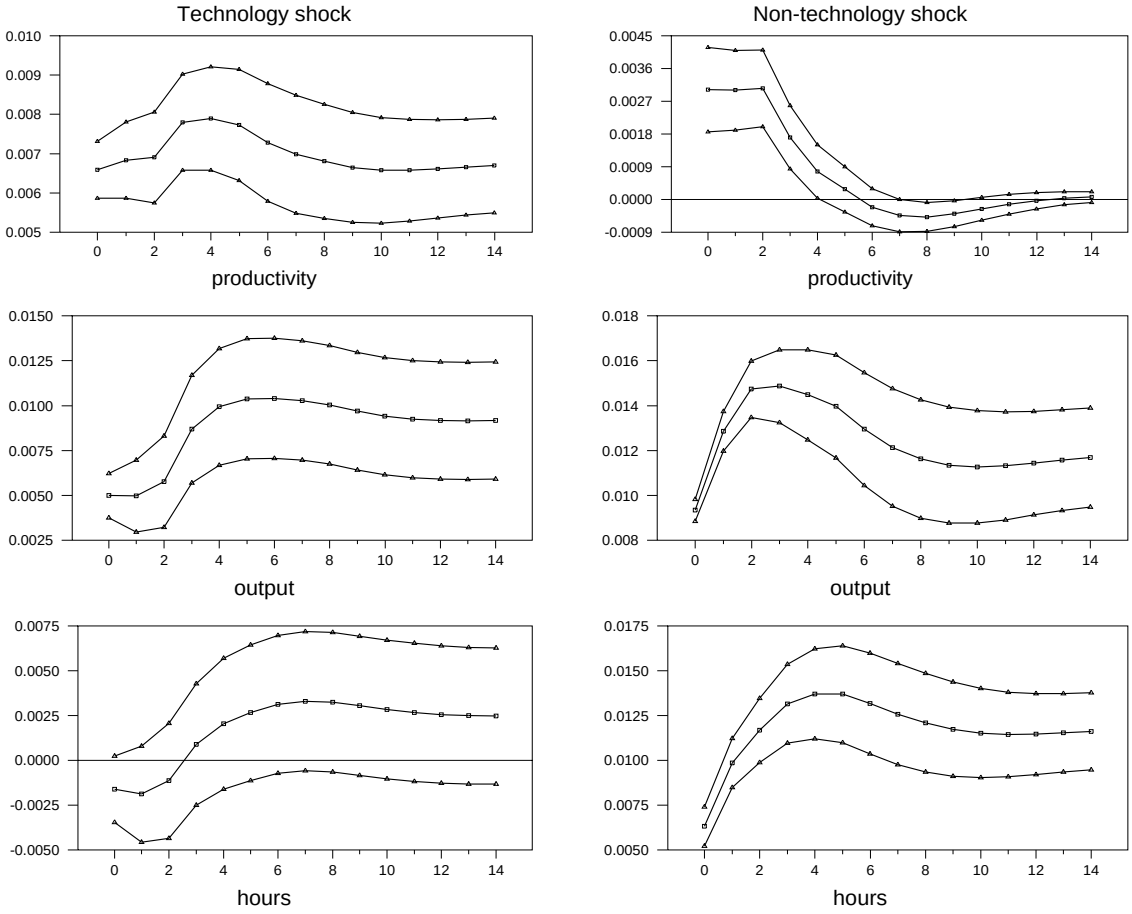


Figure 5. Output in Nonfarm Business 1995:1–2001:2

Historical decomposition

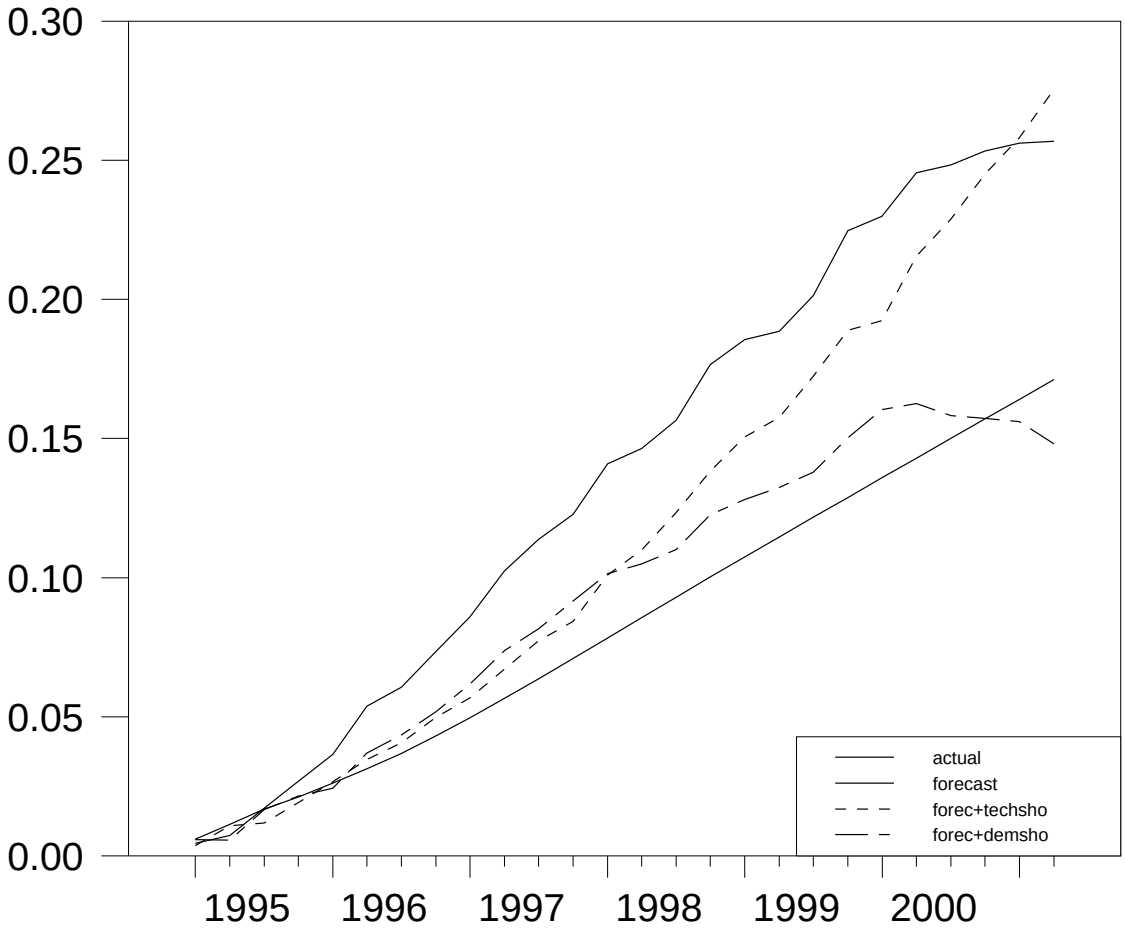
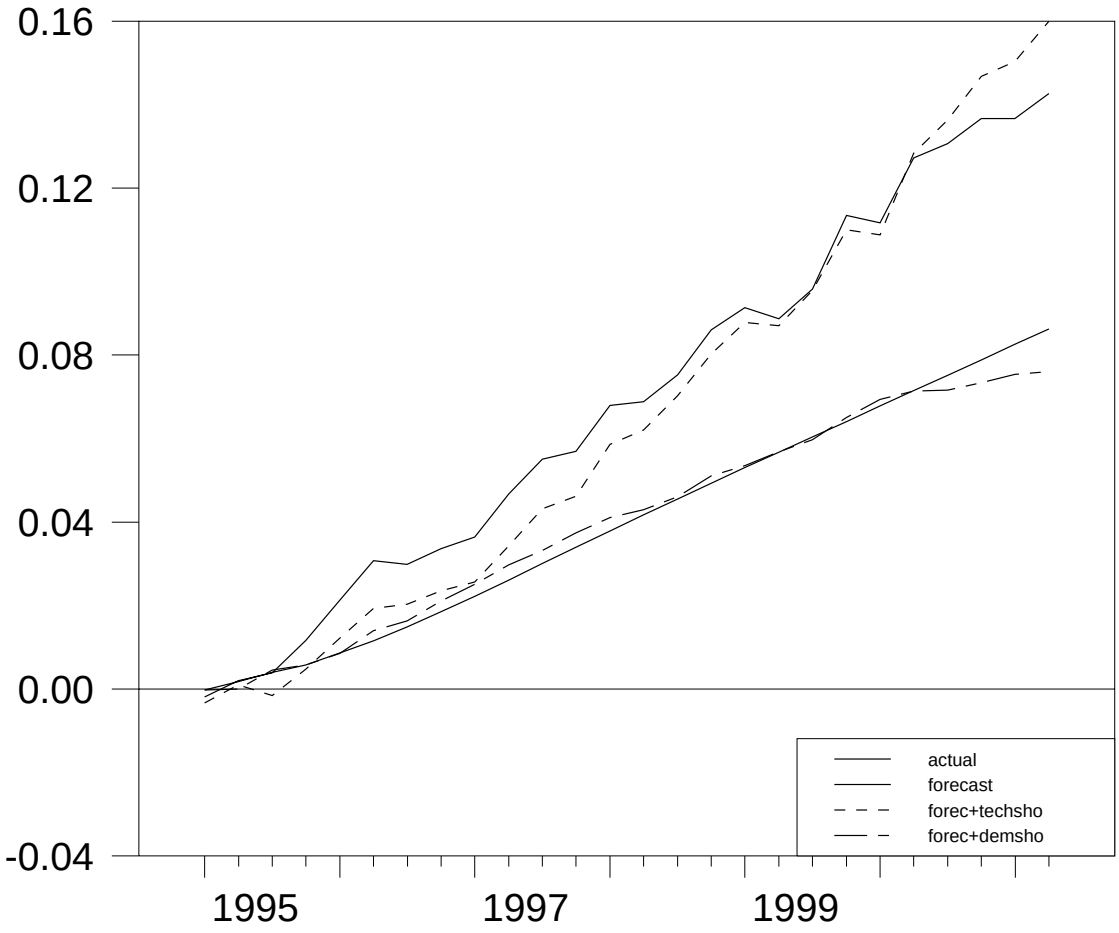


Figure 6. Productivity in Nonfarm Business 1995:1–2001:2

Historical decomposition



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