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Abstract

This study questions whether the increased European labour productivity is rather connected with labour-saving technology or if increased labour productivity leads to more labour input. For this purpose, the impact of technology and demand shocks on the growth rate of labour productivity, total hours worked and output are extracted by a structural vector autoregressive framework and analysed for 14 European countries, Japan and the United States. The dataset was received from the EU Klems. Whereas the countries show homogeneous responses to demand shocks, the results concerning the impact of a technology shock are ambiguous in this sample. Supporting the real business cycle theory, the response patterns of Ireland and Japan show a positive relationship between a technology shock and the total hours worked. For the remaining countries the opposite view, based on the theory of Jordi Galí, is found: A technology shock has a negative impact on employment. Regulation indicators for the labour market received from Nickell and Nunziata (2001), considered as potential barriers or supporters of the effects of economic shocks, are checked in a linear regression on panel data with fixed effects. The estimated interaction terms of regulation and technology or demand shocks do not support the need of a general deregulation in the labour markets as long as every regulation index features a different effect on the shocks.

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Chapter 1

Introduction

Over the last three decades, the developments of the economic activity in European countries have had one fact in common: The living standards, the incomes and the production of goods and services have increased, in some cases even drastically - Ireland is a well known example. The sum of all Irish goods and services produced in 2004 is more than three and a half times its value thirty years before. Austria could not quite double its goods and services produced in the same period, but it started on a higher initial point. Nevertheless, European countries raised their economic activities continuously. How long will this go on? Before this question can be answered, the previous questions have to be: Why does an economy grow? What are the sources of growth in the production of goods and allocation of services?

> *"Our understanding of economic growth has improved enormously [...]. Since the mid-1980s, growth has been one of the most active fields of research in economics [...] David S. Landes chose [...] the fundamental question of economic growth and development: Why are we so rich and they so poor? This age-old question has preoccupied economists for centuries."* (Jones (1998)).

Although the differences in developments between European countries are not as big as between Western Europe and sub-Saharan Africa, they show country-specific features. To explain the heterogeneous, country-specific developments of the growth rates, the growth drivers question plays an important role.

In the economics of growth, the term technology has taken on an important meaning (Jones (1998)). An increased production of goods can be the result of, for example, these two events: First, the number of employees used for production is extended using the same technology, for instance the same machines. Second, the productivity of the employees is improved e.g. by employing the same number of employees with new machines. Regarding the development of the productivity of the employees in European countries, a rise is observable. This is not that surprising due to many technology inventions often described and summarised as the digital revolution. For instance, the development of the Personal Computer and the World Wide Web have been very important steps in the technological progress. The point at issue is the effect on employment. Were these technological inventions always connected with labour-saving effects or did they push the demand for labour by increasing the demand for new products? For the first case an infinite growth would probably not be everyone's wish due to unemployment. The second case or at least a combination of both explanations could be a concept also for the future. During the second half of the 20^{th} century, the economic theories emphasised the importance of technological progress as the primary engine of continual growth. Robert Solow and Paul Romer made important contributions to the introduction of technology progress to the growth theories (Jones (1998)).

To survey the effect of technological progress on employment, some measurements and empirical evidence in European data should be introduced. There are different instruments to measure the number of employees: Employment and total hours worked. Without mentioning the precise definitions of these instruments for a moment, their developments can describe some features of the country-specific employment development. If we survey the total hours worked for instance, a huge variation across European countries between 1975 and 2004 can be found. There are groups of countries which extended it like Austria, Ireland and the United States - shown in Figure 1.1. But other countries behave in the opposite way: Germany, Finland and Portugal have a negative change in total hours worked. Assuming that the European countries and even the United States and Japan experienced nearly the same technology shocks in this period, one can suppose that these shocks seem to be transferred in different ways across the countries. In literature both effects are supported by an established concept. Following the sense of the Real Business Cycle (RBC) theory, Ellen McGrattan (2004) finds and suggests a positive relation between a technology shock and total hours worked. She computes a model for U.S. data and concludes that "technology shocks are important contributions to the business cycle" (McGrattan 2004). In contrast, Jordi Galí is committed to a labour-saving effect of technology shocks. At first glance, the data in this study supports both sides.

Using the amount of total hours worked avoids some problems. As opposed to the number of employed persons, total hours worked captures labour as input factor in a more realistic way. It is becoming more common for people to be employed in several jobs. The total employment does not account for each engagement.

It underestimates employment if one person works in two different jobs over the usual legal hour workweeks[1]. In addition, the statistics of employment do not take into account the fact that some of these jobs are only part-time or a temporary employment. In this case, the amount of employment would be overestimating the labour factor. For instance, the employment figures can rise while the total hours worked, which is independent of where or when they are employed, can fall. To compare the development of labour input across countries it is a better choice to use total hours worked than the number of employed persons. Moreover, it makes a difference in respect to the different country-specific legal hour workweeks.

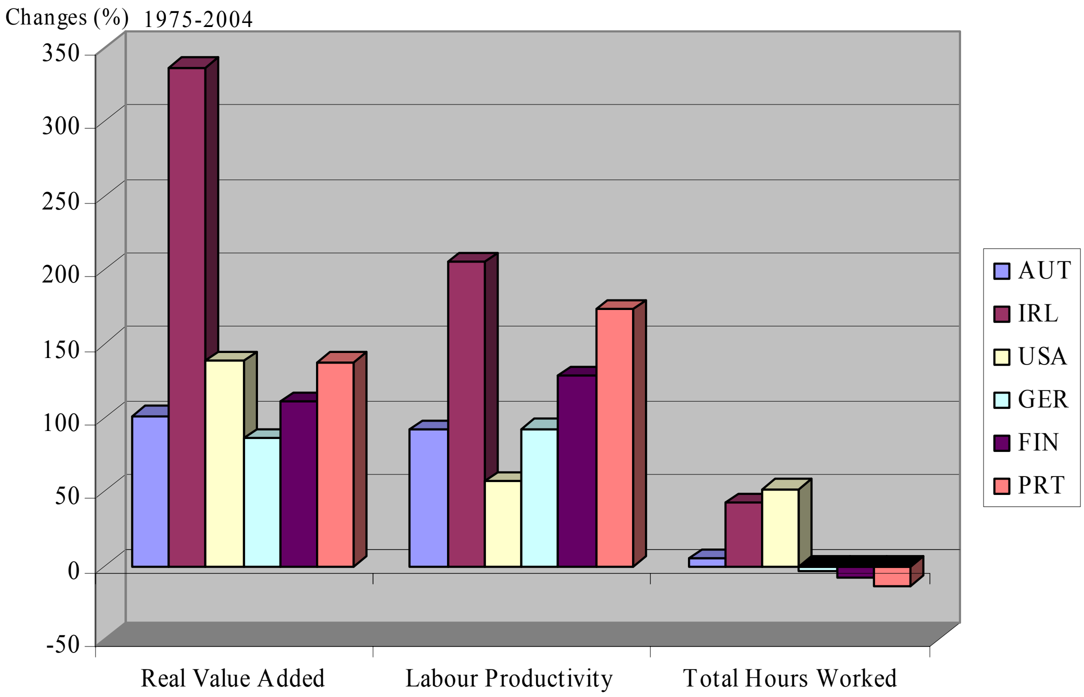

Figure 1.1: Example of different patterns in employment development

While the focus of this study lies mainly on the role of shocks, it will also consider the interaction of shocks with labour market institutions. Regulation on the labour markets are considered as potential barriers or supporters of the effects of economic shocks and discussed in literature a lot (e.g. Blanchard (2006), Baker et al. (2004), Baker et al. (2007) or Nickel et al. (2005)). Mostly in context of unemployment rates, the research tries to find a relation between a high unemployment rate and "bad" mixtures of labour market institutions.

> *"In the 1970s, European unemployment started increasing. It increased further in the 1980s, to reach a plateau in the 1990s. It is still high to-*

[1] This is particularly important in the consideration of industrial dynamics in employment: If the two jobs are in different sectors, the figure of employment can not distinguish correctly.

day, although the average unemployment rate hides a high degree of heterogeneity cross countries. The focus of researchers and policy makers was initially on the role of shocks. As unemployment remained high, the focus has progressively shifted to institutions." (Blanchard (2006))

This study focusses on the institutions as transformers of the shocks and estimates the adjusted effects. According to results of Nickel et al. (2005) or Morgan and Mourougane (2005), the estimated interaction terms of regulation and technology or demand shocks do not support the need of a general deregulation in labour markets since every regulation index features a different effect on the shocks.

In summary, this study discusses the following basic research questions:

- What is the impact of technology and demand shocks on economic performance?
- Does the interaction of the shocks with labour market institutions influence this impact on economic performance?

Therefore this paper at hand is organised as follows: Divided into three parts, Chapter 2 will address the discussion in literature and describe the models of the Real Business Cycle theory and Jordi Galí on which the empirical work is based. It describes further the theoretical considerations of the variables used and suggests identifying the shocks by using a structural vector autoregression.

After presenting the literature and the economic framework in the second part, the third chapter attends to the data itself and the nature of technology and demand shocks. Based on a panel of 16 countries, mostly European ones, the research covers a period of thirty years. This part focusses on the different characteristics of technology and demand shocks and the sources of these differences.

In Chapter 4 the impact of the shocks on economic performances is discussed. In the context of literature, the empirical results and the impulse responses are compared with the statements of Jordi Galí and the Real Business Cycle theory. Regarding the country-specific employment developments, in the fourth chapter the impacts of shocks will be additionally analysed in respect to existing labour market regulations by a panel regression analysis. It assesses the question if more flexibility on labour markets promotes the effects of technology and demand shocks. It analyses the suggestion that cyclical upturns or technical improvements have more positive effects on the labour input in a more flexible labour market than in a rigid one. A special point of comparison is constituted by the American and Japanese economy in the way they reformed their labour markets to liberalised and more flexible ones.

Closing the empirical research by the panel regression analysis, the fifth chapter provides a summary and some concluding remarks.

Chapter 2

Theoretical considerations

There are two theories that explain the impact of technology shocks on employment, especially on total hours worked[1]. This study is embedded between these theories: The standard Real Business Cycle (RBC) theory and the work of Jordi Galí (1999). This section discusses these two theories and their empirical implications. It further discusses the empirical implementation and the identification of demand and technology shocks using a structural vector autoregression (SVAR) approach.

2.1 The real business cycle theory

The total economic activity covers an interesting distance. Its development has ups and downs: From the years 1830 to 1890 the industrial revolution boosts production enormously and post-war years bring an economic miracle. But in the year 1929 the global economic crisis started and pushed the economies in respect to their production, consumption and general living standard down.

> *"Growth theory, like much else in macroeconomics, was a product of the depression of the 1930s and of the war that finally ended it."*
> Robert M. Solow[2]

To analyse this development, economists developed a measurement for the total economic activity: The gross domestic product (GDP). It is the sum of all products and services produced in one economy in a given period[3]. In fact, the interpretation of GDP includes also two other sides. GDP is also a measure of the sum of all incomes - from households, firms and government - in one economy in a given

[1] The difference between employment and total hours worked will be explained in section 2.3.1
[2] Lecture to the memory of Alfred Nobel, December 8, 1987
[3] Blanchard (1997)

period. And it can be understood as the sum of all values added together in one economy, achieved in a given period. This considers the intermediate inputs in a production and measures only the produced added value in a good. Moreover, the United Nations Statistics Division[4] computes the GDP as

$$
\begin{aligned}
GDP \quad & = \text{sum of the gross values added (VA) at basic prices} \\
& + \text{all taxes on products} \\
& - \text{all subsidies on products ,} \qquad (1) \\
VA \quad & = \text{GDP} \\
& - \text{all taxes on products} \\
& + \text{all subsidies on products .} \qquad (2)
\end{aligned}
$$

The study will use the sum of value added (VA)[5] and will consider also inflation: The inflation-adjusted real value added (RVA) provides the instrument for the aggregate output of an economy in this study.

By means of the historical examples apparent, the development of RVA and other connected major economic variables like employment or unemployment, move due to certain influences. In the first historical example, the industrial revolution refers to a technological progress. These movements are composed on the one hand of long-run developments, the so-called trend, and on the other hand of short-run fluctuations, the cycles[6]. The search for the drivers of these movements is a recent theory and focuses on the role of the technological progress: *"it has been developed in the latter half of the* 20^{th} *century"* (Pasinetti (2000), p.1). The derived task is to shed more light onto the influence of technology on economic growth and particularly to find a measurement for it. An important step was set by Robert Solow, who developed an approach to identify technology shocks, widely known as the Solow residuals (Solow (1957)). Asking about the contributions to RVA growth of an economy, a typical growth accounting equation (Francis et al. (2003)) can be presented as

[4] http://unstats.un.org/unsd/sna1993/tocLev8.asp?L1=6&L2=13

[5] For the purpose of this study, the exact meanings of the definitions in (1) and (2) will be ignored.

[6] Observing the past data of the major economic variables, the short term variations have different patterns in comparison to the cyclical development of GDP. The GDP phases into cyclical upturn and boom when the values increase as well as into recession and depression in the case of declining values. Consumption or demand is typically pro-cyclical and synchronous to GDP. Employment is agreed to be pro-cyclical as well, while unemployment behaves rather in an anti-cyclical and subsequent way - in the cyclical upturn unemployment decreases whereas it rises in the phase of recession.

$$\Delta \ln RVA = \gamma * \Delta \ln L + (1-\gamma) * \Delta \ln K + \Delta \ln A \quad (3)$$

where $\Delta \ln RVA$ represents the growth of RVA[7]. $\Delta \ln L$ and $\Delta \ln K$ are labour and capital input. γ is the share of RVA growth which is caused by the labour input. $\Delta \ln A$ reflects the Solow residual. The reason why it is called a residual is the fact that it reflects the unexplained part of the growth in RVA. Contributions from capital and labour input into the growth equation are captured but do not explain the whole growth. As long as the growth of the RVA is observable and the growth rates of capital and labour are known, the unexplained part - the Solow residuals - captures all the rest of the factors potentially causing the growth. As long as there are only two reasons for the growth of RVA per capita - capital accumulation and technological progress - the Solow residuals should cover technological progress. Many economists questioned whether the Solow residuals are the best measurement for technological progress. For instance in Hall (1988) and Evans (1992) a correlation of the Solow residuals to non-technology shocks was found: The Solow residuals do not reflect the technology shocks alone because they count for influences as technology shocks which are not related to technology at all. So the story of searching a good measurement went on.

While the short-run fluctuations of economic variables as cycles and the long-term development as a trend were regarded separately by then, the works of Kydland and Prescott (1982) and Long and Plosser (1983) renewed and combined these theories to the so-called Real Business Cycle (in the further course of this study abbreviated as RBC) theory (Gaggl and Steindl (2007)). Their theory implicated two assumptions as described in Gaggl and Steindl (2007): *"First, as in the neoclassical growth model, the economy on average grows at a constant exogenous rate, and second, stochastic disturbances in technological growth make all major economic variables fluctuate around their long run steady state levels."*

Following the work of Kydland and Prescott (1982), the economies´ total demand is not the essential factor in the RBC theory like it is in Keynes´ theory (Keynes (1936)). The RBC theory acts on the assumption that money has no real effect on the economy. Therefore, money is neutral and can not influence the economies' business cycles. In addition, the RBC theory assumes that the RVA is always on a natural level and only deviating from this level due to exogenous shocks. Consequently the question the theory is most interested in is where these movements come from (Blanchard (1997), p.544).

[7] Francis et al. (2003) are using Y for total output instead of RVA

The basic RBC theory model, developed as a dynamic stochastic general equilibrium (DSGE) model, is more micro funded. It consists of a utility function for every household, assuming they are identical,

$$U_0 = E_0 * \textstyle\sum_{t=0}^{\infty} \beta^t * u(C_t, 1 - L_t) \tag{4}$$

with the infinite sequences of consumption $\{C_t\}_{t=0}^{\infty}$, of labour $\{L_t\}_{t=0}^{\infty}$ and a constant discount factor β^t between 0 and 1. The function $u(C, 1 - L)$ is a concave utility function which reflects the trade-off between work and leisure: Earning money allows people to consume and this, in turn, increases their utility. On the other hand, work can cause disutility, and the remaining time can only be used for less leisure. E_0 is a parameter for the value the utility function is expected to reach based on the initial time point t = 0. Utility in the future will be discounted by the factor β^t: The further the time of consumption or leisure lies in the future, the less will the value of utility it will reach. Moreover, the consumption represented in equation (5), is restricted to the available private budget

$$C_t = c_0 + c_1 * (Y_t - T_t) \ , \tag{5}$$
$$C_t + I_t = \omega_t * L_t + \tau_t * K_t \ . \tag{6}$$

Following Blanchard (1997), p.44 ff, the whole consumption in an economy depends on the one hand on the parameter c_0 for the case of no income but a minimum consumption like eating. And on the other hand, it is also determined by the parameter c_1, the propensity to consume[8], and the disposable income (salary or the aggregate income of all households Y_t without taxes T_t at time t). The budget constraint for households limits their disposable income - distributed to consumption or investment. The consumption and investment is not allowed to exceed the present value of the households' setting with labour and capital. ω_t and τ_t reflect the real rental rate of labour and capital (Gaggl and Steindl (2007))[9]. The utility function should be maximised under the budget constraint.

The DSGE also consists of a production function for each firm. The production function[10] determines the output Y_t of a firm including the level of technology available A_t at time t.

[8]The part of additional income which will be spend on consumption

[9]The notation differs part wise

[10]The production function corresponds to a neoclassical production function

$$Y_t = F(K_t, L_t, A_t) \ , \tag{7}$$
$$A_t = \rho * A_{t-1} + \epsilon_t \ . \tag{8}$$

The technology level is assumed to be an autoregressive process, equation (8), with an exogenous i.i.d. error term ϵ_t and a parameter ρ between 0 and 1 (indicates the persistence of a technology shock). This technology level restricts the output of the firm which tries to maximise its profit P_t.

$$P_t = Y_t - \tau_t * K_t - \omega_t * L_t \ . \tag{9}$$

Equilibrium in this equation system will be found by the maximisation of the utility and the production function in respect to their constraints.

In order to accentuate the implications of a technology shock, the previous mechanism should be picked up in more detail. The result of a positive technology shock is that the firm can produce more with its existing amounts of labour and capital. This has implications on the firms´ output, on the aggregate supply and also on prices, assuming the technology shock affects all firms of an economy contemporaneously and to the same extent. The production curves of all firms move upwards so that the amount of all products they supply at the market - the aggregate supply - switches outward. That means that RVA increases. A new price equilibrium will settle at the point of interception of the new aggregate supply and the previous aggregate demand curve. The aggregate demand curve mirrors how much all consumers are willing to pay for the supplied amount of goods. This new price level affects the wage for labour - wages will increase. As long as labour supply is a function of wages, the labour supply should increase as well (because the incentive to work increases). As seen in equation (5), the consumption, depending on labour, will be affected by a technology shock, too. In the case of an increased price level, the firms can be interested in raising their production level a little bit further. Therefore, the demand for capital and labour can increase additionally[11].

An important aspect for modelling a system affected by exogenous shocks is based on the criticism of Robert Lucas (1976): The model has to take into account whether the shock due to an announced policy action can be expected by

[11] Criticism applies to the reasons for changes in employment: It is possible after a recession that employment will not only increase because of a technology shock and raised productivity but also due to labour hoarding. After a recession output could rise stronger than employment due to hoarded workers. This relation between output and employment after a recession in comparison to output in the time of recession seems to be more productive. See Hall (1988), p.929. Another reason could be that the used capital did not work in full capacity before comparison and now it does. See Hölzl and Reinstaller (2007)

the economic units or not. In the case of a technology shock the so-called "Lucas criticism" can be avoided when assuming the shock as an unexpected part of a change in variables.

In summary, in the sense of the RBC theory the fluctuations of aggregated macroeconomic variables seem to be caused by technology shocks. The most important conclusion for this study is that the RBC theory expects a positive impact on employment by a technology shock. For example, Ellen McGratten (2004) found technology shocks which yield to higher employment in the post-war U.S. data. She argues in tradition of the RBC theory that a higher productivity is passed on to the employed persons by higher wages. People will supply their labour more often. With this mechanism, real shocks[12] - especially technology shocks - are the main source of business cycle movements of for instance employment, output and consumption. This is the opposite result to the theory of Jordi Galí (1999), presented in the following section.

2.2 The theory of Jordi Galí

In the year 1999, Jordi Galí developed a new model out of the RBC theory to examine his doubt of technology shocks being the source of business cycles (Galí (1999)). There he identifies technology shocks with long-run restricted structural vector autoregressions (in the further course of this study abbreviated as SVAR) and takes advantage of some evidences concerning labour productivity and labour input: Labour productivity changes in response to technology shocks, labour input changes due to non-technology shocks. His long-run restrictions come from the assumption that a technology shock should have a long lasting effect on labour productivity whereas the non-technology shock should have only transitory effects. This interaction between labour productivity and labour input through the shocks is captured by a bivariate SVAR approach. The shocks identified through a structural vector autoregressive approach in Galí (1999) are proved in literature as good measures for changes in labour productivity (Basu, Fernald and Kimball (1998), Francis and Ramey (2005) or Burnside, Eichenbaum and Rebelo (1996)). Of course there are also sceptic voices doubting that the approach is useful (see overview of the discussion in Hölzl, Grieger and Reinstaller (2008)).

An important result of his model is the negative effect of technology shocks on employment. This is an opposite result compared to the result of the RBC theory

[12] Explained in section 2.3.

(Galí (1999)). The negative correlation between technology shock and employment is adopted in a sticky price model. A model implying prices which can not change in the short-run avoids the immediate reaction of the aggregate demand to a technology shock. An increased productivity should yield to lower prices. But the demand is not able to change in respond to lower prices and fixes the output on an unchanged level. The same amount of output on more favourable conditions than before can be produced with less labour input. Thus a non-moving demand on the one side and the increased productivity on the other side, leads to the possibility of employing less workers to achieve the same amount of output which is demanded still on the same level.

But it is also possible to regard a model with flexible prices for explaining the negative relationship. Francis and Ramey (2002) illustrate this by a model with sticky consumption and by a model with Leontief production function. Following Hölzl, Grieger and Reinstaller (2008), this study is based also on a model with a Leontief production function where the combination of input factors is fixed in the short-run. In addition to this fixed relation of production inputs the variables used in this study are constituted as natural growth processes. They will be derived in the next sections. This approach does not describe the macroeconomic model. It addresses rather the firm level. Understanding production as a transmission from inputs to outputs, a firm has to follow a certain plan of production which is described by its production function. Depending on the technology use, the location of the production function is fixed or the proportions between the input factors are determined.

The main character of a Leontief production function is the following mechanism. Change in one factor has to be combined with a change in another input factor, for instance machines can only be employed in combination with workers. Thus, the firms' output can only be increased by a higher input of all factors. This explains the same mechanism as with sticky prices: The higher productivity can not be transferred to the output of the firm due to the fact that it can not adjust all its input factors immediately. The minimum of one factor limits finally the quantity of production seen in the following production function.

$$Y_t = min(\frac{L_t}{\alpha_L}, \frac{K_t}{\alpha_K}) \qquad (10)$$

where α_L and α_K are the needed volume of the input factors labour L_t and capital ${K_t}$[13]. Labour-saving technology shocks will affect the labour coefficient - a po-

[13]Due to the microeconomic level, the variables have only one index for time. The country level

sitive shock reduces α_L so that less labour input is needed with the same amount of capital combined.

As long as shocks are the unexpected part of a change in variables - the demand shock is reflected in the unexpected change of labour input, while the technology shock is connected with an unexpected change in labour productivity - they are not observable directly. But with certain restrictions in the used regression system, it is possible to get information about them.

The durable effect of technology shocks on labour productivity is different to the temporary impact of other possible shocks (e.g. government purchases of planes or a shift in the preferences of consumer). Keeping this in mind, Jordi Galí identified the technology shocks by shocks which have a permanent effect on labour productivity. An additional indicator to identify technology shocks, in accordance to Francis and Ramey (2002), is to consider the effect in the long run of a technology shock on labour input, more precisely on hours worked: This effect should be only temporary so that the size of a the long-run response of hours worked to such a shock is very small. Thus the responses of productivity to shocks which feature a permanent change can be interpreted as responses to technology shocks. This is not valid automatically for other variables like output, consumption or investment. While there are also other long-run restrictions for shocks in literature, in this study it is adequate to involve Galí's restriction that only technology shocks have a permanent impact on productivity. Demand shocks are not that clear to identify by long-run effects on variables. So other long-run restrictions concerning hours worked or demand shocks are not considered. This system of long-run restrictions builds up the base of the identification scheme.

It is also necessary to consider the shocks and the responses as a dynamic system and to treat the variables total hours worked and labour productivity symmetrically: It is not clear if total hours worked is an exogenous influence on the labour productivity or vice versa. While the labour productivity is affected by labour input, of course, it is also possible that labour input is influenced by the development of the labour productivity. To treat both variables symmetrically and to account for the dynamic aspect, using a vector autoregressive framework makes sense and is illustrated in section 2.3.3.

Concluding the ideas of Galí (1999), the negative correlation between technology shock and total hours worked removes a basis for the argument of the RBC theory: Technology shocks can not lead to business cycles anymore if they have

will be introduced in later sections.

a negative impact on employment. Total hours worked move in the opposite direction of output, investment, consumption and productivity.

2.3 Econometric model

To draw near the concept of economic shocks, the idea of equilibrium is an essential starting point. While equilibrium converges to a balanced growth path, a shock can develop a transition dynamic to a new growth path by the unexpected change of economic parameters. Thus a shock is in first instance an alteration of relevant parameters (as the axis intercept of a demand curve is one relevant parameter) and hence a disturbance of the existing stability. In general it is important to distinguish the alteration of relevant parameters which are unexpected from those which are announced ex ante and could be included in the consumer behaviour. The dynamic which is started by this disturbance can lead to a new equilibrium or not: It is also possible that the market stays instable after a shock.

Depending on the variable which is affected by a shock, there are two categories of shocks: The monetary shock and the real shock. Examples of a monetary shock are changes in the money supply, in the interest rate or in the exchange rate. A real shock affects for instance production and consumption. Though in this context the focus is on the real shocks.

Regarding a market, a supply and a demand exist for the good of this market. If the demand side changes we have a demand shock. In the case of an increase or decrease of the public expenditure - concerning for instance the infrastructure, change of the export policy or a purchase of pursuit planes by the government - it is called a fiscal shock. In the event of a fiscal shock the governmental demand is increasing or decreasing. In addition to the governmental demand the total demand includes of the consumer demand. If the propensity to consume shifts by a change of the elasticity of substitution between consuming and saving or between leisure and labour, the consumer demand is affected. This is called a shock in preferences. In the case of companies, every abrupt change in the expectations modifies investment behaviour and leads to a change in total demand. It happens in the case of uncovering financial misstatement or a financial scandal which are all about bad news for investors. To summarise: Sudden upward movement or truncation in demand caused by the government, by private consumers or by companies is called a demand shock.

If the supply side is changing, we have a supply shock. Reasons for a sudden movement in the total supply of an economy can often be found as well. A change in supply means a change in output. A decrease of output as a consequence of natural catastrophes like a flood and following crop failures is called a negative supply shock. In further consequences it can imply a change in import prices or in general changed prices of raw material. If an industry has to deal with unexpected change in input costs - increase or decrease - it will eventually adjust its production. In the last resort a company can be confronted with production downtimes, common for political reasons such as war or strike. Again, if the output is decreasing one can talk of a negative supply shock. In the opposite case, the output will be raised as a result of change in productivity. This was true for the digital revolution with new communication media like the introduction of computer or other inventions. Apart from the possibility of reducing the labour input, a rise in productivity leads to more output. As long as productivity is in context with technology in most cases, this kind of supply shock is called a (positive) technology shock. Next to the demand shock it is the second shock on which this study is focused. Furthermore, the impacts of technology shocks are restricted to labour productivity changes. The demand shocks in turn effects a movement in the labour input represented here by total hours worked.

Following Hölzl and Reinstaller (2005), technology shocks on the macroeconomic level can be understood as the sum of sectoral technology shocks. But in general, technology shocks can not be directly observed or measured. In many empirical works expenditures on R&D[14] or data concerning letters patents are taken as approximation. But accounting for the fact that not all innovations are patented, this approximation is not able to mirror all technological changes. With the underlying understanding of technology and demand shocks as reasons for changes in labour productivity or labour input, this study will use labour productivity and labour input as the base in order to identify the shocks. Assuming a strong relationship between labour productivity and technology shock, or between labour input and demand shock, the identification of the shocks in an economy will be reached with the SVAR approach according to Galí (1999). Hence one should have a detailed look at the construction of the mentioned variables first.

2.3.1 Labour productivity

In order to study the effect of a technology shock on employment, it is necessary to derive the definitions for labour productivity and total hours worked. In accor-

[14] Shea (1998) for example, see Francis and Ramey (2005), p.1.

dance with the model of Pasinetti (1993) the labour input[15] called $L_{j,t}$ can be interpreted as the hours worked which are needed to produce one unit of output in country j[16] at time t for one person engaged. The labour input is represented as a natural growth process

$$L_{j,t} = L_{j,t-1} * e^{-p_{j,t}}. \tag{11}$$

The labour input per output unit is increasing by the rate of productivity $p_{j,t}$

$$p_{j,t} = \ln \frac{L_{j,t}}{L_{j,t-1}}. \tag{12}$$

This parameter describes the change in productivity. For example, in time t = 1, a worker needs 5 hours to produce one unit of output. In time t = 2 the worker only needs 3 hours. With the equation (12) the productivity rate can be computed as $p_{j,t} = \ln \frac{3}{5} = 0.5$. If there would be absolutely no change in productivity ($p_{j,t}$ = 0), the hours worked in time t would be equal to the hours worked in time t-1 for one unit of output. If the conditions of work would be worse so that the productivity would suffer ($p_{j,t}$= -0.5 for instance), the hours worked in one period later would be increased. Hence a positive productivity rate decreases the hours worked.

Unfortunately the labour input $L_{j,t}$ is not known that well. Therefore the labour productivity will be computed as the relation between the real value added and the total hours worked in an economy.

$$p = \frac{VA*100}{VA(P)} * \frac{1}{h} \tag{13}$$

Value added (VA) is a part of gross domestic product (GDP). Value added plus taxes and less subsidies equals GDP which itself is next to the intermediate inputs part of the gross output. To avoid a bias due to inflation, labour productivity is based on real terms. On the other side, hours worked are a good approximation for the input factor of labour: This measure includes all persons who are engaged in the relevant country, based on the domestic concept as employee or self-employed. Using total hours worked instead of the number of employed persons has some advantages. The total hours worked can be assumed to be more realistic as long as they do not count for hours which are paid but never have been

[15]The same notation as used in Pasinetti (1993).

[16]In Pasinetti (1993) it is applied for the sector level.

worked as it happens in the case of illness. Considering the possibility of labour hoarding it is very important to know the actual hours worked. Employment as the number of persons engaged does not account for the possibility of potential labour hoarding. Also the situation of being employed in several jobs can make a difference: The amount of employees does not change although the persons could probably work in more than one engagement. The total hours worked accounts these facts in its measurement. In the fact that labour productivity is based on total hours worked, it would be more precise to speak of an hourly labour productivity. But for purposes of readability, this study will use only the expression labour productivity up to now. In Chapter 3 there will be some diagrams which present the development of labour productivity in selected countries.

2.3.2 Labour input

The second variable of interest is total hours worked. The amount of hours of employees depends on the amount of output which has to be produced. Due to the fact that the demand of goods determines the amount of output, the total demand has to be derived. To describe the movement in demand, there should be a detailed look at the equation of consumption which is also constructed as a natural growth process (14).

$$c_{j,t} = c_{j,t-1} * e^{r_{j,t}} \tag{14}$$

from where the shift in demand can be derived as the rate $r_{j,t}$

$$r_{j,t} = \ln \frac{c_{j,t}}{c_{j,t-1}}. \tag{15}$$

Thus the yearly sum of the whole consumption per capita of goods produced in country j can change with rate $r_{j,t}$. In dependence of demand and total population in the previous period, the total produced output in period t is equal to

$$Q_{j,t} = c_{j,t-1} * N_{j,t-1} * e^{g+r_{j,t}} \tag{16}$$

whereas the consumption is shifting by the rate of shift in demand $r_{j,t}$ and total population $N_{j,t}$ is growing by the constant exogenous rate g. Knowing hours worked per unit $L_{j,t}$ from the derivation of labour productivity in the previous section and total output $Q_{j,t}$ from equation (16), it is possible to achieve a measurement for total hours worked in an economy $h_{j,t}$ as

$$h_{j,t} = L_{j,t} \times Q_{j,t}$$

$$\Leftrightarrow h_{j,t} = L_{j,t-1} * c_{j,t-1} * N_{j,t-1} * e^{g+r_{j,t}-p_{j,t}} \ . \tag{17}$$

The variables labour productivity and total hours worked develope exponentially due to their construction as a natural growth process. The SVAR approach relies on a linear model. Therefore the variables have been logarithmised. On the basis of these two variables defined, the economic model and the SVAR framework can be constituted in the following.

2.3.3 Structural vector autoregressive approach

Identification and estimation of shocks with a structural vector autoregressive (SVAR) approach has been made in different fields (Galí (1999) for shocks in unemployment or Alexius (2005) for shocks in the real exchange rate). Fur the purpose of covering the technology and demand shocks in this context, the SVAR model with a long-run restriction estimates the vector $X_{j,t} = [\Delta p_{j,t}, \Delta h_{j,t}]'$ for each country. This vector contains the growth rates of labour productivity and total hours worked and is estimated with a certain number of lags. In this study, the chosen lag is 1 and the corresponding equations for each variable are presented in (18) and (19).

$$p_{j,t} = b_{10} - b_{12} * h_{j,t} + \gamma_{11} * p_{j,t-1} + \gamma_{12} * h_{j,t-1} + \epsilon_{p_{j,t}} \ , \tag{18}$$

$$h_{j,t} = b_{20} - b_{21} * p_{j,t} + \gamma_{21} * p_{j,t-1} + \gamma_{22} * h_{j,t-1} + \epsilon_{h_{j,t}} \ . \tag{19}$$

In this system of equations, the development of the time series $p_{j,t}$ is affected by an intercept, past values, an error term and also by contemporaneous and past realisations of $h_{j,t}$. The same holds for the time series of $h_{j,t}$. This system is called a vector autoregressive process of order one, VAR (1), in structural form. It reflects reactions of the variables to each other: If $h_{j,t}$ is raising for one unit, it diminishes $p_{j,t}$ for b_{12} units. Additionally this change in $h_{j,t}$ affects $p_{j,t}$ in future realisations, respectively past rises in $h_{j,t}$ changes $p_{j,t}$ about γ_{12} units. But this study measures merely the effect of previous changes in the variables and disregards the effect from contemporaneous influences. Thus both b_{12} and b_{21} are assumed to be zero so that a change in $h_{j,t}$ produces no simultaneously change in $p_{j,t}$: Potential feedback effects are ignored by that.

The error term in general is regarded as an unobservable part of the realisations of a random variable and adds a stochastic component to the equation system: The direct deterministic dependence between the endogenous variable $p_{j,t}$ and the exogenous variable $h_{j,t}$ is overlaid by the stochastic error terms $\epsilon_{p_{j,t}}$ and $\epsilon_{h_{j,t}}$. They can cover potentially missing variables, measurement errors or unexpected events in economic context. Also unknown is their probability distribution. Therefore two assumptions should be made: First the realisations of the error terms are independent of the observations of $p_{j,t}$ and $h_{j,t}$ within the equation. "If they are not independent one may argue that the error terms consist of all the influences and variables that are not directly included in the set of y variables[...]. A correlation of the error terms may indicate that a shock in one variable is likely to be accompanied by a shock in another variable" (Lütkepohl (2006)). Second the error terms are white noise. A sequence of realisations of a random variable $\{\epsilon_t\}$ is called white noise if every value in this sequence - this value itself is again a random variable - has the same distribution. This means that every value spreads around a mean of zero with a constant, time independent variance. If this applies for $\{\epsilon_t\}$, the random variable ϵ_t is homoscedastic. Moreover, the values within the sequence should be uncorrelated to each other. In the case of t $\doteq$ 0 the autocorrelation function or the covariance is equivalent to the variance. In the case of t$\neq$ 0, the autocorrelation function is equal to zero and there is no autocorrelation. There is an autocorrelation if an error term follows another error term with the same sign.

In matrix notation the VAR-process can be converted to the following equation if both variables to time t are arranged on the left-hand side

$\binom{1\,0}{0\,1}\binom{p_{j,t}}{h_{j,t}} = \binom{b_{10}}{b_{20}} + \binom{\gamma_{11}\,\gamma_{12}}{\gamma_{21}\,\gamma_{22}}\binom{p_{j,t-1}}{h_{j,t-1}} + \binom{\epsilon_{p_{j,t}}}{\epsilon_{h_{j,t}}}$, or

$$BX_{j,t} = \Gamma_0 + \Gamma_1 X_{j,t-1} + \epsilon_{j,t}\ . \qquad (20)$$

By multiplying with the matrix B^{-1} the following equation

$$X_{j,t} = A_0 + A_1 X_{j,t-1} + e_{j,t} \qquad (21)$$

is derived with A_0 as the inverted intercept matrix $[b_{10}, b_{20}]'$ with the dimension 1x2. A_1 is the inverted parameter matrix of the variables used with one lag. Finally the vector $e_{j,t}$ built by $e_{p_{j,t}}$ and $e_{h_{j,t}}$ represents the disturbances of the reduced form of the VAR. In the case where the simultaneous effects are disregarded, the error terms $e_{p_{j,t}}$ and $e_{h_{j,t}}$ are uncorrelated, too.

To apply now the long-run restriction or the structural component in the VAR-process that only technology shocks have a permanent effect on labour productivity, the factor a_{12} has to be zero. Thus the non-technology shock has no effect in the difference of labour productivity in time t-1 and t.

$$p_{j,t} = a_{10} + a_{11} * p_{j,t-1} + 0 * h_{j,t-1} + e_{p_{j,t}} \text{ and} \tag{22}$$

$$h_{j,t} = a_{20} + a_{21} * p_{j,t-1} + a_{12} * h_{j,t-1} + e_{h_{j,t}} \text{ .} \tag{23}$$

To identify the demand shock it is necessary to include the residuals from equation (22) in equation (23). The estimated residuals from this equation are the non-technological stochastic influences. The permanent influence on hours worked will be the demand. Once the first shock is identified exactly as a technology shock, it will be included into the equation of the second variable as an explanatory regressor. The relevant shock there will capture stochastic influences which have at best a transitory effect on labour productivity.

If the SVAR process is stable[17], an infinite vector moving average $(VMA(\infty))$ process (Wold representation) exists. This is necessary for the computation of the shocks.

$$X_{j,t} = \mu_j + \Phi_j(LO) * \delta_{j,t} \tag{24}$$

at which μ_j reflects a time-invariant mean of the exogenous variable $X_{j,t}$ for every country. LO is the so-called lag operator. $\delta_{j,t}$ represents the structural shocks with $\delta^p_{j,t}$ as the shock in labour productivity and $\delta^d_{j,t}$. Later called ts and ds.

$$\delta_{j,t} = \left[\delta^p_{j,t}, \delta^d_{j,t}\right]' = [ts, ds]' \tag{25}$$

The relation between the shocks of the reduced form (22) and (23) and the shocks derived by the structural VAR (24) is equal to

[17] The time series of $p_{j,t}$ and $h_{j,t}$ are stationary and they show no cointegration. In Chapter 3 stationarity is found for the first difference of $p_{j,t}$ and $h_{j,t}$ but they do not cointegrate. This is the reason why the first difference go into the SVAR estimations.

$$[ts, ds]' = B^{-1} \left[\epsilon_{p_{j,t}}, \epsilon_{h_{j,t}}\right]' \tag{26}$$

and delivers the structural technology and demand shocks (Reinstaller (2006)).

Chapter 3

The data and estimation procedure

3.1 The data and summary statistics

While the focus of my study[1] is on the European countries in regard to their differences in labour productivity, labour input and the countries´ responses to shocks, the chosen dataset is based on the EU Klems dataset (version March 2007)[2]. The EU Klems dataset itself is the result of an international research project with the goal of providing a comprehensive database for the study of European productivity at the industry level. While the EU Klems dataset covers all EU member states my prerequisite to have a balanced panel dataset required me to reduce the EU Klems dataset to the following two dimensions:

Country (cross section):	16 countries
Time (time series):	1974 - 2004

This reduced dataset constitutes a panel concerning the aggregated data for every country with the dimensions time and country in which the data nearly covers the EU-15 with its 15 old member states Austria (AUT), Belgium (BEL), Denmark (DNK), Spain (ESP), Finland (FIN), France (FRA), Germany (GER), Greece (GRC), Ireland (IRL), Italy (ITA), Luxemburg (LUX), the Netherlands (NLD), Portugal (PRT), Sweden (SWE) and the United Kingdom (UK). While I take Luxemburg due to a lack of data out of the dataset, I include the United States (USA) and Japan (JPN) as points of comparison. It makes sense to look at macroeconomic variables over thirty years in respect to potential influences of the business cycle. Thus the country dimension with 16 units and the time-period of 30 years provide an adequate basis for my research study of 480 observations per variable.

[1] This chapter overlaps in part Chapter 3 in Hölzl, Grieger and Reinstaller (2008)
[2] www.euklems.net

Box 1 presents the central variables used in this study. Representing the economic performance, the study is based on the real value added (RVA). It was necessary to compute an adequate deflator to get rid of potential inflation in the measurement of value added (VA). For the used approach, every country has one deflator which is based on the aggregation over all industries. The object of interest in regard to the labour input are the time series of total hours worked (h) and labour productivity (p).

The empirical research draws on the main research questions mentioned in the introduction: (i) What is the impact of technology and demand shocks on economic performance? and (ii) Does the interaction of the shocks with labour market institutions influence this impact on economic performances? For the first question the shocks are derived by the SVAR approach explained in section 2.3.3. Therefore the time series of labour productivity and total hours worked are integrated in the bivariate regression influencing each other symmetrically (compare the relevant dofile in the Appendix). For this approach these time series have to be stationary and not cointegrated, tested in section 3.2. The derived shocks will be examined in section 3.3. In Chapter 4 both questions will be discussed by a regression analysis after introducing the regulation indicators. For the regression of real value added, the time series of RVA are used. In the employment regression, the time series of EMP built up the dependent variable. Considering the real value added (RVA) and the employment (EMP) as a process depending mainly on technology and demand shocks, the estimation equation looks like in the following:

$$Y_{j,t} = \beta_0 * \delta_{j,t} + \eta_j + e_{j,t} \qquad (27)$$

where $Y_{j,t}$ denotes a vector of the growth rate in RVA and in EMP in one year in an economy j. The matrix $\delta_{j,t}$ is a matrix of the technology and demand shock (compare equation (25)). The error term consists on the one hand of a country-fixed effect η_j and on the other hand of the country-specific error term $e_{j,t}$ (Hölzl, Grieger and Reinstaller (2008)). The regression analysis estimates the coefficient vector β_0.

The meaning of the constructed variable p can now be demonstrated additionally with the following numerical example: In the year 1975 the Austrian economy accomplished a gross value added from about €45.7 billion. Adjusted to the inflation by the amount of 48.15 as the macroeconomic deflator, the real value added add up to nearly €95 billion. For the production in that year, Austrian employees

BOX 1: Variables derived from the EU Klems database	
VA	Gross value added at current basic prices (in millions of local currency)
VA(P)	Gross value added, price indices, 1995 = 100: Macroeconomic deflator
$RVA = \frac{VA*100}{VA(P)}$	Real value added (in millions)
EMP	Number of persons employed (in thousands)
h	**Total hours worked** by all persons employed (in millions); domestic concept
Constructed variable	
$p = \frac{RVA}{h}$	**Labour productivity** based on aggregated deflator$*$

$*$ As a result of a robustness check it does not matter if the factor 100 is included into the computation of the labour productivity or not.

worked over 6.5 billion hours (independent of the number of people employed). Thus the Austrian productivity amounted to €14.67 per hour. After thirty years of changes in technology, the real value added came to €191 billion with a labour productivity of €28.20 per hour.

Before turning to some descriptive statistics, it is informative to have a look at the unconditional correlation between the used variables in the panel. The correlation between the growth of output, or value added and growth of total hours worked is 0.34. Between the former and growth of labour productivity it adds up to 0.68. The relation between the growth rate in productivity and total hours worked is negative, -0.29. These correlations make sense in respect to the pattern of the business cycle.

Based on the fact that the economic performance of the countries under consideration differs, Table 3.1 describes the percentage changes in real value added, employment, labour productivity and total hours worked for all 16 countries between the years 1975 and 2004 on the macroeconomic level. It is a comparison between the first and the last year of the observed period but ignores the development in between them. It should give a short impression of the variables and the differences in respect to the countries but the development will be described in more details in a following chapter concerning the statistical tests.

Table 3.1: Changes of employment relevant variables and real value added in % between 1975 and 2004

	Real Value added	**Employment**	**Total hours worked**	**Hourly labor productivity**
AUT	101.54	13.28	4.87	92.17
BEL	87.43	10.24	-1.30	89.90
DNK	90.75	10.12	2.81	85.53
ESP	113.89	42.92	29.56	65.08
FIN	110.97	1.76	-7.60	128.27
FRA	87.71	16.27	-6.91	101.67
GER	85.83	19.50	-3.62	92.81
GRC	96.26	26.30	26.67	**54.96****
IRL	**336.24***	**74.29***	42.99	**205.08***
ITA	90.44	18.22	13.00	68.53
NLD	100.7	50.53	25.24	60.22
PRT	137.85	**1.07****	**-13.03****	173.48
SWE	**77.17****	4.15	7.79	64.36
UK	88.76	11.92	1.78	85.45
EU-Average	*114.68*	*21.47*	*8.73*	*97.68*
JPN	145.35	14.12	1.31	142.78
USA	138.67	60.10	**52.06**	56.95
Sample-Average	*118.10*	*23.42*	*10.98*	*97.95*

Table 3.1 presents the rate of change between the year 1975 and 2004 for EU-15 without Luxemburg, but with Japan and the United States, whereas $*$ indicates the variables largest change and $**$ the smallest or most negative change in the appropriate variable. The dataset is received from EU Klems.

On the one hand there are two groups concerning the productivity - the first group which shows an increase in productivity over 100% and the second group which performs less than 100% during the thirty years. On the other hand, the real value added performances range between 77% and over 300%, whereas most countries are around 100% increase. All 16 countries experienced a positive change in employment which is in accord with the change in total population described in Table 3.2. Although the country-specific changes in population between 1974 and 2004 are positive over all countries, the very small changes and the fact that the world population growth rate is declining[3], suggest a different picture for the years after 2004. But in the observed time period, the rise in population can be assumed to have a positive effect on change of employment.

There are substantial differences observable between the countries also in the other variables listed, especially in the changes of employment. For example, Ireland's employment grew from 1,072,932 persons engaged in the year 1975 to

[3]See http://www.census.gov/ipc/www/idb/worldpopinfo.html

1,870,100 in 2004, this amounts to an increase in employment of about 74%. In contrast, Portugal had an employment level of 5,084,704 in the year 1975 and showed an increase of only 1% over thirty years: 2004 Portugal had 5,139,260 persons engaged. Thus the Irish change in employment is close to 70 times that of Portugal's. Also, there are visible country-specific developments over the thirty years for total hours worked.

Table 3.2: Population growth rate in % over 30 years

	Year	**Total Midyear Population**	**Growth rate**
AUT	1974	7,599,038	
	2004	8,174,762	0.08
BEL	1974	9,767,800	
	2004	10,348,276	0.06
DNK	1974	5,045,297	
	2004	5,413,392	0.07
ESP	1974	35,184,287	
	2004	40,280,780	0.14
FIN	1974	4,690,574	
	2004	5,214,512	0.11
FRA	1974	53,689,610	
	2004	62,534,159	0.16
GER	1974	78,966,137	
	2004	82,424,609	0.04
GRC	1974	8,962,023	
	2004	10,647,529	0.19
IRL	1974	3,124,200	
	2004	3,969,558	0.27
ITA	1974	55,226,259	
	2004	58,057,477	0.05
NLD	1974	13,540,584	
	2004	16,318,199	0.21
PRT	1974	9,098,300	
	2004	10,524,145	0.16
SWE	1974	8,160,560	
	2004	8,986,400	0.10
UK	1974	56,224,000	
	2004	60,270,708	0.07
JPN	1974	110,162,302	
	2004	127,480,498	0.16
USA	1974	213,854,000	
	2004	293,027,571	0.37

Table 3.2 presents the population growth between the year 1974 and 2004. Data are from the United States Census Bureau (http://www.census.gov/ipc/www/idb/worldpopinfo.html).

The change in overall hours worked is highly different between the countries. There is one group of countries - Belgium, Finland, France, Germany and Portugal - which experienced even a negative development of total hours worked. On the other side there are the countries: Austria, Denmark, Spain, Greece, Ireland, Italy, Japan, the Netherlands, Sweden, the United Kingdom and the United States with a positive percentage change. Although they bear a positive trend concerning total hours worked, the labour productivity of these countries was increasing in this period. An increase in value added and in labour productivity is observable for all 16 countries. In general the Irish performance is extraordinary - their real value added changed with the highest percentage of growth in comparison to all of the other countries. The employment in Ireland also grew at the highest rate and even if the total hours worked in the United States rose more, the Irish labour input changed during the thirty years by more than 40%. In fact, over the thirty years Ireland changed from one of the poorest countries in Europe to one of its richest. Due to the very high real value added change, the labour productivity increase in Ireland is the greatest one compared to the other countries, showing again the miraculous catch-up effect of the Irish economy.

The American relation between positive real value added change and the change in employed labour is one of the lowest after Greece, this reflects the fact that the US started in 1975 at a very high level. Table 3.1 illustrates the great divergence that can be observed for a number of performance variables across the countries. Figure 3.1 points out the common trend of log labour productivity that can be observed for some European countries like Austria, France, Germany and the Netherlands. Notwithstanding the difference in levels, Austria's and Germany's labour productivity seem to follow a quite similar trend. Labour productivity in France acts similarly to that of Germany so that both intersected with the one in the Netherlands at the beginning of the nineties. The slow rise of the Dutch labour productivity leads to the assumption that, under constant circumstances, Austria will become more productive than the Netherlands over the next years.

The positive signs for real value added, employment and also for labour productivity for all countries are remarkable. Unlike the signs for the change in total hours worked: Some countries increased their total hours worked, others reduced them. But to recognise detailed differences, one has to notice the great differences in the size of the variables. Arranging the countries according to the size of variables, one important aspect is observable: Portugal has the smallest increase in employment and total hours worked but belongs to the countries with a strong rise in value added. The situation is similar in Finland. Ireland, on the contrary, has extended its employment and total hours worked extremely to achieve the same result of such a high increase in real value added. All countries enhanced their labour productivity strongly. Portugal and Finland boosted their productivity although they only had a small positive change in employment and even a negative development in total hours worked. They could increase their value added, consequently their output with less labour input. The increased labour productivity probably led to labour saving possibilities in production. Unlike the Irish case: Its positive high productivity change could be associated with increased demand for labour. Employment and total hours worked increased strongly in Ireland.

The EU-average changes are not all that different from the sample-average. While the United States expanded its labour input the most, Japan did not experience a great increase in total hours worked. These opposite developments cancel each other out in the average. But both average measurements present more the "Portuguese development": High labour productivity change but a very small increase in total hours worked. The fact that employment increased more than total hours worked can be explained for instance by the development of decreasing legal hour workweeks or the increased possibility of job sharing in the course of an increased rate of women engaged.

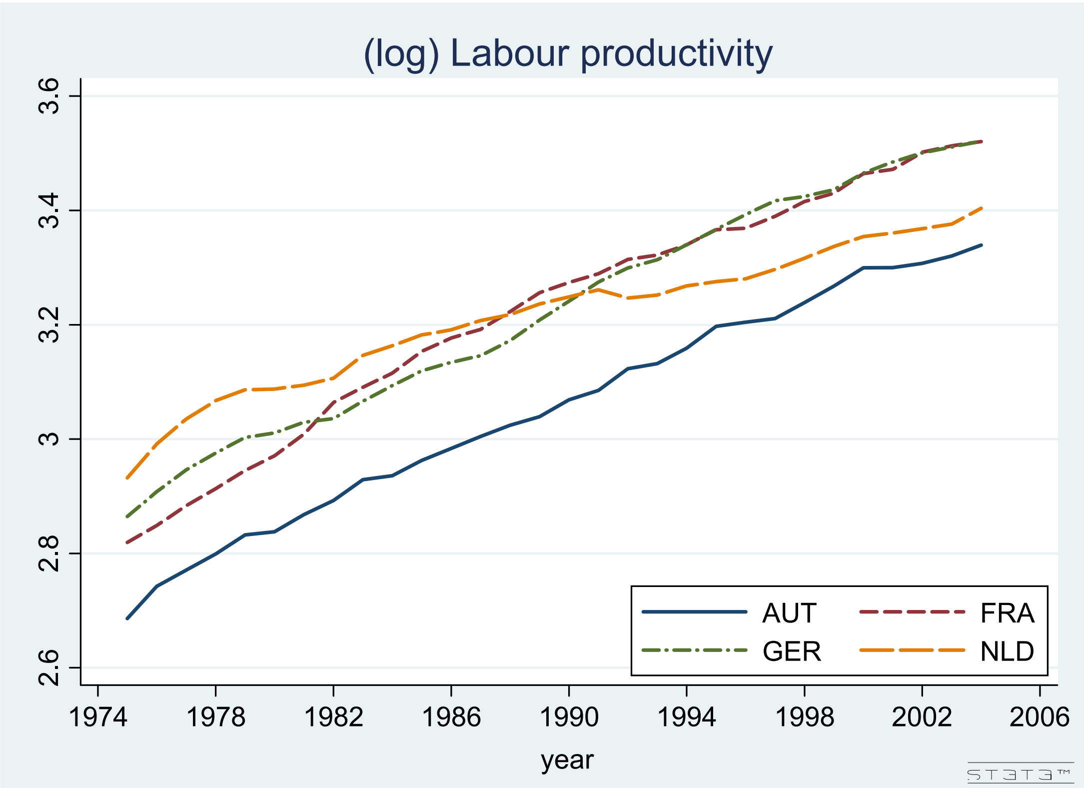

Figure 3.1: Development of labour productivity in selected countries

Figure 3.2 shows the progress in total hours worked for the chosen European countries. While the labour input, e.g. the total hours worked in Austria stayed nearly constant or shows a slight increase, the Netherlands experienced a vast rise in total hours worked since the beginning of the eighties. As opposed to France where the total hours worked decreased until the eighties and Germany where they slightly decreased over the whole period. These considerations agree

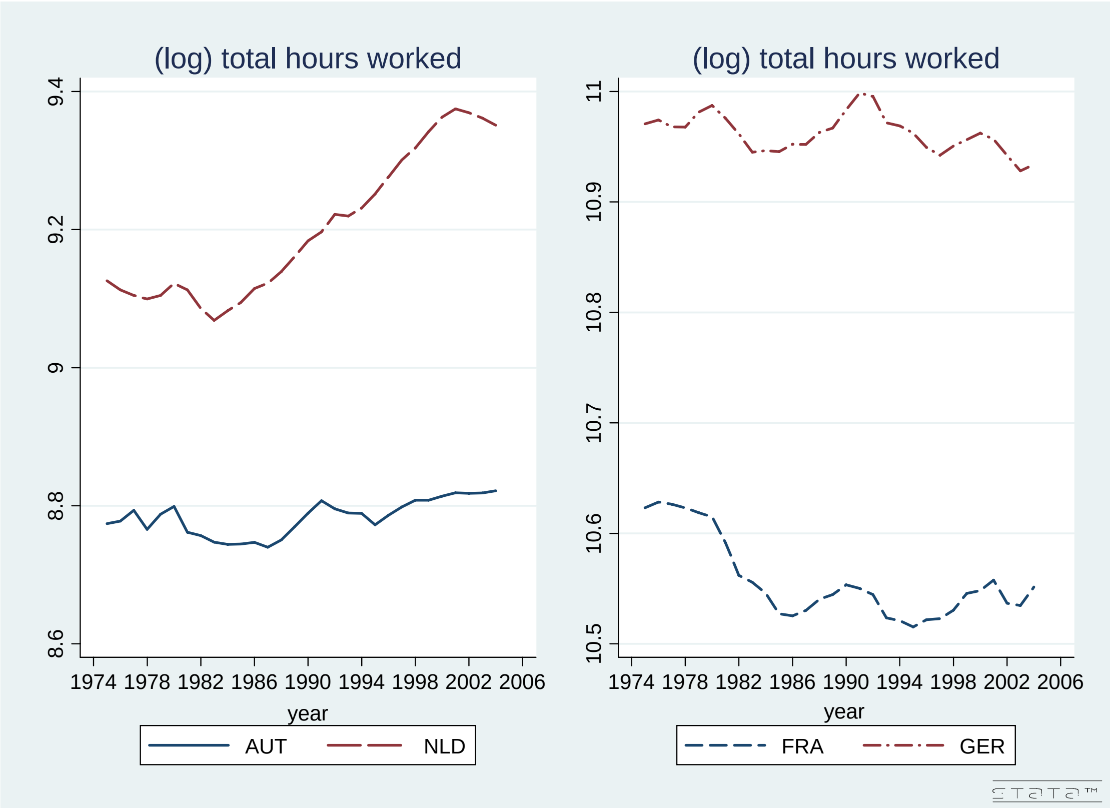

Figure 3.2: Development of total hours worked in selected countries

with the data in Table 3.1 - Germany and France had a negative change in total hours worked between the values in 1975 and 2004 and Austria and the Netherlands a positive change. In context to Figure 3.1, the declining input of total hours worked in France and Germany supply the strong rise in their labour productivity. A smaller slope of the labour productivity for the Netherlands is associated with their increasing total hours worked. The different levels of the total hours worked make sense under the concept of aggregated values instead of per capita computation.

3.2 Specification tests

In order to implement the econometric framework given by equation (24), the time series used in the SVAR have to be stationary. If they are stationary, the SVAR process can be assumed to be stable. Due to the fact that there are 16 time series for each country, it is easier to test stationarity in the panel. As unit root tests have in general low power (Baltagi (2005)) and the data consists of pooled time series, I am able to use panel unit root tests that have been proposed as a more powerful alternative to unit root tests on single time series. I use three different panel unit root tests: The Levin-Lin-Chu test (Levin, Lin and Chu (2002)), the Im-Pesaran-Shin test (Im, Pesaran and Shin (2003)) and the Pesaran test (Pesaran (2003)). In a further step, the two variables - labour productivity and total hours worked - are tested for potential cointegration. The panel is expected to have a unit root but no cointegration.

3.2.1 Unit root test

The Levin, Lin and Chu (2002) test assumes that the AR coefficients for unit roots are in particular the same across the sections. The null hypothesis is that each individual time series contains a unit root against the alternative that each time series is stationary. A rejection of the null hypothesis of the Levlin, Lin and Chu (2002) test means that all individual time series are likely to be stationary. If one can not reject the null hypothesis, every series is assumed to be non-stationary. Although the test is not the most restrictive model, the alternative hypothesis with its underlying assumption of common parameters is often criticised as an unrealistic alternative hypothesis.

In contrast to the first test, the second one is based on a model which permits more heterogeneity between the individual time series. The test proposed by Im, Pesaran and Shin (2003) is based on the average of the individual Augmented Dickey-Fuller (ADF) unit root tests, computed from each single time series. The null hypothesis is that each individual time series contains a unit root while the alternative allows for some but not all of the individual series to have unit roots. Thus it has the same null hypothesis as the Levin, Lin and Chu (2002) test. The alternative hypothesis of the Im, Pesaran and Shin (2003) test differs now in an important way - the first-order auto regressive coefficients do not have to be identical on all series thus it allows for some series to have unit roots while others have not. So for this test a rejection of the null hypothesis means that one can not be sure that all time series within the panel are stationary. There can be some time series which are stationary and some which are non-stationary. As soon as there is one time series within the panel which is stationary, the Im, Pesaran and Shin (2003) test rejects the null hypothesis. Unfortunately, it provides neither any information about the number of stationary time series nor which time series are stationary. But facing the Levin, Lin and Chu (2002) test, it can ward off the criticism concerning the unrealistic alternative hypothesis.

One major criticism of both these tests is that they require cross-sectional independence. Pesaran (2003) relaxes this requirement. It is based on augmenting the usual ADF regression with the lagged cross-sectional mean and its first-difference to capture the cross-sectional dependence. Analogous to Im, Pesaran and Shin (2003), this test is consistent when only a fraction of the series is stationary. So this test can be considered as the most powerful test of the three applied in respect to the plausible alternative hypothesis and to the conceivable cross-sectional dependence. The unit root tests applied in two different possible regressions are exemplified for labour productivity in the following

Lag(1): $$\Delta p_{j,t} = a_{10} + a_{11} * p_{j,t-1} + e_{p_{j,t}} \quad (28)$$

Lag(1) with trend: $$\Delta p_{t,i} = a_{10} + a_{11} * p_{j,t-1} + c * t + e_{p_{j,t}} \quad (29)$$

Using different information criteria and likelihood ratio tests determine the optimal lag order which are determined by the Augmented Dickey Fuller Test for every time series within the panel. In general these tests seemed to favour more complicated models. But I concentrated on employing regressions with lag 1.

Figure 3.3 shows the development of total hours worked for every country while Figure 3.4 pictures the development of real labour productivity.

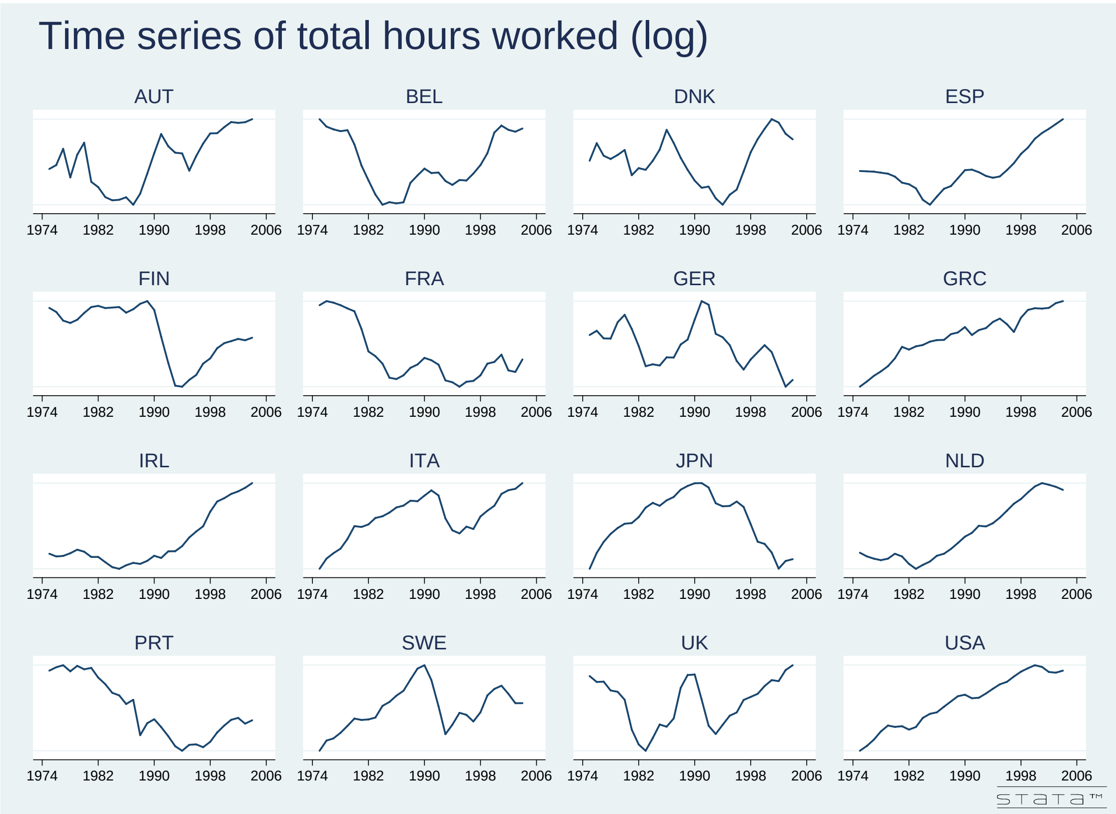

Figure 3.3: Development of total hours worked

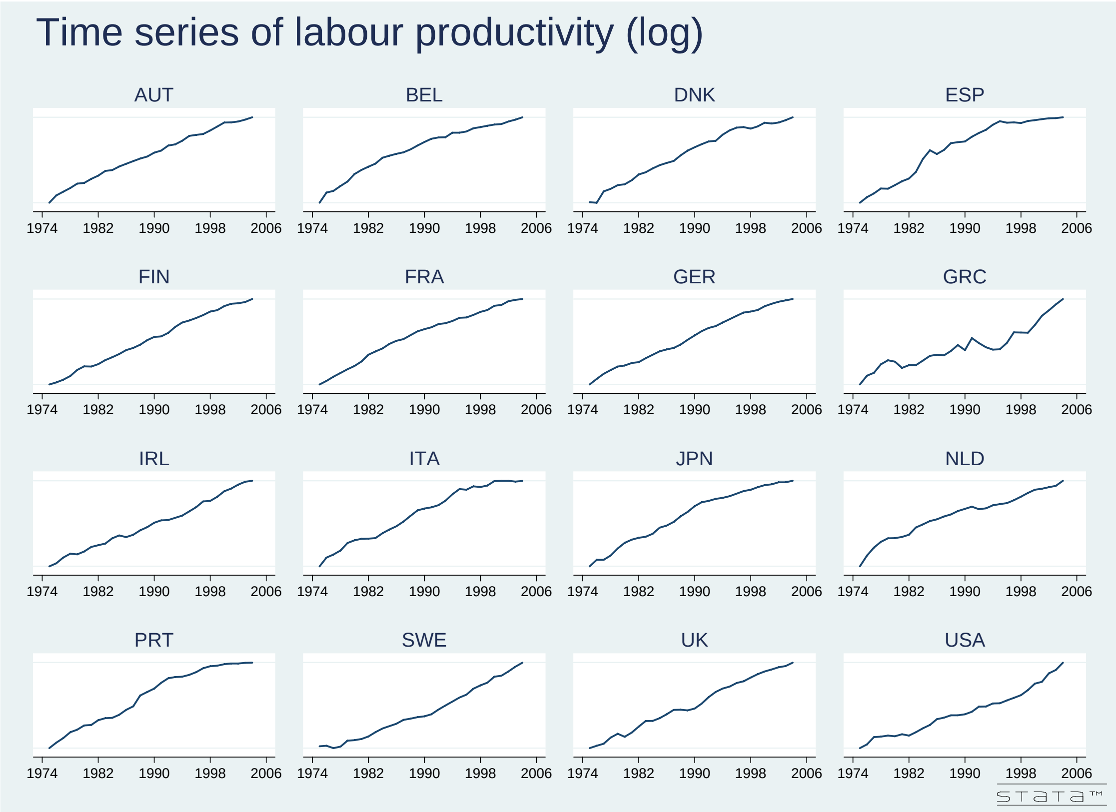

Figure 3.4: Development of labour productivity

Testing the order of integration for both variables - log total hours worked and log labour productivity - the panel dataset is employed with all 16 countries concerning their macroeconomic aggregated level. The summarised results of the panel unit root tests are presented in Table 3.3, whereas the detailed tests concerning every regression are shown in Table A.1 in the Appendix. The hypothesis of a unit-root I(1) cannot be rejected for log total hours worked in the case of not including a trend. Including the trend, the null of I(1) is rejected by Levin, Lin and Chu (2002), but not by Pesaran (2003) and Im, Pesaran and Shin (2003). The null of I(2) is finally rejected in both cases by all three tests[4]. Thus the series of log total hours worked for the panel seem to be integrated of order one. These panel test results are largely in line with individual unit root tests for every country. The results are nearly the same when the log labour productivity for I(1) is tested. Aside from the Levin, Lin and Chu (2002) test the null hypothesis of I(1) cannot be rejected for all regressions. And by testing the first differences of labour productivity in the regression which employs an intercept and a trend, all of the three tests reject the null hypothesis. So it can be concluded that the series concerning labour productivity are integrated only of order one, I(1), i.e. that they have only one unit root. Thus the performance is better than for log hours worked as

[4]Unit root tests with first differences.

expected. In macroeconomic literature the discussion is usually whether hours worked have a unit root or not. But the question discussed in literature is not extended to productivity. Thus, if one considers the whole evidence on the country level for log labour productivity[5], it is safe to conclude that all time series in these panels contain a unit root. In addition, the developments of the first difference in log labour productivity, shown in Figure 3.5, confirm this conclusion. Both variables are stationary when using their first differences.

Table 3.3: Panel unit root tests of total hours worked and labour productivity

	Rejection of H0			
	lnh	**lnh, trend**	**dlnh**	**dlnh, trend**
Levin, Lin and Chu 2002	no	yes	yes	yes
Im, Pesaran and al. 2003	no	no	yes	yes
Pesaran 2003	no	no	yes	yes
	lnp	**lnp, trend**	**dlnp**	**dlnp, trend**
Levin, Lin and Chu 2002	no	no	yes	yes
Im, Pesaran and al. 2003	no	no	yes	yes
Pesaran 2003	no	no	yes	yes

Table 3.3 presents the results of the unit root tests for labour productivity and total hours worked. The results correspond to unit root tests with lag 1. The dataset is from the EU Klems. Table A.1 in the Appendix has the more detailed results and the relevant p-values. "yes" means that the hypothese H0 (unit root exists) is rejected because the p-value is smaller than 0.05, respectively the time series are stationary, "no" means that H0 is not rejected, respectively a sign for non-stationarity. Thus, both variables are integrated of order one, I(1).

[5]Compare results in Hölzl, Grieger and Reinstaller (2008).

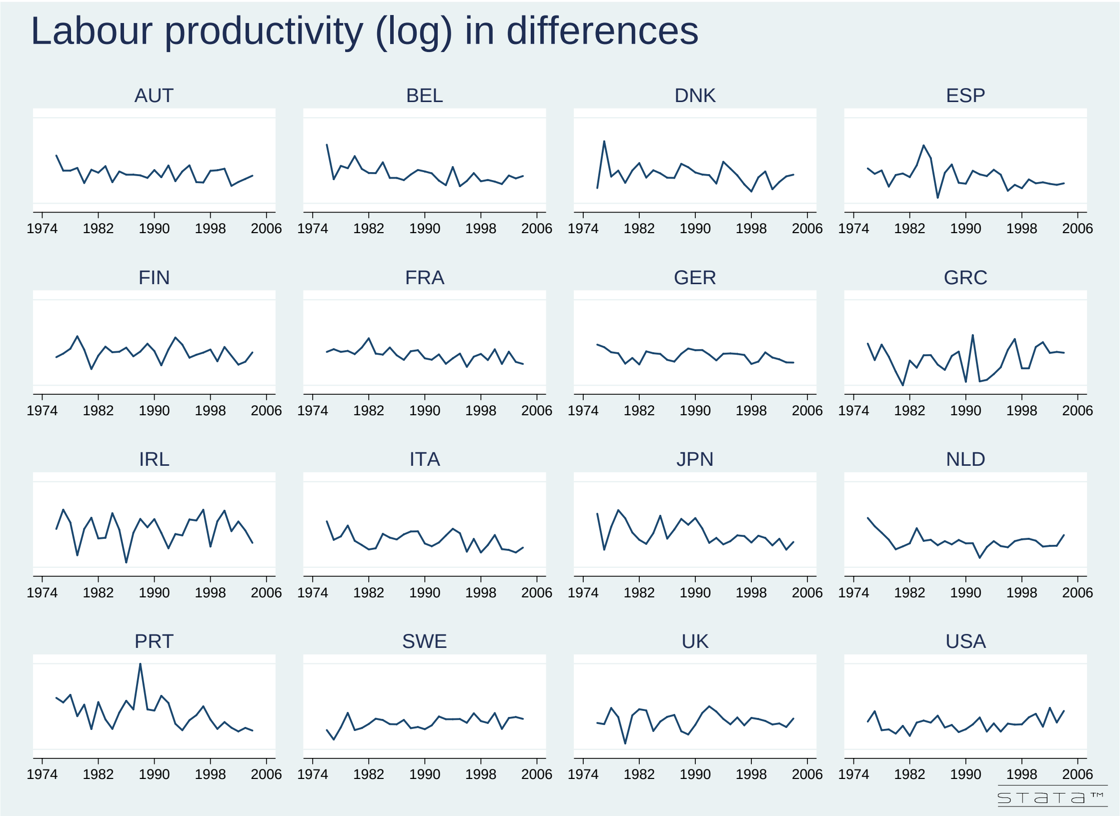

Figure 3.5: Labour productivity in differences

3.2.2 Cointegration test

These results from the panel unit root tests call for panel cointegration tests - even if the time series of the panel are non-stationary, there is a possibility of a stationary linear combination between time series concerning two variables. To check for a potential similar development between total hours worked and labour productivity - so that their differences would constitute a stationary time series - four different panel cointegration tests are used: Pedroni's group Z-rho and the group t tests (Pedroni (2004)), as well as Westerlund's (2005) group mean variance ratio and panel variance ratio statistics which are all residual based. They test for cointegration between log total hours worked and log labour productivity.

On the face of Table 3.4, all four tests fail to reject the null hypotheses which assumes no cointegration. It give evidence of possible influences out of the variables themselves.

Table 3.4: Cointegration Tests

Cointegration between (log)total hours worked and (log)labour productivity							
P(Z-rho)	p-val	P(Z-t)	p-val	W(Group)	p-val	W(Panel)	p-val
7.2	1.0	10.9	1.0	76.5	1.0	33.7	1.0

P(Z-rho): Pedroni´s group Z-rho; *P(Z-t):* Pedroni´s group t test; *W(Group):* Westerlund´s (2005) group mean variance ratio statistic; *W(Panel):* Westerlund´s (2005) panel variance ratio statistic

The p-values are equal to 1 in all cases. They uniformly reject the possibility of a cointegration between the two variables[6]. This result is important for the structural vector autoregression. Total hours worked and labour productivity can be included in the SVAR model to compute the objects of interest - the technology and the demand shocks. The series for productivity and total hours worked entered the SVAR in first differences and no error correction is needed.

3.3 Technology and demand shocks

As regards the previous results from the specification tests, one can verify that all VARs are stable. Consequently, a vector moving average (VMA) representation exists for each vector autoregression (VAR). Technology and demand shocks for the 16 economies can be extracted following the SVAR approach developed by Gali (1999). The obtained time series will be examined now in order to learn

[6]If the variables are not cointegrated in levels, they do not cointegrate in differences as well.

something about potential differences in characteristics between technology and demand shocks. A number of contributions in literature have provided robust evidence that the aggregate demand (also called non-technology shocks) attained with this approach closely match business cycle shocks (see e.g. Francis (2002), Gali (2004)). Technology shocks on the other hand are expected to be more heterogeneous across countries.

To survey the features of the estimated shocks, potential common technological or demand developments across the countries are checked by using principal component analysis (PCA). Is there a co-movement between the single shocks? Or is there even a co-movement between the technology and demand shocks? Principal component analysis tests whether productivity and demand changes across countries are driven by similar causes. If the countries were experiencing shocks to productivity and demand in a rather homogeneous fashion, then it should be possible to identify a few principal components that explain a large fraction of the correlation in the data. This would not be the case if heterogeneity was high.

Results from an analysis of variance (ANOVA) are also presented. They can shed light on the reason why the shocks fluctuate around their mean. It is perhaps possible to uncover a time structure in the development of technology and demand shocks.

3.3.1 Principal component analysis

The results of the principal component analysis for technology and demand shocks are summarised in Table 3.5 and 3.6 from which one can learn more about the underlying patterns of the data and about similarities and differences in the development of the shocks. In this context it is not practicable to identify the potential correlation between the shock and the country or between the shock and time by graphical presentation: This dataset has 28 observations of technology shocks for all 16 countries which yield to a matrix of 28 x 16 which can only be plotted as a cloud of values. Figure 3.6 presents a scatter plot for technology shocks over time in the case of one country (here Austria) and in the case of all observed countries. One can see that this cloud has a special form and certain extensions in certain directions. The principal component analysis reduces this cloud into a few axes which describe the most extended directions, orthogonal to each other. The main components explain the prevailing trends of the cloud.

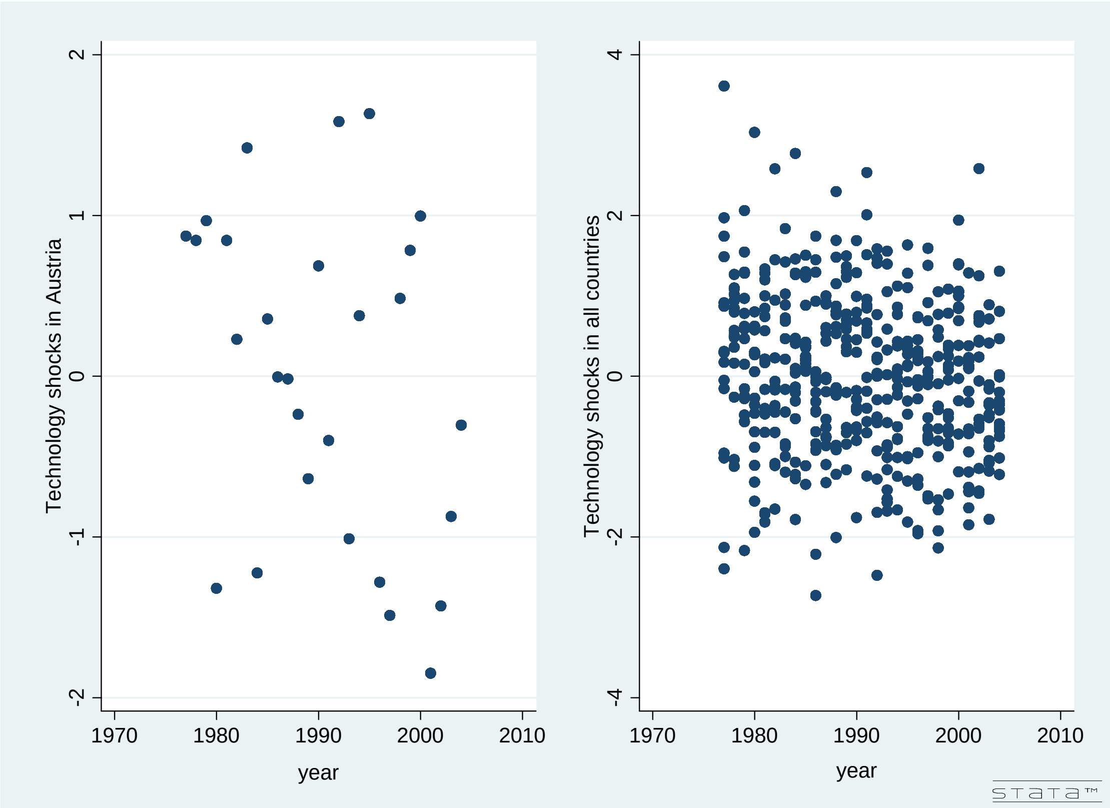

Figure 3.6: A scatterplot of technology shocks

The principal component analysis is based on the computation of the eigenvalues of the covariances. By the act of extracting the eigenvectors of the covariance matrix, it is applicable to find the parts which characterise the data. In Table 3.5 and 3.6 the eigenvalues are ordered from highest to lowest. The highest one is the main component of the data. The number of components is equal to the number of dimensions (here 16 countries). While the components are listed by their size, the received order reflects an order of significance: The first component has the highest significance. The components above the fifth component can be ignored due to their less significance.

For technology shocks the first component accounts for 18% of the variance of technology shocks across countries. It reflects a common structural effect on productivity growth and a quite substantial diffusion of technology across countries. In addition we see that the second component accounts for 12% of the variance and the third one for 11% of the overall variance of technology shocks between countries. Together the three largest components account for 42% of the overall variance. The findings for demand shocks are also reported in Table 3.5 and 3.6. For demand shocks the first three components explain 55% of the overall variance: The first component 33%, the second component 12% and the third 10%.

Table 3.5: Principal component analysis of macroeconomic shocks across countries

Component	Eigenvalue	Difference	Proportion	Cumulative
Technology Shock				
Comp 1	2.88	0.91	0.18	0.18
Comp 2	1.97	0.14	0.12	0.30
Comp 3	1.82	0.14	0.11	0.42
Comp 4	1.69	0.35	0.11	0.52
Comp 5	1.34	0.03	0.08	0.61
Demand Shock				
Comp 1	5.25	3.29	0.33	0.33
Comp 2	1.95	0.38	0.12	0.45
Comp 3	1.57	0.38	0.10	0.55
Comp 4	1.19	0.08	0.07	0.62
Comp 5	1.11	0.18	0.07	0.69

Table 3.5 shows the PCA for 16 countries concerning technology and demand shocks. The dataset is from EU Klems. Only the first five components are reported. Higher components are not significant anymore. The cumulative percentage rate gives information about the explanatory content of the corresponding component.

The findings refer to slightly more idiosyncratic technology shocks across countries compared to demand shocks. The cumulated first three components explain less of the overall variance in the case of the technology shock than in the case of the demand shock. The technology shocks are a little bit more dispersed than the demand shocks. For the demand shocks only two components are needed to explain 45% in the variance of demand shocks. But for the technology shocks three components explain 42% of the overall variation, indicating that technology shocks are fuelled more by a variety of different sources. The difference is accounted for largely by the first component. This finding seems to advert to demand shocks which have a different nature than technology shocks. It should be repeated that technology shocks can be considered as aggregations of sectoral technology shocks that are driven by largely sector-specific technological developments (compare page 19). The development of productivity at the aggregate levels seems to be related to sector-specific developments. On the other hand demand shocks seem to have a strong macroeconomic component that is similar across countries and sectors.

Table 3.6 reports the repeated analysis without the United States and Japan. The data concerns more similar countries. Comparing the cumulative percentage rates with the rates in the first PCA, the components in the “European dataset” are higher. The first three components explain 45% of the variance in the technology shocks. In the fluctuations of the demand shocks, nearly 60% is captured by the first three components. These results support the idea that the European countries experience more or less quite similar developments on the aggregated levels.

Table 3.6: Principal component analysis without the United States and Japan

Component	Eigenvalue	Difference	Proportion	Cumulative
Technology Shock				
Comp 1	2.83	0.98	0.20	0.20
Comp 2	1.85	0.25	0.13	0.33
Comp 3	1.60	0.08	0.11	0.45
Comp 4	1.52	0.18	0.11	0.56
Comp 5	1.34	0.14	0.10	0.65
Demand Shock				
Comp 1	5.07	3.46	0.36	0.36
Comp 2	1.61	0.05	0.11	0.48
Comp 3	1.56	0.46	0.11	0.59
Comp 4	1.09	0.16	0.08	0.67
Comp 5	0.93	0.13	0.07	0.73

Table 3.6 refers to the PCA for 14 countries concerning technology and demand shocks. The data are from EU Klems. Only the first five components are reported. Higher components are not significant anymore. The cumulative percentage rate gives information about the explanatory content of the corresponding component.

When the shocks are extracted, correlation between lagged shocks should be controlled. There should be no temporal relation between a shock at time t, t - 1 and t - 2. Table 3.7 supports the applied theoretical concept of shocks that they absorb deviations of the variables from their trend - a technology shock at time t shows no temporal relation with a shock one period or two period before. Due to the small coefficients, one can conclude that the shocks are not persistent. The same result holds for the demand shock.

Table 3.7: Test for correlation between shocks

	ts at t	**ts at t-1**	**ts at t-2**
ts at t	1	/	/
ts at t-1	0.0066	1	/
ts at t-2	-0.0838	0.0021	1
	ds at t	**ds at t-1**	**ds at t-2**
ds at t	1	/	/
ds at t-1	0.0843	1	/
ds at t-2	-0.1184	0.0791	1

Table 3.7 presents the correlation matrix. The data are from the EU Klems. It confirms the independence between the lagged shocks due to the fact that the shocks in period t-1 correlate slightly with the shocks at time t.

3.3.2 Are the shocks time- or country-specific?

Before analysing the impact of technology and demand shock on economic performance, it is useful to investigate to what extent the shocks show country- or time-specific patterns across countries. Analysing the variances (ANOVA) is a possible tool to explain the impacts on the variance of a variable by using the F-statistics: Which influence drives the variable away from its mean? Due to the numerous influence factors like 30 years, the test has to compare the mean of more than one group. Hence there are dummy variables for every country and every year. The fixed effects model is then tested against the pooled regression model which has constant intercepts and slopes. For fixed country effects the fixed effects model uses constant slopes but intercepts that differ according to countries. In the case of fixed time effects the slopes capture potential temporal effects.

In this study, which deals only with two dimensions, the nature of the construction of the shocks leads to the circumstance that the overall variance of the shocks can not be explained by country-specific fixed effects. In order to confirm this conjecture and to learn something about the time effect, this statistical method is used. From the construction of the shocks as random variables that are normalised with a mean of zero and a standard deviation of one to hold for stationarity for lnp (natural logarithm of labour productivity) and lnh (natural logarithm of total hours worked), one can expect the country-fixed effects to be zero. Any other results would point towards an error in the construction of the shocks: Country fixed effects unequal to zero would be evidence of different intercepts in respect to different countries which entails a different distribution for every country-specific shock, and the normal distribution of the shocks is not warranted anymore. This means that the shocks do not vary depending on which country they appear in. Time-fixed effects are indications of business-cycle effects that are present across all countries thus one does not expect such effects to explain much in the context of technology shocks. On the other hand, they should be relevant for demand shocks. The results of the analysis of technology and demand shocks are reported in Table 3.8.

The results provide an indication to what extent the overall variance is explained by the different fixed effects. As expected, the difference is exclusively due to common time effects: The results confirm the expectation that country-fixed effects do not contribute to the explanation of overall variance of the shocks. But one can see that the time fixed effects are more important for the explanation of the overall variance for demand shocks than for the technology shocks. The time effect is

Table 3.8: Anova of technology and demand shocks across all countries

	Technology shocks	Demand shocks
Country effects	0 %	0 %
Time effects	9.07 %	30.24 %
Explained variance	9.07 %	30.24 %

Table 3.8 presents the results from ANOVA including all countries. The dataset is from EU Klems. There is no country effect due to the construction of the shocks. The time effect explaining the variance of the shocks for a demand shock is higher than for a technology shock.

substantially smaller in the case of the technology shocks than of demand shocks. This suggests that the time effects are quite different across countries in the case of technology shocks. Overall, the results in Table 3.8 confirm that technology shocks are primarily driven by idiosyncratic developments that are captured in the non-explained variance. This indicates that there is a substantially more significant common component in the case of demand shocks than in the case of technology shocks, thus confirming the results of the principal components analysis in the previous section. Overall, the fraction of explained variance is substantially higher for the demand shocks than for the technology shocks giving again some weight to the conjecture that technology shocks are due to more industry-specific developments than demand shocks. And the comovement across all countries is higher for the demand shocks.

Table 3.9: Anova of technology and demand shocks for European countries

	Technology shocks	Demand shocks
Country effects	0 %	0 %
Time effects	9.66 %	34.34 %
Explained variance	9.66 %	34.34 %

Table 3.9 presents the results from ANOVA including only European countries. The dataset is from EU Klems. There is no country effect due to the construction of the shocks. The time effect explaining the variance of the shocks for a technology and a demand shock is now higher than before in Table 3.8.

In Table 3.9 the analysis of variance is repeated for a modified dataset. The United States and Japan are excluded. In comparison to Table 3.8 the time effects are larger for both shocks. Regarding the demand shock as homogeneous anyway, the effect of excluding the United States and Japan is stronger than for the technology shock: The technology shock increases by a half percentage point. A demand shock rises by over 4 percentage points. Thus the results of a sample including only European countries supports the idea that the European countries experience the shocks in a more similar way compared to the United States or Japan.

Chapter 4

The impact of technology and demand shocks

To get an idea of the impact of a technology or a demand shock on output and employment, the following chapter discusses the analysis of the estimated impulse responses and a linear regression on panel data. On the one hand, I computed the regressions with all countries involved in the panel. On the other hand, I calculated regressions with the country groups from the impulse response analysis. The impulse responses will support the developed understanding of the shocks: Positive demand shocks capture primarily the influence of the business cycle when increasing total hours worked and output. But they have nearly no impact on the labour productivity in the long run. In contrast, positive technology shocks can be interpreted as labour productivity improvements which are caused by all sectoral changes in labour productivity through sectoral technology shocks. Due to the negative impact on total hours worked, technology shocks are not a source of the pro-cyclical behaviour of employment.

The regression analysis will provide some further insights into the impact of the identified technology and demand shocks on growth rate changes of labour productivity, employment, total hours worked and output. Using a fixed effect model allows for possible heterogeneous intercepts for each country. To capture dynamic effects, lagged shocks are included in the regressions, too. The regressions will also be repeated for country groups that were derived by the patterns of impulse responses in order to investigate heterogeneous behaviour concerning technology and demand shocks. To get a step further, the regression is applied in the analysis of technology and demand shocks in interaction with regulation indicators. The underlying assumption is that the institutions and regulations can support or constrain the impact of shocks on employment and output growth. The definitions of all the variables used in the panel regression analysis are presented in Box 2.

BOX 2: Variables used in the Regression Analysis

$\Delta \ln RVA$	Growth rate of real value added (based on the macroeconomic deflator)*
$\Delta \ln EMP$	Growth rate of employment (time series EMP from the EU Klems database)*
ts	Technology shock derived by SVAR
ds	Demand shock derived by SVAR
ep	Employment protection**
ud	Union density**
bc	Bargaining coordination**
brr	Benefit replacement rate**
bd	Benefit duration**
*	Variables in the regression analysis which are derived from the EU Klems database
**	Data derived from Nickell and Nunziata (2001)

4.1 Impulse responses

With an impulse response analysis it is possible to observe the relation between the variables employed in the structural variance autoregressive framework in more detail. In the following section the focus of interest is on the responses of the growth rates of real value added, productivity and hours worked to the extracted technology and demand shocks. As long as growth rates are approximated by the difference of a logarithm, the growth rate of the real value added can be decomposed as

$$
\begin{aligned}
\Delta ln\tfrac{RVA}{h} =& \quad \Delta \ln RVA - \Delta \ln h \\
\Leftrightarrow \Delta \ln RVA =& \quad \Delta \ln \tfrac{RVA}{h} + \Delta \ln h \\
\Leftrightarrow \Delta \ln RVA =& \quad \Delta \ln p + \Delta \ln h
\end{aligned} \tag{30}
$$

Thus it is possible to analyse the responses of the real value added growth rate by adding the responses of the growth rates of labour productivity and total hours worked. The singular impulse from an impulse variable like the technology shock is a one standard deviation from its mean[1]. They are observed for each country

[1]Taking standard deviation instead of one unit is more useful due to different scales in the variables.

and with the assumption that no further shock occurs afterwards. The yearly responses of the reacting variable are cumulated over 10 steps[2]. The confidence intervals are computed by a bootstrap method with standard errors and 250 replications for each impulse response. The responses of labour productivity and total hours worked are depicted in Figures 4.1 to 4.5. The response of the real value added growth, as the consequence of the two reactions mentioned above, is presented there as well. In general one can distinguish between a permanent lasting effect and a reaction which lasts only in the short-run. A temporary shock shifts the responding variable to a different level but can not prevent the variable from going back to its original level.

Concerning the Figures 4.1 to 4.5, the following observations can be made: The responses to a demand shock are similar in all the countries. Above all, it boosts the growth of total hours worked and of real value added whereas it has no lasting effect on productivity growth as expected. The technology shock as an impulse in the productivity in turn is causal for a lasting effect on the growth rate of productivity, the total hours worked and of real value added. Studying the type of the causality, one can find 5 different patterns out of the 16 country-specific responses.

The characteristics of pattern 1 are the ceteris paribus decline in the growth rate of total hours worked and the rise in real value added growth. A single innovation in labour productivity shifts the level of the labour productivity upwards to a higher level. This technology shock reduces the growth of total hours worked permanently and lifts the growth of real value added. But increased labour productivity can be a source of labour saving, thus the real value added does not rise in the same dimensions as the labour productivity would implicate. This is in line with the observations made in the descriptive statistics on page 29. One possible reason why a country might have a higher real value added although the total hours worked declined is an increased competitiveness due the productivity improvement. In addition to the reaction to the demand shock, in this pattern the real value added growth is driven both by demand and productivity. The first pattern emerges for Denmark, France, Italy, Portugal and the United States and makes up a group of the "rising countries" due to the positive effect of technology shocks on the real value added growth. It is shown in Figure 4.1 in the example of Portugal.

Impulse responses with the second pattern are plotted in Figure 4.2 and appear only for Spain and the United Kingdom. In this pattern the negative effect of

[2] Due to the fact that the data is yearly observed it is equal to 10 years.

a technology shock on total hours worked is greater than the positive effect on labour productivity. Thus the real value added declines as a consequence. In other words, the impacts can not be uncovered by this analysis - either the improvement in productivity is labour saving and a source of the declining real value added or the fall in the growth rate of total hours worked mirrors a declined demand. This result does not correspond to the descriptive statistics on page 29. The real value added increased in each country. It seems that the real value added could increase in Spain and the United Kingdom over the thirty years only due to stronger effects of demand shocks than of technology shocks. In the case of the United Kingdom the responses of real value added growth are weak and its confidence interval is expanded. Therefore its classification among the "declining countries" cannot be seen clearly. If the response of real value added growth is not significantly different from zero, its pattern could be classified with the fourth pattern, too.

Figure 4.3 gives a picture of the dynamic relationship between the observed variables as in pattern 3. The impact of a technology shock raises the labour productivity growth rate as it does in all other patterns as well, but its effect on the growth rate of total hours worked dies away quickly. In the very short run, total hours worked grows more slowly before it tapers off to zero. The innovation in labour productivity does not have to cause a labour saving impact but can also affect the way of using the input factors and resources: If the labour input is adopted in a more efficient way, the total hours do not have to be reduced or extended and the real value added growth rises. This is conceivable in capital intense conditions for example. Pattern 3 applies for Austria, Germany and surprisingly for Greece.

Whereas the sources of real value added growth have to look for technology and demand changes, in pattern 4 technology shocks have no effect on real value added growth. This pattern is found for Belgium, Finland, the Netherlands and Sweden and is depicted in Figure 4.4 using Sweden as an example. It indicates a real value added growth which is demand driven: The effect of labour productivity and total hours worked cancel each other out completely.

Finally, the last pattern supports the real business cycle theory concerning a positive correlation between labour productivity and total hours worked. Ceteris paribus a technology shock increases the growth rate of total hours worked as well as the growth rate of real value added. This is the case for Ireland and Japan, illustrated using Ireland as an example in Figure 4.5. Both countries experienced a great catch-up effect at least in the time up until the depression in Japan, or until the structural change in Ireland was over. The above average demand in Ireland was especially due to the strongly growing information and communication technology industry and needed to be satisfied with more labour inputs, among other things.

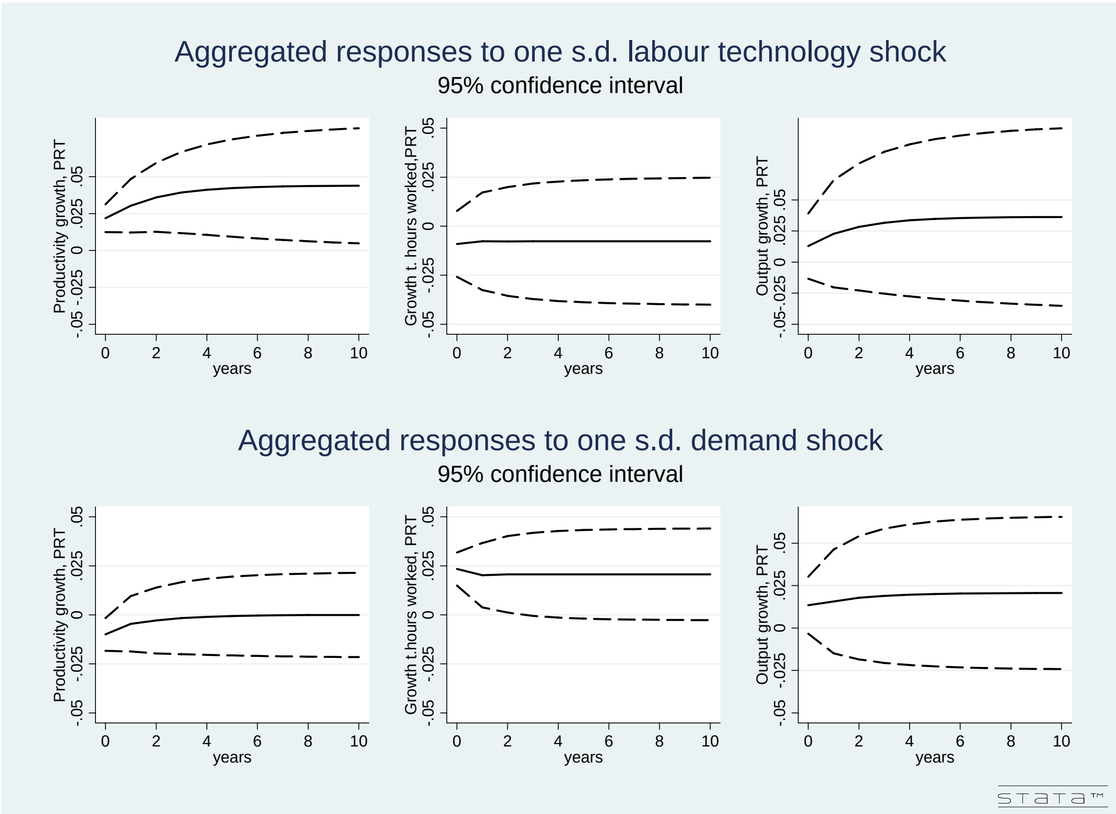

Figure 4.1: Impulse response pattern 1 illustrated by Portugal

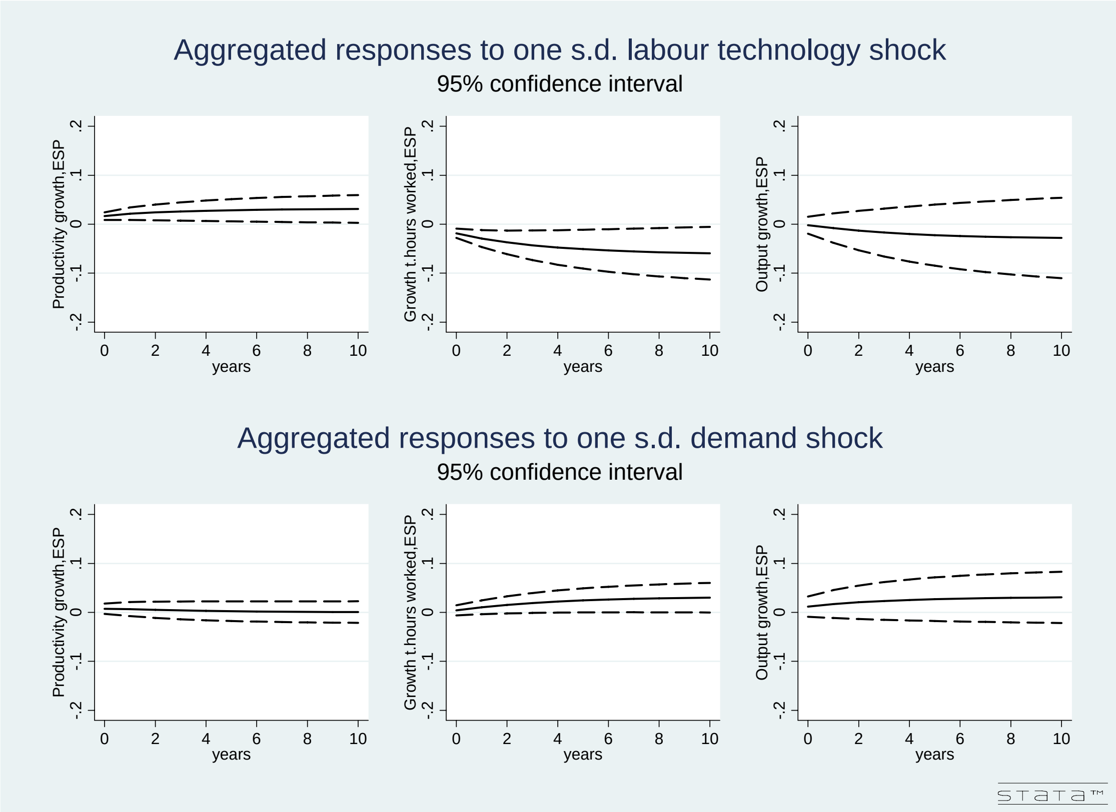

Figure 4.2: Impulse response pattern 2 illustrated by Spain

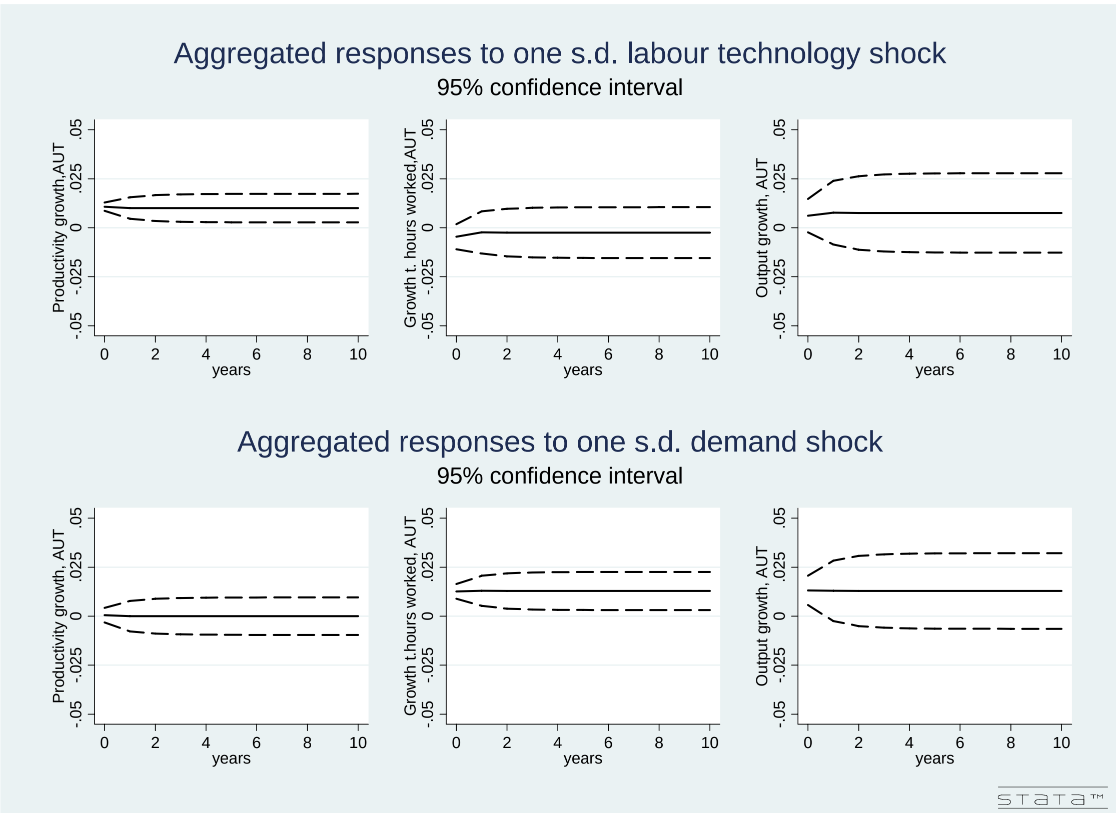

Figure 4.3: Impulse response pattern 3 illustrated by Austria

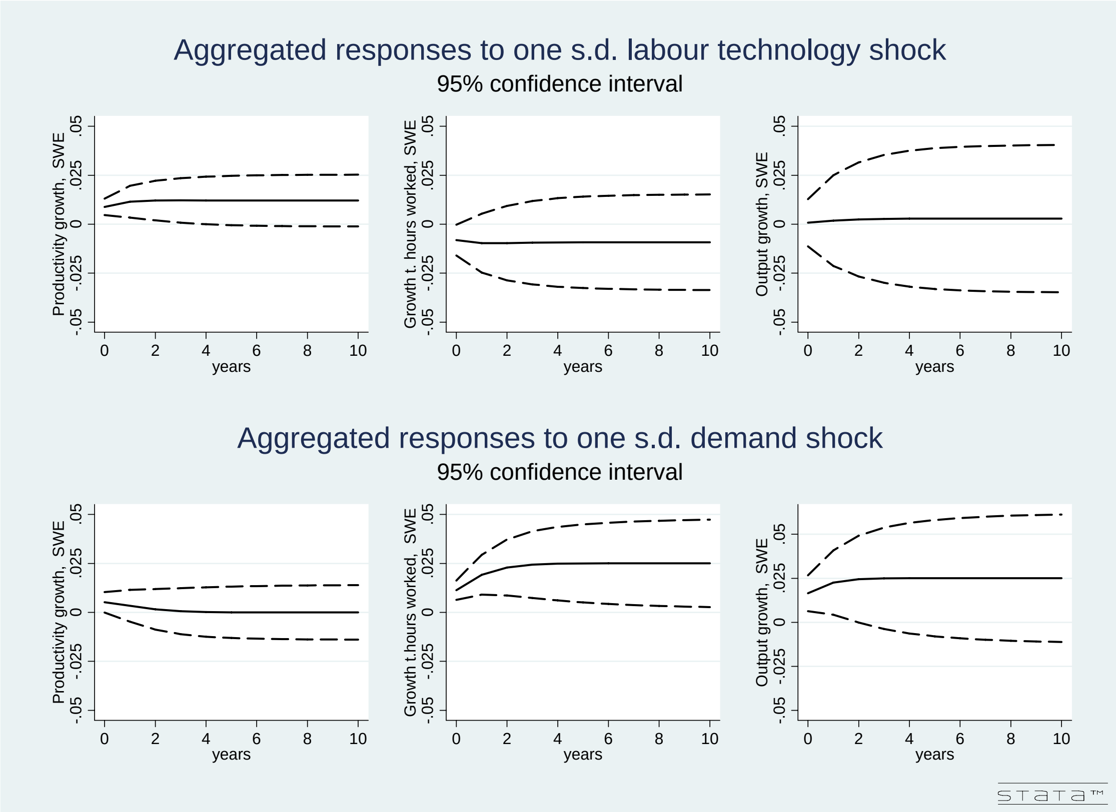

Figure 4.4: Impulse response pattern 4 illustrated by Sweden

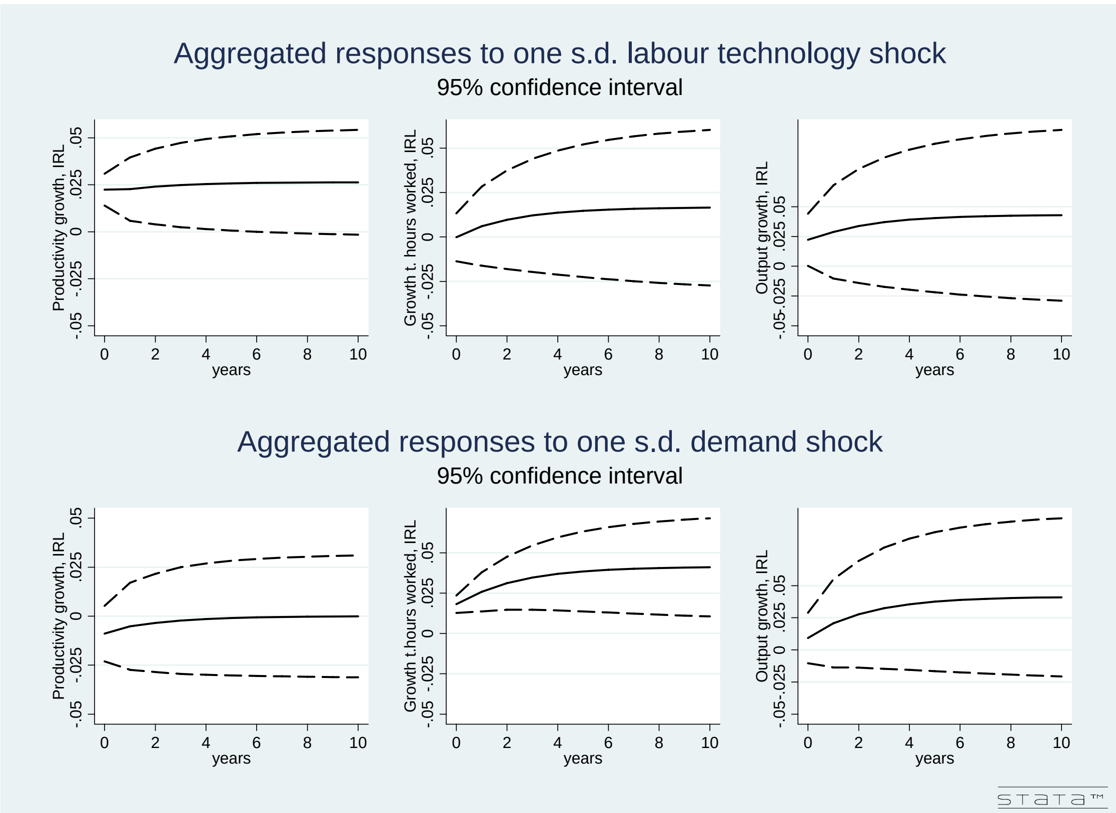

Figure 4.5: Impulse response pattern 5 illustrated by Ireland

4.2 Regulation indicators

Before turning to the regression analysis, let us take a look at the regulation indicators used in the regressions. Regulations are only considered in this study in respect to the labour market. While the regulations are originally established as protection for employed persons, the discussion poses the question whether some of them do not rather harm the employees. Rigidity in a market has special consequences for the relevant participants and variables. As mentioned in the context of Jordi Galí´s model, for instance, sticky prices can be the reason for a negative relation between a technology shock and total hours worked. It is conceivable that rigidities on the labour market in terms of impeded adjustments in employment on changed production conditions can influence the previous results of the impact of the shocks.

While the empirical question of Baker et al. (2004) is: "To what extent can these differences in unemployment[...] be explained by "bad" labor market institutions", this study analyses some common indicators of labour market institutions as introduced in the following. The fact that the indicators are not available for Greece reduces the sample to 15 countries. Also the time period is much shorter due to other problems of availability. Table 4.1 gives an overview of the regulation indicators. It presents five indicators for each country. In order to have a short overview, only the means of the available data period are presented. Obviously, the United States and Japan are among the countries with only few regulations. As mentioned in the introduction, these countries were liberalised strongly in the last years. In contrast, the mean of the indicators in Belgium and the Netherlands lie above the total average. The table does not reflect the country-specific developments of the indicators over time. The Italian benefit replacement rate for instance ranged between 1% and 8% until the mid nineties when it rose to higher rates. But on average, the Italian replacement rate is very low.

Employment protection, abbreviated as ep, is an index ranging between 0 and 2. The index is increasing with an increase in strictness of the regulation concerning employment protection. The regulations are about the terms of termination, terms of hiring and about temporary employment. For instance a severance payment after 20 years job tenure would keep the index low. More advantageous for the employed persons would be a severance payment after 9 months. Such a settlement would push the index to a higher number. Nevertheless the construction of this index is slightly problematic: It is derived through the interpolation of only two data points. This fact should be kept in mind for the interpretation of the regression results.

Table 4.1: Indicators of regulation - mean values

	Benefit Duration	Benefit Replacement Rate	Employment Protection	Union Density	Bargaining Coordination
AUT	0,75	35	1,27	47	2,43
BEL	**0,81**	49	1,42	52	**4,53**
DNK	0,73	64	0,97	77	2,46
ESP	0,23	**70**	1,80	14	4,20
FIN	0,58	46	1,16	73	2,23
FRA	0,42	59	1,38	**13**	1,93
GER	0,61	38	1,56	32	3,96
GRC	n.a	n.a	n.a	n.a	n.a
IRL	0,48	43	0,52	52	1,87
ITA	0,06	**19**	1,87	42	3,47
JPN	**0,00**	30	1,40	25	3,96
NLD	0,62	**70**	1,31	27	3,96
PRT	0,22	57	**1,92**	44	1,79
SWE	0,05	**70**	1,62	**84**	2,24
UK	0,70	24	0,35	46	3,96
USA	0,17	29	**0,10**	18	**1,00**
Total	0,43	47	1,24	43	2,11

Table 4.1 presents the mean values of the regulation indicators for each country. The data is from the OECD and the executed version by the IMF (Centre for Economic and Policy Research). The benefit replacement rate and union density are indicated in %, employment protection as an index is indicated between 0 and 2, bargaining coordination between 1 and 5 and benefit duration between 0 and 1. The data availability is different for the indicators: brr (1979-1999); ep, ud and bc (1979 - 1998); bd (1979 - 1995).

Regarding the country-specific benefits in cases of unemployment, the height of the benefit replacement rate, the duration of payment and the regulations of claiming benefits are able to display the benefit system as a whole. Due to the very country-specific rules in respect to the eligibility for benefits, there is no data available mirroring this aspect. Thus the structure of eligibility is not covered. For instance the circumstance that youth unemployment is threatened differently in respect to the height of the replacement rate is not dealt with. Although it would be possible to construct an index of the number of people who are benefiting from the system, many papers - like Blanchard and Wolfers (2000) - depict the situation of the benefit systems only by the two remaining indicators. So does this study.

The benefit replacement rate, abbreviated brr, is actually not an index but a percentage number between 0 and 100. It reflects the governmental payment in the first year of unemployment as a percentage of the net income. The lowest number represents a benefit system which is not a benefit system - an unemployed person would get no payments. The number 100 means a compensation of the lost earnings to 100 percent, which is also not usable, of course. Nevertheless, the higher the benefit replacement rates the more advantageous for the unemployed person. The used benefit replacement rate indicator factors the missing structure of eligibility: It is computed as an average over all family states. Thus it takes into account that different family status are treat differently in respect to the benefit replacement rate.

BD, short for the benefit duration, is a relation between the benefit replacement rate in the first (brr1), the second (brr2), the fourth (brr4) and the fifth (brr5) year and its range is between 0 and 1. 0 indicates a benefit system where the replacement rate is paid only in the first year of unemployment. 1 displays a maximum, constant duration over 5 years where brr1 = brr2 = brr4 = brr5 holds. For this regulation indicator it is also true that a higher number mirrors a more generous system.

Union density, ud, and bargaining coordination, bc, are parts of the concept of collective bargaining. While the first is again a percentage value ranging between 0 and 100, the latter one is an index with a range of $\{1, 5\}$. Union density only considered as a cross section does not tell us much. Finally the development of union density is decisive for the actual power of bargaining. An exemplified case is France: The union density now is very low but the bargaining coverage is high. This might assume that the unions have been very powerful due to a former high number of members. This situation is observable in many countries. The density is loosing value but the coverage does not behave contemporaneously.

The bargaining coordination is a much more difficult index which captures a lot of factors but should not be mixed up with the bargaining coverage. Whereas the bargaining coverage represents how many employed persons are benefiting from collective agreements independent of their union membership, the bargaining coordination focuses rather on the terms of bargaining wages. One example is the level of bargaining: An index of 1 is driven by a very informal coordination of wage bargaining as is mostly observable on the level of firms. This is the case for Japan and Germany. The highest value can be reached with a centralised wage bargaining by the biggest unions and associations on a national level, as in Scandinavian countries. The bargaining coordination takes also the concentration of unions and associations into account.

Additional indicators for institutions which might have an influence on the effect of shocks are home ownership and tax wedges. The first one would be interesting as a measure of the labour mobility. The second one would probably be useful for capturing the discussion about the non-wage labour costs. But to keep the list of indicators short and clear, the focus lies only on the first five mentioned indicators. A regression analysis which includes interaction terms between lagged shocks and regulation indicators would be interesting, too.

In the next two sections the regression analysis will focus on the impact of technology and demand shocks in interaction with indicators of regulation on the growth on value added, respectively on the growth of employment. Furthermore the analysis will account for the five patterns defined in the previous section.

4.2.1 The impact on value added growth

By using a fixed effect regression model one can record potential country-specific differences. It produces the same results as using dummy variables for every country. One assumption in this model affects time-invariant differences - the country-specific features are constant over time. Because this assumption might change over nearly thirty years, a pooled ordinary least square (OLS) regression with an autocorrelation correction is checked. The resulting coefficients do not differ from the coefficients yield from a fixed effect regression. Thus the usage of a fixed effect regression model is acceptable. The regression results for the following basic (31) and interaction model (32) are presented in Table 4.2. In equation (31) the growth rate of the real value added is explained by a constant term c, a contemporaneous technology and demand shock, ts and ds, as well as lagged technology and demand shocks: ts_{t-1}, ts_{t-2}, ds_{t-1} and ds_{t-2}. The extended equation (32) includes furthermore the indicator for employment protection ep at time t and its interaction with a technology ep*ts and a demand shock ep*ds.

$$\begin{aligned}\Delta \ln RVA = \ & c + \beta_0 * ts + \alpha_0 * ds + \beta_{t-1} * ts_{t-1} + \alpha_{t-1} * ds_{t-1} \\ & + \beta_{t-2} * ts_{t-2} + \alpha_{t-2} * ds_{t-2} \qquad (31)\end{aligned}$$

$$\begin{aligned}\Delta \ln RVA = \ & c + \beta_0 * ts + \alpha_0 * ds + \beta_{t-1} * ts_{t-1} + \alpha_{t-1} * ds_{t-1} \\ & + \beta_{t-2} * ts_{t-2} + \alpha_{t-2} * ds_{t-2} \\ & + \gamma * ep + \beta_1 * ep * ts + \alpha_1 * ep * ds \qquad (32)\end{aligned}$$

The growth rate $\Delta \ln RVA$ and the both shocks are stationary. This is tested by the same three unit root tests as in section 3.2.1. Table A.3, A.4, A.5 and A.6 in the Appendix present the relevant results.

Table 4.2: Linear regression on panel data for the growth of real value added in respect to employment protection

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Shocks							
Technology shock: ts	0.0065 ***	0.0035 *	0.0016	-0.01 ***	-0.009	0.0026	0.0247 ***
	[10.91]	[1.92]	[1.00]	[-4.75]	[-1.35]	[0.48]	[13.69]
ts(t-1)	0.0045 ***	0.0046 ***	0.0047 ***	-0.0033	0.0022	0.005 ***	0.0046 ***
	[8.72]	[7.04]	[8.12]	[-1.39]	[1.26]	[5.24]	[9.81]
ts(t-2)	0.0002	-0.0008	0.0005	0.0008	0.0026	0.001	0.0024 ***
	[0.30]	[-1.26]	[0.88]	[0.35]	[1.67]	[1.10]	[5.07]
Demand shock: ds	0.0124 ***	0.0167 ***	0.0198 ***	0.0154 ***	0.0296 ***	0.0277 ***	0.0133 ***
	[21.55]	[10.37]	[16.29]	[7.30]	[4.55]	[5.44]	[7.17]
ds(t-1)	0.0024 ***	0.0024 ***	-0.0002	0.0101 ***	0.0056 ***	-0.0007	0.0094 ***
	[3.72]	[3.05]	[-0.27]	[3.91]	[3.03]	[-0.89]	[9.75]
ds(t-2)	0.0024 ***	0.0032 ***	0.0011 *	0.0045 *	0.0006	0,0000	0.003 ***
	[3.63]	[4.07]	[1.69]	[1.83]	[0.38]	[0.06]	[3.27]
Institution and Interactions							
Employment Protection: ep		-0.0031	0.0055	-0.042 **	0.0018	0.014	0.0158
		[-0.47]	[1.10]	[-2.66]	[0.24]	[1.51]	[0.16]
ep*ts		0.0015	0.0042 ***	0.0062 ***	0.007	0.0043	-0.0019
		[1.16]	[3.94]	[3.94]	[1.42]	[1.16]	[-1.07]
ep*ds		-0.0028 **	-0.0043 ***	-0.0033 *	-0.0098 **	-0.0118 ***	-0.0095 ***
		[-2.35]	[-5.27]	[-2.04]	[-2.07]	[-3.21]	[-5.19]
Constant	0.0212 ***	0.0257 ***	0.0151 **	0.0658 ***	0.0146	0.0023	-0.0141
	[25.65]	[3.07]	[2.40]	[4.05]	[1.28]	[0.17]	[-0.15]
Observations	416	300	100	40	80	40	40
Number of countries	16	15	5	2	4	2	2
adj. R-squared	0.65	0.68	0.9	0.85	0.86	0.93	0.98

Table 4.2 presents the results of a linear regression on panel data with fixed effects for the growth rate of real value added: $\Delta \ln VA = b0 * ts + a0 * ds + y * ep + b1 * ep * ts + a1 * ep * ds$. The dataset is from the EU Klems and Nickel and Nunziata (2001). Column (1) corresponds to the basic model applying all countries. In column (2) the regression results are derived from an interaction model concerning the whole data sample. Column (3) to (7) correspond to the interaction model for each impulse response pattern. It reports the t-statistics in brackets below the estimated coefficients. ***, ** and * denote a 99%, 95% and 90% level of significance.

The regression tables show 7 columns: (1) is for the regression with the basic model seen in equation (31). This model is applied on the one hand for the growth rate of real value added and on the other hand for the growth rate of employment presented in the next section. This basic model is only applied for the case of including all countries but not for the pattern models. The signs of the interaction terms is the interesting part. The values themselves and especially the difference of the values in an interaction model compared to a basic model is ignored in this context. Columns (2) to (7) are for regressions with the interaction model, as in equation (32). In column (2) the regression is applied for the whole sample. The results in columns (3) to (7) are for every country group derived by the impulse response analysis. Thus column (3) corresponds to a regression with data for all countries which belongs to impulse response pattern 1. Column (4) corresponds to pattern 2 and so on.

The expected effect of a demand shock on the growth rate of value added corresponding to the impulse response is positive. The results of the regression confirm this expectation. The coefficients of the demand shock in time t, t-1 and t-2 are consistently positive and are statistically significant for the 1% level. For pattern 3 the coefficient of the demand shock is the highest with 0.03. The coefficients for the lagged shocks constitute a smaller value as for the contemporaneous shocks. As expected, the influence of the shocks declines the farther they are in the past. Their significance is also positive, though small. Based on the patterns defined in the previous section, the expectation concerning the effect of a technology shock is not that definite. The patterns show positive and negative effects as well. The coefficients of the technology shock ts are significantly positive for the group in column (2) where no differentiation was made. The same holds for pattern 5. In contrast, pattern 2 is significantly negative although the lagged coefficients have positive but very small values. These results show that the marginal effects of demand shocks are much clearer and more homogenous than the marginal effects of technology shocks. It supports again the concept of the aggregated technology shock as the sum of all particular, sectoral technology shocks. Thus the impact of a technology shock depends on the existing market structure and the elasticity of demand. While each market has its own features concerning the structure of enterprise or elasticity of demand, the impacts of a technology shock in sum can be as different as the market features can be. For instance, with a price inelastic demand the possibility of decreasing prices due to technological changes and increased competition exists, but the demand stays unchanged instead of broadening. The result is a drop in production or output and a negative effect on employment.

Does the impact change when the shocks interact with regulation indicators? The marginal effect of a technology shock on the growth rate of value added will be strengthened by an existing positive status of employment protection, computed for the example of pattern 2 (compare equation (33)). On the contrary, the marginal effect of a demand shock on the growth rate of value added shown by the group in column (2) will be weakened by the same situation concerning employment protection (compare equation (34)).

$$\frac{\delta \Delta \ln RVA}{\delta ts} = \beta_0 + \beta_1 * ep = -0.010 + 0.006 * 1 = -0.004 \quad (33)$$
$$\frac{\delta \Delta \ln RVA}{\delta ds} = \alpha_0 + \alpha_1 * ep = 0.017 - 0.003 * 1 = 0.014 \quad (34)$$

In the case of Ireland and Japan, pattern 5, the marginal effects differ. In this pattern neither a technology nor a demand shock has an influence on the growth rate of value added by a positive value of employment protection. In this case a deregulation, or a less protected employment environment, leads to a positive marginal effect of a shock, compare equation (35).

$$\frac{\delta \Delta \ln RVA}{\delta ts} = \beta_0 + \beta_1 * ep = 0.013 - 0.01 * 1 = 0.003 \quad (35)$$

The overall effect of a technology shock in the group in column (2) at time t and a positive employment protection of 1 for instance, raises the growth rate of value added by $0.0035 + 0.0015 = 0.005$ basis points. And if the base model (column (1)) indicates a coefficient of a technology shock at time t by 0.0065, there is at least a gap of 0.0015 basis points which are not explained by the interaction of the technology shock with employment protection.

The regression results of the other indicators concerning the growth rate of value added are summarised in respect to their direction of influence (positive or negative) in the following section in Table 4.4. The corresponding regression results are in the Appendix. The next section will discuss the effects on the employment growth rate. Although in most papers the institutions concerning labour market regulations are analysed as an effect on the unemployment rate, this study keeps the focus on the employment figures.

4.2.2 The impact on employment growth

Table 4.7 represents the regression results for the impact on the employment growth in accordance to the base equation (31) and the extended equation (32).

$\Delta \ln EMP$ is stationary. This is tested by the same three unit root tests as in section 3.2.1. Table A.1 in the Appendix presents the relevant results. Table 4.3 in the following presents the results of the linear regression on panel data for the growth rate of employment. Again, the regressions are made for the 7 different models, compare section 4.2.1.

$$\begin{aligned}\Delta \ln EMP &= c + \beta_0 * ts + \alpha_0 * ds \\ &+\beta_{t-1} * ts_{t-1} + \alpha_{t-1} * ds_{t-1} \\ &+\beta_{t-2} * ts_{t-2} + \alpha_{t-2} * ds_{t-2}\end{aligned} \tag{36}$$

$$\begin{aligned}\Delta \ln EMP &= c + \beta_0 * ts + \alpha_0 * ds \\ &+\gamma * ep + \beta_1 * ep * ts + \alpha_1 * ep * ds\end{aligned} \tag{37}$$

Table 4.3: Linear regression on panel data for the growth of employment in respect to employment protection

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Shocks							
Technology shock: ts	-0.0031 ***	-0.0015	0.0002	-0.0091 ***	-0.0013	-0.0044	0.0028
	[-5.68]	[-0,84]	[0,08]	[-2,85]	[-0,16]	[-0,62]	[0,70]
ts(t-1)	0.0025 ***	0.0023 ***	0.0013	-0.0115 ***	0.0007	0.0001	0.0029 **
	[5.27]	[3,68]	[1,46]	[-3,22]	[0,32]	[0,10]	[2,75]
ts(t-2)	0.0016 ***	0.002 ***	0.0005	0.0037	0.0059 ***	0.0008	0.0024 **
	[3.51]	[3,40]	[0,59]	[1,08]	[3,07]	[0,68]	[2,24]
Demand shock: ds	0.0079 ***	0.0069 ***	0.008 ***	0.002	0.0126	-0.0088	0.0176 ***
	[14.95]	[4,53]	[4,29]	[0,61]	[1,55]	[-1,30]	[4,22]
ds(t-1)	0.0045 ***	0.0053 ***	0.0034 ***	0.0208 ***	0.0095 ***	0.0039 ***	0.0078 ***
	[7.51]	[7,06]	[3,22]	[5,26]	[4,13]	[3,64]	[3,59]
ds(t-2)	0.0032 ***	0.0026 ***	0.0023	0.0063	0.0005	0.0004	0.001
	[5.25]	[3,58]	[2,24]	[1,67]	[0,26]	[0,40]	[0,47]
Institution and Interactions							
Employment Protection: ep		0.0017	-0.0002	-0.0684 ***	0.0091	0.0093	0.1848
		[0,28]	[-0,02]	[-2,85]	[0,96]	[0,76]	[0,83]
ep*ts		-0.0011	-0.0026	0.003	-0.0021	0.0037	-0.0007
		[-0,86]	[-1,63]	[1,26]	[-0,34]	[0,76]	[-0,19]
ep*ds		0.0012	0.0016	0.0008	-0.0025	0.0116 **	-0.0107 **
		[1,11]	[1,24]	[0,31]	[-0,42]	[2,39]	[-2,62]
Constant	0.0032	-0.0006	0.0053	0.071 ***	-0.0153	-0.008	-0.195
	[4.15]	[-0,07]	[0,55]	[2,87]	[-1,08]	[-0,46]	[-0,93]
Observations	416	300	100	40	80	40	40
Number of countries	16	15	5	2	4	2	2
adj. R-squared	0.56	0.59	0.65	0.71	0.73	0.76	0.73

Table 4.3 presents the results of a linear regression on panel data with fixed effects for the growth rate of employment: $\Delta \ln EMP = b0 * ts + a0 * ds + y * ep + b1 * ep * ts + a1 * ep * ds$. The dataset is from the EU Klems and Nickel and Nunziata (2001). Column (1) corresponds to the basic model applying all countries. In column (2) the regression results are derived from an interaction model concerning the whole data sample. Column (3) to (7) correspond to the interaction model for each impulse response pattern. It reports the t-statistics in brackets below the estimated coefficients. ***, ** and * denote a 99%, 95% and 90% level of significance.

The results of the linear regression on panel data concerning the interaction of the shocks with regulation indicators on the growth of employment are shortly summarised in Table 4.4 next to the results of the regression analysis for the growth rate of value added. For a detailed look, the tables A.7 to A.10 in the Appendix are useful.

Table 4.4: Interactions with indicators of regulation

	ep		**ud**		**bc**		**brr**		**bd**	
Growth rate of value added	**ts**	**ds**	**ts**	**ds**	**ts**	**ds**	**ts**	**ds**	**ts**	**ds**
(2)	+	-	0	+	+	-	-	0	-	+
(3)	.	-	0	+	-	-	0	0	-	+
(4)	+	-	.	+	+	-	+	-	-	+
(5)	.	-	-	.	.	-	.	-	.	-
(6)	.	-	.	+	.	.	.	-	-	.
(7)	-	-	+	+	+	+	+	.	+	.
Growth rate of employment										
(2)	.	+	.	+	+	+	.	+	+	-
(3)	.	+	.	+	+	-	+	+	+	-
(4)	+	.	.	.	+	.	+	.	.	.
(5)	.	.	.	.	.	.	.	-	.	-
(6)	.	.	.	-	.	.	.	.	.	-
(7)	.	-	.	.	.	.	.	.	.	.

Table 4.4 summarises the regression results. (0) reflects a coefficient close to zero, (.) denotes no significance and a positive or negative coefficient is presented by (+) or (-).

The regression results for the patterns often show insignificance due to the small number of observations. Not getting significant results does not necessarily mean that no effect is observable. For interpretation this should be kept in mind. The table brings out the differences between the interactions with technology shocks on the one side and demand shocks on the other. But there are also some common effects observable: In the interaction with employment protection the demand shock is influenced in the same way through all patterns in the case of value added growth. The same picture is seen in the interaction with union density, even if it is influenced in the opposite direction. The homogenous character is also noticeable in the benefit replacement rate. The interaction of a demand shock with the benefit replacement rate actually shows almost no effect on the growth rate of value added but also a negative one for all patterns. This holds for the benefit duration and employment growth as well. Due to a lot of insignificance in the regression with employment growth the results cannot be indicated that clearly.

As a further conceivable regression, a distinction between positive and negative shocks could be made (TScontrol = 0 if TS < 0 and TScontorl = 1 if TS > 0). This variables could also control for different interactions in the case of positive or negative technology or demand shocks.

One can conclude that the interaction of technology and demand shocks with institutions changes their effects on the growth rate. Overall, the impact on employment growth (instead of total hours worked) mirrors also the controversy between Gali (1999) and representatives of the real business cycle theory (e.g. Uhlig (2004), Christiano et al.(2004). Accordingly to Francis and Ramey (2005) and other researchers (cf Hölzl, Grieger and Reinstaller (2008)) the impact of technology shocks is negative on employment growth.

Chapter 5

Summary and concluding remarks

The development of European labour productivity and of real value added in the last three decades is uniquely a positive one. While Portugal and Finland have the smallest increase in employment and total hours worked but belong to the countries with a strong rise in value added, the opposite holds for Ireland. It has extended its employment and total hours worked to achieve the same result of a high increase in real value added as Portugal or Finland.

In the literature there are controversial views about the effect of technology shocks on total hours worked. It has not been clearly resolved whether they rise or fall after a positive technology shock. Jordi Galí suggests a negative correlation in his 1999 paper. Ellen McGrattan (2004), in contrast, does not distance herself from the Real Business Cycle theory - she supports a positive relation and the idea of technology shocks as the main engine of growth. Galí's statements conflict with the RBC theory - a technology shock which affects total hours worked in a negative sense can not be the main driver of business cycles. The effect of technology shocks is also discussed as depending on its derivation in the structural vector autoregression (e.g. Liu and Phaneuf (2007) and Gambetti (2005)).

In order to classify technology and demand shocks concerning their effect on total hours worked for European countries, they are extracted by a structural vector autoregressive approach. Using panel data form the European project EU Klems, technology and demand shocks are computed for each of the 14 European countries, Japan and the United States. The variables labour productivity and total hours worked seem to be integrated of order one, I(1), according to three different unit root tests. For some countries there can be the circumstances of structural breaks. Unfortunately, this topic is beyond the scope of this study. There is no case of cointegration between these two variables proved in four different cointegration tests. Consequently total hours worked and labour productivity are included in a structural vector autoregression in first differences and no error correction is needed. The SVAR approach produces the technology and demand shocks for each country. The impulse responses are extracted in this approach, as well. The characteristics of the shocks are surveyed by the analysis of their variances - how much and why do they fluctuate around their mean? The results advert to idiosyncratic technology shocks and homogeneous demand shocks. The homogeneous demand shocks have no persistent effect on labour productivity but increase total hours worked and output. The expected positive influence of technology shocks on labour productivity was confirmed by the data. The country-specific development of the technology shocks is expressed by a higher amount of main components in the principal component analysis. The technology shocks have more varied sources: The deviation of technology shocks in one country is driven by other reasons than in another country. Demand shocks paint a different picture. All demand shocks have one strong source which explains a main part of all variances. It is not as country-specific as the technology shock. The European countries experience nearly similar demand shocks while they differ concerning their technology shocks. Additionally, the results point to a time-specific source for the variances of the shocks. Technology shocks do not appear at the same time in all countries. In fact they are spread out over countries with a certain time lag. Again the demand shocks behave in a more homogeneous way: European countries experience a demand shock nearly at the same time. Results without the United States and Japan strengthen the characteristics of the shocks. Especially the analysis of variances for an exclusively European sample generate more homogeneous shocks.

The study also regards the impact of the shocks on the growth rate of real value added and employment. Corresponding to the results before, the effects of demand shocks do not differ between the countries. Demand shocks increase total hours worked and real value added but have no lasting effect on labour productivity. In the case of a technology shock 5 different patterns of impulse responses appear. Four of them support Galí's results and show a negative correlation between a technology shock and total hours worked. One pattern, applied for Ireland and Japan, reflects a positive relation.

The need for regulation on the labour market depends on the general view of the labour market: If the labour market is seen as perfectly working without any disturbances, than a deregulation is the solution for any problems that might crop up. The International Monetary Fund (IMF) supports this concept and in the United States this is the base of labour market politics. In contrast to that, Freeman (2000) and Hall and Soskice (2001) are searching for the right mixture of labour market institution to compensate the existing gaps in a labour market. Regulation on the labour markets considered as potential barriers or supporters of the effects of economic shocks were checked in a panel fixed effect regression for this set of data. Strong employment protection decreases the marginal effect of a positive demand shock on value added growth. But in contrast, high union density increases this marginal effect. The benefit replacement rate, along with the height of the benefits, cause nearly no change to the marginal effect of a positive demand shock on employment growth. Notwithstanding, employment increases less due to a demand shock in the case of longer benefit duration. Thus, this study reflects a further controversy between two theories. The estimated interaction terms of regulation and technology or demand shocks do not support the need for a general deregulation in the labour markets as long as every regulation index features a different effect on the shocks.

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Zusammenfassung

Während Europa durchweg einen starken Anstieg in der Bruttowertschöpfung und der Arbeitproduktivität in den letzten dreißig Jahren verzeichnen konnte, ist die Entwicklung der nationalen Beschäftigungs-zahlen in diesen Ländern aber durchaus unterschiedlich. Manche Länder haben sie gesteigert, bei anderen trat die Produktivitätssteigerung als arbeitssparend auf.

In der einschlägigen Literatur haben sich zwei Auffassungen etabliert. Der Real Business Cycle Theorie folgend kann u.a. Ellen McGratten (2004) einen positiven Zusammenhang zwischen einem Technologieschock und den geleisteten Arbeitsstunden in ihren empirischen Untersuchungen finden. Demgegenüber stellt Jordi Galí (1999) fest, dass ein Technologieschock den Arbeitsaufwand verringert.

Die vorliegende Arbeit untersucht die Wirkung von Technologieschock und Nachfrageschock - die durch eine strukturelle Vektorautoregression identifiziert werden - auf das Wachstum von Arbeitsproduktivität, Arbeitsaufwand und Gesamtoutput in 14 europäischen Ländern. Ihre Impulsantworten werden mit den von Japan und den USA verglichen. Eine positive Korrelation zwischen Technologieschock und Arbeitsaufwand, in Form von gesamten geleisteten Arbeitsstunden, findet sich für Irland und Japan. Dieses Antwortmuster entspricht der Sichtweise der Real Business Cycle Theorie.

In den restlichen untersuchten Ländern wirkt sich jedoch ein Technologieschock arbeitssparend aus und unterstützt die Auffassung Jordi Galís. Anders als bei den homogen wirkenden Nachfrageschocks kann demnach in den untersuchten Daten kein eindeutiger Wirkungszusammenhang zwischen einem Technologieschock, der die Arbeitsproduktivität steigert, und dem Arbeitsaufwand, bzw. dem Wachstum von den geleisteten Arbeitsstunden, bestätigt werden.

Potentielle länderspezifische Arbeitsmarktrigiditäten, als denkbare Transformator zwischen der Wirkung ökonomischer Schocks und dem Wachstum von Gesamtoutput oder Beschäftigung, werden zudem in einer Regression mit Paneldaten anhand von 5 Regulierungsindikatoren in Interaktion mit Technologie- und Nachfrageschock analysiert. Die verschiedenen Wirkungen der untersuchten Arbeitsmarktinstitutionen wie Kündigungsschutz, Gewerkschaftszugehörigkeit oder die Höhe der Ersatzleistung, weisen zwar darauf hin, dass sie die Wirkungen von Technologie- und Nachfrageschocks beeinträchtigen, aber einem Ruf nach grundsätzlicher Deregulierung zur Verstärkung positiver Wirkungen von ökonomischen Schocks kann damit nicht nachgegangen werden.

Appendix A

Appendix

A.1 List of variables and abbreviations

AUT	Austria
BEL	Belgium
DNK	Denmark
ESP	Spain
FIN	Finland
FRA	France
GER	Germany
GRC	Greece
IRL	Ireland
ITA	Italy
JPN	Japan
LUX	Luxemburg
NLD	the Netherlands
PRT	Portugal
SWE	Sweden
UK	the United Kingdom
USA	the United States
c	Consumption
EMP	Employment
$\Delta \ln EMP$	Growth rate of employment
GDP	Gross domestic product
g	Growth rate of population
h	Total hours worked
j	Index for country j=1 to 16
L	Labour input
N	Total population

VA	Value added
VA(P)	Value added
RVA	Real value added
$\Delta \ln RVA$	Growth rate of real value added
r	Growth rate rate of consumption
t	Time index
p	(Hourly labour) productivity / growth rate of Labour input
Q	Total output
VAR process	Vector autoregressive process
SVAR process	Structural vector autoregressive process
ts	Technology shock
ds	Demand shock
ts[t-1]	Technology shock with one lag
ep	Employment protection
ud	Union density
bc	Bargaining coordination
brr	Benefit replacement rate
bd	Benefit duration

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A.1 Dofiles

Dofile 1: Extract of the panel unit root tests

```
matrix A =J(6,8,0)
scalar zeile = 1
scalar N = 1
scalar J = 2
levinlin `k', lag(1)
        matrix A [zeile,1]= r(tstar)
        matrix A [zeile+1,1]= r(pval)
                gen p_lev = r(pval)
                if p_lev > 0.05{
                matrix A [zeile+1,2]=N
                }
                else{
                matrix A [zeile+1,2]=J
                }
                drop p_lev
ipshin `k', lag(1)
        matrix A [zeile+2,1]= r(wtbar)
        matrix A [zeile+3,1]= r(pval)
                gen p_ip = r(pval)
                if p_ip > 0.05{
                matrix A [zeile+3,2]=N
                }
                else{
                matrix A [zeile+3,2]=J
                }
                drop p_ip
pescadf `k', lag(1)
      matrix A [zeile+4,1]= r(Ztbar)
         matrix A [zeile+5,1]= r(pval)
                gen p_pes = r(pval)
                if p_pes > 0.05{
                matrix A [zeile+5,2]=N
                }
                else{
                matrix A [zeile+5,2]=J
                }
                drop p_pes
di "------------------------------------------------------------------------"
levinlin `k', lag(1) trend
      matrix A [zeile,5]= r(tstar)
         matrix A [zeile+1,5]= r(pval)
                gen p_lev = r(pval)
                if p_lev > 0.05{
                matrix A [zeile+1,6]=N
                }
                else{
                matrix A [zeile+1,6]=J
                }
                drop p_lev
ipshin `k', lag(1) trend
      matrix A [zeile+2,5]= r(wtbar)
```

Dofile 2: Extract of the structural vector autoregression

```
matrix LR=(.,0\.,.)
svar d.lnp3_`j' d.lnh_`j',lreq(LR) lag(1)
varstable
vargranger
matrix list e(B)
matrix list e(C)
predict res_lnp3_`j', equation(#1) residuals
predict res_lnh_`j', equation(#2) residuals
mkmat res_lnp3_`j' res_lnh_`j', matrix(res`j')
matrix list res`j'
matrix shtr`j'=inv(e(B))*res`j''
matrix shock`j'=shtr`j''
matrix list shock`j'
svmat float shock`j', names(makro`j')
gen shvw`j'_ts=makro`j'1
gen shvw`j'_ds=makro`j'2
```

A.2 Panel unit root tests

Table A.1: Panel unit root tests for employment, total hours worked and labour productivity

	$\ln EMP$	$\ln EMP$, **trend**	$\Delta \ln EMP$	$\Delta \ln EMP$, **trend**
Levin, Lin and Chu 2002	-1.5245	-2.3678	-6.3316	-5.827
p-val	0.0637	0.0089	0.0000	0
Im, Pesaran and al. 2003	0.2156	0.1532	-5.9114	-4.6598
p-val	0.5854	0.5609	0.0000	0
Pesaran 2003	0.5911	1.1607	-3.7662	-2.8048
p-val	0.7228	0.8771	0.0001	0.0025
	$\ln h$	$\ln h$, **trend**	$\Delta \ln h$	$\Delta \ln h$, **trend**
Levin, Lin and Chu 2002	-1.0984	-1.829	-6.5747	-6.3995
p-val	0.1360	0.0337	0	0
Im, Pesaran and al. 2003	0.4104	1.694	-6.4831	-5.8471
p-val	0.6593	0.9549	0	0
Pesaran 2003	0.4848	2.3284	-4.9105	-4.4017
p-val	0.6861	0.9901	0	0
	$\ln p$	$\ln p$, **trend**	$\Delta \ln p$	$\Delta \ln p$, **trend**
Levin, Lin and Chu 2002	-1.5987	1.012	-8.7579	-8.8509
p-val	0.0549	0.8442	0	0
Im, Pesaran and al. 2003	0.5238	2.9537	-9.963	-9.7401
p-val	0.6998	0.9984	0	0
Pesaran 2003	1.3755	-0.9944	-8.0554	-7.2118
p-val	0.9155	0.16	0	0

Table A.1 presents the results of the unit root tests for labour productivity and total hours worked. The results correspond to unit root tests with lag 1. The dataset is from the EU Klems. The hypothese H0 (unit root exists) is rejected if the p-value is smaller than 0.05, respectively the time series are stationary. Thus, all variables are integrated of order one, I(1).

Table A.2: Panel unit root tests for technology and demand shocks

	ts	**ts, trend**	**ds**	**ds, trend**
Levin, Lin and Chu 2002	-9.0466	-7.8307	-9.7044	-7.544
p-val	0	0	0	0
Im, Pesaran and al. 2003	-9.7125	-8.9778	-10.5253	-8.3184
p-val	0	0	0	0
Pesaran 2003	-7	-6.31	-7.2309	-5.5309
p-val	0	0	0	0

Table A.2 presents the results of the unit root tests for labour productivity and total hours worked. The results correspond to unit root tests with lag 1. The dataset is from the EU Klems. The hypothese H0 (unit root exists) is rejected if the p-value is smaller than 0.05, respectively the time series are stationary. Thus, all variables are integrated of order one, I(1).

A.3 Linear regressions for the growth of real value added

Table A.3: Linear regression on panel data for the growth of real value added in respect to union density

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
Shocks														
Technology shock: ts	0.0065	***	0.0062	***	0.0058	***	0.004		0.0134	***	-0.0023		0.0195	***
	[10.91]		[4.11]		[3.81]		[1.46]		[4.38]		[-1.03]		[7.57]	
ts(t-1)	0.0045	***	0.0045	***	0.0044	***	-0.0013		0.0042	***	0.0034	**	0.0049	***
	[8.72]		[7.03]		[6.28]		[-0.50]		[5.15]		[2.17]		[10.34]	
ts(n-2)	0.0002		-0.0005		0.0004		0.0021		0.0013		0.0021		0.0026	***
	[0.30]		[-0.88]		[0.56]		[0.84]		[1.61]		[1.63]		[5.16]	
Demand shock: ds	0.0124	***	0.0071	***	0.0112	***	0.0083	***	0.0027		0.0044	*	-0.0072	**
	[21.55]		[5.07]		[8.69]		[3.29]		[1.07]		[1.96]		[-2.63]	
ds(n-1)	0.0024	***	0.0024	***	0.0001		0.0085	***	-0.0004		0.0039	**	0.01	***
	[3.72]		[3.13]		[0.13]		[3.04]		[-0.52]		[2.37]		[9.91]	
ds(n-2)	0.0024	***	0.0032	***	0.0011		0.0029		-0.0001		0.0012		0.0032	***
	[3.63]		[4.23]		[1.40]		[1.08]		[-0.13]		[0.80]		[3.33]	
Institution and Interactions														
Union Density: ud			0,0000		0.0001		0.0003		0.0004	**	-0.0005	*	0.0004	
			[0.03]		[0.59]		[1.24]		[2.43]		[-1.79]		[1.11]	
ud*ts			0,0000		0,0000		-0.0002	***	-0.0001		0.0001		0.0001	
			[-0.30]		[1.22]		[-3.12]		[-1.59]		[1.55]		[1.56]	
ud*ds			0.0001	***	0.0001	***	0.0001		0.0002	***	0.0002	***	0.0003	***
			[4.90]		[2.94]		[1.69]		[3.68]		[5.71]		[4.65]	
Constant	0.0212	***	0.0217	***	0.0202	***	0.0146	*	0.0073		0.0452	***	-0.016	
	[25.65]		[3.52]		[4.36]		[1.80]		[1.17]		[2.94]		[-1.07]	
Observations	416		300		100		40		40		80		40	
Number of countries	16		15		5		2		2		4		2	
adj. R-squared	0.65		0.69		0.86		0.81		0.95		0.9		0.97	

Table A.3 presents the results of a linear regression on panel data with fixed effects for the growth rate of real value added: $\Delta \ln RVA = b0 * ts + a0 * ds + y * ud + b1 * ud * ts + a1 * ud * ds$. The dataset is from the EU Klems and Nickel and Nunziata (2001). Column (1) corresponds to the basic model applying all countries. In column (2) the regression results are derived from an interaction model concerning the whole data sample. Column (3) to (7) correspond to the interaction model for each impulse response pattern. It reports the t-statistics in brackets below the estimated coefficients. ***, ** and * denote a 99%, 95% and 90% level of significance.

Table A.4: Linear regression on panel data for the growth of real value added in respect to bargaining coordination

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
Shocks														
Technology shock: ts	0.0065	***	-0.0059	**	0.0103	***	-0.0146	***	-0.0088		0.0079		0.0199	**
	[10.91]		[-2.14]		[2.92]		[-4.25]		[-0.50]		[1.38]		[2.30]	
ts(t-1)	0.0045	***	0.0046	***	0.0044	***	-0.0024		0.0046	***	0.0019		0.0043	***
	[8.72]		[7.31]		[6.26]		[-1.06]		[4.56]		[1.08]		[7.44]	
ts(t-2)	0.0002		-0.0005		0.0004		-0.0005		0.0001		0.002		0.0029	***
	[0.30]		[-0.85]		[0.59]		[-0.21]		[0.14]		[1.32]		[4.21]	
Demand shock: ds	0.0124	***	0.0198	***	0.0187	***	0.0186	***	0.045		0.0172	***	-0.0074	
	[21.55]		[7.38]		[6.97]		[4.34]		[1.51]		[3.03]		[-0.85]	
ds(t-1)	0.0024	***	0.0024	***	0,0000		0.0084	***	-0.0003		0.006	***	0.0089	***
	[3.72]		[3.20]		[0.02]		[3.36]		[-0.40]		[3.30]		[6.62]	
ds(t-2)	0.0024	***	0.0029	***	0.0009		0.0045	*	0.0002		0.0014		0.0037	***
	[3.63]		[3.86]		[1.07]		[1.86]		[0.24]		[0.85]		[2.92]	
Institution and Interactions														
Bargaining coordination: bc			-0.0011		-0.0034		-0.0266	***	0.0051		-0.0051	**	0.0042	
			[-0.42]		[-0.81]		[-3.08]		[0.58]		[-2.04]		[0.85]	
bc*ts			0.0054	***	-0.0018		0.0071	***	0.0072		-0.0032		0.0012	
			[4.26]		[-0.95]		[3.47]		[1.00]		[-1.34]		[0.36]	
bc*ds			-0.0031	**	-0.0025	*	-0.0048	*	-0.0136		-0.0002		0.0046	
			[-2.53]		[-1.73]		[-1.99]		[-1.13]		[-0.09]		[1.40]	
Constant	0.0212	***	0.0239	***	0.0291	***	0.0622	***	0.0095		0.0301	***	-0.0114	
	[25.65]		[4.25]		[3.86]		[4.82]		[0.44]		[4.41]		[-1.11]	
Observations	416		300		100		40		40		80		40	
Number of countries	16		15		5		2		2		4		2	
adj. R-squared	0.65		0.69		0.86		0.85		0.92		0.86		0.96	

Table A.4 presents the results of a linear regression on panel data with fixed effects for the growth rate of real value added: $\Delta \ln RVA = b0 * ts + a0 * ds + y * bc + b1 * bc * ts + a1 * bc * ds$. The dataset is from the EU Klems and Nickel and Nunziata (2001). Column (1) corresponds to the basic model applying all countries. In column (2) the regression results are derived from an interaction model concerning the whole data sample. Column (3) to (7) correspond to the interaction model for each impulse response pattern. It reports the t-statistics in brackets below the estimated coefficients. ***, ** and * denote a 99%, 95% and 90% level of significance.

Table A.5: Linear regression on panel data for the growth of real value added in respect to benefit replacement rate

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
Shocks														
Technology shock: ts	0.0065	***	0.01	***	0.0058	***	-0.0116	***	-0.0123		0.0059		0.0207	***
	[10.91]		[5.25]		[3.13]		[-4.22]		[-1.40]		[1.39]		[5.08]	
ts(t-1)	0.0045	***	0.0046	***	0.0044	***	-0.0024		0.0037	***	0.0031	**	0.0042	***
	[8.72]		[7.23]		[6.25]		[-0.98]		[4.47]		[2.03]		[7.61]	
ts(t-2)	0.0002		-0.0001		0.0003		-0.0001		0.001		0.0035	**	0.0028	***
	[0.30]		[-0.20]		[0.41]		[-0.02]		[1.23]		[2.48]		[5.33]	
Demand shock: ds	0.0124	***	0.0112	***	0.0153	***	0.0148	***	0.034	***	0.0279	***	-0.007	
	[21.55]		[5.69]		[8.30]		[4.05]		[3.66]		[6.68]		[-1.52]	
ds(t-1)	0.0024	***	0.0022	***	-0.0001		0.0088	***	0.0001		0.005	***	0.0086	***
	[3.72]		[2.87]		[-0.11]		[3.26]		[0.13]		[3.12]		[8.23]	
ds(t-2)	0.0024	***	0.0023	***	0.0011		0.0043		-0.0002		0,0000		0.0032	***
	[3.63]		[2.98]		[1.30]		[1.65]		[-0.22]		[-0.00]		[2.90]	
Institution and Interactions														
Benefit Replacement Rate: brr			-0.0002	**	0,0000		-0.0007	**	-0.0005		-0.0004	***	-0.0004	
			[-2.42]		[-0.48]		[-2.14]		[-1.21]		[-3.15]		[-1.64]	
brr*ts			-0.0001	**	0,0000		0.0002	***	0.0006	**	-0.0001		0.0001	
			[-2.41]		[0.83]		[3.24]		[2.38]		[-1.39]		[0.52]	
brr*ds			0,0000		0,0000		-0.0001		-0.0006	**	-0.0002	***	0.0003	**
			[0.97]		[-0.63]		[-0.93]		[-2.40]		[-2.84]		[2.49]	
Constant	0.0212	***	0.0312	***	0.0241	***	0.0524	***	0.0406	***	0.0412	***	0.0175	
	[25.65]		[7.51]		[8.33]		[3.76]		[2.75]		[5.17]		[1.48]	
Observations	416		311		105		42		42		80		42	
Number of countries	16		15		5		2		2		4		2	
adj. R-squared	0.65		0.68		0.85		0.82		0.94		0.89		0.97	

Table A.5 presents the results of a linear regression on panel data with fixed effects for the growth rate of real value added: $\Delta \ln RVA = b0 * ts + a0 * ds + y * rr + b1 * brr * ts + a1 * brr * ds$. The dataset is from the EU Klems and Nickel and Nunziata (2001). Column (1) corresponds to the basic model applying all countries. In column (2) the regression results are derived from an interaction model concerning the whole data sample. Column (3) to (7) correspond to the interaction model for each impulse response pattern. It reports the t-statistics in brackets below the estimated coefficients. ***, ** and * denote a 99%, 95% and 90% level of significance.

Table A.6: Linear regression on panel data for the growth of real value added in respect to benefit duration

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
Shocks														
Technology shock: ts	0.0065	***	0.01	***	0.0089	***	0.0065	*	0.0224	***	0,0000		0.0219	***
	[10.91]		[6.92]		[5.94]		[1.97]		[3.28]		[-0.01]		[15.48]	
ts(t-1)	0.0045	***	0.0038	***	0.0045	***	-0.0029		0.0046	***	0.002		0.0046	***
	[8.72]		[5.52]		[5.71]		[-1.08]		[5.34]		[0.97]		[8.91]	
ts(t-2)	0.0002		-0.0008		0,0000		0.0018		0.0007		0.0011		0.0026	***
	[0.30]		[-1.17]		[0.02]		[0.67]		[0.90]		[0.59]		[4.53]	
Demand shock: ds	0.0124	***	0.0118	***	0.0141	***	0.0062	*	-0.0051		0.0175	***	0.0008	
	[21.55]		[9.17]		[11.04]		[2.02]		[-0.83]		[8.36]		[0.54]	
ds(t-1)	0.0024	***	0.0029	***	0.0004		0.0095	***	-0.0008		0.006	***	0.0102	***
	[3.72]		[3.56]		[0.38]		[3.38]		[-1.13]		[2.84]		[9.90]	
ds(t-2)	0.0024	***	0.0032	***	0.0015		0.0035		-0.0003		0.002		0.0038	***
	[3.63]		[3.95]		[1.57]		[1.21]		[-0.38]		[0.98]		[3.56]	
Institution and Interactions														
Benefit Duration: bd			0.0192	**	0.0062		0.0558		0.219	*	0.0178		-0.0066	
			[2.17]		[0.83]		[1.39]		[2.05]		[0.91]		[-0.56]	
bd*ts			-0.0112	***	-0.0064		-0.0193	***	-0.0202	*	0.0009		0.0032	
			[-4.05]		[-1.35]		[-3.29]		[-1.99]		[0.21]		[0.86]	
bd*ds			0.0038		0.0011		0.0106	*	0.0249	**	-0.0031		0.0143	***
			[1.51]		[0.35]		[1.75]		[2.79]		[-0.84]		[3.77]	
Constant	0.0212	***	0.0144	***	0.0214	***	-0.005		-0.1259	*	0.0098		0.0013	
	[25.65]		[3.81]		[8.85]		[-0.23]		[-1.74]		[0.96]		[0.32]	
Observations	416		255		85		34		34		68		34	
Number of countries	16		15		5		2		2		4		2	
adj. R-squared	0.65		0.7		0.86		0.85		0.95		0.85		0.97	

Table A.6 presents the results of a linear regression on panel data with fixed effects for the growth rate of real value added: $\Delta \ln RVA = b0 * ts + a0 * ds + y * bd + b1 * bd * ts + a1 * bd * ds$. The dataset is from the EU Klems and Nickel and Nunziata (2001). Column (1) corresponds to the basic model applying all countries. In column (2) the regression results are derived from an interaction model concerning the whole data sample. Column (3) to (7) correspond to the interaction model for each impulse response pattern. It reports the t-statistics in brackets below the estimated coefficients. ***, ** and * denote a 99%, 95% and 90% level of significance.

A.4 Linear regressions for the growth of employment

Table A.7: Linear regression on panel data for the growth of employment in respect to union density

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Shocks							
Technology shock: ts	-0.0031***	-0.0023	-0.0029	-0.0036	-0.0010	0.0074	0.0028
	[-5.68]	[-1.56]	[-1.40]	[-0.85]	[-0.36]	[1.64]	[0.50]
ts(t-1)	0.0025***	0.0021***	0.0014	-0.0089**	0.0035*	0.0004	0.0029**
	[5.27]	[3.45]	[1.50]	[-2.29]	[1.76]	[0.32]	[2.74]
ts(n-2)	0.0016***	0.0020***	0.0005	0.0054	0.0063***	0.0009	0.0026**
	[3.51]	[3.26]	[0.62]	[1.38]	[3.90]	[0.76]	[2.31]
Demand shock: ds	0.0079***	0.0067***	0.0097***	0.0047	-0.0011	0.0161***	-0.0023
	[14.95]	[4.96]	[5.60]	[1.21]	[-0.40]	[4.44]	[-0.38]
ds(n-1)	0.0045***	0.0054***	0.0033***	0.0184***	0.0063***	0.004***	0.0072***
	[7.51]	[7.25]	[3.02]	[4.25]	[3.05]	[4.01]	[3.23]
ds(n-2)	0.0032***	0.0028***	0.0025**	0.0037	-0.0015	0.0005	0.0010
	[5.25]	[3.87]	[2.29]	[0.91]	[-0.79]	[0.50]	[0.47]
Institution and Interactions							
Union Density: ud		-0.0001	-0.0000	0.0002	-0.0015***	0.0001	-0.0008
		[-0.56]	[-0.15]	[0.61]	[-4.29]	[0.45]	[-1.13]
ud*ts		-0.0000	-0.0000	-0.0001	-0.0000	-0.0002	-0.0000
		[-0.36]	[-0.27]	[-0.73]	[-0.87]	[-1.45]	[-0.06]
ud*ds		0.0000	0.0000	-0.0000	0.0002***	-0.0002**	0.0003
		[1.30]	[0.13]	[-0.41]	[3.75]	[-2.49]	[1.69]
Constant	0.0032	0.0050	0.0054	-0.0053	0.0802***	0.0012	0.0142
	[4.15]	[0.83]	[0.87]	[-0.42]	[4.17]	[0.13]	[0.43]
Observations	416	300	100	40	80	40	40
Number of countries	16	15	5	2	4	2	2
adj. R-squared	0.56	0.59	0.63	0.63	0.80	0.75	0.71

Table A.7 presents the results of a linear regression on panel data with fixed effects for the growth rate of employment: $\Delta \ln EMP = b0 * ts + a0 * ds + y * ud + b1 * ud * ts + a1 * ud * ds$. The dataset is from the EU Klems and Nickel and Nunziata (2001). Column (1) corresponds to the basic model applying all countries. In column (2) the regression results are derived from an interaction model concerning the whole data sample. Column (3) to (7) correspond to the interaction model for each impulse response pattern. It reports the t-statistics in brackets below the estimated coefficients. ***, ** and * denote a 99%, 95% and 90% level of significance.

Table A.8: Linear regression on panel data for the growth of employment in respect to bargaining coordination

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
Shocks														
Technology shock: ts	-0.0031	***	-0.0118	***	-0.0128	***	-0.0098	*	-0.0096		-0.0161		0.0041	
	[-5.68]		[-4.44]		[-2.93]		[-1.75]		[-1.36]		[-0.67]		[0.27]	
ts(t-1)	0.0025	***	0.0022	***	0.0014		-0.0105	***	-0.0003		0.0003		0.0027	**
	[5.27]		[3.62]		[1.59]		[-2.77]		[-0.15]		[0.21]		[2.61]	
ts(t-2)	0.0016	***	0.002	***	0.0005		0.0030		0.005	**	0.0002		0.0029	**
	[3.51]		[3.44]		[0.65]		[0.78]		[2.62]		[0.12]		[2.32]	
Demand shock: ds	0.0079	***	0.0081	***	0.0157	***	-0.0022		0.0092		-0.0092		-0.0049	
	[14.95]		[3.15]		[4.76]		[-0.31]		[1.32]		[-0.23]		[-0.32]	
ds(t-1)	0.0045	***	0.0055	***	0.0035	***	0.019	***	0.0105	***	0.0045	***	0.0073	***
	[7.51]		[7.47]		[3.50]		[4.62]		[4.67]		[3.88]		[3.03]	
ds(t-2)	0.0032	***	0.0028	***	0.0029	***	0.0056		0.0020		0.0006		0.0016	
	[5.25]		[3.84]		[2.90]		[1.42]		[0.99]		[0.57]		[0.70]	
Institution and Interactions														
Bargaining coordination: bc			0.0010		0.0029		-0.0236		-0.0045		-0.0060		0.0115	
			[0.38]		[0.57]		[-1.67]		[-1.46]		[-0.51]		[1.28]	
bc*ts			0.0042	***	0.005	**	0.0022		0.0023		0.0069		-0.0007	
			[3.48]		[2.17]		[0.67]		[0.78]		[0.71]		[-0.12]	
bc*ds			0.0001		-0.003	*	0.0022		-0.0001		0.0066		0.0050	
			[0.10]		[-1.72]		[0.55]		[-0.03]		[0.41]		[0.83]	
Constant	0.0032		-0.0005		-0.0009		0.0357		0.0099		0.0200		-0.049	**
	[4.15]		[-0.09]		[-0.10]		[1.69]		[1.18]		[0.69]		[-2.65]	
Observations	416		300		100		40		80		40		40	
Number of countries	16		15		5		2		4		2		2	
adj. R-squared	0.56		0.60		0.67		0.65		0.74		0.69		0.68	

Table A.8 presents the results of a linear regression on panel data with fixed effects for the growth rate of employment: $\Delta \ln EMP = b0 * ts + a0 * ds + y * bc + b1 * bc * ts + a1 * bc * ds$. The dataset is from the EU Klems and Nickel and Nunziata (2001). Column (1) corresponds to the basic model applying all countries. In column (2) the regression results are derived from an interaction model concerning the whole data sample. Column (3) to (7) correspond to the interaction model for each impulse response pattern. It reports the t-statistics in brackets below the estimated coefficients. ***, ** and * denote a 99%, 95% and 90% level of significance.

Table A.9: Linear regression on panel data for the growth of employment in respect to benefit replacement rate

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
Shocks														
Technology shock: ts	-0.0031	***	-0.0017		-0.0058	**	-0.0092	**	-0.0043		-0.0184		-0.0001	
	[-5.68]		[-0.94]		[-2.61]		[-2.07]		[-0.85]		[-1.48]		[-0.02]	
ts(t-1)	0.0025	***	0.0023	***	0.0013		-0.0103	**	0.0014		0.0006		0.0027	**
	[5.27]		[3.80]		[1.49]		[-2.62]		[0.78]		[0.47]		[2.45]	
ts(t-2)	0.0016	***	0.0023	***	0.0009		0.0031		0.0066	***	0.0003		0.0032	***
	[3.51]		[3.96]		[1.04]		[0.78]		[3.92]		[0.23]		[2.93]	
Demand shock: ds	0.0079	***	0.0045	**	0.0058	**	-0.0039		0.0187	***	-0.0203		0.0021	
	[14.95]		[2.45]		[2.61]		[-0.67]		[3.76]		[-1.55]		[0.23]	
ds(t-1)	0.0045	***	0.0053	***	0.0036	***	0.0192	***	0.0092	***	0.0039	***	0.0067	***
	[7.51]		[7.30]		[3.61]		[4.45]		[4.77]		[3.62]		[3.17]	
ds(t-2)	0.0032	***	0.0023	***	0.0021	*	0.0052		0.0005		0.0004		0.0017	
	[5.25]		[3.16]		[1.97]		[1.27]		[0.28]		[0.38]		[0.78]	
Institution and Interactions														
Benefit Replacement Rate: brr			-0.0002	**	-0.0000		-0.001	*	-0.0007	***	0.0003		-0.0005	
			[-2.30]		[-0.01]		[-2.00]		[-4.33]		[0.59]		[-0.86]	
brr*ts			-0.0000		0.0001		0.0001		0.0000		0.0005		0.0001	
			[-0.53]		[1.37]		[0.68]		[0.09]		[1.59]		[0.28]	
brr*ds			0.0001	**	0.0001	**	0.0001		-0.0002	*	0.0007	**	0.0001	
			[2.13]		[2.07]		[1.19]		[-1.95]		[2.07]		[0.60]	
Constant	0.0032		0.0103	***	0.0045		0.0461	**	0.0379	***	-0.0075		-0.0039	
	[4.15]		[2.68]		[1.29]		[2.07]		[4.01]		[-0.36]		[-0.16]	
Observations	416		311		105		42		80		42		42	
Number of countries	16		15		5		2		4		2		2	
adj. R-squared	0.56		0.60		0.67		0.63		0.81		0.74		0.70	

Table A.9 presents the results of a linear regression on panel data with fixed effects for the growth rate of employment: $\Delta \ln EMP = b0 * ts + a0 * ds + y * rr + b1 * brr * ts + a1 * brr * ds$. The dataset is from the EU Klems and Nickel and Nunziata (2001). Column (1) corresponds to the basic model applying all countries. In column (2) the regression results are derived from an interaction model concerning the whole data sample. Column (3) to (7) correspond to the interaction model for each impulse response pattern. It reports the t-statistics in brackets below the estimated coefficients. ***, ** and * denote a 99%, 95% and 90% level of significance.

Table A.10: Linear regression on panel data for the growth of employment in respect to benefit duration

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
Shocks														
Technology shock: ts	-0.0031	***	-0.0041	***	-0.007	***	0.0001		-0.0021		0.0045		-0.0006	
	[-5.68]		[-2.91]		[-3.74]		[0.02]		[-0.69]		[0.43]		[-0.21]	
ts(t-1)	0.0025	***	0.0015	**	0.0015		-0.0091	**	-0.0004		-0.0004		0.0023	**
	[5.27]		[2.29]		[1.57]		[-2.36]		[-0.17]		[-0.33]		[2.08]	
ts(t-2)	0.0016	***	0.0015	**	0.0011		0.0064		0.004	*	0.0009		0.0025	**
	[3.51]		[2.29]		[1.08]		[1.62]		[1.86]		[0.73]		[2.08]	
Demand shock: ds	0.0079	***	0.0087	***	0.0108	***	0.0056		0.0105	***	0.0324	***	0.0016	
	[14.95]		[7.00]		[6.76]		[1.27]		[4.34]		[3.41]		[0.52]	
ds(t-1)	0.0045	***	0.0057	***	0.0029	**	0.0187	***	0.0103	***	0.0048	***	0.0086	***
	[7.51]		[7.34]		[2.47]		[4.60]		[4.23]		[4.11]		[3.89]	
ds(t-2)	0.0032	***	0.0034	***	0.0020		0.0028		0.0035		0.0004		0.0028	
	[5.25]		[4.33]		[1.65]		[0.67]		[1.47]		[0.37]		[1.22]	
Institution and Interactions														
Benefit Duration: bd			0.0074		-0.0055		-0.0043		0.042	*	-0.2067		0.0036	
			[0.86]		[-0.59]		[-0.07]		[1.86]		[-1.26]		[0.14]	
bd*ts			0.0028		0.012	**	-0.0110		-0.0028		-0.0066		0.0077	
			[1.03]		[2.03]		[-1.29]		[-0.58]		[-0.42]		[0.96]	
bd*ds			-0.0018		-0.0024		-0.0069		-0.0039		-0.0369	**	0.0159	*
			[-0.75]		[-0.65]		[-0.79]		[-0.93]		[-2.68]		[1.95]	
Constant	0.0032		-0.0006		0.0057	*	0.0033		-0.0208	*	0.1454		-0.0171	*
	[4.15]		[-0.17]		[1.89]		[0.11]		[-1.77]		[1.30]		[-1.96]	
Observations	416		255		85		34		68		34		34	
Number of countries	16		15		5		2		4		2		2	
adj. R-squared	0.56		0.57		0.64		0.70		0.76		0.76		0.58	

Table A.10 presents the results of a linear regression on panel data with fixed effects for the growth rate of employment: $\Delta \ln EMP = b0 * ts + a0 * ds + y * bd + b1 * bd * ts + a1 * bd * ds$. The dataset is from the EU Klems and Nickel and Nunziata (2001). Column (1) corresponds to the basic model applying all countries. In column (2) the regression results are derived from an interaction model concerning the whole data sample. Column (3) to (7) correspond to the interaction model for each impulse response pattern. It reports the t-statistics in brackets below the estimated coefficients. ***, ** and * denote a 99%, 95% and 90% level of significance.

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PUBLICATIONS

Hölzl, W., Grieger, N. and Reinstaller, A., 2008. "Industry and employment dynamics in Europe: An industry perspective". Report for project Nr. 11807, OeNB

Assistance to: Janger, J, 2008. "Rahmenbedingungen des österreichischen Innovationssystems". WIFO. Substudy to "Systemevaluierung der österreichischen Forschungsförderung".

Assistance to: Falk, R., 2008. "Tax incentive schemes for R&D". WIFO. Substudy to "Systemevaluierung der österreichischen Forschungsförderung".