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Structural change and unemployment

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Abstract: Regional unemployment rates show large disparities which cannot be explained by different institutional settings. In the paper these disparities are related to the specialisation of regions. It can be shown that under very general circumstances the labour market performance is due to the price elasticity of product markets. With technical progress, employment decreases if product demand is elastic and it increases if demand is inelastic. A wage reaction does not change this turning point as long as wages are not totally elastic with respect to unemployment.

Keywords: Structural change; Productivity growth; Labour market dynamics

1 Introduction

One of the key problems in economics is explaining the level of unemployment in different economies. To do this "modern mainstream macroeconomics" frequently refers to institutional structures in the individual countries. Countries with "more flexible" labour markets have lower unemployment rates. This "mainstream" in economic theory and policy advice is associated above all with the so-called Euopean Labour Market Model of Layard, Nickell & Jackman (1991, 2006, cf. Carlin & Soskice 2006 for an integration with traditional macroeconomics). There, unemployment results from the competing claims of groups of economic subjects (Franz 1992: 12). The claims of workers and firm owners on the social product are kept in balance by means of unemployment. In order to increase employment, economic policy therefore has to create institutions which restrain these demands – in particular those of the workers.

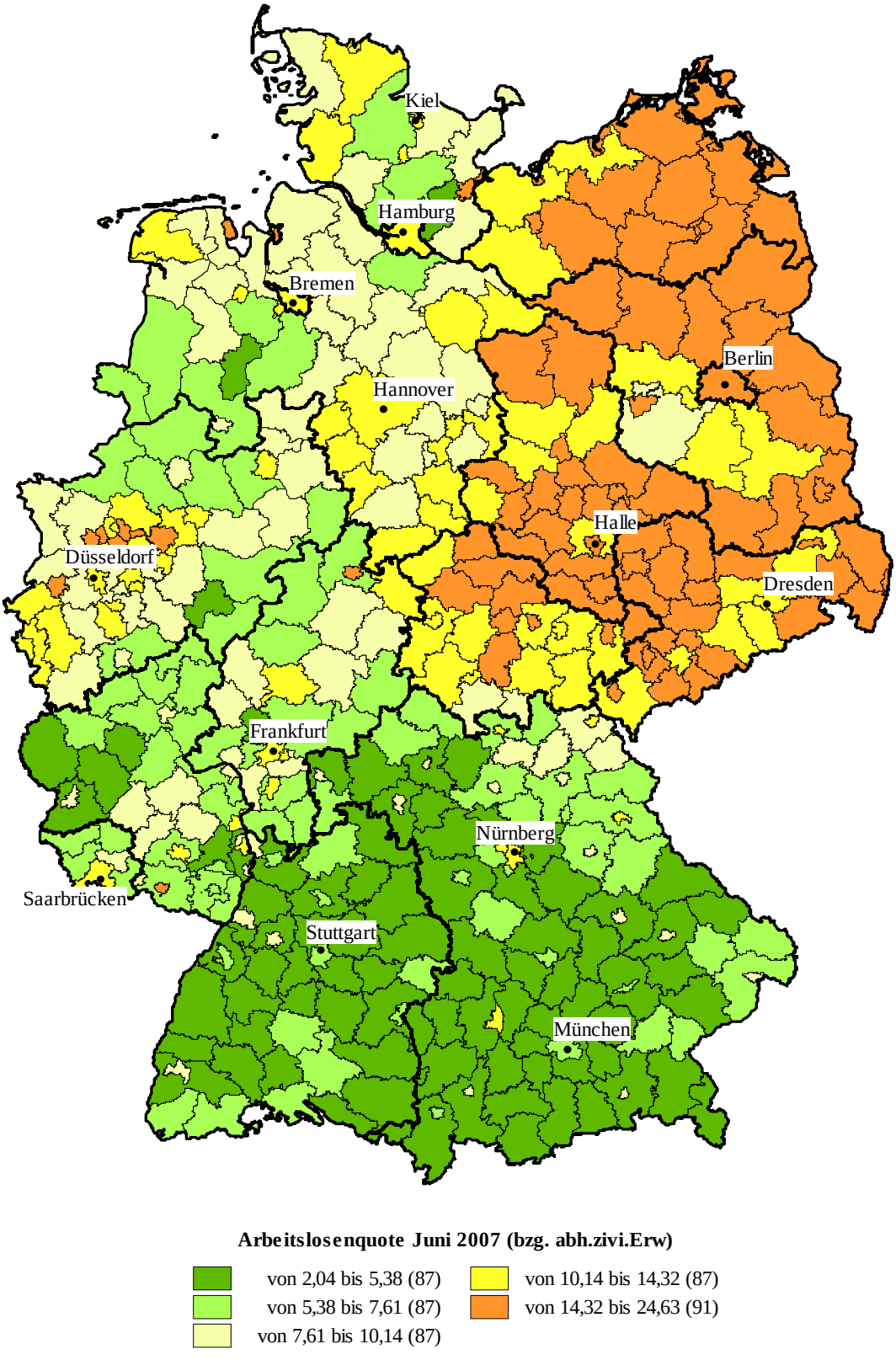
Academic economists still consider this no longer new approach to be very relevant. In a review written on the occasion of the new edition of the book by Layard et al., Blanchard (2007) emphasises that the theory contained in the book has been confirmed in principle (also Layard, Nickell & Jackman 2006, introduction). Nonetheless, since the end of the 1990s there has been increasing criticism, some of it because the empirical basis is proving to be ambivalent. Another specific point of criticism concerns the idea that various labour market institutions could simply be replaced or abolished in order to combat unemployment. Freeman (1998, 2001) argues that the institutions of an economy are connected. If an individual institution is removed, this could have far-reaching consequences. The complete structure of institutions could be destroyed and a far less optimal solution with even higher unemployment could develop.

Another criticism goes back to regional arguments. After all, unemployment within a nation shows about the same level of variation as it does between countries (Südekum 2005). Within a country, however, there are generally only minor differences in the institutions. From this point of view, the large variation in regional unemployment in Germany constitutes a problem for the economic mainstream. As is shown by Chart 1, under the relatively uniform institutional conditions of a country there are regions in which virtual full employment prevails (minimum: Eichstätt, with an unemployment rate of 2.04%) and others which are affected by a deep labour market crisis (maximum in western Germany: Bremerhaven, with an unemployment rate of 20.04 %; and in eastern Germany: Görlitz with 24.63 %).

To give an additional or alternative explanation for the variation of unemployment this paper suggests a line of argumentation, which is applicable both to regional economies and to entire national economies. The paper refers to the dynamics of economies, which are driven by processes of structural change and technical progress. The key outcome of the is that technical progress has different effects on employment and thus on unemployment. If product demand is elastic, increases in productivity result in employment growth, but if product demand is inelastic, on the other hand, productivity increases lead to a reduction in employment. This is the content of the fundamental theorem on the employment effects of productivity growth.

Map 1

Unemployment rates in Germany June 2007 for districts (Landkreise, kreisfreie Städte)



The basic argument concerning the relationship between technical progress, elasticity of product demand and employment is not new. It has already been published in a paper by Neisser (1942). There, however, it is virtually assumed to be trivial and is not formally substantiated further. This was done in various papers written by Ronald Schettkat (1997), partly in cooperation with Eileen Appelbaum (Appelbaum, Schettkat 1999). Some further improvements, however, are still of value. Their work does not include a complete microfoundation and an integration of the labour market. We have written our paper to complete the approach in these respects.

We develop a model we call the "labour market model of structural change". The reason for this is firstly that the specialisation of economies which has developed as a consequence of structural change serves as the point of departure. Some nations have specialised on markets with elastic demand and others on markets with inelastic demand. High, even dramatic consequences for unemployment might be the result. Secondly the reductions and increases in employment in certain areas are themselves signs of structural change. The approach developed in this paper should not be confused with traditional papers on problems of structural change which have mostly a descriptive and empirical orientation.

To explain the fundamental theorem of the employment effects of technical progress, we look at a very simple numerical example which takes into account the elasticity of demand. Its significance can be made clear by looking at the relationship between price changes and turnover. If demand is elastic, a price reduction results in an increase in turnover $(P \cdot Q)$. If demand is inelastic, on the other hand, the result is a reduction in turnover. This characteristic follows directly from the definition of demand elasticity.

In addition to this, the elasticity of demand also conveys the effects of technical progress (or productivity increases – we use the terms as synonyms) on employment. To see this we discriminate between two effects of productivity increases. It first leads to a drop in the demand for labour. As the same product can be produced using less labour, this is also known as the *displacement effect of technical progress*. In addition, however, the reduction in costs as a result of technical progress also leads to a drop in price. This in turn increases demand for the particular product and therefore also demand for workers who are employed in production. Here a *compensation effect* therefore occurs. How strong this effect is and whether it may even "overcompensate" are then empirical questions.

Table 1 compiles the effects of an increase in productivity due to technical progress in a fictitious example. It is assumed here that the productivity advantage is passed on to the consumers in full. The productivity gain and the price reduction are therefore equal in size. The drop in price leads to a change in the quantity sold. In the case of elasticity the quantity sold will change at a greater percentage than the price. In the case of inelasticity the change in the quantity will be comparatively smaller. This means that in the case of elastic demand the net effect on turnover is positive, but in the case of inelastic demand it is negative. The content of the theorem on structural change is that employment responds in the same direction as turnover.

Table 1: Relationship between product demand and the development of employment in the approach by Appelbaum and Schettkat, explained using a fictitious numerical example

	Elastic product demand	**Inelastic product demand**
Productivity gain due to technical progress	**20%**	**20%**
Reduction in price	**-20%**	**-20%**
Change in quantity	**30%**	**10%**
Change in turnover	**4%**	**-12%**
Change in employment	**4%**	**-12%**
Dominating effect	**Compensation effect**	**Displacement effect**

The main explanation here is developed in several stages. We begin by describing the background to the argumentation in the dimensions of space and time. This is followed by a small basic model, which summarises in particular the present state of theory development. This constitutes the preparation for a more complex microfounded model of labour demand. Various discussions about the relationship and approaches for testing it empirically conclude the paper.

2. Specialisation of nations and regions in space and time

Before proving the basic theorem we examine its potential importance. Why should labour market problems of regions and nations occur as a result of characteristics of specific product markets? Well, this is associated with processes in the two dimensions time and space.

In the spatial dimension, specialisations of economies are discernible both at regional and national level. For Krugman (1991: 5) the most striking characteristic of the geography of economic activity is its concentration. Although this concentration of individual industries in specific regions has declined somewhat in the last decades (cf. for the USA: Krugman 1991: 75ff.; for Europe: Molle 1997; for western Germany: Möller, Tassinopoulos 2000), its extent remains astonishingly large and there is a need for an explanation as to why it can withstand the powers of competition. Localisation effects describe reasons for regions specialising in a few “preferred” industries. Following Marshall, Krugman (1991: 35ff.) names three different groups of factors which support such a specialisation:

- utilisation of a pool of labour available to all the firms
- provision of intermediate (non-tradable) input factors

- occurrence of technological spillover effects

Krugman (1991: 123ff.) devotes most attention to the first factor and develops a model, whose fundamental assumption is that the business cycles for different firms do not proceed entirely synchronologically. It is therefore advantageous for firms and workers to form a joint pool of labour. Firms will settle in places where there are already firms from the same industry in order to be able to hire workers when their own demand is high and that of the other firms is lower. Such behaviour reduces unemployment or, in the case of flexible wages, ensures that wage development remains steady. Krugman's model shows that the advantage associated with this can carry more weight that the deterioration of the competitive position that subsequently results for a firm.

Localisation effects lead to the specialisation of regions according to individual industries. It tends to prove advantageous for a firm to choose a location in which other firms with a related product are already represented. In this case it is possible that a product is produced in one single region and that a large area is supplied with this product from this region. Whether or not this situation occurs depends on the level of transport costs and the strength of the localisation effects.

Specialisations are important at national level, too. The developed economies produce clearly different national products. In order to explain this specialisation of nations, the theory of comparative costs is usually used, which is standard in economics. If, for example, the production of the German economy is compared with that of other developed countries, a disproportionately large specialisation can be seen in the area of manufacturing. Germany's industry is particularly strong in mechanical engineering and the manufacture of upmarket cars. In addition many high-quality goods are manufactured in relatively small series. This type of specialisation is closely linked with Germany's institutional structure. This requires among other things particularly highly skilled workers who are geared specifically towards the preferred industries. In Germany the institutional pre-requisite for this is the dual system of vocational training.

This system is so called because it has two coordinated places of training: firms and schools. It is still usual in Germany for a young person to take up such a training place after completing compulsory general education. This is still a considerable difference to other countries, such as the Anglo-Saxon countries, where vocational training is predominantly organised in schools. In Germany this system is geared mainly towards occupations in the manufacturing industry. It provides a large degree of occupational differentiation and thus permits an intensive social division of labour, which is advantageous for the production of the described products in the manufacturing industry.

The economies of the Anglo-Saxon countries, on the other hand, specialise more in services than the German economy. Corresponding institutional preconditions are important for this, too. The financial market, for example, is organised more liberally in the Anglo-Saxon countries than in continental Europe and accordingly attracts more international capital. This corresponds with the fact that especially in the USA there is a large market for venture capital, which makes it easier for people with innovative ideas to put these ideas into practice and set up their own business. This is one of the reasons why the Anglo-Saxon countries reach a higher level of specialisation not only in services but also in innovative products in the manufacturing industry. Although

Germany achieves larger shares in manufacturing, the country's economy does not manage to bring innovative products to market maturity to the same extent as the Anglo-Saxon countries do. German firms are often particularly competitive with products that have already been launched but are now being manufactured with an especially high quality. The relationship between the institutional structure of the large capitalist countries and their specialisation can only be presented simplistically here for reasons of space. It plays an indirect role in the new debate surrounding the "Varieties of Capitalism" approach (Hall, Soskice 2001).

It must be emphasised that certain specialisations, once they have been developed, have a tendency to survive, as the agglomeration advantages described above for regions also apply for countries. The particular specialisation can then prove to be a strength or a weakness with regard to the labour market. If the particular product market responds elastically to perpetual increases in productivity, then employment gains will result - and vice versa in the case of an inelastic response. This is the explanation provided by Ronald Schettkat (1997) for Germany's relatively high unemployment rates. The workers living in Germany have the bad luck that the economy specialises in products with relatively inelastic demand. At the end of this paper we will briefly discuss some of the (scarce) empirical findings concerning this hypothesis. At the moment, it is already possible to say that the named specialisations of the German economy are indications that inelastic product markets play a role: the market for luxury cars is probably not exactly a classic example of elastic demand. If someone decides to buy a Porsche, he must not be put off by a high price. In mechanical engineering, too, German firms are successful with special products which are expensive but also correspondingly important for the buyers.

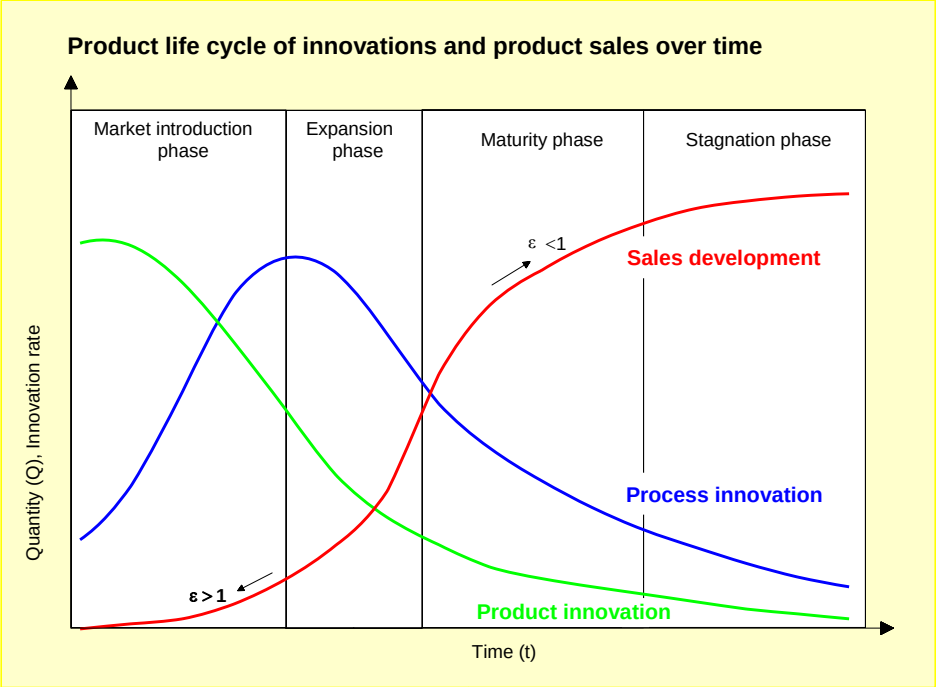
So far the argumentation of this paper has concentrated on the spatial dimension. However, it was explained above that there is a second dimension that is important for understanding the relationship described here between productivity, demand elasticity and employment or unemployment. For this it is possible to go back to the idea of the product cycle.

This idea, which is often used in the context of regional science, goes back to Schumpeter among others (1939; cf. Wienert 1990; Weinstein et al. 1985: 63ff.). It becomes relevant as it has already been shown that regions are often more or less specialised. If specialisation is really a success factor, then the production and employment in many regions is dominated by individual products from a specific industry or a specific product conglomeration. This is associated with a problem, however, since products do not generally meet with endless solvent demand. The gramophone was superseded by the record player, and the record player by the CD player, which itself is gradually being replaced by the MP3 player. This shows that many products have only a finite "lifetime". If a region has specialised predominantly in a specific product, it falls into crisis when this product reaches a phase of saturation or the end of its "lifetime".

Figure 1 shows that the product life cycle (or the product cycle, to avoid the biological association) can already result in employment problems before the "death" of the particular product. In the market introduction phase, on the other hand, both product innovations and process innovations are high,, while employment grows. A new product first enters the market as a small series at a very high price. The manufacturing firm frequently occupies a more or less pronounced monopoly position. Increasing experience with the production and efforts to improve productivity lead to the start of larger series and to clear price reductions, which, if demand is unsaturated

(elastic), result in large increases in production which by far exceed the productivity improvements. The situation changes over time as demand is increasingly satisfied, competition on the markets grows and technological leeway is exhausted. Now improvements in productivity only lead to small increases in the quantity of goods sold and thus to falling turnover and reduced employment. Firms that have reached the end of their product cycle then pull the region or country in which they are located into the crisis with them.

Figure 1



A transition from the elastic into the inelastic range of the demand function for the most important product can already suffice to plunge a region into crisis. In order to explain this in detail, a model is to be presented here which integrates the product cycle idea into economic theory via the key concept of demand elasticity. A simple model structure is intended to keep the argumentation transparent. Generalisations which modify the results are possible in various places.

Before a formal presentation, the core elements of the theory and the causal structure that is important for formulating the model are explained once again. It is assumed that under the conditions of perfect competition, the productivity gains are passed on proportionally from the firms to the prices. The development of turnover under the conditions of advancing technology is then determined by the elasticity of demand on the product market which occupies the dominating position for the region concerned. If elasticity is low, the turnover of the product concerned falls if the price is reduced as a result of productivity gains. If elasticity is high (greater than 1), turnover grows. Employment responds in the same way, unemployment the other way around.

3. A small basic model

The fictitious example described above in Table 1 makes clear intuitively the relationship between technical progress, demand elasticity and employment. However, what is missing yet is a proof that the relationship between the variables is correctly described. To fill this gap, a simple model is expounded below which follows the formulation developed by Appelbaum and Schettkat (1999) and by Möller (2001) and therefore summarises the current state of the argumentation. Further below a richer model is developed. The simple model has the advantage of providing rapid clarity regarding the relationships. It begins with a definition equation for the productivity of labour π in a firm j in which the production quantity Q is related to the level of employment N.

$$\pi_j = \frac{Q_j}{N_j} \qquad (1)$$

$$P_j = \frac{z_j W_j}{\pi_j} \qquad (2)$$

$$Q_j = f(P_j, y), \quad \text{mit:} \quad dQ_j/dP_j < 0, \quad dQ_j/dy > 0 \qquad (3)$$

The second equation is a price-setting function with a mark-up calculation. The price is P_j, z is a mark-up factor which also includes capital expenditure and W_j is the wage rate. Finally the third equation is a demand function that falls with the price and rises with the national income y. From the base equations it follows for the growth rates, if ε_j is the price elasticity and η_j is the income elasticity of demand:

$$\hat{N}_j = \hat{Q}_j - \hat{\pi}_j \qquad (1)‘$$

$$\hat{P}_j = \hat{z}_j + \hat{W}_j - \hat{\pi}_j \qquad (2)‘$$

$$\hat{Q}_j = \eta \cdot \hat{y} - \varepsilon_j \cdot \hat{P}_j \qquad (3)‘$$

From (1)‘ to (3)‘ it is possible to derive the following expression for a firm’s employment development if $\hat{z} = 0$:

$$\hat{N}_j = \eta_j \hat{y} + (\varepsilon_j - 1)\hat{\pi}_j - \varepsilon_j \hat{W}_j \qquad (4)$$

After this we switch level and move on to examining an economy. This is characterised here as a region, though it could just as easily be a national economy. In order to be able to go over to examining individual sectors of a regional economy it is necessary to aggregate all firms j of the particular industry i in the relevant region r. For this we assume in the following that all the firms of an industry i are identical:

$$\hat{N}_{ir} = \eta_{ir} \hat{y} + (\varepsilon_{ir} - 1)\hat{\pi}_{ir} - \varepsilon_{ir} \hat{W}_{ir} \qquad (5)$$

A multi-level problem has to be taken into account when conducting the aggregation: although it is possible to assume that the demand elasticities across all the firms of an industry can be deter-

mined in terms of forming a weighted average, the elasticity at sectoral level is of a different nature from that at the level of an economic unit. For the individual firm that is neither a monopolist nor an oligopolist in a cartel, the behaviour of the other firms appears to be given. If the firm lowers its price, demand for its products may increase very strongly because other firms, which maintain their prices, are displaced. If all the firms lower their price, however, the quantity sold may change only slightly. Under the conditions of monopolistic competition, individual firms will behave in a profit-maximising manner and only offer their products in the elastic area of demand. After the described aggregation of individual firms it is no longer possible to make such a statement for aggregates ir.

The model describes productivity gains as Hicks-neutral technical progress, which is defined in such a way that the input ratio of the production factors remains constant. In this case $\hat{\pi}_j > 0$ simply applies. As a consequence, workers are displaced when product demand is inelastic (i. e. $\varepsilon_{ir} < 1$). When demand is elastic ($\varepsilon_{ir} > 1$) on the other hand, employment increases. This can be seen directly from (5). Therefore the theorem of the employment effects of increases in productivity (Neisser 1942, Appelbaum, Schettkat 1999) can be derived from the simple model.

The model also shows that the development of employment depends on the interaction of two elasticities. If income elasticity is high, the demand for a product can increase even under conditions of prices rising secularly. Positive employment effects are therefore possible despite price increases.

Furthermore the model can be used to examine the effect of wage increases. According to (5), in the realistic range of values for the demand elasticity (i. e. for $\varepsilon_{ir} > 0$), wage rises lead to decreasing employment. The effect is stronger the more elastic demand is. If it is assumed that the wage is the same across all the industries of a region, it is possible to depict regional employment under this influence. However, (5) contains another term which may depend on W_r, and that is the development of the national income y. If the market area of an industry is the world market, it will be possible to ignore the effect of change in the regional wage on the national income. In the opposite case the market area of the industry concerned is solely the region in which it is located. Then, in a rough approximation, it can be assumed that $y_r = W_r$, i. e. that the profits in region r are zero. In this case (5) becomes

$$\hat{N}_{ir} = (\varepsilon_{ir} - 1)\hat{\pi}_{ir} - (\varepsilon_{ir} - \eta_{ir})\hat{W}_{ir} \qquad (6)$$

A positive effect of wage rises on employment then depends on whether $\eta_{ir} > \varepsilon_{ir}$. If this is the case, an increase in the regional wage level will really be linked with employment gains. The situation described can potentially be connected with the approaches of New Economic Geography (Krugman 1991, cf. Fujita, Krugman, Venables 1999). There the development of a region depends on its market potential.It is the purchasing power located in the trading area of the region that is decisive. However, the basic version of New Economic Geography starts out from the assumption of full employment (cf. however Südekum 2005 and Uhlig 2006). The model outlined is so simple that unemployment can not be accommodated in it directly, it does not contain a labour market and it is thus only possible to make a statement about the development of unemployment indirectly via the change in employment.

4 Generalisation and reformulation of the model idea

In order to obtain statements about unemployment, in the following a richer model is developed which explicitly contains the labour market and also otherwise uses more the common standard of microeconomic formulations. The change in employment is modelled in the usual way as the development of labour demand. A further step moves back to the European Labour Market Model in order to permit some direct comparisons. We begin, however, with a case in which we treat the wage as fixed.

i. Fixed wage

$Q = Q(P)$ product demand (7)

$Q = AL^{1-\beta}K^{\beta}$ production function, with $0 < \beta < 1$, K fixed (8)

With the function for product demand we now abstract from national income. We adopt a Cobb-Douglas function as the production function. In addition we start out from the assumption of price-setting with perfect competition. The equations are formulated for individual firms, but the subspript is dropped here. The cost function c (e.g. according to Varian 1992: 54f.) shows the minimal-cost factor combinations at given factor prices. For this it is necessary to determine in each case the quantity of a production factor (K: capital, A: technology factor, c: costs, r: interest) that is necessary for a certain production level.

$c(r,W,Q) = \min(rK + WL)$ $\quad \text{NB}: Q = AK^{\beta}L^{1-\beta}$ (9)

$$= \min\left(rK + WA^{\frac{1}{\beta-1}}K^{\frac{\beta}{\beta-1}}Q^{\frac{-1}{\beta-1}} \right)$$

$$\frac{\partial c}{\partial K} = \quad r + \frac{\beta}{\beta-1}WA^{\frac{1}{\beta-1}}Q^{\frac{-1}{\beta-1}}K^{\frac{1}{\beta-1}} = 0$$

$$rK^{\frac{1}{1-\beta}} = -\frac{\beta}{\beta-1}WA^{\frac{1}{\beta-1}}Q^{\frac{-1}{\beta-1}}$$

The demand function for capital with a given production quantity and given factor prices (conditional demand function) is then:

$$K(r,W,Q) = \left[\frac{\beta W}{(1-\beta)r} \right]^{1-\beta} A^{-1}Q \qquad (10)$$

The corresponding demand function for labour takes the following form:

$$L(r,W,Q) = \left[\frac{(1-\beta)r}{\beta W}\right]^{\beta} A^{-1}Q \tag{11}$$

It then follows for the cost function with (maximum-profit) demand quantities inserted:

$$c(r,W,Q) = rK(r,W,Q) + WL(r,W,Q) =$$

$$= r\left[\frac{\beta W}{(1-\beta)r}\right]^{1-\beta} A^{-1}Q + W\left[\frac{(1-\beta)r}{\beta W}\right]^{\beta} A^{-1}Q$$

$$= \left(r\left[\frac{\beta W}{(1-\beta)r}\right]^{1-\beta} + W\left[\frac{\beta W}{(1-\beta)r}\right]^{-\beta}\right)A^{-1}Q$$

$$= \left(rr^{\beta-1}W^{1-\beta}\left[\frac{\beta}{(1-\beta)}\right]^{1-\beta} + WW^{-\beta}r^{\beta}\left[\frac{\beta}{(1-\beta)}\right]^{-\beta}\right)A^{-1}Q$$

$$= \left(\left[\frac{\beta}{(1-\beta)}\right]^{1-\beta} + \left[\frac{\beta}{(1-\beta)}\right]^{-\beta}\right)W^{1-\beta}r^{\beta}A^{-1}Q$$

$$c = \beta^{-\beta}(1-\beta)^{\beta-1}W^{1-\beta}r^{\beta}A^{-1}Q \tag{12}$$

as:

$$\frac{\beta^{1-\beta}}{(1-\beta)^{1-\beta}} + \frac{\beta^{-\beta}}{(1-\beta)^{-\beta}}$$

$$= \frac{\beta^{1-\beta}(1-\beta)^{-\beta} + \beta^{-\beta}(1-\beta)^{1-\beta}}{(1-\beta)^{1-\beta}(1-\beta)^{-\beta}}$$

$$= \frac{\beta^{-\beta}(\beta(1-\beta)^{-\beta} + (1-\beta)^{1-\beta})}{(1-\beta)^{1-2\beta}}$$

$$= \frac{\beta^{-\beta}(1-\beta)^{-\beta}(\beta + (1-\beta)}{(1-\beta)^{(1-2\beta)}}$$

$$= \frac{\beta^{-\beta}(1-\beta)^{-\beta}}{(1-\beta)^{(1-2\beta)}}$$

$$= \frac{\beta^{-\beta}}{(1-\beta)^{(1-\beta)}}$$

The price is equal to the marginal costs (with $\mu = \beta^{-\beta}(1-\beta)^{\beta-1}$):

$$P = \frac{\partial c(W,r,Q)}{\partial Q} = \frac{\partial(\beta^{-\beta}(1-\beta)^{\beta-1}W^{1-\beta}r^{\beta}A^{-1}Q\ )}{\partial Q} = \frac{\partial(\mu W^{1-\beta}r^{\beta}A^{-1}Q\ )}{\partial Q}$$

$$P = r^{\beta}W^{1-\beta}\mu A^{-1} \qquad (13)$$

If the function derived above is taken as the starting point, the resulting change in demand for labour in the case of technical progress is:

$$L = A^{-1}\left(\frac{\beta W}{(1-\beta)r}\right)^{-\beta} Q(P(A)) \qquad \text{labour demand}$$

$$\frac{\mathrm{d}L}{\mathrm{d}A} = -A^{-2}\left[\frac{\beta W}{(1-\beta)r}\right]^{-\beta} Q + A^{-1}\left[\frac{\beta W}{(1-\beta)r}\right]^{-\beta}\frac{\mathrm{d}Q}{\mathrm{d}P}\frac{\mathrm{d}P}{\mathrm{d}A} \qquad (14)$$

$$= -A^{-2}\left[\frac{\beta W}{(1-\beta)r}\right]^{-\beta} Q + A^{-1}\left[\frac{\beta W}{(1-\beta)r}\right]^{-\beta}\frac{\mathrm{d}Q}{\mathrm{d}P}\cdot(-A^{-2})r^{\beta}W^{1-\beta}\mu$$

$$= -\left(A^{-2}\left[\frac{\beta W}{(1-\beta)r}\right]^{-\beta} Q\right)\left(1 + Q^{-1}\frac{\mathrm{d}Q}{\mathrm{d}P}A^{-1}r^{\beta}W^{1-\beta}\mu\right)$$

$$\frac{\mathrm{d}L}{\mathrm{d}A} = -\left(\frac{K^{\beta}L^{1-\beta}}{A}\left(\frac{\beta W}{(1-\beta)r}\right)^{-\beta}\right)\cdot\left(1 + \frac{P}{Q}\frac{\mathrm{d}Q}{\mathrm{d}P}\right) \qquad (15)$$

(15) yields directly the fundamental theorem on the employment effects of technical progress. The employment response to productivity increases is positive if the elasticity of demand is greater than 1. However, this is always fulfilled for individual firms under perfect competition ($\eta >> 1$). If the firms of an industry are aggregated, however, the employment in an industry can be related to the overall demand for this aggregate. Then equation (15) applies for the entire industry. The aggregation is possible since the production function shows constant economies of scale. The following two sections are formulated for the level of regions.

ii. Reaction of wages to unemployment

In the following we start out from the (extreme) simplification that the regional or national economy under observation only produces one single good. The reason for this assumption is to be able to establish a connection with the labour market. The advantage of the assumption is that the function for labour demand depicts the overall demand on a labour market. The aim of the following analysis is to construct a model that is similar to a certain degree to that of Layard et al.

Since the formalization is standard, only some basic equations are given. We do not bother with the microfoundations of the model.

For reasons of simplification, in the following employment L is measured as a share of the active population, which is in turn standardised to 1 (N = 1). Unemployment results accordingly with $U = 1 - L$. In the spirit of the work by Layard, Nickell & Jackman (1991/2006) and Carlin, Soskice (2006) for the national level and by Blanchflower, Oswald (1994, 2005) for the regional level, it is assumed that the wage responds inversely to regional or national unemployment (wage -setting curve or wage curve). In order to make the calculations easier it is assumed that the wage curve is not semilogarithmic but linear. So the following expression results:

$$W = \gamma' - \tau U \tag{16}$$

$$= \gamma' - \tau \frac{1-L}{1}$$

$$= \gamma' - \tau + \tau L$$

$$W = \gamma + \tau L \tag{17}$$

The rationale behind this formalisation is quite analogous to that of Layard et al. The wage (setting) curve can be derived concerning efficiency wage approaches and wage negotiation models. The fact that a linear and not a log-linear formulation is adopted here does not constitute a limitation. The two formulations are equally good. Our own empirical studies on the regional wage curve do not clearly favour either of the two formulations over the other (Blien 2001).

iii. Equilibrium

In the following the wage is endogenised.

$$L = A^{-1}\left(\frac{\beta W}{(1-\beta)r}\right)^{-\beta} Q$$

$$L = A^{-1}\left(\frac{\beta(\gamma + \tau L)}{(1-\beta)r}\right)^{-\beta} Q \tag{18}$$

$$L = A^{-1}\beta^{-\beta}(\gamma + \tau L)^{-\beta}(1-\beta)^{\beta} r^{\beta} Q$$

$$L(\gamma + \tau L)^{\beta} = A^{-1}\beta^{-\beta}(1-\beta)^{\beta} r^{\beta} Q$$

implicit function:

$$G = L(\gamma + \tau L)^{\beta} - A^{-1}\beta^{-\beta}(1-\beta)^{\beta} r^{\beta} Q = 0 \tag{19}$$

$$\frac{dL}{dA} = -\frac{\partial G/\partial A}{\partial G/\partial L} = -\frac{\left(\frac{K^{\beta}L^{1-\beta}}{A}\right)\left(\frac{\beta}{(1-\beta)r}\right)^{-\beta}\left(1+\frac{PdQ}{QdP}\right)}{(\gamma+\tau L)^{\beta} + \beta L(\gamma+\tau L)^{\beta-1}\tau} \tag{20}$$

difference between (15) and (20):

$$\frac{W^{\beta}}{(\gamma+\tau L)^{\beta} + \beta L\,\tau(\gamma+\tau L)^{\beta-1}} \tag{21}$$

$$= \frac{(\gamma+\tau L)^{\beta}}{(\gamma+\tau L)^{\beta} + \beta L\,\tau(\gamma+\tau L)^{\beta-1}}$$

$$= \frac{(\gamma+\tau L)^{\beta}}{(\gamma+\tau L)^{\beta}(1+\beta L\,\tau(\gamma+\tau L)^{-1})}$$

$$= \frac{1}{1+\beta\tau L(\gamma+\tau L)^{-1}} = S \tag{22}$$

with $0 < S < 1$

Thus the effect of increases in productivity is weaker in the case of endogenous wages. However, the turning point of the development, in other words the elasticity of one, is maintained exactly.

5 Connections between the labour market model of structural change and the European Labour Market Model

We have seen that in mainstream macroeconomics (in the “European Labour Market Model”) according to Layard, Nickell & Jackman (2006) the level of unemployment is attributed to the fundamental institutional setting of an economy. Unemployment is explained by competing claims made by economic subjects. A formulation is selected here which in its most extreme condensation can be reduced to one diagram. Two functions are constitutive for the model:

The wage setting curve expresses the demands of the labour force for a specific share of the social product. When the share of the labour force that is in employment is large (= low unemployment rate), it is more likely that the claims made by the labour force on the national product can be pushed through.

The price setting curve reflects the demands of the firm owners. When there is a high level of activity in the economy, i.e. when unemployment is low, firms can set higher prices. This lowers W/P, the real wage.

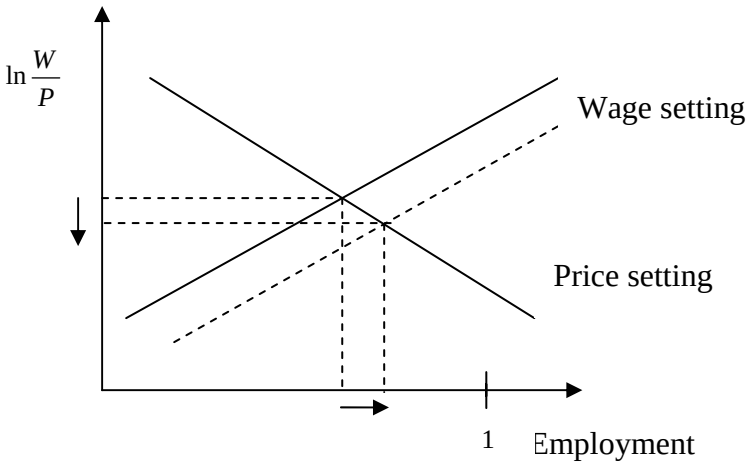
The point where the two curves intersect reflects an equilibrium situation in which the demands of the economic subjects are compatible. In this equilibrium a certain positive level of unemployment occurs, a rate which is known as *NAIRU* (“Non-Accelerating Inflation Rate of Unemployment”). The *NAIRU* is equivalent to a change in inflation of zero. If the unemployment rate is low, inflation rises, if it is high, inflation falls.

The labour market model on structural change can be depicted in a way parallel to the fundamental diagram by Layard, Nickell, Jackman. However, in the model on structural change it is not monopolistic competition that is taken as a basis, as in Layard et al., but perfect competition. The labour demand curve given above replaces the price-setting curve. Owing to the assumption of constant economies of scale, this does not depend on the price P. The function described in this way falls since it is inversely linked with the wage level:

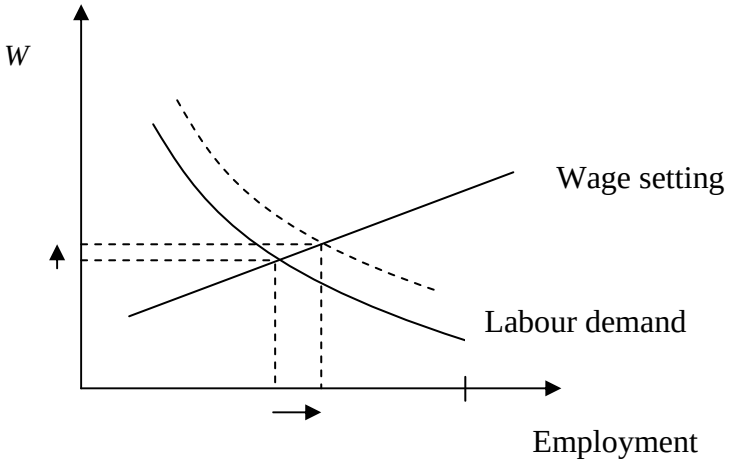
$$L = \frac{1}{AW^{\beta}} \left(\frac{\beta}{(1-\beta)r} \right)^{-\beta} Q$$

Comparison of the model on structural change and the European labour market model

Layard et al.



Labour market model of structural change



Both of the models refer to the institutional setting of the economy:

- Layard et al. take into account in particular the labour market setting in the narrower sense.
- In the structural change model this may also be of importance, but institutions related to the product market and to other social areas are important, too:
  - What is important is the incidence of innovations and the extent to which innovations are facilitated by the institutional structure.
  - The structure of the system of education and training might lead to a specific training of workers, therefore facilitating a specialisation of the economy.

The two approaches differ with regard to the possible consequences of economic-policy measures aimed at reducing unemployment. In the European labour market model, measures have the main function of reducing workers' demands on the national product. Measures of this type are linked with wage reductions.

From the labour market model on structural change it can be derived that another class of measures could help to increase employment and thus reduce unemployment. Measures in the following areas would be conceivable:

- Reorganisation of the education and training system
- Facilitation of innovations
- Reduction of bureaucracy and restrictions
- Promotion of technology for innovative sectors
- Regional policy (cross-departmental)

In general it is a matter of supporting fields that show elastic demand and rapid technical progress. What is also important is that the market is globally orientated.

6 Conclusions, empiricism and outlook

This paper has the task of showing the validity of the theorem on the employment effects of productivity growth in a very general context which is based on a microfoundation and includes the labour market. This has been done by and large. The theorem is valid under very general circumstances. The assumptions made while deriving the theorem are largely standard. The conclusions concerning the theory are thus clear. The theorem is potentially very important for explaining unemployment.

So far we have dealt primarily with the theory and now wish to turn at least briefly to the empirical conditions. In fact a number of stylised facts can be cited which suggest the effectiveness of the mechanism described. This is true both for the “positive” case as well as for the “negative” case in which the mechanism leads to a decrease in employment. Let us begin with a “negative” case, Germany: the following stylised facts suggest low demand elasticity for this economy:

- It is specialised in high-quality products (“luxury cars”) whose sales are not particularly affected by the price.
- It is specialised in high-quality manufacturing of machinery and equipment for which the price is less decisive for sales.
- It achieves the highest level of exports in the world (“world champions in exports”) -
- although a high wage level is recorded compared with competitors in Eastern Europe.

In contrast, the Anglo-Saxon countries are rather “positive” examples in this respect. They specialise in innovative products that are at the beginning of their product cycle and therefore demonstrate a price-elastic product demand. Innovative services contribute to this image of specialisation, whilst many “old industry” sectors are not present, which on the whole implies a lower share of manufacturing. Beyond current business-cycle trends, the Anglo-Saxon countries have appeared to be much better regarding the development of employment than Germany; this is proof that the theorem could be of importance in empirical terms. The extremely strong regional disparities in unemployment which were shown at the beginning (in Map 1) can also be understood using the structural approach. The consequences for the explanation of mass unemployment are obvious.

The stylised facts therefore very strongly suggest the effectiveness of the theorem which has been proven under general circumstances. However, stylised facts are not yet a hard empirical test. This paper was not intended to provide such a test but to develop the fundamental theory.

Anyhow there is already a hard empirical test in the form of investigations conducted by J. Möller (2001) for industries in three countries (USA, UK, D). These investigations showed a general shift in demand into the inelastic area, which affected the German economy most strongly. The shift occurred during the transition from the 1960s to the 1970s. Unemployment rose considerably as a consequence.

We plan to carry out empirical analyses for the German economy. Preliminary results with data from the German Official Statistics include estimations of the price elasticities of demand. Using a panel data approach for different industries we found elasticities of 0.556 for manufacturing and of 0.892 for services. These preliminary results confirm that the industry structure of the German economy is related to inelastic demand. The relatively small share of services in this economy is a disadvantage.

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