On the Identification of Relative Wage Rigidity Dynamics

A Proposal for a Methodology on Cross-Section Data and Empirical Evidence for Poland in Transition

by

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Non-Technical Summary

The relationship between wages and (un)employment is probably one of the most widely investigated issues in empirical economics. Whereas in the early post-war period, the focus was on macroeconomic Phillips-curve-type relationships from wage or price inflation to unemployment, current research is mainly concerned with wage responses to unemployment (the wage curve) or the wage and (un)employment *structure* and relies strongly on individual data. The observation of rising unemployment in Europe (especially for the unskilled) and of increasing wage inequality in the United States has led to the popular belief that these phenomena are ‘two sides of the same coin’ (Krugman), namely a fall in the relative demand for unskilled labour. This hypothesis maintains that rigid wages in Europe prevented the relative fall in unskilled wages observed in the United States, causing quantity adjustments in the form of higher unemployment.

This paper presents a new and simple approach to identify labour markets with wage rigidities empirically by a set of individual cross-section data. The basis for the proposed methodology is the observation of wage and unemployment dynamics associated with labour market characteristics. To this end, standard wage and unemployment regressions are estimated on individual data. The intuition of the approach is that a *ceteris paribus* increase in the wage rate and unemployment likelihood associated with a labour market characteristic identifies this characteristic as ‘contributing to a wage rigidity dynamic’. Although previous papers have related changes in wages to unemployment rates, we have found no study which makes *ceteris paribus* observations for both wages and unemployment and relates these to each other in a systematic way. This is the contribution of our paper.

In an application of our methodology to Polish microdata from 1994 to 1998, we find a ‘relative wage rigidity dynamic’ only for the Upper Silesian industrial region (voivodship) *Bielskie.* Thus we conclude that the Polish wage structure did not generate many new rigidities during the observation period. However, this was a period characterised by a favourable macroeconomic environment with high growth rates, rising average real wages, and falling average unemployment. Therefore, another finding is remarkable, namely that except for the *age group 16 to 25* and the *voivodship Gorzowskie*, there is also no evidence that possibly existing rigidities have been effectively reduced by significant changes in the wage structure during that period.

Abstract: We present a new and simple empirical methodology to identify relative wage rigidity dynamics. The methodology is applied to data from the Polish Labour Force Survey for the period 1994 to 1998.

We estimate *ceteris paribus* changes in relative wage and unemployment differentials for various labour market defining characteristics. A simultaneous increase in the relative wage and the unemployment likelihood is defined as a relative wage rigidity dynamic for a labour market characteristic.

We find that the Polish wage structure generated hardly any rigidities between 1994 and 1998 nor did it reduce possibly existing rigidities during that period.

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1 Introduction

The relationship between wages and (un)employment is probably one of the most widely investigated issues in empirical economics. Whereas in the early post-war period, the focus was on macroeconomic Phillips-curve-type relationships from wage or price inflation to unemployment, current research is mainly concerned with wage responses to unemployment (the wage curve, Blanchflower and Oswald, 1994; Card, 1995) or the wage and (un)employment *structure* and relies strongly on individual data. The observation of rising unemployment in Europe (especially for the unskilled) and of increasing wage inequality in the United States has led to the popular belief that these phenomena are 'two sides of the same coin' (Krugman, 1994, p. 37), namely a fall in the relative demand for unskilled labour. This hypothesis maintains that rigid wages in Europe prevented the relative fall in unskilled wages observed in the United States, causing quantity adjustments in the form of higher unemployment.

Recent empirical research thus investigates the wage and employment *structures* as opposed to only *average* wage developments. One strand of the literature estimates the extent of *nominal* wage rigidities (*e.g.* McLaughlin, 1994; Akerlof, Dickens, and Perry, 1996; Card and Hyslop, 1997; Kahn, 1997; Altonji and Devereux, 1999, for the United States; Fehr and Goette, 2000, for Switzerland; Beissinger and Knoppik, 2000, for Germany; Smith, 2000, for the United Kingdom). All these studies investigate whether wages are rigid nominally and most of them find some evidence for this hypothesis (Kahn, 1997, argues that this is not true for salaried workers, and Smith, 2000, finds the extent of nominal rigidities to be very small). In many of the papers an important question addressed is whether nominal wage rigidities justify a positive inflation target (Akerlof, Dickens, and Perry, 1996, and Beissinger and Knoppik, 2000, argue that a low rather than a zero level of inflation would increase efficiency, whereas Card and Hyslop, 1997, Altonji and Devereux, 1999, and Smith, 2000, find that the empirical evidence to support a positive inflation target on efficiency grounds is too weak). The paper by Fehr and Goette, 2000, on the other hand, focuses on the *real* impacts of nominal wage rigidity. Here, correlations between the real wage consequences of nominal rigidities with industry as well as regional unemployment rates are provided. It is this relationship between possibly rigid wages and the unemployment structure which is the focus of the current paper.

A second strand of the literature estimates the substitution elasticity between skilled and unskilled workers (*e.g.* Bound and Johnson, 1992; Katz and Murphy, 1992; Falk and Koebel, 1997; Steiner and Mohr, 1998; Fitzenberger, 1999, Chapter 5). On the basis of these estimated elasticities, the required changes in (relative) wages could be calculated for a desired change in labour demand (employment). However, only Fitzenberger (1999) carries out such an analysis. He concludes for western Germany that in order ‘to equalize the unemployment rates of the three skill groups ... the average wage gap between low-skilled and medium-skilled workers would have to increase by around 5 to 6 percent and between low-skilled and high-skilled workers by between 7 and 13 percent.’ (Fitzenberger, 1999, p. 150).

A third methodology to analyse wage rigidities has been developed by Card, Kramarz, and Lemieux (1999). The studies by Beissinger and Möller (1998) and Card, Kramarz, and Lemieux (1999), compare *inter alia* correlations between initial wages (*i.e.* wages at the beginning of some specified period, which are seen as an instrument for relative labour demand shifts) and subsequent wage and employment changes, respectively. The observations for which these correlations or regressions are estimated are socio-economic groups defined on the basis of characteristics observed in individual data. Card, Kramarz, and Lemieux (1999) find that wages in France have responded less to demand shifts than wages in the United States, but that the relative employment changes have been similar in both countries. The authors thus conclude that relative wage inflexibility in France has not been the main culprit for the poor French employment performance. Using a similar methodology for Western Germany, Beissinger and Möller (1998) find that labour demand shifts (again proxied by initial wages) impacted on the wage but not the employment structure and hence cannot explain the rise in West German unemployment, either.

This paper presents a new and simple approach to identify labour markets with wage rigidities empirically by a set of individual cross-section data. The basis for the proposed methodology is the observation of wage and unemployment dynamics associated with labour market characteristics. To this end, standard wage and unemployment regressions are estimated on individual data. The intuition of the approach is that a *ceteris paribus* increase in the wage rate and unemployment likelihood associated with a labour market characteristic identifies this characteristic as ‘contributing to a wage rigidity dynamic’. Although previous papers have related changes in wages to unemployment rates (*e.g.* Nickell and Bell, 1996; Fehr and Goette, 2000), we have found no study which makes *ceteris paribus* observations for both wages and unemployment and relates these to each other in a systematic way. This is the contribution of our paper.

The strength of the proposed methodology is that unlike the approach by Card, Kramarz, and Lemieux (1999), it does not rely on the assumption that labour markets are just hit by labour demand, but not labour supply shocks. Furthermore, no assumption on the nature of labour demand (or supply) shocks is necessary except that labour demand and supply schedules are downward and upward sloping, respectively. Furthermore, our methodology does not measure the employment, but the unemployment structure. This stems from the standard result in neoclassical economics that inefficient prices cause quantity rationing (see, for example, Maddala, 1983, chapter 10). Unlike studies which rely on elasticity of substitution estimates (*e.g.* Fitzenberger, 1999), we want to be able to make statements on possible wage rigidities for more specific labour markets than for only two to three different skill groups. Hence we compare the changes in the wage and unemployment structure dependent on many socio-economic characteristics which we believe to define a labour market. In contrast to the study by Fehr and Goette (2000) we statistically control for all these characteristics when comparing *e.g.* the regional or industrial unemployment and wage structures. Of course, we also need to make an identifying assumption to interpret our results in terms of wage rigidities. We rely on the assumption of a constant level of frictional unemployment. Although this assumption may seem strong, we argue that it serves as a viable starting point as long as data to estimate the change in frictional unemployment for specific labour markets are not readily available.

The paper is structured as follows. Section 2 presents a methodology for the identification of a relative wage rigidity dynamic using cross sections of individual data. Section 3 applies this methodology to a transition economy, namely Poland between 1994 and 1998. Section 4 concludes.

2 Relative Wage Rigidity Dynamics: Theory and Estimation

2.1 Definition and Identification of a Wage Rigidity Dynamic

A perfectly competitive market without adjustment costs should clear instantaneously at the market clearing price. Simple expositions of the labour market start off with the concept of perfect competition to show how the wage rate and the level of employment are determined in this situation. Unemployment does not exist in this world. Models that incorporate more reality account for market frictions like imperfect information and non-competitive aspects of labour markets. Search-theoretic approaches, for example, show that uncertainty can lead to search unemployment which is efficient for the market participants (see Lippmann and McCall, 1976; McKenna, 1985; or Mortensen, 1986, for surveys). Monitoring costs are another possible cause of unemployment:

efficiency wage theories state that effective labour supply can be lowered due to the existence of monitoring costs which lead to incentives to shirk (Shapiro and Stiglitz, 1984).

In this paper, we will term unemployment which is due to market frictions like incomplete information (search) or transaction costs (monitoring) *frictional unemployment*. We shall distinguish this type of unemployment from unemployment which exists because wages are set too high (*e.g.* by trade unions or other regulations) and assume for simplicity that these two types of unemployment are additive:

$$U_{rigid\ wage\ rate,t} \equiv U_{total,t} - U_{frictional,t}$$

where U denotes an unemployment rate (here defined as the number of unemployed according to the International Labour Office (ILO) definition over the total number of the working age population). We assume that there are only these two types of unemployment. Other types, like 'cyclical' or 'seasonal' unemployment for example, can in theory be traced back to the just-mentioned properties of the labour market, so that what is called 'cyclical unemployment' in fact results from rigid wages or other frictions (in the empirical analysis below, however, we do not attempt to analyse seasonal unemployment, and control for seasonal effects instead).

Wage rigidities may arise for several reasons. Trade union power is often discussed as a possible factor setting wages above the market clearing level, especially in European labour markets (Carlin and Soskice, 1990, Chapter 17; Booth, 1995). However, there exist also other institutional arrangements, not necessarily related to unions, which may cause wages to be rigid, like some public sector pay scales which are fixed by law for a certain period. Also, wage contracts in general are usually valid for longer periods and are not renegotiated immediately in the face of labour demand or supply shifts. Hence, the wage rate may not be set efficiently (which would be at the market clearing rate if no frictions existed). The consequence can be unemployment due to quantity rationing. This type of unemployment is denoted by $U_{rigid\ wage\ rate}$.

Empirically, we can only measure U_{total}, but not $U_{frictional}$ or $U_{rigid\ wage\ rate}$ separately, without making further assumptions. If one has no information on the development of $U_{frictional}$, and if it is plausible that the institutions and matching technologies which influence the level of frictional unemployment have been constant at two points in time t and $t+\tau$ for a labour market with characteristics $\mathbf{x}$ (to be discussed in Section 2.2 below), one may assume that

Assumption: $$U(\mathbf{x})_{frictional,\,t} = U(\mathbf{x})_{frictional,\,t+\tau}$$

If this assumption is valid, it follows that

$$\left[U(\mathbf{x})_{rigid\ wage\ rate,\,t+\tau} - U(\mathbf{x})_{rigid\ wage\ rate,\,t}\right] = \left[U(\mathbf{x})_{total,\,t+\tau} - U(\mathbf{x})_{total,\,t}\right] - \underbrace{\left[U(\mathbf{x})_{frictional,\,t+\tau} - U(\mathbf{x})_{frictional,\,t}\right]}_{=0}$$

$$\Leftrightarrow \quad \Delta_t^{t+\tau} U(\mathbf{x})_{rigid\ wage\ rate} = \Delta_t^{t+\tau} U(\mathbf{x})_{total}\,.$$

Hence, changes in observed unemployment can be interpreted as changes in unemployment due to wage rigidities. In this framework, the analysis of labour market developments (changes in unemployment and changes in wages) in the face of labour demand and supply shifts can be carried out within the simple framework of the 'Marshallian scissors', as by assumption, labour demand and supply shifts do not change the frictional unemployment rate. The dynamics of unemployment and wages are thus the outcome of labour demand and/or supply shifts as well as the (lack of) reactions of the wage-setting institutions to these shifts. For example, a positive labour demand shift in the face of some positive level of $U_{rigid\ wage\ rate}$ will decrease $U_{rigid\ wage\ rate}$ if the wage-setting institutions do not react by increasing the wage rate. If they do, however, one may observe no change in unemployment, but an increase in the wage rate. The wage-setting institutions may even set the wage so high, that both the wage rate and the unemployment rate increase at the same time.

In the following, we define a classification of empirical observations of wage and unemployment movements as they can be traced back to relative labour demand and supply shifts in the outlined framework (which corresponds to the standard 'Marshallian scissors'). We are not able to separately identify labour demand and supply shocks without further assumptions. However, from observing wage and unemployment dynamics we can infer on the relative movement of labour demand to supply between the time periods t and $t+\tau$. Hence we make the following definitions:

Definition 1 (Wage Rigidity Dynamic): The observation of an increase in the wage rate and the unemployment rate in a labour market between two points in time is, on the basis of our Assumption, defined as a wage rigidity dynamic.

Definition 2 (Terminology for Wage-Unemployment Dynamics): A labour market is 'rigid' in a period if both the wage and the unemployment rate rise in this period; it is 'increasing' if the wage rate rises and the unemployment rate falls; it is 'decreasing' if unemployment rises and the wage rate falls; and it is 'converging' if both the wage and the unemployment rate fall.

The intuition for the terminology of a 'rigid' labour market is that with constant frictional unemployment, rising wages above the market clearing level must be the cause of rising unemployment. Rising wages and falling unemployment are possible in our model only if there is a rise in labour demand relative to labour supply, hence the term 'increasing'. The opposite movements are possible only with a fall in labour demand relative to labour supply, hence the term 'decreasing'. Both a falling wage and unemployment rate can stem in this model only from an easing of an existing wage rigidity, hence the term 'converging'. The way the model has been set up, a fall in unemployment given a constant level of frictional unemployment is only possible if wages have already been at above the efficient level, *i.e.* have been rigid.

The following figure illustrates the possible classifications:

Figure 1: Labour Market Classifications

	Wage increase	Wage decrease
Unemployment increase	*rigid*	*decreasing*
Unemployment decrease	*increasing*	*converging*

In this section, we made statements on one specific homogeneous labour market. The following section discusses an application of this model if labour is heterogeneous.

2.2 Wage Rigidity Dynamics and Heterogeneous Labour

Unemployment rates vary considerably in modern market economies between socio-economic groups as well as regions. This should focus interest on the wage and unemployment *structure* (expectations conditional on certain characteristics less the unconditional expectation) besides movements in *average* quantities (unconditional expectations). Conditional expectations can be defined on subgroups which operate in different labour markets. Characteristics which define separate labour markets must be such that both labour supply and labour demand is to a certain degree immobile between these characteristics. To give an example, there will be a labour market for people with a specific educational level: workers cannot easily move between educational levels, neither do firms see workers with different educational levels as perfect substitutes (workers may be under- as well as over-qualified). In such a situation, inadequate wage responses to a negative labour demand shift would result in the observation of an increase in unemployment. This would not be the case if workers could immediately change their educational characteristic or supply their labour to a different labour market.

In this paper we analyse the wage and unemployment dynamics in different labour markets. These are defined by characteristics which we believe cause both labour supply and demand to be sufficiently immobile such that one can talk of separate labour markets at least in the medium run (several years). We argue that these characteristics are age (as a proxy for work experience, which is not generally observed in our data), education, disabilities, occupation, maybe the size or the region of residence (if workers and firms are immobile between them), and – as far as they describe some form of human capital – gender, industry and sector of employment (public/private).

The labour market can thus be viewed as consisting of a set of different labour markets defined by the characteristics of the type of labour traded. Within each labour market, there may still be some random component to wages and unemployment. Hence, one can define the first moments of the wage and unemployment distributions conditional on the labour-market-defining characteristics as

$$W(\mathbf{x})_t \equiv E\left(w_t \left| age, education, occupation, industry, region, ...\right.\right) = E\left(w_t \left|\mathbf{x}\right.\right)$$

$$U(\mathbf{x})_{total,\,t} \equiv E\left(u_t \left| age, education, occupation, industry, region, ...\right.\right) = E\left(u_t \left|\mathbf{x}\right.\right)$$

where w_t is the hourly wage rate and u_t is a binary variable indicating whether a person is unemployed at time t. Wage and unemployment dynamics between points in time t and $t+\tau$ for subgroup $\mathbf{x}$ can be written as:

$$\Delta_t^{t+\tau} W(\mathbf{x}) = E\left(w_{t+\tau} \left|\mathbf{x}\right.\right) - E\left(w_t \left|\mathbf{x}\right.\right) = E\left(w_{t+\tau} - w_t \left|\mathbf{x}\right.\right)$$

$$\Delta_t^{t+\tau} U(\mathbf{x})_{rigid\ wage\ rate} \underbrace{=}_{\Delta_t^{t+\tau} U(\mathbf{x})_{frictional}=0} \Delta_t^{t+\tau} U(\mathbf{x})_{total} = E\left(u_{t+\tau} \left|\mathbf{x}\right.\right) - E\left(u_t \left|\mathbf{x}\right.\right) = E\left(u_{t+\tau} - u_t \left|\mathbf{x}\right.\right)$$

Changes in the wage *structure* can be characterised by the difference between the wage and unemployment changes in labour market $\mathbf{x}$ and the changes for the population (as the reference):

$$\Delta_t^{t+\tau} W(\mathbf{x}) - \Delta_t^{t+\tau} E_{\mathbf{X}}\left[W(\mathbf{X})\right] = E\left(w_{t+\tau} - w_t \,|\mathbf{x}\right) - E\left(w_{t+\tau} - w_t\right)$$

$$\Delta_t^{t+\tau} U(\mathbf{x}) - \Delta_t^{t+\tau} E_{\mathbf{X}}\left[U(\mathbf{X})\right] = E\left(u_{t+\tau} - u_t \,|\mathbf{x}\right) - E\left(u_{t+\tau} - u_t\right)$$

where $\mathbf{X}$ denotes the vector of labour market defining variables and $\mathbf{x}$ is a realisation of that vector.

On the basis of the observation of these parameters, we can observe and classify *relative* wage-unemployment dynamics for the labour market $\mathbf{x}$ (in relation to a reference market):

Definition 3 (Terminology for Relative Wage-Unemployment Dynamics for a Labour Market): A labour market is 'rigid' in a relative sense in a period if the wage and unemployment changes in that period are both higher than the one for the reference market; it is 'increasing' in a relative sense if the wage (unemployment) change in that period is higher (lower) than the one for the reference market; it is 'decreasing' in a relative sense if the wage (unemployment) change in that period is lower (higher) than the one for the reference market; and it is 'converging' in a relative sense if the wage and unemployment changes in that period are both lower than the one for the reference market.

Note that there is an important difference between the labour market classification of Section 2.1 and the classification of *relative* wage and unemployment changes just defined: whereas the former classification is defined on absolute wage and unemployment changes, the latter is defined *in relation to* the wage and unemployment changes in the labour market as a whole (the reference market). Therefore, a labour market can, for example, be rigid in an absolute sense, but converging in a relative sense if wage and unemployment increases in this specific market have been below the wage and unemployment increases in the whole labour market.

The following section makes a proposal how the relative wage-unemployment dynamics may be estimated empirically with cross-section data.

2.3 Estimation with Cross-Section Data

Implementing the above approach empirically may be complicated by the high number of cells defined by all possible realisations of $\mathbf{x}$ on the one hand, and the low number of observations in these cells on the other. This dimensionality problem can be reduced by grouping continuous variables (like age) and defining dummy variables for these groups. Let the length of a thus redefined vector $\mathbf{x}$ be K. Then one would obtain $K \times K$ cells for which sample analogs of the above expectations could be calculated.

An alternative way which imposes more restrictions is to parameterise the conditional distribution of wages and unemployment by imposing functional forms on the conditional expectations:

$$E\left(w_t \middle| \mathbf{x}\right) = f_1\left(\mathbf{x};\boldsymbol{\beta}_t\right) \text{ or } E\left(\ln w_t \middle| \mathbf{x}\right) = f_2\left(\mathbf{x};\boldsymbol{\beta}_t\right)$$

$$E\left(u_t \middle| \mathbf{x}\right) = g\left(\mathbf{x};\boldsymbol{\gamma}_t\right)$$

Popular choices for functional forms are $f_2\left(\mathbf{x};\boldsymbol{\beta}_t\right) = \boldsymbol{\beta}_t^{'}\mathbf{x}$ (a log-linear model for wages) and $g\left(\mathbf{x};\boldsymbol{\gamma}_t\right) = \Phi\left(\boldsymbol{\gamma}_t^{'}\mathbf{x}\right)$ (a probit specification for the unemployment probability), where $\Phi(\cdot)$ denotes the cumulative distribution function of the standard normal distribution.

Approximating $E\left(\ln w_{t+\tau} - \ln w_t\right)$ by $E\left(\ln w_{t+\tau} - \ln w_t \middle| \overline{\mathbf{x}}_t\right)$ and $E\left(u_{t+\tau} - u_t\right)$ by $E\left(u_{t+\tau} - u_t \middle| \overline{\mathbf{x}}_t\right)$ ($\overline{\mathbf{x}}_t$ will henceforth be denoted $\overline{\mathbf{x}}$) we can write (see also Yun, 2000):

$$E\left(\ln w_{t+\tau} - \ln w_t \middle| \mathbf{x}\right) - E\left(\ln w_{t+\tau} - \ln w_t\right) \approx \left[\boldsymbol{\beta}_{t+\tau} - \boldsymbol{\beta}_t\right]'\left[\mathbf{x} - \overline{\mathbf{x}}\right]$$

$$E\left(u_{t+\tau} - u_t \middle| \mathbf{x}\right) - E\left(u_{t+\tau} - u_t\right) \underbrace{\approx}_{\substack{\text{first-order} \\ \text{Taylor approximation}}} \left[\boldsymbol{\gamma}_{t+\tau} - \boldsymbol{\gamma}_t\right]'\left[\mathbf{x}\,\phi\left(\boldsymbol{\gamma}_t^{'}\mathbf{x}\right) - \overline{\mathbf{x}}\,\phi\left(\boldsymbol{\gamma}_t^{'}\overline{\mathbf{x}}\right)\right]$$

Writing in terms of sums instead of matrix notation we get

$$E\left(\ln w_{t+\tau} - \ln w_t \middle| \mathbf{x}\right) - E\left(\ln w_{t+\tau} - \ln w_t\right) \approx \sum_k \left[\beta_{t+\tau,k} - \beta_{t,k}\right]\left[x_k - \overline{x}_k\right]$$

$$E\left(u_{t+\tau} - u_t \middle| \mathbf{x}\right) - E\left(u_{t+\tau} - u_t\right) \approx \sum_k \left[\gamma_{t+\tau,k} - \gamma_{t,k}\right]\left[x_k\phi\left(\boldsymbol{\gamma}_t^{'}\mathbf{x}\right) - \overline{x}_k\phi\left(\boldsymbol{\gamma}_t^{'}\overline{\mathbf{x}}\right)\right]$$

where k denotes an element of the $\boldsymbol{\beta}$ or $\mathbf{x}$ vectors. In our case, there are only dummy variables contained in $\mathbf{x}$. Assume that we have L different sets of dummy variables each of which contains D_l categories. The standard estimation procedure is to set the coefficient of one category (the base category) to zero. The coefficients then state the deviation of the expected value of the dependent variable of the respective category from the one of the base category. An alternative to this procedure is to present coefficients for each category such that they fulfil $\sum_{d=1}^{D_l} \beta^*_{l,d,t}\overline{x}_{l,d,t} = 0 \quad \forall l$ and $\sum_{d=1}^{D_l} \beta^*_{l,d,t+\tau}\overline{x}_{l,d,t} = 0 \quad \forall l$ (see Haisken-DeNew and Schmidt, 1997, and the Appendix). This presentation contains exactly the same information, but the transformed coefficients $\beta^*_{l,d,t}$ and $\beta^*_{l,d,t+\tau}$ now state the deviation of the expected value of the dependent variable of the respective category from a hypothetical reference which takes on the value of the mean at time t for all categories of the respective dummy variable set. The $\gamma^*_{l,d,t}$ and $\gamma^*_{l,d,t+\tau}$ coefficients are obtained analogously. We can thus write

$$E\left(\ln w_{t+\tau} - \ln w_t \middle| \mathbf{x}\right) - E\left(\ln w_{t+\tau} - \ln w_t\right) \approx \sum_k \left[\beta^*_{t+\tau,k} - \beta^*_{t,k}\right]\left[x_k - \overline{x}_k\right]$$

$$E\left(u_{t+\tau} - u_t \middle| \mathbf{x}\right) - E\left(u_{t+\tau} - u_t\right) \approx \sum_k \left[\gamma^*_{t+\tau,k} - \gamma^*_{t,k}\right]\left[x_k\phi\left(\boldsymbol{\gamma}_t^{*\prime}\mathbf{x}\right) - \overline{x}_k\phi\left(\boldsymbol{\gamma}_t^{*\prime}\overline{\mathbf{x}}\right)\right]$$

We have

$$\sum_k \beta^*_{t,k}\overline{x}_k = \beta^*_{t,0} + \sum_{l=1}^{L}\underbrace{\sum_{d=1}^{D_l}\beta^*_{t,l,d}\overline{x}_{l,d}}_{=0} = \beta^*_{t,0} \text{ and } \sum_k \gamma^*_{t,k}\overline{x}_k = \gamma^*_{t,0} + \sum_{l=1}^{L}\underbrace{\sum_{d=1}^{D_l}\gamma^*_{t,l,d}\overline{x}_{l,d}}_{=0} = \gamma^*_{t,0} \quad \forall t$$

Hence,

$$\begin{aligned} E\left(\ln w_{t+\tau} - \ln w_t \middle| \mathbf{x}\right) - E\left(\ln w_{t+\tau} - \ln w_t\right) &\approx \sum_{k\neq 0}\left[\beta^*_{t+\tau,k} - \beta^*_{t,k}\right]x_k + \underbrace{\left[\beta^*_{t+\tau,0} - \beta^*_{t,0}\right] - \left[\beta^*_{t+\tau,0} - \beta^*_{t,0}\right]}_{=0} \\ &= \sum_{k\neq 0}\left[\beta^*_{t+\tau,k} - \beta^*_{t,k}\right]x_k \end{aligned}$$

$$\begin{aligned} &E\left(u_{t+\tau} - u_t \middle| \mathbf{x}\right) - E\left(u_{t+\tau} - u_t\right) \\ &\qquad \approx \sum_{k\neq 0}\left[\gamma^*_{t+\tau,k} - \gamma^*_{t,k}\right]x_k\phi\left(\boldsymbol{\gamma}_t^{*\prime}\mathbf{x}\right) + \left[\gamma^*_{t+\tau,0} - \gamma^*_{t,0}\right]\phi\left(\boldsymbol{\gamma}_t^{*\prime}\mathbf{x}\right) - \left[\gamma^*_{t+\tau,0} - \gamma^*_{t,0}\right]\phi\left(\boldsymbol{\gamma}_t^{*\prime}\overline{\mathbf{x}}\right) \\ &\qquad = \sum_{k\neq 0}\left[\gamma^*_{t+\tau,k} - \gamma^*_{t,k}\right]x_k\phi\left(\boldsymbol{\gamma}_t^{*\prime}\mathbf{x}\right) + \left[\gamma^*_{t+\tau,0} - \gamma^*_{t,0}\right]\left[\phi\left(\boldsymbol{\gamma}_t^{*\prime}\mathbf{x}\right) - \phi\left(\boldsymbol{\gamma}_t^{*\prime}\overline{\mathbf{x}}\right)\right] \end{aligned}$$

Taking derivatives with respect to the change in a coefficient over time yields:

$$\frac{\partial\left[E\left(\ln w_{t+\tau}-\ln w_t\left|\mathbf{x}\right.\right)-E\left(\ln w_{t+\tau}-\ln w_t\right)\right]}{\partial\left[\beta^*_{t+\tau,k}-\beta^*_{t,k}\right]}\approx x_k\ (>0\ \ for\ x_k=1)$$

$$\frac{\partial\left[E\left(u_{t+\tau}-u_t\left|\mathbf{x}\right.\right)-E\left(u_{t+\tau}-u_t\right)\right]}{\partial\left[\gamma^*_{t+\tau,k}-\gamma^*_{t,k}\right]}=x_k\phi\left(\boldsymbol{\gamma}^{*'}_t\mathbf{x}\right)\quad(>0\ \ for\ x_k=1)$$

Hence instead of describing the relative wage and unemployment dynamics for all $K\times K$ labour markets, we can just report the K dynamics related to the defining characteristics x_k. For the relative wage dynamics, this procedure is without any loss of information as the change in the coefficient on any characteristic k is exactly equal to the contribution of this characteristic to the relative wage dynamic of any labour market which shares this characteristic. For the unemployment dynamics, the change in the coefficient on any characteristic k is larger than the contribution of this characteristic to the relative unemployment dynamic of any labour market which shares this characteristic. How much larger it is depends on the specific labour market through the term $\phi\left(\boldsymbol{\gamma}^{*'}_t\mathbf{x}\right)$. Nevertheless, one can say that the sign of the change in the coefficient on any characteristic k equals the sign of the contribution of this characteristic to the relative unemployment dynamic of any labour market which shares this characteristic.

Relative wage and unemployment dynamics can thus be defined for a labour market characteristic k on the basis of the signs of the coefficient changes $\left[\beta^*_{t+\tau,k}-\beta^*_{t,k}\right]$ and $\left[\gamma^*_{t+\tau,k}-\gamma^*_{t,k}\right]$:

Definition 4 (Terminology for the Contribution of a Labour Market Characteristic to Relative Wage-Unemployment Dynamics): A labour market characteristic k is 'contributing to a relative wage rigidity dynamic' in a period $[t,t+\tau]$ if $\left[\beta^*_{t+\tau,k}-\beta^*_{t,k}\right]>0$ and $\left[\gamma^*_{t+\tau,k}-\gamma^*_{t,k}\right]>0$; it is 'contributing to a relatively increasing market' if $\left[\beta^*_{t+\tau,k}-\beta^*_{t,k}\right]>0$ and $\left[\gamma^*_{t+\tau,k}-\gamma^*_{t,k}\right]<0$; it is 'contributing to a relatively decreasing market' if $\left[\beta^*_{t+\tau,k}-\beta^*_{t,k}\right]<0$ and $\left[\gamma^*_{t+\tau,k}-\gamma^*_{t,k}\right]>0$; it is 'contributing to a relatively converging market' if $\left[\beta^*_{t+\tau,k}-\beta^*_{t,k}\right]<0$ and $\left[\gamma^*_{t+\tau,k}-\gamma^*_{t,k}\right]<0$.

In the following section, the just outlined methodology is applied to Polish data from the transition period.

3 Empirical Application: Poland in Transition

3.1 Data

We use data from the quarterly Polish Labour Force Survey (PLFS) which has been started in May 1992. The PLFS is a representative sample of the non-institutionalised Polish population (see Szarkowski and Witkowski, 1994, for a description). It has information on wage earners, unemployed people, as well as people not participating in the labour market. The definition of the labour force states follows the International Labour Office (ILO) definition. In particular, people are classified as unemployed if they are not working in the reference week, are looking for a job, and are ready to take up a job in the very short term.

We choose the waves of November 1994 and November 1998 to define the period for which we estimate relative wage rigidity dynamics. The November 1994 wave is chosen as the starting point as the occupation classification has changed in 1994 and has been consistent from then onwards. In order to avoid seasonal effects to influence our results, we choose the most recent wave available to us for the month of November as the end point, which is November 1998. Remarkable is the increase in the share of employment in the private sector in that period, which rose from 36.39 to 48.24 per cent according to own calculations based on the PLFS. The unemployment rate in this period fell from 12.98 to 10.95 per cent. Thus, the macroeconomic view on unemployment during the defined period shows that *on average*, wages did not show rigidity dynamics as defined above because unemployment fell. However, it is an empirical question whether there have been relative rigidity dynamics in the wage *structure*.

The sample means of the variables in the wage and unemployment regressions are reported in Table A1 in the Data Appendix. The wage variable is the logarithm of the nominal hourly wage rate (in new Polish Zlotys). The large increase between 1994 and 1998 is explained by a double digit annual inflation rate during the period. The unemployment variable is coded *1* if a person is unemployed and *0* if a person is employed or not participating in the labour market. As can be seen from the table, the labour market defining characteristics $\mathbf{x}$ are age, education, gender, disability, occupation, industry, sector of employment (public/private), town size, and voivodship (administrative region) groups.

As occupation, industry, sector of employment (public/private) are possibly endogenous, we exploit the rotating panel nature of the PLFS and match these variables from the August waves to our November sample. As only about one half of the observations is in the panel both in August and November, we loose the other half by this procedure. However, the sample sizes are still large. With respect to the variables occupation, industry, and sector of employment (public/private) it also has to be kept in mind that people with *no previous work experience* (unlike unemployed people who state their previous occupation *etc.*) fall into none of the occupation, industry, or sector of employment (public/private) categories. They thus can be seen as a separate category for each of these three dummy variable groups. As to town size and voivodship (administrative region), the PLFS does not track individuals who leave their household, which means that - amongst others - movers are lost from the sample (about 3.5 per cent are lost). This loss of observations may create a potential bias in our estimates for which we do not have a straightforward solution.

3.2 Empirical Implementation

We estimate the wage regression by OLS with robust standard errors and the unemployment regression by a probit model using the software *stata 6.0*. Tables A2 and A3 in the Data Appendix report the estimation results, whereas all coefficients on the dummy variables are reported as deviations from the means (original estimation results with coefficients of base categories set to zero are available from the author upon request). Standard errors (t-values) have been adjusted accordingly (see Haisken-DeNew and Schmidt, 1997, and the Appendix).

We are aware that the wage equations are potentially affected by selection bias. Ordinary least squares (OLS) regressions are estimated without correcting for selection bias. This is because recent Monte Carlo evidence gives credence to the view that the OLS estimator may exhibit less mean squared error than Heckman's (1979) two step procedure or full information maximum likelihood estimation if no appropriate exclusion restrictions can be found (see Puhani, 2000, for a survey of Monte Carlo evidence on parametric methods to correct for selection bias). As we could not find sensible and effective exclusion restrictions in our data, we estimate OLS regressions, which is a simple practical approach to the problem, but has to be taken with a *caveat*.

3.3 Empirical Results

Table 1 presents the estimated vectors $\left(\hat{\boldsymbol{\beta}}^*_{t+\tau} - \hat{\boldsymbol{\beta}}^*_t\right)$ and $\left(\hat{\boldsymbol{\gamma}}^*_{t+\tau} - \hat{\boldsymbol{\gamma}}^*_t\right)$ with t-values based on the appropriate variance-covariance matrix (see Haisken-DeNew and Schmidt, 1997, and the Appendix). Changes in coefficients significant at the 5 and 10 per cent level are marked with two and one asterisk(s), respectively. The coefficients on the mean show that *on average*, the likelihood of being unemployed decreased significantly between November 1994 and November 1998 (also nominal and real wages increased significantly). The focus of this study is on the wage structure, *i.e.* on *relative* wage and unemployment dynamics. Because of the semi-logarithmic specification of the wage regressions, the displayed coefficients $\left(\hat{\boldsymbol{\beta}}^*_{t+\tau} - \hat{\boldsymbol{\beta}}^*_t\right)$ for the categories of the dummy variable groups can be interpreted as the approximate *ceteris paribus* percentage change in the wage differential of the, *e.g. age between 16 and 25*, category, relative to a person with mean age. The coefficients $\left(\hat{\boldsymbol{\gamma}}^*_{t+\tau} - \hat{\boldsymbol{\gamma}}^*_t\right)$ can only be interpreted in terms of their sign as they relate to the underlying index (describing the propensity to be unemployed) of a probit model (see the discussion in Section 2.3 above).

Glancing over the results shows that there have been statistically significant changes in relative hourly wage rates and unemployment likelihoods for some labour market characteristics. The relative hourly wage rate of young workers *aged 16 to 25* has decreased over the observation period. So has the relative wage of workers with *basic vocational education* and people working in the industries *mining* and *electricity, gas, water*. On the other hand, there has been an increase in the *higher education* wage premium. Furthermore, changes in the regional (voivodship) wage structure occurred which we do not discuss here. As to unemployment, for young workers *aged 16 to 25* the likelihood to be unemployed decreased, whereas it increased for those *aged 36 to 45*. Similarly, the decrease in the unemployment likelihood for workers with *higher education* is mirrored by the increase for those with only *primary education*. Further decreases in the relative unemployment likelihood have been experienced by *white-collar workers*, people from the *construction industry* and those living in *rural areas*. It may seem surprising that unemployment likelihoods have risen for people in *financial intermediation* as well as those living in towns with *more than 100 thousand inhabitants.* However, as can be seen from Table A3 in the Data Appendix, the unemployment likelihood was not above the mean in neither of these two categories in November 1998. Changes in the relative unemployment likelihoods for various voivodships will not be discussed here but can readily be observed from Table 1.

Characteristics for which both changes in the wage and unemployment coefficients are statistically significant are classified according to Definition 4 above. Graphical displays are provided in Figure 2 to Figure 4. As derived in Section 2.3, the coefficient changes describe the contribution of the respective characteristic to the relative wage or unemployment dynamic of any labour market which shares this characteristic. A characteristic appearing in the first (third) quadrant is ‘contributing to a relative wage rigidity dynamic’ (‘contributing to a relatively converging market’). A characteristic appearing in the second (fourth) quadrant is ‘contributing to a relatively decreasing market’ (‘contributing to a relatively increasing market’).

According to these definitions there is only one characteristic ‘contributing to a relative wage rigidity dynamic’, which is *voivodship Bielskie*, an industrial region in the south of Poland bordering with the voivodship *Katowickie*, a traditional staple industry region in Upper Silesia. There are two labour market characteristics which are classified as ‘contributing to a relatively converging market’, namely the *age group 16 to 25* and the *voivodship Gorzowskie*, which has a border with eastern Germany. The only characteristic which is classified as ‘contributing to a relatively decreasing market’ is *voivodship: Wloclawskie*, an agricultural region in the centre of Poland. On the other hand, the characteristics *higher education*, and *voivodship of Warsaw* are classified as ‘contributing to a relatively increasing market’.

To sum up, we have found a relative wage rigidity dynamic only for one labour market characteristic, namely the voivodship *Bielskie*, which borders with the Upper Silesian industrial centre *Katowice*. This indicates that the Polish wage structure has not generated many new rigidities between November 1994 and November 1998. However, except for the *age group 16 to 25* and the *voivodship Gorzowskie*, there is also no evidence that possibly existing rigidities have been effectively reduced by significant changes in the wage structure during that period.

Table 1: Ceteris Paribus Wage and Unemployment Changes

	Wage Regressions		Unemployment Regressions	
	$\left(\hat{\boldsymbol{\beta}}^{*}_{t+\tau}-\hat{\boldsymbol{\beta}}^{*}_{t}\right)$	t-value	$\left(\hat{\boldsymbol{\gamma}}^{*}_{t+\tau}-\hat{\boldsymbol{\gamma}}^{*}_{t}\right)$	t-value
mean	0.8355**	151.679	-0.1619**	-5.810
Age between				
16-25	-0.0223*	-1.687	-0.1233**	-3.076
26-35	0.0068	0.740	-0.0571	-1.458
36-45	-0.0029	-0.429	0.0637*	1.865
46-55	0.0105	0.918	0.0649	1.348
56-65	0.0096	0.261	0.0707	0.964
Education				
higher	0.0497**	2.285	-0.1847*	-1.709
post secondary	-0.0220	-0.836	-0.0004	-0.003
secondary vocational	0.0057	0.603	-0.0190	-0.469
secondary general	0.0272	1.320	-0.0930	-1.409
basic vocational	-0.0244**	-2.707	-0.0442	-1.417
primary	0.0015	0.093	0.1027**	3.021
less than primary	-0.0434	-0.486	0.2862	0.846
Gender				
female	0.0027	0.400	-0.0083	-0.408
male	-0.0023	-0.400	0.0089	0.408
Disabilities				
disabled	0.0187	0.346	-0.0041	-0.062
abled	-0.0002	-0.346	0.0006	0.062
Occupation				
manager	0.0136	0.418	-0.1494	-1.193
specialist	0.0031	0.231	0.0917	1.416
white collar	0.0098	0.779	-0.0873*	-1.647
blue collar	-0.0062	-0.727	0.0098	0.372
no previous employment	-0.0066	-0.102	-0.0877	-1.018

Table 1: Ceteris Paribus Wage and Unemployment Changes (ctd.)

	Wage Regressions		Unemployment Regressions	
	$\left(\hat{\boldsymbol{\beta}}^*_{t+\tau} - \hat{\boldsymbol{\beta}}^*_t\right)$	t-value	$\left(\hat{\boldsymbol{\gamma}}^*_{t+\tau} - \hat{\boldsymbol{\gamma}}^*_t\right)$	t-value
Industry				
agriculture	0.0037	0.121	0.0406	0.676
mining	-0.1059**	-3.749	0.1946	1.273
manufacturing	0.0124	1.347	-0.0035	-0.089
electricity, gas, water	-0.0608*	-1.925	0.1891	0.982
construction	0.0335	1.544	-0.1999**	-2.951
trade	0.0244	1.256	-0.0610	-0.984
hotels, restaurants	-0.0448	-1.068	0.0501	0.355
transport, communic.	0.0020	0.114	0.0559	0.602
financial intermediation	0.0048	0.130	0.3441*	1.891
real estates, renting	0.0284	0.759	-0.0257	-0.176
administration	-0.0159	-0.750	-0.1724	-1.612
education	0.0241	1.176	0.0103	0.091
health care, social work	-0.0205	-1.047	-0.0064	-0.064
other	-0.0255	-0.960	0.0742	0.736
no previous employment	-0.0165	-0.246	0.1023	0.702
Sector of Employment				
public	0.0040	0.732	-0.0373	-1.418
private	-0.0072	-0.664	0.0391	1.418
no previous employment	-0.0274	-0.376	0.1008	0.623
Town Size				
>100 thd.	0.0021	0.216	0.0870**	2.379
>20thd.	-0.0049	-0.473	-0.0068	-0.176
<20thd.	-0.0042	-0.328	-0.0062	-0.130
rural	0.0034	0.416	-0.0533**	-2.039

Table 1: Ceteris Paribus Wage and Unemployment Changes (ctd.)

	Wage Regressions		Unemployment Regressions	
	$\left(\hat{\boldsymbol{\beta}}^*_{t+\tau} - \hat{\boldsymbol{\beta}}^*_t\right)$	t-value	$\left(\hat{\boldsymbol{\gamma}}^*_{t+\tau} - \hat{\boldsymbol{\gamma}}^*_t\right)$	t-value
Voivodship				
Stoleczne Warszawskie	0.0598**	2.089	-0.2475**	-2.656
Bialskopodlaskie	0.1103*	1.933	-0.3783	-1.329
Bialostockie	0.0063	0.157	0.1840	1.223
Bielskie	0.0580**	2.044	0.2542**	2.076
Bydgoskie	0.0464	1.567	0.0415	0.409
Chelmskie	0.0268	0.444	0.2433	1.207
Ciechanowskie	0.0417	0.721	-0.1139	-0.695
Czestochowskie	0.0206	0.673	-0.0099	-0.077
Elblaskie	0.0783*	1.668	-0.0590	-0.426
Gdanskie	-0.0035	-0.123	-0.1014	-1.035
Gorzowskie	-0.1184**	-2.342	-0.4692**	-2.920
Jeleniogorskie	0.0410	1.026	0.2408*	1.675
Kaliskie	-0.0560	-1.518	-0.1848	-1.342
Katowickie	-0.0361*	-1.800	0.0611	0.928
Kieleckie	-0.0404	-1.390	0.2407**	2.429
Koninskie	-0.0130	-0.263	-0.0023	-0.014
Koszalinskie	0.0071	0.175	0.0130	0.104
Krakowskie	-0.0183	-0.633	-0.0603	-0.481
Krosnienskie	-0.0150	-0.394	-0.0020	-0.012
Legnickie	-0.0666	-1.387	0.0485	0.341
Leszczynskie	0.0675	1.210	-0.4279**	-2.174
Lubelskie	-0.0595**	-1.997	-0.1153	-0.939
Lomzynskie	0.0168	0.328	-0.1897	-0.962
Lodzkie	-0.0080	-0.265	0.0921	0.846
Nowosadeckie	-0.0010	-0.027	-0.0409	-0.315
Olsztynskie	-0.0108	-0.302	0.0189	0.156

Table 1: Ceteris Paribus Wage and Unemployment Changes (ctd.)

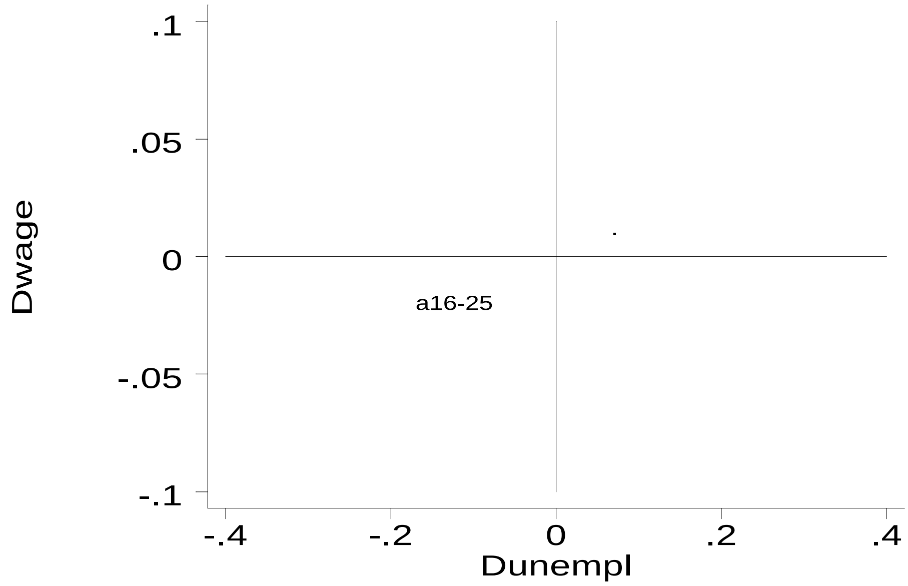
	Wage Regressions		Unemployment Regressions	
	$\left(\hat{\boldsymbol{\beta}}^{*}_{t+\tau}-\hat{\boldsymbol{\beta}}^{*}_{t}\right)$	t-value	$\left(\hat{\boldsymbol{\gamma}}^{*}_{t+\tau}-\hat{\boldsymbol{\gamma}}^{*}_{t}\right)$	t-value
Opolskie	-0.0207	-0.739	0.1870*	1.679
Ostroleckie	0.0585	1.077	0.1980	1.129
Pilskie	0.0690*	1.696	0.1129	0.698
Piotrkowskie	-0.1472**	-3.659	-0.0861	-0.643
Plockie	-0.0169	-0.369	0.0408	0.257
Poznanskie	0.0895**	3.478	-0.1882	-1.457
Przemyskie	0.0661	1.599	0.1933	1.146
Radomskie	-0.0701**	-2.004	0.1862	1.562
Rzeszowskie	-0.0570	-1.601	0.2682*	1.910
Siedleckie	-0.0167	-0.396	-0.1203	-0.842
Sieradzkie	0.0212	0.437	-0.0927	-0.541
Skierniewickie	-0.0321	-0.692	-0.2122	-1.156
Slupskie	0.0778	1.495	-0.0696	-0.479
Suwalskie	-0.0078	-0.166	-0.0949	-0.658
Szczecinskie	0.0639*	1.891	-0.1614	-1.446
Tarnobrzeskie	0.0529	1.387	-0.1890	-1.278
Tarnowskie	-0.0105	-0.280	-0.2256	-1.605
Torunskie	-0.0091	-0.256	0.0258	0.187
Walbrzyskie	-0.0415	-1.350	0.2987**	2.382
Wloclawskie	-0.1316**	-2.804	0.2750*	1.874
Wroclawskie	-0.0094	-0.329	0.1166	1.047
Zamojskie	0.0931*	1.775	0.1612	0.880
Zielonogorskie	0.0256	0.835	0.2470*	1.855

Notes: Coefficients marked with two (one) asterisk(s) are significant at the 5 (10) per cent level;

the *occupation*, *industry*, and *sector of employment* variables are taken from the corresponding August (instead of November waves); unemployed people state the variables relating to their previous employment; people with *no previous employment* build an extra category for each of these three dummy variable groups. As a consequence, this variable appears in each group of the *occupation*, *industry*, and *sector of employment* variables for the transformation of the coefficients as described in Appendix A.

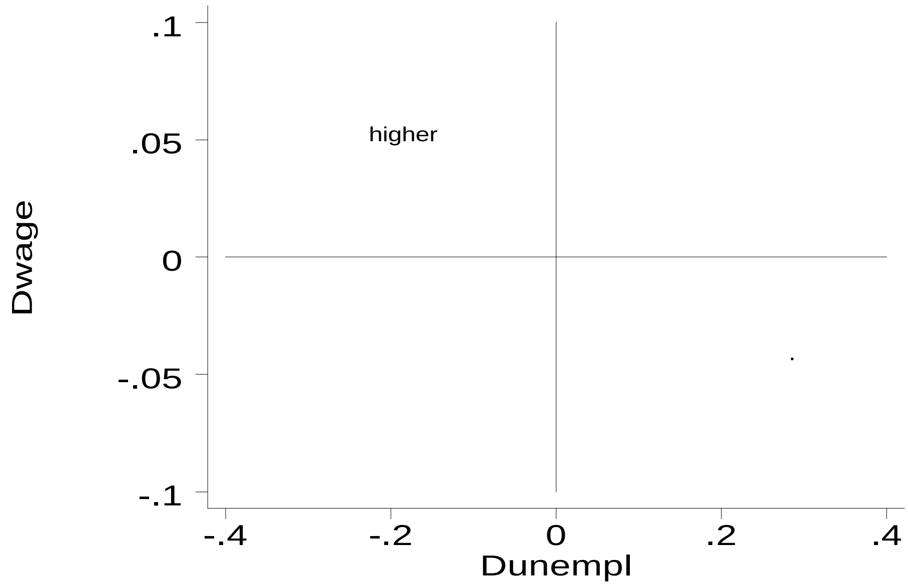
Source: PLFS; own calculations.

Figure 2: Relative Wage and Unemployment Dynamics - Age Categories



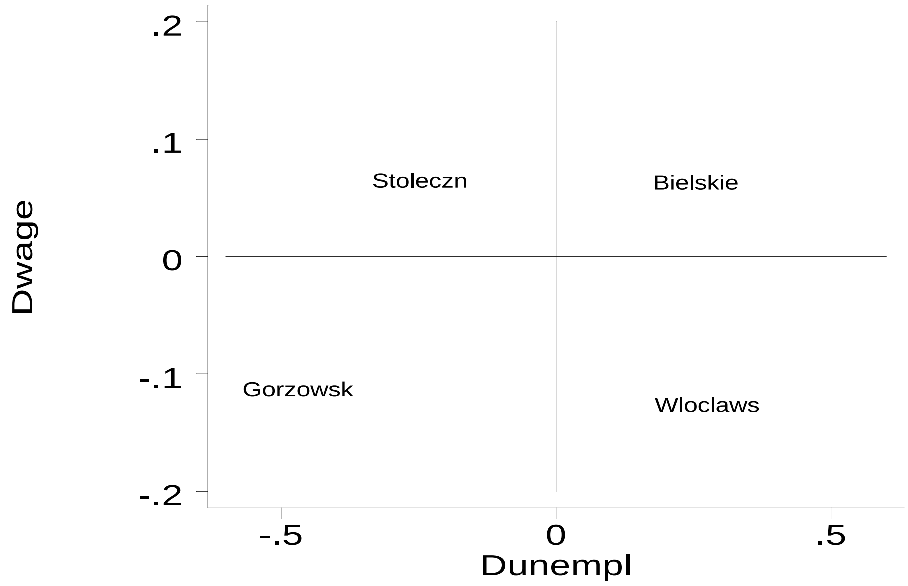
Note: 'Dwage' refers to $\left(\hat{\boldsymbol{\beta}}^{*}_{t+\tau}-\hat{\boldsymbol{\beta}}^{*}_{t}\right)$; 'Dunempl' refers to $\left(\hat{\boldsymbol{\gamma}}^{*}_{t+\tau}-\hat{\boldsymbol{\gamma}}^{*}_{t}\right)$; 'a16-26' refers to the age group 16 to 25 years, other age coefficients are not significant (see text).
Source: PLFS; own calculations.

Figure 3: Relative Wage and Unemployment Dynamics - Education Categories



Note: 'Dwage' refers to $\left(\hat{\boldsymbol{\beta}}^{*}_{t+\tau}-\hat{\boldsymbol{\beta}}^{*}_{t}\right)$; 'Dunempl' refers to $\left(\hat{\boldsymbol{\gamma}}^{*}_{t+\tau}-\hat{\boldsymbol{\gamma}}^{*}_{t}\right)$; 'higher' refers to higher education, other education coefficients are not significant (see text).
Source: PLFS; own calculations.

Figure 4: Relative Wage and Unemployment Dynamics - Regional (Voivodship) Categories



Note: 'Dwage' refers to $\left(\hat{\boldsymbol{\beta}}_{t+\tau}^{*}-\hat{\boldsymbol{\beta}}_{t}^{*}\right)$; 'Dunempl' refers to $\left(\hat{\boldsymbol{\gamma}}_{t+\tau}^{*}-\hat{\boldsymbol{\gamma}}_{t}^{*}\right)$; 'Stoleczn' refers to the voivodship 'Stoleczne Warszawskie' (Warsaw); 'Bielskie' to 'Bielskie', 'Gorzowsk' to 'Gorzowskie', and 'Wloclaws' to 'Wloclawskie'; other education coefficients are not significant (see text).

Source: PLFS; own calculations.

4 Conclusions

We have developed a simple methodology for the identification of relative wage rigidity dynamics under the assumption that the level of frictional unemployment remains constant. Although this is a strong assumption, we believe that the analysis of relative wage rigidities based on the estimation of some type of quantity rationing (changes in relative unemployment) and price movements (changes in relative wages) may be a promising research route to follow. A next step could be to try to find some proxy for changes in frictional unemployment instead of assuming that it is constant. Such a proxy could be related to movements of unemployment-vacancy ratios which would have to be observed for all labour markets (as we have defined them). Unfortunately, such vacancy data are not readily available.

In an application of our methodology to Polish microdata from 1994 to 1998, we have found a ‘relative wage rigidity dynamic’ only for the Upper Silesian industrial region (voivodship) *Bielskie*. Thus we conclude that the Polish wage structure did not generate many new rigidities during the observation period. However, this was a period characterised by a favourable macroeconomic environment with high growth rates, rising average real wages, and falling average unemployment. Therefore, another finding is remarkable, namely that except for the *age group 16 to 25* and the *voivodship Gorzowskie*, there is also no evidence that possibly existing rigidities have been effectively reduced by significant changes in the wage structure during that period.

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Appendix

A. Transformation of the Dummy Variable Coefficients

Adapting the suggestion by Haisken-DeNew and Schmidt (1997), the transformation of regression coefficients $\boldsymbol{\beta}_t^{'}$ and $\boldsymbol{\gamma}_t^{'}$ (which include *zeros* for base categories of dummy variables and indicate the *ceteris paribus* deviation of the dependent variable when in the corresponding rather than the base category) to coefficients $\boldsymbol{\beta}_t^{*'}$ and $\boldsymbol{\gamma}_t^{*'}$, which indicate the corresponding deviation from the category mean, is undertaken in the following way (including corresponding variance-covariance matrices):

$$\boldsymbol{\beta}_t^{*} = \left(\mathbf{I} - \mathbf{W}_{\boldsymbol{\beta}}\right)\boldsymbol{\beta}_t \,;\; \boldsymbol{\gamma}_t^{*} = \left(\mathbf{I} - \mathbf{W}_{\boldsymbol{\gamma}}\right)\boldsymbol{\gamma}_t$$

$$V\left(\boldsymbol{\beta}_t^{*}\right) = \left(\mathbf{I} - \mathbf{W}_{\boldsymbol{\beta}}\right) V\left(\boldsymbol{\beta}_t\right)\left(\mathbf{I} - \mathbf{W}_{\boldsymbol{\beta}}\right)^{'} ;\; V\left(\boldsymbol{\gamma}_t^{*}\right) = \left(\mathbf{I} - \mathbf{W}_{\boldsymbol{\gamma}_t}\right) V\left(\boldsymbol{\gamma}\right)\left(\mathbf{I} - \mathbf{W}_{\boldsymbol{\gamma}}\right)^{'}$$

with

$$\mathbf{W}_{\boldsymbol{\beta}} = \begin{bmatrix}
0 & -w_{\beta_{11}} & \cdots & -w_{\beta_{1D_1}} & \cdots & -w_{\beta_{l1}} & \cdots & -w_{\beta_{lD_l}} & \cdots & -w_{\beta_{L1}} & \cdots & -w_{\beta_{LD_L}} \\
0 & w_{\beta_{11}} & \cdots & w_{\beta_{1D_1}} & \mathbf{0} & 0 & \cdots & & \mathbf{0} & \cdots & & 0 \\
\vdots & \vdots & & \vdots & \vdots & \vdots & & & & & & \vdots \\
 & w_{\beta_{11}} & \cdots & w_{\beta_{1D_1}} & \mathbf{0} & 0 & \cdots & & & & & \\
\mathbf{0} & \cdots & & \mathbf{0} & \ddots & \mathbf{0} & \ldots & & \mathbf{0} & \cdots & & \mathbf{0} \\
\vdots & \cdots & & 0 & \mathbf{0} & w_{\beta_{l1}} & \cdots & w_{\beta_{lD_k}} & \mathbf{0} & \cdots & & 0 \\
 & & & & \vdots & \vdots & & \vdots & \vdots & & & \vdots \\
 & \cdots & & 0 & \mathbf{0} & w_{\beta_{l1}} & \cdots & w_{\beta_{lD_l}} & \mathbf{0} & \cdots & & 0 \\
\mathbf{0} & \cdots & & & \vdots & & & \mathbf{0} & \ddots & \mathbf{0} & \cdots & \mathbf{0} \\
\vdots & \cdots & & & & & & & \mathbf{0} & w_{\beta_{L1}} & \cdots & w_{\beta_{LD_L}} \\
 & & & & & & & & \vdots & \vdots & & \vdots \\
0 & \cdots & & & \mathbf{0} & \cdots & & & \mathbf{0} & w_{\beta_{L1}} & \cdots & w_{\beta_{LD_L}}
\end{bmatrix}$$

such that

$$\textstyle\sum_{d=1}^{D_l} w_{\beta_{ld}} = 1 \quad \forall l$$

where l denotes the type of dummy variable group (*e.g.* age) for which D_l different (*e.g.* age) categories exist. The bold $\mathbf{0}$ s in $\mathbf{W}_{\boldsymbol{\beta}}$ refer to matrices containing only zeros. Note that in some cases displayed above, the $\mathbf{0}$ s must be row vectors.

As defined, the first element of the $\boldsymbol{\beta}_t^*$ vector has to be the coefficient of the constant. For the weight $w_{\beta_{ld}}$ we choose the sample share of observations in category d within the dummy variable group l at time t, *i.e.* $w_{\beta_{ld}} = \overline{x}_{l,d,t}$. The matrix $\mathbf{I} - \mathbf{W}_{\boldsymbol{\beta}}$ thus transforms the coefficient of the constant to the (approximate) sample mean of the dependent variable in the linear model. The elements of the thus defined coefficient vector $\boldsymbol{\beta}_t^*$ satisfy

$$\sum\nolimits_{d=1}^{D_l} w_{\beta_{ld}} \beta_{l,d,t}^* = 0 \quad \forall l .$$

$\boldsymbol{\gamma}_t^*$ is defined analogously. We use the means in November 1994 $\overline{x}_{l,d,t}$ for both the transformations in November 1994 (t) and November 1998 $(t+\tau)$ as weights $w_{\beta_{ld}}$, because constant weights need to be chosen to identify wage and unemployment dynamics for a labour market relative to a constant reference level (which is $\overline{\mathbf{x}}_t$ in this case).

As outlined in Section 2.3, we are interested in the changes of the transformed coefficients, *i.e.*:

$$\left(\boldsymbol{\beta}_{t+\tau}^* - \boldsymbol{\beta}_t^*\right); \left(\boldsymbol{\gamma}_{t+\tau}^* - \boldsymbol{\gamma}_t^*\right)$$

with variance-covariance matrices

$$V\left(\boldsymbol{\beta}_{t+\tau}^* - \boldsymbol{\beta}_t^*\right) = V\left(\boldsymbol{\beta}_{t+\tau}^*\right) + V\left(\boldsymbol{\beta}_t^*\right);\ V\left(\boldsymbol{\gamma}_{t+\tau}^* - \boldsymbol{\gamma}_t^*\right) = V\left(\boldsymbol{\gamma}_{t+\tau}^*\right) + V\left(\boldsymbol{\gamma}_t^*\right)$$

as the estimates $\left(\boldsymbol{\beta}_{t+\tau}^*, \boldsymbol{\beta}_t^*\right)$ and $\left(\boldsymbol{\gamma}_{t+\tau}^*, \boldsymbol{\gamma}_t^*\right)$ are independent by assumption. The results are presented and discussed in the Section 3.3.

B. Data Appendix

Table A1: Sample Means

	Means Wage Regression		Means Unemployment Regression	
	1994	1998	1994	1998
ln hourly wage rate; or *unemployed*, respectively	0.6395	1.4559	0.0929	0.0667
Age between				
16-25	0.1310	0.1566	0.2217	0.2467
26-35	0.2722	0.2597	0.1950	0.1841
36-45	0.3854	0.3396	0.2623	0.2396
46-55	0.1797	0.2153	0.1622	0.1902
56-65	0.0316	0.0289	0.1588	0.1394
Education				
higher	0.1195	0.1289	0.0742	0.0806
post secondary	0.0411	0.0436	0.0261	0.0261
secondary vocational	0.2757	0.2782	0.1983	0.2109
secondary general	0.0683	0.0670	0.0718	0.0795
basic vocational	0.3541	0.3706	0.2965	0.3134
primary	0.1405	0.1115	0.3164	0.2813
less than primary	0.0008	0.0001	0.0166	0.0083
Gender				
female	0.4546	0.4660	0.5163	0.5117
male	0.5454	0.5340	0.4837	0.4883
Disabilities				
disabled	0.0114	0.0152	0.1336	0.1254
abled	0.9886	0.9848	0.8664	0.8746
Occupation				
manager	0.0505	0.0397	0.0455	0.0441
specialist	0.2734	0.2672	0.1504	0.1504
white collar	0.1682	0.2095	0.1337	0.1516
blue collar	0.4968	0.4750	0.4797	0.4370

Table A1: Sample Means (ctd.)

	Means Wage Regression		Means Unemployment Regression	
	1994	1998	1994	1998
Industry				
agriculture	0.0407	0.0264	0.1679	0.1439
mining	0.0475	0.0335	0.0270	0.0198
manufacturing	0.2972	0.2712	0.1983	0.1764
electricity, gas, water	0.0289	0.0242	0.0134	0.0130
construction	0.0720	0.0796	0.0579	0.0579
trade	0.0944	0.1267	0.0992	0.1126
hotels, restaurants	0.0111	0.0143	0.0116	0.0141
transport, communication	0.0723	0.0735	0.0450	0.0455
financial intermediation	0.0268	0.0292	0.0142	0.0161
real estates, renting	0.0199	0.0272	0.0128	0.0203
administration	0.0691	0.0678	0.0373	0.0356
education	0.0822	0.0811	0.0492	0.0473
health care, social work	0.0895	0.0983	0.0451	0.0505
other	0.0373	0.0383	0.0305	0.0301
Sector of Employment				
public sector	0.6647	0.5430	0.4143	0.3286
private sector	0.3241	0.4484	0.3950	0.4544
No previous employment	0.0111	0.0086	0.1907	0.2169
Town Size				
>100 thd.	0.3158	0.2781	0.2731	0.2509
>20thd.	0.2321	0.2283	0.1965	0.2087
<20thd.	0.1376	0.1450	0.1237	0.1251
rural	0.3145	0.3486	0.4068	0.4153

Table A1: Sample Means (ctd.)

	Means Wage Regression		Means Unemployment Regression	
	1994	1998	1994	1998
Voivodship				
Stoleczne Warszawskie	0.0554	0.0455	0.0524	0.0506
Bialskopodlaskie	0.0062	0.0082	0.0081	0.0080
Bialostockie	0.0149	0.0171	0.0179	0.0163
Bielskie	0.0305	0.0307	0.0267	0.0260
Bydgoskie	0.0288	0.0312	0.0283	0.0308
Chelmskie	0.0048	0.0083	0.0067	0.0081
Ciechanowskie	0.0108	0.0081	0.0134	0.0119
Czestochowskie	0.0198	0.0253	0.0190	0.0213
Elblaskie	0.0131	0.0132	0.0136	0.0131
Gdanskie	0.0353	0.0319	0.0343	0.0345
Gorzowskie	0.0138	0.0152	0.0151	0.0123
Jeleniogorskie	0.0143	0.0182	0.0136	0.0143
Kaliskie	0.0217	0.0237	0.0222	0.0235
Katowickie	0.1084	0.0868	0.0966	0.0902
Kieleckie	0.0304	0.0258	0.0319	0.0281
Koninskie	0.0103	0.0114	0.0132	0.0119
Koszalinskie	0.0154	0.0145	0.0150	0.0135
Krakowskie	0.0356	0.0332	0.0340	0.0316
Krosnienskie	0.0149	0.0144	0.0145	0.0146
Legnickie	0.0134	0.0149	0.0136	0.0150
Leszczynskie	0.0092	0.0130	0.0109	0.0114
Lubelskie	0.0233	0.0280	0.0263	0.0304
Lomzynskie	0.0103	0.0063	0.0099	0.0092
Lodzkie	0.0325	0.0316	0.0276	0.0287
Nowosadeckie	0.0135	0.0144	0.0190	0.0192
Olsztynskie	0.0187	0.0179	0.0209	0.0180
Opolskie	0.0294	0.0296	0.0265	0.0265
Ostroleckie	0.0114	0.0120	0.0109	0.0102
Pilskie	0.0131	0.0122	0.0127	0.0122

Table A1: Sample Means (ctd.)

	Means Wage Regression		Means Unemployment Regression	
	1994	1998	1994	1998
Piotrkowskie	0.0167	0.0174	0.0191	0.0180
Plockie	0.0150	0.0155	0.0143	0.0160
Poznanskie	0.0424	0.0319	0.0343	0.0311
Przemyskie	0.0107	0.0090	0.0099	0.0120
Radomskie	0.0214	0.0213	0.0207	0.0221
Rzeszowskie	0.0179	0.0148	0.0174	0.0170
Siedleckie	0.0171	0.0215	0.0176	0.0179
Sieradzkie	0.0116	0.0113	0.0113	0.0110
Skierniewickie	0.0119	0.0153	0.0122	0.0150
Slupskie	0.0104	0.0135	0.0105	0.0120
Suwalskie	0.0099	0.0108	0.0133	0.0112
Szczecinskie	0.0232	0.0268	0.0229	0.0264
Tarnobrzeskie	0.0161	0.0136	0.0163	0.0182
Tarnowskie	0.0163	0.0174	0.0179	0.0177
Torunskie	0.0166	0.0207	0.0175	0.0177
Walbrzyskie	0.0215	0.0188	0.0179	0.0196
Wloclawskie	0.0090	0.0096	0.0136	0.0118
Wroclawskie	0.0305	0.0374	0.0273	0.0305
Zamojskie	0.0060	0.0102	0.0137	0.0137
Zielonogorskie	0.0163	0.0207	0.0176	0.0199
Observations	7,472	7,433	21,720	22,058

Note: the *occupation*, *industry*, and *sector of employment* variables are taken from the corresponding August (instead of November waves); unemployed people state the variables relating to their previous employment; people with *no previous employment* build an extra category for each of these three dummy variable groups.

Source: PLFS; own calculations.

Table A2: Wage and Unemployment Differentials November 1994

	Wage Regression		Unemployment Regression	
	$\hat{\boldsymbol{\beta}}_t^*$	t-value	$\hat{\boldsymbol{\gamma}}_t^*$	t-value
mean	0.6395	164.901	-1.5537	-84.359
Age between				
16-25	-0.1146	-11.465	0.2571	9.137
26-35	-0.0314	-4.547	0.1995	7.615
36-45	0.0299	6.071	0.0638	2.736
46-55	0.0565	6.528	-0.0999	-2.869
56-65	0.0593	2.403	-0.6073	-12.260
Education				
higher	0.3003	18.455	-0.1367	-1.926
post secondary	0.1208	6.473	0.1044	1.269
secondary vocational	0.0016	0.220	0.0694	2.507
secondary general	-0.0073	-0.488	0.0820	1.823
basic vocational	-0.0541	-7.830	0.1905	9.015
primary	-0.1532	-13.773	-0.1744	-7.546
less than primary	-0.1241	-1.486	-0.8159	-3.584
Gender				
female	-0.0899	-18.229	0.0750	5.398
male	0.0749	18.229	-0.0800	-5.398
Disabilities				
disabled	-0.1984	-4.535	-0.1973	-4.397
abled	0.0023	4.535	0.0304	4.397
Occupation				
manager	0.2236	10.285	-0.4167	-5.370
specialist	0.1115	11.146	-0.3394	-7.825
white collar	-0.0640	-6.917	0.0713	1.998
blue collar	-0.0603	-9.340	0.1261	7.163
no previous employment	-0.0960	-2.208	0.6419	10.782

Table A2: Wage and Unemployment Differentials November 1994 (ctd.)

	Wage Regression		Unemployment Regression	
	$\hat{\boldsymbol{\beta}}_t^*$	*t*-value	$\hat{\boldsymbol{\gamma}}_t^*$	*t*-value
Industry				
agriculture	-0.0957	-5.004	-0.3079	-7.731
mining	0.3985	18.910	-0.4000	-3.803
manufacturing	0.0119	1.867	0.0818	3.151
electricity, gas, water	0.2168	9.308	-0.3998	-2.893
construction	0.0060	0.377	0.5281	11.726
trade	-0.0986	-6.593	0.3437	8.175
hotels, restaurants	-0.1186	-3.458	0.3662	3.665
transport, communication	0.0430	3.275	-0.1865	-2.974
financial intermediation	0.0723	2.874	-0.3580	-2.686
real estates, renting	-0.0795	-2.801	0.2702	2.527
administration	0.0557	3.732	0.0929	1.397
education	-0.0198	-1.397	-0.1733	-2.364
health care, social work	-0.1513	-9.394	-0.1715	-2.535
other	-0.0584	-3.222	0.1806	2.630
no previous employment	-0.4153	-9.104	0.7507	8.040
Sector of Employment				
public sector	0.0071	1.744	0.1079	6.368
private sector	-0.0034	-0.414	-0.1131	-6.368
no previous employment	-0.3230	-6.639	0.9455	9.105
Town Size				
>100 thd.	0.0355	5.218	-0.0826	-3.321
>20thd.	0.0084	1.149	0.0295	1.122
<20thd.	-0.0302	-3.276	0.0887	2.725
rural	-0.0286	-4.772	0.0142	0.795

Table A2: Wage and Unemployment Differentials November 1994 (ctd.)

	Wage Regression		Unemployment Regression	
	$\hat{\beta}_t^*$	t-value	$\hat{\gamma}_t^*$	t-value
Voivodship				
Stoleczne Warszawskie	0.1354	7.115	-0.0304	-0.532
Bialskopodlaskie	-0.0787	-2.074	-0.1286	-0.818
Bialostockie	-0.0021	-0.069	-0.1173	-1.104
Bielskie	0.0131	0.643	-0.2860	-3.280
Bydgoskie	-0.0734	-3.247	0.0796	1.135
Chelmskie	-0.1244	-2.722	0.0964	0.620
Ciechanowskie	-0.0281	-0.705	0.1465	1.421
Czestochowskie	-0.0817	-3.730	0.0313	0.354
Elblaskie	-0.0562	-1.497	0.3290	3.562
Gdanskie	0.0341	1.721	0.0968	1.510
Gorzowskie	0.0730	1.969	0.3386	3.878
Jeleniogorskie	-0.0283	-0.877	0.0154	0.146
Kaliskie	-0.0481	-2.054	-0.1158	-1.319
Katowickie	0.0676	4.325	-0.1981	-4.395
Kieleckie	-0.0432	-2.017	0.0691	0.994
Koninskie	0.0150	0.414	0.1004	0.924
Koszalinskie	-0.0085	-0.304	0.5030	5.950
Krakowskie	0.0400	1.781	-0.2856	-3.569
Krosnienskie	-0.0518	-1.840	-0.0904	-0.840
Legnickie	0.0620	1.727	0.1150	1.143
Leszczynskie	-0.0993	-2.076	0.1047	0.931
Lubelskie	-0.0292	-1.339	-0.0820	-0.976
Lomzynskie	-0.0829	-2.556	0.1835	1.568
Lodzkie	-0.0264	-1.194	0.0434	0.563
Nowosadeckie	-0.0891	-3.409	0.1682	1.897
Olsztynskie	-0.0389	-1.582	0.2202	2.747
Opolskie	0.0202	1.028	-0.0830	-1.040
Ostroleckie	-0.0083	-0.193	-0.0438	-0.355
Pilskie	-0.0303	-1.095	0.0204	0.185

Table A2: Wage and Unemployment Differentials November 1994 (ctd.)

	Wage Regression		Unemployment Regression	
	$\hat{\boldsymbol{\beta}}_t^*$	t-value	$\hat{\boldsymbol{\gamma}}_t^*$	t-value
Piotrkowskie	0.0450	1.364	0.1080	1.242
Plockie	0.0357	1.021	-0.0987	-0.884
Poznanskie	-0.0337	-1.891	-0.2883	-3.726
Przemyskie	-0.1661	-5.317	0.0200	0.163
Radomskie	-0.0369	-1.438	0.0710	0.806
Rzeszowskie	-0.0035	-0.142	-0.1170	-1.168
Siedleckie	0.0387	1.284	0.0362	0.384
Sieradzkie	-0.0334	-0.905	0.1333	1.215
Skierniewickie	0.0097	0.288	-0.0874	-0.723
Slupskie	-0.0574	-1.412	0.4327	4.186
Suwalskie	-0.0542	-1.774	0.4172	4.517
Szczecinskie	0.0102	0.420	0.2116	2.780
Tarnobrzeskie	-0.0321	-1.318	0.1011	1.047
Tarnowskie	-0.0081	-0.283	0.1375	1.543
Torunskie	-0.0043	-0.166	0.0381	0.398
Walbrzyskie	-0.0139	-0.605	0.0062	0.066
Wloclawskie	-0.0252	-0.748	0.1661	1.604
Wroclawskie	0.0285	1.413	-0.1056	-1.329
Zamojskie	-0.1817	-4.158	-0.1432	-1.072
Zielonogorskie	-0.0250	-1.103	-0.1258	-1.274
R^2 / log likelihood	0.3940		-5,933.64	
Pseudo- R^2 Veall-Zimmermann	-		0.2424	
Observations	7,472		21,720	

Notes: The pseudo–R^2 (Veall–Zimmermann) was found to come closest to the underlying OLS–R^2 in a Monte Carlo Study on a binary probit model by Veall and Zimmermann (1996) (where this pseudo–R^2 is called R^2_{MZ});

the *occupation*, *industry*, and *sector of employment* variables are taken from the corresponding August (instead of November waves); unemployed people state the variables relating to their previous employment; people with *no previous employment* build an extra category for each of these three dummy variable groups. As a consequence, this variable appears in each group of the *occupation, industry,* and *sector of employment* variables for the transformation of the coefficients as described in Appendix A.

Source: PLFS; own calculations

Table A3: Wage and Unemployment Differentials November 1998

	Wage Regression		Unemployment Regression	
	$\hat{\boldsymbol{\beta}}^{*}_{t+\tau}$	t -value	$\hat{\boldsymbol{\gamma}}^{*}_{t+\tau}$	t -value
mean	1.4751	377.058	-1.7156	-82.016
Age between				
16-25	-0.1369	-15.768	0.1338	4.687
26-35	-0.0246	-4.005	0.1424	4.894
36-45	0.0270	5.663	0.1275	5.114
46-55	0.0671	8.910	-0.0349	-1.048
56-65	0.0689	2.518	-0.5366	-9.912
Education				
higher	0.3500	24.256	-0.3214	-3.944
post secondary	0.0988	5.340	0.1040	1.168
secondary vocational	0.0073	1.172	0.0505	1.716
secondary general	0.0199	1.405	-0.0109	-0.227
basic vocational	-0.0785	-13.573	0.1464	6.382
primary	-0.1518	-13.773	-0.0717	-2.875
less than primary	-0.1676	-5.289	-0.5296	-2.115
Gender				
female	-0.0871	-18.552	0.0666	4.452
male	0.0726	18.552	-0.0711	-4.452
Disabilities				
disabled	-0.1797	-5.620	-0.2013	-4.207
abled	0.0021	5.620	0.0310	4.207
Occupation				
manager	0.2372	9.815	-0.5661	-5.761
specialist	0.1146	13.123	-0.2477	-5.154
white collar	-0.0542	-6.358	-0.0161	-0.409
blue collar	-0.0665	-11.755	0.1359	6.965
no previous employment	-0.1026	-2.128	0.5542	8.898

Table A3: Wage and Unemployment Differentials November 1998 (ctd.)

	Wage Regression		Unemployment Regression	
	$\hat{\boldsymbol{\beta}}^{*}_{t+\tau}$	t-value	$\hat{\boldsymbol{\gamma}}^{*}_{t+\tau}$	t-value
Industry				
agriculture	-0.0920	-3.811	-0.2673	-5.942
mining	0.2926	15.539	-0.2054	-1.850
manufacturing	0.0243	3.693	0.0783	2.670
electricity, gas, water	0.1560	7.317	-0.2107	-1.571
construction	0.0394	2.657	0.3282	6.488
trade	-0.0742	-5.994	0.2828	6.216
hotels, restaurants	-0.1634	-6.751	0.4163	4.174
transport, communication	0.0450	3.699	-0.1306	-1.909
financial intermediation	0.0771	2.868	-0.0139	-0.113
real estates, renting	-0.0511	-2.088	0.2446	2.475
administration	0.0397	2.627	-0.0796	-0.949
education	0.0043	0.291	-0.1630	-1.899
health care, social work	-0.1718	-15.325	-0.1779	-2.401
other	-0.0839	-4.331	0.2548	3.451
no previous employment	-0.4318	-8.848	0.8530	7.623
Sector of Employment				
public sector	0.0110	3.050	0.0706	3.513
private sector	-0.0106	-1.490	-0.0740	-3.513
no previous employment	-0.3504	-6.454	1.0462	8.445
Town Size				
>100 thd.	0.0375	5.620	0.0044	0.166
>20thd.	0.0035	0.466	0.0227	0.800
<20thd.	-0.0343	-3.933	0.0825	2.371
rural	-0.0252	-4.643	-0.0390	-2.051

Table A3: Wage and Unemployment Differentials November 1998 (ctd.)

	Wage Regression		Unemployment Regression	
	$\hat{\boldsymbol{\beta}}^*_{t+\tau}$	t-value	$\hat{\boldsymbol{\gamma}}^*_{t+\tau}$	t-value
Voivodship				
Stoleczne Warszawskie	0.1953	9.118	-0.2780	-3.781
Bialskopodlaskie	0.0316	0.741	-0.5069	-2.137
Bialostockie	0.0042	0.161	0.0667	0.626
Bielskie	0.0711	3.604	-0.0318	-0.370
Bydgoskie	-0.0270	-1.411	0.1211	1.657
Chelmskie	-0.0975	-2.467	0.3397	2.646
Ciechanowskie	0.0136	0.325	0.0326	0.256
Czestochowskie	-0.0610	-2.841	0.0214	0.231
Elblaskie	0.0221	0.784	0.2700	2.622
Gdanskie	0.0306	1.459	-0.0046	-0.062
Gorzowskie	-0.0454	-1.321	-0.1305	-0.968
Jeleniogorskie	0.0127	0.538	0.2561	2.605
Kaliskie	-0.1041	-3.648	-0.3006	-2.835
Katowickie	0.0315	2.518	-0.1370	-2.859
Kieleckie	-0.0836	-4.264	0.3098	4.387
Koninskie	0.0020	0.058	0.0981	0.817
Koszalinskie	-0.0014	-0.048	0.5160	5.552
Krakowskie	0.0217	1.196	-0.3459	-3.583
Krosnienskie	-0.0668	-2.614	-0.0924	-0.763
Legnickie	-0.0046	-0.143	0.1635	1.627
Leszczynskie	-0.0319	-1.114	-0.3232	-2.000
Lubelskie	-0.0887	-4.377	-0.1973	-2.201
Lomzynskie	-0.0662	-1.681	-0.0062	-0.039
Lodzkie	-0.0344	-1.675	0.1355	1.763
Nowosadeckie	-0.0901	-3.875	0.1273	1.340
Olsztynskie	-0.0497	-1.907	0.2390	2.621
Opolskie	-0.0005	-0.026	0.1039	1.338
Ostroleckie	0.0502	1.519	0.1542	1.238
Pilskie	0.0387	1.297	0.1334	1.130

Table A3: Wage and Unemployment Differentials November 1998 (ctd.)

	Wage Regression		Unemployment Regression	
	$\hat{\boldsymbol{\beta}}^{*}_{t+\tau}$	t-value	$\hat{\boldsymbol{\gamma}}^{*}_{t+\tau}$	t-value
Piotrkowskie	-0.1023	-4.431	0.0218	0.214
Plockie	0.0188	0.638	-0.0579	-0.516
Poznanskie	0.0558	3.007	-0.4765	-4.607
Przemyskie	-0.1000	-3.697	0.2132	1.833
Radomskie	-0.1070	-4.495	0.2572	3.201
Rzeszowskie	-0.0605	-2.383	0.1512	1.537
Siedleckie	0.0220	0.741	-0.0841	-0.784
Sieradzkie	-0.0122	-0.389	0.0405	0.308
Skierniewickie	-0.0225	-0.699	-0.2996	-2.170
Slupskie	0.0204	0.627	0.3631	3.558
Suwalskie	-0.0620	-1.752	0.3223	2.912
Szczecinskie	0.0741	3.155	0.0502	0.615
Tarnobrzeskie	0.0208	0.709	-0.0878	-0.784
Tarnowskie	-0.0186	-0.758	-0.0881	-0.810
Torunskie	-0.0134	-0.540	0.0639	0.646
Walbrzyskie	-0.0554	-2.698	0.3049	3.652
Wloclawskie	-0.1569	-4.809	0.4411	4.241
Wroclawskie	0.0192	0.957	0.0110	0.141
Zamojskie	-0.0886	-3.051	0.0180	0.144
Zielonogorskie	0.0005	0.025	0.1212	1.356
R^2 / log likelihood	0.4433		-4,935.19	
Pseudo- R^2 Veall-Zimmermann	-		0.1893	
Observations	7,433		22,058	

Notes: The pseudo–R^2 (Veall–Zimmermann) was found to come closest to the underlying OLS–R^2 in a Monte Carlo Study on a binary probit model by Veall and Zimmermann (1996) (where this pseudo–R^2 is called R^2_{MZ});

the *occupation*, *industry*, and *sector of employment* variables are taken from the corresponding August (instead of November waves); unemployed people state the variables relating to their previous employment; people with *no previous employment* build an extra category for each of these three dummy variable groups. As a consequence, this variable appears in each group of the *occupation, industry,* and *sector of employment* variables for the transformation of the coefficients as described in Appendix A.

Source: PLFS; own calculations.