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Do those who stay work less? On the impact of emigration on the measured TFP in Poland

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Abstract

The measured TFP growth in Poland slowed from around 4% in the second half of the 90s to 2% a decade later. This reduction in the growth rate of the Solow residual is argued to reflect the evolution of worker effort and, indirectly, of the labour market within the period. The unobserved worker effort is identified within a structural efficiency wage model with shirking. The model estimates suggest that a reduction in the generosity of the unemployment benefit system and the stabilization of the job destruction rate before 2000 reinforced worker motivation. In turn, the economic revival and the intensification of emigration around the date of the Polish accession to the European Union undermined it. Consequently, a steep increase in worker effort before 2000 temporarily boosted the measured TFP growth. A levelling off and the eventual correction of effort after 2000 depressed the observed TFP growth rates. Around 15% of the estimated decline in GDP tied to an increase in emigration after 2004 can be attributed to negative changes in worker discipline.

JEL Classification: C11, J30, J61, J64, F22

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1 Introduction

From 1995 to 2009 the measured rate of total factor productivity (TFP) growth in Poland was continuously falling. This slowdown in productivity growth cannot be attributed to deceleration in human capital accumulation. In fact, Labour Force Survey (LFS) data show that the share of workers with higher education kept increasing in the period. From 2003 onwards also the share of workers with higher education and substantial job experience grew. Neither can changes in the TFP growth be pointedly related to the business cycle. As can be seen in Figure 1, the relationship between TFP and GDP was unstable: the two variables moved hand in hand until 2003 but decoupled afterwards.

The alternative explanation laid down in the article rests on the conjecture, that labour market developments impact on the motivation of workers, and the evolution of the latter is captured in the measured TFP growth rates. The worker effort depends not only on the state of economic activity and the efficiency of domestic labour market institutions but also on patterns of cross-border worker mobility. The postulated link between migration movements and worker productivity is of particular appeal provided that the slowdown in the measured TFP growth overlapped with a pronounced increase in emigration from the country (Figure 1). In short, I argue that the labour augmenting technological progress exhibits a stable time trend g, but in the medium-run the Solow residual varies with the effort extracted from workers e (in logarithm):

$$d(tfp) = \alpha g + \alpha d(e) \tag{1}$$

where tfp represents the logarithm of the Solow residual and α the elasticity of the product to labour[1].

Unobserved worker effort is identified on the basis of a structural estimated model. The structural identification of worker discipline constitutes the other novel aspect of the study. The fairly universal merit of the model-based inference lies in the possibility to track down, in a meaningful way, separate determinants of worker motivation. The effort dynamics is in particular linked to the fading of the economic transformation[2] in the second half of the 90s, cyclical ups and downs of the economic activity and reinforcement of intra-European migration after 2004. The proposed framework establishes parallels between these relevant but apparently diverse macroeconomic phenomena. In

[1] The TFP dynamics is in the similar fashion related to worker effort by Wadhwani and Wall (1991). They explore the relationship between the Solow residual and effort to test the efficiency wage theory on the basis of the microdata on UK manufacturing enterprises.

[2] Transformation is understood as adjustments in the production sector jointly with reforms aiming at reducing the social costs of the transition. In the data, transformation is signified by excessive worker flows and substantial changes in social assistance policies.

a related manner, it also clarifies how these economic processes can interact. Not least interestingly, the suggested setting allows formalization of a rather intuitive claim that structural changes in a labour market will be reflected in labour productivity gains or losses.

Figure 2 presents the annual growth rates of the Solow residual derived from a two factor Cobb-Douglas production function. The measure of the capital input includes public and private corporate capital (the latter excludes housing) multiplied by the degree of capacity utilization in manufacturing[3]. Labour input equals the employment level times the average number of hours worked by an employed person. The three TFP series plotted correspond with the three different measures of the number of employed: the LFS employment, the average paid employment (reported by enterprises) and the gross worker flows based steady-state employment. The quality of the LFS employment data could be affected by sharp changes in migration trends[4] but the methodology of setting up the two latter employment series is robust to the analogous shifts. Irrespective of the measure of labour input, the derived TFP growth rates reduce from 4% in the mid-90s to around 2% a decade later[5]. This co-movement of the series reassures that the fall in the growth rate of the Solow residual is not an artefact tied to imprecise measurement of production factors.

Figure 3 plots year-to-year changes in the two human capital indices. The indices refer to information on wages and the individual characteristics of the employed in the LFS[6,7]. The first index illustrates the process of human capital accumulation tied to

[3]Data on the degree of capacity utilization in manufacturing is used instead of the index of the degree of capital utilization in the economy as the latter is not available. Details on the sources and method of derivation of the data used to calculate the Solow residuals are provided in Appendix B.

[4]The LFS results on labour market activity of sampled individuals are generalized for a population of all persons aged 15 and above, permanently residing in private households and staying abroad for no longer than 2 months. Population registries provide timely information on the number of permanent residents of households. In turn, the number of temporary emigrants – workers who stay abroad for at least 2 months but did not register their departure at the responsible administrative units, is the Central Statistical Office's own error-prone estimate. An imprecise estimate of the number of temporary emigrants will bias the estimate of the relevant population and next the number of the employed. This concern is addressed here as the lion's share of the total emigration from Poland after 2004 had temporary character (Budnik, 2007).

[5]Changes of the definition of capital input, namely ignoring the degree of capacity utilization or using the total stock of capital (with housing) instead of the productive capital stock only, do not affect this outcome either.

[6]Inference of workers quality on the basis of their wages originate in the works of Kydland and Prescott (1989) and Hansen (1993). Their primary focus is a secular behaviour of labour efficiency units in the USA in contrast to behaviour of employment figures irrespective of human capital content. They construct a labour input series where hours worked by individuals or different age-sex subgroups, respectively, are weighted by their relative hourly earnings, assumed to be constant over the measurement period.

[7]The method of deriving indices follows Aaronson and Sullivan (2001). The derivation is done in three stages: estimating earnings equation based on Mincer (1974) for each sample year, formulating predictions of wages and using these as weights when calculating the Fisher ideal index for changes in workers quality between two adjacent years. The method deviates form Aaronson and Sullivan (2001) in treating workers and not hours as a basic unit of the analysis. Second, when calculating

changes in the education and professional experience of workers, while the second index also assesses changes in the average productivity related to shifts in the occupational and sectoral structure of employment. Both indices allow for time-varying returns to skills and capture changes in the distribution of workers' unobservable traits. Apparently, changes in the quality of workers cannot on their own explain the evolution of the measured TFP. The growth rates of the indices and the Solow residual are negatively correlated. While human capital grew only modestly just after 1995 and much faster between 2001 and 2007, the TFP growth rates exhibit just the reverse pattern. Only after 2003 did the human capital stock and the Solow residual start to move in line.

Abstracting from the worker heterogeneity and compositional effects, I focus on changes in the motivation of the representative worker. The evolution of effort is assessed via the lenses of the Shapiro and Stiglitz (1984) model. The model hints at the intrinsic reluctance of workers to elicit effort and the inability of employers to monitor employee performance. In order to limit the shirking, firms use wages as a discipline device. Wages are set above the market clearing level to increase the welfare losses of workers who are involuntarily separated from a job[8]. The relevant implication of the model is the dependence of worker effort on the relative well-being of employed versus unemployed individuals.

The basic Shapiro and Stiglitz (1984) model is extended to account for labour market withdrawals and temporary migration. In the augmented setting, a firm and a worker face some probability of job termination due to the worker transition to non-participation and emigration. Furthermore, an unemployed worker can become inactive or search for a job abroad[9]. In the effect, non-participation and emigration, just like cyclical fluctuations in job creation or destruction rates, affect the relative utility of the employed as compared to the unemployed, and via this channel the effort level of the former. The temporariness of emigration is reflected in the assumption that the total population of workers is pre-set but the latter can move back and forth between the country of origin and foreign markets.

Within the framework the unobserved effort and the observed market and reservation wages can be expressed as functions of a set of exogenous variables and model

weights the Heckman approach is applied to tackle a problem of non-random non-reporting of wages. Third, the possibility that wages are affected by the general labour market situation next to the worker productivity is tackled by including the regional unemployment rate in the wage regressions. For a detailed description of the methodology see Appendix B.

[8]The efficiency wage models differ in the reasoning why employers prefer to pay wages above the market clearing level. While Shapiro and Stiglitz (1984) focus on asymmetric information between employees and employers, Akerlof (1982, 1984) and Akerlof and Yellen (1990) explore the importance of social norms and Weiss (1980) turns to the heterogeneity of workers and selection effects. A general overview of the efficiency wage models is provided by Yellen (1984) and a survey of theories and empirical evidence by Katz (1986).

[9]Bleaney (2005) analyses the effects of non-zero probabilities of permanent emigration and immigration on wages in the Shapiro and Stiglitz model in a similar vein.

parameters. The parameters are estimated in a system of two regressions of the observed market and reservation wage variables. Combining the estimated parameters and relevant exogenous variables yields an estimate of the effort exerted by an employed worker. The structural identification of effort is new in the literature but the similar approach is commonly employed to identify other unobserved macro variables such as the potential product (i.e. production function approach) or the equilibrium unemployment rate (i.e. van der Horst, 2003, Budnik 2008).

Empirical inference relies on a set of macro variables covering the period from the beginning of 1995 to mid-2009. These are supplemented with unique data on worker transition probabilities between employment, unemployment, non-participation and emigration, derived from the Polish LFS microdata. The worker transition probabilities, or the underlying gross worker flows, between the three labour market states are a recognized tool in an analysis of labour markets, e.g. Abowd and Zellner (1985), Blanchard et al (1990), Burda and Wyplosz (1994)[10]. The consistently produced data on transitions to and from emigration are a distinct and crucial element of this study. Precisely they facilitate the estimation of the impact of emigration on the measured TFP. Overall, transition probabilities have the advantage over more frequently used aggregate measures such as the unemployment or emigration rate of offering a more detailed picture of labour market developments. As such, they also conveniently increase empirical identification of the model parameters.

To preview the results, reforms introduced in the second half of the 90s and the diminishing labour market dynamics brought about strong, but transient, effort gains. The economic revival and intense emigration after 2004 strengthened the fallback position of workers inducing them to ,,work less". Changes in effort put in by workers can explain about two thirds of the observed slowdown in the TFP growth. Thus, the outcomes suggest that the impact of emigration on the production capacity of a sending country can go beyond quantitative losses in the labour force and extend to effects on the motivation of those who stay.

By its very nature, the analysis can be also perceived as an attempt to validate the shirking efficiency wage theory. The presented identification scheme is tailored to explain the medium-run evolution of effort. It contrasts with identification strategies which rely on the long-term implications of the shirking theory. In the latter spirit, Katz (1986) and Krueger and Summers (1988) argue that the differences in monitoring technologies between enterprises can give rise to cross-sectional variation in wages. Oh (2005) and Esteves (2007) look directly at the trade-off between wages and supervisory intensity in Korean and Brazilian companies, respectively. Cappelli and Chauvin

[10] Using a fully-specified empirical model to exploit information contained in transition probabilities between labour market states (as the one presented here) is still less conventional. An example of the related work is Broersma et al. (2006).

(1991) relate the regional wage premium to the number of dismissals for disciplinary reasons in the UK companies. Managers' surveys by e.g. Agell and Lundborg (1995, 2003), Campbell and Kamlani (1997), Barth et al. (2008) associate the prevalence of performance-related pay with a high degree of worker autonomy, firm size and its degree of unonization[11].

Even though, the time dimension is at the heart of the analysis, the suggested approach also differs from works referring to the implications of shirking on the cyclical behaviour of wages and employment. In this branch of literature, Gomme (1999) and Burnside et al. (1999) solve the RBC model with the efficiency wages to evaluate whether the shirking motive can dampen the volatility of wages within the business cycle. Alexopoulus (2004, 2006, 2007) integrates shirking into the dynamic stochastic equilibrium model and gets results consistent with the observed high degree of wage rigidity and highly volatile employment. Constain and Jansen (2006) add shirking to a setting with search and matching frictions and successfully match the high volatility of the job creation rate in the business cycle as well as replicate the Beveridge curve. Machin and Manning (1992) show that the shirking efficiency model may explain the business cycle dynamics of labour market variables in low-unionized UK industries. Malcomson and Mavroeidis (2007) replicate the latter result for whole economies, the UK and the USA

The structure of the article runs as follows. The first section outlines a model. The second section describes the data. The third section discusses the major trends in the Polish economy and emigration. It also summarizes some initial results on the empirical relationship between the TFP and the labour market dynamics. The fourth section deals with estimation of a structural model. The following two sections contain the key results. The final section concludes.

[11] General limitation of cross-industry comparisons and survey-based evidence pertains in problems to disseminate between the efficiency wage theory and the positive selection or the profit sharing hypothesis.

2 Efficiency Wage Model with Migration

2.1 Workers

A worker stays in one of four states: employment (E), unemployment (U), non-participation (N) or temporary emigration (M). A current worker's status depends only on her status a period earlier. Transitions between labour market states are governed by the exogenous Markov process represented by the probability matrix P:

$$\begin{bmatrix} p_{EE} & p_{EU} & p_{EN} & p_{EM} \\ p_{UE} & p_{UU} & p_{UN} & p_{UM} \\ p_{NE} & p_{NU} & p_{NN} & p_{NM} \\ p_{ME} & p_{MU} & p_{MN} & p_{MM} \end{bmatrix} \tag{2}$$

The first row of the matrix consists of the transition probabilities from employment to (in sequence order) employment, unemployment, non-participation and temporary emigration. To simplify notation in further sections I define $S = \{E, U, N, M\}$ as an ordered set of state indices.

An instantaneous utility function of a worker has a log-additive form and depends on her income and effort exercised at work. The elasticity of substitution between the two is equal to χ. The level of effort of shirking workers, the non-employed and temporary emigrants is normalized to $e = 0$[12]. Non-shirking employed workers elicit effort $e > 0$. Workers discount future income at a discount rate r.

The asset value of a non shirking worker i, $V^E_{i,NSH}$, discounts her wage rate net of taxes and social contributions $w_i(1 - t^{EMP})$, her expected income in case of a status change in the future minus utility losses tied to exerting effort χe. In the steady-state:

$$rV^E_{i,NSH} = ln(w) - t^{EMP} - \chi e + \sum_{s \in S/E} p_{Es}(V^s - V^E_{i,NSH}) \tag{3}$$

where V^U, V^N and V^M denote the asset values of an unemployed, a non-participant and a temporary emigrant, respectively.

Screening efficiency of employers is captured by a probability q that a worker is nailed when shirking and dismissed. The asset equation of a shirking worker i, V^E_{SH},

[12] The level of effort of the non-employed and temporary emigrants is normalized to the same value which eases the notation when describing the model. However, in the empirical model a set of statistical parameters approximates differences in the level of instantaneous utility of workers in distinct labour market states. These parameters capture the impact on worker utility of any state-specific activity such as searching for a job or residing and supplying labour abroad.

appropriately accounts for the hazard of being fired for disciplinary reasons:

$$rV^E_{i,SH} = ln(w_i) - t^{EMP} + q(V^U - V^E_{i,SH}) + \sum_{s \in S/E} p_{Es}(V^s - V^E_{i,SH}) \tag{4}$$

The asset values of a non-participant and an emigrant worker can be described correspondingly. To assure the conceptual consistency of the model, an additional assumption is imposed that instantaneous incomes of the non-employed and temporary emigrants are lower than the net wage.

2.2 Firms

Firms set the wage rate so as to prevent the shirking of their workers. The established wage fulfils a condition that the asset value of a non-shirking worker is higher than that of a shirking worker (no shirking condition):

$$V^E_{i,NSH} > V^E_{i,SH} \tag{5}$$

It can be easily seen that the above condition holds when:

$$e_i < \frac{q}{\chi}(V^E_{i,SH} - V^U) \tag{6}$$

This simple result encapsulates the major mechanism of the model. Effort depends on the relative welfare of a worker when she is employed as compared to when she is without a job. The larger the probability of being caught on shirking q is, the higher is the worker discipline. In contrast, the higher the relative disutility of exercising effort χ is, the lower is the worker motivation. In a non-dynamic setting, worker effort would simply be tied to the ratio of the wage rate to the instantaneous income of the unemployed. In a dynamic environment, the difference between the asset values of the employed and unemployed additionally depends on their expected utility gains or losses following the transition to another state in the next period. For instance, a higher job separation rate p_{EU} reduces the gap between the values of being employed and unemployed. Consequently, it leads to the impairment of the employed worker motivation. A high job creation rate p_{UE}, in turn, depresses the worker effort by raising her expected income following her job loss.

As long as the probabilities of entry or exit from non-participation and temporary emigration are greater than zero, the relative well-being of workers who stay out of the labour market and abroad feed into the effort of the employed. If the instanta-

neous utility of non-participants is relatively low, the higher probability of transition to inactivity from employment p_{EN} than from unemployment p_{UN} will chop the effort level of those employed. Analogously, the motivation of the employed is lower, if gains to emigration are substantial and the unemployed have a relatively high emigration propensity p_{UM} as compared to their own p_{EM}. Moreover, the intensification of emigration can be expected to deteriorate worker effort (irrespective of the effect mentioned above) when the probability of getting a job by return migrants is greater than that of non-employed stayers.

One additional implication of the model is worth noticing. When the employed have attractive outside opportunities, e.g. in countries with generous welfare programmes, high job stability should be reflected in stronger labour productivity. A high exogenous job destruction rate reduces the value of employment, and in stark contrast to disciplinary firings, has a negative impact on worker motivation.

2.3 Effort

In the symmetric equilibrium, where all workers elicit similar effort, (6) implies:

$$e < \frac{1}{\chi}\frac{1}{\theta^E - \frac{1}{q}(r+q+1-p_{EE})}\sum_{s\in S/E}\theta^s ln(\bar{\nu}^s) \tag{7}$$

where $\theta^s = (r+1-p_{EE})\zeta_{sU} - \sum_{\bar{s}\in S/E} p_{E\bar{s}}\zeta_{s\bar{s}}$ for each $s \in S$. $\bar{\nu}_s$ is a ratio of an instantaneous income of a worker in state s to the net wage of an employed worker. $\bar{\nu}_s < 1$ holds for all $s \in S/E$. Equation (7) conveniently formulates effort only in terms of exogenous variables. However, the non-linearity of the expression implies that the impact of any of the exogenous variables on effort depends on the values taken by other independent variables. Importantly, (7) marks that as long as there are no structural changes in the labour market, which would be reflected in non-stationarity of the relative incomes or the transition probabilities, stationarity of the effort variable is assured.

2.4 The Market and Reservation Wages

Output is generated with a Cobb-Douglas production function and two factor inputs, labour l and capital k. The output elasticity to labour is α. Technological progress is Harrod neutral and grows at a rate g. Cost minimization by firms involves the equalization of the labour cost, namely the real wage rate adjusted for the social contributions levied on employers t^{CORP}, and the marginal product of labour:

$$ln(w) + t^{CORP} = \alpha e + (1-\alpha)(ln(k) - ln(l)) + c + \alpha gtrend \tag{8}$$

where c is a constant and $trend$ is a time trend. In the long run the capital to labour ratio and the wage rate grow at a rate of technological progress g. The proportional wage rate – labour productivity relation delivers an interesting interpretation of the effort level as an inverse of a specific wedge on wages. When real wages are rigid and the capital stock is subject to significant adjustments costs constant, the equality of the marginal cost and product of labour will be restored by changes in labour input. Thus, in these circumstances, a decline in the worker effort facilitates employment cuts.

The reservation wage of an unemployed worker w^* is defined as a wage rate which makes her indifferent between being unemployed and employed, $V^E_{NSH}(w^\star) = V^U$. In the symmetric equilibrium the following relationship holds:

$$ln(w^*) - ln(w) = ln(\bar{\nu}^U) + (1-\phi_E)\chi e + \sum_{s \in S/E} \phi_s ln(\bar{\nu}^s) \tag{9}$$

where $\sum_{s \in S} \phi_s = 0$ and ϕ_s are functions of the transition probability matrix P and the discount rate r. The ratio of the reservation wage to the market wage rate is independent of worker preferences[13]. In the perfectly competitive market, where workers are paid just their reservation wage, the ratio of the reservation wage to the wage rate equals one. However, in an environment with costly effort and imperfect monitoring, the wage rate will be generally higher than the reservation wage and the gap (9) will become negative.

In line with (9) an increase in the instantaneous utility of the non-employed induces an upward shift in the reservation wage ratio. This implication of the model is broadly consistent with empirical evidence from studies exploring micro data[14]. Interestingly, the model suggest that an impact on the reservation wage gap of the relative instantaneous utility in a state is the more pronounced the more persistent the state is. In particular, the elasticity of the reservation wage ratio to unemployment benefits

[13] The parameter controlling the disutility of exercising effort χ present in (9) cancels out once e is replaced with (7).

[14] A positive effect of receiving unemployment benefit and its level on the individual's reservation wage is validated by Kiefer and Neumann (1979) and Fishe (1982) in two different samples of US workers. Feldstein and Poterba (1984), Maani and Studenmund (1986), Prasad (2003) confirm the relevance of unemployment benefits as well as of other non-wage income sources for the level of the reservation wage in the USA, Chile, and Germany, respectively. Jones (1989) fails to find a robust relationship between non-labour income and the reservation wage for UK workers. He, however, establishes the positive empirical relationship between measures of financial hardship such as family or credit commitments or regular payments and the reservation wage.

will be highest in a labour market with high unemployment duration. Next, (9) sets forth that other things equal a high escape probability from unemployment raises the reservation wage ratio[15].

[15]The results of Jones (1989), Hogan (1999), Prasad (2003) suggest that the relation between the reservation wage and the unemployment rate in the region is weak or insignificant. However, use of a more precise measure of the unemployment duration usually leads to more telling outcomes. Kiefer and Neumann (1979) and Maani and Studenmund (1986) find that the reservation wage declines with the duration of unemployment. Christensen (2001) rejects the importance of the unemployment duration for the level of the reservation wage but finds a robust relationship between the reservation wage and the expected re-employment chances.

3 Data

3.1 Empirical Transition Probabilities

Empirical transition probabilities are derived from the Polish household survey data. The household survey (or LFS) is conducted on a quarterly basis and (from the second quarter of 1993) follows a rotation scheme. Each quarter, a sample covers between 18 and 22 thousand households which are sampled with the exclusion of institutional households (army dwellings, hospitals, prisons, dormitories etc.). A household is interviewed four times, twice for two consecutive quarters with a six-month break between the two series of interviews. The household questionnaire covers all permanent residents of a sampled dwelling. As such it addresses persons who are either present during the interview or absent but for no more than 2 months (actual residents) and persons who stay abroad for longer than 2 months (temporary emigrants). More precisely, the latter category encompasses workers who did not register their departure by the responsible administrative unit and remain permanent residents of Poland, before leaving were members of a sampled household and are still related to it. These emigrants are termed temporary to distinguished from permanent emigrants who registered their leave and from that time cease to be permanent residents of Poland. Information on emigrant household members is usually provided by another current resident of a sampled dwelling.

Importantly, households and their actual residents can be unambiguously identified between the survey's waves. This allows gross flows between employment, unemployment and non-participation for workers aged 15 years or over to be computed. To calculate gross worker flows to and from temporary emigration, records of the actual residents have to be linked with records of workers temporarily staying abroad. Practically, it is the key challenge because there is no unique identifier for the actual residents and temporary emigrants for surveys conducted before 2004. To identify workers who change their status to or from a temporary emigrant in the adjacent quarter a ,,fuzzy matching" technique is applied. Variables including gender, date of birth (as far as available day, month and year, otherwise year) of a person jointly with the household's details are used to match individuals[16].

The data sample used to calculate quarter-to-quarter flows spans from the first quarter of 1995 to the third quarter of 2009. The data for the whole of 1999 are not included in the matching procedure as in the two middle quarters of 1999 the survey

[16]For all quarters within the sample 1995-2003 for which data files are available the estimated spurious matching error is significantly lower than 1%. The incidence of spurious matching is approximated by the percentage of individuals fulfilling the criteria used to match data in the second questionnaire. The error-control method takes advantage of the fact that for resident members of a household full identification is possible.

was not conducted. Changes in the sample structure, sampling design (a shift from the middle period to continuous interviews) and coding of regions introduced in the first and the last quarter of 1999, hinder the identification of individuals across these and the adjacent waves. On average 25.8 thousand single labour market flows and 165 migration flows can be matched for each quarter before 1999 and 21.5 thousand versus 270 per quarter after 1999. Observations on worker flows between labour market states are weighted with population weights from the period $t-1$[17]. Observations on flows to and from temporary emigration are weighted in a modified manner. The modified weighting scheme is targeted at minimizing the bias in final results tied to under-representation of temporary emigrants in the data. In the first step, for each individual who changed her status from or to temporary emigration, the LFS population weight is established[18]. In the second step, these weights are scaled up by constants calculated separately for four groups of workers: from towns staying abroad up to a year, from rural areas staying abroad up to a year, from towns staying abroad more than a year, and from rural areas staying abroad more than a year. The scaling factor for each of the four groups is established on the basis of the 2002 Population Census as the inverse of the fraction of emigrants belonging to the group from households with at least one current resident[19]. The flows series are next seasonally corrected and extrapolated for missing observations in 1999 with the TRAMO/SEATS method (TRAMO - Time Series Regression with ARIMA Noise, Missing Values, and Outliers, SEATS - Signal Extraction in ARIMA Time Series)[20].

A flow from state i to state j where $i, j \in S$ between periods $t-1$ and t is signed $F_{ij,t}$. Transition probabilities are derived according to the formula $p_{ij,t} = (F_{ij,t-1} + F_{ij,t} + F_{ij,t+1}) / \sum_{s \in S}(F_{is,t-1} + F_{is,t} + F_{is,t+1})$. Pooling observations of gross worker flows across three consecutive periods assures that the calculated transition probabilities for each t correspond with fractions with a denominator value based on at least 5 observations.

[17] The LFS population weights are calculated by the Polish Statistical Office and correspond with its estimates of the size and structure of the actually resident population of Poland. There is certain uncertainty concerning the latter estimates, related inter alia to robustness of the Polish Statistical Office methodology to changes in the intensity of temporary emigration. However here, any resultant biases in the LFS weights are implicitly assumed to be only moderate.

[18] For actual residents who emigrate between periods $t-1$ and t, their LFS weight from a period $t-1$ are used. Weights for temporary emigrants changing their state between $t-1$ and t are imputed as equal to those of actual residents in the $t-1$ quarter with the same gender, age and place of permanent residence.

[19] The scaling factors are chosen under assumption that information on persons from households with all members staying abroad at the time of an interview is fully missing. In fact, workers who lived in one-person households before emigration or left abroad with all their family members are very likely to be missing in the data as no other household members can report reasons of their absence.

[20] For return migration gross flows the seasonal adjustment procedure is applied to the five quarter moving averages, as cell counts below 5 constituted a significant fraction of these series. Additionally, the ARIMA regressions are augmented with a set of dummy variables for quarters when changes in the definitions of the employed, unemployed or non-participants were introduced. The estimated impact of these shifts is removed from the final seasonally adjusted series.

3.2 Other Variables

Macroeconomic variables, such as GDP, GDP deflator, the productive capital stock, the average wage rate in the economy, effective tax and social contribution rates stem from the NECMOD database. The database supports the macroeconomic model of the Polish economy and contains seasonally adjusted variables derived on the basis of the National Accounts or other official sources e.g. the Ministry of Finance publications[21]. The degree of the capacity utilization is taken from the Polish Statistical Office survey of manufacturing enterprises.

The steady-state employment is used as a measure of labour input which assures consistency of the labour input values with time-series of the transition probabilities. This way, the chosen employment measure also facilitates consistent assessment of the emigration impact on the GDP via the labour supply and worker effort channels.

The average number of hours worked per employed individual comes from the LFS. The same source of data serves to calculate the ratio of the average reservation wage to the average wage rate. In view of better comparability, both the denominator and nominator of the ratio are based on the survey results. The data on reservation wages are missing for the two sub-periods (three quarters of 1999 and for the period 2001 to 2003) when the question about the minimum wage at which an unemployed person would be willing to accept a job was not included in the LFS questionnaire.

The relative income of the unemployed and of the non-participants is approximated by the appropriately weighted replacement rates of different benefits (these include inter alia unemployment, retirement, disability, family and pre-retirement benefits). The replacement rates are aggregated into the expected relative income variables using the LFS information on fractions of the unemployed and inactive who receive any of the benefits. The expected income of temporary emigrants is established as the weighted aggregate of nominal wage rates net of taxes times the employment rate in destination countries. The weights correspond with the intensity of emigration to a destination according to the 2002 Population Census.

A more exact description of the constructed variables can be found in Appendix B. Table 1 summarizes their basic statistical properties. The stationarity of time series is tested with the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test[22]. The fifth column reports the concluded degree of integration and the sixth column the KSPP statistics

[21] The detailed description of the variables in the NECMOD database can be found in Budnik et al. (2009a) and of the seasonal correction algorithms applied to adjust the data in Budnik et al. (2009b).

[22] In contrast to the more commonly applied Dickey-Fuller test, the null hypothesis of KSPP assumes the stationarity of a time series. The choice of the test aims at avoiding rejections of the hypothesis of non-stationarity when the time-series is relatively short and there could be temporary but sufficiently persistent shocks in its short history.

(jointly with the confidence level) of an appropriately transformed series[23].

Wages and capital stock are stationary around the deterministic trend. However, a few variables exhibit non-stationary behaviour. Non-stationarity of the relative nominal income of temporary emigrants, the share of temporary contracts and some of transition probabilities to and from inactivity is likely to reflect structural changes in the Polish economy: the nominal convergence of wages, changes in the EPL regulations, the introduction plus later modifications of pre-retirement and early retirement programmes.

[23] If the stationarity of an untransformed time series can be rejected at a standard confidence level, the time series is differentiated and tested again. When the model structure suggests such a solution, in the first step, I test the stationarity of a time series around a deterministic trend. Only the last stage of a stationarity check is summarized in Table 1.

4 Non-Structural Data Analysis

Before proceeding with the estimation of the structural model, I establish the basic stylized facts about the data. In the 90s the Polish economy underwent a series of far-reaching reforms: privatization and mass closures of inefficient plants, reductions in labour hoarding and hidden unemployment, re-orientation of foreign trade toward Western European countries following the 1998 financial crisis in Russia. As signified in Figure 4, which plots the job separation probability, the restructuring process was reflected in a high level of withdrawals from employment to inactivity. Nonetheless, in the 90s transitions between non-participation and employment were also relatively common. After 2000, when the pace of reforms slowed down, outflows from employment converged to a stable and noticeably lower level. Labour market exits and entries became less frequent. The entry rate of the inactive rebounded somewhat only around 2007, when the economic upturn which started end 2003 was already in full swing.

The probability of exit from unemployment is plotted in Figure 5. The hazard rate of job finding by an unemployed person exhibits a clear cyclical pattern. Between 1995 and 1998, when economic growth was soaring and job openings in the private sector upheld labour demand, the probability of entering employment within a quarter by an unemployed person remained above 15%. This probability fell substantially during the economic slowdown between 1999 and 2004 just to rise again to close to 15% during the later revival. Per contra, a significant drop in GDP in 2009 had hardly any negative impact on the job finding rate. The other interesting feature of the Polish labour market is the pro-cyclical behaviour of worker transitions from unemployment to non-participation.

The introduction of the open-door policy after 2004 by a group of European Economic Area (EEA) countries injected new motion into the Polish labour market. Temporary emigration accelerated, and in 2006 already around 8% of Polish workers resided abroad as compared to over 2% in 2002. The share of workers staying abroad dropped to 4% only in 2009 when labour market conditions in the recipient countries deteriorated. The initial increase in temporary emigration was reflected in a clear pick up of the probability of job separation due to emigration. Before 2004 the fraction of job quits related to the temporary emigration of a worker oscillated between 1 and 3%; between 2005 and 2007 the same fraction remained between 10 and 15%. At the same time, return migrants were employed in less than 5% of all newly-created jobs. In the period 2005-2007, the fraction of new jobs filled by return migrants was not much higher than the 1 to 2% regularly observed in the earlier years.

Yet, these were primarily the non-employed who emigrated. Flows of the non-employed constituted around 60% of all gross worker flows to temporary emigration

in the sample period. The unemployed also reacted stronger than the employed to the liberalization of immigration restrictions in Western European countries. In the period 2005-2007 the emigration hazard of the unemployed jumped from 0.4% to 1.3%, as compared to an increase from 0.1% to 0.3% for the employed. A higher job destruction rate and the intensification of temporary migration clearly contributed to labour shortages during the economic boom of 2004-2007.

The theoretical model suggests that interactions between labour market variables and the measured TFP can be fairly complex. Markets with a high job creation rate are expected to be characterized by low worker effort and, consequently, the low TFP levels observed. The impact of the job destruction rate or of the emigration intensity on worker motivation is, however, already ambiguous. It depends inter alia on the value of leisure, the expected income of non-employed and emigrant workers and the relative emigration propensities of the employed versus non-employed.

The empirical relationship between worker transition probabilities and the Solow residual is statistically evaluated with Granger causality test. The test hinges on vector autoregression (VAR) models and requires only the minimum number of assumptions about the nature of the relationship between the considered variables. The VAR-based approach has an additional advantage of accommodating the non-stationarity of the time-series.

A set of VAR models with 12 lags of endogenous variables is estimated, each of the models involving two endogenous variables at a time: the Solow residual and a transition probability. Provided that the relative income of the unemployed, non-participants and temporary emigrants can shift the relationship between effort and the transition probability, all the relative income measures are included in VARs as exogenous variables. The other control variable is a dummy which equals one from the second quarter of 2004 and is expected to account for a one-off reduction in the emigration costs following the EU enlargement. The Wald statistics of the block exogeneity test run for each of the specified models are reported in Table 2.

Altogether, the exogeneity tests provide some weak support for the efficiency wage explanation of the TFP evolution. In the model, the employment and unemployment durations and the hazard rate of job finding rate of the unemployed affect effort directly. Thus the impact of these variables on the Solow residual can be expected to be the easiest to identify in the data. In fact changes in the corresponding transition probabilities are found to well predict departures of the Solow residual from its linear trend. This holds also for emigration probabilities. Inconclusively, the Granger causality between the Solow residual and the labour entry or return migration rates is reversed (the TFP measure predicts changes in a transition probability) or undetectable. However, according to the model, transitions from inactivity or temporary

migration influence the well-being of the employed and the unemployed only indirectly.

5 Estimation

5.1 Empirical Equations

The empirical model consists of the real labour cost (8) and reservation wage gap (9) equations:

$$ln(w_t) + t_t^{CORP} = \alpha e_t + \alpha(ln(l_t) - ln(k_t)) + c + \alpha(gtrend_t + h_t) + \varepsilon_{1,t} \tag{10}$$

$$ln(\frac{w_t^*}{w_t}) = \chi(1-\phi_{E,t})e_t + (1+\phi_{U,t})ln(\rho_U \bar{\nu}_t^U) + \\ \phi_{N,t} ln(\rho_N \bar{\nu}_t^N) + \phi_{M,t}(1+\tau eu_t) ln(\rho_M \bar{\nu}_t^M) + \varepsilon_{2,t} \tag{11}$$

where:

$$e_t = \frac{\theta_{U,t} ln(\rho_U \bar{\nu}_t^U) + \theta_{N,t} ln(\rho_N \bar{\nu}_t^N) + \theta_{M,t}(1+\tau eu_t) ln(\rho_M \bar{\nu}_t^M)}{\chi\theta_{E,t} - \frac{\chi}{q}(r+q-1+p_{EE,t})} \tag{12}$$

The expressions θ_t^E, θ_t^U, θ_t^N, θ_t^M, ϕ_t^E, ϕ_t^U, ϕ_t^N, ϕ_t^M are functions of the empirical transition probability matrix P_t and of a statistical parameter r. Further, it is assumed that $\varepsilon = \{\varepsilon_{1,t}, \varepsilon_{2,t}\}$ has a multivariate normal distribution $N(0, \Sigma)$. The variance of $\varepsilon_{1,t}$ will be denoted σ_1, the variance of $\varepsilon_{2,t}$ will be denoted σ_2 and the covariance between the variables $\sigma_{1,2}$.

The dynamics of two endogenous variables is explained with 21 independent variables: 12 transition probabilities in P_t, the relative income of the unemployed $\bar{\nu}_t^U$, non-participants $\bar{\nu}_t^N$ and temporary emigrants $\bar{\nu}_t^M$, the employment level l_t, the average number of hours worked by an employed person h_t, the capital stock k_t, the fraction of workers employed on a fixed-term basis f_t, a time trend $trend_t$ and the dummy eu_t which takes a unitary value from the second quarter of 2004. In contract to the VAR-based approach presented in the last section, exogeneity of the transition probabilities is assumed a priori.

Three statistical parameters ρ_U, ρ_N and ρ_M account for non-income factors which impact the well-being of the non-employed and emigrants (in the latter case, including the monetary and social costs of emigration) or mismeasurement of the relative income

variables. τ stands for a percentage change in the expected relative utility of emigrants tied to a reduction in the pecuniary and non-pecuniary costs of emigration following the EU accession.

The probability of being fired for disciplinary reasons is allowed to vary with the share of fixed-term employees f_t. It is expected to reflect that an increase in the popularity of temporary contracts, which generally offer less employment protection, made it easier to dismiss under-performing employees. Precisely, the model parameter q it is assumed to be a linear function of the share of closed-end employees $q = q_0 + q_1 f_t$. Finally, the constant in the (10) seizes not only the initial level of technology but also definitional mismatches between the explored time series; capital stock is based on the National Accounts, labour input refers to information on transition probabilities from the LFS data and the wage rate corresponds with earnings in large and medium-size enterprises.

In total, the statistical parameters to be estimated are q_0,q_1,χ,ρ_U,ρ_N,ρ_M,τ,r, α,g,c, all summarized in vector ξ, and three elements of the variance-covariance matrix Σ. It is worth noticing that, in contrast to the real labour cost, the reservation wage gap does not depend on the monetary value of effort χ and the technology parameters α, g. Forasmuch, joint estimation of the two equations improves the identification of the model parameters.

5.2 Method

The problem at hand is clearly non-linear, some variables entering the system are non-stationary and one of the endogenous variables has missing observations. All these peculiarities complicate the estimation of the model paranmeters. Furthermore, the data sample covers $T = 54$ quarters and refers to a period of intense changes in the economy; it can be judged as a relatively short sample for the inference about 14 statistical parameters. On the other side, a great share of the model parameters have structural interpretation (i.e. the utility or production function parameters) and either the developed theoretical efficiency wage model itself, or the available micro- and macro-evidence can provide fairly accurate information on possible parameter values. All these challenges speak for the use of Bayesian techniques. First, Bayesian estimation allows the consolidation of a priori information about parameter values with information contained in data. Next to it, Bayesian statistics can easily tackle the non-linearity of model equations and non-stationarity of variables entering the system.

Let $\bar{w}_t$ be a vector of realized endogenous wage variables $\{ln(w_t), ln(\frac{w_t^*}{w_t})\}$ and x_t be a set of 21 realized exogenous variables as enumerated in 5.1. Function $\mu(.)$ will

summarize the system (10)–(12) so that $\bar{w}_t - \mu(x_t, \xi) = \varepsilon_t$. Of interest is the posterior density function $p(.)$ of the parameter vector ξ and matrix Σ:

$$p(\xi, \Sigma|\bar{w}_t, x_t) = \frac{p(\bar{w}_t, x_t|\xi, \Sigma)p(\xi, \Sigma)}{p(\bar{w}_t, x_t)} \tag{13}$$

where $p(\bar{w}_t, x_t) = \int_{\Xi} p(\bar{w}_t, x_t|\xi, \Sigma)p(\xi, \Sigma)d(\xi, \Sigma)$ and Ξ is a family of probability distributions defined as $P = \{p(.|\xi, \Sigma), (\xi, \Sigma) \in \Xi\}$. The posterior joint distribution of ξ and Σ, $p(\xi, \Sigma|\bar{w}_t, x_t)$, is proportional to the probability of the realization of the data $\bar{w}_t, x_t$ if the model parameters equal ξ and Σ (as captured by $p(\bar{w}_t, x_t|\xi, \Sigma)$), times the prior probability of parameter values ξ and Σ (as captured by $p(\xi, \Sigma)$). In a nutshell, while the likelihood function $p(\bar{w}_t, x_t|\xi, \Sigma)$ brings the estimated model closer to the data, the $p(\xi, \Sigma)$ expresses researcher's belief in values of the parameter contained in ξ and Σ.

The prior distributions of elements of ξ and Σ are assumed to be independent, hence $p(\xi, \Sigma) = \prod_{i=1}^{11} p(\xi_i)p(\sigma_1)p(\sigma_1 2, p(\sigma_2)$, and are described in detail in 5.3. Consistently with the assumed normality of ε_t the likelihood function equals:

$$p(\bar{w}_t, x_t|\xi, \Sigma) = \frac{1}{2\pi|\Sigma|^{-\frac{1}{2}}} \prod_{t=1}^{T} exp(-\frac{1}{2}(\bar{w}_t - \mu(x_t, \xi))'\Sigma^{-1}(\bar{w}_t - \mu(x_t, \xi))) \tag{14}$$

5.3 Prior Parameter Distributions

The dismissal probability $q_0 + q_1 f_t$ is allowed to vary between 0 and 1. In the border case when q_0 had equalled zero, this normalization and the actual evolution of f_t, implied that the probability of a worker being fired for disciplinary reasons could have increased between 1995 to 2009 by up to 0.8 ppt. (per quarter). The prior distribution of q_1 is concentrated at zero in line with the belief that monitoring efficiency did not change in the period. The mode of the q_0 prior distribution corresponds with around a 75% hazard of being dismissed due to shirking within a year.

The χ model parameter measures the adjustment of the wage rate which causes a 1% increase in worker effort. The prior distribution of χ is established with reference to evidence on the trade-off between wages and worker productivity provided by Raff and Summers (1986). The authors study the effects of a 140-180% rise in the average wage rate at Henry Ford's production plant between 1913 and 1914. On the basis of the company's balance sheets, as well as letters and newspapers from that time, they argue that this substantial pay rise was targeted at improving the motivation of workers. It indeed contributed (after trend and seasonal correction) to a 40-65% increment in the hourly worker productivity, boosting the company's profits in the

following years. Different estimates of the productivity gains at the Ford company imply values of χ between 2.7 and 4.3. Notwithstanding, Raff (1988) points that the productivity gains attributed by Raff and Summers (1986) to the change in the average wage could be partially related to the concurrent tightening of supervision and worsening of labour market conditions. To reflect Raff's concerns, the upper bound of the χ prior distribution is shifted further to the right from the reference range and χ is assumed to remain between 2 and 6 with the mode value at 3.7.

The modes of the prior distributions of ρ_U and ρ_N are set to 1. Thus, the relative income variables are guessed to capture most of the differences in the utility levels of the non-employed and employed. The ρ_M parameter has in turn the uniform prior distribution with the zero lower bound, reflecting the lack of extra-model information about its value. The parameter τ is assumed to have the gamma prior distribution with the mode value of 15%. The value of the mode is chosen on the basis of evidence on the evolution of the wage gap between native and immigrant workers in the UK. Bruecker et al. (2009) show that a rise in immigration from the new Member States after 2004 coincided with a 15% increase in the difference between wages of the natives and immigrants from the region. The apparent persistence of emigration from Poland to the UK suggests that the widening of the gap had to be overrun either by a general increase in the UK wage level or by the reduction of the overall migration costs. However, there was neither a pronounced nominal nor real (PPS) wage rise in the UK, at least as compared to the evolution of wages in Poland. Finally, the upper bounds of the prior distributions of ρ-s parameters are set so that the model assumptions $\rho_U \bar{\nu}_t^U < 1$, $\rho_N \bar{\nu}_t^N < 1$ and $\rho_M \bar{\nu}_t^M < 1$ are fulfilled for all t. By a similar token, a restriction that $\rho_M(1+\tau)\bar{\nu}_t^M < 1$ for t-s from the second quarter of 2004 on, is imposed during the estimation.

The elasticity of output to labour α has a symmetric beta prior distribution with the mode value fixed at the share of wages in GDP as in 2003. The 2.1% estimate of the average growth rate of the potential product in the Euro Area, provided by Musso and Westermann (2005), is used as a reference value to set the mode of the g prior distribution. g is assumed to take values from the interval 1.5% to 3.5%. Positive skewness of the distribution replicates the commonly expressed belief that the rate of technological progress in emerging economies can be higher than in developed countries. The prior mode value of the yearly discount rate r is set at 5%, close to the average level of the real interest rate in Poland in 1995-2008. Columns 3 to 7 of Table 3 summarize types and the basic statistics of the prior parameter distributions.

5.4 Posterior Parameter Distributions

The posterior distribution of the model parameters (13) is simulated using the the Random Walk Chain Metropolis-Hastings algorithm with a normally distributed increment random variable. The starting values are randomly drawn from the parameter density domains. 500 thousands draws are taken, out of which 20% are dropped. The CUSUM statistics are used to check the convergence of the algorithm.

Figure 6 draws the prior (solid lines) and posterior (bars) marginal density functions of the estimated parameters and the last columns of Table 3 report the basic characteristics of the marginal posterior distributions. The narrower interquartile and interdecile ranges of the posterior as compared to the prior distributions hold up that the data are informative about parameter values. Re-estimating the model with the uniform improper prior distribution of τ does not change the 26% posterior mode value of the parameter. Thus, even though the interquartile and interdecile concentration measures of the prior and posterior distributions of τ do not substantially differ, the data are fairly informative about its most probable value. The information gain is the relatively lowest for the discount rate r.

The probability of being fired within a year because of shunning from work, as evaluated at the posterior modes of q_0 and q_1, remained nearly constant at a level of 95%. The posterior distribution of β as compared to its prior distribution is notably shifted to the right. It manifests that stronger wage incentives are required to encourage the worker effort than believed in advance. The posterior estimate of ρ_U, evaluated at its mode, suggest that the relative instantaneous utility of the unemployed as compared to that of employed was on average closer to 15% than 9%, suggested by a comparison of their expected incomes. The mode of the posterior estimate of ρ_N indicates that the instantaneous utility of non-participants was on average 17% of that of the employed, hence much lower than implied by their expected income ratio, 32%. The average relative instantaneous utility of emigrants was on average 49% as evaluated at the posterior mode values of ρ_M and τ. Finally, the mode estimate of τ suggests that returns to emigration after 2004 increased by 24%, double that as assumed a priori.

The error terms in the labour cost and the reservation wage gap equations are positively correlated. The mean posterior correlation coefficient is 0.59 and with 90% probability takes values from a 40%-74% interval.

Figures 7 and 8 contrast the predicted and actual real labour cost and reservation wage gap developments. The predicted variables are plotted jointly with the 90% distribution ranges. The efficiency wage model captures reasonably well the deceleration of real wage growth between 1996 and 2003. Performance of the model worsens, however, around the time of the EU accession. The probable explanation of the lower

predictive accuracy of the model between 2004 and 2007 is its medium-term focus. The deterioration of real wages around 2004 originated in a sharp, and largely unexpected, increase in inflation. As the model does not integrate the nominal wage stickiness it fails to capture a fall of real wages in aftermath of the inflation shock.

The model satisfactorily replicates the average level and the key trends in the reservation wage gap (for periods in which the reservation wage data are available). Nonetheless, but again consistently with its medium-run design, the model overlooks a few short-lasting jumps in the reservation wage ratio like the spike in 2008.

The posterior estimates are robust to a range of modifications in the measurement of underlying exogenous variables and in the specification of the prior parameter distributions. In particular, the main results do not change when the relative nominal income abroad is replaced with the PPS-based measure of relative wages abroad and when the EU entry shift dummy is substituted with a continuously increasing variable reflecting the percentage of the total EEA labour market opened for the new Member States citizens in the reference period. The results also remain unaffected by accounting for the labour quality index in the measure of labour input.

6 Results

6.1 Evolution of Effort and the TFP

Figure 9 depicts the mean and 90% probability bands of the predicted effort. The estimation reduced the uncertainty of the predicted effort; the 90% probability range of the prediction formulated on the basis of the posterior parameter values makes up for around 65% of the analogous range based on the prior parameter distributions. The mean predicted worker effort displays a clear upward trend from 1995 until 2001. In 2001 the effort level was 10% higher than in 1995. The mean predicted contribution of effort to the yearly changes in the Solow residual up to 2001 amounted to, on average, 1.5 ppt. After 2001 the worker effort levelled off and from 2003 to 2009 it even modestly fell; in the first half of 2009 the mean predicted effort level was lower by 6% as compared to 2003. The predicted effort growth, ergo its estimated contribution to the TFP growth, display a similar time pattern as changes in the Solow residual itself. The effort growth was strongly before 1999, decelerated between 1999 and 2001 and stalled afterwards.

Can, as originally envisaged, changes in the effort level explain the downward trend in the Solow residual? A simple test is designed to assess the role of labour market developments in introducing a fall in the measured TFP growth. Were effort one of the factors responsible for the deceleration of the observed TFP, then a slope of the Solow residual excluding the contribution of effort should be greater than a slope of the uncorrected variable. For a set of draws from the posterior parameter domain, I construct an array of uncorrected Solow residuals and an array of Solow residuals where the variation in effort is shut down. Next, the yearly growth rates of the simulated TFP measures are regressed on a time trend and a constant[24]. The trend coefficients are collected separately for the corrected and uncorrected Solow residuals.

As a matter of fact excluding the contribution of worker effort from the Solow residual shifts the slope coefficient of its growth rate clearly to the right. The 90% probability band for the slope coefficient of the growth rate of the uncorrected Solow residual is -7.5 to -7.2 per ten thousand. For the slope coefficient of the growth rate of the Solow residual excluding effort, the corresponding range is -3.5 and -1.8 per ten thousand. The evolution of worker motivation does not fully explain the downward trend in the measured TFP growth. However, as evaluated at the means of the constructed time slope distributions (-7.4 versus -2.7 per ten thousand) it accounts for up to two thirds of the observed TFP deceleration.

[24] Performing the test on levels or the quarterly growth rates of the Solow residual, instead of the yearly growth rates, does not qualitatively change the results.

Similar evaluation as reported above is repeated for a model re-estimated with the labour input measure including a labour quality index. The growth rate of the Solow residual with subtracted human capital changes falls even steeper than that of the residual. It confirms that other factors than human capital accumulation rendered the observed slowdown in the productivity growth. Howbeit, once the variation in the worker quality and effort are both excluded from the Solow residual, the yearly growth rate of the latter exhibit a modest positive time trend. It fitly demonstrates that worker effort and labour quality can constitute a complementary rather than opposing explanation of the downtrend in the TFP growth.

6.2 Factors behind Changes in Effort

The evolution of worker effort can be easier understood when looking at developments of the instantaneous utility levels of workers in different states. Figure 10 plots the mean predicted $\rho_U \bar{\nu}_t^U$, $\rho_N \bar{\nu}_t^N$ and $\rho_M(1+\tau)\bar{\nu}_t^M$ with 90% probability bands and in logarithms. Between 1996 and 1998 there was a sharp reduction in the expected utility of the unemployed as compared to the employed. A series of reforms adversely affecting accessibility and generosity of the unemployment benefits brought the expected relative utility of the unemployed below that of non-participants. For all period 1995-2009 the instantaneous utility of the inactive varied, in turn, only negligibly. Nevertheless, the stability of the relative utility of non-participants conceals a whole spectrum of changes in disability, retirement and family benefit policies. Positive and negative effects of these policy adjustments on the relative income of the inactive just kept netting out.

Changes in the unemployment benefit system in the second half of 90s undermined the fallback position of the employed and boosted their motivation to exert effort. The relative importance of this factor is assessed by the benchmarking of the baseline prediction of effort against the alternative prediction where the relative income of the unemployed is fixed at its average value in 1995-2009. The first set of bars of Figure 11 depicts changes in effort that can be attributed to time variation in the relative income of the unemployed with 90% probability bands. The bars illustrate that the reform of the unemployment benefit system significantly contributed to the built-up of worker productivity before 1999. Around the same time the worker discipline was additionally reinforced by a gradual reduction in the probability of entering employment by non-participants.

The instantaneous utility of temporary emigrants remained decidedly higher than that of the non-employed in all period 1995-2009. Nominal and real wages in Poland continuously converged to the wage level in recipient countries, yet the resulting deterioration in the relative utility of emigrants has been largely neutralized by a reduction

in the emigration costs after 2004. Actually, the gap between the asset values of emigrant and non-migrant workers was not only positive but also kept widening for most of the period of interest. Until 2002 worker flows to emigration played only a negligible role and the improvement in the relative welfare of emigrants had only minor influence on the fallback position of the employed. The situation changed dramatically after 2003. The non-employed started to more actively search for jobs abroad and the expected well-being of emigrants became an important ingredient of the shadow wage of the employed. This, jointly with a cyclical increase in the job finding rate on the Polish labour market, infringed the motivation of job holders.

The second set of bars in Figure 11 illustrates the deviation of effort from the baseline once the transitions from unemployment are fixed on their 1995-2009 average values. It can be concluded that the relatively low escape probability from unemployment between 2000 and 2003 prompted a rise in worker productivity. Per contra, positive labour market outlook and a jump in the emigration propensity of the unemployed following this period, but before the crisis of 2008, depressed worker motivation. The importance of interplay between various factors affecting effort can be realized when comparing two labour market revivals 2004-2008 and 1995-1999. In both periods, the escape probability from unemployment was similarly high. However, during the economic boom in 1995-1999, emigration opportunities were limited and the relative income of non-participants lower than that of job seekers. Thus, high outflows from unemployment in the 90s were weakening, not strengthening, the fallback position of the employed and increased their effort input.

Finally, the stable increase in the persistence of employment, observed from 1995 to 2008, was reflected in an incremental increase in worker effort. It can be read from the third set of bars in Figure 11. Had the average job duration not increased, then in particular after 2003 when outside options of the employed were favourable, the relative value of having a job would have deteriorated even stronger. This, in turn, would bring the worker effort even further down.

7 Impact of Emigration Trends on GDP

As argued in the previous section, a decrease in the emigration costs and a jump in the emigration propensity of the non-employed cut the alternative costs of losing a job and impaired effort of employed stayers. Here, I attempt to separate these effects of loosened immigration restrictions within the enlarged EU on worker effort and GDP. For this purpose a counterfactual ,,no EU accession" scenario is constructed where the intensity of emigration and return migration is kept at the levels observed in 2002. A permanent shift in the gains to emigration in the second quarter of 2004 is set to zero. The scenario excludes excessive exits from employment and non-employment to temporary emigration but also a moderate decrease in the average duration of emigration after 2003. The lower assumed emigration propensity of workers in the counterfactual scenario is compensated by a proportional rise in the persistence of the three labour market states[25]. It is clear that assumptions underlying the counterfactual ,,no EU accession" scenario have largely technical character. Consequences of the EU enlargement on the labour market are likely to be more complex and involving more channels e.g. selective emigration or income transfers.

The estimated effects of changes in the emigration patterns on the level of employment, worker effort, and GDP are depicted in Figure 12. In 2004, following the EU accession, the steady-state employment went down by a minor 1% (the solid line in Figure 12) and the worker effort by 0.5% (the first set of bars in Figure 12). However already two years later, between 2006-2007, the cumulated reduction in labour input amounted to almost 8% and the worker effort was curtailed by further 1.1%. After 2008, the general deterioration of the situation on foreign labour markets and fading of worker outflows abroad were reflected in shrinking of the estimated losses in labour input and effort back to the levels from 2004.

Decreased labour supply and weaker worker motivation after 2003 jointly subdued the level of output. The imprint of the post-accession emigration on GDP is assessed by aggregating the related reductions in labour input and effort with the Cobb-Douglas production function. Two polar assumptions as regards capital input are taken[26]. The first estimate of the GDP drop is generated under an assumption that worker outflows did not influence capital accumulation and is represented by the second set of bars in

[25] Distributing a difference between the actual and counterfactual emigration gross flows so that the transition probabilities from any labour market state to other states but temporary emigration are increased proportionately to their actual magnitude has only a very moderate impact on the reported results.

[26] Borjas et al. (1997) refer to two polar assumptions, of the infinitely elastic capital (price of capital is fixed) and of the fixed capital stock, while measuring the impact of immigration on the wages of natives. In contrast, when answering the similar research question, Ottaviano and Peri (2006) assume that immigration changes the optimal level of capital stock in an economy but capital adjusts only gradually to its steady-state level at some calibrated exogenous rate.

Figure 12. The second estimate is calculated under an assumption that the capital to labour ratio was not affected by trends in labour migration. The latter estimate, illustrated by the third set of bars in Figure 12, provides a sounder description of the longer run effects of emigration, when capital stock can adjust to a persistently lower labour supply. Intuitively, it is the speed of capital adjustment following an emigration shock which will decide which of the two GDP estimates better reflects the actual developments. In any case, the first estimate is interpreted as the lower bound and the second as the upper bound of the actual slump in GDP.

When the emigration rate reached its peak between 2006 and 2007, the production capacity of the Polish economy shrunk by 6 to 9%. The GDP losses decreased to around 1% in 2009. Diluted incentives to exert effort account for around 15% of the total negative impact on the GDP. In terms of y-o-y changes, emigration constituted a significant factor slowing down the GDP growth during the economic revival of 2003-2007. After 2008, a halving of the emigration rate reinforced the GDP growth, possibly contributing the relatively good performance of the Polish economy during the global crisis.

8 Conclusions

The article describes the evolution of the measured TFP in the context of labour market changes in Poland. Its key methodological contribution lies in the identification of the unobserved worker effort on the basis of a structural model. The model refers to the shirking efficiency wage theory of Shapiro and Stiglitz (1984). In the setting, workers scale their effort according to attractiveness of their outside options. The standard framework with employment and unemployment is extended for non-participation and temporary emigration. Thereupon, the fallback position of the employed to hangs on the transition probabilities to and from inactivity and emigration and on the expected income of non-participants and emigrants.

A system of two equations derived from the model which relate the real labour cost and the reservation wage to the relevant labour market variables is estimated with Bayesian methods. The statistical inference informs about the relative importance of different mechanisms embedded in the theoretical model in the Polish economy. The model is purposefully tailored to incorporate data on the transition probabilities between labour market states and temporary migration derived from the Polish LFS. A use of this novel data set, instead of the standard aggregate measures of labour market tensions (e.g. the unemployment rate) or emigration trends (e.g. net emigration flows), offers a more details insight into labour market dynamics and increases the empirical identification of the model parameters.

Until 2004, the Polish labour market evolved from an environment with the excessive transitions between labour market states, to a relatively stable one but with high unemployment and a meagre labour market participation rate. Meanwhile, a complex set of reforms of social assistance programs was introduced. It appears that also a significant reduction in the generosity of the unemployment benefit system before 1998 boosted worker effort. A gradual stabilization of the job destruction rate and a falling probability of return to activity by non-participants also had a moderately positive impact on the worker motivation. The growing worker effort was in turn reflected in the high growth rates of the Solow residual in the second half of 90s.

The reduction in the measured TFP growth after 2003 can be in part explained by weaker worker motivation tied to improvement of economic conditions and a rise in the job finding rate. However, a greater share of the slowdown in the growth of the Solow residual can be attributed to the higher emigration propensity of Polish workers after 2004. The EU accession and a gradual introduction of the open-door policy for Polish citizens by the ,,old" Member States broadened the spectrum of outside options for those who stayed. This in turn pushed their shadow wage up. Their work motivation dropped accordingly. Altogether, the changing labour market conditions can explain

up to two thirds of the negative trend in the growth rate of the Solow residual between 1995-2009.

When used to assess the effects of a cut in the emigration costs and an increase in emigration following the EU accession, the model suggests that these could have contributed to as much as a 6 to 9% reduction in the GDP level (depending on the assumptions regarding capital accumulation) in the peak emigration years 2006-2007. The associated fall in the employment level is estimated at 8%. Around 15% of the estimated GDP drop results from the negative influence of emigration on the motivation of non-migrants.

The model is able to coherently lay down how labour market developments impact on the productivity of workers. It succeeds in connecting apparently different phenomena, such as economic transformation, the business cycle and temporary emigration. Finally, it is able to replicates the actual evolution of the measured TFP in Poland. Still, the answers delivered in the article are certainly model-specific. At the same time the presented interpretation of the relationship between worker productivity and temporary emigration or the situation on the domestic labour market is not the only plausible one. Other theories and model specifications would offer different interpretations of the relationship and, most likely, also deliver different estimates of the magnitude of the GDP reduction following an increase in emigration.

Appendix A

A.1. Market Equilibrium

All workers have similar preferences and in equilibrium all the employed elicit effort. Therefore $V^E_{NSH,i} = V^E$ holds for each employed worker i. Let instantaneous incomes of the unemployed, non-participants and temporary emigrants be denoted by ν^U, ν^N and ν^M, respectively. Then:

$$rV^E = ln(w) - t^{EMP} - \chi e + \sum_{s \in S/E} p_{Ei}(V^s - V^E) \tag{15}$$

$$rV^s = ln(\nu^s) + \sum_{\bar{s} \in S/s} p_{\bar{s}s}(V^{\bar{s}} - V^s) \tag{16}$$

where the latter equation holds for $s \in S/E$.

A system of four asset equations for the employed, the unemployed, the inactive and emigrant workers is solved for its equilibrium values. Let Z be a matrix defined as $Z = (1+r)I - P$ where I is the identity matrix. $Z_{s\bar{s}}$ is a sub-matrix of the elements of Z that are left when the $s-th$ row and the $\bar{s}-th$ column are excluded from Z. Further, $\zeta_{s\bar{s}} = (-1)^{s+\bar{s}} detZ_{s\bar{s}}/detZ$. Then the value functions solving the set of equations (15) and (16) are of a form:

$$V^s = \zeta_{Es}(ln(w) - t^{EMP} - \chi e) + \sum_{\bar{s} \in S/E} \zeta_{\bar{s}s} ln(\nu^{\bar{s}}) \tag{17}$$

When $\bar{V} = \sum_{s \in S/E} p_{Es} V^s$ the condition (4) might be restated as:

$$ln(w) - t^{EMP} > (r + 1 - p_{EE})V^U - \bar{V} + \frac{\chi}{q}(r + 1 - p_{EE} + q)e \tag{18}$$

Denote $\theta^s = (r + 1 - p_{EE})\zeta_{sU} - \sum_{s \in S/E} p_{E\bar{s}} \zeta_{s\bar{s}}$ for each $s \in S$. $\bar{\nu}^s$ for $s \in S/E$ represent the relative instantaneous utility of a worker in a state s to the net wage of the employed $\nu^s / w(1 - t^{EMP})$. Then substituting the equilibrium (17) solution to (18) and making use of the property that $\sum_{s \in S} \theta^s = 1$ I arrive at (7).

A.2. Reservation Wage

The reservation wage of a worker fulfils $V^E(w^*) = V^U$. From (15) and (16) where the latter is used for $s = U$:

$$ln(w^*) - t^{EMP} = rV^U - \sum_{s \in S/E} p_{Es}(V^s - V^U) \tag{19}$$

After substituting the rV^U and deducting the net market wage from both sides of the equation the condition simplifies to:

$$ln(w_i^*) - ln(w) = ln(\bar{\nu}^U) + \chi e + \sum_{s \in S/U} p_{Us}(V^s - V^U) - \sum_{s \in S/E} p_{Es}(V^s - V^U) \tag{20}$$

Returning to the market solution (17), denoting $\phi^s = p_{UE}\zeta_{s,E} + (p_{EN} + p_{EM} + p_{UU} - 1)\zeta_{s,U} + \sum_{\bar{s} \in (N,M)} \zeta_{s,\bar{s}}$ and rearranging the terms I get (9).

Appendix B

The average paid employment: The average paid employment in the national economy.

Source: Polish Statistical Office. The data cover units of the national economy regardless of their ownership. The public sector units encompass state-owned economic units (the State Treasury and state legal persons), units owned by local self-government entities as well as ,,mixed ownership" units with predominance of capital (assets) of the public sector entities. The private sector units include private domestic ownership units (e.g. partnerships, co-operatives, individuals undertaking economic activities, social organizations, associations, and foundations), foreign ownership units (e.g. partnerships with exclusively foreign capital shares) and ,,mixed ownership" units with a predominance of capital (assets) of private sector entities. Information on the average paid employment regards units of the national economy excluding economic entities employing up to 9 persons. It does not embrace private agriculture, people employed abroad, those employed in social, political and trade union organizations and individuals employed in the scope of national defence and public safety.

The steady-state employment: The number of employed permanent residents of Poland in the steady-state.

Source: LFS and own calculations. The steady-state employment to population ratio is derived from a quarterly transition probability matrix P. Let $\tilde{P}$ be a P matrix where elements on its diagonal are replaced by zeros. $v = [E^\star, U^\star, N^\star, M^\star]$ is a vector with the shares of the employed, the unemployed, non-participants and temporary emigrants in the population where $E^\star + U^\star + N^\star + M^\star = 1$. Then $v = (\tilde{P}^{-1}\tilde{P}^T)v$. The employment ratio is next multiplied by the population of permanent residents of Poland aged 14 years and over.

Population: The population of permanent residents of Poland aged 14 years or over and living in private households.

Source: Polish Statistical Office and own calculations. The demographic data on population for 1994-2009 refer to the number of Polish citizens at the end of a year. The Polish Statistical Office forecasts of the number of residents of private and institutional households for 2003-2030 is used to calculate the shares of residents of private and institutional households separately for thirty gender-age groups. The analogous shares for the years prior to 2003 are set on their 2002 values. The derived number of persons living in private households is next aggregated and interpolated for missing quarters with the quadratic-match-last method.

Hours worked: The average number of hours worked of an employed person

(2008=1).

Source: LFS. Seasonally adjusted with the Tramo-Seats method.

Labour quality indices: The estimate of the y-o-y growth rate in the quality of employed workers.

Source: LFS and own calculations. Two labour quality indices are calculated: a basic one which captures differences in productivity related to the education level and professional experience of workers, and an extended one which additionally allows the worker productivity to differ across sectors and occupations.

The method relies on gross wages as a measure of worker productivity. It also assumes equal productivity of workers who report and do not report wages as long as they share similar observable traits. First, a series of wage regressions of full-time employees is estimated separately for each year between 1994 and 2009. To account for non-random non-reporting of wages by full-time employees, the two step Heckman (1979) strategy is applied. The selection equation include a female dummy, age of a person, age square, dummies corresponding with the educational attainment (higher, post-secondary, secondary, vocational or primary), interaction variables between gender and age, interaction variables between education dummies and age, a disability dummy, a full-time student dummy, the unemployment rate in the region, dummies for a sector of employment and an occupation, dummies for a size of a firm and for its ownership (private or public). The wage regressions are based on a similar set of independent variables excluding the firm size dummies (while deriving the extended index) plus the dummies for a sector of employment and for an occupation (basic index). A student dummy controls regressions for exemption of student wages from the healthcare insurance contributions. The regional unemployment rate is added to wage equations to account for possible deviations from the assumed proportionality of wages and labour productivity which can originate in the non-competitive structure of a labour market tied to e.g. wage bargaining. Observations are clustered by workers.

Second, predictions of wages are formulated for all the employed, including those who do not report wages (non-reporting employees, self-employed, farmers or helping family members, part-time employees before 2000). When formulating the predictions, the unemployment rate is set to the sample average value and the student dummy to zero. Predicted wages of the part-time employed are multiplied by 0.6. Let $\hat{w}^s_{i,t}$ be the predicted wage for a worker i who entered the survey sample in a year t which is formulated on the basis of the regression estimated on data from a year s. Let $\delta_{i,t}$ be a population weight of a person i in a year t. Along the lines proposed by Aaronson and Sullivan (1997) two year-to-year changes in the average human capital of workers are calculated:

$$dQ^0 = \frac{\sum_i \delta_{i,t} \hat{w}_{i,t}^{t-1}}{\sum_j \delta_{j,t-1} \hat{w}_{j,t-1}^{t-1}} \frac{\sum_j \delta_{j,t-1}}{\sum_i \delta_{i,t}} \tag{21}$$

$$dQ^1 = \frac{\sum_i \delta_{i,t} \hat{w}_{i,t}^{t}}{\sum_j \delta_{j,t-1} \hat{w}_{j,t-1}^{t}} \frac{\sum_j \delta_{j,t-1}}{\sum_i \delta_{i,t}} \tag{22}$$

The year-to-year percentage change in the final indices is derived as the geometric average of (21) and (22), namely $dQ_t = (dQ^0 dQ^1)^{\frac{1}{2}}$.

The reservation wage gap: The ratio of the reservation wage of the unemployed to the average wage rate.

Source: LFS. The reservation wage in the LFS data is defined as the minimum gross wage at which a person would be willing to accept a job. The average of the reservation wages of the unemployed is divided by the average net wage of the employed. Next the ratio is adjusted with the effective income tax and social contribution rates. The data are not available from the second to the last quarter of 1999 and in all quarters 2001-2003.

The share of temporary employees: The share of paid employees with closed-end contracts.

Source: LFS and own calculations. The Tramo-Seats procedure is used to derive the trend of the original variable and extrapolate it for 1999, where data are missing.

The relative income of non-employed: The expected value of benefits received by an unemployed or inactive person as related to the net nominal average gross wages and salaries.

Source: LFS, Polish Statistical Office, Polish Ministry of Finance, own calculations. The measured income of the non-employed consists of four types of benefits: unemployment, retirement (weighted average of benefits from farm and non-farm funds), disability (weighted average of benefits from farm and non-farm funds) and other social assistance including i.e. family and pre-retirement benefits. The replacement rates for these benefits are derived as the ratios of the average value of a benefit to the net average wages and salaries and appropriately corrected (if necessarily corrected) for the income tax and social contribution rates. Information on the average value of benefits is available on quarterly or yearly frequency. In the latter case, the time series are interpolated for quarters with the quadratic-match-last method. The replacement rates are aggregated into the relative income of the unemployed and non-active, separately, using the shares of workers in the respective group who receive a particular kind of benefit. The shares are extracted from the LFS which provides information

on the individual sources of the non-labour income. In the period between 1995-2009 on average around 15% of the unemployed received unemployment benefits (with a sudden reduction of those eligible for benefits in 1997) and 15% received other social assistance benefits. For non-active workers almost 40% received retirement benefits, over 15% disability benefits and over 10% other kinds of benefits.

The average income gain of temporary emigrants: The relative expected average net wage in destination countries to the average net wage in Poland (in EUR and in PPS).

Source: AMECO, Eurostat, OECD, Population Census 2002, own calculations. The expected income of a worker in a destination country is established as the average nominal wage in EUR (or the real wage in PPS) corrected for the tax wedge and the employment probability (the latter approximated by the employment rate) in the region. The reference countries include all EU-15, Norway, Iceland, Switzerland, NMS-10 excluding Poland, Asian developed countries (Japan and South Korea), the USA, Canada, Australia, New Zealand and Israel. The labour market variables stem from AMECO and Eurostat. For some countries (Israel and Switzerland), however, it is necessary to use data from national banks and national statistical offices. According to the 2002 Population Census temporary emigration to these countries accounted for around 98% of the total emigration to known destinations. Next, the expected income of an emigrant in different destinations is weighted under and assumption that the worker destination preferences can be summarized by a Cobb-Douglas function with constant parameters. The weights are proportional to the product of the average nominal wage in EUR (or PPS wage) and the ratio of temporary emigrants to a destination in 2002. Last, the destination-weighted income of a temporary emigrant is divided by the average nominal wage rate in Poland in EUR (or in PPS) which is previously corrected for the tax wedge. The emigrant relative income is decomposed into quarterly frequency using the quadratic average-match method.

The real labour cost: The average gross wages and salaries including social security contributions levied on employers and divided by the Gross Domestic Product deflator.

Source: Polish Statistical Office, NECMOD database, own calculations. Information on wages and salaries regards units of the national economy excluding economic entities employing up to 9 persons. It does not embrace wages in private agriculture, wages of the employed abroad (with the exception of the number of employees), in social, political and trade union organizations and in the scope of national defence and public safety. The original monthly data on wages and salaries are averaged for quarters and seasonally corrected with the Tramo-Seats procedure. Next they are adjusted for the effective rate of social security contributions levied on employers.

Degree of capacity utilization: Degree of capacity utilization in industrial enterprises in percentage points (2008=1).

Source: The Polish Statistical Office quarterly business tendency survey.

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Table 1: Data Description

	Structural model variables						*First differenced variables*			
	Mean	*Std. Dev.*	*Min*	*Max*	*Degree of integration*	*KPSS statistics*	*Mean*	*Std. Dev.*	*Min*	*Max*
Real labour cost per employed person (ln)	2.088714	0.137474	1.804343	2.319894	0 (deterministic trend)	0.177842*	0.009045	0.011744	-0.02375	0.069489
Ratio of the reservation wage to the net wage (ln)	-0.4005	0.0308	-0.4682	-0.3175	0	0.1941***				
Relative income of unemployed (ln)	-2.5019	0.3780	-2.8029	-1.5843	0	0.6124*				
Relative income of non-participants (ln)	-1.1456	0.0332	-1.2209	-1.0930	0	0.1406***				
Relative income of temporary emigrants (ln)	1.5594	0.1669	1.1949	1.9403	1	0.1048***	-0.0111	0.0284	-0.1208	0.0576
Share of employees working on temporary basis	0.1536	0.0962	0.0508	0.2806	1	0.2058***	0.0037	0.0053	-0.0040	0.0154
Steady-state employment (ln)	9.6486	0.0612	9.5136	9.7668	0	0.1918***				
Weekly number of hours worked per employed (ln)	0.0128	0.0133	-0.0073	0.0452	1	0.2204***	-0.0008	0.0059	-0.0188	0.0138
Productive capital stock (ln)	13.7612	0.1789	13.4560	14.0724	0 (deterministic trend)	0.1633*	0.0096	0.0242	-0.0589	0.0679
Degree of capacity utilization (ln)	-0.0747	0.0511	-0.1917	0.0144	0	0.2488***				
P_{EU}	1.28%	0.30%	0.78%	1.82%	0	0.6258*				
P_{EI}	1.46%	0.33%	1.05%	2.26%	1	0.5576*	-0.01%	0.06%	-0.19%	0.11%
P_{EM}	0.13%	0.09%	0.04%	0.33%	0	0.5022*				
P_{UE}	12.46%	3.48%	7.48%	17.37%	0	0.3482***				
P_{UI}	7.95%	2.48%	3.70%	11.97%	0	0.2470***				
P_{UM}	0.63%	0.43%	0.20%	1.82%	0	0.5972*				
P_{IE}	1.52%	0.55%	0.81%	2.61%	0	0.6838*				
P_{IU}	1.41%	0.36%	0.74%	2.05%	1	0.1099***	-0.02%	0.13%	-0.39%	0.30%
P_{IM}	0.11%	0.05%	0.04%	0.24%	0	0.5334*				
P_{ME}	2.20%	0.78%	0.91%	3.78%	1	0.2312***	-0.04%	0.39%	-1.73%	1.01%
P_{MU}	1.67%	0.63%	0.39%	2.61%	0	0.6899*				
P_{MI}	2.01%	0.88%	0.43%	3.78%	1	0.3915**	-0.04%	0.40%	-1.85%	1.12%
	Other variables									
LFS employment	9.5783	0.0483	9.5029	9.6750	0	0.2231***				
Average paid employment	8.9747	0.0521	8.8917	9.0494	0	0.480*				
TFP (the measure based on the steady-state employment)	1.3581	0.1228	1.1198	1.5579	0 (deterministic trend)	0.2106*				
Observations	*58 (43)*						*57*			

*** Significant at a 10% confidence level
** Significant at a 5% confidence level
* Significant at a 1% confidence level

Table 2: Results of Granger Causality tests

	Chi-sq statistics: p Granger cause TFP	*Chi-sq statistics: TFP Granger cause p*
P_{EE}	33.4156***	8.8336
P_{EU}	30.2185***	6.9134
P_{EI}	13.3860	5.1840
P_{EM}	29.9083***	7.6319
P_{UE}	30.7601***	9.9179
P_{UU}	30.4101***	15.0604
P_{UI}	31.4824***	16.4813
P_{UM}	44.9980***	21.1441**
P_{IE}	23.0483**	28.2682***
P_{IU}	15.3130	21.1771**
P_{II}	17.0227	25.1954**
P_{IM}	31.9123***	10.0681
P_{ME}	15.5728	14.1392
P_{MU}	14.0532	26.0567**
P_{MI}	37.3098***	13.1188
P_{MM}	9.6191	15.6003

*** Significant at a 10% confidence level
** Significant at a 5% confidence level
* Significant at a 1% confidence level

Table 3: Model parameters

			A priori				*A posteriori*		
Parameter	*Description*	*Range*	*Type*	*Mode*	*Expected value*	*Std. Deviation*	*Mode*	*Expected value*	*Std. deviation*
q_0	Punishment probability (constant)	[0,1]	beta	0.25	0.3333	0.1782	0.5650	0.5649	0.0509
q_1	Punishment probability (marginal change)	[0,3.55]	beta	0	1.1833	0.8367	0	0.1110	0.0883
β	Disutility of effort	[2,6]	beta	3.6	3.7778	0.8475	5	4.7967	0.5236
ρ_U	Rescaling of replacement rate of the unemployed	[0.5,4.8]	beta	1.0059	1.3190	0.4979	1.6610	1.7961	0.3916
ρ_N	Rescaling of replacement rate of non-participants	[0.5,2.9]	beta	1.0176	1.3176	0.4828	0.536	0.5869	0.0696
ρ_M	Rescaling of replacement rate of emigrants	[0,0.13]	uniform	any within a range	0.065	0.0375	0.0832	0.0838	0.0272
τ	Jump change in emigration costs (in %)	$[0,+\infty)$	gamma	0.1515	0.4545	0.3711	0.2390	0.4625	0.3491
α	Elasticity of product to labour	[0.63,0.73]	beta	0.68	0.68	0.0224	0.7120	0.7007	0.0182
g	Trend	[0.015,0.035]	beta	0.0207	0.0223	0.0038	0.0217	0.0214	0.0017
r	Discount rate	[0.025,0.075]	beta	0.05	0.05	0.0112	0.0462	0.0484	0.0109
c	Constant	$(-\infty,+\infty)$	t-Student	0	0	$+\infty$	0.5720	0.5304	0.0700
σ_1	Error variance	$[0,+\infty)$	gamma	0.02	0.06	0.0490	0.0010	0.0010	0.0002
σ_2	Error variance	$[0,+\infty)$	gamma	0.02	0.06	0.0490	0.0009	0.0031	0.0008
σ_{12}	Covariance of errors	$(-\infty,+\infty)$	t-Student	0	0	$+\infty$	0.0029	0.0010	0.0003

Figure 1: The TFP and GDP growth rates versus the temporary emigration rate

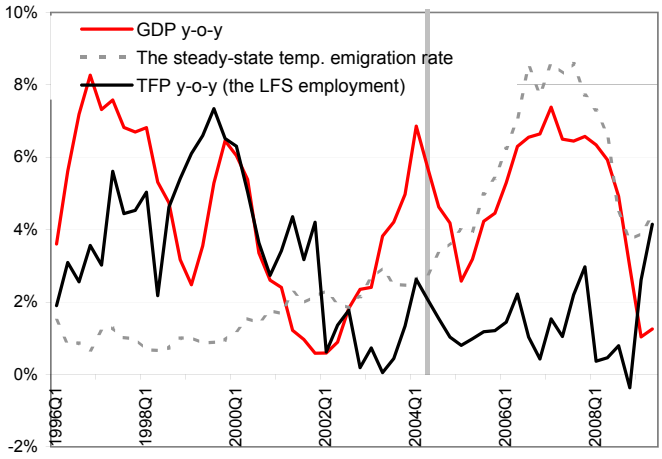


Figure 2: Different measures of the Solow residual

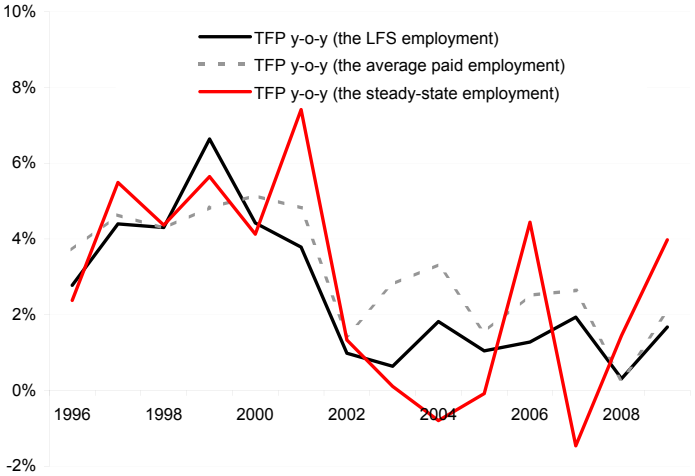


Figure 3: Labour quality indices

The basic index reflects changes in the average educational attainment and working experience. The extended index additionally accounts for shifts in the sectoral and occupational structure of employment.

Figure 4: Job separation rates

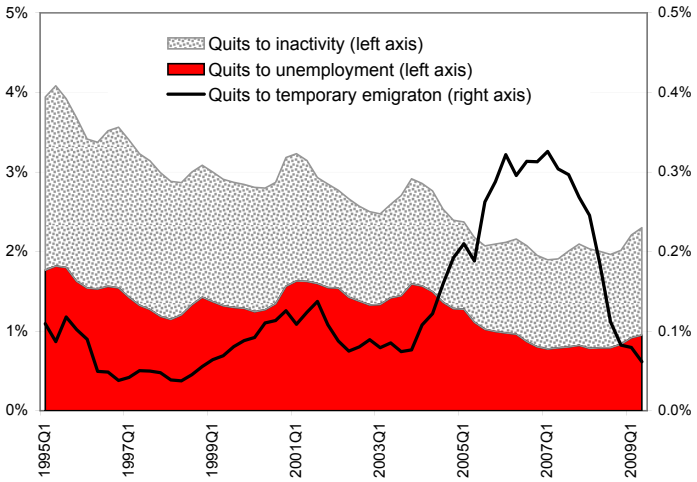


Figure 5: The probability of exit from unemployment

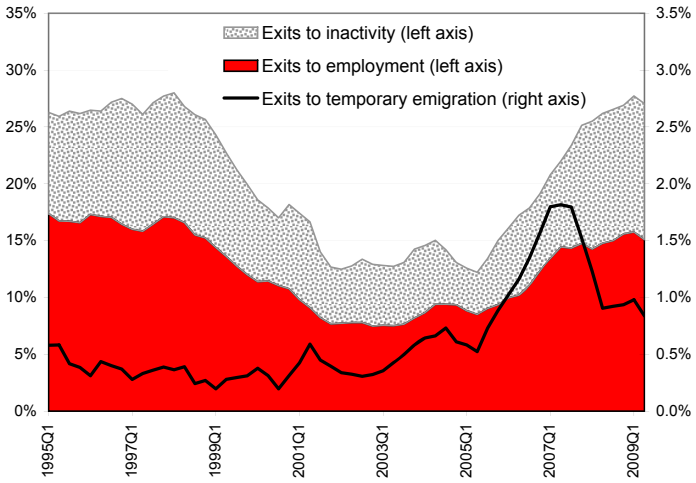


Figure 6: Posterior and prior parameter density functions

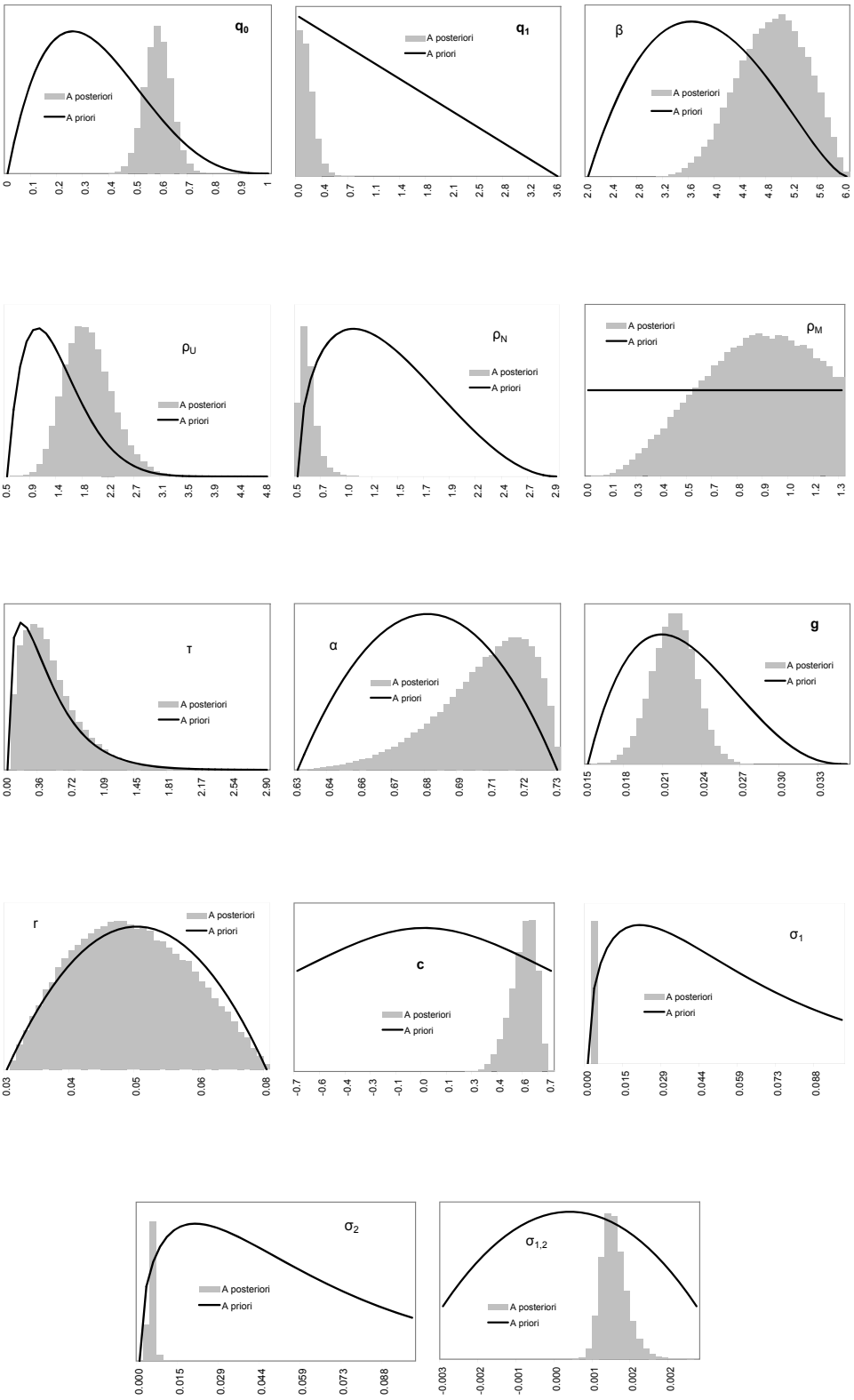


Figure 7: The actual versus predicted real labour costs

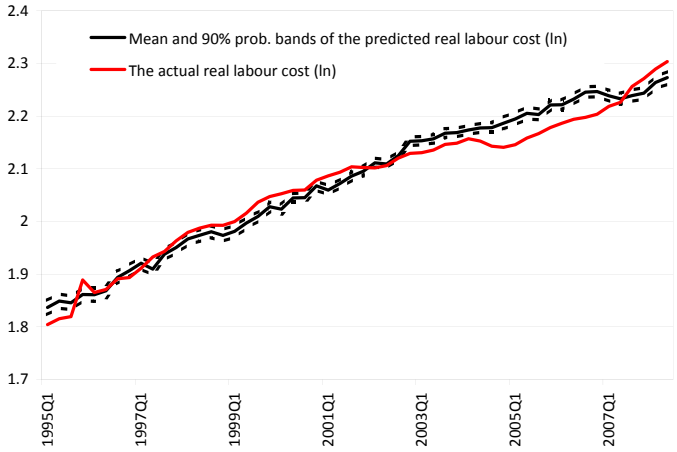


Figure 8: The actual versus predicted reservation wage gap

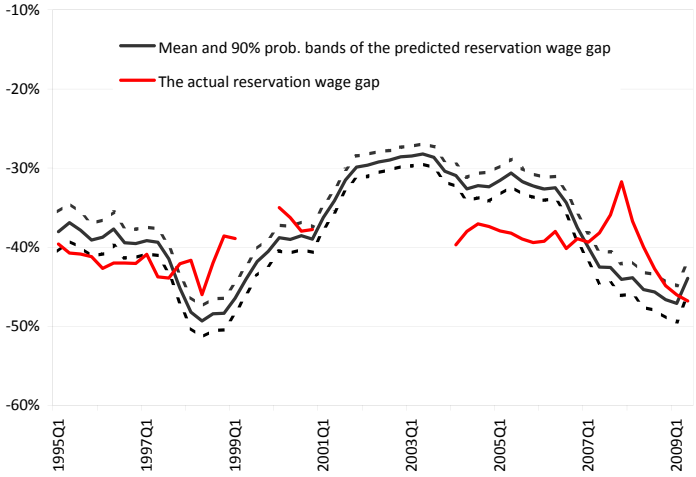


Figure 9: The predicted effort
and its contribution to the TFP y-o-y growth

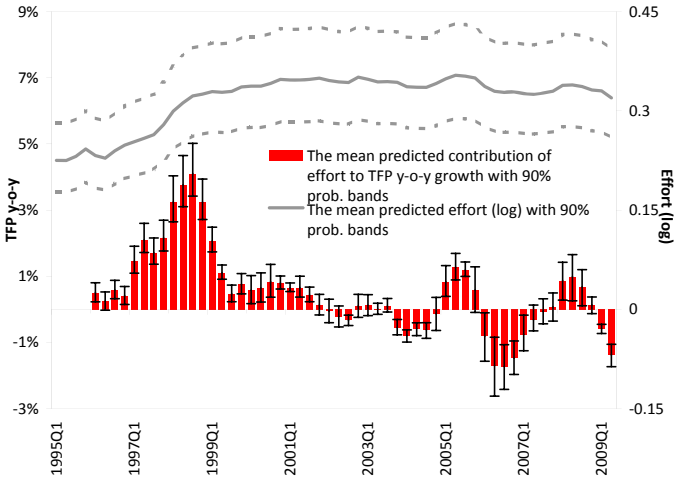


Figure 10: The instantaneous utility
of the non-employed as compared to the employed

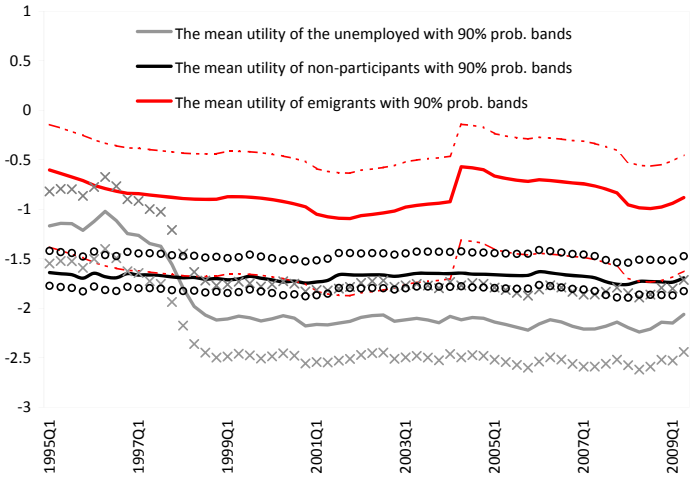
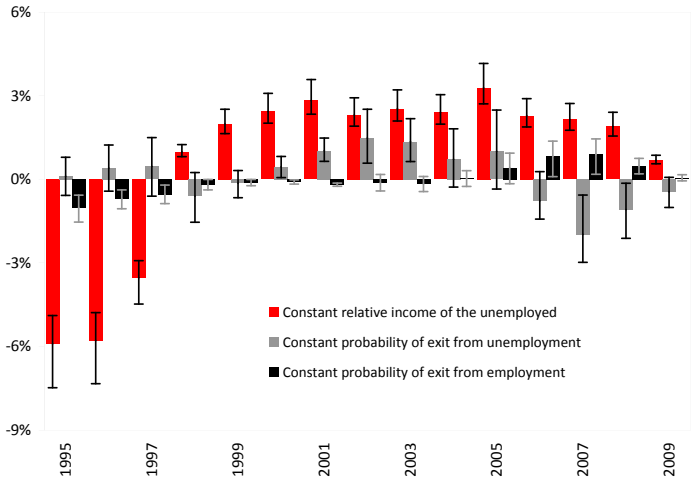
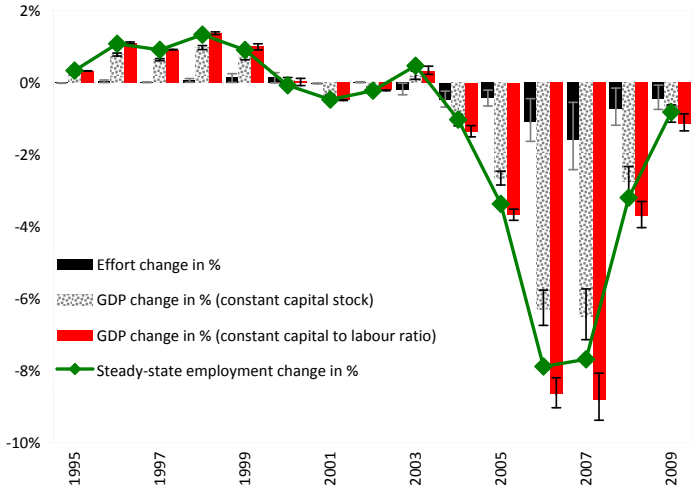


Figure 11: Changes in effort tied to variation in the relative income of the unemployed, exits from unemployment and quits from employment



The bars show the mean of the percentage difference between the baseline and a set of counterfactual predictions with 90% probability bands. In each counterfactual scenario a chosen exogenous variable is kept constant at its sample averages. The positive values of the bars signify that effort of workers would be lower under the counterfactual assumptions.

Figure 12: The estimated change in the steady-state employment, effort and GDP after the EU accession



The bars show the mean percentage difference between the baseline and the counterfactual predictions with 90% probability bands. In the counterfactual scenarios transition probabilities to and from emigration remain at their 2002 levels and there is no reduction of emigration costs after 2004.