Shevchuk Victor

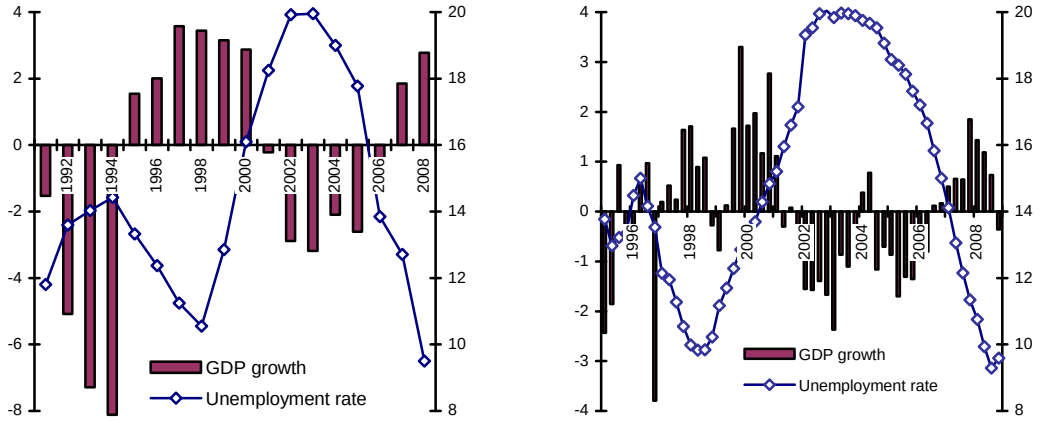
OKUN'S LAW IN POLAND: EMPIRICAL RELATIONSHIPS AND POLICY IMPLICATIONS

1. Introduction

Okun's law is a well-known theoretical and empirical concept which postulates an inverse relationship between the unemployment rate and the real GDP growth. Although American economist Robert Okun in the 1960s was primarily interested in deriving a measure of potential output in levels, assuming a given "natural" rate of unemployment of 4 percent, he nevertheless provided with two alternative versions of the relationship between the output growth and unemployment rate ─ difference and gap ones [Schnabel 2002, p. 2]. Modern interpretation of what is collectively called Okun's law, also includes the dynamic and production-functions versions of the output-unemployment relationship [Knotek 2008, p. 74─78].

Okun's law allows to convert data on GDP growth and output gap into unemployment data (and vice versa), which is of applied interest for the present situation in Poland. As expected, a remarkable decline in the unemployment rate has been observed over the 2006─08 period against the backdrop of high GDP growth rate contrasting with a jobless recovery of 2004 and similar developments in 1999─2000 (Fig. 1). On the other hand, unemployment declined in 2005, despite a slower output growth. Empirical studies for industrialized countries on general reveal lower estimates of the trade-off between output growth and unemployment, being not very stable over different time periods and quite sensitive to employment data sets, methods of estimation and specifications used [Freeman 2000, p. 557; Khemraj et al. 2006, p. 5; Villaverde, Maza 2007, p. 5]. It is found for the U.S. data that the time-varying coefficients fluctuate around the fixed-Okun's coefficient, exhibiting large variations for the entire analysis period [Huang, Lin 2008, p. 363─375]. As significant decline of the Okun's coefficient had been detected for Germany and France in the 1990s [Moosa 1997, p. 335─356; Sögner, Stiassny 2000], with the use of time-varying parameter (TVP) methods it has been recently found that the reaction of unemployment to growth rate had actually increased for France and the U.K. since the beginning of the 1990s [Khemraj et al. 2006, p. 5]. The TVP estimates reinstate a stronger relationship between real GDP and unemployment for the U.S as well [Sinclair 2009, p. 529─541].

Weakening of Okun's law (if any) is explained by a rapid rise of productivity [Huang, Lin 2008, p. 371─372], the desire of firms to retrench workers in order to minimize costs due to the rapid growth in health care costs or fixed employment costs per worker, and structural changes [Khemraj et al. 2006, p. 6─7], sectoral and regional mismatch in the operation of the labour market [Mayes, Viren 2000, p. 23], demographic and institutional changes [Grant 2002, p. 95; Knotek 2007, p. 83]. Lower Okun's coefficients for Europe used to be interpreted as the consequence of relative high rigidities among national labour markets [Lee 2000, p. 352]. Movements in unemployment are dampened by fluctuations in average working hours and labour participation [Rudebusch 1995]. As structural problems of automation, depletion of skills and bankruptcies can be attributed to higher technical progress-based growth resulting in a higher job-turnover, at the same time higher growth reduces the durability of a job match, or impact of efficiency wages [Sögner, Stiassny 2000, p. 4].



a) annual data, 1991─2008; b) quarterly data, 1995─2008;

Fig. 1. Unemployment rate and business cycle in Poland (in percent)

Note: detrended values of GDP cycle are obtained by the Hodrick─Prescott filter

Source: IMF *International Financial Statistics*

Among explanations of jobless growth in Europe, including the Central and Eastern European (CEE) countries, the convergence effect of higher productivity growth, labour market rigidities, decline of traditional industries and development of the services sector with higher value added are highlighted [Kwiatkowski et al. 2002, p. 329─346; Kwiatkowski et al. 2004, p. 53─66]. The so-called second wave of unemployment in Poland since 1998 (Fig. 1) used to be explained by either slower GDP growth, or tightening of macroeconomic policies, demographic developments and changes in the unemployment registration procedures [Arendt 2005, p. 3]. Labour

markets are not especially rigid in Poland, but nevertheless there are several structural problems, as quite high tax wedges and early withdrawal from the labour market due to high expenditures on disability programs and early retirement pensions [Annett 2008, p. 68–70], not to mention difficulties of the employment shifts between industry and service sectors [Rogut 2007, p. 22–25], regional disparities, trade union activities and selective industrial policies [Kwiatkowski, Tokarski 2007, p. 442–443][1]. In 2002, it was argued that the annual GDP growth of 7 percent would be necessary to bring the unemployment rate down to 18.5 percent by 2005 [Kwiatkowski et al. 2002, pp. 331–332]. As of 2005, it was argued that even higher output growth rate would be not enough to bring the unemployment rate significantly down [Arendt 2005, p.1], with the GDP growth rate consistent with a stable unemployment rate in the earlier studies ranging from as high as 5.3 percent for the 1993–2001 period [Czyżewski 2002] to 4.2 percent for the 1990–2000 period [Kwiatkowski et al. 2004, p. 39–68].

Despite numerous evidences of a weakening Okun's law, it is still an influential concept in explaining the output-unemployment trade-off and in forecasting full employment output [Adanu 2002, p. 2][2]. Stronger effects on unemployment by GDP growth are likely to be brought about by stronger international competition, liberalization of the labour market, and smaller turnover costs [Blanchard 1999, p. 170]. The stability of Okun's law contrasts favourably with the Phillips curve, its counterpart in the unemployment-inflation space [Freeman 2000, p. 557]. Weakening of standard Okun's law estimations can be explained by a possible asymmetry of the absolute effect that expansions and contractions in output have upon unemployment, as taking into account of these asymmetries strengthens a long-run Okun's law for such countries as the U.S. and New Zealand [Harris, Silverstone 2001; Holmes, Silverstone 2006, p. 293–299]. Empirical studies of Okun's law for CEE countries are rather scarce, but for the ten EU accession countries, classified as 'reform leaders' Okun's law is detected in its first-difference version for both 1991–94 and 1995–2000 periods, while for 'reform laggards' it is present only for the latter [Izyumov, Vahaly 2002, p. 317–331]. As the expected inverse relationship between the GDP growth and unemployment is detected for a sub-sample of the CEE countries (the Czech Republic, Hungary, Poland, the

[1] Several researchers raise caution in order not to mix unit labour costs, which are low in Poland if compared to other European countries, with labour market regulations that can be considered as rather strict [Kwiatkowski et al. 2002, p. 331–332].

[2] It is worth noting that for the U.S. despite the fact that Okun's coefficients are changing over time, they remain negative in all time periods, which is an argument for the validity of Okun's law [Huang, Lin 2008, p. 373].

Slovak Republic, Slovenia), evidences are rather weak for other transition economies, including the former Soviet Union countries [Adamczyk et al. 2006, p. 25─30]. Tentative results in favour of Okun's law are obtained for Poland [Kwiatkowski, Tokarski 2007, p. 439─455; Misztal 2007, p. 541─557] and Romania [Turturean 2007].

Our purpose is to estimate the Okun coefficient for Poland across different data samples and estimation methods. This article organizes as follows: Section 2 provides with a brief outline of Okun's law, with alternative model specifications presented. Section 3 describes the data sample and reports the estimation results. The quantitative values of Okun's coefficients are quite robust in respect to the choice of data sets, national or regional, or versions of the functional relationship, standard or extended (the latter signalizes a negative impact of the depreciation of *zloty* upon the changes in the unemployment rate). There is a tendency for the relationship between GDP growth and unemployment to strengthen slightly over time, as implied by the time-varying Okun's coefficients since 2002.

2. Different versions of Okun's law

Okun's law is based on the observation that more labor through a variety of forms, such as having employees work longer hours or hiring more workers, is typically required to produce more goods and services [Knotek 2007, p. 74].

The difference version of Okun's law can be represented as

$$\Delta U_t = a - b\Delta Y_t + \varepsilon_t, \tag{1}$$

where ΔU_t and ΔY_t are changes in the unemployment rate and output growth rate, respectively, and ε_t is the disturbance term.

Equation (1) captures the impact of output growth upon the unemployment rate. The parameter *a* is the econometric estimate of the changes in the unemployment rate that would exist when the GDP growth is zero. The parameter *b* used to be called "Okun's coefficient", while the ratio *a/b* provides with the rate of growth consistent with a stable unemployment rate [Knotek 2007, p. 75]. Output growth faster than *a/b* should contribute to a falling unemployment rate, while the opposite holds for a slower growth. It is worth noting that the first-difference form represents a convenient way to achieve a stationarity in data containing a unit root [Lee 2000, p. 333]. While the first-difference Okun's coefficients used to be stable for the U.S., the results generally have been less satisfactory for other industrial countries [Schnabel 2002, p. 1─2] [3].

[3] The estimates of *b* in the specification with change in the employment rate regressed on current and lagged changes in log GDP using annual data ranged between –0.04 and –0.21 for Japan, –0.27 and

A dynamic version of Okun's law is based on the assumption that some relevant independent variables are omitted in the output-unemployment trade-off [Knotek 2007, p. 76─77]. It is common to include lagged real output growth and unemployment rate, for example [Moosa 1997, p. 335─356], as well as other independent variables, on the right side of equation (1), though at the cost of simplicity of the original difference version of Okun's law.

Assuming significant time lags involved, the equation (1) can be rewritten as

$$\begin{aligned} \Delta U_t &= a_0 - a_1 \Delta Y_t - a_2 \Delta Y_{t-1} + \varepsilon_t \\ &= a_0 - a_1 \Delta^2 Y_t - (a_1 + a_2) \Delta Y_{t-1} + \varepsilon_t, \end{aligned} \tag{2}$$

where coefficient a_1 refers to the *impact effect* of output growth and the coefficient $a_1 + a_2$ to the *total effect* [Sögner, Stiassny 2000, p. 5].

As the extended version of equation (2) looks better specified, the simple version of Okun's law was able to capture much of the relationship between growth and unemployment for the U.S. economy [Knotek 2007, p. 89]. It is a typical feature of many studies that contemporaneous output growth has the largest impact on the unemployment rate.

The gap model of Okun's law takes the following form:

$$U_t - U^* = -\beta\left(Y_t - Y^*\right) + \varepsilon_t, \tag{3}$$

where U_t is actual unemployment, U^* is the natural rate of unemployment, Y_t is actual unemployment, Y^* is potential output.

Important advantage of the gap version of Okun's law is that it provides inference on time series behaviour over the business cycle [Lee 2000, p. 333]. According to equation (3), U^* is the econometric estimate of unemployment rate that would exist when the output gap was zero, i.e. economy was running at full and sustainable capacity. The parameter β measures the cyclical effects of unemployment of a one-percent increase in the GDP gap[4].

The gap model has important constraints as both full employment and potential output are not directly observable variables [Adanu 2002, p. 4; Knotek 2007, p. 76; Villaverde, Maza 2007, p. 3]. To obtain U^* and Y^*, several simple univariate techniques

---

–0.52 for Germany, –0.17 and –0.60 for France, –0.14 and –0.78 for Italy, –0.50 and –0.75 for the U.K., –0.33 and –0.48 for Canada, –0.23 and –0.67 for the Euro area, –0.65 and –0.58 for Netherlands, –0.48 and –0.95 for Spain, –0.25 and –0.38 for Sweden [Schnabel 2002, p. 1─2].

[4] At the end of the 1990s empirical studies of industrial countries revealed that the Okun's coefficient β was at the level as low as –0.12 for Japan and –0.15 for Austria, but as high as –0.61 for Finland and –0.82 for Netherlands [Sögner, Stiassny 2000, p. 9─10].

such as the removal of deterministic and quadratic trends, trend-cycle decomposition or first differencing were initially experimented with, but recently other methods, as the Hodrick─Prescott (HP), the Kalman, the Baxter─King filters, the Beveridge─Nelson decomposition or the Harvey structural time-series approach are used. If the output and unemployment series are cointegrated, than equation (3) is misspecified [Attfield, Silverstone 1997]. As reported by Canova [1998], different methods of detrending yield cyclical components with substantially different statistical properties. Estimation of the first-difference version is not without technical problems too, such as omitted variable bias, sectoral shifts (for example, from industry to services), possible cointegration between output and unemployment, as well as likely asymmetry between phase of increasing and decreasing output[5]; however, problems may not be too serious as the sample period is relatively short and purged of cyclical biases [Schnabel 2002, p. 4].

The rationale for an extended version of the Okun's first-difference equation is provided by a clear fact that the unemployment rate is not determined by the changes in output solely. As derived from the Cobb─Douglas function by Prachowny [1993], the change in the unemployment rate is a function of many more factors (in logs):

$$\begin{aligned}\Delta U_t = &-\eta\Delta\left(y - y^*\right) + \eta\alpha\Delta\left(k - k^*\right) + \eta\alpha\Delta\left(c - c^*\right) + \Delta\left(h - h^*\right) \\ &+ \Delta\left(s - s^*\right) + \Delta U^* + \eta\Delta\left(\tau - \tau^*\right),\end{aligned} \tag{4}$$

where $\eta = 1/(1-\alpha)$, and y is output, k is capital input, c is capital utilization rate, h is the average number of hours worked, s is labour supply, and τ is technological change (the superscript * refers to log-run equilibrium levels of the variables).

Equation (4) extends the gap-based version of Okun's law into the direction of more solid theoretical foundations and thus better understanding of the economy's idle resources [Knotek 2007, p. 77]. Even when $y = y^*$, unemployment will tend to fall under a decrease in the average number of working hours or the labour force, a decline in the capital stock or its utilization, or slower technical progress [Schnabel 2002, p. 4].

3. Empirical results

Empirical testing of the Okun's law in Poland is based mainly on the national quarterly data from 1997:Q1 to 2008:Q4, although annual data for a rather short 1992─2008 period are used to get a "feel" for the plausibility of the estimates obtained

[5] Although it is close to conventional wisdom that economic contractions are sharper and steeper whereas expansions are more gradual [Lee 2000, p. 345], seven euro zone countries do not confirm to this pattern [Mayes, Viren 2000, p. 22].

and for the potential parameter changes [Schnabel 2002, p. 4]. The data set includes the unemployment rate and real GDP growth, U_t and ΔY_t respectively (both are seasonally adjusted), and a nominal exchange rate, E_t. The sensitivity of Okun's coefficient estimates is further explored by taking into account regional data on annual basis. As Okun's coefficient is estimated for the pooled sample of 16 Poland's *voivodships*[6], the regional data set consists of annual unemployment and GDP growth series from 2000 to 2007. To provide a balanced treatment of Okun's law, either the first-difference or the gap versions are estimated, as suggested by Lee [2000, p. 333], although the former is preferred over the latter as a simpler and more reliable procedure not requiring strong — and sometimes controversial — assumptions regarding the definition and computation of potential output and natural rate of unemployment [Knotek 2007, p. 78].

The difference version. Taking into account that the sample period is relatively short, it should help to avoid abovementioned concerns on the estimation of a first-difference version of Okun's law [Schnabel 2002, p. 4]. First of all, the probability of any structural breaks for the sample period running from 1995 to 2008 is relatively low. As for the effects of the EU accession in 2004, they can be captured by a dummy. Possible asymmetry is not ruled out by a visual inspection of the quarterly business cycle (Fig. 1b), but this feature is not of critical importance for the first-difference version of Okun's law.

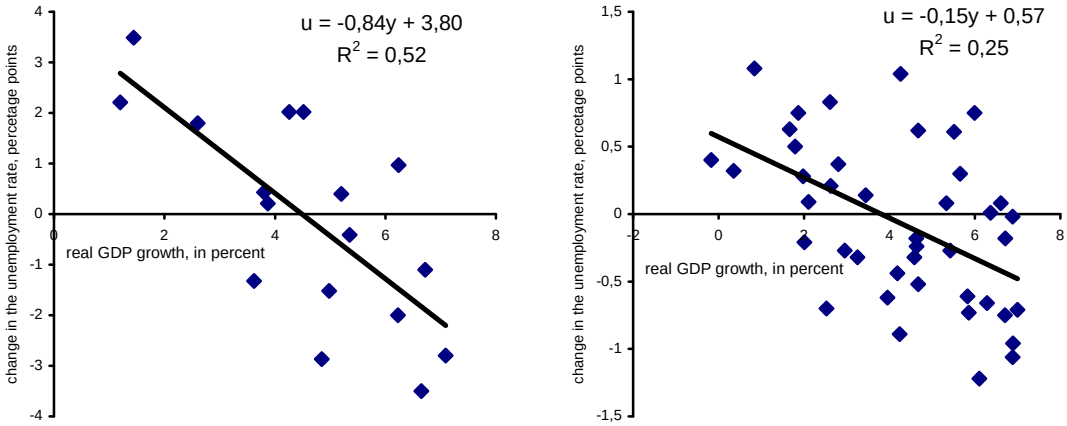
Fig. 2 is a scatter plot of annual and quarterly data for the periods of 1992─2008 and 1997:Q1─2008:Q4 respectively. The inverse relationship between the output growth and unemployment is rather obvious from both plots, with not many data points being far away from the regression line. The annual estimates imply that every percentage of GDP growth above its potential value (as implied by the constant term) decreases the unemployment rate by 0.84 percentage points (Fig. 2a). The Okun's coefficient for quarterly data is slightly lower (Fig. 2b)[7]. Dividing the constant term by the Okun's coefficient, we obtain the rate of output growth consistent with a stable unemployment rate, i.e. 4.5 percent for annual data and 3.8 percent for quarterly data[8]. Assuming that the quarterly data sample starts in 1997 compare to 1992 for the annual data sample, the results above can be interpreted that with the transformation process in

[6] Such studies have been conducted for Canada [Adanu 2002] and Spain [Villaverde, Maza 2007, p. 1─11], but in a standard time-series fashion.

[7] If divide the annual Okun's coefficient by four, we obtain 0.21 comparing to 0.15 in the estimated regression with quarterly data.

[8] As mentioned by Schnabel [2002, p. 4], the growth rate derived by setting $\Delta U_t = 0$ can best be interpreted as the rate of output growth which is compatible with a constant rate of unemployment and not necessarily as potential output growth.

progress the economy can keep stable level of unemployment with slower output growth. As the GDP growth rate averaged 5.9 percent over the 2006─08 period, it has contributed to an annual fall in the unemployment rate of about 1.2 percentage points, with a cumulative decrease in the unemployment rate of 3.6 percentage points or about a half of the actual decline in unemployment rate (Fig. 1a).



a) annual data, 1992─2008; b) quarterly data, 1997─2008;

Fig. 2. The difference version of Okun's law

Source: personal calculations based on the *International Financial Statistics* data

Using the same quarterly data sample from 1997:Q1 through 2008:Q4, the 2SLS estimates of the difference and dynamic versions of Okun's law are as follows:

$$\begin{array}{lll} \Delta U_t = & 0.512 & -0.125\Delta Y_t, \\ & (2.396^{**}) & (-3.382^{**}) \\ & R^2 = 0.57 & DW = 2.50 \quad ADF = -2.310 \end{array} \tag{5}$$

$$\begin{array}{llll} \Delta U_t = & 0.414 & -0.107\Delta Y_t & +0.020\Delta E_t, \\ & (1.891^{***}) & (-2.931^{*}) & (2.159^{**}) \\ & R^2 = 0.60 & DW = 2.56 & ADF = -9.968^{*} \end{array} \tag{6}$$

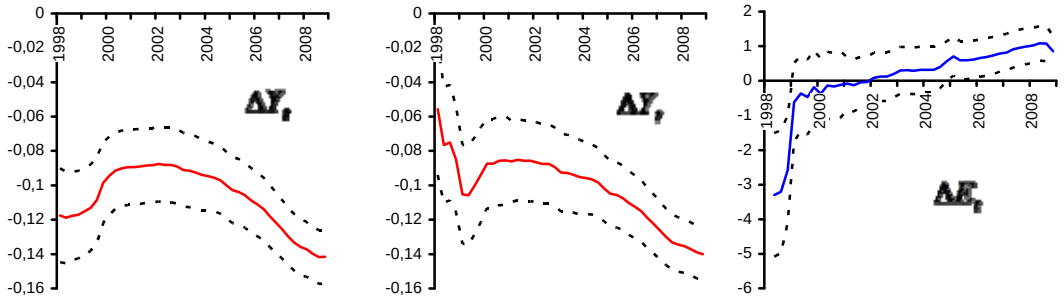
which confirm the inverse relationship between the output growth and changes in the unemployment rate. Equations (5) and (6) imply a stable level of unemployment with the GDP growth of 4.1 and 3.9 percent, respectively, which is very close to the quarterly estimates above (Fig. 2). Comparing to equation (5), estimates in the extended specification of equation (6) have better ADF statistics of the residuals stationarity. Experiments with the lagged unemployment and GDP growth have not been much productive, as the statistical significance of the constant term has been lost. No effects of the EU accession in 2004 has been detected either.

The inverse relationship between the GDP growth rate and changes in unemployment is further confirmed within a Kalman filter framework with recursive time-varying coefficients:

$$\Delta U_t = a - b_t \Delta Y_t + c_t \Delta E_t + \upsilon_t, \tag{7}$$

$$b_t = b_{t-1}, \quad c_t = c_{t-1}, \tag{7a)–(7b)}$$

where υ_t is the stochastic factor, and transition equations (7a)–(7b) represent TVP measurement procedures.



a) the difference version; b) the dynamic version;

Fig. 3. Unemployment rate and business cycle in Poland (in percent)

Note: the solid line is the point estimate, while the dotted lines represent a one-standard error confidence band around this point estimate; the estimated components begin in 1998:Q1 because a four-quarter training sample is used to start up the Kalman filter.

Source: personal calculations

As equation (7) corresponds to a dynamic version of Okun's law, it reduces to a difference version by dropping out the ΔE_t term. Fig. 3 presents TVP estimates for both difference and dynamic versions of Okun's law. If not count for a nominal exchange rate, the value of *b* decreased in absolute value from –0.12 to –0.09 over the 1998–2001 period, following a distinct upward trend since the beginning of 2002 (Fig. 3a). Estimates of *b* for the dynamic version of Okun's law reveal a different pattern for the 1998–99 period, but since then TVP estimates demonstrate considerable similarities. As of the end of 2008, a percentage point of GDP growth contributes to a decrease of the unemployment rate by 0.14 percentage points. The ratio of the estimated constant term of 0.57 for both specifications to the Okun's coefficient implies an average annual potential GDP growth rate around 4.0 percent, which is consistent with the quarterly fixed-coefficient estimates of the regressions (5) and (6). As the coefficient on ΔY_t has been decreasing since 2002, it further supports an assumption of a lower GDP growth rate required to keep unemployment stable.

Compared with earlier studies [Arendt 2005, p. 1─23; Czyżewski 2002, p. 123─133; Kwiatkowski *et al.* 2004, p. 39─68], our estimations provide with a lower jobless GDP growth rate. If the GDP growth rate falls to 1.7 percent on an annual basis, as it is forecasted for 2009 by the Polish government [Rostowski 2009], or roughly 2.5 to 3 percentage points below the potential growth rate, it means an increase in the unemployment rate in the range from 1.6 percentage points according to the latest time-varying Okun's coefficient (Fig. 3a,b) to 2.4 percentage points as suggested by the annual estimates (Fig. 2a). Quarterly estimates of the fixed-coefficient models (5) and (6) imply a slightly lower increase in the unemployment rate of 1.3 percentage points, but it is still a significant loss of employment.

For comparison with the time series Okun's coefficient estimates, a standard OLS estimation of the trade-off between GDP growth and unemployment for the pooled data sample of Poland's *voivodships* has been employed. The results are as follows:

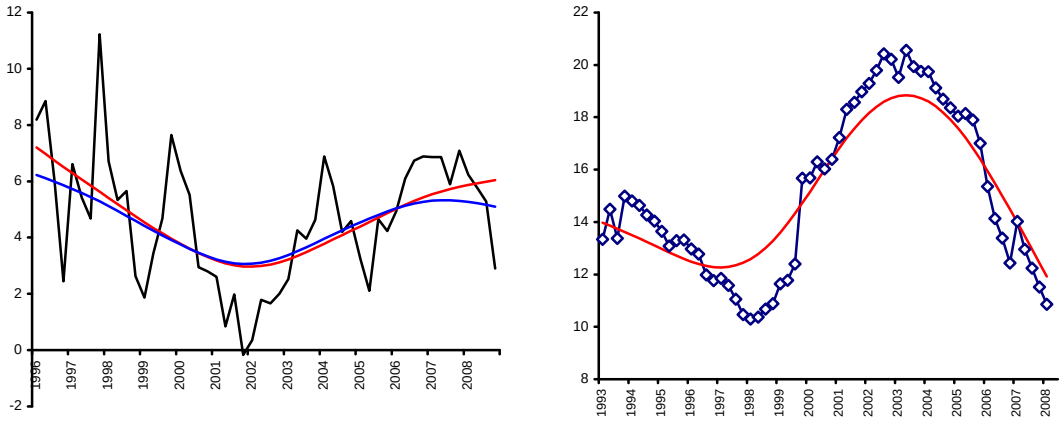
$$\begin{array}{lccc} \Delta U_t = & 3.150 & -0.388\Delta Y_t & -0.378\Delta Y_{t-1}. \\ & (2{,}560^{**}) & (-3.999^{*}) & (-3.897^{*}) \\ & R^2 = 0.25 & DW = 2.12 & \end{array} \tag{8}$$

A negative correlation between real GDP growth and the unemployment rate is confirmed, with the sum of coefficients on ΔY_t and ΔY_{t-1} being close to national data estimates (Fig. 2a). Contrasting with Kwiatkowski, Tokarski [2007, p. 451─453], the changes in the regional unemployment rate are not dependent on the lagged unemployment rate[9]. To test for the effects of structural developments, the industrial output/GDP ratio and investment per capita were included into the regression, but all coefficients were statistically insignificant. It means that the structural shifts work directly through the output channel, with no independent non-output mechanisms.

Estimations of the gap version. Similar to other studies [Knotek 2007; Lee 2000 p. 331─356; Villaverde, Maza 2007], in order to obtain trends in the unemployment rate and real GDP growth as a proxy for the natural rate of unemployment and potential output, respectively, the HP filter has been applied (the value of $\lambda = 1600$ has been used, as suggested for quarterly data), although there are suggestions of using a few alternative detrending methods as a way to produce robust estimation results [Grant 2002, p. 95─113]. Actual GDP growth and unemployment rates and their trends are presented on Fig. 4. As the output gap measures, the difference between actual and HP

[9] Kwiatkowski, Tokarski [2007, p. 451─453] found a much weaker relationship between growth and unemployment, as a 1 percent of annual GDP growth contributes to a decline in the changes of the unemployment rate by 0.1 percentage points.

detrended GDP growth rates, $\Delta Y_t - \Delta \overline{Y}_t^{*1}$, the difference between actual GDP growth rate and the growth rate of HP-filtered trend, $\Delta Y_t - \Delta \overline{Y}_t^{*2}$, and the percentage deviation of actual GDP from its long-run trend, $Ygap = \left(Y / \overline{Y} - 1\right) * 100$, are chosen.



a) the GDP growth rate; b) the unemployment rate;

Fig. 4. Actual and trend GDP growth and unemployment rates (in percent), 1992–2008

Source: personal calculations based on the International Financial Statistics data

Although both HP-filtered variables are highly correlated, ΔY_t^{*2} indicates a GDP slowdown since the beginning of 2007 to 5.1 percent, while this feature is not captured by ΔY_t^{*1} with a percentage point higher GDP growth estimate of around 6 percent. The actual unemployment rate has been below the natural rate for the 1997–99 period and again since 2006, being recently quite close to the latter. The values of U^* declined from 14 to 12.5 percent in 1993–98[10], then increased as high as to 19 percent in 2003, and has fallen below 12 percent as of the end of 2008. Similar uniformity of actual and natural unemployment rates is a feature of the 2000–01 period, though for an upward-sloping trend. In contrast to other estimations of U^* [Arendt 2005, p. 15–17; Kwiatkowski et al. 2002, p. 336], the natural rate of unemployment was above actual trend in 1997–99. For the 1997–2003 period, our estimates of the natural rate of unemployment at 12.3–18.8 percent (Fig. 4b) can be compared with other studies: 10–15 percent for the 1998–2002 period, 12–14 percent for the 1997–2002 period, 15.75 percent in 2002 (up from 13.75 percent in 1995), 16 percent in 2002, 12 percent for the 1995–2003 period, 14.1 percent for the 2000–02 period [Arendt 2005, p. 15–18].

[10] During the 1993–98 period, a downward trend in the equilibrium unemployment rate used to be explained by the reduction in structural unemployment [Kwiatkowski et al. 2002., p. 336] .

Estimations of the gap version of Okun's law are as follows:

$$\begin{aligned}(U_t - U_t^*) = {} & 0.909(U_{t-1} - U_{t-1}^*) - 0.093(\Delta Y_t - \Delta Y_t^{*1}) + 0.017\Delta E_t, \\ & (12.384^*) \qquad (-2.797^*) \qquad (2.031^{**}) \\ & R^2 = 0.91 \qquad DW = 2.35 \qquad ADF = -8.234^*\end{aligned} \tag{9}$$

$$\begin{aligned}(U_t - U_t^*) = {} & 0.906(U_{t-1} - U_{t-1}^*) - 0.103(\Delta Y_t - \Delta Y_t^{*2}) + 0.017\Delta E_t, \\ & (15.952^*) \qquad (-3.182^*) \qquad (2.043^*) \\ & R^2 = 0.92 \qquad DW = 2.31 \qquad ADF = -8.352^*\end{aligned} \tag{10}$$

$$\begin{aligned}(U_t - U_t^*) = {} & 0.711(U_t - U_t^*) - 0.186Ygap_t + 0.020\Delta E_t. \\ & (5.566^*) \qquad (-3.361^*) \qquad (2.719^*) \\ & R^2 = 0.92 \qquad DW = 2.44 \qquad ADF = -8.493^*\end{aligned} \tag{11}$$

If output growth is 1 percentage point above the growth rate potential for a quarter (Fig. 4a), the actual unemployment rate falls by about 0.1 percentage point below the natural rate (equations (9) and (10)), which closely corresponds to the first-difference estimations of Okun's law (equations (5) and (6)). According to the gap estimates (equation (11)), a 1 percent increase of GDP above its potential level causes a decrease in the unemployment by 0.19 percentage points. Similar to the first-difference estimates (equation (6)), the depreciation of the *zloty* is a factor behind higher unemployment rate. Such an outcome only strengthens the conclusion on the direct depreciation-unemployment relationship, but it is not supported by the time-varying estimates, as it was the case in our previous study [Shevchuk 2009, p. 63─78].

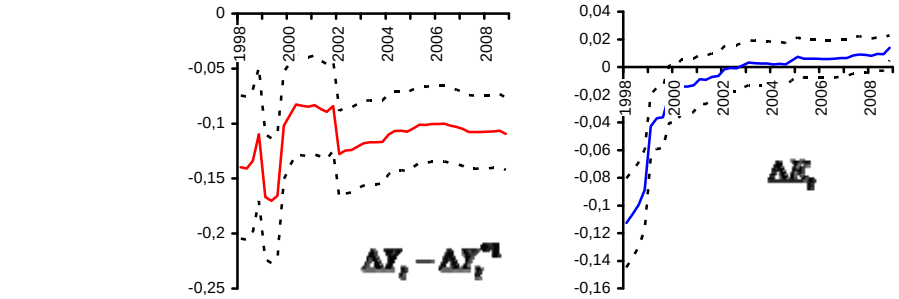
The following model with recursive coefficients has been estimated with the Kalman filter:

$$\Delta(U_t - U_t^*) = a_t\Delta(U_{t-1} - U_{t-1}^*) - b_t(\Delta Y_t - \Delta Y_t^*) + c_t\Delta E_t + \nu_t, \tag{12}$$

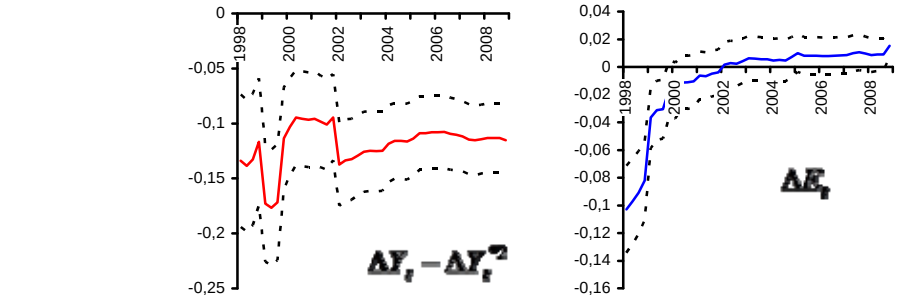
$$a_t = a_{t-1}, \quad b_t = b_{t-1}, \quad c_t = c_{t-1}, \tag{12a)─(12c)}$$

where ν_t is the stochastic factor, and equations (12a)─(12c) represent TVP measurement procedures.

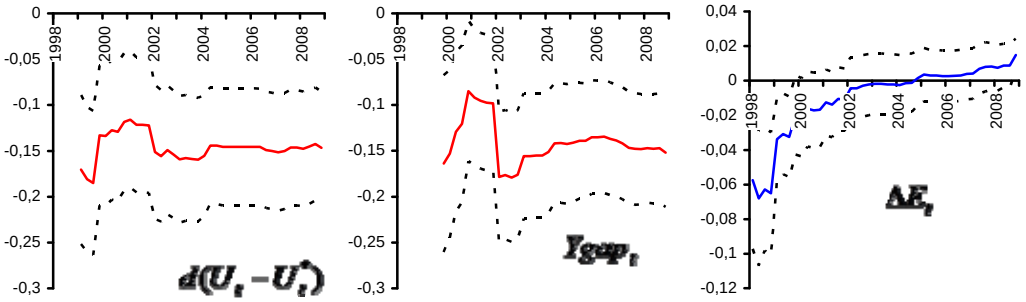
The recursive TVP estimates of the unemployment gap are presented in Fig. 5. Models I and II exclude the lagged value of the unemployment rate gap, while this feature is counted for in the Model III. TVP estimates of Okun's coefficient in the gap version reveal some sort of instability, but it is not of critical importance. For models I and II, a large change in the estimate of the Okun's coefficient occurred around 2000 and 2002, but it has been consistently negative. Over the last two years, the value of



a) Model-I;



b) Model-II;



b) Model-III;

Fig. 5. Unemployment rate and business cycle in Poland (in percent)

Source: personal calculations

Okun's coefficient has persisted at the level of –0.11. Model III presents similar pattern of β, but with more instability during the 1998─99 period (not shown in Fig. 5c). As indicated by the Kalman filter, a weaker *zloty* has contributed to a decrease of unemployment till the end of 2000, then turned to be neutral in respect to the unemployment rate, with a weak negative effect established over the 2007─08 period.

Conclusions

Our findings suggest that the inverse relationship between GDP growth and unemployment is well-established in Poland, with no significant differences detected between difference and gap versions of Okun's law estimated with different econometric techniques. The GDP growth rate of above 3.8 to 4.5 percent is necessary to reduce the unemployment rate in Poland. Quantitative estimates do not differ across

the versions of Okun's law as well as data samples. For the difference version, each percent of the GDP growth in excess of its potential level is associated with a decrease in the unemployment rate from 0.09 to 0.14 percentage points. According to the gap version of Okun's law, estimates of the quarterly data suggest that an increase in the unemployment rate of 0.12 to 0.15 percentage points above its HP-filtered natural rate is expected for a 1 percent shortfall of output from its potential growth rate.

As the real GDP growth averaged about 5.9 percent in 2006─08, well above the natural rate of output growth, it has contributed about 3.4 to 3.5 percentage points to a steep decline in the unemployment rate from 17.8 to 9.5 percent (or by 8.3 percentage points). For 2009, an expected GDP growth slowdown to 1.7 percent, or approximately 2.5 to 3 percentage points below the potential growth rate, means an increase in the unemployment rate by 1.6 to 2.4 percentage points according to the quarterly and annual estimates, respectively. Comparisons of Okun's coefficients for longer annual data sample and shorter quarterly data sample may imply that faster economic growth was required in the 1990s to maintain a given level of the unemployment rate.

The TVP estimates have also documented that Okun's law has been a relatively stable relationship, with a weak downward trend since 2002 obtained in the first-difference estimates. The gap version reveals two structural shifts in 2000 and 2002, with relative stability of the Okun's coefficients within the –0.11 to –0.14 band to follow. Among other results, it is established for the dynamic version of Okun's law that the depreciation of the *zloty* contributes to an increase in the unemployment rate, but this outcome has a weak support by the TVP estimates only since 2005. No evidence was found for the share of industrial output in the GDP and investment per capita to have an impact upon the unemployment rate of Polish *voivodships*.

Bibliography

Adamczyk A., Tokarski T., Włodarczyk R. [2006], *Bezrobocie transformacyjne w Europie Środkowej i Wschodniej*, „Gospodarka Narodowa", vol. XVII, no. 9, p. 1─33.

Adanu K. [2002], *A Cross-Province Comparison Of Okun's Coefficient For Canada*, Working Paper EWP 0204, Victoria: University of Victoria.

Annett A. [2008], *What Can Poland Learn From Other European Union Countries in Terms of Labor Market Reforms?*, IMF Country Report No. 08/131, Washington: International Monetary Fund, p. 53─81.

Arendt L. [2005], *Próba oszacowania NAIRU dla Polski*, „Gospodarka Narodowa", vol. XVI, no. 5─6, p. 1─23.

Attfield C., Silverstone B. [1998], *Okun's Law, Cointegration and Gap Variables*, „Journal of Macroeconomics", *v*ol. 20, no. 3, p. 625-637.

Blanchard O. [1999], *Macroeconomics*, 2nd Edition, N.Y.: Prentice Hall.

Canova F. [1998], *Detrending and Business Cycle Facts*, „Journal of Monetary Economics", vol. 41, no. 3, p. 475─512.

Czyżewski A. [2002], *Wzrost gospodarczy a popyt na pracę*, „Bank i Kredyt", no. 11─12, p. 123─133.
Freeman D. [2000], *Regional Tests of Okun's Law*, „International Advances in Economic Research", vol. 6, no. 4, p. 557─570.
Grant A. [2002], *Time-varying estimates of the natural rate of unemployment: A revisitation of Okun's law*, „The Quarterly Review of Economics and Finance", vol.42, issue 1, p. 95─113.
Harris R., Silverstone B. [2001], *Testing for asymmetry in Okun's law: A cross-country comparison*, „Economics Bulletin", vol. 5, no. 2, p. 1─13.
Huang H.-C., and Lin S.-C. [2008], *Smooth-time-varying Okun's coefficients*, „Economic Modelling", vol. 25, issue 2, p. 363─365.
Izyumov A., Vahaly J. [2002], *The Unemploymment─Output Tradeoff in Transition Economies: Does Okun's Law Apply?*, „Economics of Planning", vol. 35, no. 2, p. 317─331.
Khemraj T., Madrick J., Semmer W. [2006], *Okun's Law and Jobless Growth*, Policy Note No. 3, N.Y.: Schwartz Center of Economic Policy Analysis.
Knotek E. [2007], *How useful is Okun's Law?*, „Economic Review", 4th Quarter, Kansas: Federal Reserve Bank of Kansas City, p. 73─103.
Kwiatkowski E., Kucharski L., Tokarski T. [2002], *Bezrobocie i zatrudnienie a PKB w Polsce*, „Ekonomista", no. 3, p. 329─346.
Kwiatkowski E., Roszkowska S., Tokarski T. [2004], *Granice wzrostu bezzatrudnieniowego w Europie i krajach WNP*, „Ekonomista", no. 1, p. 39─68.
Kwiatkowski E., Tokarski T. [2007], *Bezrobocie regionalne w Polsce w latach 1995─2005*, „Ekonomista", no. 4, p. 439─455.
Lee J. [2000], *The Robustness of Okun's Law: Evidence From OECD Countries*, „Journal of Macroeconomics", vol. 22, no. 2, p. 331─356.
Mayers D., Virén M. [2000], *Asymmetry and the problem of Aggregation in the Euro Area*, Bank of Finland Discussion Papers No. 11/2000, Helsinki: Bank of Finland.
Misztal P. [2007], Wzrost gospodarczy, zatrudnienie i bezrobocie w krajach członkowskich Unii Europejskiej, „Ekonomista", no. 4, p. 541─557.
Moosa I., [1997], *A cross-Country Comparison of Okun's Coefficient*, „Journal of Comparative Economics", vol. 24, issue 3, p. 335─356.
Prachowny M. [1993], *Okun's Law: Theoretical Foundations and Revised Estimates*, „The Review of Economics and Statistics", vol. 75, no. 2, p. 331─336.
Rostowski J. [2009], *Przez kryzys idziemy inną drogą*, „Rzeczpospolita", 13 lutego.
Rudebusch G. [1995], *New Estimates of the Recent Growth in Potential Output*, Federal Reserve Bank of San Francisco Weekly Letter, no. 95─40.
Schnabel G. [2002], *Output trends and Okun's law*, BIS Working Papers No. 111, Basel: Bank of International Settlements.
Shevchuk V. [2009], *Exchange rate dynamics and unemployment in Eastern European Countries*, [in:] Współczesne problem modelowania i prognozowania zjawisk społeczno-gospodarczych, J. Pociecha (red.), University of Economics, Cracow, p. 63─78.
Sinclair T. [2009], *The Relationships Between Permanent and Transitory Movements in U.S. Output and the Unemployment Rate*, „Journal of Money, Credit and Banking", vol. 41, no. 2─3, p. 529─541.
Sögner L., Stiassny A. [2000], *A Cross-Country Study on Okun's Law, Working Paper Series: Growth and Employment in Europe: Sustainability and Competitiveness*, Vienna: Vienna University of Economics and Business Administration.
Turturean G. [2007], *Okun's law for Romania during 1992─2004*, Munic Personal RePEc Archive Paper No. 10638.
Villaverde J., Maza A. [2007], *Okun's law in the Spanish regions*, „Economics Bulletin", vol. 18, no. 5, p. 1─11.