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## **Empirical Analysis of A.W. Phillips Curve in Poland under Transition**

### **Abstract**

One of the most frequently discussed important problems which arise in the process of stabilization policy implementation is a simultaneous achievement of a stable value of money and a low rate of unemployment. In the related literature this interdependence is known as A.W. Phillips curve and its interpretation is different in the Keynesian economics and in the monetarist approach.

According to the Keynesian school of economic thought such relationship reveals negative correlation between rate of inflation and rate of unemployment. The acceptance of the idea of trade-off between inflation and unemployment is very important for stabilization policy, because it shows possible consequences of anti-inflationary policy of central banks. The A.W. Phillips curve idea was subject to criticism from the monetarist economic school (especially by M. Friedman). M. Friedman pointed out that in the long run, the A.W. Phillips curve is vertical, i.e., there is no trade-off between unemployment and inflation.

The aim of this paper is an empirical analysis of the nature of dependencies which constitute A.W. Phillips curve in the Polish economy under transformation. Studies are conducted on the basis of quantitative and qualitative data in the years 1992 - 2006. In the Polish economy the analyzed period is a time of transition from the centralized system into the market economy with a simultaneous adjustment of Poland's economic conditions to the European Union standards. The results of the analysis made it possible to identify relationships between studied variables, and they assessed the probability of using monetary policy as a tool of determining situation on the Polish labour market.

**Key Words:** Phillips curve, Stabilization policy

**JEL Classification:** E24, E31, E52

## **1. Introduction**

One of the main problems which occur in particular economic systems during the process of implementation of short- and medium-term stabilization policy is how to simultaneously achieve the stable value of money and equilibrium on the labour market. These questions are interpreted in a different way by particular schools of contemporary economic thought and the most significant differences exist between Keynesian economics, where these relationships are known as A.W. Phillips curve, and the monetarist school. The character of these relations depends not only on the time factor taken into account in the analysis but also on economic, institutional, legal and social conditions of given economic systems.

The aim of this paper is an empirical analysis of A.W. Phillips curve, i.e., the relation between the rate of inflation and the rate of unemployment in the Polish economy during systemic transformation which was also a period of adjustment to the EU standards.

Empirical analyses are conducted on the basis of monthly time series of quantitative indicators (consumer price indexes, gross nominal wages in the business sector, rate of unemployment) and qualitative indicators estimated by means of business survey method. The other group of subjective data includes the series of expectations of economic entities concerning selling prices, inflation and anticipated unemployment. The period under analysis covers the years 1992-2006 due to accessibility of comparable, continuing empirical data of both quantitative and qualitative indicators.

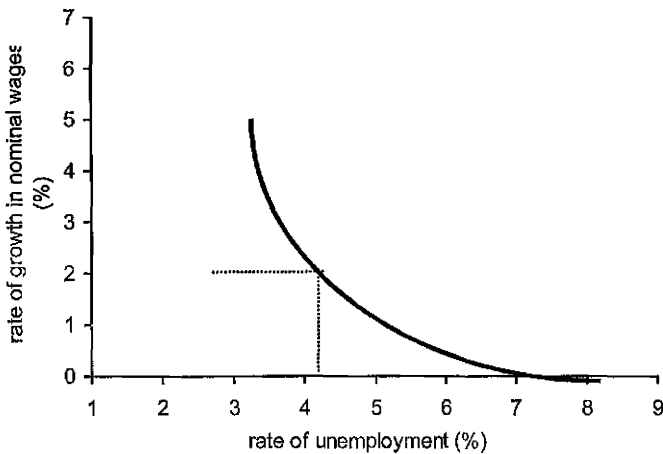
## **2. Hypothetical interpretation of relationship between situation on the labour market and value of money**

According to the related literature, one of the first economists of the Keynesian school who analyzed the relationship between the situation on the labour market and the value of money was Phillips (1958), a professor of the London School of Economics. His empirical analyses conducted for the British economy in the years 1896-1957 proved that the policy of full employment had inflationary consequences because the growth in employment (decline in unemployment) meant higher inflation. The primary form of Phillips curve described the relationship between the dynamics of growth in nominal wages and the level of employment measured by means of

unemployment rate (Figure 1)<sup>3</sup>. This relationship was negative and non-linear and with unemployment rate equaling 5.5% the rate of growth in nominal wages amounted to 0%. When the rate of unemployment was 2.5%, the rate of growth in nominal wages reached about 2.0% (Milewski, 2004, p. 575).

Phillips explained the non-linear character of the above-mentioned relationship by relative rigidity of wages when they decrease, which means that under growing unemployment the rate of decline in nominal wages is relatively low. If the situation on the labour market improves (unemployment decreases), then nominal wages increase relatively fast.

**Figure 1** Primary form of Phillips curve



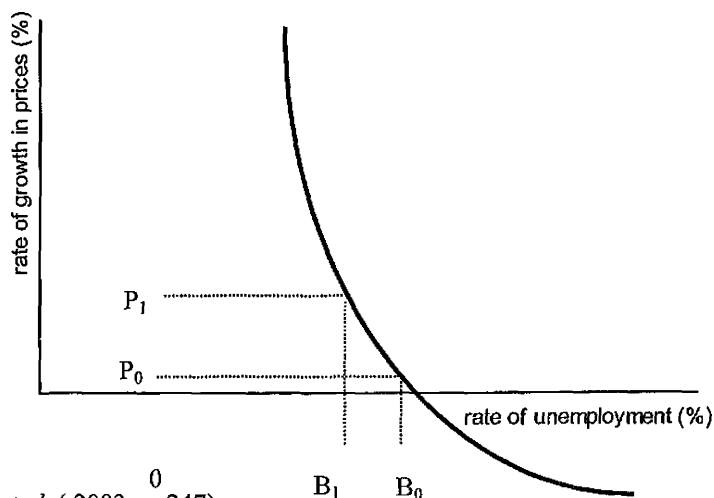
Source: Milewski (2004, p. 575).

The significance of Phillips curve for stabilization policy increased when Samuelson and Solow (1960) formulated a thesis about directly proportional relationship between the dynamics of growth in nominal wages and the rate of growth in prices. In this way a modified Phillips curve was created, depicting an inverse

<sup>3</sup> Further work in this field was done by Lipsey (1960) who, while interpreting the Phillips curve, stated that the rate of change of nominal wages depends on the surplus of the supply of labour force on the market, measured by the rate of unemployment. This led to a theoretical concept called Phillips-Lipsey model in the related literature. More on the subject see: Welfe (1993, p. 79).

relationship between the dynamics of the growth in prices (inflation) and the rate of unemployment (Figure 2).

**Figure 2** Modified Phillips curve



Source: Begg *et al.* (2003, p. 247).

These considerations provide an important guideline for the stabilization policy according to which there exists a trade-off between inflation and unemployment, i.e., one can choose between higher inflation and lower unemployment or between lower inflation and higher unemployment. When the existing rate of unemployment is regarded as too high ( $OB_0$ ), then under given inflation ( $OP_0$ ), as a result of the implemented expansive monetary and fiscal policy the situation on the labour market may be improved (the rate of unemployment may be limited to  $OB_1$  level) but at the expense of inflation rising to  $OP_1$ .

The concept of modified Phillips curve proved right in the economic reality of many highly developed market economy countries and in the 1960s it became a basis for implementing stabilization policy. Application of this curve in empirical studies for the American economy in the 1960s led to the conclusion that it would be possible to achieve an inflation free state if unemployment rate amounted to 6-8%. The rate of unemployment not exceeding 3-4% of the labour force would be possible only when the rate of inflation was contained in the interval 4-6% (Hübner, 1992, pp. 36-44).

In the mid-1970s economic reality in the market economy countries proved that the Phillips curve concept could not be sustained any longer. Contrary to the thesis about a trade-off between inflation and unemployment, many highly developed countries

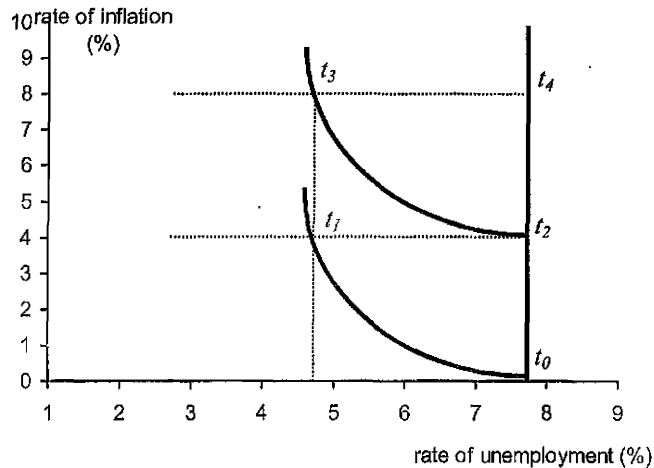
experienced both high levels of inflation and unemployment in that period. This new phenomenon was called stagflation and theories based on the Phillips curve failed to explain it. In this situation new theoretical hypotheses concerning money illusion and natural rate of unemployment emerged. Economists started to search for the factor which caused disappearance of trade-off between inflation and unemployment. Friedman (1968) and Phelps (1968) independently came to a conclusion that inflationary expectations are responsible for this. Friedman (1968, p. 8) formulated the link between inflation and unemployment in the following way: "... there always exists a temporary trade-off between inflation and unemployment, however, there is no permanent trade-off. A temporary trade-off does not result from inflation per se but from unpredictable inflation and this generally means – from the growing rate of inflation". In Friedman's analyses a significant role was played by natural rate of unemployment and the assumption that rational economic agents would always set wages and prices dependent on the expected rate of inflation and these expectations are of adaptive character. Expectations as to the level of inflation differ from actual rates of inflation which results not only from a gradual adaptation of expectations to real changes but also from incomplete information. Within a short-run the difference between the expected rates and the actual ones is bigger which shows that the conclusions formulated on the basis of Phillips curve are true (Pollok, 2000, pp. 16 - 17).

Figure 3 presents Phillips curve in Friedman – Phelps' approach. The long-run Phillips curve may be presented by means of a line parallel to the vertical axis. It crosses the horizontal axis at the point of natural unemployment rate equaling 6%. Sections  $t_0t_1$  and  $t_2t_3$  mark the short-run Phillips curves resulting from interventionist policy of the state. Sections  $t_1t_2$ ,  $t_3t_4$  mark the growth of unemployment up to the level of natural rate, after economic entities have considered the information on the real rate of inflation in their current decisions.

Point  $t_0$  demonstrates equilibrium between zero rate of inflation and 6% natural rate of unemployment. With the assumption that the state implements expansive monetary and fiscal policies in order to reduce unemployment below its natural rate, the growth in money supply results in higher production and employment and, consequently, higher nominal wages and unexpected increase in prices. Unemployment is reduced to 3% under inflation of 4% (point  $t_1$ ). The growth in employment occurs under money illusion of employees who treated the growth in nominal wages as the one in real terms and due to this fact they increased the supply of labour. The higher number of employees is only temporary because in the course of time they realize that their

inflationary expectations were wrong and adjust them to the actual inflation which in the figure amounts to 4% (a hypothesis of adaptive expectations). Employees will demand higher nominal wages which will boost real wages. Employment will fall to the initial level determined by the natural rate of unemployment but under inflation of 4% (point  $t_2$ ). When the state implements again an expansive policy, unemployment decreases to 3% but inflation will equal 8% (point  $t_3$ ). Employment will be lowered again to the level of natural rate of unemployment, however, under the expected rate of inflation of 8% (point  $t_4$ ). Therefore, it can be assumed that for each of the expected levels of inflation there exists a separate Phillips curve and changes in inflation shift them upwards to the right (Winiecki, 1984, p. 22).

**Figure 3** Long – run Phillips curve



Source: Winiecki (1984, p. 22).

The long-run Phillips curve in Friedman-Phelps model is of vertical straight line intersecting points  $t_0$ ,  $t_2$ ,  $t_4$ . This means that it is not recommendable to apply expansive monetary or/and fiscal policies to curb unemployment because the trade-off between inflation and unemployment may occur only within a short period. Positive results of this policy (reduced unemployment) are disproportionately small as compared to negative consequences (higher inflation). State interventionism causes destabilization which in the long run leads to increasingly high actual and expected rate of inflation (Pollok, 2000, p. 17).

Another conclusion from these considerations is that a restrictive monetary policy may be used in order to reduce inflation. Although a decline in money supply may cause the growth in unemployment above its natural rate, after some time the economy will return to its natural state, however, with inflation at a lower level (Milewski, 2004, p. 578).

Discussions concerning the Phillips curve were also held by advocates of the new classical macroeconomics who assumed the hypothesis of rational expectations. According to them both current and expected decisions formulated by economic entities, as well as adjustment processes, occur instantly. Therefore, the situation in which nominal magnitudes are treated as the real ones cannot arise. When economic entities have full access to information, they are able to anticipate inflation correctly which means that an unemployment/inflation trade-off does not occur in the short-run either and the policy of curbing unemployment at the cost of inflation will inevitably fail (Socha, 1987, p. 86). Such a policy brings about unintended results leading to the growth in inflation.

The above-presented theoretical considerations concerning relationships between changes on the labour market (rate of unemployment) and nominal wages as well as the rate of inflation relate to the economies with well-developed market mechanisms. As empirical analyses in the further part of the paper concern the relations occurring in the economy under transformation, it should be emphasized that the nature of these relations, their impact and time lags may be different from those in the market economies.

Those differences may be caused, among others, by the following factors:

- the level of economic development in the economies under transition is relatively low, their economic structures are different and the dynamics of economic growth is relatively high. Goals, instruments and influence of the state authorities on the economic phenomena and processes are also different;
- in the economy under transformation market mechanisms are not flexible and fully effective, which is caused, among others, by: absence of well-developed market infrastructure, limited access to instant and full information, frequent administrative impact of the state on the market;
- changes in nominal wages are generated not only by market factors - they result from structural changes, are an effect of the activity of trade unions or, finally, a political battle between particular lobbies. The reasons for inflationary processes are not homogeneous either;

- origin of unemployment in the economy under transition is frequently different from that in the highly developed countries. Moreover, institutional, structural and business activity factors play a different role not only in the origin of unemployment but also in its development over time.

### **3. Empirical analysis of relationships between changes in nominal indicators and situation on the labour market in Poland under transformation**

#### **3.1. Subject and time range of analyses**

For the analytical problem discussed in the paper, it was necessary to determine some indicators the observation of which would make it possible to estimate relationships associated with the concept of A.W. Phillips curve. To do so, it is indispensable to define the measures which will describe changes occurring in the nominal sphere.

As has been mentioned before, Phillips initially focused on nominal wages. Bearing this approach in mind, this paper assumes that nominal wages are the average gross monthly compensation in the business sector. This means that the analysis does not take into account tax burden and social security contributions. Therefore, this type of measure should not be confused with income from labour. Where necessary indexes of dynamics of gross wages were estimated and each time on the basis of analogical period of the previous year. The measure obtained in this way can be defined as wage inflation. The studied series were changed into natural logarithms.

Another nominal measure was the indicator of prices for consumer goods and services. Again the indexes of dynamics were calculated against the analogical period of the previous year and expressed in natural logarithms. The series obtained identifies inflation.

The situation on the Polish labour market is described by means of unemployment rate registered by labour offices. This is the measure obtained from the calculations which use a definition of an unemployed person according to the Polish legislation. Therefore, the obtained data can only be applied for Poland because other countries may have different definitions as regards the right to be unemployed, which is particularly visible in the case of students or graduates. Thus it should be underlined that this paper does not use the data obtained according to the assumptions of the International Labour Organization and collected through labour force surveys.



Rejection of this measure resulted from inconsistencies in the process of its construction and from the fact that the data were collected on a quarterly basis<sup>4</sup>. The rate of unemployment was determined with reference to demographically corrected data from the National Census of 2002.

Apart from the quantitative series observed on a monthly basis and processed on the basis of source materials from the Central Statistical Office in Warsaw, qualitative data were also used in this paper. The authors referred to studies on business activity conducted by the Central Statistical Office and used the results showing the expected employment and the expected selling price. Additionally the authors analyzed the expected inflation also estimated as the indexes of dynamics against the analogical period of the previous year. The related data are collected by the National Bank of Poland in cooperation with IPSOS<sup>5</sup>.

All the series used in this paper were collected on a monthly basis. Although transformation of the Polish economy started in January 1990, the analysis was limited to the period from January 1992 to March 2006. The authors decided to neglect the first two years because what Poland experienced at that time was undoubtedly a transformation shock with the symptoms of hyperinflation and the emergence of registered unemployment. After initial 24 months it was possible to implement some principles of market economy which created the conditions to verify hypotheses posed by the theory of economics.

Time horizon of the analysis where qualitative indicators provided by the Central Statistical Office were used was also shortened to June 1992 – March 2006. This was due to the fact that at that time the Central Statistical Office started to monitor changes in the Polish economy by means of business tendency surveys. Each time the data were seasonally adjusted using Census X12 method.

### 3.2. Estimation of Phillips curve

Figure 4 shows key magnitudes for the analysis of relationships in the spirit of Phillips curve<sup>6</sup>. Throughout the whole studied period one can see a clear disinflation trend which (bearing in mind hyperinflation of 1990) proves that activities of the economic authorities were effective. Undoubtedly the monetary policy carried out by the National Bank of Poland deserves praise for that.

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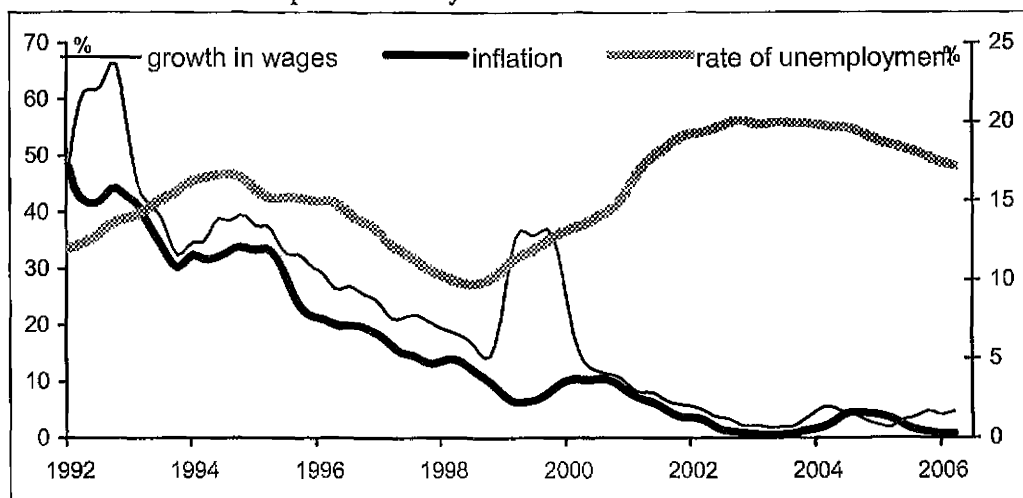
<sup>4</sup> According to recommendations of EUROSTAT in the first quarter of 2001 people over 74 years of age were excluded from the population of the unemployed.

<sup>5</sup> More on this subject: see Łyziak (2003).

<sup>6</sup> The right vertical axis illustrates the rate of registered unemployment.

The growth in nominal wages developed in a fairly similar way to price inflation. Some difference could only be observed at the turn of 1998 and 1999 when the growth in wages significantly exceeded the growth in consumer prices. It should be underlined that virtually in the whole period under consideration the rate of growth in nominal wages exceeded the rate of inflation, so the growth in real wages continued.

**Figure 4** Growth in nominal wages, inflation and rate of registered unemployment in Poland in the period January 1992 – March 2006



Data Source: "Statistical Bulletin", Central Statistical Office.

However, the growth in real wages, positive for the labour market, was accompanied by changes in employment. After the initial growth in the rate of registered unemployment, from zero in the central planned economy to nearly 17% in mid-1994, economic transformation brought about the expected results, i.e., the decline in the number of jobless. The lowest rate of registered unemployment occurred in Poland in August 1998 and amounted to 9.5%. From that moment this indicator was continuously increasing – in February 2003 the rate of unemployment reached 20.7%. Only the last few years witnessed a moderate reduction in unemployment although the rate of registered unemployment in Poland is the highest among the EU countries.

Examining the relationship between the rate of growth in nominal wages and unemployment, the simplest, short-term "trade-off" equation can be used

$$\omega = k - aU, \quad (1)$$

where:  $\omega$  – rate of growth in nominal wages,

$U$  – rate of unemployment,

$a, k$  – parameters of the equation where  $a, k > 0$ .

However, this equation should not be interpreted as a reproduction of economic relationship constant in time. The previously mentioned works of Friedman and Phelps indicate that expectations formulated by rational agents must be taken into account in the analysis.

Therefore, equation (1) can be expressed as a formula which defines the desired growth in wages, but this time the real ones

$$(\omega - \pi)^* = k - aU, \quad (2)$$

where  $\pi$  denotes the rate of price inflation.

In the least expanded version the agents which are wage-setters must make one-period lead decisions. Then it is possible to determine the intended growth in nominal wage ( $\omega$ ) equal to the targeted real growth,  $(\omega - \pi)^*$ , plus the expected inflation

$$\omega = k + \pi^e - aU, \quad (3)$$

where  $\pi^e$  denotes the expected rate of price inflation.

According to Ball and Moffit (2001) equation (3) is “the wage” Phillips curve augmented by inflationary expectations.

The latter relationship may be transformed into the formula indicating the relationships with the actual price inflation. Then, however, one should use the neoclassical assumption about wage setting according to maximization of profit. Equilibrium on the labour market is obtained when the cost of employing an additional unit of labour is equal to the revenue from an additionally manufactured unit of product

$$w\Delta L = P\Delta Y, \quad (4)$$

where:  $w$  – nominal wage,  
 $L$  – labor input,  
 $P$  – price of product,  
 $Y$  – output.

While changing this relationship into a dynamic approach, it turns out that

$$\omega = \pi - \theta, \quad (5)$$

where:  $\theta$  denotes growth in labour productivity.

Using “the wage” Phillips curve the following equation is obtained

$$\pi = k + \pi^e - aU + \theta, \quad (6)$$

Moreover, it should be stated that labour productivity may undergo significant economic shocks, therefore expectations augmented “the price” Phillips curve yields the following relationship

$$\pi = k + \pi^e - aU + b\theta, \quad (7)$$

where  $b$  is a parameter.

At first "the wage" Phillips curve was estimated in the version presented by equation (1). The calculated relationship assumed the following form<sup>7</sup>

$$\hat{\omega} = 5,446 - 0,159U, \text{ adjusted } R^2 = 0,37, F = 107,66. \quad (8)$$

(26,23) (12,15)

Next, expectations were introduced, so the depended variable was the difference  $\omega - \pi^e$ . In the latter case adaptive approach was used where  $\pi^e = \pi_{-1}$  or qualitative measures were taken into account, i.e., the expected rate of inflation calculated by the NBP in cooperation with IPSOS. Changes in labour productivity were expressed as indexes of dynamics (based on the analogical period of the previous year) of sold industrial production per one employee. They were also changed into natural logarithms and the results are presented in Table 1.

**Table 1** "The wage" Phillips curve in Poland in the period January 1992 – March 2006

Specification	Adaptive expectations ( $\pi^e = \pi_{-1}$ )		Expectations according to NBP and IPSOS	
	(I)	(II)	(III)	(IV)
Intercept	3.899 (21.14)	3.652 (20.11)	3.296 (12.67)	3.687 (12.60)
<i>U</i>	-0.110 (10.84)	-0.103 (10.09)	-0.087 <b>(5.311)</b>	<b>-0.097</b> <b>(5.91)</b>
$\theta$		<b>0.759</b> <b>(2.77)</b>		<b>1.207</b> <b>(2.73)</b>
Adjusted $R^2$	<b>0.41</b>	<b>0.44</b>	<b>0.14</b>	<b>0.17</b>
<i>F</i>	<b>117.56</b>	<b>65.02</b>	<b>28.21</b>	<b>18.41</b>

Note: figures in parentheses are t-Student statistics.

The obtained relationships justify an assumption about a trade-off between the rate of growth in nominal wages and the rate of unemployment i.e., the higher rate of unemployment is associated with a decreasing rate of growth in wages. However, the introduction of expectations improves the quality of the obtained regression relations because equations (I) and (II) demonstrate a higher coefficient of determination than function (8). Moreover, changes in labour productivity improved the adjustment of econometric model to the phenomena observed in Poland's economy during transformation.

However, it should be underlined that using the measure obtained thanks to qualitative studies, in this case it concerns inflationary expectations, did not improve the results. It is proved by equations (III) and (IV) where NBP and IPSOS qualitative

<sup>7</sup> Figures in parentheses are t-Student statistics.

data were used but the model's goodness to fit was much worse. Therefore, one can say that as regards "the wage" Phillips curve data from business surveys cannot reflect inflationary expectations formulated in accordance with the hypothesis of rationality of expectations. In reality data obtained from qualitative studies reveal important "memory" of the past inflation, so it can be assumed that there exists an adaptation mechanism shaping Polish expectations as regards the growth in wages correlated with changes in consumer goods prices.

Further on "the price" Phillips curve was estimated. Then the depended variable was the difference  $\pi - \pi^e$ . Once again a few possible forms were used, taking into account differently formulated inflationary expectations, and then the relation with the rate of growth in labour productivity was added. The results are presented in Table 2.

In the obtained equations the parameters have the expected signs. This again confirms the trade-off between the rate of unemployment and changes in the nominal sphere. This time it can be stated that higher unemployment is correlated with a lower rate of growth in consumer prices. Moreover, it should be noted that the values of parameters at variable  $U$  make it possible to estimate approximate "costs" of disinflation. After their assessment was averaged out, it turned out that when the rate of inflation was reduced by one per cent point during one year it was accompanied by the yearly rate of unemployment of about 4.3%.

The equations presented in Table 2 prove that as regards "the price" Phillips curve the use of adaptive expectations as well as those obtained from qualitative studies is equally effective. This confirms the respondents' inflationary "memory" due to which the formulation of future assessments is very strongly influenced by changes of prices in the past.

**Table 2** "The price" Phillips curve in Poland in the period January 1992 – March 2006

Specification	Adaptive expectations ( $\pi^e = \pi_{-1}$ )		Expectations according to NBP and IPSOS	
	(V)	(VI)	(VI)	(VIII)
Intercept	6.065 (15.72)	3.856 (13.02)	6.368 (15.91)	4.169 (12.91)
$U$	-0.254 (10.45)	-0.193 (11.55)	-0.270 (10.66)	-0.207 (11.43)
$\theta$		6.542 (14.72)		6.511 (13.43)
Adjusted $R^2$	0.34	0.53	0.31	0.51
$F$	109.26	<b>65.02</b>	<b>93.15</b>	<b>207.98</b>

Note: figures in parentheses are t-Student statistics.

**Table 3** "The wage" Phillips curve with qualitative data in Poland in the period June 1994 – March 2006

Specification	Adaptive expectations ( $\pi^e = \pi_{-1}$ )		Expectations according to NBP and IPSOS	
	(IX)	(X)	(XI)	(XII)
Intercept	2.737 (19.96)	2.285 (13.57)	2.965 (21.35)	3.242 (16.45)
$N^e_{-24}$	0.079 (4.53)	0.016 (3.49)	0.030 (6.57)	0.033 (6.89)
$\theta$		1.510 (4.20)		-0.776 (1.96)
Adjusted $R^2$	0.12	0.22	0.27	0.28
$F$	<b>20.54</b>	<b>20.35</b>	<b>43.19</b>	<b>24.06</b>

Notes:  $N^e_{-24}$  – anticipated employment with a 24- month lag.  
Figures in parentheses are t-Student statistics.

**Table 4** "The price" Phillips curve with qualitative data in Poland in the period June 1994 – March 2006

Specification	Adaptive expectations ( $\pi^e = \pi_{-1}$ )		Expectations according to NBP and IPSOS	
	(XIII)	(XIV)	(XV)	(XVI)
Intercept	2.613 (8.20)	0.646 (2.00)	2.273 (8.14)	0.678 (1.97)
$N^e_{-24}$	0.028 (2.58)	0.006 (0.63)	0.031 (2.72)	0.007 (6.89)
$\theta$		6.571 (9.54)		6.836 (9.41)
Adjusted $R^2$	0.04	0.42	0.04	0.41
$F$	<b>6.65</b>	<b>51.03</b>	<b>7.37</b>	<b>50.30</b>

Notes:  $N^e_{-24}$  – anticipated employment with a 24- month lag.  
Figures in parentheses are t-Student statistics.

This part of studies was supplemented by estimations of relationships in which the GUS qualitative variables were included. First the rate of registered unemployment was replaced with the assessment of anticipated employment. As this is an indicator of leading character, it was necessary to introduce appropriate time shifts. Tables 3 and 4 present the structure of equations which are regarded to fulfil the assumed criteria in the best way.

In this case the parameter at variable  $N^e_{-24}$  should be positive as this time it refers to employment, not unemployment. The obtained equations confirm this, i.e., a decline in the rate of growth in wages is linked with worse expectation concerning the number of working people. It should be noted, however, that the qualitative data with 24-month lag were introduced into the equations. Keeping in mind that the Polish economy was undergoing transformation, such a significant shift calls for interpreting the obtained result with extreme caution.

It should also be underlined that the estimated equations are characterized by formal features of rather low quality. For example "wage Phillips curves" reveal a low degree of adjustment. On the other hand, equations (XIV) and (XVI) contain statistically insignificant variables. This means that while modifying the Phillips curve it is better to apply quantitative, not qualitative categories.

**Table 5** Regression functions between the rate of growth in nominal wages or rate of inflation and rate of unemployment, expected selling price and changes in labour productivity in Poland in the period June 1992 – March 2006

Specification	Depended variable			
	$\omega$		$\pi$	
	(XVII)	(XVIII)	(XIX)	(XX)
Intercept	0.265 (9.74)	0.267 (9.83)	3.308 (12.61)	3.303 (12.55)
$U$	-0.013 (8.77)	-0.014 (8.96)	-0.151 (10.22)	-0.150 (9.84)
$P^e$	0.009 (9.74)	0.0071 (6.34)	0.082 (18.82)	0.087 (7.92)
$\theta$		0.162 (1.62)		-0.497 (0.51)
Adjusted $R^2$	0.80	0.80	0.80	0.80
$F$	329.80	<b>222.91</b>	<b>335.46</b>	<b>222.72</b>

Notes:  $P^e$  – expected selling price.  
 Figures in parentheses are t-Student statistics.

The analyses of relationships between inflation and unemployment were completed by introduction of the qualitative factor determining the expected selling price. It was included in equations (3) or (7) replacing variable  $\pi^e$ . However, it should be reminded

that the internal construction of the measure of the rate of inflation or the rate of growth in nominal wages differs from estimations of qualitative variables. Therefore, it was impossible to determine the *quasi* Phillips curve function where instead of difference  $\pi - \pi^e$  (or  $\omega - \pi^e$ ) appears the difference between  $\pi$  and the expected selling price. Nevertheless, the authors estimated a set of relations the structure of which is presented in Table 5.

In the above presented equations the rate of growth in labour productivity turned out to be a statistically insignificant variable. The remaining elements of the equations are convergent with the theoretical assumptions, i.e., that the expected growth in selling prices will be accompanied by a higher rate of inflation (including wage inflation) and lower unemployment.

### 3.3. Estimation of natural rate of unemployment

According to the previously made theoretical remarks, augmenting Phillips curve concept with inflationary expectations demands that natural rate of unemployment should be taken into account. Using the "wage" version of the Phillips curve one can say that the natural rate of unemployment is such a level of unemployment which slows down to zero the rate of growth in nominal wages. Therefore, such an indicator may be defined as NAWRU (*Non-Accelerating Wage Rate of Unemployment*). In the analysis of "the price" Phillips curve the natural rate of unemployment determines zero rate of growth of inflation, which is better expressed by a substitute term NAIRU (*Non-Accelerating Inflation Rate of Unemployment*).

Referring to formal notation the following relationships can be assumed:

$$\omega = k + \pi^e - a(U - U^*), \text{ or} \quad (9)$$

$$\pi = k + \pi^e - a(U - U^*), \quad (10)$$

where:  $U^*$  denotes natural rate of unemployment.

In this approach the actual rate of unemployment may be divided into the natural rate (being synonymous with the state of long-run equilibrium) and into medium- and short-run fluctuations around the level of equilibrium which demonstrate the shifts of Phillips curve.

Econometric estimation of natural unemployment is a simple task assuming that it is constant in time and the principles of formulating inflationary expectations are well-known. For example, an approval of adaptive model of the structure of expectations in "the price" Phillips curve reduces the problem to estimating the function

$$\Delta\pi = aU^* - aU + k, \quad (11)$$

where:  $k$  denotes random disturbances, uncorrelated with  $U$ .



As  $U^*$  was to be constant,  $aU^* = \text{constans}$  as well, so the simplest linear equation is estimated. The value of  $U^*$  is obtained by determining the relation between  $aU^*$  and the absolute value of parameter  $a$ . Applying this approach and using relation (V) from Table 2 NAIRU for Poland is obtained at the level of 23.8% per annum.

However, a commonly approved view appeared in the related literature: the natural rate of unemployment can be a time-varying variable<sup>8</sup>. Then, it is worthwhile to remember about the previously mentioned decomposition of the real rate of unemployment into a long-run component identified with the natural rate and into fluctuations which are short-run distortions of the equilibrium. Thus equation (11) may be expressed as follows

$$U^* + (k/a) = U + (\Delta\pi/a), \quad (12)$$

and its left side shows the structure of real unemployment.

However, practical application of this approach requires the knowledge of parameter  $a$ . Ball and Mankiw (2002) are of the opinion that its assessment can be derived from estimation of the Phillips curve. In this paper these are parameters at variable  $U$  in Tables 1 and 2. Therefore, the right side of equation (12) is calculated on the basis of actual observations of the rate of unemployment and changes in the rate of growth of consumer prices (or nominal wages). Then extraction of the long-term component may be carried out by means of Hodrick-Prescott filter (HP)<sup>9</sup>. In this procedure constant equal to 144 000 was used in the HP filter<sup>10</sup>.

Figures 5 and 6 show the results obtained thanks to the "wage" and "price" Phillips curve, i.e., they illustrate the rate of unemployment which does not accelerate the rate of growth in wages or the rate of growth in inflation. Additionally they present the actual rate of registered unemployment.

The results show that in the case of Poland the natural rate of unemployment fluctuates from about 11 to 20 per cent. This corresponds with other studies which frequently use different analytical methods (See: Kuczyński, Strzała (2002); Bukowski (2005); Borowski *at al.* (2005); BREBANK (2005)). Such a level of  $U^*$ , markedly higher than in well-developed economies means that the Polish economy has not fully developed market mechanisms so far. Generally, the actual rate of unemployment

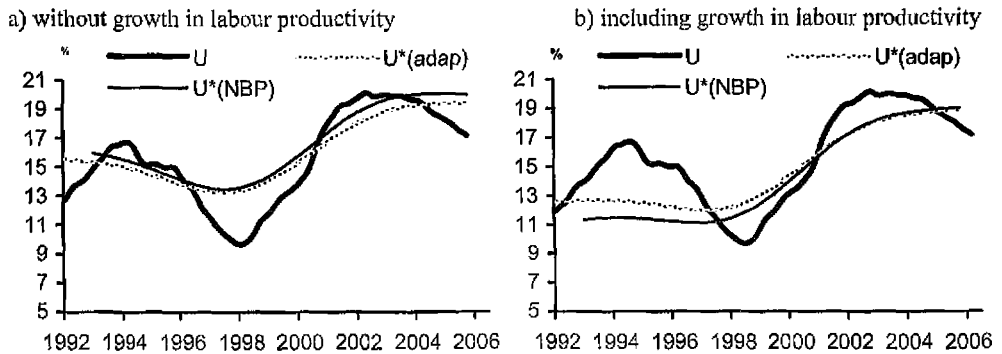
<sup>8</sup> Such statement was done even by Friedman (1968), but more often it is stressed by representatives of new keynesian economics in their hysteresis models. More on this subject: Gordon (1998); Staiger *at al.* (1997).

<sup>9</sup> See: Hodrick and Prescott (1997).

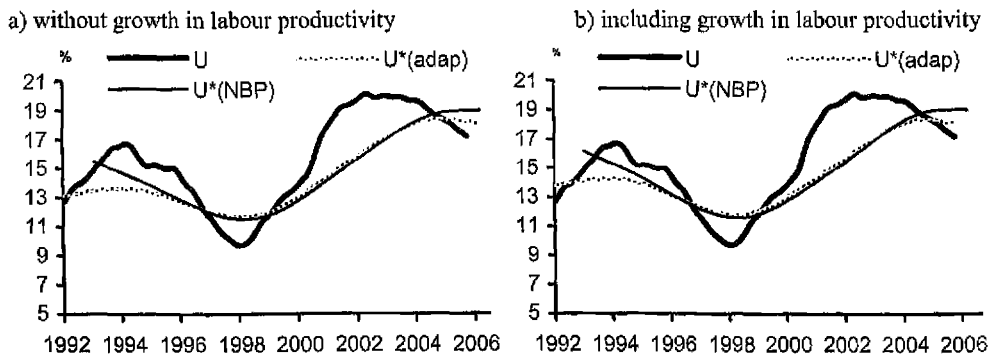
<sup>10</sup> Value 14400 is used as a standard for monthly data but due to rather short time series the authors assumed that it would be reasonable to smooth out the growth tendency.

exceeds the rate of equilibrium. This means a pressure to reduce wage or price inflation. Periods from the turns of 1998/1999 and 2004/2005 deviate from this pattern. All the curves from Figures 5 and 6 show that at that time the natural rate exceeded the actual one. Other phenomena observed in that period are the growth in the rate of changes in nominal wages and the leap of inflation.

**Figure 5** Time-varying natural rate of unemployment obtained on the basis of “wage” Phillips curve



**Figure 6** Time-varying natural rate of unemployment obtained on the basis of “price” Phillips curve



Note:  $U$  – real rate of registered unemployment;  $U^*(\text{adap})$  – natural rate of unemployment with adaptive inflationary expectations;  $U^*(\text{NBP})$  – natural rate of unemployment including expectations measured by NBP.

#### 4. Conclusions

Estimations presented in this paper confirm that in the Polish economy there exist relationships which are crucial for the construction of A.W. Phillips curve. Therefore, it can be stated that in the economic system undergoing transformation a trade-off between inflation and unemployment occurs. This conclusion, however, can only be formulated when Phillips curve is supported by expectations. Thus the trade-off relationships do not concern the rate of inflation (price or wage inflation) but its dynamics.

The conducted empirical analyses show that in the studies on Phillips curve both quantitative and qualitative data can be used. The latter, however, generate the relations of worse formal-statistical properties.

Having accepted a thesis about the existence of relationships characteristic of Phillips curve, one may try to estimate the natural rate of unemployment. Depending on the version of the model this will be NAWRU or NAIRU. The chosen method enforces the use of a parameter informing about the slope of Phillips curve. Such an approach requires cautious treatment of the results obtained because regression relationships revealed only a moderate fit to the real data. Despite this reservation, the generated information does not seem to be much different from the reality of the Polish economy, which is confirmed by the analyses of other authors.

Therefore, it can be stated that in the case of Poland the concepts of A.W. Phillips and natural rate of unemployment are empirically confirmed. This, however, requires introduction of significant model modifications, i.e., evaluation of inflationary expectations and changes of NAWRU or NAIRU over time. Then estimations of the natural rate of unemployment may be used in the economic policy, including stabilization policy. Observation of the real rate of unemployment against the natural one, becomes a tool to forecast the future dynamics of inflation or wages. Knowledge of this subject may be applied when making decisions in the sphere of e.g. monetary policy. However, a more extensive use of such a tool would require introduction of additional elements - potential sources of economic shocks - into the model. This paper considers only changes in the rate of labour productivity. The results are encouraging but still insufficient. Therefore, studies on the relationships connected with Phillips curve in the economic system under transformation should be continued.

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