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ECONOMIC POLICY TARGETS: RELATIONSHIPS BETWEEN INFLATION RATES AND GDP GROWTH RATES IN OECD COUNTRIES IN 1990–2013

1. INTRODUCTION

Economic policy targets are different. Depending on the economic and political situations in a given economy in a given time period there are usually at the same time, for example, GDP growth rates higher than expected, unemployment rates and/or inflation rates lower than expected, exchange rates close to the expected level and the sustainability of public finances. They almost always are at least partly contradictory.[1] Therefore, striving to achieve them at the same time leads to in a long period to a political instability,[2] especially in times of economic crises.

In such a situation, one could consider putting a specific combination of individual targets as an overall aim of the macroeconomic policy. The solution of this issue would be to build a model of optimal control (Błaszczuk 2014b) or multi-criterion programming (Galas, Nykowski, Żółkiewski 1987). The main issues that would arise in such a situation would be: determination of targets of economic policy and instruments for their implementation, an analytical form of a criterion function, the weights of variables in it, considering interdependencies between the targets and interdependencies between the instruments, as well as a variety of feedbacks between the targets and instruments. In addition, more

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[1] For example, higher economic growth is generally associated with a lower level of unemployment, but the two phenomena are frequently accompanied by higher inflation rates, and the stability of domestic prices usually interferes with the stability of the exchange rate.

[2] The collapses of the centrally-planned economies were classic examples of such a situation. The common target in these economies was to optimise the levels of individual economic policies' targets. Of course, these collapses were caused by a whole convolution of causes, of which the above-mentioned was not the only important one. Recently, the case of Spain may be recalled in this context.

or less rigid substitution between policy targets is usually assumed in such models. Unfortunately, quantification of all these variables would be very difficult, if possible at all.[3] Moreover, there would be an issue of data collection and, later, their classification and aggregation according to the needs of the economic policymakers.

To this end, these needs are changing even during one parliamentary term, especially if cabinet members are shuffled. In addition, these terms are sometimes shortened. On the other hand, the construction and solution of a multi-criterion programming model and the more optimal control model takes a few years. Moreover, in this respect, the criticism of the econometric modelling of economic processes according to R. Lucas is at least partially justified.[4] It would, however, be an essential issue to find sufficient resources to finance relevant research studies, especially considering that the vast majority of macroeconomic politicians have usually no idea about either optimal control or multi-criterion programming (if they ever heard of them at all), not to mention the tools of these techniques.

Therefore, the purpose of this paper is to present a solution that most likely would be easily understood and accepted by the majority of politicians. It reads as follows: in the long-term macroeconomic policymakers should not aim to achieve a few selected individual targets, but to maximise GDP growth rate to enable the fastest possible improvement in the standards of living of the citizens of the country[5] while maintaining the levels of other targets within predetermined limits. The way to achieve this target is to change accordingly the relationships between the pairs of the respective targets (Błaszczuk 2013: 73-75).

This solution consists of a few steps. The first one is to determine the overall economic policy target by the economic policymakers. This should be the maximum growth rate of GDP (equal to or almost equal to the potential one) and the ranges for other macroeconomic policy targets (for example, the ranges of inflation rates, unemployment rates, etc.). In other words, the desired "*optimal*" long-term equilibrium point is to be predetermined.

Secondly, one has to specify on the basis of empirical data for a sufficiently long period of time an empirical long-term equilibrium point for the given

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[3] It looks quite different at the level of micro-enterprises, in particular SMEs. In their case, the corresponding, generally accurate, decisions are based on intuition, and at most on very approximate calculations.

[4] Econometric models are built on the basis of historical data. On the other hand, decedents make their decisions on the basis of their expectations as to the processes, etc. that, in their opinions, most likely occur in the near as well as the more distant future. Additionally, they usually have quite a good understanding of their nature (Lucas 1976: 19-46).

[5] This standpoint is different from what has been represented, for instance, by P. A. Samuelson and W. D. Nordhaus, who claim that the level of inflation is such an aim (Samuelson, Nordhaus 2004).

economy. This point is the respective combination of individual economic policy targets in the multidimensional space. The number of dimensions is equal to the number of targets. One of the possible ways to find this point is to solve the appropriate set of equations. Every equation in this set describes the relationship between a pair of the above-mentioned economic policy targets.

Then, one must determine the direction (in the appropriate multidimensional space), in which the empirical long-term equilibrium point should be moved in the nearer and further future to possibly closely approach the desired point of the long-term equilibrium. In this respect, one has to determine the factors that will force the movement of the empirical point of the long-term equilibrium in the desired direction as well as the direction and the strength of the influence of each of them. In other words, it is necessary to determine relationships between different variables in the given economy not only in the past, but in the present and especially in the future. In the course of the relevant works, it would also be possible to correct the co-ordinates of the desired long-term equilibrium point.

The penultimate stage is the implementation of an appropriate economic policy. The evaluation of the results of this policy will always be the final stage. In democratic countries, this evaluation belongs to the voters.

The suggested solution consists of several stages. One of the first of them is to determine the relationships between all pairs of economic policy targets. In this paper, there are presented the results of the analysis based on quarterly data of the relationships between the rate of inflation and the GDP growth rates in the period 1990–2013 separately for each OECD country. The results of this analysis are then used to build maps of "strategic groups" of the analysed countries. The criteria applied to construct these maps are based on the two variables: the level of inflation and co-existing growth rate of GDP. An analysis of the maps allows for the providing of initial recommendations for economic policymakers of the relevant countries.

The relationships between unemployment rates and inflation rates for approximately the same group of countries and for almost the same period were presented to the 4th Zbigniew Czerwiński Memorial Conference held in Poznań Economic University (Błaszczuk 2015). The relationships between unemployment rates and GDP growth rates for similar group of countries and almost in the same period were presented to the 15th International Conference on Quantitative Methods in Economics (Błaszczuk 2014a).

Further research will be focused on the empirical points of the long-term equilibrium for individual countries and respective recommendations for economic policy makers of the individual countries.

2. RELATIONSHIPS BETWEEN PAIRS OF SELECTED ECONOMIC POLICY TARGETS IN THE LIGHT OF (MATHEMATICAL) ECONOMIC THEORY

According to the possibility of graphical presentation, let us consider three of the mutually interdependent, commonly occurring, economic policy targets: growth rate GDP, unemployment rate and rate of inflation.

The relationship between employment and GDP is expressed through a variety of functions, including linear, logarithmic, power, exponential and logistics ones with only one independent variable. Each of these lines tends to reflect the specific situation of a given country in a given period. Regardless of the formula, GDP growth is associated with increase in employment. In the short term, assuming that the labour resources are available, unemployment and unemployment rate are reduced simultaneously.

Therefore, one can analyse a relationship between the unemployment rate (*UNR*) and the growth rate of GDP [$r(GDP)$]. A popular formula in this respect reads as follows (see: Figure 1a[6]):

$$r(GDP) = b_{10} - b_{11}UNR,\qquad(1)$$

where: b_{10} and b_{11} – estimates of the parameters.

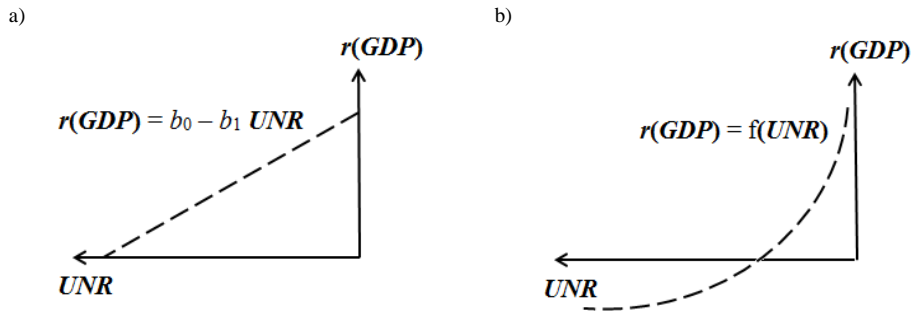a)   b)

Figure 1. Growth rate of GDP as linear (a) and non-linear (b) functions of the unemployment rate

Source: own elaboration.

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[6] The direction of the co-ordinates of UNR on Figures 1a and 1b is relevant to the subsequent analysis.

Assuming that the actual growth rate of GDP is equal to the potential one and that the changes of the natural unemployment rate are equal to 0, Formula 1 approximately reflects the Okun's law.[7]

On the other hand, the curve in Figure 1b illustrates a situation when increases in the unemployment rate are combined with slower and slower declines of the GDP growth rate. It also includes a situation observed in practise, namely the possibility of negative GDP growth rates.

The second relationship, namely the relationship in the short period between unemployment rate (*UNR*) and inflation rate [*r(p)*] is often described with the help of a short-term Philips curve (1958: 283-299) (see: Figures 2a and b[8]). Deflation, as well as NAIRU, is also shown on the figures.

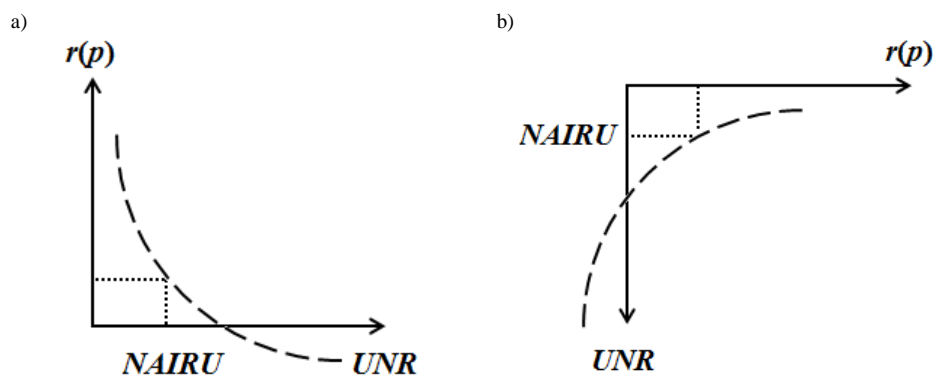a)   b)

Figure 2. Short-term Philips curve

Source: own elaboration.

However, from the point of view of the considerations set out in this paper J. Bednarczyk's concept of neutral inflation is important. According to Bednarczyk (2011), neutral inflation means the level of inflation in the economy ensuring the maximum growth rate of GDP[9] and is different for different countries. In addition, Bednarczyk (2012) claims that the level of neutral inflation does not need to be close to any level decided in an arbitrary manner, as is the case in practise. In particular, he says that it does not need

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[7] Any increase of the unemployment rate in the US economy by 1 p.p. above the natural unemployment rate caused the decline in the rate of GDP by 3 p.p. (Prachowny 1993: 331-336). The results of subsequent tests of the US economy (on the basis of quarterly data from the period 1947–2002 where Equation 1 took the form of: $r(GDP)= 0.856-1.827*UNR$) are somewhat different (2 p.p. instead of 3 p.p.), (Abel, Bernanke 2005).

[8] In view of the further considerations, Figure 2b is equal to Figure 2a rotated clockwise by 90°.

[9] This definition is wrong. It would be better to say that "*the neutral inflation is the inflation rate in the economy that occurs when the GDP growth rate is maximum*" or, in other words, "*the neutral inflation is the inflation rate that coexists with the maximum GDP growth rate*".

to be equal 0% or 2% or be smaller than average level of inflation in the three EU countries with the lowest inflation rates (excluding unusual situations) increased by 1.5 p.p.
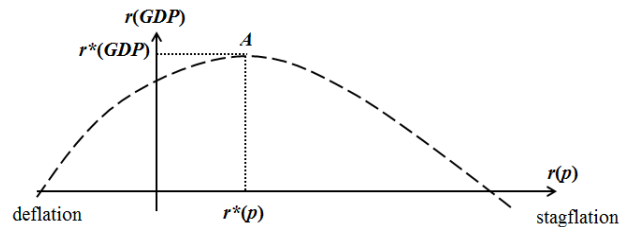

Figure 3. Relationship between inflation rates and GDP growth rates

Source: own elaboration.

Going forward, it should be noted that in practise GDP growth rates lower than the maximum one, in particular those close to 0 and even negative, coexist with inflation rates that are both higher and lower than neutral inflation, in particular, negative inflation (referred to as deflation that is a disaster for monetary authorities).[10]

Therefore, one can formulate the hypothesis that the relationship between the inflation rate and GDP growth rate in a given economy in a given period is more or less similar to the trace of curve shown in Figure 3. This curve reflects both the neutral inflation, $r^*(p)$, as well as the corresponding maximum GDP growth rate, $r^*(GDP)$. In this Figure, one can also easily see the co-occurrence of low GDP growth rates, both with deflation and with very high inflation (known as stagflation), that exist in practise.

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[10] Such a situation is particularly disadvantageous for the economy because central banks cannot effectively counter an increase in the levels of real market interest rates, as the levels of the Central Bank interest rates should not be cut down below 0. Therefore, in order to counteract deflation, central banks lower in advance (9 months as a rule, based on simulations with the help of nonlinear econometric models (Błaszczuk 2014b) levels of interest rates and, usually on a large scale, increase the liquidity of commercial banks, thus encouraging them to increase the supply of cheap credit to spur demand, which in turn is expected to result in an increase in the level of prices (Wojtyna 2004: 252-277).

3. INTERDEPENDENCE OF THE GDP GROWTH RATE, INFLATION RATE AND UNEMPLOYMENT RATE

The relationship between selected pairs of economic policy targets can be represented, first of all, in an n-dimensional space where n is the number of selected targets and, secondly, as a set of equations.

Therefore Figures 1b, 2b and 3 presented in the previous section can be combined into one (see: Figure 4). The curves appearing on these charts are the orthogonal projections of the respective surfaces on the planes of corresponding pairs of coordinates.
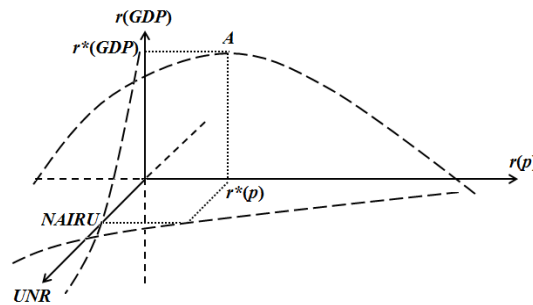

Figure 4. The interdependence of the GDP growth rate, inflation rate and unemployment rate

Source: own elaboration.

The projections of the planes shown in Figure 4 (and, similarly, in the case of more than three targets) reflect the situation in a given economy in a given period. This situation is, generally, not only non-optimal (the GDP growth rate is not maximal), but also unstable. This can be seen clearly, both in Figure 5a, where "*a clockwise spiral*" is shown, as well as in Figure 5b, where there is a "*counter clockwise spiral*".

The clockwise spiral is to be read as follows:
1)   move from point A to the axis $r(p)$, finding point $r^*(p)$;
2)   move from point $r^*(p)$ to the Philips curve, finding point B_1;
3)   move from point B_1 to axis UNR and find point UNR_1;
4)   move from point of UNR_1 to the Okun's curve and find point C_1;
5)   move from point C_1 to the axis $r(GDP)$ and find point $r_1(GDP)$;
6)   point $r_1(GDP)$ corresponds to points D_{11} and D_{12}; they are different from point A from which we started;
7)   repeating the spiral loop a number of times, each time starting from new GDP growth rates, we have:
    a.   either no solution or
    b.   the long-term equilibrium point, different from point A.

Similarly, one reads the counter clockwise spiral:

1) start from point A and move to the axis $r(GDP)$ and find point $r^*(GDP)$;
2) move from point $r^*(GDP)$ to the Okun's curve and finding point C_2;
3) move from point C_2 move to axis UNR and find point UNR_2;
4) move from point UNR_2 to the Philips curve and find point B_2;
5) move from point B_2 to axis $r(p)$ and find point $r_2(p)$;
6) move from point $r_2(p)$ to the point D_2 on the curve illustrating relationship between inflation rate and GDP growth rate; this point is not the same as point A;
7) repeating the spiral loop a number of times, starting every time from the new GDP growth rates, we have, as in the case of the clockwise spiral:
    a. either no solution, or
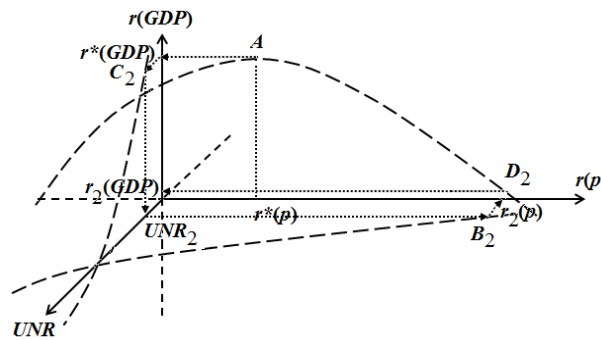   b. the long-term equilibrium point, different from point A.[11]

a)
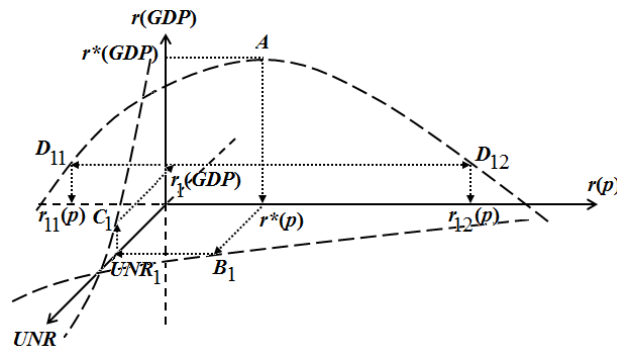
b)

Figure 5. Clockwise (a) and counter clockwise (b) spirals of GDP growth rate and inflation rate and unemployment rate

Source: own elaboration.

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[11] Because of the assumed shapes of the analysed curves, every point in the case of counter clockwise spiral, as opposed to the clockwise one, always corresponds to one point only.

Analytical reasoning leads to these identical conclusions. With the three targets, we have three continuous functions:

$$r(GDP) = f(UNR), \tag{2}$$

$$r(p) = g(UNR), \tag{3}$$

$$r(GDP) = h[r(p)]. \tag{4}$$

Function 3 and 4 may be presented as inverted functions:

$$UNR = G[r(p)], \tag{3'}$$

$$r(p) = H[r(GDP)]. \tag{4'}$$

Substituting 4' into 3' and then transformed 3' into 2, we get:

$$r(GDP) = f\{G[H(r(GDP))]\}. \tag{5}$$

Equation 5 may have either no solution, or one, or, in a special case, more than one solution.[12] If it has only one solution, it is $r_0(GDP)$. On the other hand, if it has more solutions, the optimal solution, in accordance with the purpose of the study, is:

$$r_0(GDP) = \max_k \{r_0^{(k)}(GDP)\}. \tag{6}$$

The value of $r_0(GDP)$ corresponds to the values of the inflation rate equal to $r_0(p)$, calculated according to Formula 4', and the unemployment rate UNR_0, calculated in accordance with Formula 3'. Of course, both $r_0(p)$ as well as UNR_0 should be subject to the two-sided boundary conditions:

$$\begin{matrix} r_d(p) < r_0(p) < r_g(p) \\ UNR_d < UNR_0 < UNR_g \end{matrix}, \tag{7}$$

where, in addition to the previously explained: $r_d(p)$ and $r_g(p)$ – the respective upper and lower limits of the inflation rate; and UNR_d and UNR_g – the respective upper and lower limits of the unemployment rate (NAIRU?).

The solution $E[(r_0(GDP), UNR_0, r_0(p)]$ is the empirical point of long-term equilibrium. In this point, with a very high level of probability:

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[12] Every two planes intersect along a specified curve. The solution is the intersection of all those curves.

$$r_0(GDP) < r*(GDP),\qquad\qquad(8)$$

and sometimes even:[13]

$$r_0(GDP) << r*(GDP).$$

This statement is due to the above-presented considerations based on clockwise and counter clockwise spirals.

The reasoning carried out above can be easily extended to any number of targets as well as to the microeconomic level. Obviously, they should be exactly the same as those applied by the macroeconomic policymakers or managers, respectively.

4. ASSUMPTIONS, STATISTICAL DATA SOURCES AND RESEARCH METHODS

Assumptions apply to the subject of research, scope of the investigation and period of analysis. According to the statements in the introduction, the analysis is assumed to cover, separately for every country, the relationships between inflation rates and GDP growth rates in all OECD countries in the period $1990q_1$–$2013q_4$, so during more or less the past two Juglar business cycles.

In order to obtain comparable results, it is assumed that the data source are the OECD statistics: the chain harmonised indices of consumer prices of goods and services[14] (*HCPI*) or chain consumer goods and services price indices[15] (*CPI*) and the growth rates of GDP.[16]

It seems that the HCPI is a better indicator, but eight countries[17] do not provide the information concerned. In addition, individual data for other countries is available not earlier than from $1991q_1$, while some of the HCPI data is published for shorter, sometimes even much shorter, periods. On the other

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[13] The symbol "<<" is used to indicate that the left side is "*much less*" than the right one.

[14] Harmonised consumer prices - all items; percentage change from previous period, http://stats.oecd.org/index.aspx?DatasetCode=MEI_PRICES [access: April 28, 2014].

[15] Consumer prices – all items; percentage change from previous period, http://stats.oecd.org/index.aspx?DatasetCode=MEI_PRICES [access: May 02, 2014].

[16] Gross domestic product – expenditure approach, growth rate compared to previous quarter, seasonally adjusted, http://stats.oecd.org/WBOS/index.aspx [access: April 28, 2014].

[17] Australia, Canada, Chile, Israel, Japan, Korea, Mexico and New Zealand.

hand, the CPI data is much more complete. First of all, it is available for all 34 countries Secondly, only three countries have incomplete time series and the data gaps in all these cases are much smaller.[18] In the light of the above, it was decided to carry out a study for both inflation indicators.

As regards to data on GDP growth rates, it is completely unavailable for Greece and, for many other countries, it is available for shorter periods, and sometimes much shorter than the assumed analysis period. Unfortunately, these periods do not always comply with the periods for which data on the HCPI or CPI is available.

Moreover, no account has been taken of the fact that, in some cases, estimates are given, and in others there were breaks.

Having noted these circumstances, an examination of the relationships between the HCPIs and the GDP growth rates was made for 25 countries, and between the CPIs and the GDP growth rates for 33 countries. For 23 out of 25 countries and for 31 out of 33 countries, the number of observations was above 60 (see: Columns: 4 and 12 of Appendix 1).[19]

Next, it has been assumed for each country separately that GDP growth rates' $[r_{jt}(GDP)]$ dependence on the harmonised indices of consumer goods and services prices $(HCPI_{jt})$ can be expressed as a polynomial function of the second degree:

$$r_{jt}^{H}\left(GDP\right) = b_{0j}^{H} + b_{1j}^{H}(HCPI_{jt}) + b_{2j}^{H}(HCPI_{jt})^{2} + \xi_{jt}^{H}, \qquad (9a)$$

where: $j = 1, 2, …, 25$ – country number and $t = 1, 2, …, T$ – quarter number, and, similarly in the case of the consumer goods and services price index (CPI_{jt}):

$$r_{jt}^{C}\left(GDP\right) = b_{0j}^{C} + b_{1j}^{C}(CPI_{jt}) + b_{2j}^{C}(CPI_{jt})^{2} + \xi_{jt}^{C}, \qquad (9b)$$

where: $j = 1, 2, …, 33$ – country number and $t = 1, 2, …, T$ – quarter number.

At the end, it was assumed that each of the 25+33=58 equations can be estimated using *OLS*, taking into account, among others, that Equations 9a-b are linear after the appropriate transformations.

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[18] Czech Republic and Slovakia miss first 5 quarters each while Estonia misses first 32 quarters.

[19] In the case of HCPI: Switzerland 35 observations, and in the case of CPI: Chile 43 observations, while Ireland has 55 observations in both cases.

5. ANALYSIS' RESULTS

The results are partly consistent with expectations. First of all, relatively low and sometimes even very low values of R^2 do not dismay, because the dispersion of points on the vast majority of the 58 charts did not allow to determine in advance of any regression function (see: Appendices 2 and 3).

Therefore, in the case of the models based on HCPI (see: the first part of Appendix 1) $^1/_3$ (25 out of 75) of the estimates of the structural parameters are clearly statistically insignificant.[20] This statement is true in case of seven countries (Denmark, the Netherlands, Norway, Slovakia, Sweden, Turkey and the United Kingdom) with respect to the evaluation both of b_{2j}^H and b_{1j}^H.

Moreover, in the case of Denmark, the assessment of b_{0j}^H is not statistically significant and the entire model is inconsistent with expectations (positive first derivative). In all other cases, however, the estimates of the intercept are clearly statistically significant. It means that in this group of countries, the GDP growth rates were approximately constant and therefore independent of the rate of inflation measured by the HCPI, but in the case of Sweden the model is incompatible with the expectations. The model is also incompatible with the expectations in the case of Iceland, but in this case the b_{2j}^H estimate is clearly statistically insignificant. The other three clearly insignificant statistically estimates of b_{1j}^H are for the Czech Republic, Finland and Poland. In all three cases, however, the estimates of the intercepts are clearly statistically significant and the estimates of b_{2j}^H are poorly statistically significant. Unfortunately, in the case of Poland this estimate is positive.

Slightly different results have been obtained for the models based on CPI (see: second part of Annex 1). Also in this case, $^1/_3$ (32 of 99) of the estimates of the structural parameters are clearly statistically insignificant, but one of them relates to the intercept (for Ireland). In the case of nine of the countries discussed above (the Czech Republic, Denmark, Iceland, the Netherlands, Norway, Poland, Slovak Republic, Turkey and the United Kingdom) the results coincide, as a rule, with the models obtained on the basis of HCPI. In addition, Australia and Israel joined the group of countries with statistically insignificant estimates of both structural parameters and clearly significant estimates of intercept. The other three cases of statistically not significant estimates refer to b_{2j}^H for Ireland (let us recall that for this country, the estimate of intercept was also

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[20] The assumed level of significance here as well as in all further considerations is equal to 5%.

clearly statistically insignificant) and b_{1j}^{H} for New Zealand and Switzerland, but for these two countries the estimates of b_{2j}^{H} are not statistically significant and the intercept estimates are clearly statistically significant.

Thus, in the case of both types of models, the hypothesis that there is approximately parabolic relationship between the rates of inflation as measured by the HCPIs and the GDP growth rates with the negative first derivative must be firmly rejected in the case of Poland, and in the cases of Denmark and Iceland adoption of this hypothesis is not justified. Moreover, for up to seven countries: the Netherlands, Norway, Slovak Republic, Turkey and the United Kingdom as well as Australia and Israel (the last two, of course, only in the case of models based on CPI) estimates of both b_{2j}^{H} and b_{1j}^{H} are clearly insignificant statistically, and the estimates of intercept are statistically significant. It means that in this group of countries the GDP growth rates were approximately constant, and therefore independent of the rate of inflation (in the case of the first five countries regardless of the method of measurement of inflation rates).

All of these results may be justified by the specificities of the economic policies pursued in each of these countries.

In addition, a clear convergence of estimates of the structural parameters b_{2j}^{C} and b_{2j}^{H} for all countries except for Germany, Ireland, Austria, Sweden, Finland and Luxembourg is noticeable. In the case of the last two countries, however, the relative differences between them in relation to b_{2j}^{C} exceed slightly the level of 50% (see: Figure 6).
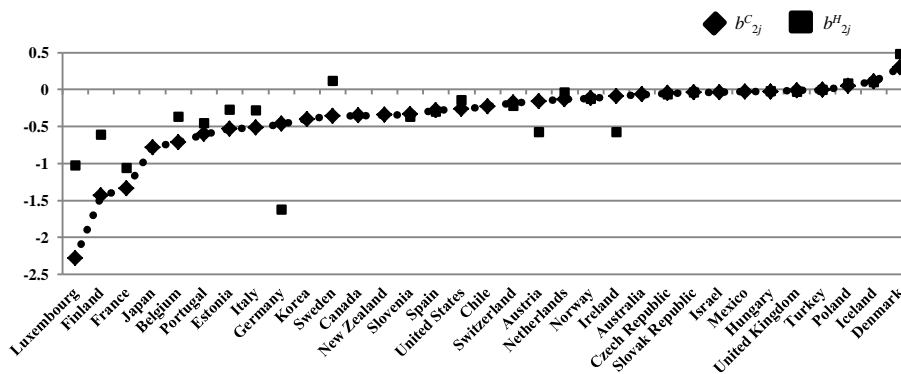

Figure 6. Values of b_{2j}^{C} and b_{2j}^{H} for OECD countries

Source: own calculations.

A general cause of these differences is, of course, different values of the explanatory variables, namely:

− various numbers of observations on the CPI and HCPI; and

− differences between the corresponding values of the CPI and HCPI. These differences are particularly evident in the case of Sweden. As a result, the estimates of the respective b_{2j}^C and b_{2j}^H have even different algebraic signs.

At the same time, "*strategic groups*" can be clearly noticed. First of all, the attention is drawn to the degree of convexity/concavity of the theoretical line as well as the position of point $r^*(GDP)$ in relation to the volatility of the empirical values for CPI/HCPI. From this point of view, one can distinguish, irrespective of the explanatory variable, three groups of countries, namely countries:

− with unusual theoretical line (Denmark, Iceland and Poland always and Sweden in the case of HCPI);

− with $r^*(GDP)$ located outside the area of CPI/HCPI empirical variation (United Kingdom always, Ireland in the case CPI and the Netherlands in the case of the HCPI);

− other.

For obvious reasons, the first two groups are excluded from further considerations. In the case of the third group, further stratification of countries is possible, at least according to the following pairs of criteria:

− CPI*/HCPI* and $r^*(GDP)$; and

− empirical area of CPI/HCPI variation (the difference between the maximal and minimal values) and $r^*(GDP)$.

Table 1. "*Strategic groups*" of OECD countries according to $r^*(GDP)$ and CPI*

$r^*(GDP)$ / CPI*	0.36	0.44-0.57	0.62 -0.69	0.72-0.77	0.81-0.90	1.01-1.09	1.28-1.37	1.42-1.53	1.68
0.19					AU				
0.30–0.40		CH NE J	CZ	NZ					
0.47-0.52		F	CA	US				L	
0.58-0.66		PT			SF				
0.72-0.75			B N						
0.80-0.88		G A			S	IS			
0.99-1.12	IT			ES			CHI		
1.35-1.6						SV	TQ	EST	K
1.94						SL			
3.55			H						
4.54						M			

Source: own elaboration.

In the first case, both CPI[*]/HCPI[*] and $r^*(GDP)$ levels are divided into three classes[21]: high, medium and low. There are eight strategic groups, but within three of them there is only one country (see: Table 1).

Similar strategic groups occur in the case of classification according to HCPI[*] and $r*(GDP)$, (see: Table 2). Table 2 differs in principle from Table 1 only with respect to the location of three countries:

− in the case of Switzerland, there is a noticeable increase both of $r*(GDP)$ as well as of the price index (justified mainly by differences in sample size);

− in the case of Germany, there is a noticeable decline in the price index (partly justified by differences in sample size and partly by differences in levels of price indices); and

− in the case of Turkey, there is a very significant decline in the price index (partly justified by differences in sample size and partly by differences in levels of price indices).

Table 2. "*Strategic groups*" of OECD countries according to $r^*(GDP)$ and HCPI[*]

$r^*(GDP)$ / HCPI[*]	0.4	0.52-0.55	0.61-0.66	0.74-0.77	0.80-0.84	1.03-1.11	1.31-1.32	1.63
0.05							TQ	
0.34-0.41			G SF					
0.49-0.54		F	CZ				L	
0.66-0.71			US A					
0.77-0.84	IT	PT	N					
0.90-0.92			B	CH	ES			
1.15						IR		
1.55						SV		
1.91-2.01						SL		EST
3.58			H					

Source: own elaboration.

This time, however, there are only seven "*strategic groups*" and four of them consist of only one country.

In the case of the distribution of countries according to the revised areas of empirical CPI volatility (the difference between the largest and the smallest values after rejecting the extreme ones, clearly different from the adjacent[22])

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[21] Obviously with slightly altered compartments' borders in the case of HCPI[*] in relation to CPI[*] ones.

[22] This applies, in total, to 23 countries. There were removed 20 observations of unusually small values for 13 countries and 54 observations of unusually big values for 16 countries. Then Mexico (with 1 uncharacteristically small) and Turkey (with 5 unusually large) were removed in view of the evidently greater values for these two countries then for the others. Deleted observations do not influence significantly the number of degrees of freedom in the respective models. In both cases (with Mexico and Turkey, and without these two countries) deleted observations amount to less than 3% of the total number of observations (i.e. for all countries in total).

and $r^*(GDP)$, it is clearly seen that $r^*(GDP)$ increases with the increase in the value of $\left[\text{CPI}_{\max} - \text{CPI}_{\min}\right]$, especially for 28 countries[23]. Moreover, linear function and polynomial of the second degree function practically overlap (see: Figure 7).
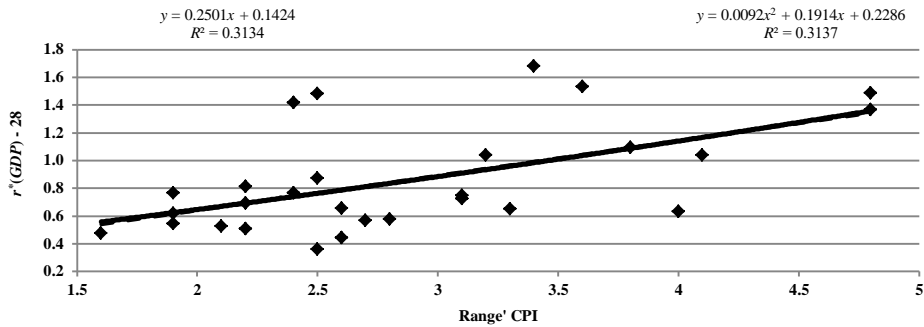

Figure 7. Dependence of $r^*(GDP)$ and the revised areas of volatility of empirical CPI for 28 OECD countries

Source: own calculations.

At the same time, one can assume that with the increase in the corrected range of volatility of the CPI by one p. p., $r^*(GDP)$ increased in the analysed group of countries during the period of the analysis, on average, by 0.25 p. p.

The same relationship can be also traced in Table 3 where according to the breakdown according to the same two criteria, there are seven "*strategic groups*", but only one of them consists of one country only.

Table 3. "*Strategic groups*" of OECD countries according to $r^*(GDP)$ and the corrected ranges of volatility of the CPI

CPI* range / $r^*(GDP)$	1.6-1.9	2.1-2.8	3.1-3.8	4.0-4.8	10.2-13.0
0.36-0.47	G	IT CH			
0.50-0.57	F	J NE PT A			
0.61-0.69	B	N CA	CZ	H	
0.72-0.77	NZ	SF	US ES		
0.81-0.87		AU S			
1.00-1.09			SL SV	IS	M
1.28-1.53		L		CHI EST	TQ
1.68			K		

Source: own elaboration.

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[23] Without the three countries with the unusual relationships and two "*outliers*" from the other (i.e.: Mexico and Turkey).

A little different is the relationship between both uncorrected as well as corrected[24] areas of volatility of empirical HCPI and $r^*(GDP)$ (see: Table 4).

Table 4. "*Strategic groups*" of OECD countries according to $r^*(GDP)$ and the uncorrected and corrected ranges of volatility of HCPI

Range HCPI	1.8-3.2	3.5-3.8	4.1-5.7	6.5-7.1	8.0-9	23.6
Range' HCPI	1.4-2.1	2.3-2.5	3.1-3.3	x	4.1	18.1
$r^*(GDP)$						
0.24-0.40			IT			
0.52-0.56	G F		PT			
0.61-0.66	A SF B	N US'	CZ	US	H	
0.74-0.77	CH					
0.80-0.84			ES			
1.03-1.11		IR SL'	SV	SL		
1.31-1.32		L				TQ
1.63			EST			

Note: the characters "*prim*" behind the symbols of the countries indicate the position of the countries concerned in view of the corrected areas of volatility, and the symbols of the same countries but without these characters indicate their location due to the unadjusted areas of volatility.

Source: own elaboration.

The differences between results based on uncorrected and corrected ranges of HCPI are negligible. In the Table 4 one can see nine "*strategic groups*". The differences concern only two countries (the Slovak Republic and the United States). In addition, in case of uncorrected ranges of HCPI singleton groups form: Estonia, Italy, Norway and Turkey, and in the case of corrected: additionally Slovenia and Hungary but Norway disappears from the list.

Also in this case, one can see that $r^*(GDP)$ increases with the increase in the value of the range $\left[HCPI_{max} - HCPI_{min} \right]$, especially for 19 countries[25] (see: Figure 8). As in the case of the Figure 7, linear function and the second-degree polynomial one practically overlap.

At the same time, one can say that with the increases in the corrected range of variation of the HCPI by 1 p.p., $r^*(GDP)$ increased in the analysed group of countries in the given period, on average, by 0.08 p.p., so more than three times less than in the case of CPI.

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[24] A total of 20 countries are concerned. There were removed 60 unusually large observations for 18 countries and 33 unusually small observations for 14 countries. The deleted observations do not significantly influence the number of degrees of freedom in the respective models. The deleted observations amount to less than 5% of the total number of observations.

[25] Without the four countries with atypical relationships and two "*outliers*" from the other (i.e.: Turkey and Hungary).
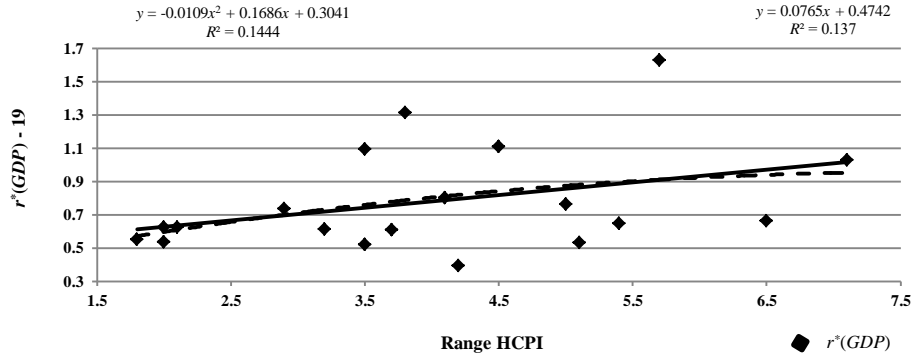
Figure 8. Dependence of $r^*(GDP)$ and the revised areas of volatility of empirical HCPIs
for 19 OECD countries

Source: own calculations.

Unfortunately, it is very difficult to determine the informal criteria for the substantive premises for an individual country to belong to a given "*strategic group*" and not to another. Often, however, the specified "*groups*" seem at least partly homogeneous.[26] Namely, in the case of criteria based on the CPIs the following were in the same group:

   a)   Austria, Germany, Italy;
   b)   Belgium, Finland, Norway, Sweden;
   c)   France, the Netherlands, Portugal, Switzerland (and Japan);
   d)   Estonia, Slovak Republic, Slovenia (well as Chile and Israel);
   e)   Australia, Canada, New Zealand and the United States (the latter "*next door*" in the case of CPI Range').

On the other hand, in the case of criteria based on HCPI, Finland, France, Germany and Austria (the latter "*next door*" in case of the corrected area) are in the same group.

6. PRELIMINARY RECOMMENDATIONS FOR ECONOMIC POLICYMAKERS

Recommendations for the economic (and social) policymakers that can be derived basing on the results of this study are limited because of

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[26] Luxembourg forms a group in the case of both criteria based on the CPI. In the case of both criteria based on the HCPI Estonia and Turkey form singleton groups, while Hungary does so only for the corrected range.

the assumptions and the methods of the analysis, as well as because of the statistical data used in investigation not mentioning the values of the statistical measures of the quality of results of the analysis. All of these resulted in the classification of individual countries to the appropriate "*strategic group*".

However, a thorough analysis of the values of each of the classification criteria in relation to the countries included in the various "*strategic groups*" allows giving the following preliminary recommendations:

1. Poland and likely also Denmark and Iceland, and perhaps also Sweden should determine:

    a)   a list of factors influencing the relationships between inflation rates and GDP growth rates;

    b)   the relationships between these factors, and the shape and location of the curve describing the relationship between the variables analysed in this paper;

    c)   a list of policy actions that will result in changing these relationships, and therefore in **inversing the shape** (**change of sign of the first derivative**) and also in changing the **respective locations** of the analysed curves.

2. Mexico and Turkey, as well as Israel, Hungary, Chile, Estonia, the Slovak Republic and the United States should determine:

    a)   a list of factors causing volatility in inflation rates;

    b)   the relationships between these factors and inflation rate volatility;

    c)   a list of policy actions that will result in the reduction of this volatility and therefore **change the shape** (**increase of the absolute values of b_{2j}^{C} or b_{2j}^{H}**) of the analysed curves, and also to **some extent** their **corresponding locations**.

3. Turkey and the Slovak Republic, as well as Poland, Hungary, Iceland, Estonia and the Czech Republic should determine:

    a)   a list of factors causing the inflation rate levels;

    b)   the relationships between these factors and the inflation rate levels;

    c)   a list of policy actions that will result in the reduction of inflation rates and therefore **change the shape** (**increase the absolute values of b_{2j}^{C} or b_{2j}^{H}**) of the analysed curves as well as change their **location** (**movement leftwards**, especially of the right arm).

4. All of the analysed countries should determine:

    a)   a list of factors causing deflation;[27]

    b)   the relationships between these factors and levels of deflation rates;

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[27] Cases of deflation occurred especially in the last quarters of the period under investigation in every analysed country. Therefore, the number of negative HCPI in Switzerland (which provided only recent data) was relatively (in relation to the total number of observations for this country) high when compared to other countries.

c) a list of policy actions that will result in the elimination of deflation and therefore **change the shape** (**increase the absolute values of** b_{2j}^C **or** b_{2j}^H) as well as the **locations** (**movement rightwards**, especially of the left arm) of the analysed curves.

The recommendations above are preliminary, similar to those given in the papers on the Philips curves and Okun's curves mentioned in the Introduction. Further, non-preliminary recommendations for macroeconomic policymakers will be formulated after each country Equation 5 presented in paragraph 2 of this paper.

REFERENCES

Abel A. B., Bernanke B. S. (2005), *Macroeconomics* (5th ed.). Pearson Addison Wesley.

Bednarczyk J. L. (2011), *Hipoteza inflacji neutralnej a problemy wzrostu gospodarczego w krajach strefy euro*, "Acta Universitatis Lodziensis, Folia Oeconomica", no. 248, Wydawnictwo Uniwersytetu Łódzkiego, Łódź.

Bednarczyk J. L. (2012), *Inflacja neutralna (NDEGRI) czy apriorycznie określony cel inflacyjny?*, (in:) Pyka I., Cichorska J. (eds.), *Finanse w niestabilnym otoczeniu - dylematy i wyzwania. Bankowość*, "Studia Ekonomiczne", no. 105, Uniwersytet Ekonomiczny w Katowicach, Zeszyty Naukowe Wydziałowe.

Bielecki J. K. (2003), *Reguła Taylora*, "Rzeczpospolita", [access: September 27, 2003].

Błaszczuk D. J. (2013), *Polityka gospodarcza Polski w długim okresie; cele i uwarunkowania*, (in:) Rybiński K. K. (ed.), *Polska w niestabilnej gospodarce europejskiej i globalnej. Problemy polityki gospodarczej i rozwoju*, Akademia Finansów i Biznesu w Warszawie, Warszawa.

Błaszczuk D. J. (2014a), *Okun's Law in OECD Countries in 1990–2013*, "Quantitative Methods in Economics", Volume XV, no. 2, pp. 47-63.

Błaszczuk D. J. (2014b), *Wprowadzenie do prognozowania, symulacji i sterowania optymalnego*, Wydawnictwo Naukowe PWN, Warszawa.

Błaszczuk D. J. (2015), *Zależność między celami polityki gospodarczej. Stopa inflacji a stopa bezrobocia w rajach OECD w latach 1990–2013*, (in:) Appenzeller D. (ed.), *Matematyka I informatyka na usługach ekonomii. Analityka gospodarcza. Metody i narzędzia*, Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu, Poznań.

Domitrovic B. (2011), *The Economics Nobel Goes to Sargent and Sims: Attackers of the Phillips Curve*, http://www.forbes.com/sites/briandomitrovic/2011/10/10/the-economics-nobel-goes-to-sargent-sims-attackers-of-the-phillips-curve/ [access: October 10, 2011].

Filar D. (2011), *Profesor Taylor nie ceni dyskrecjonalności*, "Rzeczpospolita", [access: September 4, 2011].

Friedman M. (1963), *A Monetary History of the United States, 1867–1960*, NBER, New York.

Galas Z., Nykowski I., Żółkiewski Z. (1987), *Programowanie wielokryterialne*, PWE, Warszawa.

http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2011/press.html

http://www.stats.oecd.org/WBOS/index.aspx [access: April 28, 2014].

Janecki J. (2011), *Podwyżki stóp a reguły*, http://blog.parkiet.com/janecki/2011/06/09/podwyzki-stop-a-reguly/ [access: June 09, 2011].

Kokoszczyński R, Pietrzak B. (eds) (2006), *Bankowość centralna od A do Z*, NBP, Warszawa.

Lucas R. (1976), *Econometric Policy Evaluation: A Critique*, "Carnegie-Rochester Conference Series on Public Policy", no. 1, pp. 19-46.

Lutkowski K. (2004), *Od złotego do euro – źródła obaw i nadziei*, Twigger, Warszawa.

Machaj M. (2013), *Prawda o krzywej Philipsa*, http://www.obserwatorfinansowy.pl/forma/ debata/prawda-o-krzywej-phillipsa/ [access: May 09, 2013].

Morawski I. (2012), *Po co bankom centralnym cel inflacyjny*, http://www.obserwatorfinansowy.pl/ forma/debata/po-co-bankom-centralnym-cel-inflacyjny/ [access: February 27, 2012].

Phelps E. S. (1968), *Money-Wage Dynamics and Labor Market Equilibrium*, "Journal of Political Economy", no. 76, no. 4, pp. 687-711.

Philips A. W. (1958), *The Relation between Unemployment and the Rate of Change on Money Wage Rates in the United Kingdom 1861–1957*, "Economica", v. 25, issue 100, pp. 283-299.

Prachowny M. F. J. (1993), *Okun's Law: Theoretical Foundations and Revised Estimates*, "The Review of Economics and Statistics", vol. 75, no. 2, pp. 331-336.

Samuelson P. A., Nordhaus W. D. (2004), *Ekonomia*, tom 2, Wydawnictwo Naukowe PWN, Warszawa.

Sławiński A. (2006), *Rynki finansowe*, Wydawnictwo Polskie Ekonomiczne, Warszawa.

Sławiński A. (2008), *Ewolucja poglądów na politykę pieniężną* (in:) Przybylska-Kapuścińska W. (ed.), *Studia z bankowości centralnej i polityki pieniężnej*, Difin, Warszawa.

Taylor J. B. (2010), *Zrozumieć kryzys finansowy, przyczyny, skutki, interpretacje*, PWN, Warszawa.

Wojtyna A. (2004), *Szkice o polityce pieniężnej*, Wydawnictwo Naukowe PWN, Warszawa.

ABSTRACT

There are always a few economic policy targets to be achieved at a given time. Politicians always strive to simultaneously achieve the optimal size for each of them. However, these targets are always at least partly contradictory. Therefore, striving to achieve an optimal level of individual targets does not lead to a stable, optimal long-term equilibrium. On the contrary, as the experiences of many countries show, whatever the number of targets, no optimal GDP rate and lack of political stability have been observed in the long run.

This conclusion is supported by the results of theoretical analyses using the graphical and analytical methods of the rate of GDP as well as unemployment and inflation rates on the basis of the Okun's law, the short-term Philips curve and the relationship between the rate of inflation and the rate of GDP. These three concepts are then combined into one model.

Theoretical considerations lead to the conclusion that the target of long-term economic policy should be to maximise the rate of GDP growth while maintaining levels of other targets within specific limits. Ways to achieve this target in the long run, while maintaining political stability, are the appropriate impacts of policymakers on the relationships between every pair of targets.

As a result, it is proposed (based on empirical data for the economy for a long enough period) to:
− explore analytical forms and parameters of functions describing the relationships between all possible pairs of individual targets;
− determine the empirical long-term equilibrium point (a combination of permissible individual economic policy targets):
  - directly, by solving the respective sets of equations, and, when this has no solution;
  - indirectly, on the basis of the indications of economic policymakers and theoreticians of various economic branches;
− determine (in co-operation with politicians and theoreticians of various economic branches) the optimal combination of economic policy targets in the long run (the desired long-term equilibrium point), i.e.: the maximum growth rate of GDP and acceptable lower and upper bounds for all other targets;

–   determine the direction in which the empirical long-term equilibrium point should be moved in the near and further future to become the same as the desired long-term equilibrium point;

–   determine the factors in a given economy in a given period of time in the future that will move the long-term empirical equilibrium point in the desired direction, as well as the direction and strength of the influence of each of these factors;

–   implement by the policymakers the appropriate economic policy measures, i.e. to cause the replacement of the permissible combination of the individual targets of economic policy by the respective optimal combination (to influence the analytical forms and the parameters of functions describing the relationships between all pairs of individual targets, so that the rate of GDP would be the closest possible to its maximum value and at the same time boundary conditions for all other economic policy targets would be met). Of course, it is possible to depart slightly, in short periods, from maximising the rate of GDP growth in order to take into account any demand or supply shocks affecting other economic policy targets that may occur.

The last step is always an assessment of the results of the economic policy by the voters.

Theoretical considerations are complemented by an empirical analysis (based on quarterly data, separately for each OECD country) of the relationships between the rates of inflation and the growth rates of GDP during more or less the last two business Juglar cycles.

An analysis of these relationships allows to construct "strategic groups' maps" based on two criteria: the maximum GDP rates and the corresponding inflation rates. The analysis of these "maps" allows drawing preliminary proposals for economic policymakers.

Further research (for individual OECD countries) will encompass empirical analyses of the investigations of the respective empirical long-term equilibria. The final result will be considerations on optimal economic policy measures for different countries based on results of the empirical studies.

CELE POLITYKI GOSPODARCZEJ: ZALEŻNOŚĆ MIĘDZY STOPĄ INFLACJI A TEMPEM PKB W KRAJACH OECD W LATACH 1990–2013

ABSTRAKT

Politycy każdego kraju wyznaczają zazwyczaj kilka różnych celów gospodarczych zakładając, że każdy z tych celów osiągnie pożądany przez nich poziom. Jest to jednak niewykonalne, bowiem niektóre cele są zawsze ze sobą sprzeczne. W rezultacie, dążenie do osiągnięcia określonego poziomu każdego z celów uniemożliwia osiągnięcie stabilnej równowagi długookresowej na poziomie optymalnym.

Powyższy wniosek jest poparty wynikami analizy teoretycznej (metodami graficzną i analityczną) na przykładzie wzajemnych związków między trzema wybranymi celami polityki gospodarczej: tempem PKB, stopą bezrobocia i stopą inflacji, a mianowicie: zależności opisywanych prawem Okuna, krótkookresową krzywą Philipsa oraz zaproponowanej przez autora zależności między stopą inflacji a tempem PKB. Następnie te trzy zależności połączone są w jeden nowy autorski model. Rozważania teoretyczne na podstawie tego modelu prowadzą do wniosku, że celem polityki gospodarczej powinna być maksymalizacja tempa PKB przy utrzymaniu poziomów pozostałych celów w z góry określonych granicach.

Osiągnięcie tego celu w okresie długim wymaga odpowiednich oddziaływań na zależności między każdymi dwoma celami polityki gospodarczej. Do tego niezbędne jest:

1)   poznanie kształtów i położeń funkcji, opisujących zależności między każdymi dwoma celami polityki gospodarczej (na podstawie danych empirycznych dla danej gospodarki w okresie długim);

2)   określenie empirycznego punktu równowagi długookresowej (dopuszczalnej kombinacji celów polityki gospodarczej):

    a)   bezpośrednio, rozwiązując odpowiedni układ równań, a gdy nie ma on rozwiązania,

    b)   pośrednio, na podstawie wskazań polityków gospodarczych i teoretyków ekonomik szczegółowych;

3)   ustalenie dla okresu przyszłego (przy współpracy z politykami gospodarczymi i teoretykami ekonomik szczegółowych) optymalnej kombinacji celów polityki gospodarczej (pożądanego punktu równowagi długookresowej), tj. maksymalnego tempa wzrostu PKB oraz dopuszczalnych przedziałów wahań poziomów pozostałych celów;

4)   ustalenie kierunku, w którym empiryczny punkt równowagi długookresowej powinien się przesuwać w bliższej i dalszej przyszłości aby stał się on tożsamy z pożądanym punktem równowagi długookresowej;

5)   ustalenie czynników, które w danej gospodarce w okresie przyszłym spowodują przesuwanie empirycznego punktu równowagi długookresowej w pożądanym kierunku, a także określenie kierunku i siły wpływu każdego z tych czynników;

6)   wdrażanie przez polityków gospodarczych odpowiedniej polityki gospodarczej, tj. takie oddziaływanie na położenie i kształt każdej z funkcji, opisujących zależności między każdymi dwoma celami polityki gospodarczej, aby tempo PKB było możliwie bliskie maksymalnego i jednocześnie, aby spełnione były warunki brzegowe dla wszystkich pozostałych celów polityki gospodarczej. Oczywiście, okresowo możliwe jest nieznaczne odstąpienie od maksymalizacji tempa wzrostu PKB w związku z koniecznością uwzględniania ewentualnych szoków podażowych lub popytowych.

Rozważania teoretyczne zostały uzupełnione analizą empiryczną zależności między stopą inflacji a tempem PKB (na podstawie danych kwartalnych, oddzielnie dla każdego kraju OECD) w okresie, mniej więcej, ostatnich dwu cykli koniunkturalnych (Juglara).

Analiza ta pozwoliła zbudować „*mapy grup strategicznych*", uwzględniające kryteria związane z maksymalnym tempem PKB oraz współistniejącą z nim stopą inflacji. Na podstawie tych „map" wyprowadzone zostały wstępne wnioski dla polityki gospodarczej każdego z badanych krajów.

Przedmiotem dalszych badań autora (również obejmujących poszczególne kraje OECD) będzie ustalenie oraz analiza empirycznych punktów równowagi długookresowej. Końcowym efektem będą pogłębione wskazówki dla polityków gospodarczych poszczególnych krajów OECD.

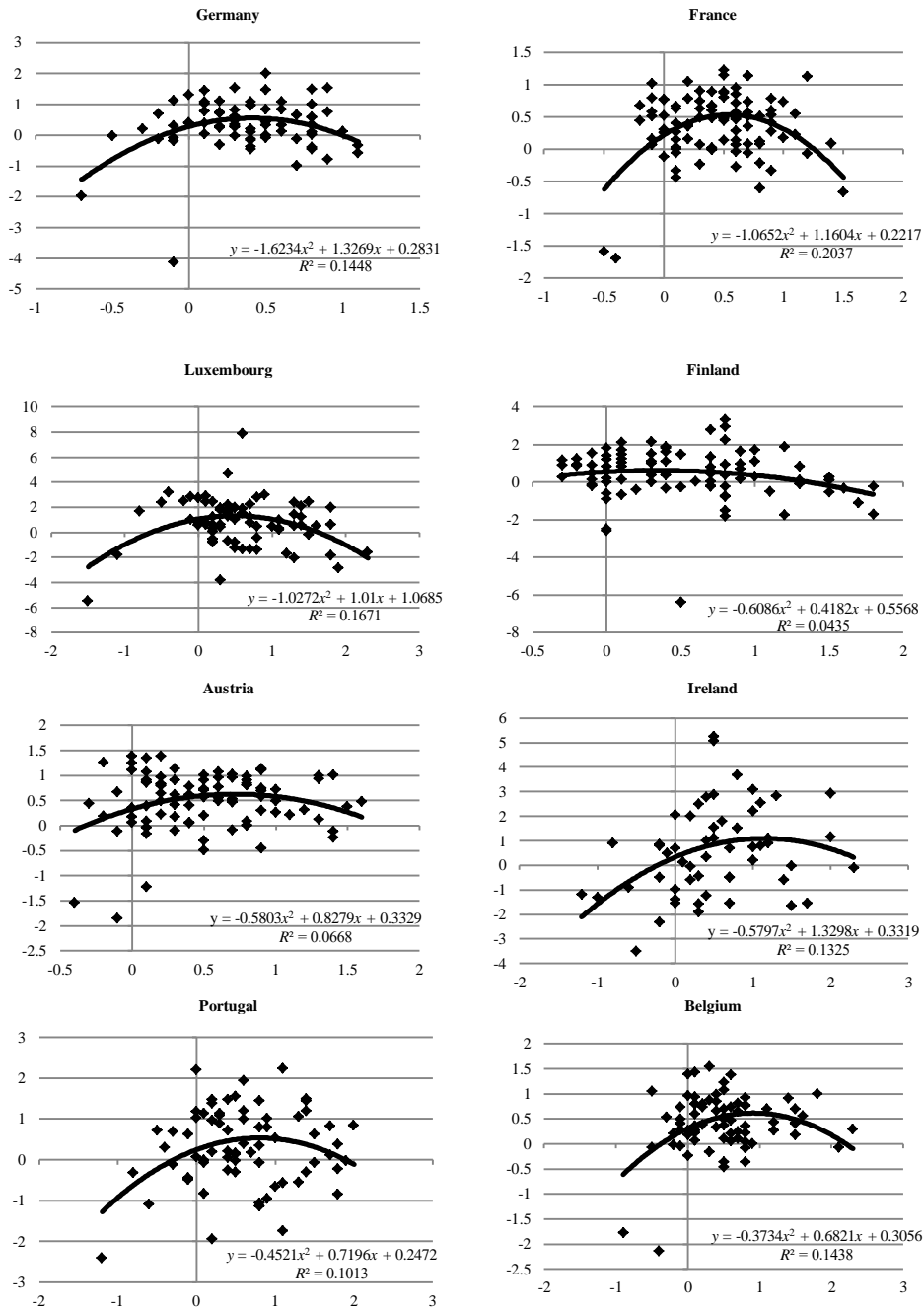Appendix 1. Summary of the analysis results

Part 1

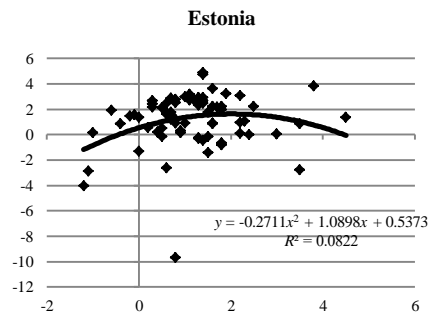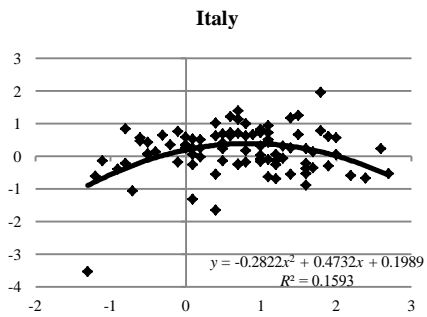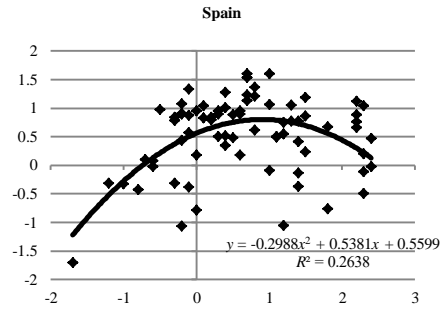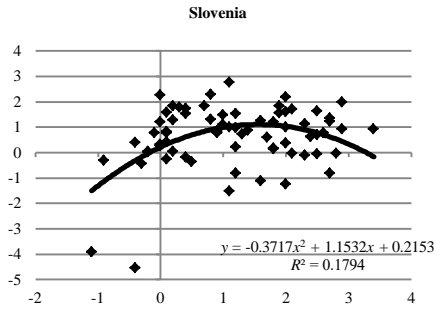| No.	Country	$r(GDP) = f(HCPI)$							
		Observations		b_{2j}^{H}	t Stat	b_{1j}^{H}	t Stat	b_{0j}^{H}	t Stat
		from	No.						
1	**Australia (AU)**	x	x	x	x	x	x	x	x
2	**Austria (A)**	Q1-1991	92	-0.5803	-2.27	0.8279	2.52	0.3329	3.48
3	**Belgium (B)**	Q2-1995	75	-0.3734	-3.12	0.6821	3.46	0.3056	3.69
4	**Canada (CA)**	x	x	x	x	x	x	x	x
5	**Chile (CHI)**	x	x	x	x	x	x	x	x
6	**Czech Republic (CZ)**	Q2-1996	71	-0.062	-1.12	0.0626	0.31	0.6342	4.52
7	**Denmark (DE)**	Q2-1991	91	0.4815	0.91	-0.284	-0.46	0.2866	1.56
8	**Estonia (EST)**	Q2-1995	75	-0.2711	-2.07	1.0898	2.47	0.5373	1.4
9	**Finland (SF)**	Q1-1991	92	-0.6086	-1.39	0.4182	0.67	0.5568	2.9
10	**France (F)**	Q1-1991	92	-1.0652	-4.61	1.1604	4.63	0.2217	3.01
11	**Germany (G)**	Q2-1995	75	-1.6234	-3.29	1.3269	3.31	0.2831	2.15
12	**Hungary (H)**	Q2-1995	75	-0.026	-1.35	0.1859	1.34	0.2992	1.62
13	**Iceland (IC)**	Q2-1997	67	0.0947	0.86	-1.0222	-1.68	1.6599	2.82
14	**Ireland (IR)**	Q2-2000	55	-0.5797	-1.87	1.3298	2.8	0.3319	1.13
15	**Israel (IS)**	x	x	x	x	x	x	x	x
16	**Italy (IT)**	Q1-1991	92	-0.2822	-3.86	0.4732	3.84	0.1989	2.11
17	**Japan (J)**	x	x	x	x	x	x	x	x
18	**Korea (K)**	x	x	x	x	x	x	x	x
19	**Luxembourg (L)**	Q2-1995	75	-1.0272	-3.78	1.01	2.37	1.0685	3.94
20	**Mexico (M)**	x	x	x	x	x	x	x	x
21	**Netherlands (NE)**	Q1-1991	92	-0.0388	-0.32	-0.0372	-0.23	0.513	5.19
22	**New Zealand (NZ)**	x	x	x	x	x	x	x	x
23	**Norway (N)**	Q2-1995	75	-0.1224	-0.67	0.18978	0.86	0.5379	2.98
24	**Poland (PL)**	Q2-1995	75	0.0781	1.63	-0.161	-0.73	0.9245	4.94
25	**Portugal (PT)**	Q1-1996	72	-0.4521	-2.57	0.7196	2.72	0.2472	1.75
26	**Slovak Republic (SL)**	Q2-1997	67	-0.0422	-0.55	0.1614	0.36	0.8769	2.36
27	**Slovenia (SV)**	Q1-1996	72	-0.3717	-3.16	1.1532	3.79	0.2153	1.08
28	**Spain (ES)**	Q2-1995	75	-0.2988	-4.8	0.5381	4.78	0.5599	6.51
29	**Sweden (S)**	Q2-1993	83	0.119	0.42	-0.0074	-0.02	0.6068	4.55
30	**Switzerland (CH)**	Q2-2005	35	-0.2225	-1.21	0.4088	2.4	0.5498	4.2
31	**Turkey (TQ)**	Q2-1998	63	-0.0075	-0.83	0.0007	0	1.3142	2.57
32	**United Kingdom (UK)**	Q1-1991	92	-0.0324	-0.56	-0.131	-0.7	0.6346	6.01
33	**United States (US)**	Q1-1991	92	-0.1423	-4.08	0.1892	2.31	0.6009	6.18

Source: own calculations.

Part 2

No.	Country	Observations		b_{2j}^c	t Stat	b_{1j}^c	t Stat	b_{0j}^c	t Stat
		$r(GDP) = f(CPI)$							
		from	No.						
1	Australia (AU)	Q1-1990	96	-0.0665	-0.89	0.0248	0.12	0.8101	7.13
2	Austria (A)	Q1-1990	96	-0.1592	-1.19	0.2806	1.46	0.4503	5.44
3	Belgium (B)	Q2-1995	75	-0.7126	-3.49	1.0262	3.74	0.2466	2.64
4	Canada (CA)	Q1-1990	96	-0.355	-4.41	0.3669	2.5	0.5973	7.42
5	Chile (CHI)	Q2-2003	43	-0.2275	-2.66	0.4798	2.22	1.1142	5.23
6	Czech Republic (CZ)	Q2-1996	71	-0.0496	-1	0.0324	0.17	0.6432	4.47
7	Denmark (DE)	Q2-1991	91	0.2965	0.48	-0.1451	-0.2	0.3055	1.45
8	Estonia (EST)	Q2-1995	75	-0.5338	-3.05	1.4427	3.08	0.5092	1.33
9	Finland (SF)	Q2-1990	95	-1.4381	-3.25	1.667	2.9	0.2824	1.56
10	France (F)	Q1-1990	96	-1.3368	-5.25	1.3043	5.13	0.2255	3.15
11	Germany (G)	Q2-1991	91	-0.4689	-2.47	0.7634	2.17	0.1621	1.2
12	Hungary (H)	Q2-1995	75	-0.0272	-1.36	0.1929	1.34	0.2901	1.52
13	Iceland (IC)	Q2-1997	67	0.1085	0.65	-0.9607	-1.13	1.6414	2.08
14	Ireland (IR)	Q2-2000	55	-0.09	-0.65	0.6733	2.63	0.2711	0.85
15	Israel (IS)	Q2-1995	75	-0.0389	-0.79	0.062	0.38	1.0122	7.38
16	Italy (IT)	Q1-1990	96	-0.517	-2.43	1.1542	3.02	-0.2864	-1.74
17	Japan (J)	Q2-1994	79	-0.7842	-3.7	0.5506	2.19	0.4087	3.32
18	Korea (K)	Q1-1990	96	-0.4039	-5.54	1.16	4.04	0.8461	3.86
19	Luxembourg (L)	Q2-1995	75	-2.2876	-3.67	2.2593	2.87	0.8586	2.91
20	Mexico (M)	Q1-1990	96	-0.0294	-4.22	0.2671	2.79	0.4055	2
21	Netherlands (NE)	Q1-1990	96	-0.1334	-0.59	0.0837	0.31	0.5128	4.45
22	New Zealand (NZ)	Q1-1990	96	-0.3466	-1.8	0.2765	0.92	0.7085	5.53
23	Norway (N)	Q1-1990	96	-0.1204	-0.8	0.1804	0.76	0.5881	3.54
24	Poland (PL)	Q2-1995	75	0.0503	1.36	-0.083	-0.41	0.923	5.03
25	Portugal (PT)	Q1-1996	72	-0.6068	-3.01	0.8058	2.99	0.2986	2.05
26	Slovak Republic (SL)	Q2-1997	67	-0.0438	-0.57	0.1703	0.37	0.8705	2.28
27	Slovenia (SV)	Q1-1996	72	-0.3388	-3.34	1.0846	3.84	0.224	1.14
28	Spain (ES)	Q2-1995	75	-0.28	-3.88	0.5568	4.33	0.4721	5.25
29	Sweden (S)	Q2-1993	83	-0.3587	-1.9	0.6108	2.7	0.6112	5.01
30	Switzerland (CH)	Q1-1991	92	-0.1801	-1.74	0.1064	0.87	0.4274	5.84
31	Turkey (TQ)	Q2-1998	63	-0.0096	-0.85	0.0302	0.16	1.2592	2.34
32	United Kingdom (UK)	Q1-1990	96	-0.0102	-0.18	-0.185	-0.99	0.6419	5.97
33	United States (US)	Q1-1990	96	-0.2667	-5.16	0.2488	2.63	0.6665	7.52

Source: own calculations.

Appendix 2. Empirical values of $r_{jt}(GDP)$ and $HCPI_{jt}$ and the theoretical values of $r^H_{jt}(GDP)$
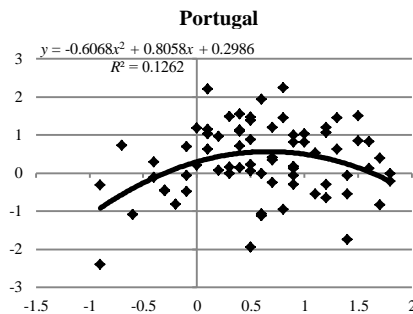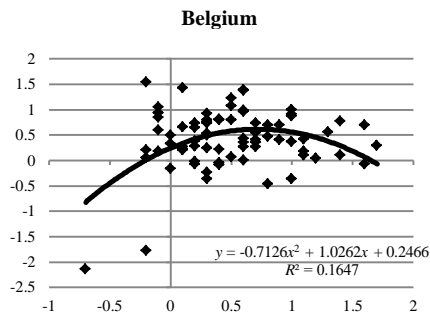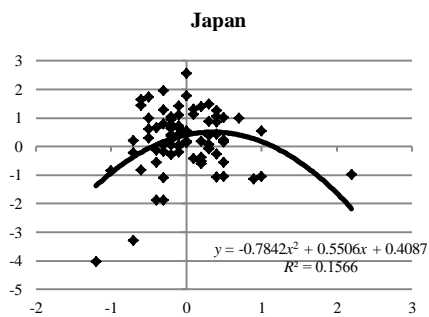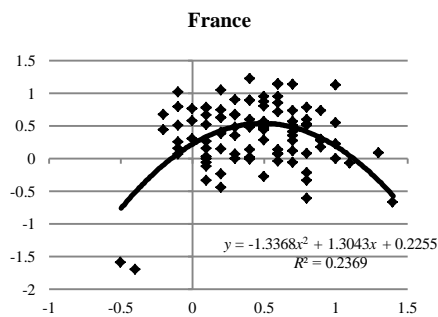
Germany

$y = -1.6234x^2 + 1.3269x + 0.2831$
$R^2 = 0.1448$

France

$y = -1.0652x^2 + 1.1604x + 0.2217$
$R^2 = 0.2037$

Luxembourg

$y = -1.0272x^2 + 1.01x + 1.0685$
$R^2 = 0.1671$

Finland

$y = -0.6086x^2 + 0.4182x + 0.5568$
$R^2 = 0.0435$

Austria

$y = -0.5803x^2 + 0.8279x + 0.3329$
$R^2 = 0.0668$

Ireland

$y = -0.5797x^2 + 1.3298x + 0.3319$
$R^2 = 0.1325$

Portugal

$y = -0.4521x^2 + 0.7196x + 0.2472$
$R^2 = 0.1013$

Belgium

$y = -0.3734x^2 + 0.6821x + 0.3056$
$R^2 = 0.1438$

Slovenia

$y = -0.3717x^2 + 1.1532x + 0.2153$
$R^2 = 0.1794$

Spain

$y = -0.2988x^2 + 0.5381x + 0.5599$
$R^2 = 0.2638$

Italy

$y = -0.2822x^2 + 0.4732x + 0.1989$
$R^2 = 0.1593$

Estonia

$y = -0.2711x^2 + 1.0898x + 0.5373$
$R^2 = 0.0822$

Switzerland

$y = -0.2225x^2 + 0.4088x + 0.5498$
$R^2 = 0.155$

United States

$y = -0.1423x^2 + 0.1892x + 0.6009$
$R^2 = 0.2799$

Norway

$y = -0.1224x^2 + 0.1897x + 0.5379$
$R^2 = 0.0116$

Czech R.

$y = -0.062x^2 + 0.0626x + 0.6342$
$R^2 = 0.04$

Slovak R.

$y = -0.0422x^2 + 0.1614x + 0.8769$
$R^2 = 0.0079$

Netherlands

$y = -0.0388x^2 - 0.0372x + 0.513$
$R^2 = 0.0054$

United Kingdom

$y = -0.0324x^2 - 0.131x + 0.6346$
$R^2 = 0.0485$

Hungary

$y = -0.026x^2 + 0.1859x + 0.2992$
$R^2 = 0.0256$

Turkey

$y = -0.0075x^2 + 0.0007x + 1.3142$
$R^2 = 0.0883$

Poland

$y = 0.0781x^2 - 0.161x + 0.9245$
$R^2 = 0.0782$

Iceland

$y = 0.0947x^2 - 1.0222x + 1.6599$
$R^2 = 0.0706$

Sweden

$y = 0.119x^2 - 0.0074x + 0.6068$
$R^2 = 0.0064$

Denmark

$$y = 0.4815x^2 - 0.284x + 0.2866$$
$$R^2 = 0.0159$$

Source: own calculations.

Appendix 3. Empirical values of $r_{jt}(GDP)$ and CPI_{jt} and the theoretical values of $r^C_{jt}(GDP)$

Luxemburg

$$y = -2.2876x^2 + 2.2593x + 0.8586$$
$$R^2 = 0.16$$

Finland

$$y = -1.4381x^2 + 1.667x + 0.2824$$
$$R^2 = 0.1031$$

France

$$y = -1.3368x^2 + 1.3043x + 0.2255$$
$$R^2 = 0.2369$$

Japan

$$y = -0.7842x^2 + 0.5506x + 0.4087$$
$$R^2 = 0.1566$$

Belgium

$$y = -0.7126x^2 + 1.0262x + 0.2466$$
$$R^2 = 0.1647$$

Portugal

$$y = -0.6068x^2 + 0.8058x + 0.2986$$
$$R^2 = 0.1262$$

Estonia

$y = -0.5338x^2 + 1.4427x + 0.5092$
$R^2 = 0.1454$

Italy

$y = -0.517x^2 + 1.1542x - 0.2864$
$R^2 = 0.095$

Germany

$y = -0.4689x^2 + 0.7634x + 0.1621$
$R^2 = 0.065$

Korea

$y = -0.4039x^2 + 1.16x + 0.8461$
$R^2 = 0.2674$

Sweden

$y = -0.3587x2 + 0.6108x + 0.6112$
$R^2 = 0.085$

Canada

$y = -0.355x^2 + 0.3669x + 0.5973$
$R^2 = 0.1784$

New Zealand

$y = -0.3466x^2 + 0.2765x + 0.7085$
$R^2 = 0.0448$

Slovenia

$y = -0.3388x^2 + 1.0846x + 0.224$
$R^2 = 0.1772$

Spain

$y = -0.28x^2 + 0.5568x + 0.4721$
$R^2 = 0.2127$

United States

$y = -0.2667x^2 + 0.2488x + 0.6665$
$R^2 = 0.2458$

Chile

$y = -0.2275x^2 + 0.4798x + 1.1142$
$R^2 = 0.1599$

Switzerland

$y = -0.1801x^2 + 0.1064x + 0.4274$
$R^2 = 0.0329$

Austria

$y = -0.1592x^2 + 0.2806x + 0.4503$
$R^2 = 0.0224$

Netherlands

$y = -0.1334x^2 + 0.0837x + 0.5128$
$R^2 = 0.0045$

Norway

$y = -0.1204x^2 + 0.1804x + 0.5881$
$R^2 = 0.0084$

Ireland

$y = -0.09x^2 + 0.6733x + 0.2711$
$R^2 = 0.1205$

Australia

$y = -0.0665x^2 + 0.0248x + 0.8108$
$R^2 = 0.0245$

Czech R.

$y = -0.0496x^2 + 0.0324x + 0.6432$
$R^2 = 0.0409$

Slovak R.

$y = -0.0438x^2 + 0.1703x + 0.8705$
$R^2 = 0.0083$

Israel

$y = -0.0389x^2 + 0.062x + 1.0122$
$R^2 = 0.0111$

Mexico

$y = -0.0294x^2 + 0.2671x + 0.4055$
$R^2 = 0.1976$

Hungary

$y = -0.0272x^2 + 0.1929x + 0.2901$
$R^2 = 0.0256$

United Kingdom

$y = -0.0102x^2 - 0.185x + 0.6419$
$R^2 = 0.0476$

Turkey

$y = -0.0096x^2 + 0.0302x + 1.2592$
$R^2 = 0.0834$

Poland

$y = 0.0503x^2 - 0.083x + 0.923$
$R^2 = 0.0915$

Iceland

$y = 0.1085x^2 - 0.9607x + 1.6414$
$R^2 = 0.0319$

Denmark

$y = 0.2965x^2 - 0.1451x + 0.3055$
$R^2 = 0.0065$

Source: own calculations.