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The usefulness of disaggregated data in the monetary policy of the central bank conducted within the IT strategy on the example of Poland - selected issues

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Introduction

After the experiences of the oil crisis of the 70s, when inflation in the world clearly and relatively permanently increased, central banks have begun to pay greater attention to stabilization of inflation at a low level, which would create positive conditions for the economic development of countries. This resulted, among other things, in a change in the approach to monetary policy and adoption in the early 90s by a number of countries the strategy of inflation targeting (IT).

As part of the IT strategy the central bank is committed to maintain relatively stable prices, assuming achievement of its own numerical inflation target in the medium term. Such commitment of the central bank allows for flexible adjustment of monetary policy parameters to the shocks in the domestic economy and the external environment, and at the same time supports the anchoring of the inflation expectations of economic agents.

Given the role of the inflation indicator in the inflation target strategy, from the point of view of the central bank it is important to know the processes taking place in the economy and price-setting behavior of the economic agents affecting inflation. Literature analyzing these issues, both domestic and foreign, is extremely extensive. However, it focuses mainly on the analysis of the aggregate CPI, while the studies based on disaggregated data are still relatively scarce.

Purpose, method and research problems

The purpose of my research articles described below is to show the informational advantage of disaggregated data analysis over aggregate data for the understanding of inflation processes in a small open economy, like Poland. For each research problem presented here I perform an appropriate decomposition of the CPI in order to analyze economic processes influencing the price dynamics of individual components of the inflation index from various perspectives.

The presented output consists of the thematically coherent collection of articles, mostly co-authored, which analyze selected aspects of inflation in Poland. Each study is based on disaggregated data on the consumer goods and services price index.

In my articles I focused on four research problems. The first one was to analyze the impact of changes in the domestic economic situation on price developments in a small open economy, like, among others, Poland. My analysis was intended to verify the hypothesis of a potentially low impact of domestic factors on the development of the price index. At the same time in this study I wanted to estimate the usefulness of core inflation measures for the assessment of demand pressures in the economy.

The obtained results concerning the impact of the economic situation in the country on inflation indicated the existence of a group of the CPI components which are not sensitive to the changes of the domestic economic situation. Therefore, in the subsequent analyses I decided to attempt a more precise identification of external factors influencing inflation, which is my second research problem presented in this collection of articles. The analysis of this issue was

carried out from three perspectives. First, I analyzed what type of external shocks have the greatest influence on the variability of inflation in Poland. Second, what is the transmission of price impulses from a large economy (the euro area) to small open economies (including Poland). And third, is there one common factor shaping the components of the price index in the countries of our region, or is it possible to distinguish various common factors depending on the analyzed sector or country .

The third research issue I undertake to analyze is to assess the formulation of inflation expectations of households, and in particular to check which components of the CPI are taken into consideration when forming these expectations. From the point of view of conducting an effective monetary policy this problem is important because, as Woodford (2005) and Svensson (2004) claim, monetary policy to a large extent consists in managing expectations. Therefore, the knowledge of how consumers assess current and especially future inflation processes is necessary to fully understand the character of monetary policy transmission.

The fourth and final research problem is to assess the quality of the published price index and, in particular, whether it is biased due to the substitution of goods and services, what can be done only on the basis of disaggregated data. This problem only superficially focuses on the statistical issue of estimating the bias of the CPI in Poland. Many economists are interested whether the assessment of price changes of the average price basket is adequate because the CPI has numerous applications. It is particularly important in the case of countries where central banks implement the strategy of inflation targeting expressed in the CPI. As shown by i.a. Kokoszcyński (2004), Wojtyna (2004) and Baranowski (2008), the potential bias of the CPI estimate is one of the reasons for setting the inflation target at positive level.

As mentioned earlier, in the domestic and foreign literature on price-setting processes and inflation we encounter a large number of studies based on aggregate indices - mainly the CPI and core inflation measures. Analyses based on disaggregated data are relatively rare. In my work I hypothesize that the analysis of disaggregated data may contribute to deepening the understanding of price-setting and inflation processes, as well as the formulation of expectations by households. Moreover, an analysis based on disaggregated data is necessary when attempting to estimate the precision of inflation measurement.

The analysis of the presented research problems was performed on the basis of disaggregated data with the use of a wide range of econometric methods. Among the tools used are both simple correlation analyses, linear regression models estimated using the least squares method and generalized method of moments, as well as some more advanced models, including factor models, or structural vector autoregression (VAR) models.

The impact of domestic economic situation on price development in a small open economy

One of the research areas in which the need for disaggregated data analysis has a particular significance is the estimation of the parameters of the aggregate Phillips curve, in the case of

which there often is a problem with obtaining the statistical significance of the parameter linking inflation to the output gap (i.a. Orphanides and van Norden, 2005, Nason and Smith, 2008, Rümmler and Valderrama, 2010, Blanchard et al. 2015). There are numerous works on the relationship between inflation and domestic economic activity based on aggregate data (i.a. Razzak, 2002, Del Negro et al., 2007, Kuttner and Robinson, 2010, Rümmler and Valderrama, 2010, Vasicek, 2011). Studies based on aggregate data often point to the weakening of the response of inflation to the changes in domestic demand, which can be identified with the so-called flattening of the Phillips curve (e.g. Borio and Filardo, 2007).

While the flattening of the Phillips curve can be really observed in Poland (Szafranek, 2016), the analysis on the level of aggregate CPI does not provide an answer to the question of whether the weakening of this relationship is evenly distributed between different components of inflation, or rather if there is a group of prices which are strongly influenced by the domestic economic situation. In this case, the advantage associated with the analysis based on disaggregated inflation data is the possibility to extract this part of the CPI which is statistically significantly influenced by the changes in the output gap, and what in turn allows for the identification of the group of goods and services with prices potentially affected by the domestic monetary policy (see i.a. Bryan and Meyer, 2010, Froehling and Lommatzsch, 2011). At the same time, aggregation of components considered sensitive to changes in the domestic economic situation enables construction of a price index which can show demand pressures in the economy, and is available sooner than other commonly used measures of demand pressure, as e.g. output gap.

Although there are studies which address this issue using disaggregated indices of inflation for the euro area and the US economy, to the best of my knowledge the presented study constitutes the first attempt to extract from the CPI in Poland the components with prices reacting to the domestic economic situation (Hałka and Kotłowski, 2014¹).

The analysis of the disaggregated inflation index for Poland was carried out based on the Phillips curve. The equations describing the relationship of the price index of individual CPI components with the output gap also included factors such as exchange rate and inflation abroad. Such construction of the Phillips curve allows not only to define the components of the inflation indicator which react to the changes in the domestic economic situation, but also makes it possible to assess the impact of the exchange rate on the development of individual prices².

Disaggregation performed during the study allowed me to extract in a formal way the components of the CPI basket which are sensitive to changes in the domestic demand and exchange rate fluctuations. The results of the analysis indicate that more than half of the consumption basket (55%) responds to the changes in the output gap. Apparently, the prices most

¹ The article is part of a thematically coherent collection. My contribution is estimated at 50%. I was responsible for the concept of the study, preparation of data, calculation of the index of goods and services responsive to the output gap (IDSG), interpretation and description of the results.

² The central bank through its monetary policy affects also, though due to the role of external factors to a limited extent, the exchange rate and indirectly the imported inflation.

sensitive to the changes in domestic economic activity are those which are characterized by relatively high volatility, that is a significant part of components from the food and energy group. The conclusions from this part of the study indicate that contrary to widespread opinions about a relatively fixed demand for food and energy in developing countries, the prices in these groups are influenced by the domestic economic situation changes and do not depend only on global trends in commodity markets. Moreover, only a small part of the durable and semi-durable goods prices is sensitive to changes in the output gap. Most likely, the prices in these groups are shaped by globalization manifesting itself among other things in moving production to countries with lower production costs (Rogoff, 2003) and the ongoing acceleration of technological development in this period. This hypothesis is confirmed by my another study: Hałka and Kotłowski (2016), in which I find a statistically significant relationship between global non-commodity supply shock and price developments in these groups of goods. A more detailed look at the behavior of the indices of these prices indicates that many of them showed a downward trend over the last decade - unrelated to the cyclical position of the Polish economy.

With reference to the impact of the exchange rate changes on prices, 30% of the CPI basket in Poland shows sensitivity to its changes. Moreover, almost all the components sensitive to the exchange rate changes react also to the changes in the domestic economic situation. The categories most sensitive to the exchange rate fluctuations are durable and semi-durable goods, although it should be emphasized that among these goods there is a group where the prices do not show sensitivity to changes of neither the exchange rate nor the domestic output gap (which, as already indicated, can be associated with the globalization process). As expected, the force of the impact of the exchange rate is not the same for all components. Short-term impact of the exchange rate (pass-through) varies from 0.004 (for furniture and household appliances) to 0.23 (for food and expensive goods, such as cars), and the average impact is 0.05, which is a slightly lower result than indicated by the results of the research by Kapuściński et al. (2015), who analyzed the impact of the exchange rate using aggregate data.

The results of a similar study for the euro area countries were presented by Froehling and Lommatzsch (2011). However, as the euro area is a large closed economy, the authors did not take into consideration the exchange rate while estimating the Phillips curve and the results indicate a greater proportion of the components responsive to the changes in the output gap (two-thirds of the components included in the consumer basket). As it is the case in Poland, in the euro area on one hand the domestic economic situation quite strongly affects food prices, and on the other hand the prices of durable and semi-durable goods are relatively less responsive to changes in the output gap.

The study on defining the categories of goods responsive to the changes in the domestic economic situation was continued in the article by Hałka and Kotłowski (2016)³. The authors

³ The article is part of a thematically coherent collection. My contribution is estimated at 50%. I was responsible for the concept of the study, choice of the research method, review of literature, preparation of data, interpretation of results from the SVAR model and Phillips curves.

found that the impact of the domestic economic situation on inflation in a given country is idiosyncratic, depending on the structure of the economy - the study confirmed the importance of the domestic output gap in shaping inflation in Poland. However, in the case of the Czech Republic the output gap does not have such a strong impact on inflation. In Sweden this effect was significant only in the period preceding the outbreak of the global financial crisis and during its initial phase, when the gap was characterized by high volatility, then it remained modest. The results obtained in this study I discuss in the latter part of this paper.

The results of both presented studies indicate that the lack of statistical significance of the parameter linking changes in inflation to the level of domestic economic situation (i. e. the Phillips curve) may be due to the fact that a significant portion of the CPI basket is not sensitive to changes in the output gap, which may reduce the sensitivity of the aggregate CPI to changes in the domestic economy. Thus the analysis of disaggregated data allows to define the reasons for the lack of statistical significance or instability in the estimates of this parameter for the aggregate index (CPI or HICP), which is indicated for example in the studies by Vasicek (2011) for Poland and the Czech Republic. At the same time thanks to this analysis, assuming that the central bank has influence on the domestic economic situation, it is possible to attempt to answer the question to what extent the central bank in Poland can shape inflation in the country.

The results also indicate that the core inflation indicators are not the best measure reflecting the actual inflation pressures in the economy, although some authors see such application for them. For example, Rogers (1998) indicates that the measure constructed by excluding certain components, usually groups with prices highly sensitive to supply shocks and/or external factors of a temporary nature, may constitute a better approximation of changes in the domestic demand. However, Filar (2009) rightly emphasizes that the exclusion of food and fuel prices does not mean that an index constructed in this way will reflect the effects of demand changes in a given economy due to the inclusion of such components, the prices of which are, for example, administratively regulated. The question arises whether it is possible to construct an indicator which will reflect demand pressures in the economy and to express it in terms of price changes.

In my study (Hałka and Kotłowski, 2014), by identifying groups of goods and services with prices sensitive to the domestic economic situation, I could also perform their aggregation in order to construct an index of goods and services sensitive to output gap (IDSG)⁴. The changes of this index will be parallel to the fluctuations in the domestic economy.

The analysis of relations between the chosen measures of inflation (CPI, core inflation and the proposed IDSG index) and the output gap has confirmed that among those measures the IDSG

⁴ It is worth reminding that the analysis of disaggregated data on the basis of the Phillips curve for a small open economy (e. g. Poland) also allows to specify the categories of goods and services, the prices of which are affected by changes in the exchange rate. My co-authorship study: Hałka and Kotłowski (2014) indicated that the so-constructed index also includes almost all components of the price index, which are sensitive to the changes in the exchange rate.

index is most responsive to the changes in the domestic economic situation⁵. A similar analysis for the euro area was conducted by Froehling and Lommatzsch (2011), also confirming good properties of an index constructed in this way.

It is possible to indicate the following benefits from creating an index defined in this way. First, the IDSG index can show demand pressures in the economy in terms of price growth, and not only in real terms (that is, by estimating the output gap)⁶. Second, because of its construction, information on the index is available relatively frequently (every month⁷), and the delay in publishing is smaller than in the case of the output gap estimates (approximately 11-14 days after the end of the month, while estimates of the output gap are available on a quarterly basis, 45 days after the end of the quarter). In addition, the CPI is not subjected to revisions⁸, as is the case of the GDP data, and hence the IDSG index does not change back with the influx of new information.

Third, taking into account the basic channels of monetary transmission, the IDSG index – on one hand including goods sensitive to demand, on the other hand almost all goods sensitive to exchange rate fluctuations⁹ – will express changes in those prices, which are most responsive to the changes in the parameters of the domestic monetary policy .

It is worth mentioning that when we construct measures of core inflation by excluding food and energy prices, we exclude from the index those components which react to the demand in the economy, and at the same time we leave some components which are not sensitive to the domestic output gap. For this reason, core inflation may not be the best approximation of demand pressures in the economy and basing the analysis only on this index can lead to erroneous conclusions.

It should be noted, however, that the IDSG index should not be considered as a measure competing with the traditionally used measures of core inflation, but only as a complementary measure, providing a different perspective on inflationary processes in the economy.

Characteristic of external shocks affecting inflation in Poland

In the already quoted study by Hałka and Kotłowski (2014), a fairly large group was found of goods with prices insensitive both to the domestic economic situation and to changes in the

⁵ The strength is measured by the value of the coefficient standing at the output gap in the equation.

⁶ A similar analysis was performed by Chmielewski and Kot (2006), showing that the indicator that excludes part of the CPI components (considered to be under the influence of globalization) is more strongly linked to the domestic economic situation.

⁷ The exception is the data for January, when the CSO publishes only a preliminary estimate of the CPI indicator. Complete data is published in mid-March with the release of inflation data for February.

⁸ In September of 2015 the CSO began to publish a preliminary estimate of the CPI (so-called flash) approximately two weeks before the publication of the final result. In this case, we cannot perceive it as the revision of the inflation rate, as a preliminary estimate: first, takes into account only part of the information on changes in prices, and second, does not provide information about the dynamics of the individual components of the CPI.

⁹ Due to the limited impact of the central bank monetary policy on the exchange rate (and an important role of external factors), this channel will have an indirect influence.

exchange rate. This led me to identify external factors, probably of a global nature, affecting this part of the inflation index.

A study by Borio and Filardo (2007) pointed to the growing significance of the global output gap in the price formation in many countries, while the significance of the domestic output gap is decreasing. Most studies undertaking the problem of the impact of global shocks on inflation in small open economies focus on aggregate inflation indices (e.g. Maćkowiak, 2007, Globan et al., 2015, Vasicek, 2011, Boivin and Giannoni, 2007, Jaaskela and Smith, 2013, Aastveit et al., 2011 Charnavoki and Dolado, 2014). They allow only to answer the question what shocks and to what extent affect the CPI in the analyzed countries, without showing in what particular groups of goods and services the prices are influenced by the identified shocks. In turn, part of the studies based on disaggregated price indices simply apply factor analysis, which identifies one common factor and then analyzes the impact of shocks on the indicated variable (Boivin and Giannoni, 2007, Muntaz and Surico, 2009, Soares, 2013, Aastveit, 2013, Baumeister et al., 2013). This makes these studies similar to the earlier mentioned works concerning aggregate data.

The analysis performed by me on disaggregated data, which is, to my knowledge, the first such attempt at identifying the impact of shocks on individual components of the CPI for Poland, allowed me to identify the components of the CPI with prices reacting to the previously identified various global shocks – the demand shock, commodity-specific shock and non-commodity supply shock (Hałka and Kotłowski, 2016)¹⁰. The disaggregated approach makes it possible to distinguish the components of inflation which most strongly react to external factors. Therefore, we may determine what part of the inflation is beyond the influence of the domestic monetary policy and what shocks affect its volatility.

The majority of studies on the impact of global shocks on the aggregate index are carried out under one SVAR or FAVAR model. With this procedure, all received shocks, both for the global and domestic variables, are orthogonal to each other. In the case of the disaggregated data such procedure is difficult, because of the large number of potential variables in the model. Instead, in this study a two-stage estimation procedure was applied. In the first stage, in the model of vector autoregression (VAR), based on three variables describing the global economy, three global shocks were extracted: demand, commodity-specific and non-commodity supply, interpreted here as a productivity shock and/or globalization shock. In the second stage, equations were constructed binding the individual disaggregated price indices with the previously identified shocks, and the domestic output gap and the nominal effective exchange rate (NEER) were used as the control variables for each indicator subindex.

This analysis brought additional advantage – its comparative potential. The study considered the impact of global shocks not only on the Polish economy, but also on two other economies

¹⁰ The article is part of a thematically coherent collection. My contribution is estimated at 50%. I was responsible for the concept of the study, choice of the research method, review of literature and interpretation of results from the SVAR model and Philips curves.

with different levels of development and degree of openness, which remain outside the euro area - the Czech Republic and Sweden. This enabled me to compare the results for Poland with the results for the other two countries.

The conclusions of this study, although made using data on a slightly different level of disaggregation, complement the results of the previously discussed impact analysis of the domestic economic situation on disaggregated inflation indicator (Hałka and Kottowski, 2014). The results indicate that the prices of a large part of the goods referred to as being under the influence of globalization and showing in the earlier study low sensitivity to changes in the domestic output gap, have evolved over the sample period under the influence of the non-commodity supply shock. The shock can be identified with technological progress (which is manifested by the increase in productivity) and/or moving production to countries with lower production costs, leading to increased competition and falling prices (globalization). For this reason, it can be expected that the prices of components such as electronics and household appliances, telecommunications equipment, or clothing and footwear will show sensitivity to the non-commodity supply shock – these assumptions are confirmed by the results of my survey. In the case of other durable and semi-durable goods, the prices of which have the potential to react to the non-commodity supply shock, the above relationship is not so obvious. Most likely this is due to a fairly strong reaction in prices of these goods, as tradable goods, to changes in the exchange rate.

In addition, the above analysis indicated a statistically significant correlation between the prices of food and energy (on a slightly different level of disaggregation) and the domestic economic situation, thereby confirming earlier findings that the index of core inflation is not the best measure reflecting the demand pressure in the economy. This conclusion would be difficult to formulate only on the basis of the analysis of the aggregate CPI. Moreover, the analysis at the aggregate level could point to a weaker impact of global factors on inflation in Poland due to the fact that the unit also includes components insensitive to the changes in the global economic situation.

The assessment of the impact of external factors on inflation in the country was the subject of my another study (Hałka and Szafranski 2015)¹¹. This analysis is an attempt to answer the question whether the external determinants of inflation are dominated by only one global factor or is it possible to distinguish more factors with a significant impact on inflation in individual countries, in particular shocks specific to a particular group of countries or goods. This study conducted on disaggregated components of inflation gives a different view of the inflation process than works on aggregate data. For example, Ciccarelli and Mojon (2010) working on the aggregate data indicate that 70% of the variation in inflation in the 22 developed countries of the OECD may be attributed to one global factor. However, those authors do not show what kind of factor this is and only speculate that in the long run similar formation of the

¹¹ The article is part of a thematically coherent collection. My contribution is estimated at 50%. I was responsible for the concept of the study, collection of data, calculation (e. g. analysis of correlation), interpretation and description of the results.

inflation indicators may be due to the synchronization of monetary policies in the surveyed economies. On the other hand, my study of the disaggregated inflation indicators in the countries of Central and Eastern Europe leads to different conclusions. In this case, the conducted analysis indicated that the global common factor is responsible for only 17% of the variation in inflation in the countries of the region, and a significant part of the variation is determined by factors common to the given sector¹², product groups, or a country.

The analysis examines common factors influencing inflation in Poland and in the countries of Central and Eastern Europe, and as I already indicated, not only refers to the search for common factors affecting the aggregate inflation indicator, but was expanded to include an analysis of common factors affecting inflation in particular sectors (goods-services), factors specific to the country or a sector in the country. Similar studies have been performed for the euro area countries and the United States (Boivin et al., 2009, Maćkowiak et al., 2009, Beck et al., 2011, Kaufmann and Lein 2013). Importantly, the studies of disaggregated price indices indicate that a single common factor influencing inflation in all countries is much less important than in the case of research using aggregate CPI indicators.

The results received by me indicate that in the case of Poland the common global factor influencing inflation in the countries of Central and Eastern Europe is responsible for only about 13% of the variation in inflation, but idiosyncratic factors for the individual components of inflation answer for as much as 55%. The analysis at the disaggregated level indicated that in the countries of Central and Eastern European food prices react not only to changes in global commodity prices, but also to the domestic economic situation, confirming the conclusions from my other works previously mentioned here. In turn, changes in the prices of energy components, as expected, on the one hand are strongly determined by the prices of oil, gas and coal on world markets, and on the other hand also show a connection to the economic situation in the euro area.

The conclusions of the previous studies are also somehow confirmed by the correlation obtained here between the prices of services and the economic situation in a given country and the lack of influence of both global and domestic factors on prices of durable and semi-durable goods. In the case of the latter two groups, as I previously showed, this result may be due to the influence of globalization and technological progress on the prices of these goods.

In addition, factors specific to a given country pointed to a greater volatility and lower persistence of inflation index in countries with the higher GDP *per capita*, productivity and openness of the economy. This is probably due to the fact that prices in these countries tend to be more flexible (e. g. in Estonia see Dabušinskas and Randveer, 2006), and open economies more quickly adapt to the changing external environment in order to maintain the competitiveness of domestic enterprises.

¹²A sector means here a category to which given components of the price index are classified, i. e.: services, durable, semi-durable and non-durable goods based on the classification by COICOP (<http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=5>).

Similar conclusions were reached by economists studying analogous issues for the US or the euro area. The research by Boivin et al. (2009) or Beck et al. (2011), shows that both factors specific to the country, as well as sector-specific factors play an important role in the process of price formation, and a common global factor affects the volatility of inflation to a much lesser extent.

Also this study, through the analysis made on the basis of disaggregated data, shows the dependence of inflation in Poland from domestic factors (almost 30% of the variation in the inflation index depends on domestic factors), which - as already mentioned - confirms the conclusions from the publications mentioned previously. Therefore, despite the fact that Poland is a small, relatively open economy, external factors are not the sole determinants of inflation processes. Fluctuations in domestic economic activity are also important, which emphasizes the role of the domestic economic policy, including monetary, in the process of price formation.

In addition, the analysis highlighted the importance of the exchange rate regime and the ability to pursue an independent monetary policy for the variability of inflation. Countries with fixed (or pegged to the euro) exchange rate exhibit greater volatility of the factor specific for the country, which suggests that the floating exchange rate and associated with that independent monetary policy can, to a certain extent, function as an absorber of shocks and prevent significant fluctuations in the price index, especially in the period of global turbulence.

A continuation of the previous analyses is my study (Hałka and Szafranek, 2016¹³) on the spillovers of price impulses from large countries (the euro area) to the economies strongly associated with them, characterized by varying degrees of openness (Poland, the Czech Republic and Sweden). This analysis was preceded by a study of the prevalence of co-occurrence of deflation or low inflation in recent years in chosen countries.

The first part of this study was to answer the question of whether the price index decline observed in 2013-2014 was due solely to falling prices of oil and agricultural commodities, which is reflected in the negative dynamics of the food and energy prices indices, or whether phenomenon is observed in a broader group of consumer goods and services. To achieve it, I constructed a discrepancy index, which explores the difference between the percentage of components with the negative price dynamics, and the percentage of components, where the dynamic exceeds 4%. The share of these components was adjusted by the weight of each component in the CPI basket and normalized to 1. The analysis of the discrepancy index pointed out that the recently observed deflation in the Polish economy is not only the result of falling commodity prices on international markets, but it is widespread and affects over 50% of the basket weight. Moreover, from 2012, the proportion of components with the dynamics of price

¹³ The article is part of a thematically coherent collection. My contribution is estimated at 50%. I was responsible for the concept of the study, review of literature, preparation of data, calculation of the Discrepancy Index, interpretation and description of the results.

growth above 4%¹⁴ was steadily decreasing and at the end of the analyzed period was around only 10%, which is the lowest result ever. This is the case also in other analyzed countries - the euro area, the Czech Republic, and Sweden.

Coexistence of the universality of low inflation in the analyzed countries contributed to the attempt at estimating the effect of spillovers of low inflation between countries. The transmission channel is formed by the downward pressure on prices in the country, both from decreasing import prices of finished products, as well as lower prices of components used as intermediate goods. In this case, the analysis was performed on both the aggregate CPI, as well as its main components. The studies on the aggregate level do not show clear signs of the penetration of inflation from the euro area, which is an important economic partner of Poland, to the price index in the country. But already the analysis of the disaggregated data shows that the prices of individual components in Poland are partly determined by inflation in the euro area. The results indicate that in the case of the prices of goods, Poland is a major "recipient" of inflation from the euro area in this group. The result also shows a growing dependence of prices of services in Poland on the formation of prices in the euro area (which can be understood as an effect of globalization of services' prices).

The presented studies of external conditions of inflation showed on one hand the current impact of global factors on inflationary processes in Poland. On the other hand, they confirmed the conclusions obtained in the study on the impact of domestic economic situation on inflation, that a large part of the change in the CPI stems from domestic factors. At the same time it is worth noting that the phenomenon of low inflation (or deflation), is a common phenomenon resulting not only from a positive commodity shock, it but covers a wide range of components of the CPI. In my study (Hałka 2016b) I show that despite the influence of global factors in shaping domestic inflation, central banks in small open economies consider in their decision making process predominantly the forecasts of the domestic inflation regardless the level of commodities price volatility on global markets. This may be due to, among others, the concern of those banks paid to anchoring of inflation expectations at a target level expressed in the domestic CPI which is stressed by prominent central bankers (Bernanke, 2007, Carney, 2012, Draghi, 2014, King, 2012, Lacker, 2016, Mishkin, 2008).

The synthesis of the results of the studies referred to in the first two parts of this summary is presented in my article: Hałka (2016)¹⁵. It shows the main findings and conclusions for the monetary policy, which I obtained conducting research on the assessment of inflationary processes in Poland using disaggregated inflation index. When confronting the results obtained in the abovementioned studies I could more comprehensively assess the accuracy of

¹⁴ The choice of 4% is purely arbitrary. The research on the level of inflation which could adversely affect economic processes, also distorting decisions of economic agents with the appropriate allocation of capital does not lead to clear conclusions. It is possible to indicate, *inter alia*, the works of Ball (2013) or Blanchard (2010), who show that the inflation rate equal to 4% should not have a negative impact on the economic growth. Hence the arbitrary choice of the interval $\langle 0; 4 \rangle$.

¹⁵ The article is part of a thematically coherent collection. My contribution is 100%.

the hypotheses stated in my articles, in particular those concerning the role of domestic and external determinants of inflation in a small open economy. The conclusions can be formulated as follows. First, while Poland is a relatively small open economy, a large part of the volatility of inflation depends on domestic factors. Second, the core inflation index should not be associated with the measure of demand pressures in the economy. Third, a set of external factors affecting the price-setting process in Poland is relatively wide and varies for different components of the price index.

Formulation of expectations by households

Another research problem, which got into the framework of this series of articles is the way of formulating inflation expectations by economic agents, in particular, checking which components of the CPI they take into account when forming expectations (Hałka and Łyziak, 2015)¹⁶. Monetary policy affects the economy by shaping expectations of future interest rate, and consequently has an impact on the expectations of future inflation and the output gap. Therefore, the role of the monetary policy (see Svensson, 2004, Woodford, 2005) is to manage expectations. Seen from this point of view, the monetary policy needs relevant knowledge on formulating expectations by, among others, households. Therefore, the answer to two questions seems crucial. First, how do households formulate their inflation expectations, and in particular what proportion of the CPI basket they include in this process? Second, does the conducted monetary policy influence the prices of those components of the inflation index which are taken into account in formulating these expectations.

In my analysis, I concentrated on the expectations of households which are adaptive, in contrast to the expectations of professional forecasters (market analysts), which are often well-anchored in the inflation target (Łyziak, 2014). In this study I isolated those components of the CPI, which affect the inflation perceived by households (Hałka and Łyziak, 2015). Such analysis of the structure of expectations of agents can provide information on the risk that price increase of individual components of inflation will influence the effects of the second round and, in consequence, a need to change the monetary policy parameters. Thus, for monetary authorities it is important to know which components of inflation are taken into account in the process of formulating inflation expectations by households. Are these the components, in case of which price changes are influenced by the changes of the interest rate, or perhaps those components with prices which are substantially influenced by exogenous factors, e. g. changes in commodity prices on world markets and globalization.

The purpose of the study was to present such a price index, which to the greatest extent reflects the perception of consumers in the process of formulating expectations of current and future price changes. In the study, the indicators taken into account were those which are con-

¹⁶ The article is part of a thematically coherent collection. My contribution is estimated at 50%. I was responsible for the concept of the study, preparation and analysis of time series of price changes on disaggregated level, calculation of indices of frequently purchased goods, interpretation of the results.

structured in accordance with the proposal of Brachinger (2006) - the Index of Perceived Inflation, the index of frequently purchased goods¹⁷, as well as the index of frequently purchased goods ignoring price declines. These indices were compared with the CPI and one of the measures of core inflation - inflation excluding food and energy prices.

The results of my analysis indicated that consumers take into account in their expectations a fairly broad basket of frequently purchased goods - food and non-alcoholic beverages, tobacco, housing and energy carriers, fuel, communication services, newspapers as well as articles and products for personal care. It is worth noting that a significant number of these components do react to the changes in the domestic economic situation¹⁸. At the same time, interestingly, Polish consumers seem not to notice declines in the prices of these components, noting only their growth¹⁹.

These results may indicate that in a situation of rapid increases in the prices of certain goods or services, e. g. food, we will see a relatively stronger growth of expectations than it is shown by the CPI and the monetary authorities will have to either strongly adjust the parameters of the monetary policy, or use verbal interventions in the form of declarations about the pursuit of the central bank to bring inflation in the medium term to the target. Moreover, by combining the results of this study with the results of the analysis of the impact of the domestic economic situation on inflation in Poland, I can also get the answer to the question of whether monetary policy can affect the process of formulating inflation expectations. This study indicates that the central bank using the tools of monetary policy by shaping the output gap may affect inflation expectations of Polish consumers, as the prices of goods and services to be taken into account when formulating inflation expectations in large part respond to the changes in the domestic economic situation. The results therefore indicate that the conducted monetary policy can be effective in shaping inflation expectations of economic agents.

The problem of the CPI bias

The final research problem, dealt with in this series of my articles is the method of calculating the consumer price index (Hałka and Leszczyńska, 2011)²⁰. This is only seemingly a statistical problem. The central bank in the framework of the direct inflation targeting strategy defines its target for the CPI (inflation). This indicator is to be the approximation of changes in the cost of household consumption, which keeps utility at a constant level (ILO, 2004; Diewert, 1998).

¹⁷ The index is similar to the FROOP index calculated by the ECB (frequent out-of-pocket purchases [http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Frequent_out-of-pocket_purchases_\(FROOPP\)](http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Frequent_out-of-pocket_purchases_(FROOPP))). The composition of the created index is slightly different and includes the characteristics of the expenditure of Polish households, e. g. the expenditure on restaurants and hotels is not included in this index.

¹⁸ Components form the following groups: food, tobacco, energy, part of medical products, personal care and costs associated with maintenance of the dwelling.

¹⁹ Lack of consumer reaction to price declines is confirmed by the results of the CSO survey, in which the fraction of respondents who feel the price drops is very small (less than 3%).

²⁰ The article is part of a thematically coherent collection. My contribution is estimated at 50%. I was responsible for the concept of the study, methods of estimating the substitution bias, calculation of the substitution effect, and interpretation of the results.

However, due to the common choice of the formula for calculating the index among countries (Laspeyres formula²¹), the price index may be biased and not fully reflect changes in the cost of living.

The problem of incorrect measurement of inflation can lead to suboptimal economic policy (due to the indexation of many values with the CPI), including the monetary policy. As already mentioned, the importance of the CPI in conducting the monetary policy is particularly important for the countries where central banks pursue inflation targeting strategy. Central banks express their goal in terms of the CPI, and the assumed positive level of the index is motivated among others by the possibility of the occurrence of the positive bias of the indicator (ECB, 2004). As indicated by the researchers in this area (e. g. Kokoszczyński, 2004, Wojtyna, 2004, Baranowski, 2008) the potential positive bias of the CPI estimates is one of the reasons for maintaining a positive inflation target.

The research on the bias of the inflation target was initiated by the Boskin Commission, whose task was to estimate the bias of the inflation index in the United States (Boskin et al., 1996). Due to the wide scope of competences and powers and institutions involved, the Boskin Commission had the opportunity to make a full estimation of the index bias caused by: substitution (substitution bias), introduction of new goods (new goods bias), changes in quality (quality bias), place of quotation (outlet bias) and the method of calculation²² (formula bias). The results of the Commission's work indicated a significant bias of the CPI in the US, with the substitution bias accounting for more than one-third of the total bias.

My research on the CPI bias estimates for Poland for the years 2005-2009, to the best of my knowledge, was the first attempt to estimate the imperfections of inflation measurement in Poland. Due to the availability of data and the methodology for calculating the CPI by the Central Statistical Office, the study was limited to the estimates of the substitution bias.

The analysis of the CPI substitution bias was carried out by comparing the officially published CPI index with the superlative index (index according to the Fisher formula). Another element of this study was an attempt to estimate the so-called "plutocratic gap", i.e. the difference between the published price index, which is based on the plutocratic weights²³ and the democratic index, where the weights are calculated on the basis on the average share of expenditure of individual households on a given product in their total expenditure. In this case, one cannot speak of an indicator bias since the difference between these indices has not only a statistical dimension, but also has implications for the economic policy. The choice between the democratic and plutocratic index is an evaluative choice dependent on the purpose for which the

²¹ The Laspeyres formula is based on the historical pattern of purchases made by households.

²² The methodology of calculating the CPI published by the CSO shows that this indicator is not biased due to the calculation method (GUS, 2014).

²³ The weight of a given product in the plutocratic index is calculated as the share of expenses of all households on a given product in their total expenditure. That means that the structure of the expenses in the index is dominated by the households with higher consumption spending.

index is calculated. However, this issue goes beyond the framework of the research problems presented in this paper.

The results of my analyses of the CPI bias indicate that the average underestimation in Poland due to substitution is approximately 0.1 pp., although in individual years it varies between 0.0 pp and 0.1 pp. This result is surprising against the background of the international literature, which indicates that in most countries the CPI is overestimated (e. g. Boskin et al., 1996, Crawford, 1998, Filer and Hanousek, 2003). One of the reasons for obtaining such results may be an annual change of weights made by the CSO²⁴. A similar study for Poland, though made for a different period, covering years 2010-2013 (Bialek, 2014) pointed to only a slight overestimation of the CPI - 0.034 percentage points. This means that the extension of the research sample confirms that the annual change of weights in the CPI leads to a lack of bias of the index due to substitution.

Therefore, the study indicated that due to the methodology for calculating the CPI by the Central Statistical Office in Poland there is no systematic problem of a substitution bias of this measure²⁵. From the point of view of the monetary authorities it means that the adopted inflation target in Poland is not underestimated.

Summary

The presented research suggests that the disaggregated approach to the analysis of inflation phenomena allows for a fuller understanding of the nature of the price-setting processes and identification of factors affecting inflation in Poland. At the same time it allows for the analysis of the price index bias, as well as a better understanding of the process of formulating inflation expectations by households.

Thorough knowledge of factors affecting price changes of individual components may help to reduce the uncertainty associated with the conduct of monetary policy and the earlier changes of its parameters, even before the effects of changes in the cyclical position of the domestic economy, or changes in the external environment of the Polish economy will be reflected in an increase or decrease in the CPI inflation. The compiled analyses lead to the following conclusions helpful in the conduct of monetary policy:

First, inflation in Poland, seen as a relatively small open economy, is largely dependent on domestic factors, which in the era of inflation globalization should be considered as a relevant conclusion. Indirectly, this means that the central bank, influencing the domestic economic situation can at least partially influence inflation. It should be noted, however, that in the light

²⁴ The analysis of the CPI due to substitution shows that the more frequently the change of weights occurs, the smaller the bias is. As an example we may look at the US (estimated bias at 0.4 pp, weights from 14 years ago) and Canada (bias at 0.2 pp, weights from 4 years ago).

²⁵ It is impossible to exclude the presence of other types of bias, e. g. connected with the introduction of new goods, changes in the quality of listed goods or place of quotation. However, due to the available data and information it is not possible to estimate them. At the same time it is worth noting that the adopted methodology for calculating the CPI by the CSO means that there is no bias on account of the method of calculation.

of the obtained results global factors, such as commodity prices on world markets and inflation in major trading partners, also play an important role in shaping the inflation processes in Poland.

Second, the identification of the core inflation indicator with the measure of demand pressures in the economy may lead to erroneous conclusions. On the one hand, the core inflation indicator covers changes in prices of goods and services not sensitive to the changes in the domestic economic situation. On the other hand, the groups excluded from it are those, where prices change due to changes in the output gap. For this reason, a full assessment of the demand pressures measure entails the use of various measures of inflation.

Third, the disaggregated analysis allows for the differentiation of inflation factors into those that are common to many countries (e.g. inflation in the euro zone), common to a given sector (e.g. non-durable goods) and those that are characteristic of a particular country. At the same time, these results indicate that the set of factors which shape inflation is very wide and sometimes different for individual components of the price index - the prices of individual components are influenced by various global shocks. This reinforces the belief prevailing in the direct inflation targeting strategy that the decision making process on the optimal monetary policy should involve considering the entire spectrum of economic variables, and this decision should not be based only on the behavior of one indicator, which is the aggregate consumer price index.

Fourth, the analysis of the process of formulating inflation expectations by households indicated that these entities in their expectations take into account a fairly broad basket of goods and services, at the same time, however, remain insensitive to price declines. Comparison of the range of goods taken into account when formulating the expectations and the range of goods responsive to the domestic economic situation leads to the assumption that the monetary policy will largely affect the expectations of households.

Fifth, the chosen measure of the inflation target is not biased due to substitution, which is a relatively rare result against the results obtained for other countries, although, as already indicated, it can be explained by the frequent change of weights system by the institution dedicated to measuring inflation, in this case the CSO. At the same time, because of the narrow scope of the study, from the point of view of the possible sources of the bias it cannot be unambiguously concluded that the CPI in Poland is unbiased.



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