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II. ARTICLES

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STABILITY PRICE INDEX: PECULARITY OF MODELING IN UKRAINE **

This paper considers the theoretical and methodological foundations of modeling price index for central banks targeting that is the mean of preventing significant fluctuations in monetary policy which are the reason for many macroeconomic mistakes. In accordance with the model, the transition from the index of consumer prices to the index of stable prices when targeting inflation reduces the variance of output. The choice of the central banks around the world to use the stable prices index for the effective monitoring and targeting of inflation is an important factor in the context of achieving the highest degree of stability in economic activity.

Keywords: price index, stability price index, inflation targeting, financial crisis, monetary policy, modeling of stability price index.

INTRODUCTION

At the present stage of economic development, price stability is considered to be the primary goal of central banks around the world. The guideline for monetary policy in this case is inflation targeting. This strategy was first tested in 1990 in New Zealand. To date it has been introduced in 30 countries.

Inflation targeting in monetary policy is seen to be the means to prevent significant fluctuations, especially during the financial crisis, which is the reason for many macroeconomic mistakes (Faust, Henderson, 2004; Svensson, 2009).

Among the positive aspects of strategy implementation should be noted the following:

- rapid decline of inflation and its stabilization at a low rate;
- improvement of the professional level of transparency and confidence in monetary policy.

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In turn, especially at an early stage of implementation, there are some difficulties with this strategy, including:

- difficulties with implementing the strategy through the inflationary impact of exogenous factors;
- difficulties through the rejection of the active exchange policy;
- problems associated with analytical and forecasting basis for implementing this strategy.

In inflation targeting the price level becomes the nominal anchor of the economy. So central banks must have precisely defined numerical pricing benchmarks. In many cases, this key point is the different variations in consumer price index.

At the same time there are several views on modeling the index of inflation that was researched in the works of modern economists. Foreign scholars note that the developers of monetary policy should not use the consumer price index. In works (Phelps, 1978) and (Mankiw, Reis, 2001) the authors propose central banks to target the nominal wage, and allow prices for goods and services to vary by the shock proposal. The study (Wynne, 2008) analyzes actual problems of the definition of price stability and the application of relevant price indices. In (Aoki, 2001) the two sector model (sectors with stable and flexible prices) is studied and proposed that the central bank should target inflation in the sector with steady prices.

This article discusses the approach to the choice of price index for central bank targeting that will lead to the highest degree of stability in economic activity. This concept is called the index of stable prices.

The key issue in the construction of that index is a weight of the prices in different sectors. When one builds the price index to measure the cost of living, the weight fraction of each product should be used in the budget of a typical consumer, but when constructing a price index for targeting such factors should be taken into account as the cyclical sensitivity of each sector that affects sectors to specific shocks, and the speed with which prices in each sector respond to changing conditions (Romer, 2001).

Thus our goal is to show how the weights in the stability price index must depend on the sector characteristics.

1. MODELING OF THE STABILITY PRICE INDEX

Here are the basic assumptions for the study of optimal choice of price index. The model will include only one time unit. The National Bank is

obliged to target inflation as follows: before shocks are realized the national bank must choose the price index and maintain it at a constant level.

The model includes many sector prices that differ in four characteristics. Sectors vary by weight and part of the budget that gets their prices in the standard price indices.

In some sectors the equilibrium prices is rather sensitive to business cycles, in other – less sensitive. Some prices are flexible while other ones are inert in response to changing economic conditions.

The equation determining the equilibrium prices in the sector k is:

$$p_k^* = p + \alpha_k y + \varepsilon_k ,$$

where all variables are expressed in terms of logarithms, p_k^* – the equilibrium price in the sector k, p – price level, α_k – the sensitivity of equilibrium prices of sector k to business cycle, y – the output (or other measure of economic activity), ε_k – a unique shock in the sector k with dispersion σ_k^2. This equation shows that the equilibrium relative price in the sector depends on the business cycle and some other shock.

So if there are k sectors,

$$p = \sum_{k=1}^{K} \theta_k p_k ,$$

where θ_k – the weight of different sectors in the budget of a typical consumer. Economic activity y has an influence on the equilibrium price due to the impact on marginal costs and the pricing of firms. Shocks ε_k reflect changes in the level of competition in the sector k.

Sectors may also have inert prices. We model inert adjustment assuming that some prices in the sector are defined in advance. The main reason for this is that prices are set in advance due to nominal contracts.

Let denote λ_k – the part of price makers of sector k that set prices based on updated information, while $1-\lambda_k$ – the part of price makers that sets prices based on old plans and information.

Thus the price in the period t is determined as follows:

$$p_k = \lambda_k p_k^* + (1-\lambda_k) E(p_k^*) .$$

Parameter λ_k measures the extent of inertness of prices in the sector k. The less λ_k is, the prices are less sensitive to information about the equilibrium price.

When λ_k approaching 1, then the sector is approaching the point at which the actual and equilibrium price are equal.

Suppose that a national bank must target inflation. Consequently the national bank supports the weighted average of sector prices at a given level which we set to zero:

$$\sum_{k=1}^{K} w_k p_k = 0$$

for the set of weights such that

$$\sum_{k=1}^{K} w_k = 1$$

So $\{w_k\}$ are the target weights, and $\{\theta_k\}$ are consumer weights.

Target weights are the variable of selection for national banks. Sector characteristics ($\theta_k, \alpha_k, \lambda_k, \sigma_k^2$) are considered to be exogenous.

Suppose that a national bank tries to minimize the volatility in economic activity. Consequently its goal is to minimize $\mathrm{var}(y)$ – the variance of output.

Thus the key issue of constructing this model is a choice of set $\{w_k\}$ which will lead to macroeconomic stability.

Summarizing the above statements the optimization problem for the National Bank is:

$$\min_{\{w_k\}} Var(y)$$

$$\sum_{k=1}^{K} w_k p_k = 0$$

$$\sum_{k=1}^{K} w_k = 1$$

$$p_k = \lambda_k p_k^* + (1-\lambda_k) E(p_k^*)$$

$$p_k^* = p + \alpha_k y + \varepsilon_k$$

$$p = \sum_{k=1}^{K} \theta_k p_k \ .$$

In other words, the national bank chooses the weights in the target price indices to minimize the variability of output based on those restrictions imposed on the dynamics of prices in time.

The decision of this problem will be to find a set of $\{w_k\}$ in the optimal price index as a function of sector characteristics $\theta_k, \alpha_k, \lambda_k, \sigma_k^2$. We will call the resulting figure the index of stable prices because it leads to the greatest possible stability in economic activity.

To illustrate the interpretation of this model we will assume that there are only two sectors A and B (K = 2), shocks (ε_A, ε_B) that affect these sectors are uncorrelated. Suppose also that α_A and α_B are non negative.

Therefore the optimal weights for the sector A are

$$w_A^* = \lambda_B \frac{\alpha_A \sigma_B^2 - \theta_A \lambda_A (\alpha_A \sigma_B^2 + \alpha_B \sigma_A^2)}{\alpha_B \lambda_A (1-\lambda_B)\sigma_A^2 + \alpha_A \lambda_B (1-\lambda_A)\sigma_B^2}$$

From this equation one can obtain several statements that illustrate the nature of this interpretation.

If the two sectors are identical (same $\theta_k, \alpha_k, \lambda_k, \sigma_k^2$) then the stable price index will give them similar weights ($w_k^* = 1/2$). This statement reflects the symmetry of the two sectors.

More interesting results can be obtained in a situation where the characteristics of segments ($\theta_k, \alpha_k, \lambda_k, \sigma_k^2$) are different.

The increase α_k leads to the increase of optimal w_k. So the more sensitive sector is to the business cycle, the more weights the sector prices should receive in the index of stable prices.

The increase of σ_k^2 leads to the reduction of the optimal w_k. Or, the more shock value in the sector, the smaller weights of price sector should receive in the index of stable prices.

When economists consider prices as an economic indicator for monetary policy, they base on the fact that these prices are sensitive to the business cycle. The index of leading indicators, for example, includes the change in prices for materials.

At the same time when economists reduce weights, provided a specific sector, they are based on the fact that these sectors are subject to large specific data sectors shocks.

Let's consider now the effects of price inertness on the optimal price weights.

If the optimal sector weight is not greater than 100% ($w_k \le 1$), then increase in λ_k reduces optimal w_k.

Thus the more flexible the price of sector is, the smaller will be the weight that sector gets in the index of stable price.

If the two sectors are identical in all respects except one (the same $\theta_k, \alpha_k, \lambda_k, \sigma_k^2$, but $\lambda_A = 1, \lambda_B < 1$) then you must target the index of prices in the sector with constant prices ($w_B = 1$).

This result is parallel to the result presented in (Aoki, 2001).

The increase in θ_k decreases the optimal w_k. Hence, the more significant the price index of consumer prices, the smaller will be the weight that sector gets in the index price stability. This statement illustrates the fact that the choice of price index to achieve the greatest economic stability differs from the choice of price index to measure the cost of living.

In terms of inflation targeting, unwanted fluctuations of output occur when there are shocks to the equilibrium prices ε_k that national banks are compensated through monetary policy. The effect of shock in sector k depends on the weights of consumption θ_k.

Hence keeping all options on a permanent level the sectors with greater weight in the consumer index should get weights in the target index.

In summary, the ideal sector prices for national banks monitoring are the prices that are very sensitive to the economy (high α_k), with slight sector shocks (small σ_k^2), inert prices (low λ_k) and relatively small in aggregate price indices (small θ_k).

Consider the four sector prices: the price of food products, energy production sector, the other goods and services and the level of nominal wages. The first four types of prices are the categories of consumer prices index, wages is the hourly compensation in the business sector. To measure the level of economic activity we will use a logarithm of the real GDP.

The key issue arises in determining the parameters for these four sectors.

The following equation that takes place in the model:

$$p_k - Ep_k = \lambda_k (p - Ep) + \alpha_k \lambda_k (y - Ey) + \lambda_k (\varepsilon_k - E\varepsilon_k),$$

The expected price level in the k sector depends on the expected level of prices, expected production and shocks. For computation of figures expected values we will build regression equations of depending p_k, p and y from their own lag values, constants and trends.

To determine the parameter λ_k that governs the level of inertness in prices we will rely on realistic assumptions. Suppose that prices in food and energy sectors are completely flexible, so $\lambda_k = 1$. Other prices and wages stagnate or be regarded as equally severe. Set $\lambda_k = 1/2$ which indicates that half of price makers set prices based on expected rather than actual economic conditions.

Another key parameter α_k is the sensitivity of desired prices to the level of business activity. We choose α_k so that the equation without any disturbances accurately carries out for the year.

On the basis of α_k and λ_k we can calculate the time series $\varepsilon_k - E\varepsilon_k$ and its covariance matrix. But we do not assume that shocks are uncorrelated between sectors.

If there is a shock that has the desired impact on prices in all sectors (for given p and y), then it can be found by analyzing covariance matrix.

The last parameter we are to determine is the consumer weights θ_k. This is determined on the basis of "relative importance" of each sector in the index of consumer prices. For the nominal wage the θ_k is equal to zero because wages are not represented in the index of consumer prices.

2. COMPUTATION RESULTS FOR UKRAINE'S ECONOMY

Results of models estimation are presented in Table 1.

Table 1

Results of models estimation

Sector	λ	α	var(ε)	θ	w^u	w^c
Energy	1.0	0.55	0.00856	0.34	0.35	0.31
Food	1.0	0.31	0.00931	0.56	0.61	0.54
Other goods and services	0.5	0.15	0.00239	0.15	-0.52	0
Wages	0.5	0.13	0.00091	0	1.97	0.82

Source: own calculations

The last two columns of table 1 present the results of optimization. The last column (w^c) imposes the restriction that all sector weights in the stability price index are non negative. Value w^u assumes the possibility of negative weights.

Results of calculations are similar for two cases: the index of prices which the national bank uses to maximize economic stability should provide the maximum weights to the nominal wages.

The value α for the nominal wage 0.13 reflects the fact that real wages are procyclical. The values of this parameter in the energy and food sectors also demonstrate procyclicality and are much greater than in the food sector. Variations of the error in these sectors are also the largest ones, which makes them undesirable for inclusion in the index of stable prices.

Table 2 presents the same calculations as in table 1, but assume that in the index of prices in economy half of the weights provided for the nominal wage ($p = 0.5w + 0.5cpi$). Therefore the most important component in the index of stable prices is the level of nominal wages.

Table 2

Results of models estimation assuming that $p = 0.5w + 0.5cpi$

Sector	λ	α	$\mathrm{var}(\varepsilon)$	θ	w^u	w^c
Energy	1.0	0.64	0.00892	0.32	0.31	0.22
Food	1.0	0.35	0.00754	0.21	0.39	0.41
Other goods and services	0.5	0.06	0.00691	0.03	-0.82	0
Wages	0.5	0.19	0.00045	0.5	2.12	0.85

Source: own calculations

Two other important results are the significant weights for food prices and prices in the energy sector and the negative weight to prices in the production of other goods and services. These results largely depend on the coefficients of correlation among the estimated shocks. It can be concluded that shocks covariance matrix performs a key factor in choosing the optimal price index.

CONCLUSION

In accordance with this model the transition from the index of consumer prices to the index of stable prices when targeting inflation reduces the variance of output.

Thus the choice of the central banks around the world to use the stable prices index for the effective monitoring and targeting of inflation is an important factor in the context of achieving the highest degree of stability in economic activity.

REFERENCES

Aoki, K., *Optimal monetary policy responses to relative price changes*, "Journal of Monetary Economics",No. 48, 2001.

Faust, Jon, Henderson Dale, W., *Is inflation targeting best-practice monetary policy?*, "Federal Reserve Bank of St. Louis Review", 86(4), pp. 117-43, July/August 2004.

Mankiw, N. G., Reis, R., *Sticky Information: A Model of Monetary Nonneutrality and Structural Slumps*, "NBER Working Paper", No. 8614, 2001.

Phelps, E. S., *Disinflation without Recession: Adaptive Guideposts and Monetary Policy*, "Weltwirtschaftsliches Archiv", No.114 (4), 1978.

Romer, D., *Advanced Macroeconomics*. Second edition., McGraw-Hill, 2001.

Svensson Lars, E. O., Flexible Inflation Targeting: Lessons from the Financial Crisis, speech at the workshop "Towards a New Framework for Monetary Policy? Lessons from the Crisis," organized by the De Nederlandsche Bank, Amsterdam, September 21, 2009. http://people.su.se/~leosven/papers/090921e.pdf.

Svensson Lars, E. O., Monetary Policy, lecture at Stockholm School of Economics, November 9, 2009. http://people.su.se/~leosven/papers/Monetary%20Policy%20-%20SSE%200911.pdf.

Wynne Mark, A., How Should Central Banks Define Price Stability?, http://www.dallasfed.org/institute/wpapers, 2008.

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