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# Consequences of gas price shock for Ukraine's economy; preliminary estimations

# 1. Introduction

At the end of 2005 – beginning of 2006 Ukraine entered the first wave of energy shocks which came from high energy consumption and strong dependence on external suppliers of energy resources. Obviously, "orange revolution" played the role of trigger for sharp revision of gas supply contracts between Ukraine and Russia. After tough negotiations with "Gazprom" the price for the one of the most important energy resources, natural gas, doubled and that is just the beginning. In this paper we will not discuss the reasons of price changes. We are also not going to analyze the peculiarities of the negotiation process. The goal of this work is to estimate pure economic consequences of the price growth for natural gas. As during the period of independence of Ukraine the price for imported natural gas remained almost unchanged (only minor changes took place) the traditional econometric methods are not appropriate for estimating the possible consequences. However, the probability of further price increases prompts for searching and testing some other, rough methods of estimation. The paper is structured as follows: In section 2 we will review the attempts of other institutions to estimate effects of the gas price shock. Section 3-6 will elaborate our own (i.e. CASE Ukraine) proposal of estimation methodology. Finally, the results of our estimation will be presented in Section 7.

# 2. Review of other analyzes

Due to limited time period, which has passed from signing the new gas agreement between Ukraine and Russia at the beginning of January 2006 only few very preliminary analyzes of consequences of gas price increase have been publicly presented so far. Below we make a brief review of three of them. They employ mostly a simple net import model, in addition VAR model and simple IS-LM model were also applied.

The results of simulations differ strongly. For instance, L. Vinhas de Souza (2006) in his work for the European Commission estimates losses in potential growth as about 14.7 percentage points of GDP assuming the gas price of US\$230 per one thousand cubic meters. The World Bank analysis (see Davis et al., 2006) expects that the impact on the economy will be in range of 0.4-8.6 percentage points of GDP "loss", depending on the scenario (assuming various price dynamics). Another vision of the future developments has been suggested by The Bleyzer Foundation (see Segura et al, 2006), which estimated losses on the level of 2-3 percentage points of potential GDP growth rates. To large extent, the methods of estimations used by all these institutions are rather rough and there is room for improvement.

In the work of L. Vinhas de Souza there were used both simple IS-LM model and VAR model. The major drawback of simulations with IS-LM model and VAR model is historical "stability" of the prices for natural gas, thus estimations of the shock with this kind of tools could not produce realistic results.

The World Bank and The Bleyzer Foundation used simple net import model for estimations. The main idea of this kind of model is that the increase in imported gas prices will lead to deterioration in net exports, thus contributing negatively to the GDP growth. Also at their estimations it was considered substitution effect of expensive natural gas for cheaper energy resources. The major drawback of these estimations is the absence of distinction between balance of payment and net exports in national accounts. For balance of payments, a nominal change in imports is important (that is actually took place with gas prices shock), while for national accounts only real dynamics of imports is of use (in case of prices growth real imports would not increase). Therefore, the deterioration is expected to take place for BoP while the

dynamics of GDP should not suffer specifically from additional deterioration of net exports. Nevertheless, an adverse impact on GDP will take place; however, other channels will influence negatively real GDP dynamics.

# 3. Suggested methodology

For estimation of the consequences of gas prices shock we will use CASE Ukraine macroeconomic model, which will allow us to see the effects of the imported energy price growth on the major sectors of the economy, demand components, price indices and balance of payments.

The model works as a partial equilibrium model and is built on growth rates of the components of demand side and supply side. There are two possibilities at the model to estimate the effect of the energy prices growth. The first one is to catch the relations between the performance of the major sectors of the economy and natural gas price dynamics. The second option is to define analytically the channels, which will be activated in economic system in case of energy price shock, estimate the parameters of the shock and introduce these parameters into the model to see how the economic system will react.

Actually, we chose the second method for calculations. The first option could not be used at the moment as we do not have historical observations concerning significant fluctuation of gas prices in Ukraine; however, this method would be much more preferable because it could give more precise results. In future estimations, we will switch to the first method as soon as the number of observations will be sufficient for computing.

# 4. Assumptions

In our analysis we investigate three major channels of the price shock impact on the economic system: decrease in profitability of enterprises, deterioration of current account due to strong nominal imports growth, increase in general price level at the economy. We take into account some substitution of the more expensive gas by cheaper alternative energy resources. For simplicity of our analysis we also take the following assumptions:

- the effect of the energy price shock will have zero influence on the fiscal system: revenues and expenditures are assumed to remain unchanged comparing to the baseline scenario (i.e. the one in which gas prices do not change); actually, the fiscal consequences will depend on policy reaction to gas shock, i.e. to which extent government will try to neutralize the adverse consequences of price increase for gas consumers.
- fundamental structural changes in the energy sector and the entire economy will not take place in short run, they will require more time (2-3 years or more) what remains outside the time horizon of our analysis;
- the second-round effect in terms of additional costs at energy generation, manufacturing, services, etc. will be shared by consumers (higher prices) and producers (decrease in profits);
- initial conditions estimated on the basis of data for nine months of 2005 are considered to be true for the whole year 2005;

# 5. Channels of the price shock impact

## 5.1. Reduction in level of profitability of enterprises

The growth in natural gas prices, obviously, will have direct impact on the cost level and as a consequence on the level of profits in the enterprise sector. In Ukraine, enterprise profit is the main source of investment financing. Thus, we consider that worsening of investment dynamics will become the main consequence of decrease in profits.

For purpose of the concrete estimation we assume that even the enterprises that become lossmaking as result of gas price increase will continue their activity in a short run (revenues are assumed to be sufficient for covering operational costs).

The assumption on deteriorating profits will not hold necessarily in mid- and long-run because enterprises can adopt energy saving technologies or switch to cheaper energy resources; thus the level of profits can be restored in future.

## 5.2. Nominal growth of imports

The internal production of natural gas is not sufficient for domestic needs thus about 2/3 of total gas consumption is covered by import. The growth of prices for imported gas will not cause increase in a real volume of import; but the nominal value of imported gas will increase about twice.

The distinction between nominal and real import volumes is essential as nominal volumes are important for current account while real dynamics is accounted in national accounts. Therefore, surge in prices for natural gas will have strong negative impact on current account while net export in national accounts should not deteriorate, other things being equal.

#### 5.3. Increase in general price level

Obviously, drastic surge in prices for one of the key energy resources will lead to increase in general price level at the economy. In short run one should consider a typical one-off cost-push inflation effect: increase in enterprises' costs (and, as a result, in a producers price index) and increase in costs of communal services (and, consequently in their tariffs). Whether this cost-push will be transmitted into the second round effect and more sustainable inflation pick up will depend on monetary policy reaction. For purpose of this simulation we will consider only the original first-round effect.

Thus, CPI inflation will be influenced by the energy price shock (given moderate inflationary expectations) through a PPI channel with a lag of about one quarter.

## 6. Estimation

In order to introduce the shock effect into our model we need to estimate "shock parameters". Specifically, we will estimate decrease in profits, cost increase, and changes in import and export deflators.

## 6.1. Substitution effect

Drastic increase in natural gas prices will stimulate enterprises to substitute gas by another energy source or introduce energy saving technologies, which will decrease consumption of natural gas. We will use in our simulation the demand elasticity coefficients (in respect to gas price changes) estimated by OECD (The World Bank and The Bleyzer Foundation took the same coefficients for their calculations). For the first year after shock the coefficient of elasticity is expected to amount to 0.055 and for the second year after the shock - 0.4. This means that 100%

price increase will lead to 5.5% reduction of gas consumption in the current year and 40% reduction in the next year.

Noteworthy, the suggested coefficients were estimated for the case of oil price shock; however, they were accepted as proxy for gas price shock too.

## 6.2. Natural gas internal consumption

The volume of natural gas consumption in Ukraine amounted to 62.9 billion cubic meters in 2005 (according to GasUkraine), which cost UAH16.1 billion. So the estimated average price per one thousand cubic meters for the entire economy was about UAH256.4 (roughly US\$ 50). Hence, we take an average price of US\$50 per thousand cubic meters as the benchmark for calculation of gas expenditures in the baseline scenario (no gas price shock).

	200	)4	9 months 2005		2005	
	million cubic meters	thousand UAH	Million cubic meters	thousand UAH	million cubic meters	thousand UAH
Total (rows1+2+3+4+5+6) including:	41532,5	9368026,4	48401,2	12618815, 3	62877,6	16122815, 9
1. Regional administrations	18817,0	2697800,1	21072,5	3119280,8	29207,0	4288715,3
Including:						
1.1. Population	12108,0	1352406,4	12973,5	1388423,1	17568,6	1868724,8
Including:						
households	12108,0	1064176,8	12973,5	1136166,9	17568,6	1540304,8
privileges*		172417,9		185845,1		252536,2
subsidies**		115811,7		66411,1		75883,8
1.2. Public organizations	684,2	111214,9	733,7	115629,6	1069,7	168223,7
Including:						
Local budgets	352,8	57326,4	394,4	62024,5	574,5	90144,2
State budget	331,4	53888,5	339,3	53605,1	495,3	78079,5
1.3. Communal services	6024,8	1234178,8	7365,3	1615228,1	10568,7	2251766,8
2. Private communal services	189,7	54860,5	196,1	73921,8	275,4	105203,7
3. Industry	14807,2	4586987,8	17659,3	6442679,4	21226,6	7830769,7
Including:						
Chemical industry	4026,7	1247451,2	5213,8	1887976,9	6065,9	2235253,8
metallurgy	7658,5	2378766,0	7871,3	2862651,8	9416,3	3441006,6
machinery	14,1	4084,5	19,0	7084,4	30,9	11543,9
agriculture	49,6	14988,2	66,7	24559,0	86,4	32240,4
energy sector	425,4	133301,5	404,6	148270,1	451,2	169048,2
Other	2633,0	808396,4	4083,9	1512137,2	5176,0	1941676,8
4. Energy generating companies	2616,0	799024,0	2563,1	942448,0	3026,9	1121848,8
5. SEC "Kyivenergo"	2783,3	482934,8	2824,1	704315,9	3596,8	891136,2
6. Other consumers	2319,3	746419,2	4086,1	1336169,4	5544,8	1885142,2

Table 1. Internal natural gas consumption, 2004-2005

\* Privileges are granted to some categories of citizens based on social status (merits at society, invalids or pensioners).

\*\* Subsidies are granted to persons that do not have minimum level of income.

Source: GasUkraine

#### 6.3. Gas price dynamics

The publicly available information suggests that the new price at least for some part of the imported natural gas will be US\$95 per thousand cubic meters. For purpose of our projection, we assume that at the shock scenario price doubles from US\$50 (estimated average price on internal market) to US\$100 per one thousand cubic meters.

#### 6.4 Profit reduction estimate

It is almost impossible to estimate the actual profits at the economy. Especially, this is true for the transition economy with a large share of shadow economy. However, for projection purposes, we will assume that "Gross profits and other revenues" in the national account statistics could be taken as a good proxy of the level of profits at the entire economy.

The formulas below describes that the level of profits will be reduced by the equivalent of increase of gas-related costs corrected by the coefficient of demand elasticity.

 $index\_profit_{shock} = \frac{profit - \Delta gas\_cons}{profit}$ 

 $\Delta gas\_cons = \Delta price * real\_gas\_cons * (1-e)$ 

profit - gross profits and other revenues;

e - demand elasticity of gas price changes;

 $\Delta gas\_cons$  - nominal change in natural gas consumption;

 $\Delta price$  - change in price for natural gas;

*real \_ gas \_ cons* - real change in natural gas consumption, thousand cubic meters;

#### 6.5. Expenses growth estimate

The growth of expenses for gas purchase is taken as a proxy for producers' prices index (PPI); virtually, other things being equal, increase in gas expenses should closely correlate with PPI, which reflects changes in the price of enterprises' inputs.

Material costs of production in the economy are estimated as gross output minus value added. This aggregate includes total costs except of labor costs (which are related to PPI base).

The formula below shows that increase in material costs of production is equal to increase in gas-related costs corrected on the coefficient of gas price elasticity demand.

$$\Delta \exp_e = \frac{\Delta gas \_cons}{\exp_e e}$$

 $\Delta gas\_cons = \Delta price * real\_gas\_cons * (1-e)$ 

exp\_e - estimate of material costs of production at the economy;

 $\Delta price$  - change in price for natural gas;

*real\_gas\_cons* - real change in natural gas consumption, thousand cubic meters;

e - demand elasticity of gas price changes;

#### 6.6. Imports deflator estimate

As we expect that imports will be growing nominally it is important to estimate import deflator for projection of current account developments.

Similarly to the estimates suggested above, we estimate the import deflator based on the data reflecting a share of natural gas import in total structure of imported goods and services. Obviously, we correct the real volume of imported gas by the gas price demand elasticity coefficient.

 $\Delta imports = \frac{\Delta gas\_import}{imports}$ 

 $\Delta gas\_import = \Delta price * (1-e) * gas\_import$ 

imports - total imports of goods and services;

gas\_import - import of natural gas;

 $\Delta price$  - change in price for natural gas;

e - demand elasticity of gas price changes;

#### 6.7. Exports deflator estimate

To make the picture complete we also estimate exports deflator because of increase in transit tariffs for natural gas.

The formulas below shows that exports deflator will be equal to the share of gas transit services in the total exports multiply by the index of transit tariff growth.

 $\Delta \exp orts = \frac{\Delta gas \_ transportation}{\exp orts}$ 

 $\Delta gas\_transportation = \Delta tariff * gas\_transportation$ 

exp orts - total exports of goods and services;

gas\_transportation - volume of transit transportation of natural gas;

 $\Delta tariff$  - change in a transit tariff for transportation of one thousand cubic meters of natural gas per 100 km.

#### 6.8. Model structure

At our model the three suggested channels will work as the following:

- a) decrease in profits will lead to decrease in financial resources for investments and weakening in investment dynamics (see Annex 1) => as a consequence, the industry and other sectors will slow down;
- b) increase in material costs will be incorporated as increase in PPI dynamics and will have effect on a general price level;
- c) the changes in imports and exports deflators will have an influence on the current account performance;

## 7. Results of the estimations

The estimated parameters of the shock suggest that in case when price for imported gas increase by 100% (other things being equal) the volume of profits will decrease by 8.2% comparing to the baseline scenario in the first year and will pick up by 3.3% in the second year after the shock; material costs will increase by 2.4%; the imports deflator will increase by additional 10.3 percentage points; and the exports deflator will increase by additional 1.5 percentage points.

#### Table 2. Shock parameters

		Year 1	Year 2
Profits	change in %	-8.2	+3.3
PPI (level of expenses)	change in %	+2.4	-
Deflator of imports	change in %	+10.3	-
Deflator of exports	change in %	+1.5	-

Source: CASE Ukraine estimate

After accounting for the shock consequences the growth rate of GDP will decrease by 0.6 percentage points, comparing to the baseline scenario (without a gas price increase) in first year after the shock and will even improve by 0.4 percentage points in the second year due to recovery in profits. The major negative impact will affect investments and the current account balance. Specifically, the shock will cause losses in a gross capita accumulation of 2.6 percentage points, comparing to the baseline scenario in the first year. We will also observe a strong deterioration in current account (comparing to the baseline scenario) due to worsening in terms of trade and trade balance. Also additional inflation effect will be observed.

			2006		2007	
Indicator		2005	Baseline	Shock	Baseline	Shock
			scenario	consequences	scenario	consequences
GDP	change in %	2.4	4.1	3.5	4.7	5.1
Private consumption	change in %	15.7	13.5	13.6	13.0	13.1
Gross capital accumulation	change in %	-1.4	2.2	-0.4	2.8	2.9
Industry (value added)	change in %	3.2	1.1	0.1	3.0	2.1
Market services (value added)	change in %	-0.2	6.0	5.2	7.2	6.5
СРІ	change in %, yoy	13.5	10.6	12.3	8.5	11.8
PPI	change in %, yoy	17.0	9.3	12.3	7.3	8.3
Current account	% of GDP	2.3	1.2	-3.3	-2.3	-5.5

**Table 3. Simulations results** 

Source: CASE Ukraine estimate

## 8. Drawbacks of the estimation

The suggested method of estimations has significant room for improvement. Specifically, the drastic surge in natural gas prices will lead to deeper *structural changes* in the economy (other than just short-term substitution effect) while in our calculations the sectoral/industry structure of economy is assumed to remain unchanged (what may be true in a short run). Also it is impossible to estimate how the additional costs will be *distributed between consumers and producers*. Additionally, we have not considered the extra investment demand for *energy saving technologies*, which may be stimulated by the price surge. Finally, the parameters of the shock have been estimated based on the data for nine moths of 2005 and the *seasonality* factor has not been fully accounted.

## 9. Summary

The simulations based on the CASE Ukraine macroeconomic model do not give a complete picture of possible developments after the gas price increase. However, it can be considered as a step for developing a more sophisticated analytical framework for future simulations. Unlike previous researches we take into account a more detailed analysis of the sector specific

developments after the shock. Still we do not consider monetary and fiscal policies effect on the real sector, which could be considered as a room for further researches.

According to conducted estimations the general dynamics of *real sector will not suffer that much as it is generally expected* while the current account will deteriorate strongly. Moreover, inflation impact will be also substantial, other things being equal.

Noteworthy, the poor dynamic of real sector that we have observed recently and expect to be continued has resulted from some other factors and the gas price shock cannot be seen as the key source of its deterioration.

As result of deterioration in trade balance and higher inflation a strong political pressure of the export lobby for devaluation of national currency could emerge. The situation looks even more alarming if we take into consideration that the "party of exporters" (Regions of Ukraine) will have political capacities for doing such a step – it is likely to receive the biggest support in the parliamentary elections in March 2006.

## Literature

Davis, Mark et al. (2006), The Impact of Higher Natural gas and Oil Prices, the World Bank

Segura, Edilberto L. et al. (2006), Ukraine – Impact of Gas Prices Increase, The Bleyzer Foundation

Vinhas de Souza, Lucio (2006), Effects of Gas Price Increases in CIS Countries: The Case of Ukraine, EUROPEAN COMMISSION

# Annex 1.

Dependent Variable: G\_FAOFF Method: Least Squares Date: 02/27/06 Time: 18:18 Sample(adjusted): 2004:1 2005:4 Included observations: 8 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
С	-0.069458	0.077352	-0.897943	0.4038
(PROFIT/G_DEF_FA	0.015269	0.009640	1.583922	0.1643
OFF)/PROFIT(-4)				
R-squared	0.294848	Mean deper	ndent var	0.042877
Adjusted R-squared	0.177323	S.D. depend	dent var	0.096289
S.E. of regression	0.087336	Akaike info	criterion	-1.825795
Sum squared resid	0.045765	Schwarz cri	terion	-1.805934
Log likelihood	9.303179	F-statistic		2.508809
Durbin-Watson stat	1.514571	Prob(F-stati	stic)	0.164302

## Annex 2

#### Table 4. GDP structure by income components

		2004	9 months 2005
Gross profits and mixed revenues	million UAH	153477	120486
Net taxes on production and imports	million UAH	39481	39345
Labor earnings	million UAH	151864	137753

Source: State Committee of Statistics of Ukraine

#### Table 5. Natural gas in imports and exports

		2004	9 months 2005
Imports of goods	million UAH	28996.0	26016.4
Imports of services	million UAH	2008.1	1940.2
Imports of natural gas	million UAH	3591.4	3013.6
Exports of goods	million UAH	32672.3	25268.3
Exports of services	million UAH	5307.9	4316.6
Exports of natural gas	million UAH	391.4	335.1
Exports of pipeline transportation services	million UAH	1887.1	1431.7
Share of pipeline transportation services in exports of	0%	5.0	18
goods and services	70	5.0	4.0
Share of natural gas in imports of goods and services	%	11.6	10.8
Share of natural gas in exports of goods and services	%	1.0	1.1
Ratio gas exported versus imported	%	10.9	11.1

Source: State Committee of Statistics of Ukraine

# Table 6. Expenses at the economy

		2004	9 months 2005
Production of goods and services	million UAH	827234	705598
Total value added	million UAH	344822	297584
Estimate of the expenses level	million UAH	482412	408014
at the economy	Share in the volume of		
	goods and services	58.3	57.8
	production, %		

Source: State Committee of Statistics of Ukraine