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Ukraine

The Impact of Higher Natural Gas and Oil Prices

The World Bank[1]

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Executive Summary

Traditionally the impact of higher international energy prices on Ukraine have been mitigated by three factors: (i) the effect of oil wealth in Russia, which has translated into increased demand from Russia for Ukrainian exports; (ii) low cost energy imports through negotiated import prices of natural gas which are fixed significantly below European prices (through its long term contracts with GazProm and Turkmenistan); and (iii) pro-cyclical increases in the prices of Ukrainian exports (such as metals and chemicals) which have maintained strong terms of trade.

But what has helped Ukraine can also hurt it. These same factors have contributed to high energy intensity of energy use which makes Ukraine vulnerable to energy price increases. Net energy imports are equal to 16 percent of Ukraine's GDP. Oil imports are equivalent to 7.5 percent of GDP and gas imports are equivalent to 5.5 percent of GDP. While these are not particularly high, the energy intensity of use in Ukraine is perhaps the highest in the region — 22 times more than Germany on a GDP basis, and 3.6 times higher than Germany on a purchasing power parity basis. This high energy intensity makes Ukraine especially vulnerable to both oil and gas price increases.

According to a simple model employed in the paper, if the price of a barrel of Ural oil were to average US$57 in 2006 and fall to US$54 per barrel in 2007, while the price of Russian and Turkmen gas were to rise to US$105 and US$126, respectively, for 1000 cubic meters (that is, by approximately 110%), the negative impact on GDP would be roughly 4 percent in the first year after the price shock and 3 percent in the second year. The total impact may be higher or lower depending, not only on the extent of the price changes, but also on how the energy sector and the economy respond to higher prices.

Overall, it is clear that upward energy price pressures are going to be a fact of life for Ukraine over the coming few years. Oil prices have already risen dramatically. Russia has established an oil stabilization fund which, over the foreseeable future, will tend to moderate the potential growth in export demand from Russia. At the same time,

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pressures are increasing from both Russia and Turkmenistan to fundamentally renegotiate long term natural gas contracts and bring gas import prices closer to European prices.[2]

While some of the sources of its energy vulnerability are external, Ukraine has within its own control the ability to significantly reduce its vulnerability. This requires urgent reforms to its energy sector, reforms that have been identified for many years, and whose implementation is now overdue. They include measures to promote energy efficiency, quicken and deepen the effort to create market supporting institutions, pursue hard budget constraints on energy producers and consumers that should include full cost recovery and economic price setting, and create a market-friendly regulatory environment in the energy sector that would attract additional investment and expertise.

[2] Ukraine presently pays between $50 and $60 per thousand cubic meters of natural gas. The World Bank estimates the European parity price at $235 per thousand cubic meters.

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1. INTRODUCTION

1. This note addresses the issue of higher energy prices impact on Ukrainian economy. It concentrates on oil and natural gas prices, but notes how those prices relate to the price of other energy sources in Ukraine, as well as to measures of inflation. High oil prices are already a reality, while the import gas price, which is far below the market price in Central Europe, is increasingly under pressure to increase by Russian and Turkmen suppliers. The analysis is limited to impact on GDP and some discussion of the direct inflation response.[3] Information is also provided about energy inputs and consumption shares across the economy, which helps shed light on microeconomic pressures that many sectors would experience in the face of price increases. The main quantitative result is that, depending on the scenario, the impact on the economy would be in range of 0.4-8.6% GDP "loss" for the first year after the shock relative to the baseline (no energy price change) and 0.2-6% GDP "loss" for the second year, with the high end of these ranges being the result of separate, drastic, price shocks in both oil and natural gas simultaneously. A discussion of additional non-linearities in the economy's response is also provided.

2. The note is organized as follows. First, we describe the structure of the Ukraine's market of oil and gas, and explore oil and gas price trends in the country. Then, we estimate oil and gas vulnerability indicators for Ukraine and compare them with other countries. Next, using assumptions on price elasticities drawn from cross country studies, we calculate the direct impact of higher oil and gas prices on Ukraine's GDP. We then discuss the potential impact of increases in oil and gas prices on inflation. Finally, we provide some policy recommendations for reducing Ukraine's vulnerability to energy price increases.

2. STRUCTURE OF THE MARKET

3. Oil and gas play an important role in Ukraine's economy. Table 1 shows the energy balances of Ukraine in percentages of total final energy consumption (TEC).[4] Natural gas and oil products constituted 60% of final energy consumption in 2002. Natural gas is the most important source of energy, accounting for 43.3% of energy consumption by end users. Industry is by far the major final consumer of energy at 41%, followed by the residential sector with 31% and transportation with 10%. The largest final consumers of natural gas are residential sector (41%) and industry (36%). Oil products are most heavily used by transportation (55%) and agriculture (18%).

4. Total primary energy supply (PES) exceeds the final consumption by 71%;[5] this figure is 20 to 30 percent higher than figures for OECD countries, due to aging capital, outdated energy transformation technologies and distribution losses (both technical and non-technical). 20% of PES (equivalent to 34% of TEC) is used by electric plants as an

[3] We recognize the related important variables influenced, such as exchange rate, current account and fiscal balance, but leave those beyond the scope of this note.
[4] Annex 1 presents energy balances in thousand tons of oil equivalent (ktoe) on a net calorific value basis.
[5] This is much higher than in many other countries: for example, in the OECD countries this indicator is equal to 45%, in the EU – 41%, in Russia – 50%.

input for energy production. Coal transformation takes 7% of PES (12% of TEC), and 7% of PES (11% of TEC) is lost during energy distribution. While the relative level of intermediate energy consumption by energy plants is comparable to the level in many OECD countries, Ukraine has much higher relative coal transformation costs and distribution losses. Additionally, within final consumption, there is significant additional waste due to outdated technologies, lack of metering devices, and other related shortcomings.

5. According to the International Energy Association (IEA) data, 90% of domestic supply of oil and 77% of domestic supply of gas are imported in Ukraine. Ukraine exports 9% of locally produced gas and 16% of locally produced oil. Nearly all primary supply of crude oil is being transformed into oil products in Ukraine. The primary natural gas supply is about evenly distributed for final consumption (discussed above) and for transformation into electrical and heat energy.

Table 1: Energy Balances for Ukraine, 2002

%, Total Final Consumption =100

SUPPLY and CONSUMPTION	Coal	Crude Oil	Petroleum Products	Gas	Nuclear	Electricity	Heat	Total
Production	40.1	4.9		20.5	26.6			93.5
Imports	4.4	25.4	1.7	61.7		0.6		93.8
Exports	-1.9	-0.6	-11.1	-1.7		-1.0		-16.3
Total Primary Energy Supply	42.6	29.7	-9.4	80.4	26.6	-0.4		171.0
Statistical Difference	-0.5							-0.5
Electricity Plants	-3.6		-0.9	-19.1	-26.6	17.3		-33.9
CHP Plants	-12.9					2.2	6.8	-3.9
Heat Plants	-2.6		-0.7	-14.6			15.9	-2.0
Petroleum Refineries		-29.7	28.1					-1.6
Coal Transformation	-12.3							-12.3
Own Use	-0.1		-0.5	-1.7		-3.2	-0.1	-5.7
Distribution Losses				-1.6		-3.8	-5.7	-11.1
Total Final Consumption	10.6		16.6	43.3		12.2	16.9	100.0
Industry sector	8.4		1.2	15.7		6.4	9.1	40.8
Transportation sector			9.2			1.0		10.2
Other sectors	2.2		3.6	27.6		4.8	7.8	46.5
Agriculture			2.9	0.5		0.4		3.8
Commercial and Public Services				9.4		1.9		11.4
Residential	2.2		0.7	17.7		2.4	7.8	30.9
Non-Specified								0.4
Non-Energy Use			2.5					2.5

Source: IEA Energy Statistics

6. Thus, Ukraine's economy appears to be largely dependent on oil and gas, of which domestic production is far from sufficient to satisfy demand. Therefore, an increase in natural gas and oil prices are likely to have a significant impact on the economy. The structure of energy consumption reveals that a natural gas price increase

would directly and most heavily affect industrial production and households, while the direct effect of oil price increases will be the most noticeable in transport and agriculture.

7. Table 2 provides the data on energy imports to Ukraine for 2001 and 2004. Energy imports represented 16% of GDP in 2004, and they increased by 62% in US$ terms in three years since 2001. Oil imports increased by nearly 130% during 2001-2004. While natural gas decreased as a share of energy imports, its value increased by 9% since 2001.

Table 2: Imports of Energy to Ukraine

	2001	2004
Energy imports, US$ million	6253.5	10160.9
Energy imports / GDP, %	16.5	15.7
Structure of imports, %		
Imports	100.0	100.0
Mineral products	42.6	37.4
Energy	39.6	35.0
coal	1.8	3.1
Oil	13.3	16.7
natural gas	20.8	12.4
oil products*	3.6	2.9
Index of value in US$, 2001=100		
Imports	100.0	183.8
Mineral products	100.0	161.3
Energy	100.0	162.5
coal	100.0	312.6
Oil	100.0	229.8
natural gas	100.0	109.2
oil products*	100.0	145.3

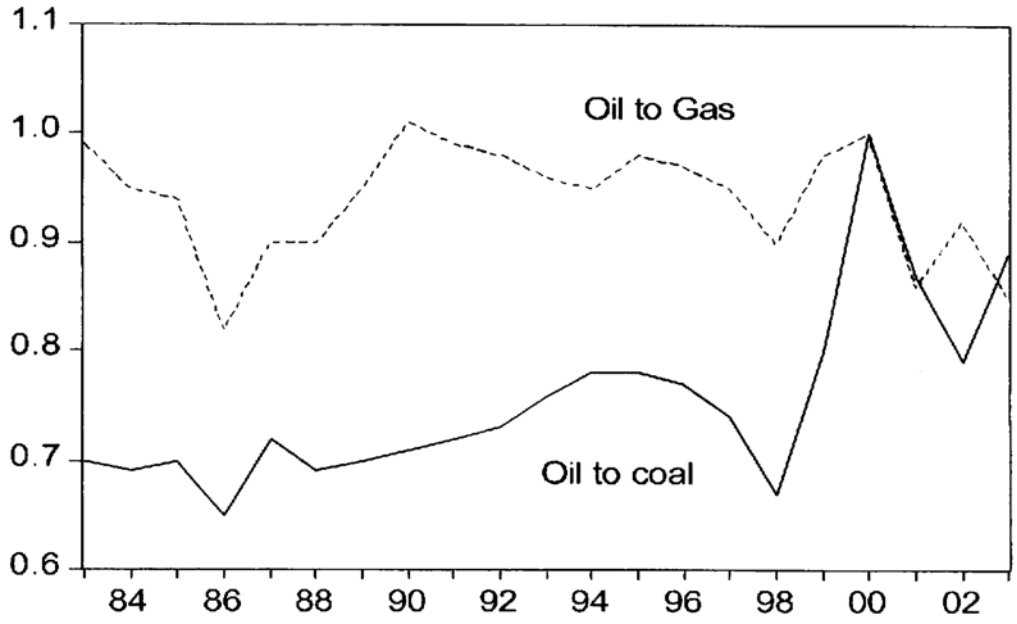
* Oil products import is calculated as a residual in the energy sub-group.
Source: State Statistics Committee of Ukraine.

3. PRICE TRENDS

8. Relative prices of energy sources are not stable in Ukraine. In theory, in a perfectly functioning market economy, the cross elasticity of substitution between energy sources approaches unity (that is, if the price of oil goes up by 10%, so does the price of coal, gas, and derivatives of these supplies – such as power). However, as Figure 1 reveals, there are large variations in energy supply prices even in OECD countries (i.e., the cross elasticities are not 1, and they appear to vary over time). Factors determining prices in Ukraine are especially complex, and while market forces are at play, they work in ways that are not obvious. The impact of oil price increases on coal, hydro and/or nuclear power prices will be closer to a market relationship than with gas. Gas price setting between Ukraine and its suppliers is affected by political factors, leverage and market factors combined (and they appear to have been dominated by political factors and leverage to date). Coal prices also appear to be heavily influenced by political

factors, budget allocations and leverage between suppliers and buyers, who tend to have varying linkages to policy setting at the state level.

Figure 1: Ratio of Oil to Coal and Oil to Gas Prices to End User in OECD



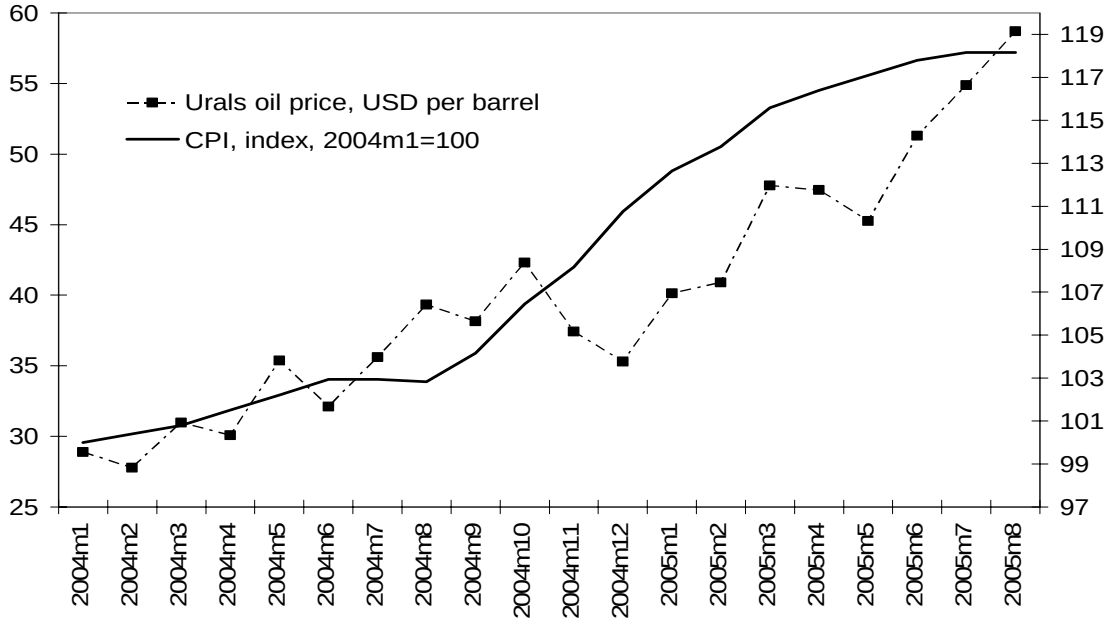
Source: The Impact of Higher Oil Prices on Low-Income Countries and on the Poor, March 2005 UNDP/ESMAP

9. In Ukraine, oil prices are more dependent on the market mechanism than prices of natural gas. In order to make quantitative sense of these issues, the first step is to review World market oil and gas price trends as they apply to Ukraine. For oil, the relevant price of a barrel of oil is for Ural crude. Urals has risen from US$29 per barrel at the end of 2003, to US$35 at the end of 2004, and US$59 in August 2005 (see Figure 2). In the absence of further unexpected supply shocks on the world market, we do not expect further price increases next year.

10. Oil price increases have influenced directly the cost of petroleum products (0.7% share in CPI) and city and road transportation services (1.8% share in CPI) for households. During 2004, the prices of petroleum products increased by 61.6% (accounting for some of the CPI growth in that year[6]), while during 9 months of 2005 it further grew by 32.9%. Cost of transportation services increased in 2004 by 11.8%, and during 9 months of 2005, by 20.3%. The impact of increased oil prices on cost of transportation services was mitigated due to subsidized transport tariffs by local authorities.[7] The immediate contribution of these factors to CPI growth is relatively small given their share in the CPI market basket, but if one includes indirect and macroeconomic effects, their contributions can be substantial.

[6] During 2004, CPI increased by 9%, while in Sep 2005, y/y growth of CPI was 13.9%.
[7] For example, in Kyiv prices for public transportation services did not change for more than 5 years.

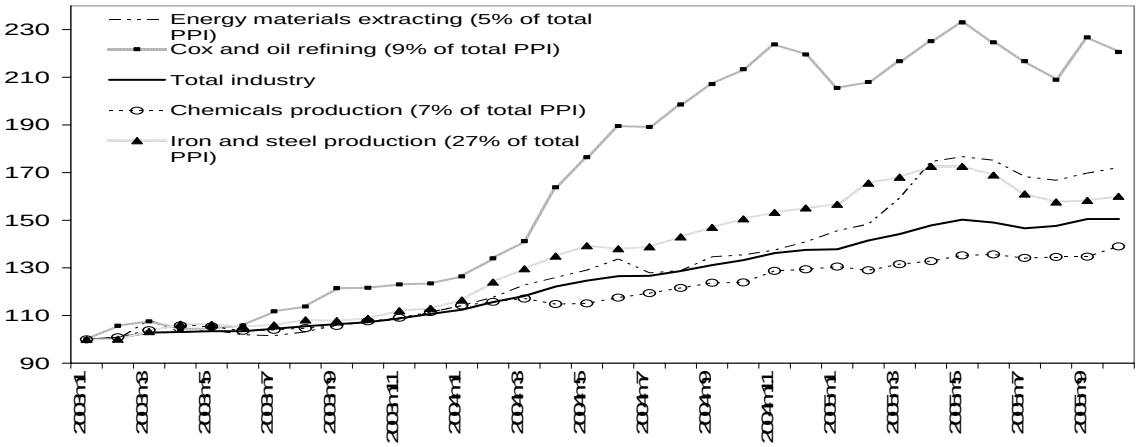
Figure 2: Urals crude oil prices and CPI



Source: State Statistics Committee of Ukraine, State Statistics Committee of Russian Federation

11. Oil price increases directly influenced Ukraine's PPI through prices in oil refining (their share in total industry PPI is about 9%) and energy material extraction (5%).[8] In 2004, oil refining prices increased by 78% and the direct effect alone accounted for at least 7% of the total PPI growth.[9] In the first 9 months of 2005 there has been much slower at 3.3%. Energy materials extraction prices increased by 26.4% in 2004 and 20.5% in the first 9 months of 2005.

Figure 4: Indices of PPI in different industries, 2003m1=100



Source: State Statistics Committee of Ukraine.

[8] There are three main energy materials extracted in Ukraine: oil, natural gas and coal. Unfortunately, we do not have a disaggregated data to be able to take coal out of PPI in this industry.
[9] In 2004, PPI increased by 24.1%, while in Sep 2005, y/y growth of PPI was 14.7%.

12. For natural gas, European prices have increased by 67% since 2003 (prices in the US are about proportional to that). European price parity for Ukraine could be as high as $235 per 1000 cubic meters. However, gas prices in Ukraine are determined through bilateral negotiations with Russia and Turkmenistan. For several years, Russia has continued to provide gas to Ukraine at US$50 per 1000 cubic meters. Earlier this year, Ukraine and Turkmenistan negotiated a cash-based gas price of US$44 per 1000 cubic meters, which implies US$60 at Ukraine's border after Russian transport costs are included. Negotiations are ongoing between Naftogaz and Gazprom on the future prices of Russian gas. While Ukraine may not see a significant increase in the cost of its gas supplies in 2006, there is concern about gas costs subsequently. Naftogaz has an arrangement with Gazprom covering payment in kind for gas transmission through 2013 that should provide 25 to 28 billion cubic meters per year at a deemed cost of about US$50 per 1000 cubic meters. However, this arrangement has been put into question in recent months and pressure is clearly building on the Russia side for significant implicit price increases to be built into the arrangement. Ukraine has secured an arrangement with Turkmenistan for gas supplies in 2006. However, starting in January 2007, all of Turkmenistan's gas is effectively committed to Russia, and Ukraine will have to secure its purchased import volumes (about 30 to 35 billion cubic meters/year) from Russia, which would become the sole importer of all Central Asian gas after signing purchase and transit agreement between Gazprom and Turkmenistan, Kazakhstan and Uzbekistan.

13. Ukraine currently transits about 115 billion cubic meters of gas annually, and receives about 25 billion cubic meters worth of gas as payment for that transit. The transit fee used as a basis for this calculation is US$1.09 per 1000 cubic meters per kilometer. The "European Parity" price of gas is about US$235 and the parity transit fee is about $2.6 per 1000 cubic meters per kilometer. Ukraine annually consumes additionally about 29 billion cubic meters of gas from Turkmenistan. Own production for domestic consumptions represents about 18 billion cubic meters.

14. The result of gas price negotiations is hard to predict. Russia can put pressure on Ukraine for payment in cash at "European prices", but this terminology is questionable for Ukraine which has leverage in negotiations. In addition to the pipeline, it has a valuable gas storage facility which is an important part of providing Westward gas flows consistent with demand. Ukraine must continue to focus on the long term goal of being the transit country of choice for Russia. In negotiations, it can increase transit fees along with the price increase proposed by Gazprom, and the gas pass-through is significantly larger than its own consumption, which gives it net leverage on this point. Yet, should gas supply break down with negotiations, even though the warehouse will provide some cushion, market reactions in Europe will likely lead to pressure on Ukraine from European partners to quickly settle the matter. Whatever the case, it will be crucial to come to a reasonable solution, presumably which moves the payment form to cash and which envisages a stepwise increase in gas prices for Ukraine, which is affordable to both Ukrainian and Russian industrial producers in Ukraine and preserves Ukraine consumers as a growing customer base for Russian suppliers in the future.

15. It is important to note that this paper is not about what factors realistically determine the framework of price negotiations, nor the eventual outcome. Political and specific economic variable interact in these negotiations in ways that yield outcomes which are difficult to predict analytically. This paper aims just to provide a reasonable sensitivity analysis of a range of outcomes of those discussions. It does not envelop the full range of potential outcomes, but rather provides a simple model that interested parties can use to test their own views on what outcome may take place, and a few scenario results to illustrate the potential impact. Further, we are not attempting to imply anything positive (about what would be the outcome) or normative (about what should be the outcome) of these discussions.

4. VULNERABILITY INDICATORS

16. Ukraine's energy vulnerability[10] can be broken down into three complimentary indicators, derived from the ratio of net oil and gas imports to GDP:[11]

$$\text{Oil vulnerability} = \frac{\text{net oil imports}}{\text{GDP}} = \frac{\text{net oil imports}}{\text{total oil use}} * \frac{\text{total oil use}}{\text{total energy use}} * \frac{\text{total energy use}}{\text{GDP}}$$

Equivalently,

$$\text{Gas vulnerability} = \frac{\text{net gas imports}}{\text{GDP}} = \frac{\text{net gas imports}}{\text{total gas use}} * \frac{\text{total gas use}}{\text{total energy use}} * \frac{\text{total energy use}}{\text{GDP}}$$

By component, we then have,

$$1\text{-self sufficiency in oil/gas production} = \frac{\text{net oil/gas imports}}{\text{total oil/gas use}}$$

$$\text{Dependence on oil/gas as energy source} = \frac{\text{total oil/gas use}}{\text{total energy use}}$$

$$\text{Energy intensity} = \frac{\text{total energy use}}{\text{GDP}}$$

17. Using data for Ukraine and comparator countries yields the following results for Ukraine's relative vulnerability (see Table 3):

- Ukraine is the most energy-intensive in the region.
- Ukraine is less oil dependent and more oil self sufficient compared to other countries in the region, but the country's high energy intensity makes it much more oil vulnerable than the EU countries.

[10] Energy vulnerability is measured here in ioe per US$ GDP.
[11] The vulnerability analysis is based on "The Impact of Higher Oil Prices on Low-Income Countries and on the Poor", March 2005 UNDP/ESMAP.

- Ukraine is more gas self sufficient than all the countries in the table apart from Poland and obviously Russia. The country is less gas dependent than Belarus and Moldova, but more gas dependent than Poland and Germany. High energy intensity makes the country the second by gas vulnerability in the table.

Table 3: Oil and Gas Dependency and Vulnerability

	Oil vulnerability, ioe per 2001 US$ GDP	*Oil vulnerability , index, Germany=1*	1- self sufficiency in oil production, ratio	Oil dependency, ratio	Gas vulnerability	*Gas vulnerability , index, Germany=1*	1- self sufficiency in gas production, ratio	Gas dependency, ratio	Energy intensity, ioe per 2001 US$ GDP	*Energy intensity, index, Germany=1*	Energy intensity, ioe per 2001 US$ GDP in PPP	*Energy intensity (GDP in PPP), index, Germany=1*
Russian Federation	-0.99	*-15.4*	-1.95	0.21	-0.57	*-18.3*	-0.44	0.53	2.4	*13.6*	0.56	*3.5*
Moldova	0.42	*6.6*	0.98	0.19	1.57	*50.9*	1.00	0.69	2.3	*12.8*	0.51	*3.2*
Ukraine	0.35	*5.5*	0.76	0.12	1.36	*44.1*	0.75	0.47	3.9	*21.8*	0.58	*3.6*
Belarus	0.48	*7.4*	0.76	0.31	1.17	*38.0*	0.99	0.59	2.0	*11.2*	0.48	*3.0*
Poland	0.12	*1.8*	0.99	0.23	0.04	*1.3*	0.66	0.11	0.5	*2.9*	0.21	*1.3*
Germany	0.06	*1*	0.97	0.37	0.03	*1*	0.79	0.22	0.2	*1*	0.16	*1*

Source: World Bank and IEA Energy Statistics; calculations by authors

18. The challenges for policy are to understand what factors determine oil and gas dependency and energy intensity. As Table 4 shows, apart from gas and oil, Ukraine uses more coal and nuclear as measured by their shares in PES comparing with other countries (it is outperformed in use of coal only by Poland). It is the relative abundance of coal and nuclear that allows Ukraine to be less oil and gas dependent than its comparators. Ukraine's industry for the most part uses inefficient, highly energy intensive technologies, which brings about high level of energy intensity of the country. It is clear that the transition to less energy intensive technologies has been hindered by understated energy prices.

Table 4: Shares of energy resources in Primary Energy Supply, %

Shares in PES	Coal	Crude oil	Petroleum products	Gas	Nuclear	Hydro	Combustibles, renewables and waste	Electricity	Total
Russian Federation	17.3	31.6	-10.8	52.7	6.0	2.3	1.1	-0.2	100.0
Moldova	2.4	0.0	18.9	68.9	0.0	0.3	2.0	7.5	100.0
Ukraine	24.9	17.3	-5.5	47.0	15.5	0.6	0.2	-0.2	100.0
Belarus	2.5	61.9	-30.5	59.4	0.0	0.0	4.4	2.3	100.0
Poland	61.6	20.5	2.0	11.3	0.0	0.2	5.0	-0.7	100.0
Germany	24.6	31.7	5.5	21.8	12.4	0.6	2.6	0.2	100.0

Source: World Bank and IEA Energy Statistics; calculations by authors

5. THE DIRECT IMPACT OF HIGHER OIL AND GAS PRICES ON COUNTRIES' GDP

19. Estimates of the direct impact of oil and gas price increases on Ukraine can provide great insight into structural and macroeconomic difficulties Ukraine faces over the next few years. But of course there are a number of other factors (beyond energy prices) affecting GDP changes, including momentum from past years, World growth trends, progress on institutional and structural reform, and financial discipline.

20. Beyond direct effects of energy price increases, there can be important indirect effects which can both help and hurt a particular country. The net affect is usually negative for a net energy importing country. However, without the use of a world general equilibrium model, it is difficult to estimate these effects with confidence. A couple of examples from Ukraine are illustrative. Increased World oil prices may hurt Ukrainian producers through their costs, but help them in terms of sales due to increased import demand for their products by now more wealthy Russian trading partners. At the same time, establishment of the oil stabilization fund in Russia introduces a stability factor, which over the foreseeable future, will tend to moderate the potential growth in export demand from Russia. Also, increasing World oil prices are also expected to hit the car industry very hard, yet the trends toward new production in Eastern Europe and Western Ukraine may well quicken in such a cost-crunch environment, and the momentum and potential capacity in Ukraine for growth in this sector are tremendous. Also, increased World oil prices are expected to weaken World economic growth, which could have a relatively negative impact on Ukraine, through less foreign investment and demand for Ukrainian goods (in the oil-importing countries).

21. To keep things relatively simple, several assumptions are made in this paper which can be debated. However, the results are indicative of the range of effect that Ukraine may experience, and interested researchers may adjust the assumptions to test the robustness of the results presented below, in light of their own priors about the energy environment Ukraine is likely to face over the coming few years.

5.1 Simple Net Import Model

22. In order to estimate the direct effect of price increases, a simple net import model can be used.[12] It is based on the observation that terms-of-trade changes for energy products will affect the wealth of countries positively or negatively, depending on whether they are net importers or exporters of these products. Ukraine is a net importer of oil and gas, but is potentially a net exporter of coal and electricity. The simplest version of the model (most relevant for a country significantly poorer than Ukraine) assumes that in case of a terms-of-trade deterioration, the country will not be able to raise additional external financing, nor will it have excess reserves to spend. Thus, the entire value of the higher costs will be reflected by a reduction in GDP. The model recognizes, however, that elasticity of demand for energy products is not zero – that is, as prices go up, producers and consumers substitute away from energy, or between energy products.

[12] See for example, "The Impact of Higher Oil Prices on Low-Income Countries and on the Poor", March 2005. -UNDP/ESMAP.

Therefore, in order to estimate the net impact on GDP, we need additionally to calculate these demand elasticities from cross country estimates, which can be segmented by level of development of the countries in question.

23. Using the net import model, the equation of impact on GDP is as follows:

$$\%\Delta GDP = \%\Delta TT * (1 - E) * \frac{-NI}{GDP},$$

where:
$\%\Delta GDP =$ the percentage change in GDP,
$\%\Delta TT =$ the percentage change in price of energy imported,
$\frac{NI}{GDP} =$ net import of energy, and
$E =$ price elasticity (written in absolute value).

24. This equation can be interpreted as follows. The change of GDP from a terms of trade shock in energy (a price increase) is a function of the size of its net imports as a ratio to GDP (if it is a net importer, this is a negative factor on GDP) and the price elasticity of energy demand (the more inelastic its energy demand, the more a price increase reduces GDP).

25. Our analysis is limited to a 2-year horizon. The starting point (year 0) is 2005 where the estimated average price of Urals oil is assumed to be US$52[13]. This implies a 50.5% increase of average price comparing with 2004. The average price of Russian gas is US$50 per 1000 cubic meters in 2005, while Turkmenistan's gas price is US$60 at Ukraine's border after Russian transport costs are included.

26. We assume that all gas price increases are permanent,[14] and only 50% increases of oil price are permanent (this assumption is supported by the empirical evidence). Beyond year 2 (2007), we make no estimates; this is convenient given uncertainties about World energy prices. But the implications for other years are obvious from the estimate results below. In our estimates of oil price increases, it is assumed that there is no impact on coal, hydro and gas (or that these secondary effects are insignificant). Likewise, gas is determined by a separate negotiation, which does not then affect oil and other primary energy supplies. This has the added benefit of building some conservatism into the assumptions. Given lags in adjustment of the energy prices facing Ukraine, these secondary effects would tend to become more important out of sample (beyond the second year forecasting horizon).

27. Price elasticity estimates are taken from the literature.[15] The elasticities are drawn in relation to oil price changes. Fuel switching, energy efficiency and switching away to

[13] During 9 months of 2005, the oil price increased by about 65% since 2004 to US$55. We assume price of Urals oil does not change in the last quarter of 2005.
[14] Of course, this assumption will no longer be applicable if Ukraine and Russia eventually reach European-parity prices.
[15] As these elasticities are drawn from country estimates in response to a US$10 per barrel increase in the price of oil, they are more applicable to marginal price increases than dramatic price shocks..

less energy intensive activities explains these elasticities, with the latter requiring more time, investment, innovation, and thus the whole range of institutional strengths that characterize well diversified economies. Research shows that elasticities in the second year (it is much harder to switch in the first year) are positively correlated with the *ex ante* level of development of the economy in question.

28. Table 5 shows estimate results for OECD and other developing countries in year 1 and year 2. They are higher in year 2, as the economies have more time to shift away from the higher priced energy imports. Ukraine has the capacity to export both coal and electricity, and it is a country with access to international financial markets, which potentially can help it to adjust more quickly away from high cost energy inputs while softening the negative GDP impact in the meantime. Thus, OECD elasticities for our estimates would seem more appropriate. However, in the scenarios below, both oil and gas prices are moving up, which means there are less alternative uses for energy switching, as compared to the studies from which the elasticities were drawn (these studies looked at only oil price shocks). We therefore use the average OECD's elasticity estimates in our calculations for partial (oil or gas alone) estimates. In case both prices change, we assume joint price elasticity to be lower than partial elacticity for the second year (0.25 versus 0.4), since there are fewer alternatives for energy switching when both oil and gas prices are moving up from separate (albeit related) external shocks. These elasticity estimates are summarized in Table 5.

Table 5: Demand Elasticity of Oil (and Gas) Price Changes[16]

	OECD (oil)	Developing World (oil)	Ukraine (gas or oil)	Ukraine (jointly gas and oil)
Year 1	0.055	0.055	0.055	0.055
Year 2	0.3-0.5	0.2	0.4	0.25

5.2 Scenarios

29. Throughout the scenarios below we make the following specific assumptions:

- The shares of gas imported from Russian and Turkmenistan do not change.
- The transit fee will move to a cash basis. The change in the transit fee for Russian gas through Ukraine is proportionally equal to the increase in the price of Russian gas supply (and Turkmen gas through Russia). This means that the cash generated from transit will be sufficient for Ukraine to import from Russia the quantity of gas that it currently receives as payment for transport. However, the net impact on Ukraine will be felt due to the extra gas imports Ukraine will need to purchase from Russia (this is the gas Ukraine currently imports from Turkmenistan).
- The import share for the simulations below is calculated differently for oil and gas. Net imports of oil is used, since Ukraine is operating in almost market conditions on

[16] These price elasticities are reflected in absolute value. A figure of 0.5 would mean that if the price increases by 100%, the quantity demanded would decline by 50%.

both import and export sides, so the price change will have the same effect, and the net imports of oil is really what matters for the economy. However, we use gross imports of natural gas, because Ukraine gets under-priced imports while exporting the gas on market terms. Therefore, price adjustment will affect gross imports while exports will not change.

30. Our specific price assumptions per scenario are as follows (each number reflects the scenario number):

Oil 1-3, 5: Average price per barrel facing Ukraine in 2006 (year 1) is US$57. Using our assumption on the permanent price impact, this implies an average price of US$54 per barrel for 2007 (year 2).

Oil 4: The price of oil increases by 50% to US$78 per barrel in 2006 and goes back to US$65 in 2007.

Gas 1: Naftogaz/GazProm negotiations result in no change of prices.

Gas 2, 4: As a result of the Naftogaz/GazProm negotiations, a price of US$80 per 1000 m^3 in cash results (a 60% increase). We assume the same increase (60%) in the price of Turkmen gas to US$96 per 1000 m^3 (with transit costs included).

Gas 3: Prices of Russian and Turkmen gas goes up by 110% (to US$105 and US$126 respectively).

Gas 5: Russia and Turkmenistan both raise the cost of gas by 220% (to US$160 per 1000 m^3 and $192 per 1000 m^3 respectively).

Table 6: Scenarios description

	2005	Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5	
		Year 1	Year 2*	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Urals oil price, US$ per barrel	52	57	54	57	54	57	54	78	65	57	54
Russian gas price, US$ per 1000 m^3	50	50	50	80	80	105	105	80	80	160	160
Turkmen gas price, US$ per 1000 m^3	60	60	60	96	96	126	126	96	96	192	192

Source: authors' calculations

5.3 Scenario Results

31. Table 7 presents the results of the simulations, divided into two blocks. In each block, the shock column shows the change in the price of oil and gas in each scenario. The next two columns demonstrate the resulting estimated change in GDP in years 1 and 2 relative to the baseline path, which, by default, implies no changes in prices for oil and gas. Firstly, we show the effect of a "pure" price shock, that is change in the price of oil and gas without any changes to the transit fee. Then we show the effect of an "effective"

price shock, correcting for the same proportional change in the transit fee, as described in the assumptions. Actually, the range between the two estimates provides an insight into the costs of the bargaining power in the negotiations. For all scenarios, we show both estimates of the partial effects (when the increase in oil price occurs without any change in gas price and vice versa) and, most importantly, the composite effect, which reflects the joint impact of both gas and oil price changes. The composite effect is higher than the sum of partial effects because the joint elasticity is assumed to be lower than partial elasticities due to there being fewer alternatives for energy switching when both oil and gas prices are moving up at the same time.[17]

32. Depending on the scenario, the estimated impact on the economy would be in range of 0.4-8.6% GDP "loss" relative to the baseline for the first year after the shock, and a range of 0.2-6% GDP "loss" relative to the baseline for the second year. For example, in scenario 2, the GDP would be 2.2% lower relative to baseline in Year 1, and 1.6% lower in Year 2.

Table 7: Estimation of the Price Changes' Impact on GDP

	Imports, % GDP (2004)	Price Shock	In % of GDP		Effective Price Shock	In % of GDP	
			1 year	2 year		1 year	2 year
		Scenario 1					
Partial impact							
oil and oil products (net)	-4.7%	10%	-0.4%	-0.1%	10%	-0.4%	-0.1%
natural gas (gross)	-5.5%	0%	0.0%	0.0%	0%	0.0%	0.0%
Composite (joint) impact			-0.4%	-0.2%		-0.4%	-0.2%
		Scenario 2					
Partial impact							
oil and oil products (net)	-4.7%	10%	-0.4%	-0.1%	10%	-0.4%	-0.1%
natural gas (gross)	-5.5%	60%	-3.1%	-2.0%	33%	-1.8%	-1.1%
Composite (joint) impact			-3.6%	-2.7%		-2.2%	-1.6%
		Scenario 3					
Partial impact							
oil and oil products (net)	-4.7%	10%	-0.4%	-0.1%	10%	-0.4%	-0.1%
natural gas (gross)	-5.5%	110%	-5.8%	-3.7%	61%	-3.2%	-2.0%
Composite (joint) impact			-6.2%	-4.7%		-3.7%	-2.7%
		Scenario 4					
Partial impact							
oil and oil products (net)	-4.7%	50%	-2.2%	-0.7%	50%	-2.2%	-0.7%
natural gas (gross)	-5.5%	60%	-3.1%	-2.0%	33%	-1.8%	-1.1%

[17] It is important to remember that, as we have clarified above, natural gas import prices in Ukraine are not determined by the oil equivalent value of natural gas btu's.

Composite (joint) impact			-5.4%	-3.4%		-4.0%	-2.3%
		Scenario 5					
Partial impact							
oil and oil products (net)	-4.7%	50%	-2.2%	-0.7%	50%	-2.2%	-0.7%
natural gas (gross)	-5.5%	220%	-11.5%	-7.3%	123%	-6.4%	-4.1%
Composite (joint) impact			-13.7%	-10.0%		-8.6%	-6.0%
Memo: Price elacticities							
Partial			0.055	0.4		0.055	0.4
Joint			0.055	0.25		0.055	0.25

Source: authors calculations

33. While these estimates provide a useful gauge of the importance of energy prices to Ukraine's economy, they should be considered with caution. First, some good news. As Ukraine's economy is highly energy dependent, hard budget constraints and full cost energy tariffs toward market prices should encourage a more rapid modernization of Ukraine's production techniques and an adjustment toward Ukraine's true comparative advantages in production and services. This is of course provided that macroeconomic stability and access to finance are maintained through responsible stewardship of the economy during the transition period. The bad news, however, is that the analysis does not take into consideration potential non-linearities following from micro-considerations in Ukraine's largest export sectors. These are discussed briefly below.

5.4 Non-Linearity

34. The impact of increased oil and gas prices on the Ukraine's economy may be non-linear. The Ukrainian economy grew rapidly since 2000 despite substantial increase in oil prices. In the context of strong world growth and better financial discipline at home, Ukrainian producers brought industrial capacity back on line, while being helped by the fact that export commodity prices were rising, such as metals, chemicals and agricultural products.

35. Ukraine has continued to operate with cheap inputs of gas. Focusing on the exporting sector, we can assume that the world market prices for goods produced by Ukraine can be taken as given. If the price of gas increases, industrial enterprises can be expected to dramatically reduce production in a step-wise manner since they are unable to change output prices. Further, at some level of gas prices, many plants and many sectors would likely all be affected at once, complicating matters, and due to multiplier

effects, potentially making the resulting fall in GDP steep and larger than the estimates provided above.[18]

36. That said, according to estimates of the IMF, Ukraine accumulated terms of trade gains during 2000-04 amounting to about 24 percent--correspondingly roughly to a positive current account impact of 12 percent of GDP. Most of the positive terms of trade gains have accrued to the corporate sector, although some of the gains have been experienced by households (via wages) and the public sector (via tax revenue increases). An increase of gas prices to US$200 per 1000 cubic meters would only amount to a terms of trade loss of about 7 percent and a negative CA impact of 3.5 percent of GDP. Thus, Ukraine is relatively well positioned to digest a terms of trade loss of this size - it would reverse only a fraction of recent terms of trade gains. What is of potentially more concern, is a concurrent large drop in the price of Ukraine's exports, especially metals.[19]

5.5 Potential Impact on Inflation

37. Beyond GDP, the increase in energy prices will also have both direct and indirect effects on inflation. Increases in oil and gas prices can directly lead to higher overall inflation indexes as petroleum products and gas are consumed by households. Indirect impacts come as producers pass through some part of higher oil and gas costs to the prices of final goods. Induced macroeconomic effects follow also. For example, higher goods prices can lead to higher wage costs that result in further prices growth. The role of expectations, the composition and size of the public budget, and monetary policy all play interlinking roles. It is also important whether the increases in gas and oil prices are expected to be temporary or sustained. If consumers and producers perceive the increases as permanent, the impact of higher oil and gas prices on inflation will be larger.

38. The direct impact of oil and gas prices increases on inflation depend on the share of petroleum products and gas in the consumption basket and the ability of consumers to substitute toward produces with less energy content and or which use cheaper energy sources. The direct impact of the gas price increase on CPI would also depend on the policy of Naftogaz towards passing through the price increase to households and/or the industrial sector.

39. Among other things, the magnitude of the indirect impact of higher gas and oil (petroleum products) prices on inflation is influenced by dependence of producers on these energy products, ability to switch to cheaper energy sources, and the extent to

[18] In 2005, Ukraine's metallurgical enterprises have encountered decline in world prices of their products, increase in transportation costs and real appreciation of hryvnia, which made downward pressure on their profits. However, they still have been benefiting from the substantial increase in metals prices during last years. For more details see *Ukraine Trade Policy Study, World Bank, 2004*. Enterprise managers of metal and coal companies have reported prices of gas at which they would have to significantly cut back production, ranging from a price of US$100 per 1000 cubic meters to US$160. However, given the very public nature of these declarations, and in light of the dramatic terms of trade increases they have experienced, these figures can only be considered indicative of the non-linear supply response to price increases.

[19] For more on this, see IMF Article IV, Selected Issues, "Ukraine: External Risks and Opportunities".

which prices of other energy sources prices rise in response to oil and gas prices increase. These factors are implicitly included in our analysis above with respect to GDP estimates.

40. The duration and strength of the inflation increase depends on the economic policy response. Subsidies to producers and consumers can mitigate shocks of oil and gas prices increases. However, attempts to keep energy prices stable at the internal market would lead to an increase in the fiscal burden and make such practice unsustainable in the long run. Moreover, such policy may lead to accumulation of inflationary pressures and worsen the impact of higher prices in the long run, while blocking adjustment of the economy that otherwise would be the upside of the energy price pressures. Price controls have already proved unsustainable in Ukraine. In April-May 2005, the government attempted to fix gasoline prices, but this policy lead to deficit of gasoline supply and the government had to abolish price controls.

6. POLICY RECOMMENDATIONS

41. It is clear that Ukraine is both vulnerable to oil and natural gas price increases, and that upward price pressures are going to be a fact of life for the coming few years. Oil price pressures are driven by World market trends that are essentially beyond the influence of policy makers in Ukraine. With regard to natural gas prices, the pace and magnitude of increases will be affected by Ukraine's use of diplomacy and finesse in its international negotiations. At the same time, moving to a cash basis will be an important step toward governance improvements in Ukraine while helping to bring transparency to the sector. Beyond prices and transparency, Ukraine has in its hands the task of reducing its vulnerability. The following recommendations provide a broad roadmap for policy makers in Ukraine in this regard. More detailed recommendations can be found in a number of studies produced by the World Bank and other organizations over the past few years. The bibliography below is intended as a resource for policy makers who would focus on this issue in more depth. "Taking the Next Steps in Energy Sector Reform" (WB Jan. 2005) and "Ukraine: Challenges Facing the Gas Sector" (Sept. 2003) are good starting places for such analysis.

- Seek a step by step and gradual reduction of gas price increases from main suppliers, in return for a credible commitment by Ukraine as a high quality and dependable manager of the transit system.

- Maintain hard budget constraints on energy producers, intermediate energy suppliers and consumers to encourage them to improve efficiency, modernize capital, and reduce energy dependency. This will be particularly important as Naftogaz and GazProm enter into a cash-only arrangement.

- Eliminate cross subsidization of energy tariffs and bring them to full cost recovery, including needed investment costs.

- Implement the Law on Debt Restructuring of the Energy Sector and adopt a strategic plan for further restructuring, ownership transformation and private sector participation in the energy sector.

- Improve corporate governance and foster commercialization of majority state-owned energy companies based on transparent performance targets contracted with the corporate management and supervised by independent Boards.

- Foster competition in coal and electricity supply through further market opening and gradual liberalization of the wholesale electricity trade.

- Strengthen financial and administrative independence of the energy regulator (NERC) and gradually introduce main regulatory principals governing the EU gas and electricity markets.

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ANNEX 1: ENERGY BALANCES FOR UKRAINE, 2002

in thousand tonnes of oil equivalent (ktoe) on a net calorific value basis

SUPPLY and CONSUMPTION	Coal	Crude Oil	Petroleum Products	Gas	Nuclear	Electricity	Heat	Total
Production	30680	3746	0	15664	20325	0	0	71520
Imports	3384	19417	1300	47149	0	470	0	71720
Exports	-1459	-482	-8487	-1332	0	-738	0	-12498
Total Primary Energy Supply	32605	22681	-7187	61481	20325	-268	0	1E+05
Statistical Difference	-413	0	0	0	0	0	0	-413
Electricity Plants	-2748	0	-664	-14629	-20325	13253	0	-25956
CHP Plants	-9874	0	0	0	0	1688	5217	-2968
Heat Plants	-1989	0	-547	-11139	0	0	12174	-1501
Petroleum Refineries	0	-22681	21461	0	0	0	0	-1220
Coal Transformation	-9372	0	0	0	0	0	0	-9372
Own Use	-76	0	-390	-1333	0	-2453	-111	-4363
Distribution Losses	0	0	0	-1261	0	-2880	-4348	-8489
Total Final Consumption	8134	0	12673	33120	0	9340	12932	76460
Industry sector	6420	0	946	11979	0	4880	6957	31182
Transportation sector	0	0	7033	0	0	791	0	7824
Other sectors	1714	0	2760	21140	0	3668	5976	35519
Agriculture	*0*	*0*	*2243*	*352*	*0*	*321*	*0*	*2916*
Commercial and Public Services	*0*	*0*	*0*	*7223*	*0*	*1476*	*0*	*8699*
Residential	*1714*	*0*	*503*	*13565*	*0*	*1871*	*5976*	*23629*
Non-Specified	*0*	*0*	*14*	*0*	*0*	*0*	*0*	*276*
Non-Energy Use	0	0	1934	0	0	0	0	1934

Source: IEA Energy Statistics

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