Optimal Taxation of Energy Trade: The Case of Russia and Ukraine[1]

Clinton R. Shiells
Joint Vienna Institute

August 2005

Abstract

Given the substantial rents involved in oil and gas trade and the incentives for non-cooperative behavior, Russia and Ukraine have each chosen to levy taxes on shipments of energy products from Russia to Ukraine. Oil and gas trade is a major source of Russian tax revenue, although the structure of energy export taxation has changed markedly over time. This paper shows that, if non-distorting taxes are unavailable, Ukraine would benefit by taxing away the pure profits of the domestic seller of natural gas imports from Russia. It also assesses the circumstances under which Ukraine would benefit from simultaneously providing a subsidy on Russian gas imports.

JEL Classification Numbers: D40, F12, F13, F14, H21, L71, Q43

Keywords: Russia, Ukraine, Energy Trade, Taxation, Imperfect Competition

Author's E-Mail Address: cshiells@jvi.org

[1] This paper was prepared for the European Trade Study Group (ETSG) Seventh Annual Conference in Dublin during September 8-10, 2005. The views expressed in this paper are those of the author and do not necessarily represent those of the Joint Vienna Institute or the International Monetary Fund or the policy of these organizations.

I. INTRODUCTION

Russia is one of the world's largest energy producers and the largest producer in the Commonwealth of Independent States (CIS).[2] Until this year, it benefited from the application of value-added tax (VAT) on oil and gas exports to other CIS countries based on the origin principle. Following the elimination of VAT on its energy exports, Russia raised other taxes on these exports, effectively offsetting—at least to some degree—the removal of VAT. This paper analyzes the incentives for taxation of these energy exports by Russia and Ukraine. It updates and extends the analysis in Shiells (2005).

Much of Russia's energy exports within the CIS are purchased by Ukraine. For its part, Ukraine levies VAT on oil and gas imports from Russia (as is appropriate under the destination principle), implying that these imports are effectively taxed twice.[3] Although the Ukrainian authorities apparently believe they have benefited from this double taxation through rent-shifting, it is not obvious that this is the case. The analysis for natural gas trade is complicated by the presence of market power on both the selling and buying side. This paper analyzes whether Ukraine is likely to have benefited from the current regime of double taxation and what are Ukraine's incentives to levy taxes on its energy imports from Russia. Though the paper is centered on Russia and Ukraine, it should also be of broader interest given that tax regimes must often be designed in a regional context.

The paper is organized as follows. Section II provides some information concerning the structure of energy trade between Russia and Ukraine as well as the tax regimes on such trade and market structures in each country. Section III briefly considers the effect of Russian taxes on exports for the oil sector. Section IV analyzes this change, as well as Ukraine's optimal response if Russia were to maintain its taxes on energy exports, for the natural gas sector using a bilateral monopoly model. In particular, the paper shows that, given Russia's current energy trade taxes, Ukraine would benefit from taxing away the pure profits of its monopoly seller but might or might not benefit from providing a subsidy for gas imports. Finally, Section V offers some conclusions.

II. ENERGY TRADE, MARKET STRUCTURE, AND TAXES

Russia produces about 80 percent of the region's crude oil and natural gas and accounts for a similar share of total net exports from the region.[4] The majority of Russia's exports of oil and gas are supplied to countries outside the CIS and Baltics (see Tables 1 and 2). Ukraine is broadly self-sufficient in coal and electricity but produces only around one quarter of its domestic consumption of crude petroleum and natural gas and imports the rest (Tables 3 and

[2] The CIS is an economic alliance of 12 of the former Soviet republics—Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, the Kyrgyz Republic, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.

[3] The origin and destination principles for the VAT are explained in Box 1.

[4] Dodsworth et al. (2002) discusses the role of Russia and Ukraine in the energy markets of the CIS countries at greater length.

4). Ukraine was the largest buyer of Russian gas within the CIS and Baltic countries in 2000, the second largest buyer of crude oil (behind Lithuania), and the third largest buyer of refined products (behind Estonia and Latvia).[5]

Much of the Russian oil industry is now within private hands following rapid privatization which led to the divestiture of majority stakes in all but two oil companies. With the notable exception of transportation, competition in these markets is generally robust. Oil processing capacity is predominantly integrated with the larger extractive firms. Russia has considerable excess refining capacity, a situation also prevailing in a number of neighboring states. The Russian oil transportation system is overwhelmingly dominated by the state-owned enterprise Transneft. The administrative allocation of crude and refined oil exports in Russia drives a wedge between domestic and world export prices (see Dodsworth et al. (2002)). Ukraine has six crude oil refineries which are operating significantly below capacity. Until recently, Ukraine's refineries did not even receive enough crude oil to supply domestic demand.[6]

In 2000, Ukraine imported about two thirds of its gas from Russia, of which roughly half was taken as in-kind payment for use of Ukraine's transit pipelines to Europe. Ukraine provides the main transit route for Russian natural gas shipments to Europe, accounting for 90 percent of Russia's total natural gas exports to Europe. About half of Russian gas exports to Ukraine in 2000 (after losses and amounts used for pumping) were supplied as an in-kind transit fee whose value is based on a negotiated accounting price. Turkmenistan also supplied about a third of Ukraine's total gas imports in 2000, more than half of which was paid in barter, and minor quantities were imported from Uzbekistan.

With some caveats, Russian gas exports to Ukraine may be described as a bilateral monopoly. Gazprom is close to holding a monopoly in the Russian gas market. It controls some 90 percent of gas production in Russia, 80 percent of reserves, the gas transportation network, and has monopoly rights to export gas outside the CIS. Gas exports from Russia to Ukraine are generally handled by Gazprom, and gas imports into Ukraine are generally handled by government-owned company Naftogaz, who in turn produces gas domestically and sells most gas (both domestic and imported) to consumers (including industry, households, and government) in Ukraine. Naftogaz remains the largest delinquent taxpayer in Ukraine owing to a variety of factors including the following: (i) Naftogaz receives the fee for transit of Russian gas through Ukraine as an in-kind rather than monetary payment;

---

[5] According to data provided by the Russian authorities, Russia exported to Ukraine 39.7 billion cubic meters of gas, 4.0 million tons of crude oil, and 2.1 million tons of oil products, in 2000. There are, however, problems of comparability between these figures, the Ukrainian official statistics, and the oil and gas balances in Tables 1 and 2.

[6] The increase in crude oil imports in 2001 shown in Table 4 appears to reflect Ukraine's success in securing sufficient crude oil imports for its refineries by offering oil exporters in Russia and Kazakhstan a stake in the country's refineries (see U.S. Department of Energy (2003)).

(ii) gas tariffs remain below cost recovery levels; and (iii) poor governance and insufficient oversight by the state (see IMF (2003), Chapter VI).[7]

The extent to which Russia-Ukraine gas trade may be characterized as a bilateral monopoly depends on the exact definition of this trade and the period under consideration. In 1998-1999, part of imports from Russia (some 20-30 percent) bypassed Naftogaz and was sold directly to Ukrainian enterprises by Itera, a privately held company which has become an increasingly important player in Russian gas trade. In 2001, Itera supplied Turkmen gas directly to some Ukrainian enterprises, although in 2002 the Turkmen gas was sold in Ukraine through Naftogaz. More generally, the imports of Turkmen gas in 2000-2003 somewhat weakened the monopoly features of the Gazprom-Naftogaz trade, but only to a limited extent, in part because Russia controlled the transit of Turkmen gas on its territory. Naftogaz also produces gas domestically at a cost of $11 per thousand cubic meters (official estimate), which is well below the cost of imported gas (see IMF (2003), Chapter VI for further discussion).

Russia's tax regime has changed markedly over time. Of particular relevance in this context, effective July 1, 2001, Russia adopted the destination principle for VAT on non-energy trade with CIS countries, except for Belarus, to which all exports are considered as domestic sales. VAT on all trade with non-CIS countries was already based on the destination principle. The VAT rate is 18 percent. Its VAT on energy products was based on the origin principle and Russia accordingly levied VAT on their energy exports to other CIS countries, perhaps as a way of enhancing government revenue.[8] Russia also levies excises on natural gas and export tariffs (mostly linked to world oil prices) on crude oil and oil products. The excise rates on natural gas are 15 percent for gas sold to other CIS countries and 30 percent for gas sold outside the CIS. In August 2004, Russia agreed to eliminate VAT on energy exports to other CIS countries, and Ukraine in particular, in exchange for access to the Odessa-Brody pipeline. However, it also raised the resource extraction royalty and export duty on oil as offsetting measures. (The net effect on Russia's effective energy export tax rates is unclear.)

Ukraine applies VAT to trade based on the destination principle. The VAT rate is 20 percent. Imports of crude oil, natural gas, and condensate gas from Russia and Turkmenistan were VAT exempt prior to this year but now Ukraine levies VAT on oil imports at the border and on gas sales by Naftogaz. While it is unclear how Russia assesses the value of oil and especially gas exports supplied to Ukraine as an in-kind transit fee for VAT purposes, if it is based on the negotiated accounting price, this may provide another venue for bargaining

[7] Other factors cited as factors accounting for the large budgetary arrears of Naftogaz include lags between the time when payments to the budget and external suppliers are due from Naftogaz and when consumer payments are received, as well as the increase over time in the share of the transit fee to be transferred to the budget.

[8] Prices of oil and oil products have to a significant extent converged to world market prices, in contrast to natural gas (and electricity), whose prices remain well below Western European levels. In the case of gas, it may be argued that this involves an element of implicit subsidization, even after including Russian taxes on exports (see Dodsworth et al. (2002)).

over the distribution of rents. Refined petroleum products (including imports from Russia and other CIS countries) are subject to specific excise taxes.

III. Russian Oil Exports to Ukraine

The Russian oil industry has been mostly privatized and is, broadly speaking, amenable to a standard demand and supply analysis based on perfect competition. Elimination of a Russian tax on exports of oil to Ukraine would shift the Russian export supply curve down and to the right along an unchanged Ukrainian import demand curve, leading to an increase in export volume, an increase in the price net of Russian tax received by Russian oil producers, and a decrease in price inclusive of the Russian tax paid by Ukrainian importers (see Figure 1). The Russian treasury would lose revenue from oil exports. Ukrainian tax revenue would also change in response to the increased volume of oil imports and a lower price of output, though the direction is ambiguous.

IV. Russian Gas Exports to Ukraine

If Russia were to maintain its taxation of gas exports, should Ukraine eliminate its double taxation of gas imports? Should it for instance provide a subsidy to offset (fully or partially) Russian tax paid by importers? Is there a case for simultaneously raising its own VAT rate on goods produced using imported gas to tax away the pure profits from Naftogaz? More generally, what is the optimal tax/subsidy scheme for Ukraine's gas imports and sales, recognizing that non-distorting taxes are not available? The remainder of this section analyzes these questions.

As discussed above, Russian gas exports to Ukraine are (with some caveats) subject to a bilateral monopoly. If the Russian producer (Gazprom) and the Ukrainian seller (Naftogaz) were behaving cooperatively, they would choose the level of output at which the seller's marginal revenue is equal to the producer's marginal cost since this would maximize their total profits. If they were behaving non-cooperatively, a variety of solutions are possible depending on the bargaining game between the producer and seller over who will earn the pure profits. This section develops a model based on the assumption that the Russian producer takes the lead by choosing its export price to maximize profits, incorporating the expected response of the Ukrainian seller who is assumed to choose its level of sales to maximize profits taking the export price as exogenous.[9]

A. Energy Taxation in a Bilateral Monopoly Model

The model developed in this section extends one of the models used in Lahiri and Ono (1999). The latter paper examined the issue of optimal import tariffs under a variety of market structures, including two in which there is a single foreign producer and a single domestic seller. These two models differ according to whether the foreign producer or

[9] In fact, as noted above, gas prices paid by consumers are set administratively in Ukraine and fall well short of the levels that would be chosen by a monopolist. The optimal tax/subsidy measures derived below would need to be accompanied by a variety of supporting measures to achieve the first-best social optimum.

domestic seller is the leader. Lahiri and Ono (1999) also considered various oligopolistic situations by allowing for multiple producers and sellers. As described above, a model with a single producer and a single seller is broadly appropriate for modeling Russian gas exports to Ukraine. It will be assumed that the Russian producer is the leader given its dominant position in the world market in general and the CIS market in particular.[10] While in reality Russia exports gas to many other destinations, notably Europe, this paper will take it as a stylized fact that Russia is able to price discriminate due to market segmentation, as argued by Tarr and Thomson (2004). Ukraine also buys from other countries such as Turkmenistan, although as noted above two thirds of its imports are from Russia, and Turkmen shipments have indirectly been controlled by Russia.[11] Also, as noted above, the marginal cost of producing gas domestically in Ukraine is reportedly well below the price of imported gas and therefore domestic production of gas is infra-marginal and does not influence the domestic seller's behavior at the margin.

In this model, a single Russian firm produces natural gas and sells it to a single Ukrainian firm, which in turn sells it to Ukrainian consumers. The Ukrainian seller, as the follower, chooses the level of imports in order to maximize profits taking the price of Russian gas exports as given. This gives rise to a reaction function for the export price as a function of the export quantity and tax parameters. The Russian producer incorporates Ukraine's reaction function into its objective function and chooses its export quantity to maximize profits.[12] The Russian producer and the Ukrainian importer are assumed to take the Russian and Ukrainian tax rates and the rate of Ukrainian subsidy on gas imports (currently zero) as exogenous. A social welfare function is specified for Ukraine which is used to consider the optimal choices of the Ukrainian tax and subsidy rates.[13]

---

[10] If Ukraine were assumed to be the leader, results in Lahiri and Ono (1999) suggest that the optimal input subsidy would be unambiguously positive, which would simplify considerably the analysis below. Section D below also considers a Nash equilibrium solution.

[11] If there were two competing foreign producers and one monopolistic seller, it might be more appropriate to assume that the domestic seller is the leader.

[12] It may be more natural to think of the Russian producer as choosing the export *price* to maximize profits, incorporating the seller's reaction function for export *quantity* as a function of export price (and tax parameters). The more tractable and equivalent approach adopted below is to assume that the Russian producer chooses export *quantity* to maximize profits, incorporating the seller's reaction function for export *price* as a function of export quantity (and tax parameters).

[13] The assumption that the producer and seller take the tax and subsidy rates as exogenous is consistent with the view that the firms are unable to influence these rates. If the firms are able to influence the rates, the strategic interaction between the firms and the governments should ideally be incorporated into the model. This would considerably complicate the model and is accordingly beyond the scope of this paper.

The Ukrainian seller buys quantity x of gas from the Russian firm at price $q(1+t_R)$ inclusive of Russian tax and faces a downward sloping (inverse) demand curve $p(x)$ for its sales in the domestic market at Ukrainian tax-inclusive price p. The seller maximizes profits by choosing x as follows:

(1) $$\max_x \pi_U$$

where

(2) $$\pi_U = \left\{\left[p(x)/(1+t_U)\right] - [1+t_R(1-\mu)]q\right\} x$$

and t_R is Russia's effective tax rate on exports, t_U is Ukraine's VAT rate, and μ is the proportion of Russian tax offset in the form of a subsidy by Ukraine. The seller's reaction function is obtained by solving its first-order condition for q:

(3) $$q(x, t_R, t_U, \mu) = \frac{p(x) + xp'(x)}{(1+t_U)[1+t_R(1-\mu)]}$$

The Russian producer maximizes its profit function, which incorporates the seller's reaction function, by choosing x:

(4) $$\max_x \pi_R = q(x, t_R, t_U, \mu)x - c(x)$$

where $c(x)$ is the cost function.

Ukraine's welfare is the sum of consumer (indirect) utility, the seller's profits, and government tax revenue:

(5) $$v(p, y) = v(p) + \pi_U + \delta R_U$$

where $y = \pi_U$,

(6) $$R_U = \left[t_U/(1+t_U)\right] px - \mu t_R qx$$

and $\delta > 1$ reflects the absence of non-distorting taxes.

To facilitate the analysis of the socially optimal choices of t_U and μ, the model will be re-parameterized as follows, using a combination of a profits tax at rate t and an input subsidy at rate s:

(7) $$\begin{aligned} 1-t &\equiv 1/(1+t_U) \\ 1-s &\equiv (1+t_U)[1+t_R(1-\mu)] \end{aligned}$$

If the Ukrainian government levies a profit tax t and an input subsidy s, Ukraine's profit function is as follows:

(8) $$\pi_U = (1-t)[p(x)-(1-s)q]x$$

The revenue function corresponding to a profit tax and an input subsidy is as follows:[14]

(9) $$R_U = t[p(x)-(1-s)q]x - sqx$$

Section IV.B derives the socially optimal choices of t and s under the simplifying assumption that input price q is exogenous, while Section IV.C derives the optimal choices of t and s allowing the input price q to be endogenous based on the bilateral monopoly model.

B. Exogenous Input Price

Assuming that the input price q is exogenous, the social optimum is obtained by choosing t and s to maximize social indirect utility subject to the constraint that the monopoly seller's profits be non-negative:

(10) $$\begin{aligned} &\max_{t,s} v(p,y) \\ &st: \pi_U \geq 0 \end{aligned}$$

It will be shown that the socially optimal choice is to tax away 100 percent of the monopolist's pure profits ($t=1$) and provide a positive input subsidy ($s>0$) to correct (albeit partially) for the sub-optimal level of the monopolist's sales.

The Kuhn-Tucker conditions for this problem are as follows:

(11) $$\frac{\partial v(p,y)}{\partial t} = \lambda \frac{\partial \pi_U}{\partial t}$$

(12) $$\frac{\partial v(p,y)}{\partial s} = \lambda \frac{\partial \pi_U}{\partial s}$$

(13) $$(1-t)[p(x)-(1-s)q]x \geq 0; \lambda \leq 0$$

(14) $$\lambda\{(1-t)[p(x)-(1-s)q]x\} = 0$$

where λ is the Kuhn-Tucker multiplier for the non-negativity constraint on profits.

[14] The revenue function (8) differs slightly from the revenue function in (6), reflecting the difference between a credit for Russian tax and an input subsidy.

From equation (11), it follows that $\lambda = -(\delta - 1) < 0$ and therefore from equation (14) after-tax profits must be zero, implying that $t = 1$. From equation (12), it follows that

$$-xp' \frac{\partial x}{\partial s} = \delta sq \frac{\partial x}{\partial s} \tag{15}$$

implying that

$$s = -xp' / \delta q = p / \delta \varepsilon q > 0 \tag{16}$$

where ε is the demand elasticity, defined to be positive. As shown, the rate of subsidy s is positive. Moreover, as $\delta \to +\infty$, $s \to 0$, implying that the rate of subsidy tends to zero as the marginal social utility of tax revenue becomes infinite. Finally, as $\delta \to 1$, $s \to -xp'/q$, ensuring that price equals marginal cost. If $\delta > 1$, the subsidy falls short of the rate needed to bring price down to marginal cost because there is a trade-off related to the loss of tax revenue.

C. Endogenous Input Price

This section allows for the possibility that Ukraine could improve its terms of trade by levying a tax (or subsidy) on its imports from Russia. It is assumed that Russia and Ukraine constitute a bilateral monopoly. The social optimum for Ukraine is obtained from the maximization problem specified in equation (10) above but now the solution incorporates the bilateral monopoly behavior of the Russian producer and Ukrainian seller. As the follower, Ukraine maximizes profits taking the input price q as exogenous. This yields the following reaction function:

$$q = q(x; s) = \frac{p + xp'}{1 - s} \tag{17}$$

The Russian producer maximizes profits incorporating Ukraine's reaction function. The Kuhn-Tucker conditions for Ukraine's constrained social indirect utility maximization problem (10) were given in equations (11)-(14) above. In this case, equation (11) yields the result that $t = 1$ as before. Compared to equation (15), derived assuming that the input price is exogenous, equation (18) contains an additional term:

$$-xp' \frac{\partial x}{\partial s} = \delta sq \frac{\partial x}{\partial s} - \delta \frac{dq}{ds} x \tag{18}$$

The extra term arises from the effect that changes in the subsidy rate have on tax revenue via changes in the input price. Rearranging this expression yields the following:

$$s = (p / \delta \varepsilon q) - (\rho / \sigma) \tag{19}$$

where

$$\rho \equiv \frac{dq}{ds}\frac{s}{q}$$

$$\sigma \equiv \frac{\partial x}{\partial s}\frac{s}{x}$$

Compared to the exogenous input price case, the expression for the socially optimal input subsidy contains an additional term. This additional term renders the sign of the socially optimal input subsidy rate ambiguous for reasons analogous to those considered by Lahiri and Ono (1999). The gain from increasing the Ukrainian firm's sales toward the level at which price equals marginal cost may be offset fully or partially if this is accompanied by a deterioration in the terms of trade. Whether the terms of trade worsens in response to an input subsidy depends on model parameters including in particular the curvature of the demand function (see Appendix I for a fuller discussion).

To sum up, the socially optimal policy is to tax away 100 percent of the seller's pure profits. Notwithstanding the ambiguity of the sign of the optimal subsidy rate, a simple, intuitive expression has been given which shows clearly the tradeoff between eliminating the domestic seller's monopoly distortion, sacrificing government revenue, and possibly worsening the terms of trade through granting an input subsidy.

Instruments t_U and μ are imperfectly suited to achieving the social optimum. Setting $t = 1$ would require $t_U \to +\infty$, whereas the feasible range for t_U would presumably be $0 \le t_U \le 0.2$ given the current 20 percent VAT rate in Ukraine. The rate at which Russian tax payments are offset in the form of a subsidy, μ, would normally lie between 0 and 1, precluding the possibility of a positive input subsidy rate ($s > 0$). Even if $\mu > 1$ were permitted, an increase in t_U designed to tax profits would require a commensurately large increase in μ to obtain $s > 0$. For instance, at the current 20 percent Russian tax and Ukrainian VAT rates, the credit rate μ would need to be higher than 1.8 to obtain a positive input subsidy rate s.

D. Nash Equilibrium

To assess the robustness of these findings to changes in the assumed form of strategic interaction between the producer and the seller, this section briefly considers a Nash equilibrium in which the Russian producer chooses the export price given Ukraine's import quantity and, simultaneously, the Ukrainian seller chooses the import quantity given Russia's export price.

Under this specification, the Russian seller maximizes profits by choosing the level of sales taking the output price as exogenous. It expands the volume of its sales until the export price equals its marginal cost. Export price is thus a function of the level of sales. The Ukrainian seller chooses the level of its purchases to maximize its profits, implying an optimal mark up over the (net of subsidy) input price. The Nash equilibrium solution is obtained for the levels of sales and export price that satisfy the producer's and seller's reaction functions simultaneously. However, in this case, the solution is very simple since the seller's reaction function simply specifies that the export price is equal to marginal cost, the latter being a

function of the level of sales. Effectively, then, the export price is exogenous and the system is recursive. As shown in Section B above, the optimal input subsidy is unambiguously positive in the case where the input price is exogenous.

V. CONCLUSIONS

This paper has examined the incentives for rent shifting by Russia and Ukraine under the current regime of double taxation of energy trade. The paper analyzes the oil and gas markets separately, focusing mainly on the latter since it is characterized by imperfect competition.

Starting with the market for oil, which is broadly competitive, removal of the Russian tax on its oil exports to Ukraine would increase the price (net of tax) to Russian producers, reduce the price (inclusive of tax) paid by Ukrainian buyers, and increase oil export volume. This would therefore raise the net return to producers and reduce the cost to Ukrainian buyers, lower Russian tax receipts, and could raise or lower Ukrainian tax revenues.

Natural gas exports from Russia to Ukraine may be characterized (subject to some caveats) as a bilateral monopoly, with Russian firm Gazprom accounting for virtually all of Russian production and exports, and Ukrainian firm Naftogaz dominating imports and domestic sales. Moreover, Ukraine has substantial leverage with Russia due to its possession of key gas transit pipelines which handle most Russian gas shipments to Europe. Russia chooses to maintain its taxation of gas exports to other CIS destinations, including notably Ukraine, which constitutes an important source of government revenue. This paper analyzed Ukraine's optimal response if Russia were to maintain its taxation of gas exports. If the export price were exogenous, it would be socially optimal for Ukraine to tax its domestic seller's pure profits at 100 percent and to subsidize gas imports to offset the monopoly distortion. The monopoly distortion would be offset only partially, reflecting the impact of subsidies on government revenues and the absence of non-distorting taxes. If the export price were endogenous, in the bilateral monopoly model considered, it would still be socially optimal for Ukraine to tax the seller's pure profits at 100 percent but the optimal input subsidy rate could be either positive or negative depending on the terms of trade effect. Notwithstanding this ambiguity, the paper provides a simple expression for the optimal subsidy rate for imported gas (which may be negative) that depends on the subsidy's effect on the monopoly seller's distortion, government revenue, and the terms of trade.

Box 1. Origin and Destination Principles and the VAT

There are two broad approaches to the application of the VAT, which are referred to as the origin and destination principles. Under the origin principle, the VAT is applied to sales of goods and services originating in the domestic market irrespective of whether they are sold at home or abroad. Under the destination principle, the VAT is applied to goods and services sold in the domestic market irrespective of whether they were produced at home or abroad.

More precisely, and although definitions vary, under the origin principle as defined in this paper, VAT is applied to domestic production irrespective of destination, so that imports are exempt, credit is given for VAT paid in the exporting country based on the importing country's VAT rate, and VAT is paid on exports. Using the VAT rate in the importing country to compute the credit given for VAT paid to the exporting country ensures that the value added in each country is taxed at the tax rate of that country.

Under the destination principle, VAT is applied to domestic consumption irrespective of origin, so that imports are subject to VAT while exports are "zero rated." Zero rating means that export sales are not taxed while credit is given for VAT paid on inputs. The credit reduces the firm's liability for payment of VAT. An exporter who has paid VAT on its inputs but whose sales are zero rated should receive a refund equal to the tax paid on its inputs. See Chapter 1 of Ebrill et al. (2001) for an introduction to the VAT.

Table 1. Oil Balance for the Russian Federation, 1998-2000 1/
(in millions of metric tons)

	1998	1999	2000
Crude Oil Production	303.2	305.0	323.2
Refinery Throughput	162.9	170.1	174.1
Direct Use of Crude/Residual 2/	9.6	5.9	10.9
Refined Products Consumption	113.3	120.3	112.6
Oil Exports			
Crude Oil	137.1	134.5	144.5
CIS and Baltic Countries	25.2	22.2	21.2
Other Countries	111.9	112.3	123.4
Refined Products	53.8	50.8	61.9
CIS and Baltic Countries	2.6	3.0	3.5
Other Countries	51.2	47.8	58.4
Oil Imports			
Crude Oil	6.4	5.6	6.3
CIS and Baltic Countries	6.4	5.6	6.3
Other Countries	--	--	--
Refined Products	4.1	0.9	0.4
CIS and Baltic Countries	1.8	0.5	0.3
Other Countries	2.4	0.4	0.1

SourcePlanEcon.

Notes:
1/Crude Oil Production - Oil Exports + Oil Imports
= Refinery Throughput + Direct Use of Crude/Residual
2/ Balancing item.

Table 2. Gas Balance for the Russian Federation, 1998-2000
(in billions of cubic meters)

	1998	1999	2000
Gas Production	591.0	590.7	584.2
Gas Consumption (total apparent)	390.8	389.8	404.4
Deliveries	331.6	339.9	347.1
Pipeline use/changes in storage 1/	59.2	49.9	57.3
Pipeline use and losses (reported)	53.0	53.0	51.0
Change in storage (residual)	6.2	-3.1	6.3
Gas Exports	202.5	204.5	217.1
CIS and Baltic Countries	82.0	77.7	88.1
Other Countries	120.5	126.8	129.0
Gas Imports	2.3	3.6	37.3
CIS and Baltic Countries	2.3	3.6	37.3
Other Countries	--	--	--

Source: PlanEcon.

Note:
1/ Balancing item.

Table 3. Production and Consumption
of Major Energy Products by Ukraine, 1998–2001

	1998	1999	2000	2001
Production				
Crude petroleum (in millions of tons including gas condensate)	3.9	3.8	3.7	3.7
Natural gas (in billions of cubic meters)	17.3	17.3	17.2	17.6
Coal (in millions of tons)	59.5	62.8	62.4	61.7
Electricity (in billions of kilowatts)	172.8	172.1	171.4	173.0
Domestic consumption				
Crude petroleum (in millions of tons including gas condensate)	13.7	13.3	9.4	16.9
Natural gas (in billions of cubic meters)	71.1	71.5	68.4	65.8
Coal (in millions of tons)	60.8	63.0	63.3	64.2
Electricity (in billions of kilowatts)	142.1	138.5	136.4	135.8

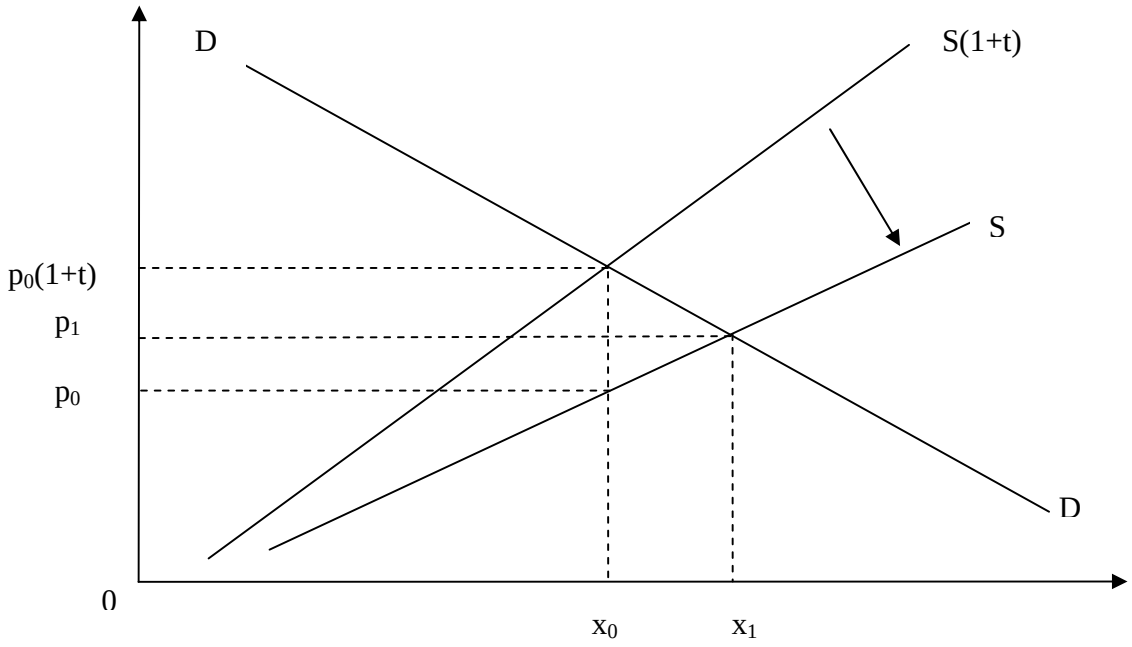
Source: Ukrainian State Statistics Committee.

Table 4. Values and Volumes of Energy Imports of Ukraine, 1998–2001
(Value in millions of U.S. dollars; other units as indicated)

	1998	1999	2000	2001
Crude oil	1,055	884	1,091	2,105
Volume (in millions of tons)	9.9	9.4	6.0	13.3
Unit price (in U.S. dollars per ton)	106.5	94.1	181.8	158.5
Oil products	802	816	1,270	501
Volume (in millions of tons)	4.7	4.0	4.6	2.1
Unit price (in U.S. dollars per ton)	170.6	209.1	276.2	238.7
Natural gas	3,524	3,256	3,324	3,288
Volume (in billions of cubic meters)	53.5	59.9	59.2	56.9
Unit price (in U.S. dollars per 1,000 cubic meters)	65.9	54.4	56.1	57.8
Coal	371	207	262	288
Volume (in millions of tons)	8.4	5.0	6.6	6.6
Unit price (in U.S. dollars per ton)	44.2	41.4	39.7	43.6

Sources: State Statistics Committee of Ukraine; and National Bank of Ukraine.

Figure 1. Effect of Russia Eliminating its
Taxation of Oil Exports to Ukraine



APPENDIX I

Terms of Trade Effects in the Endogenous Input Price Case

This appendix considers how the underlying model parameter values determine the terms of trade effects and the socially optimal input subsidy in the endogenous input price model analyzed in Section IV.C. This depends on the magnitude and sign of the term ρ/σ in equation (19) above.

To begin with, consider σ, which is the elasticity of input quantity x with respect to the input subsidy rate s. A closed-form solution for this parameter may be obtained by differentiating the Russian producer's first-order condition with respect to s, which yields the following:

$$\frac{\partial x}{\partial s} = -\frac{c'}{(1-s)\Delta_R} \tag{20}$$

where

$$\Delta_R = \frac{\partial^2 \pi_R}{\partial x^2} = q_{xx}x + 2q_x - c'' < 0 \tag{21}$$

by the concavity of the profit function.[15] If $s < 1$ then $\sigma > 0$.

The other parameter in equation (19) that needs to be considered is ρ, which depends on

$$\frac{dq}{ds} = q_x \frac{\partial x}{\partial s} + q_s = \frac{(2p' + xp'')}{1-s}\frac{\partial x}{\partial s} + \frac{q}{1-s} \tag{22}$$

where q_x and q_s were obtained by differentiating Ukraine's reaction function (17). It is apparent from (22) that a sufficient (but not necessary) condition for $\rho > 0$ is that

$$2p' + xp'' > 0 \tag{23}$$

or, equivalently,

$$\theta \equiv xp''/p' < -2 \tag{24}$$

where θ is a measure of the curvature of the demand function. For a linear demand function, $\theta = 0$ and this condition is not satisfied. For a constant elasticity demand function with

---

[15] Here, $q_x \equiv \frac{\partial q}{\partial x}$ and $q_{xx} \equiv \frac{\partial^2 q}{\partial x^2}$.

elasticity (defined to be positive) ε, $\theta = -(\varepsilon + 1)$ and therefore equation (24) is satisfied iff $\varepsilon > 1$.

If $s < 1$ and hence $\sigma > 0$, as shown by equation (19), whether or not the socially optimal subsidy rate is positive or negative depends on how changes in the input subsidy rate s affect the terms of trade q, an effect measured by parameter ρ. If an increase in s improves the terms of trade by lowering q (implying that $\rho < 0$), this raises tax revenue by reducing the fiscal cost of the subsidy sqx, increases social welfare, and ensures that the socially optimal subsidy is strictly positive. A necessary (but not sufficient) condition for $\rho < 0$ and hence $s > 0$ is that $\theta > -2$, which means that the demand function is sufficiently concave. A linear demand function satisfies this condition ($\theta = 0$) but unfortunately the sign of the socially optimal subsidy rate is nevertheless ambiguous. If an increase in s worsens the terms of trade by raising q (implying that $\rho > 0$), this lowers tax revenue by increasing the fiscal cost of the subsidy sqx, lowers social welfare, and makes the sign of the socially optimal subsidy ambiguous. A sufficient (but not necessary) condition for $\rho > 0$ is that $\theta < -2$. The constant elasticity demand function satisfies this condition and hence the sign of the socially optimal subsidy rate is ambiguous in this case as well.

REFERENCES

Dodsworth, John R., Paul H. Mathieu, and Clinton R. Shiells, 2002, "Cross-Border Issues in Energy Trade in the CIS Countries," IMF Policy Discussion Paper No. 02/13 (Washington: International Monetary Fund).

Ebrill, Liam, Michael Keen, Jean-Paul Bodin, and Victoria Summers, 2001, *The Modern VAT* (Washington: International Monetary Fund).

International Monetary Fund, 2003, "Ukraine: Selected Issues," IMF Country Report No. 03/173, June (Washington: International Monetary Fund).

Lahiri, Sajal, and Yoshiyasu Ono, 1995, "Optimal Tariffs in the Presence of Middlemen," Discussion Paper No. 389, The Institute of Social and Economic Research, Osaka University, Osaka, Japan.

Lahiri, Sajal, and Yoshiyasu Ono, 1999, "Optimal Tariffs in the Presence of Middlemen," *Canadian Journal of Economics*, Vol. 32 (No. 1), February, pp. 55-70.

Shiells, Clinton R., 2005, "VAT Design and Energy Trade: The Case of Russia and Ukraine" *IMF Staff Papers*, Vol. 52 (No. 1), pp. 103-19.

Tarr, David, and Peter Thomson, 2004, "The Merits of Dual Pricing of Russian Natural Gas," *World Economy*, Vol. 27 (No. 8), August, pp. 1173-94.

U.S. Department of Energy, 2003, "Ukraine," Country Analysis Brief, Energy Information Administration, September, Washington: U.S. Department of Energy, available at http://www.eia.doe.gov/emeu/cabs.