Environmental tax reform in Vietnam: An ex ante general equilibrium assessment

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1. Introduction

Vietnam is planning to implement a new environmental tax law in 2012. The objective of the study is to provide a predictive quantitative evaluation of the impacts of the proposed draft environmental tax law of Vietnam on producer and user prices, sectoral output and employment, the commodity structure of demand, government tax revenue, CO2 emissions and household welfare.

The assessment is based on a multisectoral computable general equilibrium (CGE) model calibrated to a new social accounting matrix that represents the current structure of the Vietnamese economy. The model distinguishes 33 production sectors, 20 household groups, and incorporates a sophisticated treatment of energy substitution in production, allowing substitution possibilities between liquid fuels and gas, coal, and electricity as well as technology switches towards less energy-intensive modes of production.

2. Methodology

The analysis is an economy-wide multisectoral assessment. A simulation analysis using a **C**omputable **G**eneral **E**quilibrium model of the Vietnamese economy is used to model the impact of the environmental tax.

The CGE model is calibrated to a new **S**ocial **A**ccounting **M**atrix for Vietnam (Arndt et al, 2010). The SAM provides a detailed consistent representation of the present input-output structure of production, the commodity structure of domestic demand and international trade, income distribution and government expenditure, taxes and transfers. The SAM uses 2007 data.

The parameters of the CGE simulation model employed in this study are calibrated to this data set, so that the equilibrium of the model in the absence of tax policy changes exactly reproduces the observed SAM data.

Below is a concise list of main features and dimensions of the CGE model:

- 33 production sectors (*see Table 1 below*) with detailed representation of the commodity structure of intermediate inputs and demand for primary production factors;
- 33 commodity groups;
- 9 primary production factors (*skilled and unskilled labour, capital, land, natural resources (livestock, fishery stocks, coal and oil endowments)*);
- 20 household groups (*rural and urban farm and non-farm households by income quintile*);
- Cost-minimizing firms;
- Utility-maximizing households;

- Market-clearing price adjustments (*differences between demand and supply are assumed not to persist in the long term*);
- A sophisticated treatment of energy substitution in production, allowing substitution possibilities between liquid fuels and gas, coal, and electricity as well as technology switches towards less energy-intensive modes of production
- Imperfect factor substitutability (*sectors can increase/decrease the relative amounts of labour and capital that they use*);
- Domestic and imported goods are imperfect substitutes in demand
- Intersectoral labour and capital mobility.

A detailed technical description of the basic modelling framework can be found in Robinson et al (1999). For purposes of the present study, this basic framework has been extended to include environmental tax parameters and a careful state-of-the-art representation of technical substitution possibilities among different energy sources in production.

Figure 1 provides a schematic representation of the substitution hierarchy between different inputs in production in the model. The production technology in each domestic sector is described by a so-called KLEM (Capital (**K**), **L**abour, **E**nergy, **M**aterials) production function, which relates inputs to outputs. In each sector, the production of a given output quantity requires non-energy inputs and a composite "value-added/energy composite in fixed proportions. For the few sectors that use crude oil directly as an input (i.e. the refined fuels industry and the chemical industry), crude oil inputs are also a fixed proportion of output. The value added/energy composite requires energy and primary factors in variable proportions. Thus, when the price index of energy rises due to the environmental tax on coal and refined fuels, it is possible to replace energy inputs to some extent by additional inputs of capital and/or labour. In other words, the model allows to some extent a switch to less energy-intensive modes of production in response to an increase in energy prices.

Required energy inputs in each sector are composed of electricity purchases from the electricity sector in the model and direct use of fossile fuels. The model allows substitution of these primary fossile energy carriers for electricity. As a matter of course, the model takes into account that additional electricity demand for production entails additional use of fossile fuels in electricity generation. At the bottom of the input substitution hierarchy, the sectoral production functions allow for imperfect substitutability between coal and a refined oil/gas composite, and between refined oil and natural gas.[1]

[1] The ease of substitution between inputs is governed by the elasticity of substitution. The assumed elasticities in this study are 0.4 for substitution between energy and value added, 0.15 for substitution between electricity and fossile fuels, 0.25 for substitution between coal and the oil-gas composite, and 1 for substitution between oil and gas. These elasticities have been determined by scaling down the corresponding values commonly used in studies for advanced economies (see e.g. Böhringer et al, 2004)

The KLEM approach is widely used in energy/environmental modelling and represents the current state of the art in this field (see e.g. Böhringer et al, 2004).

Table 1 presents the sectors of the model and their respective shares (in gross output) in the Vietnamese economy in 2007: In the model, the transport sector is further disaggregated into road transport, air transport and other transport services.

by a factor 0.5. In other words, this study is based on quite conservative assumptions about the scope for energy substitution.

Figure 1: Energy Input Substitution inProduction

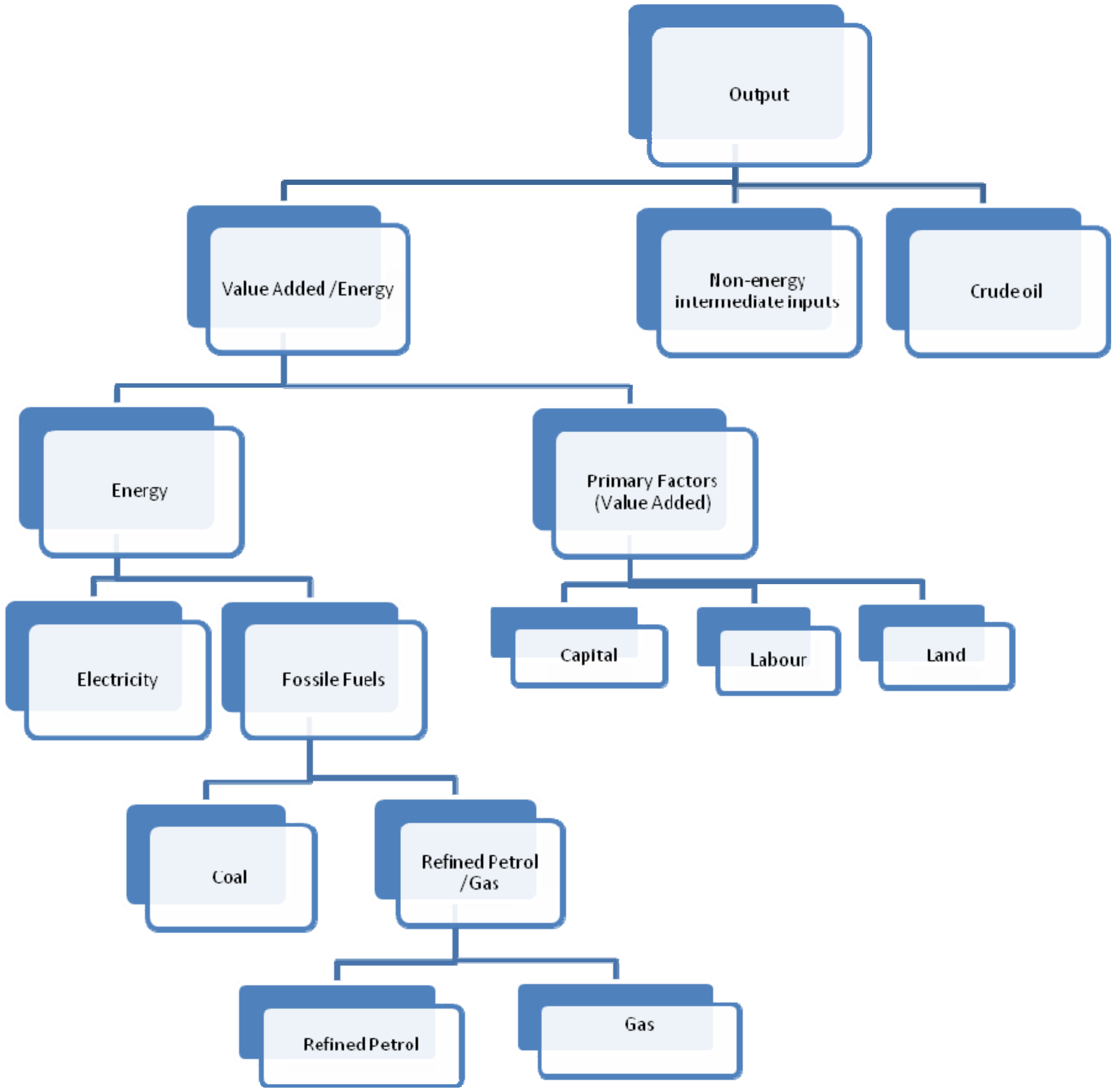


Table 1: Model Sectors and Shares in Domestic Production 2007

Production Sector / Commodity Group	% Share in Gross Output
Paddy rice	3.54
Other crops	2.80
Livestock	2.02
Forestry	0.89
Fishing	0.97
Aquaculture	2.06
Coal	0.86
Crude oil	3.70
Mining	0.38
Meat products	0.70
Fish processing	2.56
Other food processing	8.70
Textiles, clothing, leather and footwear	6.23
Paper and printing	1.30
Oil refining	0.10
Other chemicals	4.95
Non-metallic mineral products	2.51
Base metals	2.11
Metal products	2.89
Machinery and equipment	0.45
Electrical machinery	4.94
Vehicles and other transport equipment	4.17
Other manufacturing (inc Wood products and Furniture)	3.26
Electricity and Gas	2.36
Water distribution	0.22
Construction	10.08
Trade services	6.88
Hotels and catering	3.00
Transport (3 transport sectors: air, road, other)	3.30
Business, financial, communication and real estate services	6.71
Public administration, education and health	5.35
Total	100.00

3. Environment Tax Scenarios

The taxable objects proposed in the draft environment law include refined fuels (gasoline, diesel, mazut, paraffin, kerosene), coal, hydrochlorofluorocarbon (HCFC) substances, soft plastic bags, and a subset of harmful chemical substances used in agriculture and forestry. In the CGE analysis, we focus on the taxes on coal and on refined fuels, which – as shown below - account for around 99.5% of the estimated environmental taxes. The other taxable objects account only for a tiny share of domestic production and consumption within the "Other chemicals" industry and commodity group of the model, and it is safe to conclude that their taxation will have no noticeable impact on economy-wide variables or on sectoral variables at the 33-sector disaggregation level used in this study.

The fact that the environmental tax on selected harmful chemicals has negligible impacts on macroeconomic variables and on tax revenue does not mean that the imposition of these taxes is not worthwhile. Imposing a tax on these products with negative environmental externalities is certainly sound economic and environmental policy, and should be encouraged. In theory, revenues from the taxes on these products should eventually be driven to zero, as buyers of these goods shift to more environment-friendly substitutes that are available. Falling revenue from these taxes over time should be interpreted as a sign of success.

The draft environmental tax law specifies a lower and an upper limit for the specific tax rates that apply to each taxable object. Therefore, the simulation results presented below consider a *Low* and a *High* tax rate scenario. In the case of coal, the environmental tax rates used in the *Low* and *High* simulation scenario are just the lower and the upper limit of the tax rate band specified in the draft law. For refined fuels, however, the environmental tax rates used in the simulation analysis take into account that existing fees or surcharges on the use of gasoline and diesel will be abolished when the environmental tax is introduced in 2012. Information provided by the MoF suggests that the existing fee/surcharge rates are roughly equal to the lower limits of the proposed tax band, i.e. 1000 VND/litre for gasoline and 500 VND/litre for diesel. The introduction of the environmental tax rate for gasoline and diesel at the lower limit of the tax rate band in combination with the abolition of existing tax surcharges with the same rate is significant from a fiscal accounting and administration perspective,[2] but is effectively irrelevant from a taxpayer's perspective and trivial for an economic impact analysis: The mere relabeling of an existing tax will have no impact on relative prices and economic behaviour. Therefore, the *Low* simulation scenario assumes that the environmental tax rates for gasoline and diesel are 2000 VND/litre and 1000 VND/litre respectively (i.e. *higher* than the lower limits in the draft law), so that the *net increase* in

[2] It is understood that the existing fees/surcharge revenues and the future environmental tax revenue accrue to different administrative units

the overall tax rate after abolition of surcharges *relative to current tax rate levels* is 2000-1000 = 1000 VND/litre for gasoline and 1000-500 = 500 VND/litre for diesel. Correspondingly, the *increase* in the overall tax rate after abolition of surcharges *relative to current tax rate levels* in the *High* scenario is 4000-1000 = 3000 VND/litre for gasoline and 2000-500 = 1500 VND/litre for diesel.

In the SAM and the CGE model, gasoline, diesel, mazut, paraffin and kerosene all belong to the same commodity group labelled *Refined fuels*. The increase in the tax rate on the use of refined fuels for the simulation analysis is therefore calculated as a weighted average over the different fuel types as detailed in Table 2.

In this Table, the *specific* tax rates- i.e. tax rates per unit of physical quantity – are transformed into equivalent *ad valorem* tax rates, which express the tax rate as a percentage of the price of a good prior to the tax reform. The ad valorem tax rates in columns C1 and C2 show the size of the *additional* wedge the tax drives between the supply price (received by the seller net of tax) and the price paid by the purchaser as a proportion of the initial price.

For example: Gasoline has currently a price of 17,000 VND per litre before the tax reform (Viet Nam News, 11 May 2010). When the government imposes a specific tax of 4,000 VND per litre, the ad valorem equivalent environmental tax rate is 4/17 = 23.5%. However, with a simultaneous drop in other fees on gasoline of 1000 VND, the net increase in the ad valorem tax rate is only 3/17 = 17.6%-points relative to the situation before the tax reform. The tax rates for other refined fuels subject to the tax are calculated in the same way. The expenditure weights used to determine the average percentage tax rate increase for refined fuels are derived from data provided by the MoF.

Table 2: Calculation of the Ad Valorem Tax Rate Variations for Refined Fuels

	A	B1	B2	C1=B1/A	C2=B2/A	D	C1*D	C2*D
	Price/Ltr	Low	High	Low %	High %	Weight		
Gasoline	17,000	1,000	3000	5.9	17.6	0.47	2.8	8.3
Diesel	14,600	500	1500	3.4	10.3	0.44	1.5	4.5
Mazut	10000	300	2000	3.0	20.0	0.06	0.2	1.2
Paraffin	10000	300	2000	3.0	20.0	0.00	0.0	0.1
Kerosene	15000	1000	3000	6.7	20.0	0.05	0.3	1.1
					Sum	1.00	**4.6**	**15.2**

Table 3 displays the percentage-point increases in the ad valorem equivalent tax rates for both coal and refined fuels. The key message from Table 3 is that the environmental tax rate on coal remains very moderate in both scenarios and is significantly lower than the environmental tax rate on refined fuels. The implication is that the percentage increase in the user price of coal will be far lower than the user price increase for refined fuels, so that the *relative* user price of coal in relation to the price of refined oils drops. To the extent that refined fuels and coal are substitutes, this may induce substitution effects in an undesirable direction. From an environmental perspective, the effective ad valorem tax rate on coal should be set higher than the rate on refined fuel substitutes, given that CO_2 emissions per unit of energy content are significantly higher for coal compared to refined oils.

Table 3: Environmental Tax Rates in the Simulation Scenarios

	Unit	Tax rate ('000 VND/unit)		Equivalent ad valorem tax rate %	
		Low	High	Low	High
Coal	ton	6	30	1.5	7.4
Refined Fuels	litre	0.3	3	4.6	15.2

4. Simulation Results

We first turn to the macroeconomic impact of the simultaneous imposition of the proposed taxes on coal and refined fuels before presenting sectoral results. The simulation analysis assumes that the government spreads the additional tax revenue from environmental taxes among public investment spending, government consumption and additional transfers to the private sector. Table 4 contains the main economy-wide results.

Table 4: Impact on Real Macroeconomic Aggregates

% deviations from baseline growth path

	LOW	HIGH
Absorption (C+G+I)	0.0	-0.2
Household Consumption	-0.7	-2.7
Investment (Public and Private)	0.9	3.6
Goverment Consumption	0.3	1.0
Exports	-0.6	-1.6
Imports	-0.4	-1.2
Real Exchange Rate*	-0.1	-0.6
Government Revenue	1.9	7.3

* Minus sign indicates real exchange rate appreciation

The reader should note that figures do *not* represent point forecasts for a particular year – they show deviations from the baseline growth path of the economy (i.e the growth path in the absence of an introduction of the environmental tax). Numbers are presented in real terms – this means that quantities are valued at constant 2007 prices.

Absorption is defined as total domestic demand for final goods in the economy, including imports. That is, the sum of household consumption (C), investment expenditure including public investment (I) and government consumption purchases (G).

Ultimately it is the household sector that bears the burden of the tax as reflected in the noticeable drop in C at the high end of the tax band. The reduction in private consumption would be higher if the government would not pass back part of the tax revenue to households in the form of income transfers or reduction in other taxes.

The government, on the other hand, claims a higher share of productive resources as a result of the imposition of the tax. The increase in real government expenditure (which means an increase in demand for domestic non-tradable goods and services) causes the price of non-tradable goods relative to export goods to rise, and thus discourages exports. Exports are thus observed to fall. The negative sign of real exchange rate change (a measure of the prices of tradable goods relative to the price of non-tradable goods) indicates a real appreciation of the VND.

The core message from Table 4 is that at the high end of the proposed tax interval the tax reform would imply substantial economy-wide effects - provided that the move to the upper end of the tax band is actually associated with tax rate increases in real terms. If *real* increases in the tax rates on refined liquid fuels are envisaged, it is advisable to phase in the tax increases gradually according to a transparent pre-announced time table to allow advance planning of investments in more energy-efficient technologies. This was amply illustrated by the extreme high scenario presented at the first stage of the impact assessment.

Table 5: Environmental Tax Revenue 2012 (in 2007 prices, Billion VND)

TAXABLE ITEM	LOW	HIGH
Coal	571	2488
Refined Fuels	8967	35158
HCFC	4	21
Chemicals	1	7
Plastic bags	114	170
Total	9657	37844

Table 5 shows the estimated tax revenue in 2012 that would result from the imposition of the environmental taxes on coal, refined fuels, HCFCs, chemicals, and plastic bags. The table is based on assumption of average annual real GDP growth rate of 7.0 percent between 2008 and 2012 and zero inflation. The figures for coal and refined fuels are results from the CGE analysis, while the revenue estimates for the other taxable objects are based on partial-analytic calculations. Table 5 confirms that the taxes on HCFC substances, selected chemicals and plastic bags will generate relatively little tax revenue in comparison to coal and refined fuels. As noted earlier, the impact of imposing taxes on these products on the overall economy is negligible, and this is why the CGE impact assessment focuses exclusively on the taxation of coal and refined fuels.

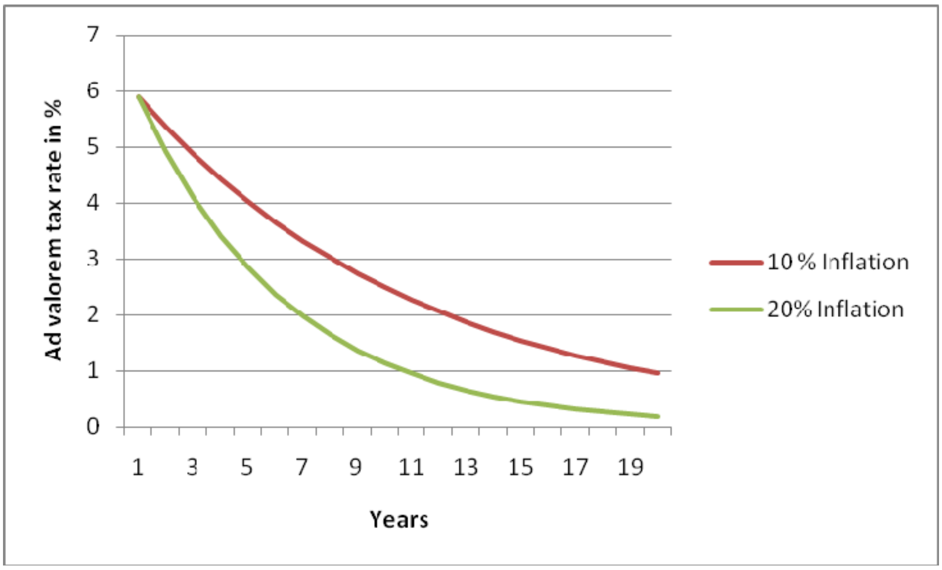
As noted earlier, the high tax scenario is based on the assumption that the environmental tax rates actual rise in real (inflation-adjusted) terms. In the presence of sustained general price inflation, this would require that the nominal specific tax rates rise at a rate that is *higher* than the rate of inflation, if we assume that the nominal domestic prices of coal and refined fuels rise in line with overall inflation. However, if the purpose of the tax band is only to allow for an inflation adjustment (i.e. the nominal tax rates rise in line with inflation but not more), the real tax rates remain at the initial level until the upper limit of the tax brackets is reached. In other words, the economy stays in the *Low* scenario up to this point. If inflation continues and the upper tax limit is not indexed to the rate of inflation, the real tax rates and the real purchasing power of the environmental tax revenue would begin to drop from this point onwards, and would eventually converge to zero. Figure 2 illustrates the erosion of the real tax rate for gasoline over time in the presence of sustained inflation if the initial actual nominal tax rate is not indexed to rate of inflation.

To repeat, if the aim is to move tax rates in real terms to the upper limit of the tax band, actual nominal rates need to rise at a rate higher than the rate of inflation, and once the nominal upper limit specified in the tax law is reached, this upper limit needs to be indexed to the rate of inflation in order to keep the real tax rate permanently at the upper level.

In this context it is worth pointing out that existing fears that the environmental tax will itself generate inflation is based on a common misperception. The tax reform will make some goods more expensive relative to others in order to induce desirable substitution effects – and that is the whole point of an environmental tax. These *relative* price changes are in principle compatible with any rate of general price inflation including a zero rate of inflation. This is why all price changes reported below are expressed relative to the consumer price index.

Of course, if all nominal prices are rigid downwards, the environmental tax will have a one-off level effect on the price index every time tax rates are raised, but this effect is conceptually different from a persistent process of price inflation – the latter is ultimately determined by the monetary policy of the Central Bank. In short, any claims by opponents of the environmental tax, that the reform will lead to a persistently higher rate of inflation should be robustly rejected.

Figure 2: Erosion of Effective Real Tax Rate in the Presence of Inflation



We are now turning to sectoral economic impacts. The environmental tax is imposed on domestic intermediate and final consumption of coal and refined fuels. Both domestically produced and imported coal and fuels are taxed. The immediate impact effect is a rise in the user price for these commodities as shown on the left side of Figure 3.

On the household side these user price effects induce income and substitution effects in final consumption. As the real purchasing power of household incomes declines due to the price increases, the pure income effect reduces demand for all consumer goods, while the pure substitution effect entails a shift in demand from coal and refined oils to other goods.

On the production side, the price increases for the taxed commodities induces substitution effects between energy inputs (recall Figure 1 above) and affects production costs and hence the supply prices of domestically produced commodities. Figure 4 shows the initial refined fuel share in total cost for the six most fuel-intense sectors out of the total of 33 sectors distinguished in the model, as these sectors will be most affected by the tax-induced increases in input costs. Next to the small domestic refined fuel sector itself, the capture fishery and transport sectors use refined fuels most intensely. In the case of fisheries, it is worth pointing out that there is a large upstream and downstream industry associated with fisheries (e.g. processing and marketing). It is estimated that employment in these up/downstream industries is larger than the fishery sector by a factor of three. Therefore, as shown further below, there will be further indirect impacts on other sectors through forward and backward linkage effects.

Figure 3: Sectoral User Price Impacts *(% relative to Consumer Price Index)*

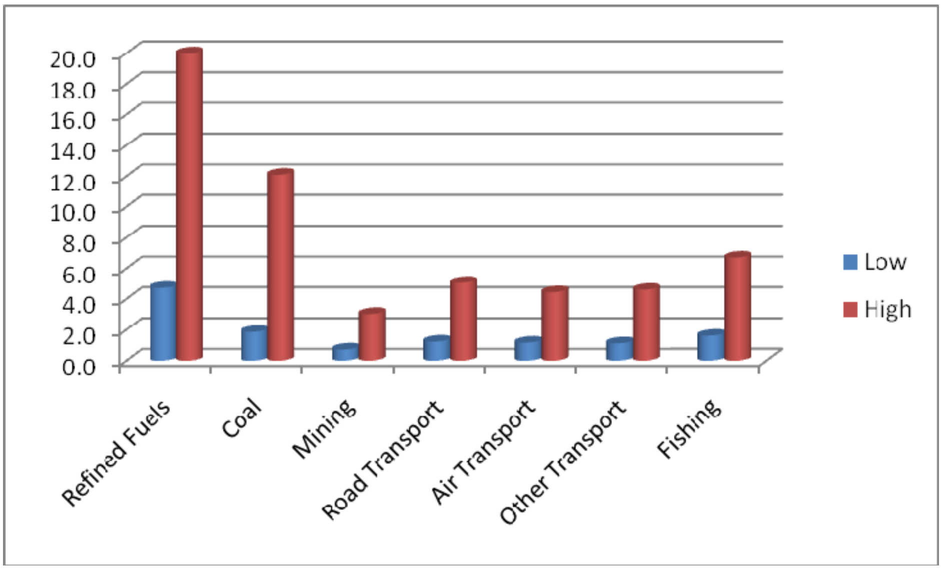
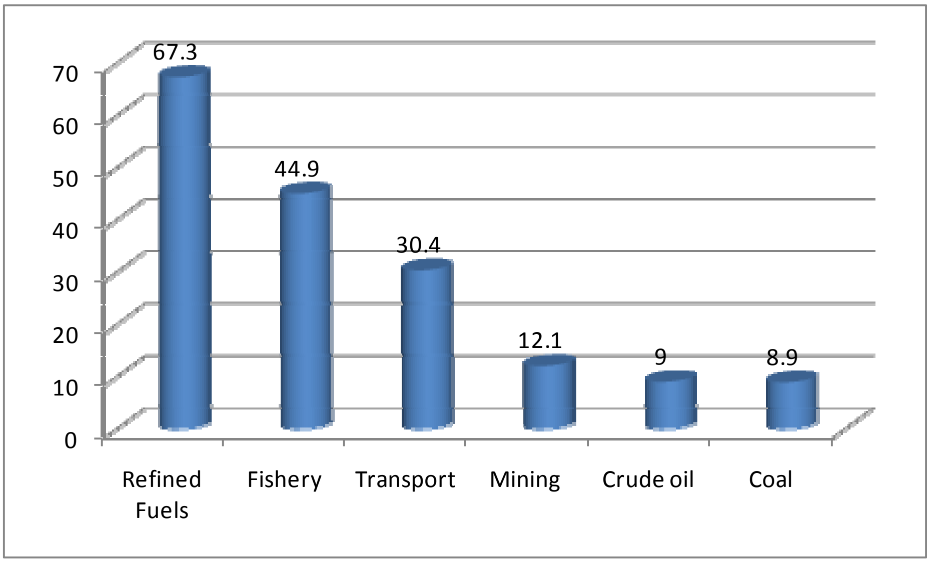


Figure 4: Refined Fuel Share in Total Cost for the Most Fuel-Intense Sectors (%)



In the case of transport, indirect follow-on effects throughout the economy are also important as all portable goods will be impacted by a higher transport margin. The intense own use of refined fuels as an intermediate input for the fuels sector carries with it the potential danger of tax cascading effects.

A glance at Figure 5 confirms that the refined fuel, fishery and transport sectors experience the largest cost-driven rises in producer prices, which in turn feed through into the user prices for these commodities as shown in Figure 3 above. Note that the user prices shown in Figure 3 are the commodity price indices over domestic and imported goods. Thus for commodities with a high share of imports in total domestic demand, the indirect impact on user prices through increases in fuel costs for domestic sectors remains small The refined fuels commodity is a case in point. Since the share of domestically refined fuels in Vietnam's total refined fuels demand is actually very small, most of the user price increase in Figure 3 is *not* due to the indirect rise in producer cost for the domestic refinery sector displayed in Figure 5, but due to the direct effect of the fuels tax on intermediate and final consumption.

Figure 5: Producer Price Increase by Sector (% relative to CPI)

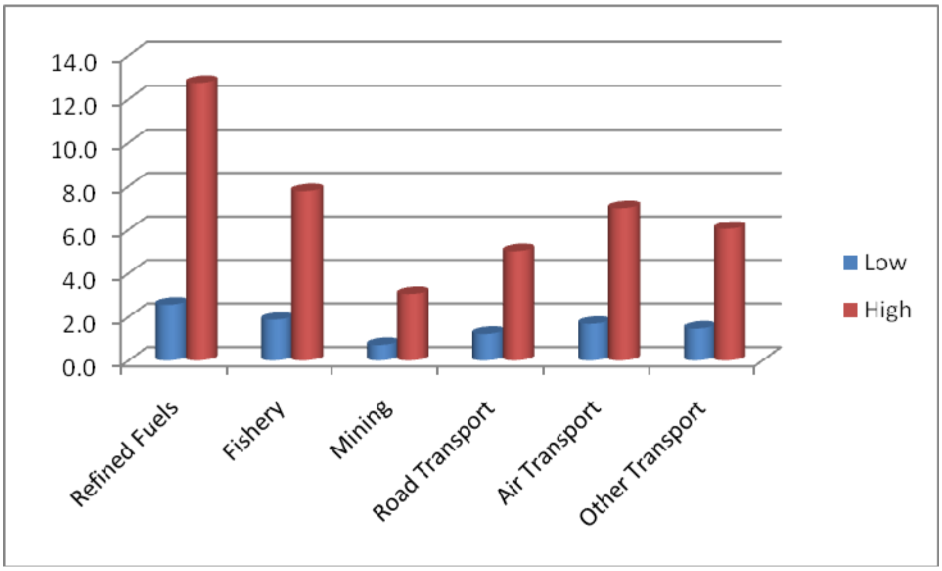


Table 6 and Figure 6 present the impact of the coal and refined oils environmental tax on real output on selected strongly affected sectors in the economy. Changes in sectoral employment follow the same pattern and order of magnitude and are therefore not separately reported. The results indicate in particular that the fuel tax poses a serious threat for the survival of Vietnam's small refinery sector. As we have seen, the rise in the cost of refined fuel inputs requires a compensating rise in domestic producer prices which renders the sector uncompetitive in relation to imports. Although imports of refined fuels are also taxed, producers abroad are of course not affected by the tax-induced rise in input costs. The virtual eradication of the domestic refinery industry under the High scenario predicted by the model may be exaggerated, since currently there is only one refinery in Vietnam, and to the extent that the intermediate use of fuel is internal own consumption it may not be subject to the tax, as discussions with MoF staff seem to suggest. However, to the extent that the fuels used by the domestic refinery are imported, they are subject to taxation, and with the development and diversification of the domestic refinery sector, one would expect more inter-firm trade in fuel inputs among refineries in the future. Therefore it appears worthwhile to draw attention to these extreme simulation results, as they indicate the possible emergence of a serious problem in the future.

The Table also confirms the aforementioned presence of strong forward linkage effects associated with the cost rises and resulting shrinkage of the domestic capture fishery sector. As the domestic fish processing sector uses the output of the capture fishery and aquaculture sector intensely as its prime inputs and imports very little fresh fish, the processing sector is forced to contract, which in turn reduces the demand for aquaculture products, and as a result this sector also contracts.

However, additional simulations reported below in section 6 indicate that these presumably unintended side effects can be largely eliminated through an output subsidy for the capture fishery sector.

The contracting sectors release production factors for re-employment in other sectors. The model simulation results suggest that the textiles and clothing sector – a sector with a low fuel intensity – will be able to expand output and employment considerably. Such intersectoral employment reallocation processes are in practice associated with significant adjustment costs, and a part of the additional tax revenue needs to be set aside for policy measures aimed at reducing these adjustment costs for affected households.

Table 6: Impact on Real Output by Sector (%)

	Base level 2007	**Low**	**High**
Refined fuels	*2.795*	-87.3	-98.8
Coal	*23.196*	-2.5	-10.8
Road transport	*60.092*	-1.2	-4.7
Air transport	*8.436*	-5.9	-21.2
Other transport	*20.823*	-0.9	-3.6
Fishery	*26.410*	-1.8	-7.4
Fish processing	*69.441*	-2.8	-11.6
Aquaculture	*55.887*	-0.9	-3.9
Textiles and clothing	*168.903*	2.5	11.1

Figure 6: Impact on Real Output by Sector (%)

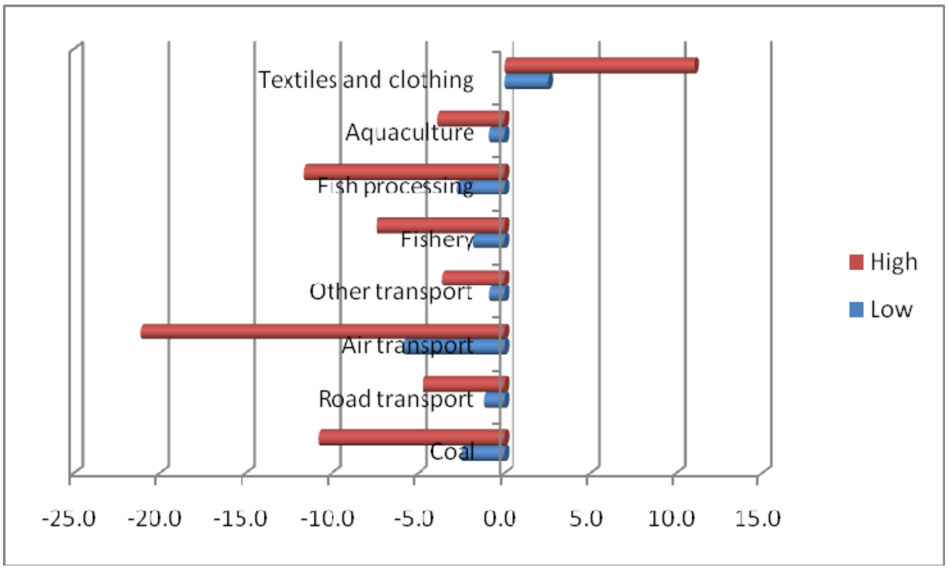


Figure 7 displays the impact of the environmental tax on total real domestic demand – comprising domestic demand for domestically produced output as well as imports – for selected commodity groups of interest. The domestic demand for crude oil shrinks considerable under both scenarios. This is partly due to the contraction of the domestic refinery sector that uses domestic crude oil as an input, but also due to a contraction of crude oil exports as a result of the aforementioned real exchange rate appreciation. Coal and refined oil use drops noticeably in the Low scenario and considerably in the High scenario relative to the baseline growth path. These are exactly the intended effects of an environmental tax on fossile fuels. They are not only due to substitution effects in intermediate and final consumption, but also a result of the relative contraction of fuel-intensive sectors in the economy. The resulting CO_2 emission reductions are analysed in the following section.

Table 7 presents the impact of the coal and refined oil tax on household welfare for various household categories. Household welfare is here measured by the Hicksian equivalent variation. This is in the present case the hypothetical amount of money that would have to be taken away from a household in order to generate the same loss of utility in the absence of the environmental tax as the utility loss due to the tax. In the Table, this amount is expressed as a percentage of initial disposable income. Thus, in the Low scenario the welfare impact of the environmental tax is on average equivalent to the welfare impact of a 0.66 percent loss in household income.
However, it is important to note that household welfare is here narrowly defined as utility derived from the consumption of private goods. The measure does not take into account that the use of the tax revenue by the government will – hopefully – also lead

to the improvement of the well-being of private households. In particular, the welfare indicator reported here does not take into account the potential long-run welfare gains due to improvements in the environment. So, if the government of Vietnam succeeds in investing the tax revenue received to successfully improve the natural environment as planned, the net household welfare effects may well be positive.

Figure 7: Impact on Total Domestic Demand by Commodity Group (in %)

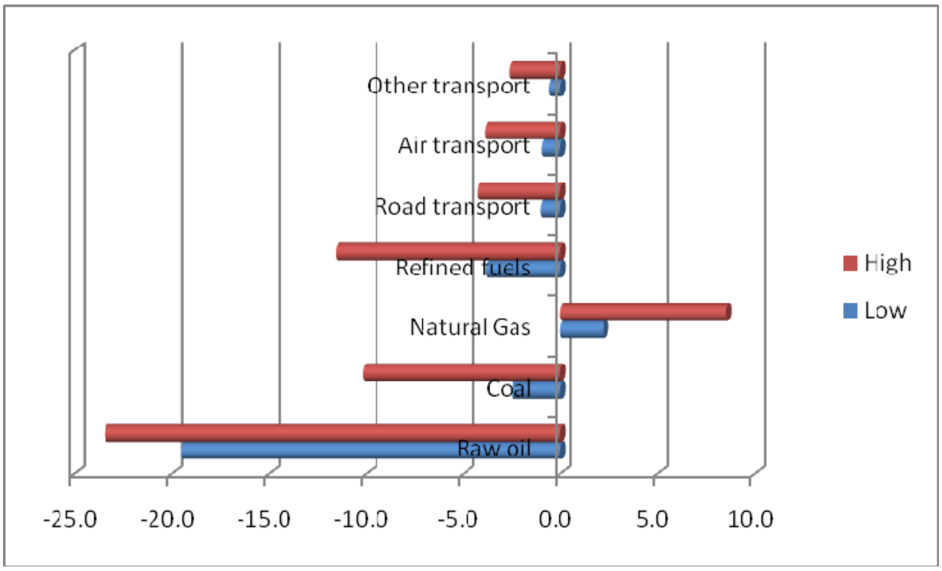


Table 7: Impact on Household Welfare (%)

	LOW	HIGH
Urban Farm 1	-0.66	-2.79
Urban Farm 2	-0.66	-2.79
Urban Farm 3	-0.70	-2.89
Urban Farm 4	-0.70	-2.89
Urban Farm 5	-0.65	-2.65
Urban Non-farm 1	-0.54	-2.29
Urban Non-farm 2	-0.61	-2.54
Urban Non-farm 3	-0.62	-2.60
Urban Non-farm 4	-0.69	-2.85
Urban Non-farm 5	-0.56	-2.29
Rural Farm 1	-0.67	-2.81
Rural Farm 2	-0.69	-2.89
Rural Farm 3	-0.76	-3.15
Rural Farm 4	-0.74	-3.07
Rural Farm 5	-0.70	-2.89
Rural Non-farm 1	-0.52	-2.19
Rural Non-farm 2	-0.61	-2.56
Rural Non-farm 3	-0.69	-2.87
Rural Non-farm 4	-0.69	-2.85
Rural Non-farm 5	-0.58	-2.37
All	-0.66	-2.75

Note: 1 is low income quintile (poorest); 5 is high-income quintile (richest). Welfare is measured by the Hicksian equivalent variation as % of base income. The measure expresses the tax burden as a lump-sum reduction in real income with equivalent welfare impact

5. Impact on CO_2 Emissions

The general equilibrium approach adopted in this study allows quantifying the CO_2 emission reductions associated with the imposition of the environmental tax, as the model takes complete and internally consistent account of the use of fossile fuels in intermediate and final consumption.

Table 8 translates the quantitative changes in the domestic use of coal, refined fuels and natural gas reported above into changes in carbon emissions. We start from physical quantity data for the total use of fossile fuels in Vietnam in 2007 as shown in the second column of the Table. Using standard coefficients, these data are first converted into energy content in Tera Joule (TJ), and then into CO_2 emissions for 2007 using the emission coefficients in the fifth column of the Table. In a next step, the emissions for 2007 are projected towards 2012 assuming a real annual growth rate of 7.5% in line with Vietnam's recent GDP growth performance. Finally, the changes in fossile fuel use generated by the CGE simulation scenarios (Figure 7) are used to generate the net emission reductions reported in the bottom right corner of Table 8.

The results suggest that CO_2 emissions drop by around 2.3% under the Low and by 7.5% under the High tax rate scenario.

Table 8: Reductions in CO_2 Emissions

	Quantity	Unit	Energy Content	Emissions	Emissions 1000t CO2		Reduction in %		CO2 Reduction 1000t	
	2007		TJ 2007	per TJ	2007	2012	Low	High	Low	High
Coal	10,957	1000 t	328,710	94	30,899	44,359	-2.5	-10.2	- 1,109	- 4,525
Fuels	13,285	1000 t	572,584	70	40,310	57,870	-3.8	-11.5	- 2,199	- 6,655
Natural Gas	7,080	Mill m^3	265,500	56	14,868	21,345	2.2	8.5	470	1,814
Total					86,077	125,586			- 2,838	- 9,365
							Total %		-2.3	-7.5

Sources: 2007 fossile fuel quantities from General Statistical Office (2009). Conversion into energy content in Tera Joule(TJ) and CO_2 emissions/TJ based on standard coefficients in Forschungsstelle für Energiewirtschaft (2010). The author is particular grateful to Sina Johannes (GTZ) and Ho Cong Hoa (CIEM) for the collection of data and helpful discussions at this stage.

6. Countering Adverse Impacts on Fishery Sectors

In section 4 it was shown that the fuel tax is associated with significant adverse effects for the capture fishery sector, given its high fuel share in total cost, with strong follow-on effects for fish processing and aquaculture. From a purely environmental perspective this might be considered as a beneficial side effect of the environmental tax, as the contraction of capture fishery relative to the baseline growth path reduces the pressures on fragile marine ecosystems. However, fish-related sectors employ a significant fraction of Vietnam's total labour force and fish is an important component of household diets. On average, 15% of total household spending on food is allocated to fresh and processed fish products. From this perspective it makes sense to consider policy options that reduce or neutralize the impact on the fishery sector.

Thus, in the simulation scenario reported below[3] the introduction of the environmental taxes on fuels and coal is combined with a production subsidy for the fishery sector in the model. The subsidy rates that are applied to the value of gross output of the fishery sector are set at 1.8% for the Low and 7.7% for the High scenario. These rates are set approximately equal to the increases in the producer price for fishery output reported in

[3] This additional simulation scenario has been inspired by discussions with Kai Schlegelmilch (BMU).

Figure 5, so that the subsidy compensates the sector for the tax-induced fuel cost increase.

The simulation results confirm that this complementary policy measure would serve to eliminate the fishery producer price increase completely – indeed the producer and user prices for fishery output *decline* slightly by 0.1 to 0.2% relative to the CPI in presence of the subsidy. Table 9 reports the output effects for selected industries in the presence of the subsidy, and for comparison also the previously reported effects without subsidy. As can be seen, the subsidy is effective in reducing the adverse production and employment effects for the fishery sector and related sectors considerably. Note that in this scenario, the textile sector expands far less because far fewer fish industry workers are forced to become textile workers. The fiscal budget cost of the government subsidy to the fishery sector amounts to 6.8% of the environmental tax revenue in the Low and 7.4% in the High scenario.

Table 9: Real Output Effects with a Fishery Production Subsidy (%)

	With Subsidy		**Without Subsidy**	
	Low	**High**	**Low**	**High**
Refined fuels	-87.3	-97.5	-87.3	-98.8
Coal	-2.5	-10.9	-2.5	-10.8
Road transport	-1.0	-4.0	-1.2	-4.7
Air transport	-5.8	-21.1	-5.9	-21.2
Other transport	-0.8	-3.3	-0.9	-3.6
Fishery	-0.1	-0.8	-1.8	-7.4
Fish processing	-0.1	-0.6	-2.8	-11.6
Aquaculture	-0.1	-0.6	-0.9	-3.9
Textiles and clothing	1.4	5.2	2.5	11.1

7. Summary and Policy Implications

- Among the various environmental taxes, the refined liquid fuels taxes will be the dominant source of tax revenue.

- To have a discernible impact at all, the initial nominal tax rates for gasoline and diesel oil must be set at higher rates than the lower limit specified in the draft law, given that existing fees/surcharges at rates equal to these lower limits will be abolished once the environmental tax is implemented. The mere replacement of one tax by another with a different label but the same rate will have *zero* allocative effects

- If the aim is to move tax rates in *real* terms gradually to the upper limit of the tax band, actual nominal rates need to rise at a rate higher than the rate of inflation, and once the nominal upper limit specified in the tax law is reached, this upper limit needs to be indexed to the rate of inflation in order to keep the real tax rate permanently at the upper level.

- At the higher end of the proposed tax rate band, the environmental tax on fuels will have noticeable economy-wide repercussions.

- The results suggest that CO_2 emissions drop by around 2.3% under the Low and by 7.5% under the High tax rate scenario.

- The tax-induced fuel price increase raises the production cost and output prices of other fuel-intensive sectors to some extent – notably for fishing and the transport sector.

- The tax-induced rise in the cost of transport services spreads the impact of the fuel tax widely across the economy through its effect on transport margins for all non-service commodities.

- At high levels of the tax rate, the environmental tax shifts a significant amount of purchasing power from households to the government.

- As the additional tax revenue is spent on environmental protection measures (or other non-traded goods and services), the real exchange rate appreciates to some extent and real exports decline slightly relative to the no-eco-tax growth path.

- Household welfare – narrowly defined as utility derived from the consumption of private goods – declines significantly across all households groups. However, this result does not take account of future welfare gains due to beneficial environmental impacts.

- The analysis suggests that higher real tax rates for fuels should be phased in gradually according to a transparent pre-announced time schedule to allow firms to plan investments in fuel-efficient technologies.

- There is a need for supportive measures to facilitate a smooth low-carbon technology transition.

- The proposed tax rates raise the price of refined oil *relative* to coal. The relation of coal tax rates to fuel tax rates should be reconsidered to avoid potential unintended substitution effects from relatively clean refined fuels towards relatively "dirty" coal.

- Taxation of HCFC, avoidable harmful chemical substances and plastic bags is good economic policy despite insignificant tax revenue and economy-wide repercussion effects. Convergence of tax revenue to zero should be seen as success of policy.

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