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Fossil Fuel Subsidy Reform in the Developing World: Who Wins, Who Loses, and Why?

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Fossil Fuel Subsidy Reform in the Developing World: Who Wins, Who Loses, and Why?

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Abstract

Fossil fuel subsidies are widespread in developing countries, and reform efforts are often derailed by disputes over the likely distribution of gains and losses. Subsidy reform is transmitted to households through changes in energy prices and prices of other goods and services, but also factor earnings. Most empirical studies focus on consumer expenditures alone, and computable general equilibrium analyses typically report only total effects without decomposing them by source. Meanwhile, analytical models neglect important open-economy characteristics relevant to developing countries. In this paper we develop an analytical model of a small open economy with a pre-existing fossil fuel subsidy and identify direct and indirect impacts of subsidy reform on real household incomes. Our results, illustrated with data from Viet Nam, highlight two important drivers of distributional change: the mix of tradable and nontradable goods, reflecting the structure of a trade-dependent economy, and household heterogeneity in sources of factor income.

Key words: Energy subsidy, real exchange rate, trade, household income, labor, distribution

JEL codes: H2, Q43, O25, F18.

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I. Introduction

A large and growing literature assesses the distributional implications of energy policies. Where developing economies are concerned, most (though not all) of these studies rely heavily, if not exclusively, on household expenditure data to quantify changes in wellbeing. In this paper we advance the claim that where developing countries are concerned, focusing on changes in household cost of living alone may be insufficient to account for the distributional effects of a major energy price reform. Our key point is that energy's primacy as an input to production in lower-income economies means that is also reasonable to expect that a meaningful change in energy subsidy or tax rates will also have macroeconomic impacts through economy-wide changes in sectoral relative prices and factor demands, and thus on key sources of household income. Since the sources of household earnings from factors are heterogeneous across the income distribution, ignoring changes through factor market channels may overlook an important source of distributional impact.

There is no question that in many countries the scale of fossil fuel subsidies merits an economy-wide perspective. They are remarkably widespread in the developing world. The global value of these subsidies was estimated at about $300 billion in 2015, but has peaked in prior years at over $500 billion (OECD/IEA 2017). While countries at the top of the subsidy rankings are mostly oil exporters, in the mid-2000s several Asian economies, among them India, Pakistan, Bangladesh, People's Republic of China, Indonesia, Malaysia, Thailand and Viet Nam, were all in the International Energy Agency's "top 40" countries with large subsidy-to-GDP ratios despite being net energy importers or marginal exporters. Despite substantial subsidy reduction in recent years, in many Asian economies subsidies remain large, both in absolute terms and in relation to total spending and government outlays. In the most recent global rankings of subsidy spending compiled by the International Energy Agency (IEA), People's Republic of China, India and Indonesia are the top three among net energy importers, with 2015 subsidy outlays of $19 billion, $19 billion and $15 billion respectively. In 2015, Indonesia spent 1.8% of gross domestic product (GDP) on fossil fuel subsidies; the respective share for India was 0.9%, for Bangladesh 1.2%, and Pakistan 1.3%.[1]

Eliminating or significantly reducing fossil fuel subsidies has long been a prominent feature of the global policy reform agenda. In 2009 the G20 heads of state agreed to joint efforts to reduce "inefficient" fuel subsidies.[2] Lowering subsidies is predicted to have a measurable impact on aggregate income; Coady et al. (2015b) calculated the total global gain from removal of subsidies in 2015 at $2.9tn, or 3.6% of global GDP. Among world regions, they found that the largest proportional gains (about 9% of regional GDP) would be in emerging Asian economies, along with oil-exporting regions in the Middle East and the Commonwealth of Independent States. Reducing subsidies would also reduce global GHG emissions—by 8% by 2050, according to Burniaux and Chateau (2014), or by up to three times that if the savings from subsidy reductions are invested in renewables and improved efficiency.[3] This has been discussed in the economics literature for many years (Larsen and Shah 1992; Poterba 1993), but interest has deepened considerably along with concerns over the effects of global climate change. A multi-agency analysis issued in 2010 estimated that global energy consumption could be cut by as much as 5% in 2020 if fossil fuel subsidies were completely phased out (IEA, OECD and World Bank 2010). The scale of potential global benefits from subsidy reduction was one of the key motivating forces behind the recent global agreement on GHG reduction, the so-called Paris Agreement.

The persistence of subsidies in spite of the magnitudes of these potential benefits, fossil fuel subsidies persist in many countries has a variety of explanations. These include promoting industrial growth, and lowering and stabilizing consumer prices of fuel, electricity and heating. Advocates often claim that fossil fuel subsidies disproportionately help the poor by reducing their living costs, and by helping address "energy poverty" or lack of access to ready sources such as electricity. These perceptions are widespread, and as a result, proposals to reduce

[1] International Energy Agency: Energy Subsidies Database. http://www.iea.org/statistics/resources/energysubsidies/, accessed 2 August 2017.

[2] The G20 heads of state (and later in the same year, APEC heads of state) committed to "phase out and rationalize over the medium term inefficient fossil fuel subsidies while providing targeted support for the poorest."

[3] Merrill et al. 2015, cited in Rentschler and Bazilian 2016.

subsidies encounter considerable popular and political resistance due to concerns that higher prices will undermine efforts to achieve economic growth and poverty reduction (Pradiptyo et al. 2015). Opponents of subsidies point to efficiency costs, the opportunity costs of fiscal outlays, additional off-budget costs such as those associated with policy support for state-owned energy generators, and impacts on local co-pollutants (e.g. SO_2, NO_x, and particulate matter) due to the promotion of cheap carbon-based energy sources. They also question whether subsidies really benefit the poor relative to other groups. There are thus active debates over the merits of subsidies as tools of economic growth, and whether their removal would have positive or negative effects on income distribution. Lack of consensus on the welfare and distributional effects of subsidy reform has inhibited effective and timely policy measures in many countries.

The empirical literature on the incidence of environmental taxes or subsidies does not provide a clear signal on this important question. This literature takes a variety of approaches, from single-market (or partial equilibrium) empirical studies using household survey data, to simulations using computable general equilibrium models or macro models. There is substantial disagreement over the incidence of fossil fuel (or energy) subsidies. Partial equilibrium calculations based on household consumption changes often find that higher environmental tax rates (i.e., lower rates of subsidy) would be progressive in developing countries (Datta 2010; Sterner 2011; Rentschler 2016). Others, however, find the opposite, or yield inconclusive results (see Dennis 2016, Table 1). In addition, calculations of incidence based only on changes in household cost of living lack a full accounting of the channels through which households are impacted (Fullerton 2011, Parry et al. 2006). Estimates from a multi-country survey of reform efforts (Arze del Granado et al. (2012) and from single-country models (e.g. Jiang et al., 2015) show that the indirect elements of a subsidy account for about 60% of its total impact. Some studies include impacts through the prices of non-energy consumption goods (e.g. Metcalf 1999, West and Williams III 2004, Grainger and Kolstad 2010). A representative view holds that:

> The impact of increasing domestic fuel prices on the welfare of households arises through two channels. First, households face the direct impact of higher prices for fuels consumed for cooking, heating, lighting, and personal transport. Second, an indirect impact is felt through higher prices for other goods and services consumed by households as higher fuel costs are reflected in increased production costs and consumer prices. The magnitude of these impacts depends on the importance of cooking, lighting, heating, and personal transport costs in total household consumption, as well as on the fuel intensity of other goods and services consumed by households. The distribution of the impacts across

> different income groups will depend on the relative importance of these factors across income groups. (Coady et al. 2015a: 6)

These claims notwithstanding, the factor market consequences of energy pricing policies are especially likely to matter in developing countries. First, industrial consumers of electricity represent a much larger share of total energy use than in wealthy countries. In the average wealthy country, residential, commercial and transport end-uses account for 60% of total energy use, compared to 40% for industry. In the average developing country it is industry that accounts for the largest share (62%), with residential and transport using 15% each and commercial just 7%. In People's Republic of China, a relatively highly industrialized emerging economy, industrial usage is 76% of the total (Table 1).

Table 1 about here

Second, because factor earnings directly affect incomes, and because factor ownership is not uniformly distributed, we should also expect factor market impacts to be both important and heterogeneous across households.

After taking these general equilibrium effects into account, the *ex-ante* incidence of subsidy reform is neither as clear, nor as easily measured, as in studies using expenditure data alone. This ambiguity is reflected in the empirical general equilibrium literature, where some studies of a carbon tax or energy subsidy reform find regressive effects, others progressive effects, and others still no effects at all (Solaymani and Kari 2014; Coxhead et al. 2013; Yusuf and Resusudarmo 2015).[4] What is surprising is that none of these studies provide a quantitative breakdown of the of changes in real household incomes.[5] This lack of detail, in turn, reduces the power of these analyses as bases for policy recommendations.

Uncertainty over the distribution of gains and losses motivates a deeper analytical examination of the channels through which reforms affect household welfare. Analytical general equilibrium

[4] A common finding from this literature is that subsidy reform is only progressive when budgetary gains from lower subsidy rates are applied to a specific form of compensation for poorer households; that is, the first-order effects of the reform may be regressive and/or increase poverty (Bruvoll and Vennemo 2014; ADB 2016). In addition to the studies cited in the text, IEA et al. 2010 and ADB 2016 both provide surveys and discussion of many other related studies.

[5] Plante (2014) presents a macroeconomic model of subsidy reform that identifies several of the key channels discussed here, but for the case of a single representative household.

models of the kind we will present below can contribute insights. Although highly stylized, they help identify structural characteristics that may be ignored in partial equilibrium, or whose influence in numerical general equilibrium simulations may be conflated with other effects. We shall demonstrate in particular that trade, by imposing limits on some, but not all, domestic price adjustments to a policy shock, plays a major role in predictions of the incidence of a fossil fuel policy—and in particular that its factor market effects are likely to be felt in household incomes.

II. Intuition on trade, energy subsidies and household welfare

Before presenting the model, we develop some of the intuition behind the distribution of energy tax burden in a trade-dependent, developing economy.

The economic incidence of a tax differs from its statutory incidence because the net tax burden is passed on through product and factor markets. The extent to which tax burden is passed forward (to consumers) or backward (to factor owners) depends on behavioral and technological responses to the tax—for example the elasticity of consumer demand for a product, or the substitutability of a less highly taxed input for a more highly taxed one. In general, tax burden is distributed according to relative magnitudes of relevant elasticities of demand or supply. The definition of a small open economy is that it is a price-taker in global markets—that is, the price elasticity of demand for its exports, and the elasticity of supply for goods that it imports, are both very high. This eliminates the capacity of domestic producers of tradable goods for price-shifting, since any attempt to do so will simply result in substitution to lower-priced suppliers. This feature of a small open economy plays a central role in the analysis of tax incidence.

In an economy with competitive markets, economic profits are zero in equilibrium. In the short run, with technology fixed, an increase in the price of energy used as an input to some productive activity creates negative profits. To restore equilibrium, either the price of that activity's output must rise or the price of an input or inputs must decline—or both. Whether the output price will rise or not depends on whether domestic producers can pass higher energy costs forward to consumers. Industries that compete directly with foreign producers at prices that are determined in world markets cannot do this. Instead, their adjustment to the tax or subsidy change will be deflected back onto other inputs, especially factors used intensively relative to other sectors, or those (such as fixed capital or land) that are used exclusively in the affected industries.[6]

This constraint on tradables-producing sectors stands in contrast to conditions facing producers of nontradables, whose markets are by definition protected from international competition. If the producers of nontradables can pass additional tax burden forward in the form of higher prices while producers of tradables cannot, then in a small open economy, a higher tax (or lower subsidy rate) applied to a widely-used input such as energy causes an increase in the relative price of nontradables to tradables—a change referred to as a *real exchange rate appreciation*, or simply a *real appreciation*. For net energy importers, lowering the subsidy reduces fuel import demand. In the short run this creates a current account surplus that is resolved by a real appreciation.[7] This diminishes competitiveness of domestically produced tradable goods and services relative to those supplied elsewhere in the world market; as a result, exports decline and imports increase (Burniaux et al. 2011). The negative effect on exports is scaled by their energy-intensity, since a larger energy cost share results in a proportionally greater increase in production costs. These implications of the subsidy reform for trade, which are intuitively understood by many policymakers, are nonetheless absent from most *ex ante* carbon tax models since these assume either that prices are all symmetrically either fixed, or (more commonly) endogenous (Fullerton and Heutel 2007; Metcalf 2009; Heutel and Kelly 2016).[8]

The same phenomena can be equivalently described in terms of macroeconomic adjustments. If higher domestic energy prices raise costs in tradable sectors, their resulting loss of international competitiveness creates (or widens) a trade deficit, with a matching excess of domestic aggregate expenditure over income. To eliminate these deficits, assuming no international capital flows or factor payments, requires some combination of lower aggregate expenditure and a fall in domestic relative prices, so as to restore the equilibrium real exchange rate. Among

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[6] In the limit, when some input is used exclusively in the affected industry, this is merely a restatement of an insight from the Ricardo-Viner-Jones specific factors model, that a change in output price has a magnified effect on returns to the specific factor in that industry.

[7] Or, if a country is large enough to influence world prices, a deterioration in the external terms of trade.

[8] Several models of carbon policy highlight the importance of international trade, though they generally do not focus on distributional impacts (e.g. Böhringer et al. 2014). To our knowledge, there are no analytical models that address the questions on which we focus here.

tradable industries, higher costs and lower profits cause the tax burden to be passed back in the form of lower factor prices. Accordingly, the shifting incidence of the tax affects not only the structure of production and trade, but also factor prices and employment, and ultimately, through this channel, the distribution of household income and welfare.[9]

In addition to the foregoing structural responses there is also a fiscal dimension, and this may be important in countries where the costs of financing a subsidy are large. To the extent that a subsidy must be financed from the public budget, it limits opportunities to compensate losers and crowds out other development-related spending. The problem is more severe when a subsidy policy fixes domestic energy prices in nominal terms, as is common in some countries, since this is equivalent to a variable subsidy rate that is an increasing function of the world energy price. During global energy price booms, the cost of defending a fixed domestic price can absorb a large share of the public sector's discretionary spending (Clements et al. 2013). This was the case in several Asian economies, most notably Indonesia, in the early 2000s.[10] Thus an energy subsidy raises a different set of distributional and welfare issues, drawing attention to the tradeoff between job creation (caused by cheaper energy) and diminished capacity for public spending on development goods such as education, infrastructure and antipoverty programs.

The foregoing discussion draws our attention to the roles played by factor intensity, energy intensity, and price endogeneity—especially that associated with the distinction between traded and nontraded goods in a small open economy—in the supply-side determination of tax incidence. These three features emerge clearly in a general equilibrium analysis, as we show in the next section.

[9] In the case of an environmental tax, some adverse distributional or welfare impacts can be offset through revenue recycling and other policy packages financed by tax revenues, an issue extensively explored in the "double dividend" literature (e.g. Bovenberg and Goulder 1996). A subsidy, however, imposes costs rather than raising revenues, and so creates no such opportunity.

[10] During the run-up in global energy prices that took place between 2003 and 2008, pass-through from global to domestic prices varied greatly across the developing world. Among Asia-Pacific countries the average rate was high at almost 95%; in some individual countries, however, it was much lower. India and Indonesia each passed through only about 1/3 of the world price change on all or some fossil fuel products (Arze del Granado et al. 2012). Between 2009-2012 India (except gasoline), Indonesia, Malaysia and Thailand (for kerosene and LPG) all showed extremely low pass-through rates, ranging from 13-30%, as compared with median rates of 76-84% for a group of 65 developing countries (Kojima 2015).

III. An analytical framework

In this section we present a stylized model of the incidence of energy subsidy reform in an open developing economy. Our goal, as already noted, is to identify the effects of an energy policy change on responses by industries that use different technologies and face different market conditions, and the economy-wide consequences of these responses including their impacts on real household incomes. We address only the case of a net energy-importing country. We make several simplifying assumptions with the goal of capturing the major relevant phenomena without imposing a burdensome level of complexity; these are noted in the text.

The model assumes two primary factors, two final goods, and a third good, energy, that is both used by industry as an intermediate input and consumed directly by households. We assume constant returns to scale and competitive markets and ignore international trade in factor services. We also assume that energy is imported but not produced domestically. Equivalently, we can suppose that there is domestic energy production, but whether through small size or market segmentation, the energy sector has no influence on domestic factor markets.

The economy is endowed with fixed quantities of two factors v_i, i = 1,2, with prices w_i. These are used to produce two composite goods with quantities g_j and domestic prices p_j. The first, labeled T, is a Hicksian composite of tradable goods on the assumption that their relative price in world markets does not change. The second is a nontraded good, N. Energy, E, is imported as just described. The price of energy is subject to a subsidy at rate s. We define the subsidy using the "price-gap" approach: that is, the domestic price is $p_E = p_E^*(1-s)$, where p_E^* is the world market price in local currency terms.[11] With this structure, analysis of the producer effects of an energy tax change is analogous to that in models of effective protection in the international trade literature (e.g. Corden 1966): that is, a policy change alters the *net* output price received.

Following trade models developed by Woodland (1982) and Dixit and Norman (1980), the supply side of the economy can be summarized by an aggregate revenue (or GDP) function $g(p, v)$, where $p = \{p_T, p_N, p_E\}$ is the vector of domestic prices and v is a vector of factor endowments.

[11] The price-gap approach is a widely-used benchmark that captures the most common forms taken by fossil fuel subsidies in the developing world. For further discussion of the advantages and disadvantages of this approach see Burniaux et al. 2011.

This function is the result of profit maximization by a representative producer subject to factor endowment constraints and is increasing in v and homogeneous of degree 1 in prices. It is increasing and convex in p_T and p_N. Differentiation with respect to these prices yields, by Shephard's lemma, final good supply functions $y_j = g_j(p, v) = \partial g(p, v)/\partial p_j$. Similarly, the gradient of $g(p, v)$ with respect to any factor endowment gives the shadow price (or under the assumption of complete and competitive markets, the market-clearing price) of that factor, so we have $w_i(p, v) = \partial g(p, v)/\partial v_i$, i=1,2.[12] Finally, the derivative with respect to p_E is the negative of the total quantity of energy demanded for intermediate use.

Consumers derive income from ownership of labor and capital and maximize utility subject to their factor income budget constraint. Representing each household's decisions by an expenditure function, we can define total household spending by an aggregate expenditure function equal to total income, $e(p,U) = Y$. The derivative of $e(p,U)$ with respect to each price is the quantity demanded of the corresponding good for final consumption. These derivatives are written $e_j(p,U) = \partial e(p,U)/\partial p_j$.

With this set of derivatives, we can construct comparative-static predictions of the direction of change in variables of interest to our story: factor prices, household incomes, and real expenditures. To maintain focus on the subsidy reform policy experiment, we assume that growth in factor endowments and changes in technology are exogenous and set them to zero.

Household real income effects: Households earn income from factor endowments v_i^h and their real incomes are the sum of factor incomes deflated by household-specific consumer price indices, $R^h \equiv \sum_i w_i v_i^h / P^h$, where $P^h = \prod_j p_j^{\alpha_j^h}$ is a cost-of-living index and each α_j^h is the share of good j in the total expenditures of household h. Expressed in proportional changes of variables using $\hat{x} = dx/x$ for all variables x, the change in each household's real income, with $dv_i^h = dp_T^* = 0$, is:

[12] This assumption need not hold if there are unaccounted environmental externalities. Our analysis abstracts from these in order to focus on the economic incidence of the subsidy.

$$\hat{R}^h = \sum_i \delta_i^h \, \hat{w}_i - \alpha_{\mathrm{N}}^h \hat{p}_N - \alpha_E^h \hat{p}_E. \tag{1}$$

where δ_i^h is the share of factor *i* in the income of household *h*. For convenience choosing quantities such that $p_E^* = 1$, the proportional change in energy prices due to subsidy reform is $\hat{p}_E = \frac{-s}{1-s}\hat{s}$. Using this in (1) reveals the total effect of subsidy reform on real household income, expressed in terms of household income and budget shares, and the general equilibrium elasticities of income and prices with respect to the subsidy rate:

$$\hat{R}^h = \sum_i \delta_i^h \, \hat{w}_i - \alpha_{\mathrm{N}}^h \hat{p}_N + \alpha_E^h \frac{s}{1-s} \hat{s}. \tag{2}$$

Expression (2) provides a decomposition, for each household, of the general equilibrium impact of a subsidy change. The magnitude of the direct "pump price" effect is captured in the third right-hand side term, which is the product of the household's expenditures on fuel and a term capturing the proportional impact of the subsidy change on the consumer fuel price. The other two RHS terms capture general equilibrium impacts through factor markets and through changes in those consumer prices that are determined within the domestic economy. We will investigate signs and magnitudes of these price effects next.

Expression (2) also helps us begin to identify likely winners and losers among households, in terms of expenditure patterns and the distribution of factor endowments. This information is captured by inter-household variation in the values of the expenditure and income parameters, α and δ. Consider an *n*-household economy, where for each household real income changes depend on factor earnings and consumer prices as just described. So long as all households face the same price changes for factors and goods, the incidence of a subsidy change depends on the extent to which households differ in the structure of income and expenditure. If we compare each household *h*'s experience to that of the national mean (denoted by superscript μ), for example, we have:

$$\hat{R}^h - \hat{R}^\mu = \sum_i \left(\delta_i^h - \delta_i^\mu\right) \hat{w}_i - \left(\alpha_N^h - \alpha_N^\mu\right)\hat{p}_N - \left(\alpha_E^h - \alpha_E^\mu\right)\left(\widehat{1-s}\right). \tag{3}$$

This is the relevant construct for assessing distributional outcomes due to a shock that changes economy-wide product and factor prices. To illustrate, consider the subsidy change term on its own. In equation (3), $\alpha_E^h - \alpha_E^\mu > 0$ indicates that household h spends more than the average on fuel, so a lower subsidy rate will reduce h's real income relative to the population mean. Obviously, if most households have similar values for some parameter, then the distributional effects of a change in the associated price or wage variable will necessarily be small.

Factor price changes. As noted earlier, factor prices are found from the derivative of the revenue function with respect to endowments. Thus, for factor *i*, the effect of a change in the subsidy on its price, holding other exogenous variables constant, is:

$$dw_i = g_{iN} dp_N + g_{iE} dp_E. \tag{4}$$

Converting to proportional changes and again substituting in the subsidy change expression:

$$\widehat{w}_i = \varepsilon_{iN}\hat{p}_N - \frac{s}{1-s}\varepsilon_{iE}\hat{s}, \tag{5}$$

where $\varepsilon_{ij}$is the elasticity of wage *i* with respect to price *j*. Assuming that factor inputs and energy are complementary inputs, the sign of $\varepsilon_{iE} = \partial\widehat{w}_i/\partial\hat{p}_E$ is negative. In this two-factor model the sign of $\varepsilon_{iN} = \partial\widehat{w}_i/\partial\hat{p}_N$ is positive for the factor used intensively in N production and negative for the other.[13] In this case, *reducing* the energy subsidy will unambiguously reduce w_1, used intensively in T production, and could either increase or reduce w_2, depending on the relative magnitudes of the two right hand side terms. In the event that there is no change in p_N, both factors will see their prices fall, a consequence of reduced demand as the price of a complementary input goes up.[14]

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[13] By the symmetry of second partial derivatives of the revenue function, these "Stolper-Samuelson" elasticities are dual to the "Rybczinski elasticities" ε_{Ni}, and have the same signs.

[14] When energy is an intermediate input, as in this model, a rise in its price when output price is fixed is equivalent to negative total factor productivity growth for primary factors. See Coxhead and Grainger 2017 for more details.

Aggregate income and price-shifting. To complete the analysis, we need an expression for the general equilibrium change in the price of nontradables relative to that of tradables. This change will affect households both through prices of consumption goods and through changes in demand (and thus returns to) factors of production from which they derive income.

The change in p_N has several contributing elements. An increase in the price of energy reduces profitability in nontradable production; for a given quantity demanded, supply of nontradables diminishes, raising p_N. A lower subsidy rate also induces consumers to substitute away from energy in their consumption choices; this cross-price effect in final demand also raises p_N. Finally, if subsidy reform increases aggregate income by reducing deadweight losses, then demand for all normal goods increases, and this too tends to increase p_N. All of these components of the relative price effect depend critically on differences in the markets for tradables and nontradables. Producers of tradables face elastic demand (for exports) or supply (for imports), so their output prices are effectively fixed relative to prices in world markets. Producers of nontradables face domestic demand that may be quite inelastic with respect to price; this guarantees that changes in the profitability of nontradables' production will be met at least in part through changes in their prices. This part of the analysis highlights the importance of the distinction between endogenously priced nontradables and exogenously priced tradables.

Recalling our assumption that fuel is imported, define the fiscal cost of the subsidy as the unit subsidy rate times the number of units imported, or $s[e_E(p,U) + g_E(p,v)]$.[15] The terms within brackets are the quantities of imports for final and intermediate consumption, respectively.

The aggregate budget constraint of the economy states that aggregate expenditure on for final consumption be just equal to aggregate net income from production less the cost of the subsidy, or:

$$e(p,U) \equiv g(p,v) - s[e_E(p,U) + g_E(p,v)]. \qquad (6)$$

[15] Our focus rests on the case of fuel-importing countries. In fuel exporters—especially those where mining and refining is carried out by a state or quasi-state enterprise—the true fiscal cost is likely to be lower in that the subsidy is now a transfer among domestic entities and may be recovered through some other tax or pricing instrument. Unsurprisingly, the highest fossil fuel subsidy rates, by far, are found in exporting countries such as the Gulf states, Russia, Central Asian oil producers, Iran, Venezuela and others.

Before proceeding, it helps to denote the excess domestic demand for any good, j, by $z_j = e_j(p, U) - g_j(p, v)$. With respect to trade, $z_j > 0$ indicates a net import and $z_j < 0$ a net export. The derivative of z_j with respect to another variable k is the difference between the derivatives of the respective demand and supply functions, i.e., $z_{jk} = e_{jk}(p, U) - g_{jk}(p, v)$. The properties of the excess demand functions are carried through from those of their components.

By definition, the market for nontradables must clear domestically, so in equilibrium:

$$z_N = e_N(p, U) - g_N(p, v) \equiv 0. \quad (7)$$

Equilibrium. The aggregate expenditure and revenue functions defined earlier represent optimizing behavior by firms and consumers, and thus satisfy full employment of factors and binding consumer budget constraints. Accordingly, if (6) and (7) both hold then external trade is also in balance, by Walras' Law. Since by construction there are no leakages through savings or externalities, the model as described represents general equilibrium.

Effect on aggregate welfare. To evaluate the general equilibrium effects of a change in the subsidy, we take the total derivatives of the foregoing two expressions, holding world prices and factor endowments constant at their initial levels. From equation (6), the complete derivative after collecting terms is:

$$\begin{aligned}(e_U + se_{EU})dU = -z_T dp_T^* - z_N dp_N - (e_E + g_E)dp_E - (e_E + g_E)ds \\ - s(e_{EE} + g_{EE})dp_E - s(e_{EN} + g_{EN})dp_N.\end{aligned} \quad (8)$$

Energy is a normal good for consumers, so we know that $e_{EU} > 0$. With $dp_T^* = 0$ by assumption, $z_N = 0$ by equation (7), and $dp_E = -ds$ because $p_E^* = 1$, the first four terms on the right-hand side sum to zero. The own-price derivatives e_{EE} and g_{EE} are both negative. If energy and nontradables are substitutes in consumption, then $e_{EN} > 0$. Finally, the sign of g_{EN} is unknown a priori, but more likely to be negative if tradables are more energy-intensive than nontradables, so that a rise in the latter's relative price reduces overall industry demand for energy, other things equal.

To see the net effect of a subsidy reduction on welfare, and to identify the parameters whose values govern this effect, we convert the remaining terms to log changes and again use $\hat{p}_E = \frac{-s}{1-s}\hat{s}$. This gives:

$$\beta\hat{Y} = (\varepsilon_{EE}^{H}\alpha_E^H + \varepsilon_{EE}^{F}\alpha_E^F)\hat{s} - s(\varepsilon_{EN}^{H}\alpha_E^H + \varepsilon_{EN}^{F}\alpha_E^F)\hat{p}_N\,, \quad (9)$$

where $\beta = (1 + se_E) > 0$ scales the welfare effect of a subsidy change when $s>0$. Where needed, superscripts H and F refer to households in the aggregate (i.e. consumer demand) and firms in the aggregate (intermediate demand), respectively. In this expression $\hat{Y}$ is, as noted, a money metric of change in utility, equal to $e_U dU/Y$. [16]

Equation (9) provides an unambiguous indication of the *direct* effect of a subsidy reduction on aggregate income: a lower subsidy rate increases Y. This effect is larger, the more elastic is energy demand for either final or intermediate uses and the larger is its share in aggregate household spending or production costs. The net welfare effect however, depends on the sign and relative magnitude of the indirect effect, through $\hat{p}_N$, which remains to be solved.

Effect on nontradable price. From equation (7), by total differentiation, using $e_{NU}dU = e_N dY$ and rearranging terms, we obtain:

$$e_N dY = - z_{NN} dp_N - (e_{NE} - g_{NE}) dp_E. \quad (10)$$

Converting once again to proportional changes:

$$(\varepsilon_{NN}^{H} - \varepsilon_{NN}^{F})\hat{p}_N = -e_N\hat{Y} + \frac{s}{1-s}(\varepsilon_{NE}^{H} - \varepsilon_{NE}^{F})\hat{s}. \quad (11)$$

The interpretation of this expression is again intuitive. Note that $(\varepsilon_{NN}^{H} - \varepsilon_{NN}^{F}) < 0$ because its elements are the own-price elasticities of demand (negative) and supply (positive) for N. Assume that income remains constant at its base level. Reducing the subsidy rate raises the price of energy relative to other prices. It has a positive effect on p_N through household expenditures to the extent that energy is a substitute in consumption for nontradables, i.e. $\varepsilon_{NE}^{H} > 0$. On the

[16] The derivative is the reciprocal of the marginal utility of income $\partial V/\partial Y$, so the term on the LHS measures the additional income required to maintain utility V.

production side, if energy is a normal input to production of N, then $\varepsilon_{NE}^{F} < 0$. Combining these results, when aggregate income is unchanged, a lower subsidy rate raises the price of N from both demand and supply sides. Finally, higher aggregate income raises p_N since nontradables are normal goods. The prediction of an increase in p_N is supported by empirical studies confirming real appreciations among net energy importers following unilateral subsidy removal (Burniaux et al. 2011, Table 2; ADB 2016).

Equations (9) and (11) comprise a two-equation system with two unknowns, $\hat{Y}$ and $\hat{p}_N$. There is ambiguity over the general equilibrium signs of both changes, since a rise in p_N is seen in equation (9) to be associated with a decline in Y. The ambiguity comes from second-order effects that should not be expected to dominate the outcomes described above, but cannot be ruled out except through empirical investigation. This in turn conveys ambiguity to changes in the prices of factors from which household income changes are derived. The distributional impact of a subsidy change will depend on parameter values that are unique to each country and case.

IV. The incidence of subsidy reduction: an illustration from Viet Nam

From the foregoing analysis, it is easy to see that households may experience the effects of a subsidy reform through several channels beyond changes in consumer fuel prices. In this section we consider possible distributional effects of a subsidy change, highlighting the channels described in the model.

In developing countries, wealthier households typically have larger fuel expenditure shares (this is confirmed in the numerous country studies presented in Sterner (ed.) 2011). Data from developing-country household surveys show fuel expenditure shares ranging from about 3% for households in the lowest expenditure groups up to 8-10% for those in wealthier groups. By this measure, equation (1) suggests that the direct effects of a subsidy reduction (i.e., $\hat{s} < 0$) are progressive—and that is indeed the most frequent finding from work on lower-income economies. However, direct effects need not be large, either in absolute or in relative terms. Data compiled by the International Energy Agency showed 2011 fossil fuel subsidy rates in five

Southeast Asian countries ranging from 4.3% in the Philippines to 23.2% in Indonesia (Table 2).[17]

Table 2 about here

Including other consumer price effects (for example, the increased cost of transportation services) will increase cost of living impacts. Since markets for nontradables clear domestically, their prices may adjust in the wake of a policy shock whereas domestic prices of tradable goods are limited by those established in global markets. In the United States, goods and services (mainly the latter) classed as nontradable account for 63% of total household expenditures (Johnson 2017). In that case, the effect on real household income of a 10% rise in nontradables' prices is about 20 times greater than the direct impact of a 10% rise in fuel prices. But the distributional impact of these changes depends also on the extent to which expenditure shares vary across households at different levels of income.

Finally, we have emphasized that a subsidy change has additional distributional implications insofar as it exerts asymmetric effects on industries that are heterogeneous in terms of factor intensity, and insofar as households are heterogeneous in terms of income sources. This brings to the fore what is arguably the least-studied question pertaining to the structural incidence of subsidy reforms: in which direction, and by how much, can factor prices be expected to move as a subsidy rate is reduced?

A complete assessment of incidence requires a general equilibrium model in which the total effect of a given change is decomposed into contributions through the various adjustment channels. In this section, we conduct a more limited exercise. Using the most recent data available from one subsidy-affected country, Viet Nam, we compute values of the most important parameters in the model developed above. We then use these values to sketch the likely distributional outcomes from a policy shock.

Data are from the 2012 Viet Nam Social Accounting Matrix (SAM), published in 2016 (CIEM-WIDER, 2016). The SAM is constructed from data obtained in surveys of households, firms and

[17] It follows that in Indonesia, where subsidy rates were highest, the *direct* impacts of a 10% subsidy cut range from –0.23% for quintile 1 households with a 3% fuel expenditure share, up to –0.77% for quintile 5 households with a 10% share.

other entities and activities, and provides a consistent database of production and factor demand, household income and expenditures, and other relevant data from which we can compute necessary parameter values. The 2012 SAM is disaggregated into 164 industries and commodities, six labor types as well as several forms of capital, and twenty household types.

In the spirit of the stylized facts in the foregoing model, we aggregate all non-energy agricultural and manufactured goods into a traded goods category, and all services into one nontraded category. Energy consists of coal, oil, gas, refined petroleum products and electricity. Labor is classified as rural or urban, and of three "skill levels" based on reported educational achievements. However, defining skills based on educational achievement really reflects only the educational attainment of the population, not the skills they bring to the labor force, so we combine the lowest two levels—based on primary and secondary schooling—into one category. Moreover, labor in Viet Nam is mobile among industries, so for each skill level we combine rural and urban labor within each skill category. Households are sorted into five quintiles by expenditure, and each quintile is subdivided into rural and urban subgroups. These are each further subdivided by primary income source into farm and non-farm households, a useful distinction since it identifies households' capital income by sector. Of course, these groups are not equal in size (Table 3); rather, they are representative of the distribution of the Viet Namese population, the large majority of which remains rural and farm-based.

Table 3 about here

In Viet Nam, the data indicate a range of expenditure shares for fuel from 3.2% for rural farm households in quintile 1 up to 7.1% for urban non-farm households in quintile 2 (Table 4 summarizes these data, for succinctness aggregating over household types within each quintile). Fuel expenditure shares in the upper three quintiles vary between 3.5% and 6.6% over all household types. There is, therefore, some variation in fuel expenditure shares. However, this variation is not strongly correlated with income and moreover, even the largest shares are relatively small as a percentage of total household expenditure. It follows that even a large change in energy prices can have only a limited effect on distributional incidence. Using these expenditure data, the direct impact of a hypothetical 10% increase in pump prices ranges only from 0.32% to 0.71% of household expenditures.

Table 4 about here

There is more variation among households in their expenditures on traded and nontraded goods, and it is more systematically associated with income. Table 4 shows that 70% of total spending by quintile 1 households is on traded goods, and less than one-third on services. Unlike fuel expenditures, these shares do change monotonically across quintiles; wealthier households spend proportionally more on services, so that in quintile 5 the shares are almost equal. It follows that the real appreciation effect of an energy price change, as discussed in the previous section, will have a proportionally larger effect on upper-quintile households, whose expenditure share on nontraded services is almost double that of the poorest quintile. Moreover, all households' expenditure shares for services are, very roughly, an order of magnitude larger than those for fuel. A 10% increase in fuel prices that also generated a 1% increase in the prices of services would result in two effects of roughly similar magnitude on household welfare. But whereas the fuel price increase would have a similar effect on the cost of living for all quintiles, the effect of a services price increase would be about double for quintile 5 relative to quintile 1 households, generating a more strongly progressive impact.

In contrast to the fuel expenditure data, there is a great deal of variation in the sources of household factor incomes. Across the twenty household types, the coefficient of variation in factor incomes is 70% for high-skill labor; 28% and 74% respectively for medium and low skill, 107% for agricultural capital, and 86% for other (non-agricultural) capital. Moreover, factor shares in household income for labor, the most important income source by far, show strong and predictably monotonic variation from the poorest to the richest households. Table 5 summarizes this variation over quintiles. Most strikingly in these data, quintile 1 households derive 87% of their income from low-medium skilled labor and agricultural capital; in quintile 5 only 30% of income comes from these sources (Table 5). It follows that the effects of an asymmetric shock to factor prices, even one that is fairly modest in magnitude, may have a more far-reaching distributional impact than the direct impacts of changes in energy prices, or even of changes in the relative prices of traded goods and services.

Table 5 about here

The likelihood of asymmetric factor price changes is an increasing function of the heterogeneity of factor intensity in production across industries. Table 6 summarizes factor-intensity and energy-intensity for traded goods, services and energy (and since transportation services are heavily energy-dependent, we also consider these as a distinct category). The energy and transport sectors together account for 13% of value-added and are highly energy-dependent. The traded and nontraded sectors are of similar size. The traded sector, however, is much more intensive in its use of less-skilled labor and capital, but more dependent on intermediate inputs (the share of value-added in total costs, 32%, is nearly half that of nontraded goods).

Interestingly, direct spending on fuel is about equal in both sectors (4-6% of total cost). The direct effect of an energy price shock will be similar in the two sectors; differences between them, therefore, will depend more on indirect effects—price changes in upstream industries, and the capacity to pass on cost increases through higher prices to purchasers. This provides a reminder of the potential importance of cost pass-through in response to policy change.

Table 6 about here

Finally, we recall that heterogeneity in factor employment across sectors would play a critical role in determining the incidence of subsidy reform. Table 7 shows the factor employment shares for high- and low-skilled labor as well as agricultural and non-agricultural capital for each of the composite sectors. The traded part of the economy is both more intensive in the use of low and medium skill labor, and accounts for 61% of its employment. Thus, low- and medium skill workers (who tend to be from low-income households) would be most impacted through changes in factor returns in the traded sectors.

Table 7 about here

V. Discussion

The previous section "walks through" key predictions from the model developed earlier in this paper by highlighting the key parameters from Viet Nam. We now briefly discuss the implications.

As discussed earlier, many of the Asian countries facing energy subsidy reform are small, open economies. These emerging economies are increasingly specialized in the manufacturing of goods requiring low- or medium-skilled labor for export to world markets. These industries, plus agriculture, fishery and forestry, typically account for around half of domestic value-added. Of the other half, much is generated in a broad set of service industries that range from low-skill, labor-intensive (personal services, wholesale and retail trade, local transportation, etc.) through construction, hotels and restaurants, and other medium-skill activities to white-collar and professional services such as finance, education and government.[18] Much employment in the fastest-expanding subsectors of services is at the low-skill end of the skill range, and capital investment per worker is low relative to manufacturing. Although there are exceptions, it is reasonable to assume for the purposes of a stylized account that tradables are relatively less labor-intensive overall, but that they are more intensive in the use of lower-skill labor relative to higher skilled.[19]

If, as our model predicts, subsidy reform raises the relative price of nontradables, the effects across the income distribution will be mixed. The burden of higher consumer prices in the nontradables sector will fall more on wealthy than on poor households. But on the production side of the economy, reform will tend to reduce returns on most sector-specific capital relative to those on labor, and to reduce the return on lower-skilled labor relative to higher skilled. Since lower-skill labor is provided primarily by poor households whereas the rich earn mainly from capital or skills, the labor market adjustment could cause poorer households to lose in a relative sense—and by more, if they are agricultural households deriving significant income from land or other agriculture-specific capital. Even a relatively small decline in factor earnings could be sufficient to leave poorer households worse off from subsidy reform, after taking account of pump price effects and increases in the overall cost of living.

This back-of-the-envelope calculation comes with many obvious caveats, but it makes the case that a significant subsidy reform applied to purchasers of fuels as intermediates as well as to consumers may well have more profound impacts on households, and especially on poorer households, through factor markets in general, and the labor market in particular, than through changes in the consumer prices of goods and services that they purchase.

We also note that the results shown are short-medium run in nature. In the longer run, firms and consumers will respond to relative price changes in the usual ways, for example by adopting new

[18] The remainder comes from heavy industry sectors producing processed ores, basic metals, chemicals and plastics, paper and other timber products, machinery, fertilizer, and cement.

[19] An important exception is transportation, which is both highly capital and energy-intensive and also largely nontradable.

technologies and through inter-fuel substitution. Nevertheless, it is shorter run effects (or perceptions of them) that are most relevant to politically-charged debates over subsidy reform, or energy tax increases. Many debates over incidence are also defined along other recognizable criteria besides tiers of the expenditure distribution (notably, rural and urban populations are often regarded separately), and the illustrative data used in this section reveal substantial variation across those categories. One gain, these variations should help in debates where energy policy intersects other areas of policy concern, such as agricultural or rural development.

Our illustrative calculations underscore the point that there is considerable ambiguity in the distributional consequences of the subsidy reform. *Ex ante* predictions become less clear as the dimensions of the model increase. While we can gain a degree of *ex* ante analytical power from the model, for detailed empirical results it is necessary to go to a computable general equilibrium approach.[20] One outcome that we can hope for is that future general equilibrium analyses of the incidence of energy policies provide more detailed decompositions of their results. This will permit a more focused discussion of the sources of distributional change, leading perhaps to better targeting of ameliorative policies.

VI. Conclusions

Fossil fuel subsidies have been widespread in the developing world and especially in Asia, and have made a substantial contribution to excessive energy demand. The broad direction of current policy favors reducing subsidies and/or introducing carbon taxes. In 2014, for example, India, Indonesia, Malaysia and several other regional governments took advantage of sharply declining world energy prices to cut back or eliminate fossil fuel subsidies. These moves have the potential to reduce both localized air pollution (with substantial local co-benefits) and to reduce global greenhouse gas emissions in line with commitments made in global emissions reduction agreements. There are other economic rationales as well for such policy measures.

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[20] Among CGE models addressing carbon taxes and energy subsidies, Yusuf and Resosudarmo (2015) is exemplary in integrating detailed household data to generate continuous distributional results. Yusuf, Patunru and Resosudarmo (2017) provides a regionally disaggregated analysis, also for Indonesia.

However, impediments to progress in subsidy reduction remain. Prominent among these are doubts about their impacts on other measures of development progress and concerns about the distribution of gains and losses from reform. These doubts have not yet been conclusively resolved through empirical studies, whether partial or general equilibrium. In this paper, we have explored some of the channels through which energy policy reforms affect welfare and income distribution in a developing-country setting. Our focus has been on the interactions of policies and prices in a trade-dependent economy.

We show that the constraints placed on an economy through its trade with the global market play an important role in the economic response to energy policy reform. Industries that produce for the global marketplace find that their response to higher energy prices is constrained by prices in world markets; these limit producers' capacity to pass tax increases forward. Producers of nontradables, on the other hand, are able (up to a point) to pass higher energy costs on as higher prices since their purchasers cannot switch to substitutes in external markets. This difference, and the associated macroeconomic linkages expressed in the real exchange rate, condition the economy's aggregate response to subsidy reform, and exert a potentially large influence over the distribution of gains and losses from that reform.

We have modeled the distributional impacts of fuel subsidy reform in general equilibrium with emphasis on the role of trade and factor markets in determining incidence. This is a neglected point in the analytical literature, and one that is typically not readily accessible in currently published simulation results from computable general equilibrium models. The greater importance of industry as a source of energy demand in developing countries relative to wealthier countries makes factor market linkages a prime target for analytical attention.

For the purpose of guiding the design of real-world empirical and policy research, several additional considerations outside the scope of the model are worth noting. First, some important welfare gains or losses are ignored in the model—specifically those associated with reduced emissions and associated changes in expenditures for pollution abatement or adaptation. Studies in many developing countries indicate that particulate matter and gaseous emissions from industries and vehicles have large and costly impacts on human health and longevity, as well as reducing the productivity of labor. If reducing the fuel subsidy rate lowers emissions growth, then it also delivers benefits in the form of a healthier and productive workforce and lower rates of depreciation of some forms of capital.

Second, for simplicity we have not modeled the policy choices that a government faces when the fiscal burden of a subsidy is reduced. In the real world, the government's budget constraint means that spending on fuel subsidies crowds out other potentially growth-enhancing expenditures, such as on infrastructure, education and health. Increased spending on these (or indeed, other fiscal policy responses such as lowering income taxes or making direct cash transfers to households) will have different implications for aggregate income growth and the distribution of welfare changes.

Third, in focusing on the real exchange rate mechanism our model has aggregated many industries into a few categories, ignoring within-category heterogeneity. Unpacking the details of this stylized result is a task for numerical general equilibrium modelers. The model likewise neglects longer-run responses to a policy shock, including inter-fuel substitution and other adaptive changes, by firms and households, that tend to minimize losses or increase gains.

Finally, lower subsidies move the economy onto a less carbon-intensive growth path, but may come at a cost in terms of aspirations for industrial growth. Unilateral subsidy reform may reduce a country's potential for globally-connected economic growth, and this has consequences for development in the longer run. Even though one country's subsidy reform is likely to have a negligible impact on global greenhouse gas emissions, there is nevertheless a case to be made for compensation from the international community, as the total effect of fossil fuel subsidies is indeed substantial. Such compensation could be used to increase overall income, reduce energy poverty, or further amend distributional inequality.

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Table 1: Energy use by end-use sector (percent, 2011)

	Developing countries	Developed countries	United States	People's Republic of China*
Residential	15	20	22	11
Commercial	7	16	19	7
Industrial	62	40	32	76
Transport	15	25	28	8

Source: US Energy Information Administration data for 2011, compiled by Wolfram et al. (2012), except * http://www.chinafaqs.org/library/energy-consumption-major-end-use-sector-china-1980-2007-and-us-2007, data for 2007, accessed 15 September, 2017.

Table 2: Regional subsidies on fossil fuel usage, 2011

Country	Subsidy rate (%)	Value ($ billion)	Share of GDP (%)	Share of gov exp. (%)
Indonesia	23.2	21.3	2.5	14.3
Thailand	20.0	10.3	3.0	15.2
Malaysia	18.4	7.2	2.6	10.1
Viet Nam	15.5	4.1	3.4	12.8
Philippines	4.3	1.5	0.7	4.4

Source: World energy subsidy database http://www.iea.org/subsidy/index.html, and http://www.iisd.org/gsi/sites/default/files/ffs_gsibali_meetingreport.pdf, accessed 2 December 2013. Subsidy rates are calculated for 2009-11, when world petroleum prices were about 50% of levels prior to the 2008 global economic crisis. Gov. expenditure data are from www.adb.org.

Table 3: Distribution of households by type and expenditure quintile, Viet Nam

Type	Rural, farm	Rural, nonfarm	Urban, farm	Urban, nonfarm	Total
Poorest 20%	0.168	0.013	0.012	0.008	0.20
Quintile 2	0.147	0.021	0.016	0.016	0.20
Quintile 3	0.129	0.022	0.016	0.033	0.20
Quintile 4	0.095	0.029	0.018	0.058	0.20
Richest 20%	0.053	0.028	0.011	0.108	0.20
Total	0.592	0.112	0.074	0.222	1.00

Source: Authors' calculations from 2012 VHLSS.

Table 4: Household expenditure shares on energy, traded goods and services, Viet Nam

	All	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Energy	0.046	0.034	0.047	0.052	0.051	0.045
Traded	0.587	0.700	0.619	0.595	0.532	0.490
Services	0.367	0.266	0.333	0.353	0.418	0.466

Source: Authors' calculations from 2012 SAM.

Table 5: Factor shares in household income by quintile, Viet Nam

	All	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
High skill	0.297	0.118	0.182	0.268	0.369	0.551
Low-med skill	0.527	0.723	0.662	0.569	0.452	0.228
Agr. capital	0.113	0.147	0.129	0.120	0.097	0.072
Non-ag capital	0.063	0.012	0.027	0.044	0.082	0.150

Source: Authors' calculations from 2012 SAM.

Table 6: Factor intensity of production in sector aggregates, Viet Nam

	Energy	Traded	Nontraded	Transport
Sector share in total VA	0.10	0.44	0.43	0.03
Factor shares in sector VA				
High skill labor	0.36	0.23	0.44	0.27
Low-med skill labor	0.06	0.45	0.25	0.37
Agricultural capital	0.00	0.11	0.00	0.00
Other capital	0.58	0.21	0.31	0.36
Total	1.00	1.00	1.00	1.00
VA share in total cost	0.52	0.32	0.57	0.32
Energy share in total cost	0.41	0.04	0.06	0.44

Source: Authors' calculations from 2012 SAM. Factor shares computed using value-added weights. Energy shares computed using total cost weights.

Table 7: Sectoral distribution of factor employment

	Energy	Traded	Nontraded	Transport	Total
High skill labor	0.11	0.30	0.56	0.02	1.00
Low-med skill labor	0.02	0.61	0.34	0.03	1.00
Agricultural capital	0.00	1.00	0.00	0.00	1.00
Other capital	0.20	0.32	0.45	0.03	1.00

Source: Authors' calculations from 2012 SAM.