SPECIAL REPORT 303:
EQUITY OF EVOLVING TRANSPORTATION FINANCE MECHANISMS

The Incidence of Public Finance Schemes

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Paper prepared for the
Committee on the Equity Implications of
Evolving Transportation Finance Mechanisms
Transportation Research Board

2009

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I. INTRODUCTION

The objective of this paper is to explain the equity implications of adopting a public finance policy, such as imposing a tax. It draws on examples from the broad literature on tax incidence and from the literature on transportation finance. This paper explores both direct and indirect incidence; that is, it investigates who pays directly and how these burdens may be shifted in both the short and long term through other markets. It focuses on incidence of the costs of public finance schemes, leaving to other experts discussion of the many potential benefits of such schemes.[1] Incorporating such benefits into equity analyses would reduce burdens for all income groups and might have important distributional effects if the benefits are unevenly distributed across those groups.

To characterize the equity implications of a public finance scheme, one must first determine who experiences a change in well-being as a result of the scheme. Who bears the burden of a revenue-raising policy may differ quite dramatically from whom the law states will pay. Consider, for example, the effect of an increase in the gasoline tax. The obvious effect of the increase is to raise the consumer price of gasoline, thus imposing an additional burden on gasoline consumers. But because the quantity of gasoline demanded falls as a result of the imposition of the tax, it also could lower the price producers get per gallon. This imposes a burden on gasoline producers and retailers, and perhaps in turn on workers in those industries through lower wages. It could also affect the prices of other goods that use gasoline as an intermediate input, and the relative prices of fuel-efficient and fuel-inefficient vehicles.

An ideal measure of incidence would begin by calculating *all* of the changes in prices that would occur throughout the economy in response to the change in the tax rate, over the short- and long-run, and then calculate the effects of those price changes on households' well-being. Whoever is more responsive to a price change brought about by a public finance scheme will escape a greater proportion of the burden of the policy. Section II examines the critical importance of relative price responsiveness on incidence measures, comparing incidence measures calculated under the most stringently restrictive of simplifying assumptions, and exploring the effect of adding layers of complexity on equity implications.

Once one has calculated the absolute costs of a public finance scheme for members of different groups, one must choose the measure of income or total consumption with which to make a comparison of the costs of the scheme relative to people's overall well-being. Section III examines the important effect of this choice on incidence estimates. Rebating tax revenue or using it to reduce other taxes can have dramatic effects on incidence estimates. So can dynamic considerations, how evasion is punished, the salience of a tax, and the degree to which market

[1] The incidence of benefits received is addressed by King (2009) in the context of remedies for equity problems. Also see Baumol and Oates (1988) and Brooks and Sethi (1997) for general discussion of the distribution of benefits of environmental policies.

participants factor price changes into their decisions. Section IV discusses these complications, and Section V sums up the main points analysts and policymakers should keep in mind when considering incidence.

Understanding these complexities is far more than an academic exercise. Who bears the burden of a public finance scheme has direct implications for the amount of revenue raised and from whom, the amount of goods and services that will be bought and sold, for the political feasibility of a scheme, and for the overall amount of well-being in society.

II. PRICE RESPONSIVENESS AND INCIDENCE MEASURES

Suppose a policymaker wants to understand the equity implications of introducing a tax on (or fee for) vehicle miles travelled (VMT). Holding other policies unchanged, the addition of such a tax raises the per mile cost of driving, and therefore reduces demand for goods associated with driving.[2] While gasoline and vehicle markets easily spring to mind as markets that would be influenced by such a tax, other goods associated with driving would also be affected. Roadside convenience stores and out-of-town resorts would likely experience a reduction in demand, while the demand for bicycles and meals cooked at home would likely increase. The full incidence of a VMT fee would first involve calculating the effects on the price paid by consumers and the (different) price received by producers in these and all other markets affected by the fee.

Only rarely do economists and policymakers have the resources and information needed to perform such a "general equilibrium" analysis that traces the effects of a price change in one market on all markets, allowing for feedback to the original market. Most often, incidence analysis focuses on one or perhaps two main markets affected by the policy. For example, analyses of the incidence of a gasoline tax or a VMT tax are likely to focus first on the incidence within gasoline markets. Figure 1 shows that even within a single market, in a "partial equilibrium" context, incidence analysis is complicated by the fact that both the price that consumers pay and the price that producers receive can be affected by the policy.[3] If consumers are assessed a tax or fee on a good, the price they pay for the good rises, thereby reducing their demand for the good. Producers respond to the reduction in demand by reducing the price they charge. If producers are assessed a tax or fee, their costs rise, thereby reducing supply, raising consumer price and reducing the quantity consumers demand, which reduces the price that sellers can charge. No matter whether the fee is assessed on the consumer or on the producer, both experience a change in price. This assumption of *tax equivalence*, that the economic incidence of a tax does not depend on the statutory incidence, is central in conventional tax incidence theory.

Having estimated the price changes for consumers and producers, the incidence analyst then determines the *equivalent variation* of the price changes, the amount of money that would need to be taken away from (or given to) an individual or group of consumers or producers to

[2] If a VMT tax *replaces* a gas tax, then how much per mile driving costs change and in what direction depends on the magnitude of the VMT tax relative to the gas tax, and on fuel efficiency.

[3] The figures in this section depict the incidence of a unit tax, which is levied as a fixed amount per unit of the good sold, as opposed to an ad valorem tax, a tax with a rate given as a proportion of the price. The federal gas tax is an example of a unit tax, while general state and local sales taxes are set ad valorem (where sometimes these ad valorem rates also apply to gasoline, but more often states assess a unit tax on gasoline on top of the federal gas tax rate). The conclusions reached here using unit taxes apply equally as well to ad valorem taxes.

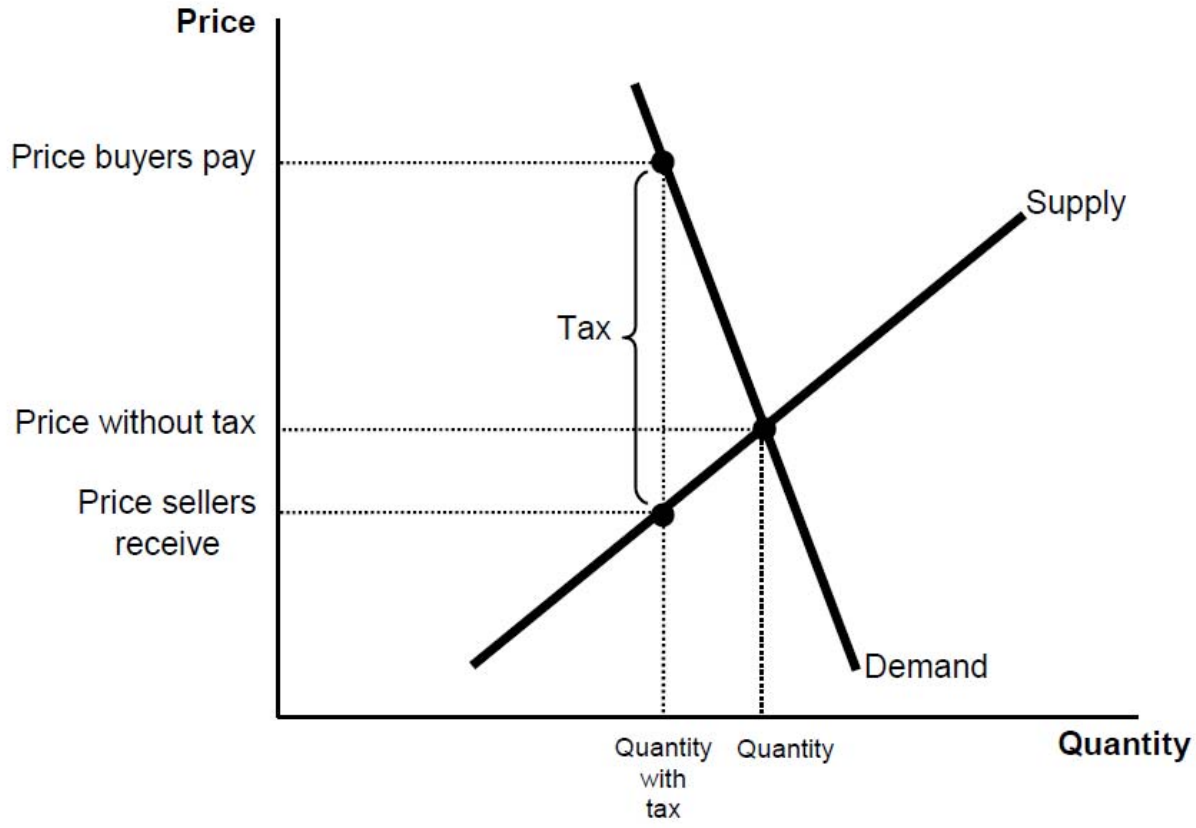

FIGURE 1 Partial equilibrium incidence of a tax.

make them equally as worse off (or better off) as they were made by the tax or fee. It addition to the price change, the burden on a given consumer or producer depends on the amount of the good consumed or produced. Specifically, when analysis is confined to one market, the equivalent variation of a tax for consumers is approximately equal to the reduction in *consumer surplus,* where consumer surplus is the amount that consumers value the goods purchased over and above the purchase price.

The striped area in Figure 2 depicts the reduction in consumer surplus due to the same tax imposed in Figure 1. For any given price change and initial quantity consumed, the size of the striped trapezoid decreases as the demand curve becomes flatter, that is, when consumers are more flexible and the elasticity of demand is larger in magnitude. Here the importance of time horizon becomes apparent—in the long run, consumers are likely to be far more responsive to changes in price than they are in the short run. For example, in response to a gasoline tax, in the short run, drivers make fewer trips, use the bus more often, or seek out carpools, but do not make changes large enough to significantly reduce gasoline consumption. That is, in the short run, the

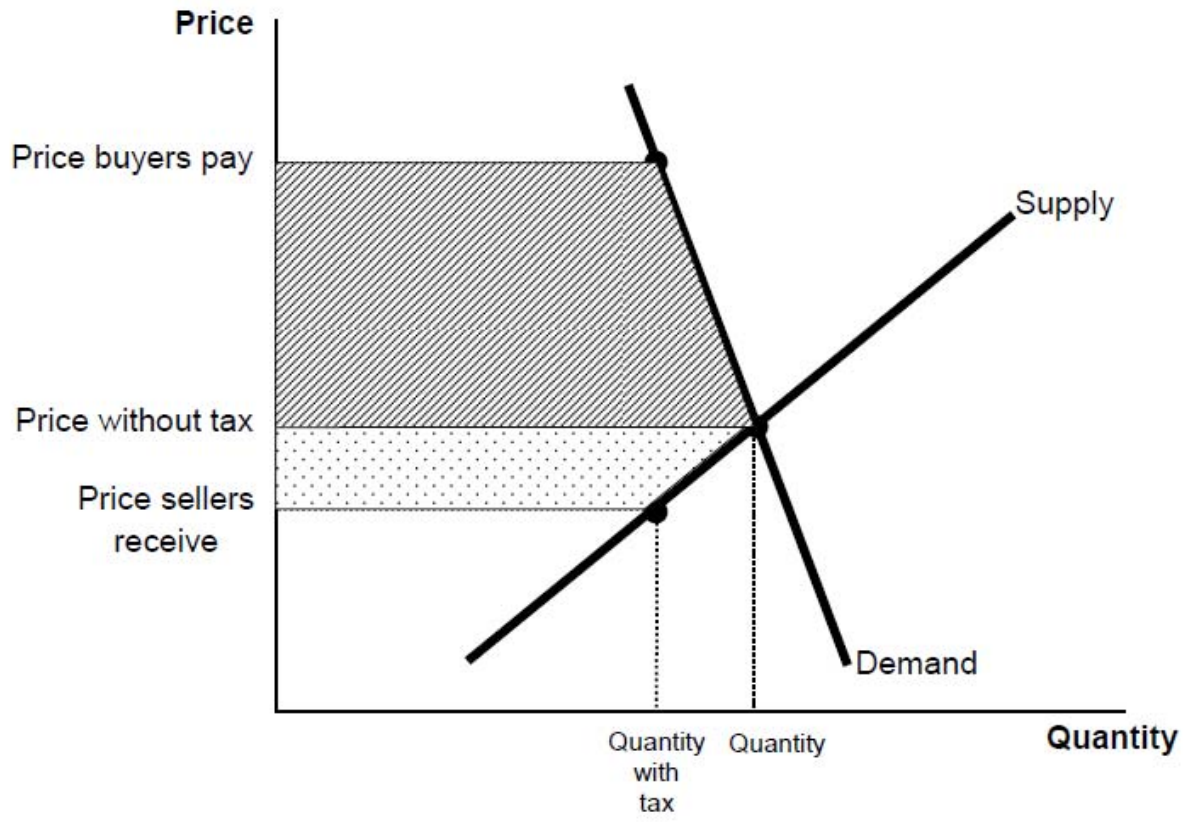

FIGURE 2 Approximations of equivalent variation: consumer surplus and producer surplus.

demand for gasoline is quite inelastic, with a 10 percent increase in gas price reducing gasoline consumption by as low as 1 percent. The literature finds a more flexible response in the long run, after consumers have had a chance to buy more fuel efficient vehicles, estimating that a 10 percent increase in gas price reduces gasoline consumption by between 3 and 9 percent (Dahl and Sterner 1991; Goodwin 1992; Parry and Small 2005; and U.S. Department of Energy 1996). Thus over the long run, consumers escape more of a tax, reducing the lost consumer surplus burden they bear.

Similarly, the equivalent variation of a tax for producers (in one market) is approximately equal to the reduction in the amount a producer gains from the sale of a good, over and above production costs, the reduction in *producer surplus*. The dotted area in Figure 2 shows this reduction in producer surplus. The more flexible are producers, the flatter (more elastic) the supply curve, and the smaller the dotted trapezoid of tax burden will be.[4]

[4] For discussion of the differences between surplus measures and equivalent variation, see Willig (1976), Slesnick (2001) and West and Williams (2004).

How burden is divided *between* consumers and producers therefore depends on the relative price elasticities of demand and supply for the product. The more flexible are producers relative to consumers, the more the tax will be shifted *forward* onto consumers. Conversely, the less flexible are producers relative to consumers, the more of the tax will be shifted *backward* onto the workers and owners in the producing industry. A classic example both of the importance of relative elasticities and the irrelevance of statutory incidence is the incidence of the U.S. payroll tax. While law states that employers must pay a tax equal to 7.65 percent of workers' earnings and workers must also pay a tax at the same rate, because employees change the number of hours they work far less flexibly than employers change the number of hours they employ, workers probably bear most if not all of the payroll tax, at least in the short run (Rosen and Gayer 2008).

Estimating such elasticities can be difficult, so analysts often assume that producers are extremely responsive to the tax, that the price elasticity of supply is infinite. Such an elasticity implies that producers are infinitely willing and able to change the quantity they supply, that when faced with a reduction in demand due to the tax or fee, producers easily find alternatives to producing the taxed good. This might occur, for example, if conventional unblended gasoline is taxed but gasoline blended with ethanol is not.

Figure 3 shows the effects on the market of this kind of flexibility on the part of producers. Since producers are infinitely flexible, they can pass the entire amount of the tax on to consumers; the price paid by consumers rises by the amount of the tax, while the price the sellers receive is unchanged. Researchers that assume supply is infinitely elastic therefore conduct incidence analysis assuming that consumers bear the full burden of the tax. To determine how much the consumer surplus changes, they need only know the amount consumed before the tax and the price elasticity of demand.

Consumers will also bear the full burden of a tax when demand is perfectly inelastic, that is, when they are completely inflexible. Commuters with no public transportation options, no opportunities for car-pooling, and no chance for telecommuting may have perfectly inelastic demand for VMT in the short run, before they have a chance to make changes that reduce the need for driving. Such inflexible consumers would therefore bear the entire burden of a VMT fee. That is, the VMT tax would be *fully shifted* onto the consumer.

Figure 4 depicts this scenario, showing that the price paid by consumers rises by the full amount of the tax, while the price received by sellers is unchanged. It also demonstrates why analysts often assume, explicitly or implicitly, that a taxed good is demanded inelastically—the quantity of the good demanded after the imposition of the tax or fee is the same as the quantity demanded beforehand. This implies that the amount of revenue from the fee or tax is equal to the current (untaxed) amount demanded times the amount of the fee, which is far easier to calculate than doing the calculation accounting for how each household will respond to the tax. And, it implies that the reduction in consumer surplus, the measure of burden on consumers, is also equal to this easy-to-calculate tax revenue measure. Metcalf (1999) uses this approach to estimate the incidence of a range of environmental taxes, Poterba (1991) uses it to estimate the incidence of the gas tax, and Walls and Hanson (1999) use it to estimate the incidence of vehicle emissions taxes and taxes on vehicle miles of travel. For any policy that induces behavioral changes, whether by intent or not, this method will produce results that differ from the true incidence. In particular, this method will tend to overstate the burden of tax increases, because it ignores consumers' shift away from the taxed good. Especially for estimates meant to capture long-run behavioral responses, the assumption of perfectly inelastic demand is quite problematic.

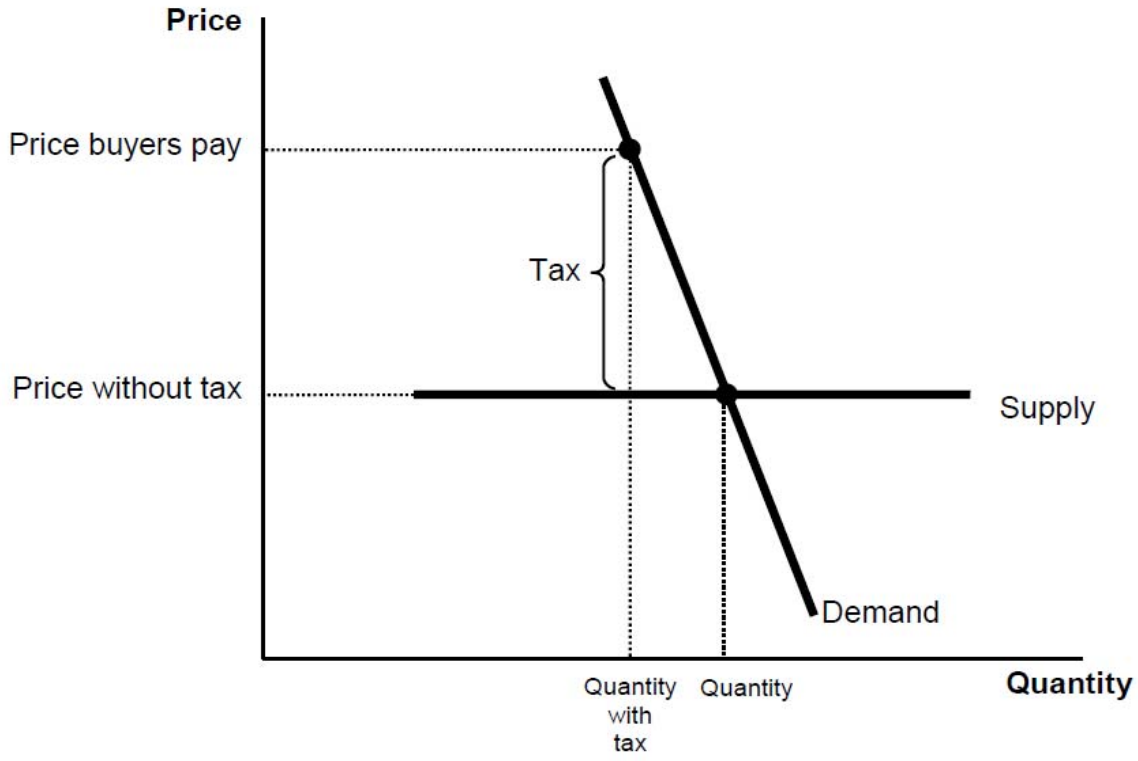

FIGURE 3 Partial equilibrium incidence of a tax, infinitely elastic supply.

Time horizon also critically determines producers' ability to respond to a tax, as does the degree of market competitiveness. In the short run, both producers and consumers are likely to bear some of the burden of a tax, as each group is unable to completely shift away from the taxed good (this is called *partial shifting*). The more substitutes are available to consumers or producers, the less burden they will bear. But as explained by Fullerton and Metcalf (2002), Poterba (1996), Besley and Rosen (1999) and Alm et al. (2009), if suppliers are perfectly competitive (selling indistinguishable products, facing many competitors), then the elasticity of supply is likely to approach zero in the long run, and consumers are likely to bear the full burden of a tax in that market.

If firms are not perfect competitors, then a number of different incidence outcomes are possible, depending on the kind of strategic behavior present in the market, the number of firms, possibilities for entry, the degree of product heterogeneity, and a number of other factors. Under some scenarios, it may even be possible for firms to *overshift* taxes onto consumers, so that the price consumers pay increases by more than the amount of the tax. As explained in Fullerton and Metcalf (2002), firms "recognize that forward shifting of the tax will decrease demand for their product. Thus, under some circumstances, they will wish to raise the price more than the increase in tax to compensate for the revenue loss from decreased demand" (p. 1825). They are able to

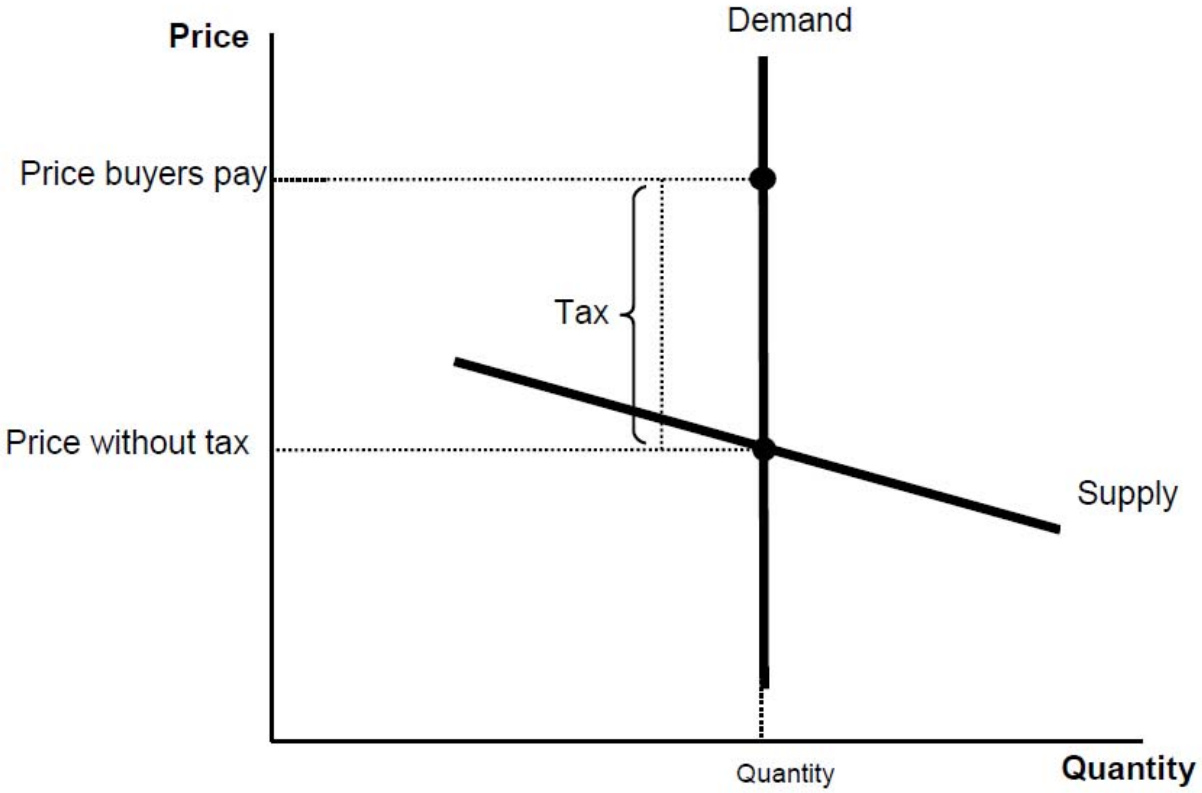

FIGURE 4 Partial equilibrium incidence of a tax, perfectly inelastic demand.

raise the price in this way because they have market power; they are imperfect competitors. If they had no market power, then they could not overshift, as a competitor would undercut them if they tried.

Poterba (1996) finds that in general, state and local taxes are shifted fully onto the consumer, while Besley and Rosen (1999) find full forward shifting for a number of commodities but also overshifting for others, a result they attribute to price-setting power on the part of producers. Alm et al. (2009) examine the incidence of a gasoline tax on buyers and sellers in gasoline markets, ignoring the effects this tax might have on automobile producers. They find that in urban areas, where gasoline markets are more competitive, the gasoline tax is fully shifted to the final consumer, while some burden is borne by producers in less-competitive rural markets.

Their results contrast with those found by the Congressional Budget Office (2003), which uses a simulation model to determine the effects of the gasoline tax on not only gasoline producers and final consumers, but also on vehicle manufacturers. Because it assumes that consumers are somewhat flexible and producers not completely flexible, it finds that consumers bear about 83 percent of the burden of the tax.

It is clear that to understand the results of incidence studies, one must uncover what the study assumes about the price responsiveness of producers relative to consumers. But one must also uncover what the study assumes about price responsiveness *within* these groups. For example, West (2004) and West and Williams (2004) find that poorer households are more responsive to gasoline price changes than are wealthy households. This may be because gasoline price increases have greater relative impacts on poor households' budgets. Whatever the reason, when gasoline prices rise, poor households are likely to reduce gasoline consumption up to twice as much as wealthy households, thereby escaping a greater proportion of the gasoline price increase. Care must be taken to account for the fact that gasoline price increases can make it disproportionately more difficult for poor households to get to work, and that consumers may not bear the full burden of the tax as these studies assume. Overall, however, studies that fail to account for differences in gasoline price responsiveness *overstate* the regressivity of a gas tax. In contrast, Cervero (1990) finds that low-income public transit riders are *less* sensitive to fare increases than high-income households, which often have the opportunity to drive a car instead. Studies that do not account for these differences in transit fare responsiveness across income groups would therefore *understate* regressivity of the fare.

A second kind of heterogeneity, differences in consumption patterns across income groups, can also have important implications for incidence on the consumer side. These differences are particularly important to keep in mind when estimating the equity implications of vehicle-related public finance schemes, as many poor people, and roughly 6 percent of the entire population, neither own nor lease a vehicle, and therefore do not directly pay vehicle registration fees, gasoline taxes, or other auto-related fees (see West, 2005).[5] Among those who do own vehicles, differences in buying patterns also have incidence implications. Policies such as Corporate Average Fuel Economy (CAFE) standards and gas guzzler taxes increase the relative price of new vehicles that are large (Goldberg 1998). West (2004) shows that in the 1990s, households that purchased large new cars had more income, so these implicit *size* taxes on *new* vehicles may have been progressive.

As differences in elasticities and consumption patterns across households matter for incidence on the demand side of a market, differences between taxed and untaxed industries' input intensities matter on the supply side of the market. On the production side, the burden of a tax is distributed among those who supply the factors of production, including labor, owners of capital, and owners of the land on which production takes place. To understand the incidence on these groups, we need to turn to a general equilibrium model, because we must now analyze input markets in addition to the market whose good is taxed. Harberger (1974) provides the foundational tools with which to conduct this kind of analysis. Consider a tax on carbon-intensive goods such as coal and petroleum-based fuels. Such a tax would decrease production of carbon-intensive energy and increase production of energy from solar or wind-based industries. As production of carbon-based energy falls, labor and capital used in that production are forced to find employment elsewhere, perhaps in the production of alternatives. What happens to the wage taken in by workers versus the value of capital depends on the relative intensity with which labor and capital are used in coal and oil versus in other industries. For example, if displaced labor and capital find employment in renewable energy, and coal and oil use labor more intensively than solar and wind-based industries, then the growing sector would have to absorb relatively large amounts of labor. The only way for labor to be absorbed, then, is for all wages to

[5] To the extent that workers who do not own cars are still likely to get to work in private vehicles, the indirect effects of such taxes and fees may be substantial.

fall relative to the price of capital. Conversely, if the taxed industry is uses capital relatively more intensively than the untaxed industry, then the relative price of all capital, measured by the rate of return on capital, must fall. Thus in the corporate sector, as the owners of capital, shareholders would bear the relative burden of the tax.

We also need a general equilibrium model to help us understand how other related markets might be affected by a public finance scheme. Because labor markets are so large and are already operating inefficiently because of preexisting taxes, public finance economists are particularly interested in the effects on those markets. However, while West and Williams (2007) find an important role for the interactions between gasoline prices and labor markets for the setting of the optimal tax on gasoline, they do not find an important role for these interactions for incidence (West and Williams 2004). These interactions may be more important in the case of a substantial tax on (or permit price for) carbon, which would affect the prices of a far broader set of goods in the economy, and therefore is more likely to have more significant effects on purchasing and work decisions (see Cornwell and Creedy 1997; Brännlund and Nordström 2004). For example, since lower-income households spend more as a fraction of income on energy than wealthy households, they may be more likely to make significant changes in lifestyle when faced with higher energy prices, which may involve working more or less, depending on the precise nature of the lifestyle changes. Alternatively, wealthy households may be more likely to make lifestyle changes that affect work hours and well-being, because they can more easily afford to go "off the grid."

Changes in transport costs can also have important effects on land markets. Indeed, since land use may be significantly less responsive to price changes than are labor or capital, we might expect this inelastic factor to bear a significant share of the burden of a transportation public finance scheme. In a monocentric city where jobs are concentrated in a central business district (CBD), theory predicts that an increase in transport costs brought about by a gasoline tax, a tax on vehicle miles traveled, congestion pricing, or other fee will induce households to bid up the price of land closer to the CBD. On the other hand, diminishing demand for land on the periphery will cause its price to fall (see Deakin 1994). Because of these changes in land values, some of the burden of a transportation finance scheme is therefore borne by renters near the center (who may be more likely to be poor) and by home- and landowners on the periphery. Even within a simple model of a monocentric city, however, the details of the public finance scheme can change these basic conclusions. For example, if the revenue from a tax or fee is used to build a highway artery from the center to the periphery, this will cause transport costs to fall, thereby having an offsetting effect on land values (a classic article on this topic is Mohring 1961). And, as discussed further in Section IV, revenue rebate schemes can have dramatic effects on spatial incidence.

Likely incidence of an increase in transport costs on landowners and renters in different locations becomes even murkier once one moves to a more realistic polycentric city model. (See Anas et al. 1998, for a review of the literature on urban spatial structure.) Addressing the realities of cities, such as urban and suburban subcenters, the fact that most employment is located outside of center cities, and that much movement is not directly related to commuting, requires one to move outside the neat predictions of the monocentric city model and into complex simulation models whose inputs vary across different city contexts (Deakin 1994). The spatial incidence of transportation public finance schemes through their effects on land prices therefore remains a fruitful area for future research.

III. MEASURES OF WELL-BEING

Say one determines that the equivalent variation of a new toll road fee is a loss of $100 per year for poor households, and a loss of $200 per year for wealthy households. This tells us what the households pay in absolute terms, but is not an especially informative measure of the burden borne by each, as a wealthy household has a much higher ability to pay than a poor household. A better measure calculates this burden relative to some measure of ability-to-pay or material well-being. If the equivalent variation (or another measure of loss such as consumer and producer surplus) of a tax or fee divided by the measure of well-being rises as well-being rises, then the policy is said to be progressive; if it stays constant, the policy is proportional; and if it falls, the policy is regressive.

While annual income is commonly used as a basis for comparison, a household's lifetime income is a better indicator of material well-being. MBA students and retired people, for example, may have very low annual income but high lifetime income and thus high material well-being. Annual measures of income also reflect transitory components which should have smaller effects on well-being than permanent changes in income. Households can maintain levels of well-being in the face of temporary reductions in income by taking money from savings or by borrowing. In good economic times, households smooth consumption by saving.[6] Precisely because households engage in such consumption smoothing to maintain well-being, and because calculating lifetime income is tricky, annual consumption is often used as a proxy. That is, because purchasing decisions depend on permanent, lifetime income, consumption should approximate lifetime income well. A well-defined consumption-based index can also capture values important to standards of living not included in annual income, such as the value of a home.[7]

Which measure of well-being one uses can have important effects on equity estimates. For example, using an annual income measure, the gas tax is clearly regressive. Data from the 2007 Consumer Expenditure Survey (conducted by the Bureau of Labor Statistics) can be used to show that spending on gasoline tax as a proportion of annual income falls monotonically as annual income rises, with households with the highest annual income (in the top 20 percent) paying less than one third of what poor households (in the bottom 20 percent) pay. One reason for this is that lower-income households are more likely to drive older, used vehicles, with relatively higher fuel consumption rates. Another is that vehicles miles driven tend to rise by less than in proportion to household income. But when the amount of gasoline taxes paid is divided by total expenditures (consumption), rather than income, highest-income households still spend less in gasoline taxes as a proportion of total expenditures (half a percent) than the lowest-income households (0.7 percent), but the poorest households actually spend less than middle-income households. The gasoline tax is still regressive using the consumption measure, but significantly less so. Poterba (1991) finds similar results, also for gasoline, and Lyon and Schwab (1995) find similar results for alcohol.[8]

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[6] See Friedman (1957), Pechman (1985), Fullerton and Rogers (1993), and Lyon and Schwab (1995) for more detailed discussion.

[7] Consumption may be a better approximation to well-being than annual income, but it is still an approximation. It is problematic, for example, for households that cannot smooth consumption by saving or borrowing. See Slesnick (2001) for further discussion of the appropriateness of different income measures.

[8] Blumenberg (2003) raises the concern that underreporting of income by poor households renders it misleadingly lower than consumption expenditures, and that this can have meaningful effects on the comparison of incidence measures that use expenditures with measures that use annual income. If the poor are more likely to underreport

Other studies find more dramatic sensitivity to the choice of income measure. Davies et al. (1984) find that using annual income implies that Canadian sales and excise taxes are significantly regressive, while using lifetime income implies they are roughly proportional. Fullerton and Rogers (1993) find that since the share of capital owned by high-income groups is higher than that share for low-income groups, taxes on capital such as state and local property taxes are progressive when annual income measures are used. But using lifetime calculations that account for the fact that capital holdings change over time, they find that taxes on capital affect *both* high- *and* low-income groups more than the middle.

Overall, since lifetime income and its proxy, consumption, are more evenly distributed across the population than annual income is, incidence measures that employ them are more likely to result in estimates that are less regressive.

IV. OTHER CONSIDERATIONS IN INCIDENCE ANALYSIS

So far this paper has set aside a critical aspect of public finance schemes—they raise revenue. It has also focused exclusively on conventional economic incidence theory. This section discusses the potential effects of revenue recycling and discusses recent developments in the literature on incidence.

Revenue Recycling

When revenue raised by a tax policy is used to reduce other distortionary taxes or government deficits or is rebated to households, it is said to be "recycled." A number of researchers have found that careful recycling of revenue back to households can mitigate or even completely overcome the regressive nature of taxes on energy-intensive goods or activities. For example, West and Williams (2004) find that by using the revenues from the gasoline tax to reduce taxes on work hours, the policy can be made significantly less regressive. The overall effect of the tax rate increase and revenue rebate could be made more progressive by targeting these tax rate reductions toward the poor, or by increasing the earned-income tax credit (EITC). If the revenues are used to give rebates of the *same* amount to all households regardless of their consumption behavior, that is, when they are refunded in "*lump sum*," the policy could be made progressive. With such a rebate scheme, the poorest households could actually be made better off, compared to facing no gasoline tax. And because a household's rebate amount would not depend on the amount of gasoline it consumes, it does not affect the household's perceived price per gallon of gasoline.[9]

Rebates of gasoline tax revenue can also affect the spatial incidence of the tax. For example, Bento et al. (2006) find that in a monocentric city, if gasoline taxes are rebated in lump sum, for a household living at the center of the city it is likely that the amount of the rebate will more than compensate for the amount of tax paid, while for a household in the suburbs, it is

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income than are the wealthy, and misreporting of expenditures is uncorrelated with income, then using actual income rather than underreported income would push incidence estimates that use (actual) income closer to incidence estimates that use expenditures. In such a case, the studies discussed above would overestimate the differences between the two measures.

[9] The return of revenue would, however, increase the amount of gasoline consumed compared to a scenario with no rebate, a potentially important but understudied effect.

likely that the tax paid will exceed the rebate, because gasoline taxes paid increase with distance from the CBD.

Lump-sum rebates are analogous to the "dividends" in "cap-and-dividend" proposals for climate change policy analyzed by Burtraw et al. (2009). In such schemes, carbon dioxide emissions are "capped" at a maximum, and polluters who emit them must purchase one emissions allowance per ton of CO_2-emitted. In principle, the government would auction the emissions allowances and return the auction revenues in a lump-sum to each person, in the form of a dividend. Using change in consumer surplus as a percent of after-tax income as their incidence measure, they find that households in the lowest income deciles see a "dramatic improvement in their well-being as a result of the lump-sum dividend of allowance revenues" (Burtraw et al. 2009, p. 14). While the effects of fees for CO_2 are by themselves regressive, the net incidence of the cap-and-dividend is quite progressive.

Small's (1983) results for congestion pricing are comparable. He estimates the incidence of a highway congestion toll, calculating both the costs and the benefits of the policy for different income groups. He finds that while congestion pricing in the absence of redistribution of funds is "adverse to low-income groups," under a wide variety of assumptions about how revenue is rebated, "*every* income class benefits from a highway congestion toll, except when congestion is initially at a low level" (p. 106-107). It is important to note that this result involved counting a benefit of the tax, congestion relief. As indicated in the introduction, a complete incidence analysis would include such benefits.

Environmental tax reforms—measures that use pollution tax revenue to reduce taxes on employment or investment—are now common in Europe. Such reforms have also been proposed in state legislatures in the United States (Hoerner and Erickson 2000), and modeled in the context of transportation pricing in Europe (DeBorger and Proost 2001).

While many studies conduct simulations assuming that all revenue is rebated, this need not be the case. A system that rebates some but not all revenue could still mitigate regressivity significantly, while reserving funds for transportation projects or other spending.

Should revenue from a public finance scheme be used to counter that scheme's regressive impacts? Public finance economists generally would recommend that policymakers set taxes at their efficient levels, so that people face the full costs of their actions, regardless of the distributional implications. Then, if they think that the public finance scheme places too much burden on poor and working-class households, policymakers can use the most efficient redistributive tools to attain equity goals, be they lump-sum rebates of that scheme's revenue or modifications to the broader income tax and benefit system.

Recent Challenges to Conventional Incidence Theory

A number of recent papers in the public finance literature explore conditions under which tax equivalence theorems fail, that is, where the legal specification of who remits the tax or is paid a subsidy affects the economic incidence of the policy. Kopczuk and Slemrod (2006) and Slemrod (2007) explore the possibility that the ability to avoid a tax, and punishment for such avoidance, may depend on who remits a tax. For example, it may be easier for governments to monitor tax compliance on the part of sellers, compared to enforcing taxes consumers must remit. Such findings might be particularly important for comparing the incidence of a gas tax (remitted by sellers) with the incidence of a VMT tax (presumably remitted by drivers).

Tax equivalence may also fail to hold when consumers cannot quickly process all of the available information about prices they see, that is, when they are "boundedly rational." Under this condition, consumers respond differently to prices that include the tax versus prices that do not. In particular, when sales taxes are added at a store's cash register, consumers tend to ignore their effects on price (Chetty et al. 2007). This implies that the "salience" of a policy, how visible and palpable a policy is, affects responses to the policy and therefore affects incidence. Finkelstein finds evidence that this is indeed the case for road tolls—drivers are less responsive to price when tolls are collected electronically (2009).

Busse et al. (2006) find differences in the incidence of manufacturer incentives in vehicle markets, depending on whether incentives are rebated to consumers or dealers. They find that customers obtain 70–90 percent of a customer rebate, but only 30–40 percent of a dealer discount promotion. They hypothesize that this is due to asymmetric information: customer rebates are well-publicized to customers, while dealer discount promotions are not.

Sallee's (2008) analysis of the incidence of subsidies to gas-electric hybrid vehicles highlights conditions under which statutory incidence matters for another reason: the cost of searching for a new product implies that current price influences future demand. Waitlists implied that between 2004 and 2007, the supply of Toyota Priuses was perfectly inelastic, which in turn implied that Toyota should have pocketed the entire subsidy. Instead, Sallee finds that consumers captured the subsidy, which poses a challenge to standard models of tax incidence. Sallee argues that consumers gained instead of producers because Toyota believed that raising price to clear the market would lower future demand for hybrids. This would be possible if consumers, finding it costly to gather and process information on current prices, use information they already gathered on prices in the past.

This recent research implies policymakers need to be aware that contrary to standard theories of incidence, the statutory incidence of a policy may affect the economic incidence. The probability of getting punished for avoiding a tax, whether posted prices include taxes, whether fees are collected fees by hand or electronically, and whether incentives are provided to manufacturers or to consumers may affect behavioral responses, and therefore have different equity implications.

V. CONCLUSION

Much policy discussion of public finance schemes implicitly assumes that the people on whom a tax or fee is levied are necessarily the people who end up bearing the burden of the policy. This implies that those people do not change their behavior as a result of the policy, for if they change their behavior, they shift the burden of the policy onto others.

In reality, behavioral responses are critical to determining the equity of a public finance scheme. The more substitutes are available to consumers or producers, the more each group can avoid a tax or fee. As the number of available substitutes tends to increase over time, these groups tend to respond more elastically in the long-run than in the short-run, thereby shifting more of the burden. Differences in flexibility and buying patterns across consumer groups can affect incidence estimates, while differences in input intensities between taxed and untaxed industries matter for the relative burden a tax or fee places on workers versus the owners of a firm. What researchers assume about these behavioral responses can have important effects on their estimates. The researcher's choice of measure of well-being also affects equity

implications. Characteristics of the public finance scheme itself may also have important implications for who bears its burden. How likely a taxed party is to be punished for evasion and how much consumers and producers know relative to one another in a market whose good is taxed may affect who bears the final burden.

So, as is the case in most policy analyses, with incidence estimation, the devil is in the detail. A few broad conclusions, however, can be drawn from the empirical work discussed above. First, despite the fact that consumers become more responsive to increases in gasoline prices in the long run, competition among suppliers implies that consumers bear the great majority of the burden of a gasoline tax. Second, tax incidence estimates obtained using lifetime income or consumption, which are better indicators of well-being, are usually less regressive than those employing the same data and elasticity assumptions, but using annual income. Third, carefully designed revenue rebate programs can render a once regressive scheme progressive, and in many cases can make poor households better off than before the policy is implemented. Last, the more individuals know about a policy, the more likely they are to be able to avoid its burdens or exploit its benefits. Making a policy transparent, especially to poor households, can reduce its regressivity.

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