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A COMPARISON OF SALES TAXES

by

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Abstract: Four main types of ad valorem sales taxes, the retail sales tax, the value added tax, a cascading sales tax and a manufacturer's sales tax are compared in a partial equilibrium model with a competitive intermediate goods industry and a non-competitive final goods industry. The retail sales tax and the VAT, which are equivalent in the absence of uncertainty, must be levied at a higher rate than a cascading tax to ensure equal revenue yield. However, output under a retail sales tax exceeds that under a cascading sales tax and deadweight losses are lower if both tax rates are such that there is a positive relation between them and tax yield. The equal yield manufacturer's sales tax has a higher tax rate, lower output and greater deadweight loss than the other three sales taxes.

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I. INTRODUCTION

This paper discusses the simple analytics of the main types of sales taxes. If different ad valorem sales taxes with equal revenue yields are levied, how do the tax rates, consumer prices, output and deadweight losses differ? Claims that the Cascade-type Sales Tax (CST) is more distortionary than a Value Added Tax (VAT) are made frequently in the literature. It turns out that the claim is not universally true -- it requires an assumption about the Laffer curve. Furthermore, the extent of cascading varies with the structure of intermediate and final goods markets. Our concern is with a simple demonstration -- so we use a partial equilibrium model that is amenable to graphical analysis. Nevertheless, besides the VAT and the CST the framework permits us to examine a Retail Sales Tax (RST) and the Manufacturer's Sales Tax (MST). Thus we present a unified treatment of four standard sales taxes in a simple framework.

Earlier contributions to the area include Friedlaender (1967) and Bhatia (1992). Friedlaender (1967) examines tax effects on tax inclusive producer or seller's prices using a model with fixed input-output coefficients and retail, wholesale and manufacturing sectors, of which there are two each. However, demand plays a passive role in her analysis. In her framework, the VAT is neutral in that it does not alter the relative price at the retail stage. However, a general (cascade) sales tax on all goods leads to cascading and a distorted relative price at the retail stage. Bhatia (1992) extends this analysis to allow for two substitutable factors of production assuming fixed total factor supplies and competitive industries. Though VAT neutrality continues to hold Bhatia finds that, as can be expected, factor substitution leads to a weakening of Friedlaender's finding for the cascade tax, in that it may now turn out to be neutral if

factor substitution effects happen to be offset by demand side effects. However, the specification of demand in his model rules out Laffer curve effects.

Our contribution is two-fold. First, we show that cascading may take place even when general equilibrium (i.e., factor market) effects are neglected if some industries are not competitive. Thus we identify a link between tax incidence and market structure not discussed in earlier work. Secondly, the model is simple enough to allow for discussion of welfare effects in terms of deadweight losses and allows for graphical and intuitive comparison of different sales taxes using a standard monopoly diagram. Thus, we are able to complement and clarify earlier contributions.

Other related work exists on the macro effects of indirect taxes, in which imperfections in factor markets can lead to unemployed resources and which permit for tax evasion. Following a pioneering paper by Peacock and Shaw (1982) the study of the relationship between tax evasion and tax revenue in macroeconomic models has attracted the attention of several scholars [Ricketts 1984, Lai and Chang 1988, Von Zameck 1989, Bhattacharyya 1994]. In these simple macroeconomic models, consumption taxes are found to enhance tax revenue relative to income taxes and have positive effects on reported income. Regarding explicit comparisons of sales taxes in the presence of tax evasion, these are still lacking. For example, Das-Gupta and Gang (1995) is the first model of VAT evasion we are aware of, while models of evasion under the RST and the CST have not yet appeared even though tax evasion by a single firm was examined by Marelli (1984).

We develop our framework in Section II and compare the VAT, RST and CST in

Section III. In Section IV we compare the MST and RST using a simple graphical analysis. Section IV concludes.

II. BASIC INDUSTRY STRUCTURE

There is a final goods industry producing a homogenous good \mathbf{F} and an intermediate goods industry producing a homogenous input, \mathbf{I} . For brevity, final and intermediate goods producing firms are referred to as f-firms and I-firms respectively. The term firms is used when both I-firms and f-firms are being referred to. The market structures in the two industries are chosen so as to yield a tractable, text book, model. The intermediate goods industry is thus assumed to be perfectly competitive with many identical I-firms. The number of I-firms is determined endogenously. The final goods industry is assumed to consist of \mathbf{n} identical firms, each of whom is a monopolist in its own region, where regions are assumed to be non-overlapping and possess identical downward sloping demand curves for the final good. The revenue of a representative f-firm is denoted $\mathbf{R}(\mathbf{F})$. F-firms may buy inputs from more than one I-firm, the number of I-firms being determined endogenously where relevant. Likewise, I-firms may sell inputs to more than one f-firm.

The cost of production for a representative I-firm is $\mathbf{W}(\mathbf{I})$. $\mathbf{W}(\mathbf{I})$ has a U-shaped average cost curve reaching a minimum at \mathbf{I}^* . The cost of production for the representative f-firm consists of two parts, the cost of primary inputs, $\mathbf{C}(\mathbf{F})$, and the cost of intermediate inputs, $\alpha\mathbf{wF}$, where α , the input-output coefficient, is assumed to be constant and \mathbf{w} is the price per unit of input purchased (and $\alpha\mathbf{F}$ units of the input are

purchased).¹ The marginal primary cost function is assumed to be positive and increasing. Revenue and cost functions are assumed to be at least twice differentiable. It is also assumed that no inventories are held by f-firms or I-firms: all intermediate purchases are used up in production in the same period and all final and intermediate goods produced are sold. Consequently, in the absence of taxation, profits are $\pi_I(\mathbf{I}) = \mathbf{w}\mathbf{I} - \mathbf{W}(\mathbf{I})$ for I-firms and $\pi(\mathbf{F}) = \mathbf{R}(\mathbf{F}) - \mathbf{C}(\mathbf{F}) - \alpha\mathbf{w}\mathbf{F}$ for f-firms. Given competition, $\pi_I = \mathbf{0}$ and $\mathbf{I} = \mathbf{I}^*$ in long-run equilibrium.² Without loss of generality, units of input are chosen so that $\alpha=1$. This is a partial equilibrium model, since factor supplies underlying cost curves and the demand for final goods are taken as given.

III. RETAIL SALES TAXES, THE VAT AND CASCADE TAXES

We first compare three types of ad valorem sales taxes: A Value Added Tax (VAT) implemented by the invoice method, a Retail (here final goods) Sales Tax (RST) and a Cascade-type Sales Tax (CST). We assume throughout the paper that all firms in a taxed industry are liable to pay sales taxes - there are no exempt firms.³ Rates of tax are chosen to yield equal revenue. Furthermore, under either the VAT and CST the rates of

¹The extension of the analysis to include capital purchases requires an explicitly dynamic model as treatment of capital purchases may differ under different variants of a Value Added Tax. Either primary or intermediate inputs may, however, be interpreted as including the cost of capital services, depending on which variant of the VAT is being examined, without affecting the analysis. For a discussion of VAT variants see, for example, Due and Friedlaender (1973) and Due (1988, chapter 16).

² We assume the existence of stable and unique equilibria for all sets of tax and enforcement parameters that arise in the course of this analysis without further comment.

³ In practice, various types of firms are exempt from tax. Such exemptions have distortionary consequences.

tax across industries are taken to be identical. The rates of tax under a VAT, a RST and a CST are \mathbf{v} , \mathbf{r} and \mathbf{s} respectively. Note that, since no tax is levied on I-firms under the RST, the price of \mathbf{I} will continue to be \mathbf{w} in equilibrium. Under the VAT and the CST, the average cost curves of I-firms are shifted up by a constant amount as a result of the tax. This implies that zero profit equilibrium will continue to occur at a per I-firm production of \mathbf{I}^* . The equilibrium price of the intermediate good under the VAT is therefore determined by the relation $\mathbf{w}_v(\mathbf{1}-\mathbf{v}) = \mathbf{w}$. Similarly under the CST the relation $\mathbf{w}_s(\mathbf{1}-\mathbf{s}) = \mathbf{w}$ holds. The number of I-firms in equilibrium under the RST is denoted \mathbf{m} . The number of I-firms under a VAT and a CST are \mathbf{m}_v and \mathbf{m}_s respectively.

Profit equations for f-firms under the three sales taxes are

$$(1) \quad \pi_r(\mathbf{F}_r) = \mathbf{R}(\mathbf{F}_r)(\mathbf{1}-\mathbf{r}) - \mathbf{C}(\mathbf{F}_r) - \mathbf{w}\mathbf{F}_r,$$

$$(2) \quad \pi_v(\mathbf{F}_v) = \mathbf{R}(\mathbf{F}_v)(\mathbf{1}-\mathbf{v}) - \mathbf{C}(\mathbf{F}_v) - \mathbf{w}_v\mathbf{F}_v(\mathbf{1}-\mathbf{v}),$$

$$(3) \quad \pi_s(\mathbf{F}_s) = \mathbf{R}(\mathbf{F}_s)(\mathbf{1}-\mathbf{s}) - \mathbf{C}(\mathbf{F}_s) - \mathbf{w}_s\mathbf{F}_s,$$

for the RST, VAT and CST respectively. In (2) the price of intermediate goods is reduced by the tax $\mathbf{w}_v\mathbf{v}$ rebated to producers per unit of intermediate goods purchased (against purchase invoices), to offset the tax paid by I-firms on their sales of intermediates. This rebate is not granted under the CST resulting in the usual cascading effect or tax on tax paid by f-firms, amounting to $\mathbf{w}_s\mathbf{s}^2$ in terms of f-firm producer prices.

To determine equal revenue yield conditions, first compare the RST and the VAT. From the relation between \mathbf{w} and \mathbf{w}_v , it is clear that (1) and (2) are identical if $\mathbf{r} = \mathbf{v}$. Furthermore, since all taxes collected from I-firms are rebated to f-firms under the VAT, government revenue net of rebates is equal to the tax collected on final goods

sales. Consequently, with identical rates of tax ($\mathbf{r} = \mathbf{v}$) the RST and the VAT yield the same revenue and have identical effects on firm output and prices and, therefore, industry sizes. In what follows, we denote the common rate of tax by \mathbf{v} .

Next compare the RST with the CST. First note that tax revenue from the I-industry under the CST is $\mathbf{m}_s \mathbf{s} \mathbf{l}^* \mathbf{w}_s = \mathbf{n} \mathbf{s} \alpha \mathbf{F}_s \mathbf{w}_s = \mathbf{n} \mathbf{s} \mathbf{F}_s \mathbf{w}_s$. Consequently, for the two taxes to have the same revenue yield, it must be the case that

$$(4) \quad \mathbf{n} \mathbf{v} \mathbf{R}(\mathbf{F}_r) = \mathbf{n} \mathbf{s} [\mathbf{R}(\mathbf{F}_s) + \mathbf{F}_s \mathbf{w}_s].$$

We assume that RST, VAT and CST rates are such that revenue increases with the tax rate. That is, tax rates do not result in production being beyond the peak(s) of the associated Laffer curve. It is easily shown that $\mathbf{v} > \mathbf{s}$ and, with the Laffer curve restriction on tax rates, $\mathbf{F}_r > \mathbf{F}_s$. To show this, consider the marginal conditions for profit maximization by f-firms under the RST and the CST. Differentiating (1) and (3) with respect to output and using primes for derivatives gives

$$(5) \quad \boldsymbol{\pi}'_r(\mathbf{F}_r) = \mathbf{R}'(\mathbf{F}_r)(\mathbf{1}-\mathbf{v}) - \mathbf{C}'(\mathbf{F}_r) - \mathbf{w} = \mathbf{0},$$

$$(6) \quad \boldsymbol{\pi}'_s(\mathbf{F}_s) = \mathbf{R}'(\mathbf{F}_s)(\mathbf{1}-\mathbf{s}) - \mathbf{C}'(\mathbf{F}_s) - \mathbf{w}_s = \mathbf{0}.$$

Since f-firms operate where marginal revenue is positive, given positive marginal costs, (4) implies that $\mathbf{v} > \mathbf{s}$ if $\mathbf{F}_s \geq \mathbf{F}_r$. Conversely, if $\mathbf{F}_s < \mathbf{F}_r$, then $\mathbf{v} > \mathbf{s}$ from (5) and (6). Thus, $\mathbf{v} > \mathbf{s}$. Suppose now that $\mathbf{F}_s = \mathbf{F}_r$. Then revenue will be greater with an RST. To see this, suppose to the contrary. From (5) and (6) and the relation between \mathbf{w} and \mathbf{w}_s , we see that

$$(7) \quad \mathbf{v} \mathbf{R}'(\mathbf{F}_r) = \mathbf{s} [\mathbf{R}'(\mathbf{F}_s) + \mathbf{w}_s].$$

Replacing the equality in (4) by the assumed inequality (RST revenue \leq CST

revenue) and dividing (7) by (4) gives rise to the inequality

$$\mathbf{R}'(\mathbf{F}_r)/\mathbf{R}(\mathbf{F}_r) \geq [\mathbf{R}'(\mathbf{F}_s) + \mathbf{w}_s]/[\mathbf{R}(\mathbf{F}_s) + \mathbf{F}_s\mathbf{w}_s].$$

Defining weights $\mathbf{z} = \mathbf{R}(\mathbf{F}_s)/[\mathbf{R}(\mathbf{F}_s) + \mathbf{F}_s\mathbf{w}_s]$, this inequality can be rewritten as

$$(8) \quad \mathbf{R}'(\mathbf{F}_r)/\mathbf{R}(\mathbf{F}_r) \geq [\mathbf{R}'(\mathbf{F}_s)/\mathbf{R}(\mathbf{F}_s)]\mathbf{z} + (1/\mathbf{F}_s)(1-\mathbf{z}).$$

Noting that $\mathbf{F}_s = \mathbf{F}_r$, the inequality above reduces to the condition that the elasticity of revenue (\mathbf{FR}'/\mathbf{R}) is at least 1. The revenue elasticity is equal to $(1+\mathbf{D})$, where \mathbf{D} is the inverse elasticity of demand. Clearly, $\mathbf{D} \geq 0$ only if the demand curve has a non-negative slope which contradicts the assumption of downward sloping demand. This establishes that revenue under the RST is greater than under a CST if \mathbf{F} is identical under both taxes.⁴ Thus, since our Laffer assumption implies that taxes and tax rates are positively related, \mathbf{v} must be reduced from the level that causes $\mathbf{F}_s = \mathbf{F}_r$. This, of course, causes \mathbf{F}_r to exceed \mathbf{F}_s , from (5), establishing the claim made above about relative output levels. It is easy to construct an example with linear demand and marginal cost curves to show that, if the VAT tax rate is beyond the peak of the Laffer curve, then output may be higher with an equal yield cascade tax. Thus tax rates and revenue being positively related for the VAT is important to our demonstration.

A simple extension of the argument above shows that the maximum revenue possible under the RST exceeds that under the CST with downward sloping firm level demand. Let the tax rates that maximize revenue under each of the two taxes be \mathbf{v}^* and \mathbf{s}^*

⁴ A diagrammatic illustration using the standard monopoly diagram for the f-firm quickly becomes cluttered. We provide a graphical comparison below of the RST and the MST since the graph is less cluttered.

respectively.⁵ From the argument given above, it is clear that if \mathbf{v} is chosen so that $\mathbf{F}_r = \mathbf{F}_s^*$ (such a choice of \mathbf{v} is clearly feasible), then revenue will be greater under the RST. Consequently, revenue under the RST at \mathbf{v}^* will also be greater than revenue under a CST at \mathbf{s}^* .

Note that, if \mathbf{D} is zero (the demand curve is horizontal), then equal revenue yield is maintained at equal output. This implies that, if the f-industry is also competitive, equal output can result from equal yield retail and cascading ad valorem sales taxes - output is the same as under the RST. This shows that the extent of distortion of output prices is sensitive to the degree of monopoly power as measured, for example, by the well known Lerner Index of monopoly power, $-\mathbf{D}$ (see, for example, Pyndick and Rubinfeld, 1995). Why does this sensitivity to market structure arise? The reason is that the incidence of a tax on sales by a monopolist falls partly on the economic rent or profit earned by the monopolist. As is well known, a pure profits tax is non-distorting (see, for example, Stiglitz, 1988). In contrast, f-goods sellers have no market power in the intermediate good market. This argument is similar to the standard demonstration in intermediate public finance texts (for example Stiglitz, 1988), that the impact of an ad valorem sales tax on output is smaller in a monopoly than an equal yield specific tax. This arises since the tax paid by I-firms is equivalent to a specific purchase tax on f-firms (at rate $\mathbf{s}/(\mathbf{1}-\mathbf{s})$) if it is not rebated. If, in contrast, I-goods rather than f-goods

⁵ Differentiating revenues under the RST and CST with respect to their tax rates and setting the derivatives to zero, it can be seen that necessary conditions for revenues to be maximized under the two taxes are $[\mathbf{vF}'(\mathbf{Q}_r)/\mathbf{F}(\mathbf{Q}_r)](\mathbf{dQ}_r/\mathbf{dr}) = \mathbf{1}$ for the RST and $\mathbf{s}\{[\mathbf{F}'(\mathbf{Q}_s)/\mathbf{F}(\mathbf{Q}_s)]\mathbf{WT} + (\mathbf{1}/\mathbf{Q}_s)(\mathbf{1}-\mathbf{WT})\}(\mathbf{dQ}_s/\mathbf{ds}) = \mathbf{1}$ for the CST.

sellers were monopolistic, then the result would be reversed since a part of the tax on I-sellers would be absorbed by them by way of lower economic rents.

These results show that market structure, and not just the input price and substitution effects examined by Friedlaender (1967) and Bhatia (1989), are important in determining the tax and output impact of the CST versus the RST/VAT. The traditional interpretation of distortion is, however, in terms of deadweight loss.⁶ To calculate deadweight losses under the RST and the CST, the equivalence between the purchase tax on f-firms and the sales tax on I-firms can be exploited. With such a purchase tax, the I-industry is untaxed so that all deadweight losses occur in the f-industry itself. Since deadweight losses will be inversely related to output in the presence of taxes, losses under an RST are lower than under a CST. Under the assumptions that lead to the RST and the VAT being equivalent to a proportional tax on lifetime income, the relative price between consumption and saving is unaffected.⁷ Consequently, deadweight losses under the VAT or RST must reflect the distorted relative price of market and non-market goods ("labor" and "leisure").

IV. RETAIL VERSUS MANUFACTURER'S SALES TAXES

We can now comment on the case of a sales tax levied only on the intermediate sector --

⁶We restrict our comments to the deadweight loss calculated with the uncompensated demand curve or, equivalently, when the income elasticity of demand is zero. The analysis with compensated demand is more complex.

⁷The absence of uncertainty, inheritances and bequests. See, for example The United States Treasury (1977).

a manufacturers sales tax, MST (or "first point" tax). With such a tax the profit equation of final goods producers will be

$$(9) \quad \pi_m(\mathbf{F}_m) = \mathbf{R}(\mathbf{F}_m) - \mathbf{C}(\mathbf{F}_m) - \mathbf{w}_m \mathbf{F}_m,$$

where $\mathbf{w}_m(\mathbf{1}-\mathbf{m}) = \mathbf{w}$ given an ad valorem MST at rate \mathbf{m} . If f-firms are profit making in the absence of taxes, then the rate of tax under the MST must exceed the rate under the equal yield RST. From the arguments of the previous section the MST is equivalent to a specific purchase tax on f-firms which is, therefore, more distortionary than the VAT/RST. We illustrate this for the case of linear demand and marginal cost curves for a typical f-firm. In the accompanying figure, the pre-tax curves are labeled D, MR and MC so that the profit maximizing output and price are F_0 and P_0 . The deadweight loss triangle is labeled abc. The RST or VAT give rise to the demand and MR curves D_V and MR_V . The profit maximizing output and consumer price are now F_V and P_V while the producer receives a price P_{PV} per unit. Consequently, additional deadweight loss is given by the area dbcf and the tax revenue is shown by the area $P_V deP_{PV}$. The MST causes the marginal cost curve of the f-firm to shift to MC_1 which is selected so that the area representing tax revenue, $MC_M jhM_1$ is equal to $P_V deP_{PV}$ as is shown output F_M and price P_M are higher under the equal yield MST giving rise to additional deadweight loss gdfj. Since the CST is a convex combination of an RST and an MST levied at equal tax rates, output and deadweight losses under the CST will be between those under the RST and the MST after adjusting the rates to maintain equal revenue yield. Consequently, output will be lowest and deadweight losses highest under the MST. This argument, of course requires tax rates and taxes to be positively related.

V. CONCLUSION

We have described the simple analytics of four types of sales taxes: the retail sales tax, the value added tax, a cascading sales tax and a manufacturers sales tax under equal revenue yield. We ask how the tax rates, outputs and deadweight losses differ under each of the taxes. The introduction of monopoly power in the final goods market allows to demonstrate the possibility of cascading even in the absence of general equilibrium effects. More importantly, the extent of cascading - and hence the relative superiority of the VAT or RST over cascade taxes or the MST has been shown to depend critically on industry structure. If intermediate goods markets are more competitive than final goods markets, then the advantages of a VAT over the CST or the MST are emphasized. If, on the other hand, intermediate goods markets are less competitive than final goods markets, then the advantages of a VAT may be overstated.

In comparing the retail sales tax (or the value added tax) to a cascading sales tax, equal revenue yields imply that the retail tax rate will exceed the cascading tax rate. We further show, however, that if we are on the rising portion of the Laffer curve and the final goods industry is less than competitive, equal yield implies that output under a retail sales tax exceeds that under a cascading sales tax. If, on the other hand, the final goods industry is competitive, equal revenue yield implies equal output under the two taxes in the absence of the induced factor market distortions or differential intermediate goods requirements emphasized in the literature. The maximum revenue possible under a retail sales tax exceeds that under cascading. The manufacturers sales tax offers the worst of all worlds: with revenue neutrality the manufacturers sales tax has a higher tax

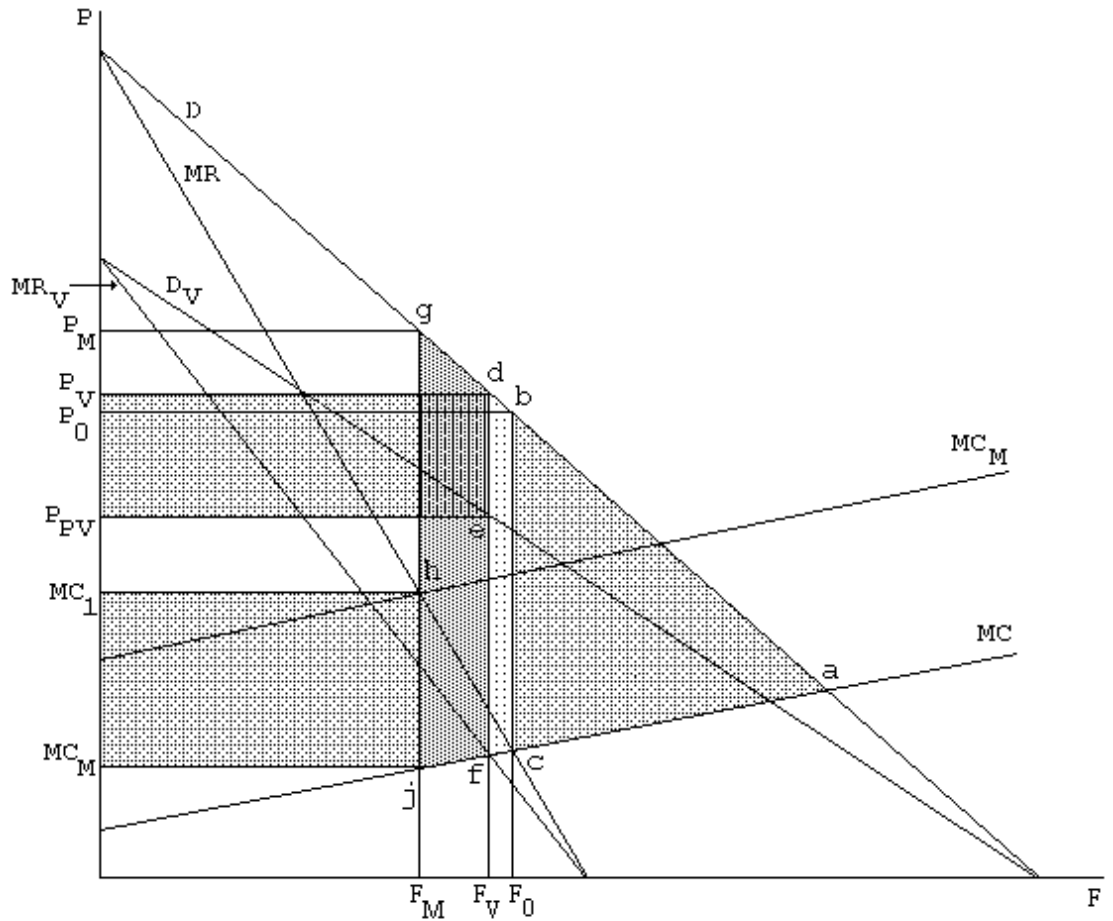
rate, lower output and greater deadweight loss than all the other taxes when final goods firms have a greater degree of monopoly power.

As discussed in the introduction, our analysis is in partial equilibrium and ignores open economy complications. Extensions that still need to be incorporated before the theory can be said to be adequately worked out include: (1) allowing for cross-border transactions, (2) allowing for tax evasion and (3) allowing for a more general sales tax structure with, for example, exemptions and rebates.

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EFFECTS OF AD VALOREM RETAIL AND MANUFACTURER'S SALES TAXES