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*JEL-codes:* D60, H21
*Keywords:* tax, deadweight loss, price elasticity

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# Clarifying the analysis of deadweight loss from taxation

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The standard analysis of taxation suggests that excise taxes on goods with a price-inelastic demand are more efficient in that they lead to a lower deadweight loss than taxes on goods with price-elastic demand. This argument ignores secondary effects on the rest of the economy. By narrowly focusing on the primary effects on the taxed market, the overall deadweight loss is underestimated when demand is price-inelastic and overestimated when demand is price-elastic, putting into question the validity of the standard textbook argument. In this paper we address this issue by considering how taxes affect consumer behavior in other markets.

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## 1. Introduction

The standard microeconomic analysis of taxation suggests that the deadweight loss of an excise tax levied on a good is smaller the more price-inelastic both the supply and demand schedules (Mankiw, 2015, 155-170; Gwartney et al., 2017, 83; Cowen & Tabarrok, 2021). We argue that this analysis falls short of providing an accurate assessment of the overall welfare loss of taxation as it narrowly focuses on the partial equilibrium on the market where the tax is imposed. It ignores the broader implications of the tax on other markets.

It is possible to describe the interrelations between the different markets using standard tools, but these interrelations are often ignored in modern textbook expositions. In this paper, we will turn to Böhm-Bawerk's (1930) price theory to show the basic connections. The elegant simplicity of Böhm-Bawerk's theory not only makes it a fruitful avenue of introducing students to prices in courses on principles of economics (Egger 1998), it also allows us to more easily get an overview of the connection between specific markets and the general economy. It can therefore also serve as the basis for fruitful discussions of deadweight loss, in the classroom or outside of it.

We do not mean to suggest that only by following Böhm-Bawerk can we realize the limitations of the standard analysis of welfare costs from taxation. Ramsey (1927) in an early work described the secondary effects on other markets from an excise tax and suggested a system of taxes and bounties to keep the tax neutral. Harberger (1964, 34) showed how the welfare loss from a tax on one good is partially offset by welfare gains in other markets, and argued that we could measure this partial offset as the area under the triangle i.e., as the fall in quantity consumed, since this fall reflects a potential increase in the consumption of some other good. We will argue that both these contributions fall short of describing the secondary consequences of taxation on other markets accurately and we present a simple graphical illustration to convey the main idea in a classroom setting.

Our argument is based on the fact that the price elasticity of demand determines changes in total expenditure of buyers after a price change. Total expenditure in one market can only be increased, *ceteris paribus*, by either decreasing the cash balance or lowering total expenditure in other markets. A lower total expenditure in one market implies an increase in the cash balance or an increase in total expenditure on other markets (or both). These secondary effects are important in order to assess the overall welfare effects of an excise tax.

The paper will proceed as follows. First, we will set out the standard account of deadweight loss in section 2. Then we will turn to explain the shortcomings of this account in neglecting the secondary effects of taxation in section 3, and then in section 4 revisit the welfare-economic implications of taxation. Section 5 concludes.

## 2. The standard microeconomic account

The conceptual tools used in the treatment of so-called deadweight loss in relation to taxation have a long history. Jules Dupuit in 1844 first developed the idea of consumer surplus (Ekelund and Hébert, 1999, 2002), understood as the excess in welfare over the price paid enjoyed by a consumer, although it was not until Alfred Marshall (1920) that the terminology of consumers' and producers' surplus became established. Following Marshall, A. C. Pigou

made extensive use of consumer surplus and other welfare-economic concepts, in early papers (1904) as well as in his famous *Economics of Welfare* (1932). He also made extensive use of diagrammatic expositions in the mathematical appendix to *Economics of Welfare* and some of these diagrams, and the reasoning behind them, bear an unmistakable resemblance to the discussions of deadweight loss - whether from monopoly or taxation - we find in modern textbooks.

The concept of deadweight loss in relation to the burden of taxation was introduced to economics by Hotelling (1938), who made his indebtedness to Dupuit explicit, as “dead loss” and also advanced the now standard argument that dead loss would be slight if either the demand or the supply curve is “very steep” (i.e., inelastic) in the neighborhood of the equilibrium point. Hotelling even suggested that there would be no dead loss from a tax on the rental value of land, since the supply of land is vertical (ibid., 256). The idea of dead loss quickly caught on after Samuelson (1952, 1960) rebranded it as deadweight loss (see Deardorff, n.d.). In the first article, Samuelson only incidentally mentioned deadweight loss as one income effect from tariffs (1952, 294), although it is clear that he attaches the meaning to it current in modern economics. In his 1960 article, Samuelson (1960, 24) refers to deadweight loss as though it was by now standard in economics. The classic graphical presentation was pioneered by Harberger (1964). After Samuelson and Harberger, the terminology and theory of deadweight loss became ubiquitous, and nowadays the theory amounts to a virtually unchallenged part of economic teaching.

Mankiw (2015, 155-70) provides a good example of the standard analysis of deadweight loss from taxation and is our main guide for the following brief exposition. The price-elasticity of supply and demand is central. Their relative strength determines the tax incidence, that is, how the burden of the tax is spread between buyers and sellers. The stronger the price-elasticity of demand compared to the price-elasticity of supply, the stronger the reduction in producer surplus and the heavier the burden for suppliers. In case of a perfectly price-elastic (i.e. horizontal) demand schedule, as imagined in the pure and perfect competition model for an individual firm, sellers would bear the full burden of the tax. In contrast, if the demand schedule is perfectly price-inelastic (i.e. vertical) over the relevant price segment, buyers would bear the full tax burden.

The total revenue extracted from both sellers and buyers through the tax is not regarded as a loss in total welfare, but rather as a means of redistribution. It is taken from one party and given to another and is treated as neutral to the overall welfare of society in the standard account. However, on the margin, any excise tax reduces the exchange volume on the market where it is imposed as it raises the price and thereby prevents exchanges that would have been mutually beneficial in the absence of the tax. This corresponds to a reduction in consumer and producer surplus that is not transferred to any other party, but is simply lost. No tax can be extracted from an exchange that does not take place. This loss in the exchange volume and the corresponding loss in the mutual gain of buyers and sellers is the deadweight loss. The more price-elastic both supply and demand are, the larger its size.

**Figure 1: Deadweight loss on a market with excise tax as a function of the price elasticity of demand**

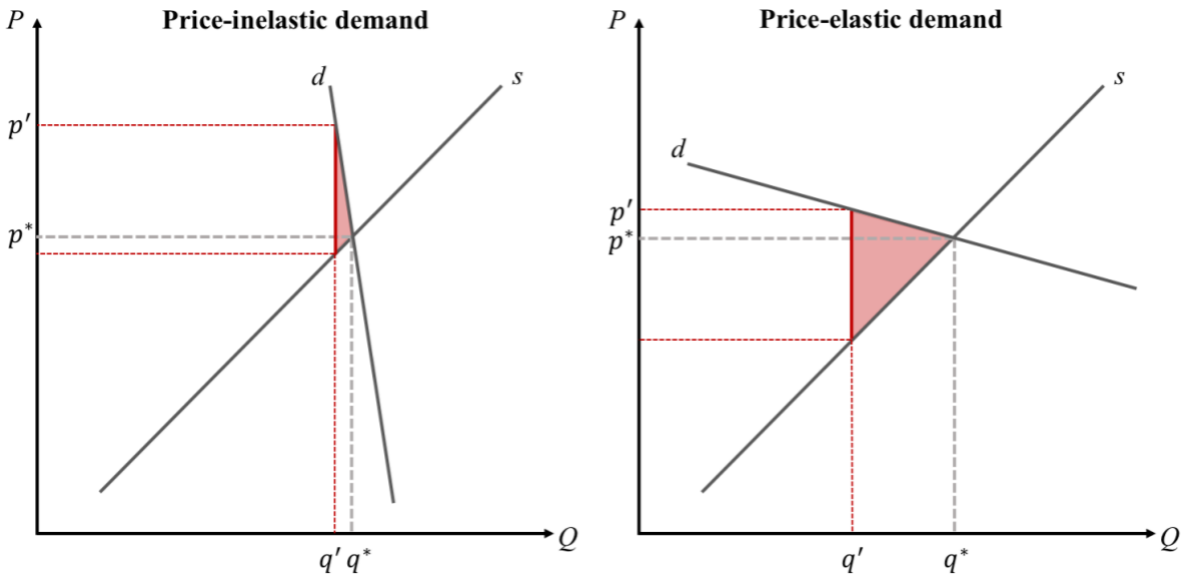



Figure 1 illustrates the standard account. For a given supply schedule, the deadweight loss increases as the demand schedule becomes more price-elastic (i.e. flatter) and the reduction in the exchange volume reflected by the distance between $q^*$and $q'$ increases. The area of the red triangle between the supply and demand schedules reflects the deadweight loss that occurs on the market. The tax drives a wedge between the supply and demand schedules and precludes the otherwise mutually beneficial exchanges between $q'$and $q^*$. As Mankiw (2015, pp. 161-162) summarizes:

> The lesson [...] is apparent. A tax has a deadweight loss because it induces buyers and sellers to change their behavior. The tax raises the price paid by buyers, so they consume less. At the same time, the tax lowers the price received by sellers, so they produce less. Because of these changes in behavior, the equilibrium quantity in the market shrinks below the optimal quantity. The more responsive buyers and sellers are to changes in the price, the more the equilibrium quantity shrinks. Hence, *the greater the elasticities of supply and demand, the greater the deadweight loss of a tax.*

This analysis points to an important problem with taxation: in preventing otherwise mutually beneficial exchanges, it causes a welfare loss. However, the solution it suggests seems unconvincing upon closer inspection and it has diverted the attention of economists away from the normative but essential question of *how big a tax revenue should be raised in the first place* towards the positive and technical question of *how price-elasticities affect the deadweight loss in partial equilibrium*.[4] It is quite understandable why economists avoid the normative questions related to taxation, and focus instead on the technicalities once the normative questions are solved or are at least assumed to be solved. But in doing so they have to zoom out from partial equilibrium and take a broader look at the effects of a tax not only on the market where it is imposed but on all markets. Can it really be true that the deadweight loss of a tax on a good is negligible as long as the price-elasticities of supply and demand are sufficiently low?

[4] Rothbard (2009, p. 1163) came to a similar conclusion and even claimed that: “Far too much has been written on the elasticity of demand in relation to the effect of taxation.” We believe that in at least one respect there has not been enough written yet.

We can take an extreme example to stimulate our imagination. Take *life* as a good. Presumably this is the one good for which demand is the most inelastic. Once it is given to us, we cling to it and do not easily give it up. In that sense, we *demand* it, and we demand it at almost any price. Of course, not even our demand for life is perfectly inelastic as the rate of suicide varies with the subjectively felt cost of the price we have to pay for living. So the standard account tells us that there is a deadweight loss, albeit a small one, if the government would impose a tax on life. How about an onerous head tax of $500 a day and forced labor in a government factory upon failure to pay? Even if nobody opted for suicide under these circumstances, would we assume that there is no welfare loss at all to the taxpayer, or that it is perfectly compensated by the gain to the tax recipient? Probably not. Even though we cannot see the loss along the vertical demand curve for life, we intuitively know it must be elsewhere. If more and more labor is bound in government factories, we know it is missing somewhere else.

### 3. The secondary effects on other markets

There is nothing new in the proposition that we need to consider the economy as a whole to see the welfare costs of a given tax. Ramsey (1927) examined this question in some detail. He arrived at the conclusion that the welfare costs of a tax could be neutralized by a comprehensive system of taxes and bounties (subsidies). Ramsey uses the example of the consequences of a tax on sugar. When sugar is taxed, a bounty must be placed on damsons, a type of sour fruit, to ensure that consumption of damsons does not fall disproportionately. It is assumed that the two goods are complementary, so when sugar becomes more expensive, damson consumption falls. It falls more than proportionately to the fall in sugar consumption since, again by assumption, damsons are more marginal, they are less intensively valued than sugar or than other goods complementary to sugar. Ramsey's (1927, 55) general conclusion was that the whole system of taxes had to be such that the production of all commodities is reduced in the same proportion. While such a theoretical, comprehensive system of taxes and bounties might leave the shape of the production structure unchanged, it is a mistake to think that this would minimize the welfare loss. After all, if the consumers reduce their purchases of damsons, this is because they consider this to be the optimal spending pattern when faced with the new, higher price of sugar.

Harberger (1964) recognized the important interconnections between different markets when considering welfare costs of taxation. While the quantity bought and consumed of the taxed commodity or service is reduced, the quantity of some other commodity or commodities is increased. This rearrangement of the spending pattern partially offsets the loss from the tax. Graphically, it can be measured as the space beneath the triangle: i.e., the difference between quantity purchased with and without the tax. While this hints at the same result we will suggest, it is only half-way there. The importance of secondary effects on other markets is recognized, but it is erroneous to conclude that this only amounts to the shift in expenditure measured in the way Harberger suggests. After all, here too we would have to conclude that when a tax is imposed on a market with very price-inelastic demand, there are virtually no secondary effects on other markets.

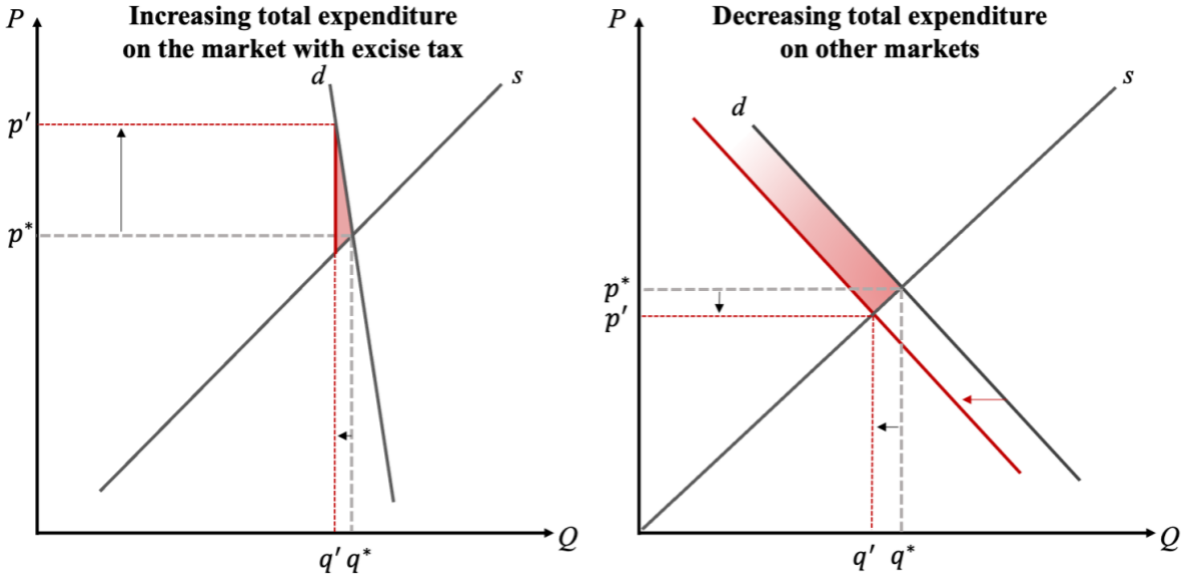
One important missing element in the standard account are the expenditure shares that buyers allocate to various markets. Israel (2018, 2020, 2022) suggests an alternative

conceptualization of substitution effects as referring to changes in the expenditure shares for various goods. This perspective is helpful in analyzing the broader effects of an excise tax. Following the expenditure approach, a genuine substitution between goods and services in response to a price change for a given good is necessary only insofar as the expenditure share allocated to that good changes and by implication at least one other expenditure share or the cash balance change in the opposite direction (Israel, 2022). If the expenditure share allocated to the good, whose price has changed, remains constant, the aggregate expenditure share on all other goods, including the cash balance demand for money, remains constant, too. In that sense there would be no genuine substitution or trade-off with respect to other goods considered in the aggregate.[5]

Let us look at the price increase for a good which occurs when an excise tax is imposed. The price elasticities of demand and supply determine the size of the increase in price that emanates from the tax imposed. The elasticity of demand more specifically determines the change in the expenditure share allocated to the good in response to the price increase. When demand is price-inelastic, the expenditure share increases after the tax is imposed. It decreases when demand is price-elastic. It remains unchanged whenever there is unit-elasticity of demand.

Price-inelastic demand according to the standard account leads to a lower deadweight loss as shown in Figure 1. However, what is not seen in the figure is that the increase in total expenditure necessitates a reduction of expenditure somewhere else in the economy. Such a reduction implies a loss in consumer and producer surplus, and a reduction in the volume of mutually beneficial exchanges on other markets that are not taken into account. Figure 2 illustrates the overall deadweight loss as the aggregate demand schedule on all other markets is shifted inwards.

**Figure 2: Overall deadweight loss from an excise tax with price-inelastic demand**

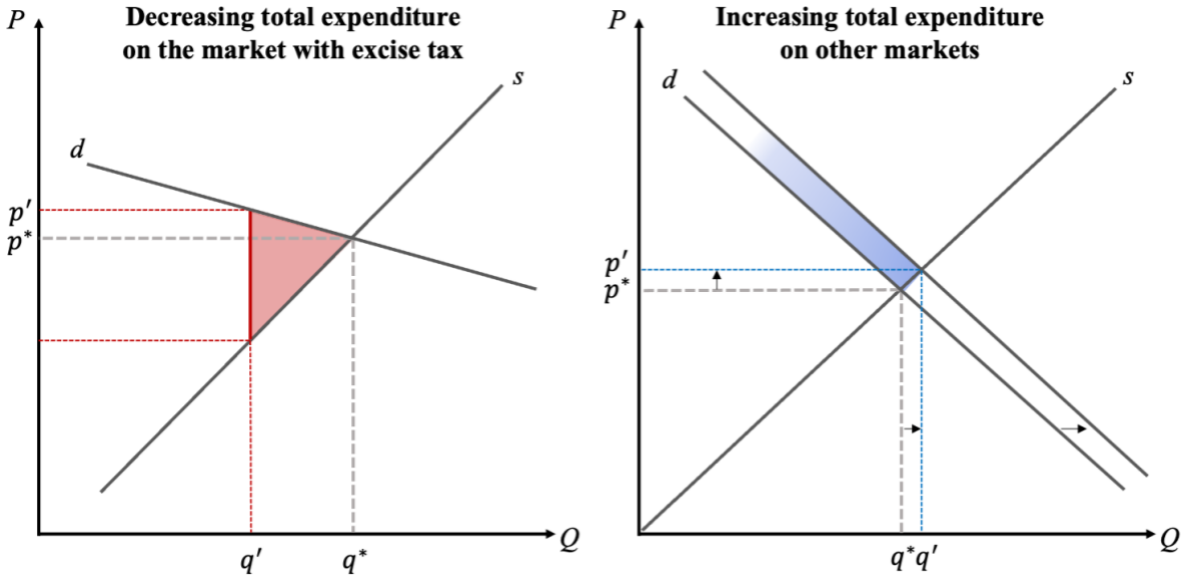



[5] It is possible, however, that on some specific, narrowly defined other market the expenditure share is reduced, while it is increased on another. But such level of detail would render the following exposition unnecessarily complicated.

In this situation, the relationship between the taxed good and all other goods considered in the aggregate is one of complementarity.[6] The upward movement along the demand curve of the taxed good is accompanied by an inward shift of the demand curve for other goods. Buyers reduce their demand for other goods in order to be able to keep the reduction in the quantity demanded of the taxed good small. The aforementioned expenditure approach to substitution effects would identify a positive substitution effect with respect to the quantity demanded of the taxed good. The latter is kept relatively high by increasing the expenditure share at the expense of the demand for other goods (Israel, 2022).[7]

In a situation where the demand for the taxed good is price-elastic, its relationship to other goods considered in the aggregate becomes one of substitutability.[8] The substitution effect according to the expenditure approach is then negative. The imposition of the excise tax triggers a movement along the price-elastic demand curve and leads to a reduction in expenditure on that market. This in turn implies an increased expenditure for other goods, potentially including money in the form of an increased cash balance. Other goods are bought in order to substitute the taxed good. This increase in demand for other goods leads to an increase in total surplus on other markets that is again not noticed in the standard account. Figure 3 illustrates the case.

**Figure 3: Overall deadweight loss from an excise tax with price-elastic demand**




By focusing on price-elasticity of demand as well as the expenditure shares that result from them both on the taxed market and the rest of the economy, we can see that the overall deadweight loss from an excise tax is overestimated when demand is price-elastic as

[6] Another way of saying this is that the cross-price elasticity of demand is negative. As the price for the taxed good increases, the demand for other goods decreases.

[7] Note that standard microeconomic substitution effects after a price increase are always negative (Varian, 2010, p.142). In contrast, the expenditure approach conceptualizes the income effect as being the hypothetical effect on the quantity demanded that would emerge without any adjustments to the expenditure shares, that is, if demand would be unit price-elastic (Israel, 2022). From that perspective, it is the income effect that is always negative after a price increase. It can be reinforced, weakened or even reversed by a positive substitution effect.

[8] The cross-price elasticity is positive. As the price of the taxed good increases, consumers demand more of other goods.

consumer surplus and producer surplus on at least one other market increase (blue area in Figure 3). The deadweight loss is underestimated when demand is price-inelastic as producer and consumer surplus on at least one other market decrease (read area in right panel of Figure 2).

While the connections between demand for different goods and deadweight loss across all markets are invisible or at least ignored in the standard approach, considering the interconnectivity of all markets can explain what is going on (Böhm-Bawerk 1930, book IV). Particular goods and prices can never be considered only in isolation as they are always connected to the greater whole of the economic system. Mises (1998, p. 392), in explaining the connexity of all prices, emphasized that "[a] price is expressive of the position which acting men attach to a thing under the present state of their efforts to remove uneasiness. It does not indicate a relationship to something unchanging, but merely the instantaneous position in a kaleidoscopically changing assemblage (...) What is called a price is always a relationship within an integrated system which is the composite effect of human relations."

Supply and demand diagrams are useful in explaining price formation in specific markets, but the supply of and demand for a specific good is always connected to the markets for other goods. This is clearly seen when we remember that any specific supply and demand diagram is always derived from the value scales of the individuals exchanging in the market. Since all goods are related ordinally on the value scales of individuals, it is clear that changes in the terms of exchange on one market in isolation cannot but affect all other markets as well.

These changes are communicated through the general medium of exchange, viz., money, which enters as one term of every exchange in all markets. In order to show this clearly, we can construct a table showing the relative positions of different goods, including money, on an individual's value scale. To simplify matters we will assume there are only three kinds of goods in existence: horses, barrels of fish, and monetary units. At the outset of the market day our individual Smith has only money in his possession and is interested in buying horses and fish (indicated by being in parentheses on his value scale, following the notation of Rothbard (2009, p. 106ff)). What price he is willing to pay for each good we can see on his value scale. At a price of 10 monetary units (m.u.) he is a buyer of neither horses nor fish. At a price of 9 m.u. per horse he will buy one horse, as the horse is above the m.u. on his value scale and so on. At a price of 3 m.u., Smith will buy 5 horses. This is Smith's demand schedule for horses which we could plot as a demand curve. We can do the same for barrels of fish if we so desire. Each market day Smith comes to the market and spends his income on horses and fish.

Table 1

| **Smith's value scale** | |
|---|---|
| 1. | 10 m.u. |
| 2. | (A horse) |
| 3. | 9 m.u. |
| 4. | (A barrel of fish) |

| | |
|---|---|
| 5. | (A second horse) |
| 6. | 8 m.u. |
| 7. | (A third horse) |
| 8. | 7. m.u. |
| 9. | (A fourth horse) |
| 10. | (A second barrel of fish) |
| 11. | (A third barrel of fish) |
| 12. | 6 m.u. |
| 13. | 5 m.u. |
| 14. | 4 m.u. |
| 15. | (A fifth horse) |
| 16. | (A fourth barrel of fish) |
| 17. | 3. m.u. |

Let us assume that the market price of horses is 3 m.u. Smith buys 5 horses at this price and the seller makes a total revenue of 15 m.u. (assuming no other buyers.) Now the government imposes a new tax on the sale of horses of 3 m. u. per horse. Smith's value scale has not changed, so when he next comes to the market, he is only willing to buy 4 horses, since the fifth horse he values less than 6 m. u. The seller now only makes 12 m.u., a loss of 3 m.u. compared to what he would have earned in the absence of the tax, and Smith has lost the service of the fifth horse as well as of the 9 m.u. he has had to pay extra. The deadweight loss is expressed in these two losses of the seller and the buyer. At the same time, the state has made a gain of 12 m.u.

However, so far we have only looked at the horse market, but it is clear that the fish market will also be affected. Smith's income has not increased, after all, so the higher outlay on horses will have to come from somewhere else. Smith will either have to draw down his cash balance or spend less on fish. Let us assume that the market price of fish at the outset is 4 m.u. per barrel. Smith then spends each market day 12 m.u. on fish and 15 m.u. on horses for a total outlay of 27 m.u. Let us assume that he does not add to or detract from his cash balance. When the tax is imposed, we can now see that his fish spending will also be affected. In fact, at the current price of fish he would not be able to buy any fish out of his income. At the same time, we can tell from his value scale that he prefers at least one barrel of fish to the fourth horse (and to the third and second as well, for that matter). There are two ways this problem can be resolved: either the price of fish falls - a reasonable assumption given the steep fall in demand for fish - and Smith can buy at least 1 barrel of fish; or Smith decides to spend some of the cash he's holding, as he now discovers that prices have changed from what he expected them to be.

Most likely, it will be a mixture of the two: the price rise in horses indicates that the purchasing power of money is falling, although this is somewhat compensated by the fall in the price of fish.[9] However, since we can see from his value scale that Smith on the margin clearly prefers horses to fish, the price of horses is likely to be much more important to him in evaluating money. Therefore, the marginal monetary unit he is holding in his cash balance will be worth less to him now and he will want to get rid of it. At the same time, the fall in demand for fish means that the price falls to 3 m.u. per barrel. Smith therefore decides to buy 4 horses and 2 barrels of fish for a total expenditure of 30 m.u. He funds this purchase by drawing down his cash balance by 3 m.u.

The loss from the tax is therefore: the loss of 3 m.u. in revenue to the seller of horses; the loss of 6 m.u. in revenue to the seller of fish; the value of the fifth horse to Smith; the value of the third barrel to Smith; and the value of 3 m.u. he has spent from his cash balance.

These losses are only the first step, however, since Smith cannot continue to draw on his cash balance indefinitely. Long before he runs out of cash, the value of the marginal unit of money will be worth more to him than the marginal units of fish or horses. There will be a tendency for Smith's purchases to again correspond to his income. The drawdown of his cash balance will probably be temporary. Indeed, since what Smith aims at in holding money is a certain amount of real purchasing power, it is likely that he on subsequent trading days will restrict his purchases to add to his cash balance. The amount of nominal m.u. he holds will thus increase. However, Smith is now clearly poorer, as his income can no longer buy him the same amount of real goods. This will also be reflected in his cash holding: while the nominal amount may increase, the real purchasing power of his cash holding will be smaller than it was before.

The welfare losses are thus three-dimensional: the producers lose revenue due to the tax, Smith loses the use of the goods he can no longer afford, and he suffers a loss of purchasing power. The loss of purchasing power is ambiguous when the tax is imposed on a market with a price-inelastic demand curve, but clearcut in the case of price-elastic demand. Similarly, some producers can make a gain by supplying substitutes if the tax is imposed on a market with an elastic demand curve, while all producers suffer losses in the opposite case.

The figures shown above merely illustrate a general tendency, but the size of the areas that represent welfare losses and welfare gains on the aggregated market for other goods and services are not proportional to the deadweight losses in partial equilibrium. They are not directly comparable. Is it still possible to draw any general conclusions about under what conditions overall welfare is reduced least? The standard argument is misleading in that it exaggerates the advantage of taxing goods with price-inelastic market demand, but is it wrong? Is there any way of comparing the overall welfare loss in both cases at least in theory?

## 4. A general welfare assessment

We have to think about what makes demand for a certain good elastic or inelastic in the first place. The most important and commonly mentioned determinant is the availability of close

[9] Note that in the case of a tax imposed on a market with a price-elastic demand, there is a clear-cut fall in the purchasing power of money (see Figure 3).

substitutes (Varian, 2010, p. 273; Mankiw, 2015, p. 90) that satisfy a similar need at a similar price. If there are perfect substitutes readily available at the same price, demand is perfectly elastic. If there are no substitutes available but the need to be satisfied by the good is essential, demand tends to be inelastic. All other cursory determinants of elasticity that are often mentioned in textbooks are related to the availability of close substitutes and the importance of the need that is satisfied. Mankiw (2015, p. 91) mentions, for example, the *definition of a market* or a good, that is, the analytical boundaries drawn. Narrowly defined markets, such as the market for blue pencils in Angers, Pays de la Loire, tend to have a higher price elasticity of demand than more broadly defined markets, such as the market for pencils in France, precisely because the closest substitutes (such as red pencils in Angers) are subsumed into the broader market and are thus not available as substitutes outside of it by definition.

This is also the reason why the demand for *life* in the rather extreme example mentioned above tends to be more inelastic than for almost all other conceivable goods. It refers to the broadest possible definition of a good, since life is complementary to the enjoyment of all other goods. There is, strictly speaking, only one alternative to it, and for most people it takes a lot before they consider it to be a close substitute.

Hence, demand tends to be inelastic whenever there are few viable alternatives with which to substitute the good in question. The standard deadweight loss from an excise tax as shown in Figure 1 is small precisely because there is no way out for the buyers. There is no getting around the tax. While this might be a good argument for such a tax from the vantage point of public finance as it increases government revenue, all other things equal, it is certainly not a good argument when it comes to welfare economics. The claim that overall market distortions are reduced when the tax is imposed on a market with price-inelastic demand is misguided, since distortions from the tax do not exclusively materialize on the market where it is imposed.

A higher deadweight loss along a price-elastic demand curve is in that sense a good sign from the point of view of the buyers, because they have, given the increased price due to the tax, better and readily available substitutes that they can buy instead. In contrast, a smaller deadweight loss along a price-inelastic demand curve indicates that buyers have no such alternatives.

We have not explicitly discussed the price-elasticity of supply in this context, because we wanted to highlight the importance of expenditure shares. But a similar analysis can be provided for the supply side of the market. When supply is very responsive to price changes, i.e. elastic, producers in that market have alternatives available to them. They can avoid the tax either by entering other lines of production or by enjoying leisure instead. Coming to grips with that potential transition within the graphical exposition above is a difficult task, however. One could argue that part of the transition into other lines of production is already reflected in the right panels of Figures 3 by the movement along the aggregate supply schedule due to the shift of aggregate demand and the corresponding increase of expenditure outside of the taxed market. An additional rightward shift of the aggregate supply schedule in Figure 3 would only reinforce our analysis. In Figure 2, however, where demand is price inelastic on the taxed market, net prices received by producers go down everywhere as a result of the tax. It is not immediately clear whether a transition into any other line of production would be worthwhile. Instead, we can see that the excise tax on a specific market reduces net prices received by producers, and hence returns and production everywhere (Salin, 2014). In fact, in the

theoretical state of general equilibrium, the rate of return in all lines of production would tend to be equal, so the rates of return would be expected to go down everywhere due to a tax, regardless of price elasticities.[10]

In contrast, if production efforts remain bound up in the taxed market along an inelastic supply curve, producers have no better alternative but to carry a relatively high burden of the tax. There probably is no such thing as a perfectly inelastic supply curve. Not even Hotelling's (1938, p. 256) suggestion that there would be no "dead loss" from a tax on the rental value of land, since the supply of land is vertical, is convincing. The stock of usable and cultivated land for specific purposes that exists at any given moment in time is indeed fixed (vertical), but it may change over time as a function of the expected returns from it. Landownership may be abandoned and cultivated land may fall back into wilderness.

In fact, the stock of any good at any given moment in time is fixed and hence inelastic, but this should not be confused with the standard analysis of demand and supply schedules. They refer to units of a good that actors want to buy and sell *over a certain period of time*. Exchanges never take place instantaneously. They are not a snapshot of a specific point in time. Due to this time element in standard demand and supply analysis, which is different from the total stock analysis (Rothbard, 2009, pp. 137-142), there is some degree of elasticity also for the supply of land.[11]

When considering the total stock of land understood as all nature-given factors of production, a perfectly inelastic (vertical) curve is a sufficiently accurate approximation.[12] What would then be the effect of a tax on the total stock of land? First of all, it is important to note that it would not be a tax on the selling price of a unit of land. If it were, it would hardly be a tax on the stock of land, but only a tax on the subset of land that is actually exchanged on the market over any given period of time. The analysis would then be the same as above. However, the tax we are looking at would have to be a property tax that the owners of any piece of land pay on a regular basis. Let us assume that it is simply a fixed annual tax per acre regardless of its quality.

This scenario changes the framework within which we can analyze the effects of the tax. Such a tax would not at all drive a wedge between the standard demand and supply schedules, that is, the quantity offered for sale and the quantity demanded by potential buyers at any given price. It would instead tend to reduce demand and increase supply, because the property tax reduces the present value of any given piece of land, i.e. the discounted sum of expected future net revenues earned from that land. Hence, current owners of land would be more willing to sell (increased supply) at any given price, and potential future owners would be more hesitant to buy (decreased demand). Although the selling prices per unit of land would

[10] This would also be true for Figure 3. The rate of return could diminish in the aggregated market for other goods and services due to an increase in the prices of (specific) factors of production. This could be reflected by a clockwise rotation of the supply schedule, such that the integral below the curve and between 0 and $q$, which is commonly interpreted as the cost of production, is increased.

[11] The time horizon is indeed another commonly cited factor that determines elasticity, but it is again related to the availability of substitutable goods, because it tends to be easier to find viable alternatives the longer the time horizon (Alchian and Allen, 1983, pp. 28-29). Land as a factor of production is to some degree substitutable by capital and labor.

[12] Technological progress could still in some sense increase the stock of nature given factors of production that we have access to and thus increase the total stock of land over time.

decrease, private individuals and businesses would face a stronger economic incentive to economize on land use. This too constitutes a welfare loss. Owners of land see their revenues decline and part of that revenue loss will translate into higher rental prices for land. The tax thus has an impact on all businesses. On the margin the tax will drive land out of productive use in private ownership and into some form of public or common ownership as Henry George (1935 [1879]), the great advocate of land taxes, himself analyzed.[13] This is analogous to the mutually beneficial exchange agreements precluded by an excise tax. It is precisely here where something like a deadweight loss can be observed and it depends most notably on the size of the tax. The larger the tax, the stronger the distortion in the private control of factors of production, and the larger the portion of land and its product extracted from private owners.

Land that is not held and exchanged privately cannot be taxed, just like exchanges of goods cannot be taxed when the goods are not produced in the first place and are thus never bought and sold (standard deadweight loss). Yet, land is different in that it does not have to be produced. It will still be there, but not in private ownership. The state cannot tax it, but can still employ it in various ways. Overall welfare then crucially depends on how this is done. In Spencer's (2012 [1858], pp. 79-80) discussion of the doctrine "that men are equally entitled to the use of the earth," he claims that public ownership in land is compatible "with the highest state of civilization" as the state could operate much like the management of a joint stock company representing the citizens as equal share-holders and offering pieces of land for use to the highest bidders. Every individual would be free to bid or refrain. Such a system could indeed turn out to be economically very efficient in allocating land to its most productive use, but is not without its drawbacks.[14]

## 5. Conclusion

The standard approach to analyzing deadweight loss from taxation is misleading in that it fails to consider the secondary effects of taxation upon consumer behavior in other markets. In so doing, it underestimates the deadweight loss that results from the taxation of goods with inelastic demand and overestimates that which results from taxation of goods with elastic demand. An approach that considers these effects demonstrates that taxation of goods with inelastic demand decreases consumer spending on all other goods, decreasing consumer and producer surplus resulting from exchanges that would have otherwise taken place. It also demonstrates how this takes place through the medium of money expenditures and that the value of money is also affected by the imposition of taxes.

Further, contrary to earlier attempts at clarifying this point, there is no way in principle to determine whether the taxation of a good with inelastic demand is less distortive than taxation of a good with elastic demand. In a strict sense, there is no such thing as a neutral tax (Rothbard, 1981): in the case in which a tax does not result in a decrease of the quantity exchanged of the taxed good, welfare is reduced somewhere else. Indeed, an argument could be made to the effect that producers and consumers would be better off if taxes were levied

[13] In commenting on Herbert Spencer's nationalization of land, George (1935 [1879], p. 404) claimed to "propose to accomplish the same thing in a simpler, easier, and quieter way, than that of formally confiscating all the land and formally letting it out to the highest bidders." This passage is cited in Rothbard (2011, p. 580).

[14] We refer the interested reader to Rothbard's (2011) critical discussion of Henry George's vision and its economic and moral implications, which apply equally to Spencer's outright nationalization of land.

on goods with an elastic demand and supply, since, as we have shown, this means that they can more easily avoid the negative impact of the tax by redirecting production efforts and spending their money on close substitutes instead. However, it is not possible for the *wertfreie* economist to make a judgment as to whether taxing elastic vs. inelastic goods leads to bigger or smaller welfare losses, since this involves not just a value judgment but an interpersonal comparison of utility. Economists have accepted the impossibility of such comparisons since Robbins.

All we can say is that the standard account overestimates the deadweight loss of taxes on goods with an elastic demand curve and underestimates the deadweight loss of taxes on goods with an inelastic demand curve; that is all. Students of economics would benefit from exposure to these problems of the interconnectedness of markets from their first lessons on deadweight losses. We have presented a simple and straightforward graphical exposition of our argument that can easily be incorporated in classroom discussions in introductory courses without diving into the more advanced notions of equivalent and compensating variations.

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