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ABSTRACT

Harberger triangles are used to calculate the efficiency costs of taxes, government regulations, monopolistic practices, and various other market distortions. This paper considers the historical development of Harberger triangles, the associated theoretical controversies, and the contribution of Harberger triangles to subsequent empirical work and theories of market imperfections. Prior to the publication of Arnold Harberger's papers, economists very rarely estimated deadweight losses. The empirical deadweight loss literature expanded greatly since the 1960s, making such estimation now quite common. Meanwhile, critical evaluation of deadweight loss estimates led to new theories of rent-seeking and other inefficiencies of economies with multiple distortions.

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Introduction.

Prevailing economic wisdom is highly critical of injudicious tax policies or government regulations, uncorrected externalities, unchecked monopolistic practices, and various other market failures. When economists are challenged to quantify the economic costs of associated price distortions, it is standard practice -- and has been since the 1960s -- to use a small number of assumptions and selected elasticities to estimate areas of the relevant "Harberger triangles." This simple and straightforward exercise has numerous applications and the virtue of producing answers rather than conjectures.

Harberger triangles come in many shapes and sizes. Figure 1 offers an illustration of such a triangle for the simple case of an excise tax. Point A of Figure 1, at which the demand and supply schedules intersect, denotes market equilibrium in the absence of the tax, with quantity q_1 transacted at price p_1. Introduction of an excise tax at rate τ, payable by firms selling the commodity, shifts the supply schedule upward by τ. At the new market equilibrium, firms sell q_2 units of the commodity at a market price of p_2, receiving (after tax) $p_3 = (p_2 - \tau)$. Market equilibrium at point A in Figure 1 has the feature that marginal consumption benefits equal marginal production costs. The excise tax drives a wedge between marginal benefits and marginal costs. At consumption level q_2, consumers are willing to pay any amount up to p_2 for additional units of the good, and suppliers would readily provide additional units of the good for any price of p_3 or greater -- but these additional transactions do not take place, due to the effect of the tax wedge. The loss associated with the foregone transaction of a single unit at q_2 is: $p_2 - p_3 = \tau$. Summing differences between the prices that consumers would pay, and the prices at which suppliers would provide goods, for all units between q_2 and q_1, indicates the welfare loss due to the excise tax, and is represented by the shaded "Harberger triangle" in Figure 1. In this case, the height of the Harberger triangle is the tax rate, its base is the amount by which sales fall in reaction to the tax, and its area is one measure of the efficiency cost, or "deadweight loss," or "excess burden," associated with the excise tax.

Harberger triangles, now common fare, were once rare delicacies. In two influential papers published in 1964, Arnold C. Harberger (1964a) offered a clear and persuasive derivation of the triangle method of analyzing deadweight loss, and (1964b) applied the method to estimate deadweight losses due to income taxes in the United States. Having earlier used the triangle method to calculate the size of monopoly-induced distortion in the U.S. economy (1954), corporate income taxes (1959a), and various and sundry distortions to the Chilean economy (1959b), Harberger shortly thereafter (1966) produced estimates of the welfare cost of U.S. capital taxes. In a subsequent survey, Harberger (1971) clarified various aspects of this method and addressed a number of its perceived shortcomings.[1]

While the theory of deadweight loss measurement was well established by the 1950s, economists very rarely estimated deadweight losses prior to the appearance of Harberger's work. Harberger's papers illustrated the techniques, the usefulness, and the realistic *possibility* of performing such calculations, and in so doing, ushered in a new generation of applied normative work. Deadweight loss triangles became known as "Harberger triangles" due to the broad influence of Harberger's papers on subsequent research. The new deadweight loss estimates, in turn, led to an important reevaluation of the welfare effects of multiple distortions in an economy, and consideration of the possibility that various market failures may transform Harberger triangles into even larger trapezoids.

This essay examines Harberger triangles from three sides. The first is the place of the Harberger triangle in the historical development of the theory of consumer surplus and its use in evaluating the costs of economic distortions. The second is the theoretical controversy evoked by applications of Harberger triangles. And the third is the impact of Harberger triangles on subsequent empirical work and theories of market imperfections.

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1 These papers and others are reprinted, together with interpretive notes, in Harberger (1974).

Before Harberger.

It was understood long prior to the 1960s that the welfare cost of a commodity tax could be approximated by the size of what would later come to be called the Harberger triangle. Jules Dupuit (1844) is generally credited as being the first to observe that demand schedules can be used to infer the welfare effects of price changes. Dupuit was an engineer who was interested in applying economic principles to evaluate public works, and who was unimpressed by the existing economic orthodoxy (due largely to Jean-Baptiste Say) that equated the value of a good with its market price. Dupuit notes that consumer expenditure constitutes a *lower bound* on the total valuation of an item. He produced a diagram much like Figure 1 (with axes reversed),[2] in which price changes induced by taxes or tolls reduce consumer satisfaction by more than the revenue they generate. Being careful to distinguish resource transfers (from consumers to the state) via taxes and tolls from resource losses due to inefficiency, Dupuit (1844 [1969], p. 281) describes the welfare loss triangle (the shaded area in Figure 1) as "the utility lost both to the taxpayers and the fisc [the public sector]." He went on to make other trenchant observations, such as that the area of this welfare loss triangle is generally a function of the square of the tax rate, and that there exists a tax rate beyond which tax revenue falls.

Dupuit's insight was shared by Fleeming Jenkin, who, like Dupuit, was an accomplished engineer, but who was unaware of Dupuit's work of the 1840s. Jenkin was stimulated by the work of Stanley Jevons, a professor at the University of Manchester in England, who, in his classic *The Theory of Political Economy* (1871), discusses the effect of price changes on utility. Jevons, who was also apparently unaware of Dupuit's work, correctly notes (1871 [1911], p. 147) that, for a very small rise in the price of a commodity, a consumer's

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2 The economics profession has Alfred Marshall to thank for putting quantity on the abscissa and price on the ordinate of supply-and-demand diagrams such as Figure 1, and, through his influence, institutionalizing this arrangement. Writing 46 years before Marshall, Dupuit used the more mathematically compelling alternative of price on the abscissa and quantity on the ordinate.

utility falls by an amount equal to the product of the price change, the quantity purchased, and the marginal utility of income. Jevons expresses reservations, however, about expanding this method to consider nontrivial price changes, due to the nonconstancy of the marginal utility of income.[3]

This approach was unsatisfactory to Jenkin, who rediscovered the use of supply and demand curves (Jenkin, 1870); uses the curves to construct a diagram that is remarkably similar to Figure 1 (again, with axes reversed) and to the diagram used by Dupuit (Jenkin, 1871/72); and then applies the analysis to calculate the incidence of a tax (the distribution of its burden between buyers and sellers) and the efficiency loss it creates. Jenkin argues (1871/72, pp. 109-110) that his [and Dupuit's, as it happens] method of determining the cost to consumers is superior to Jevons's because

> ... utility, as he [Jevons] defines it, admits of no practical measurement, and he bases his curve, not on the varying estimates of value set by different individuals each on what he has or what he wants, but on the varying utility to each individual of each increment of goods. The above estimate of the gain due to trade deduced from the demand and supply curves as originally drawn in my Recess Studies article is, I believe, novel, and gives a numerical estimate in money of the value of any given trade, which might be approximately determined by observing the effect of a change of prices on the trade; the curves throughout their whole lengths could certainly not, in most cases, be determined by experiment, but statistics gathered through a few years would show approximately the steepness of each curve near the market price, and this is the most important information.

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3 Jevons (1871 [1911], p. 148) writes: "The price of bread, for instance, cannot be properly brought under the equation in question, because, when the price of bread rises much, the resources of the poor are strained, money becomes scarcer with them, and ψc, the [marginal] utility of money, rises."

The intuition that Dupuit and Jenkin offer in deriving their welfare triangles is essentially unchanged today. However, a number of details on which they are silent became the focus of more than a century of subsequent research. One of the earliest questions was raised by Léon Walras, a professor at Lausanne and the founder of modern general equilibrium theory. He was well aware of Dupuit's work, and while conceding (1874 [1954], p. 443) it to be "very thorough and ingenious," felt compelled to "call attention to an egregious error which Dupuit committed in a matter of capital importance." Walras explains that a consumer's willingness to pay for an item is a function not only of its price, but also of the consumer's income and the utility potentially available from consuming all other commodities. Walras evidently felt that this dependency makes Dupuit's concept of consumer surplus too situation-specific to serve as an objective measure of satisfaction derived from consumption, and therefore inappropriate for deadweight loss measurement as well.

More broadly, Walras's criticism can be viewed as raising questions of comparability of utility, both across people and across time. The point of Dupuit's analysis is to determine the money equivalent of the welfare effect of a price change.[4] But a given amount of money may generate satisfaction that differs between individuals or for the same individual at different times. Furthermore, the marginal utility of income depends on prices, making welfare comparisons problematic when prices differ between situations. If an excise tax raises the price of a good from 12 to 17 francs, thereby reducing aggregate "consumer welfare" by, say, 6,200 francs, it is not clear whether the 6,200 franc reduction reflects the valuation of utility when the price is 12, 17, or some intermediate level.

This ambiguity troubled Alfred Marshall considerably less than it did Walras. Marshall, the most influential economist of his time, canonized the Dupuit-Jenkin diagram in his *Principles of Economics* (1890

4 Dupuit's primary concern was with valuing new projects, such as new roads or canals, and he considered the effect of price changes due to taxes or tolls partly as expositional devices. In his framework, the effect of a new road is to reduce the price of road travel from infinity to the amount travelers must pay in tolls.

[1920], p. 473). Marshall coined the phrase "consumers' surplus" to describe the area above the price line and below the demand curve, conceding that this captures exactly the change in consumer welfare only if the marginal utility of income is held constant. Marshall's formulation aroused considerable subsequent controversy, due in part to its influence and in part to certain ambiguities about how, exactly, he intended demand curves to be constructed. While Marshall stresses the importance of constancy of the marginal utility of income to obtain exact answers, in other instances he appears to favor holding income and consumption levels constant, formulating demand curves on the basis of amounts that consumers would willingly pay to obtain varying quantities of the good in question.

A practical defense of Dupuit's method is provided by Harold Hotelling, who argues that it relies on properties of demand curves that they are likely to satisfy. Hotelling was primarily a mathematical statistician, though he held an appointment in the Economics Department at Columbia from 1931-1946, and his occasional forays into economic theory represented major contributions to demand theory, oligopoly theory, public finance, and the theory of natural resources. In an article based on his Presidential Address to the Econometric Society, Hotelling (1938, p. 242) begins: "In this paper we shall bring down to date in revised form an argument due essentially to the engineer Jules Dupuit...." Hotelling analyzes the difficulty of applying Dupuit's method to cases in which several prices change simultaneously. It might seem that such situations can be handled by calculating deadweight loss triangles separately for each taxed commodity, summing the areas to obtain a total. Unfortunately, the order in which each of the prices is taken to change affects the total calculated deadweight loss! Since, for simultaneous price changes, the order is perfectly arbitrary, a multiplicity of answers reflects that something in the calculation is almost surely amiss. Hotelling notes that this problem disappears if the so-called "integrability conditions" are satisfied. This essentially means that cross-price demand derivatives are symmetric; that is, for any two goods i and j, the change in the quantity of good i consumed as a result of a unit change in the

price of j is equal to the change in the quantity of good j consumed as a result of a unit change in the price of good i. If so, then the calculated change in consumer welfare due to several prices varying at once is unaffected by the order in which price changes are taken to occur. However, the integrability conditions are satisfied by ordinary demand curves only if income effects are either nonexistent (which is possible only for a subset of commodities) or if they have very special features (such as those generated by homothetic preferences). Hotelling invokes his earlier work (1932) to argue that income effects are unlikely to be large enough to make ordinary demand curves unsuitable for the construction of Dupuit-style triangles.

The demand curves that form the upper-right boundary of the Harberger triangle may fail to satisfy the integrability conditions, but not so the supply curves that form the lower-right boundary, since income effects are (in theory) nonexistent for firms. Consequently, subsequent theoretical work on the measurement of Harberger triangles focuses on the way in which demand curves are formed. Sir John Hicks, Oxford professor and the author of *Value and Capital* (1946), reevaluated Marshall's conception of consumer surplus and the remaining fuzziness in Marshall's notion of the demand curve. Hicks considered the conceptual experiment of fully compensating consumers for the effects of price changes on their real incomes, in the process tracing demand curves corresponding to differing prices.[5] He christened as "compensating variation" the area between such a demand curve and the initial price line. Hicks also considered the effect on market demands of extracting from consumers the money that they would willingly pay to avoid price changes, using "equivalent variation" to refer to the area between the initial price line and demand curves thereby generated. Hence, Hicks describes two methods of constructing demand curves that can be used to measure deadweight loss triangles; both maintain

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5 See Hicks (1941, 1942, 1943, 1945-46). His development of this concept, to which he elliptically refers in the first edition of *Value and Capital*, is anticipated by Henderson (1941), whom Hicks thanks (1942, p. 126). Hicks also considers alternatives to consumer surplus that are constructed on the basis of quantity rather than price variations; these alternatives are not reviewed here.

utility constant, but they differ because they are based on differing utility levels. Compensating variation effectively maintains utility at the level that obtains before the price change occurs, while equivalent variation maintains utility at the level that obtains after the price change occurs.

Measures of consumer welfare based on compensating or equivalent variation have desirable properties that have intrigued economists working in this area ever since. Specifically, the compensated demand curves on which they are based satisfy Hotelling's integrability conditions, making the resulting welfare calculations uniquely defined even if several prices change simultaneously. Endogenous changes in the marginal utility of income do not affect such measures, since utility levels are (by construction) held constant along their lengths. Compensating variation differs from equivalent variation, and they each differ from Marshallian consumer surplus in which income is held constant, to the degree that income effects are important.

Hicks was himself unimpressed by the likely importance of the distinction between welfare measures constructed using compensated and Marshallian demand curves. It is easy to see why, since a compensated demand elasticity differs from the corresponding uncompensated demand elasticity only by the consumer's marginal propensity to spend on the good in question. Unless a commodity represents an extremely large fraction of a consumer's budget, compensated and uncompensated demand elasticities will not differ greatly; and any differences between them are likely to be much smaller than the statistical uncertainty associated with demand elasticity estimates. Hicks notes at the conclusion of a paper in which he evaluates compensated measures (1943, p. 40): "When, in an earlier paper [Hicks, 1941], I first considered the possibility of the sort of analysis I have here been carrying through, I dismissed it as `a fiddling business, not likely to be of much importance.' And that still holds. Nevertheless I am glad that I have brought myself to carry it through." He adds later (1945-46, p. 68): "For most purposes, for which the the consumer's surplus analysis is utilisable at all, Marshall's measure is a sufficient approximation; but for purposes of clear thinking it is necessary that the basic measures should be distinguished,

and their relations cleared up."

The economics profession continued to perform Hicks's "fiddling business," composing numerous variations along the way. Marcel Boiteux (1951) generalizes the Hicksian measures of deadweight loss to situations in which initial prices are distorted and in which producer prices are endogenous to quantities sold. Gerard Debreu introduces (1951, 1954) an altogether different measure of deadweight loss defined to be the value (or alternatively, the fraction) of society's resources that could be abandoned, without any loss in aggregate utility, if distortions were removed.[6] James Meade (1955) analyzes the welfare consequences of interactions between multiple distortions, with an emphasis on tariffs and other trade restrictions.

By the mid-1950s, it was clear that knowledge of demand and supply conditions was sufficient to calculate welfare losses due to distorted prices -- but also that certain adjustments might be necessary in applying ordinary demand functions for this purpose. At this time, however, two important developments in economic theory emerged that were unconnected to traditional welfare analysis, but that complicated any attempt to measure deadweight loss triangles. The first was the appearance of rigorous general equilibrium theory, which seemed to imply the inappropriateness of analyzing a single market in isolation, since all markets in an economy influence each other. In particular, Corlett and Hague (1953-54) and Lipsey and Lancaster (1956-57) called attention to the possibility that introducing distortions in one market might enhance the efficiency of the economy by mitigating the effects of distortions elsewhere. The second development was the analysis of difficulties of obtaining well-behaved social decision rules from individual preferences, which suggested the impossibility of producing an overall social measure of policies affecting heterogeneous consumers -- indeed, social welfare itself

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6 Both Boiteux and Debreu acknowledge the influence of earlier work by Maurice Allais (1943), yet another engineer. Diewert (1981) identifies conditions in which the measures proposed by Debreu, Boiteux, and Harberger coincide, and King (1983) and Kay and Keen (1988) show that the application of the Hicksian measure considered by Kay (1980) (to be analyzed shortly) can be thought of as a special case of the Debreu measure.

became a problematic concept! Since full-scale general equilibrium models were virtually nonexistent, and since almost any conceivable distortion affects the welfare of multiple consumers, the applied analysis of consumer surplus was stymied.

Harberger Enters the Picture.

Harberger was well aware of this intellectual history and the knotty issues with which it is concerned. In motivating his presentation of deadweight loss estimation methods, Harberger (1964a, pp. 58-59) writes,

> The measurement of deadweight losses is not new to economics by any means. It goes back at least as far as Dupuit; and more recently Hotelling, Hicks, Debreu, Meade, and H. Johnson have made important contributions. Nonetheless I feel that the profession as a whole has not given to the area the attention that I think it deserves. We do not live on the Pareto frontier, and we are not going to do so in the future. Yet policy decisions are constantly being made which can move us either toward or away from that frontier. What could be more relevant to a choice between policy A and policy B than a statement that policy A will move us toward the Pareto frontier in such a way as to gain for the economy as a whole, say, approximately $200 million per year, while policy B will produce a gain of, say, about $30 million per year? What could be more useful to us as a guide to priorities in tax reform than the knowledge that the deadweight losses stemming from the tax loopholes (percentage depletion and capital gains) open to explorers for oil and gas are probably greater in total magnitude than the deadweight losses associated with all the other inefficiencies induced by the corporation income tax? What could be more tantalizing than the possibility (which I believe to be a real one) that the U.S. tariff,

> whose indirect effect is to restrict the equilibrium value of U.S. exports, produces by this route a gain for the U.S. from a partial exploitation of U.S. monopoly power in world markets which nearly offsets (or perhaps fully or more than fully offsets) the efficiency-losses produced by tariff-induced substitution of more expensive domestic products for cheaper imports? These and similar questions seem to me so interesting, so relevant, so central to our understanding of the economy we live in, that I find it hard to explain why the measurement of deadweight losses should be the province of only a handful of economists rather than at least the occasional hobby of a much larger group.

In his empirical work, Harberger calculates deadweight loss triangles based on demand curves constructed by returning tax revenue to consumers in lump-sum fashion, thereby forming a simple general-equilibrium economy in that all markets clear and no funds are left unaccounted. In this framework, taxes affect prices and distort individual decision-making in spite of the fact that tax revenues are ultimately returned to consumers. Because returning revenue to consumers offsets the amount of taxes that are paid, but does not offset the distortion in individual decision-making, consumers are made worse off by the imposition of the taxes. The demand curves that Harberger uses are not Marshallian demands, since consumers receive tax rebates, nor are they Hicksian compensated or equivalent demands, since utilities change. They are something different: "Harbergerian demands." Harberger notes that these demand curves can be used to generate welfare measures that are second-order approximations to those based on Hicksian demands; this claim is made more precise by Diewert (1976) and McKenzie and Pearce (1976), who identify various properties of welfare measures based on Harbergerian demands.

The empirical results are useful and interesting. Harberger (1954) finds that resource misallocation due to

monopolistic behavior in U.S. industry generates an inefficiency equal to approximately 0.1 percent of U.S. GNP; that the U.S. corporate income tax generates distortions valued at $1 billion (0.5 percent of GNP) annually (1959a); that resource misallocation of various types reduces Chilean welfare by 15 percent (1959b); that distortions to labor-leisure choices induced by the U.S. personal income tax reduce welfare by $1 billion (0.4 percent of GNP) annually (1964b); and that all U.S. capital income taxes taken together are responsible for economic losses of $2 billion (0.8 percent of GNP) annually (1966). These results have proven robust to subsequent careful picking-over and reworking, since the effects of alternative calculations and methodological specifications tend to cancel each other (see, for example, Shoven, 1976).

Harberger's efforts attracted wide attention in the economics community, particularly after publication of his 1971 survey article in the *Journal of Economic Literature*. Much of the subsequent criticism of Harberger's work focuses on three issues: the use of Harbergerian demand curves; his simplified treatment of general equilibrium; and the omission of explicit consideration of redistribution.[7] Each of these controversies deserves a few words.

Use of Compensated Demands.

Hicks and likeminded authors had been so influential that efforts to evaluate welfare without using compensated demands met immediate skepticism in the professional community. Using a demand curve based on equivalent variation -- that is, a demand curve along which the consumer's income changes in order to maintain utility at the level that exists after the price change -- consider the case of a tax on a single good, depicted in Figure 2. The compensated demand curve has a steeper slope than the corresponding Marshallian demand curve if the commodity in question is normal, since the consumer responds only to the substitution effect

7 Alan Auerbach (1985) provides a very useful interpretive survey of this literature.

of higher prices, not the income effect, and will therefore reduce consumption of a normal good by less as the price rises. The compensated demand curve and the Marshallian demand curve intersect at price $\mathbf{p}_2$, since at that point no compensation is necessary to transform Marshallian demands to compensated demands. To the left of the compensated demand between $\mathbf{p}_1$ and $\mathbf{p}_2$, the area $(\mathbf{p}_2\text{-}\mathbf{p}_1)\mathbf{q}_2 = R$ is the government's tax revenue, leaving just the shaded triangle as the equivalent variation measure of deadweight loss.

As depicted in Figure 2, the equivalent variation measure of deadweight loss is smaller than the deadweight loss measure based on the Marshallian demand curve -- but this is not always the case. If the taxed good is inferior (the income derivative of demand is negative), then the compensated demand curves have shallower slope than the Marshallian demand curves, and the equivalent variation measure of deadweight loss exceeds the Marshallian measure. And in somewhat more complicated situations than that depicted in Figure 2 -- such as cases in which several goods are taxed -- any ordering of the welfare measures is possible.

The most attractive aspects of using the equivalent-variation compensated demand curve are not apparent from the simple figure. Welfare measures based on equivalent variation are single-valued even when many prices change simultaneously, and tax alternatives that generate greater consumer satisfaction (conditional on raising a given level of tax revenue) are associated with lower deadweight loss.[8] Together, these two features make the equivalent variation measure almost irresistible to economists.

There is the complication that compensated demand curves are not directly observable, since no one actually compensates consumers for tax-induced price changes, while Marshallian demands are, in principle, observable. With sufficient information about consumer behavior that distinguishes price from income effects, however, it is possible to construct compensated demands -- and there is a sizable literature devoted to elucidating

8 Kay (1980) reformulates Diamond and McFadden's (1974) framework to offer a formal demonstration of this point.

methods to do just that.[9] It is therefore possible to use econometrically-derived estimates of consumer demands -- or, for that matter, labor supply functions, saving functions, or other behavioral responses to price changes -- to construct compensated demand functions for welfare analysis. Indeed, much of the literature since the 1980s seems to hint that estimates of deadweight loss triangles based on Marshallian or Harbergerian demands, rather than on compensated demands, reflects the use of subpar technique.[10]

Is there validity to this critique? There certainly is if what one actually desires is a measure of deadweight loss based on the equivalent variation. The Harberger triangle, as measured by either Marshallian or Harbergerian demands, does not share the feature of equivalent variation-based measures that, for a given tax collection, final utility is guaranteed to be directly related to measured deadweight loss. While Harberger triangles are generally good approximations to the areas of deadweight loss triangles constructed from compensated demand schedules, this is not guaranteed to be the case. For example, Rosen (1978) finds that Harberger measures of deadweight loss track compensated measures rather closely, but Hausman (1981) offers some examples in which the Harberger and compensated measures differ significantly.

It is noteworthy that the application of an equivalent variation-based measure of deadweight loss has its own ambiguity. To give the measure of deadweight loss the desirable features of being single-valued, even when a number of prices change, and of being inversely related to final utility (for a given level of tax collection), all that is required is that utility be held constant along the demand curve, as King (1983) notes. A demand curve based on equivalent variation holds utility constant at the level that obtains after the price change, but any other constant

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9 See, for example, Mohring (1971), who identifies the steps necessary to use estimated demand relationships to construct compensated schedules, and subsequent work by McKenzie and Pearce (1976), Rosen (1978), Hausman (1981), Vartia (1983), Breslaw and Smith (1995), Hausman and Newey (1995) and Irvine and Sims (1998).

10 For example, Hausman (1981, p. 663) contributes the observation, "From an estimate of the demand curve, we can derive a measure of the exact consumer's surplus, whether it is the compensating variation, equivalent variation, or some measure of utility change. No approximation is involved. While this result has been known for a long time by economic theorists, applied economists have only a limited awareness of its application."

utility level (corresponding to a different reference price vector) would do. Consequently, there exist an infinite number of deadweight loss measures, based on demand curves constructed by holding utility constant at various levels, that share the feature that deadweight loss is inversely related to final utility. Since consumers do not actually make the payments envisioned in constructing equivalent variation, or in constructing any of the other compensated demand schemes, it is hard to maintain that one of these measures has a claim to special validity. If the purpose of deadweight loss measurement is not only to provide an ordinal indicator of whether consumer well-being is rising or falling, but also to offer a cardinal measure of the actual magnitude of inefficiency, then this ambiguity is troubling. The "right" answer depends critically on the question being asked, and there are many possible such questions corresponding to differing reference price vectors.[11]

General Equilibrium Considerations.

General equilibrium considerations are important for deadweight loss measurement whenever price changes in one market affect supply or demand in other markets subject to distortions. Strictly speaking, a proper accounting for general equilibrium effects requires the construction of a complete general equilibrium model of the economy, an exercise that is not beyond the theoretical abilities of modern economists but one that would represent empirical overkill for most applications. However, it is not necessary to take explicit account of spillover effects into undistorted markets in calculating deadweight loss, since price and quantity changes in undistorted markets do not affect the efficiency of resource allocation – after all, in such markets, marginal values to consumers equal marginal costs of supply. Consequently, the analysis need focus only on spillovers into

11 The deadweight loss measure due to Debreu does not share this feature, since it is uniquely defined with reference to the size of a nation's GDP, but it expresses deadweight loss as a fraction of an economy's resources, and therefore offers an answer cast in terms that may or may not be useful. As King (1983, p. 195) observes, "[T]he statement that a particular reform is equivalent to discovering an extra million barrels of oil at current current prices may seem more natural than the statement that it is equivalent to giving each household an extra pair of shoes which they are not allowed to trade."

markets subject to distortions.

Harberger's papers consistently emphasize the importance of spillovers into distorted markets that thereby generate rectangular deadweight loss polygons that can easily swamp the sizes of deadweight loss triangles.[12] The treatment of these cases from an analytic standpoint is quite straightforward, and easily incorporated by Harberger's expressions for deadweight loss, since the relevant deadweight loss triangles become areas bounded by supply and demand schedules at quantities reflecting changes induced by taxes or other policies under consideration. Figure 3 illustrates the calculation of the deadweight loss of a tax when the market for a substitute commodity is distorted by a price ceiling. In the absence of the tax, a binding price ceiling reduces market sales of the substitute commodity from $\mathbf{q}_2$, the free market level, to $\mathbf{q}_1$, the amount sellers are willing to provide at the ceiling price. The welfare cost of this distortion equals the area of the darkly shaded triangle in Figure 3. Imposition of a tax raises the price of the taxed good and therefore shifts rightward the demand curve for the substitute commodity (depicted in Figure 3). The new deadweight loss triangle exceeds the size of the original triangle by an amount equal to the area of the lightly shaded trapezoid in Figure 3. Hence, the efficiency cost of the tax equals the area of the Harberger triangle in the market for the taxed commodity plus the area of the welfare trapezoid in the market for the substitute commodity.

Harberger's papers do not take explicit account of all possible general equilibrium price interactions between markets, relying instead on the assumption that the effects of any unaccounted price changes are unlikely to overturn the qualitative conclusions of his analysis. The general equilibrium work of numerous writers -- for example, Shoven and Whalley (1972, 1977), Shoven (1976), Ballard, Shoven and Whalley (1985) and

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12 See, for example, Harberger (1964b, p. 36): "By far the most disquieting assumption underlying Figure 3 [depicting a Harberger triangle] and the analysis of it is the assumption that no excise taxes or other distortions exist in the `rest' of the economy (industry Y). It is possible, however, to modify the anaysis so as to avoid making this assumption."

Ballard et al. (1985) – largely supports this assumption. General equilibrium models identify the effects of interactions between markets at the cost of considerable modelling complexity. Numerical results generally resemble those produced by much simpler models, though in specific cases there can, of course, be important differences.

Distribution of Income.

A final concern that has been expressed over the use of Harberger triangles stems from their apparent disregard of the distribution of income. While it is certainly true that canonical applications of Harberger triangles (as in Figures 1 or 2) treat symmetrically the money equivalent of welfare losses accruing to different consumers, such a treatment is not intrinsic to the method. It is straightforward to amend, as many have, the estimation procedure by attaching differing distributional weights to the welfares of different individuals, and thereby constructing an aggregate efficiency indicator (for example, King 1983; Kay and Keen, 1988). Indeed, Harberger (1971) mentions the possibility of assigning distributional weights that differ between individuals, but argues that available data often are inadequate to establish the identities of winners and losers in heterogeneous populations, and further notes the formidable problem of identifying distributional weights that are widely enough accepted that the resulting calculations will be meaningful.

In part, the idea of distributional weights begs the question of what a deadweight loss calculation is intended to convey. Does the statement "the deadweight cost of the corporate income tax is $40 billion" mean that consumers, taken together, would be willing to give up an amount $40 billion greater than current corporate tax receipts in return for abolishing the tax and the distortions it creates? Or does the statement mean that that a social planner with certain interpersonal preferences would do so, bearing in mind all the redistributions and distortions that the tax entails? In arguing in favor of the former interpretation, Harberger (1971) notes that the

usefulness and widespread acceptance of national income accounting suggests that users of economic statistics prefer to do their own distributional corrections.[13] Certainly the omission of distributional weights simplifies both the calculation of deadweight loss and its interpretation.

Beyond Harberger Triangles.

Harberger triangles influenced the subsequent course of at least two streams of economic research: the empirical measurement of economic efficiency, and the development of applied normative microeconomics, particularly in the areas of public finance and public choice.

Deadweight Loss Measurement.

Harberger (1964a) gently chides the economics profession for its reluctance to measure the welfare losses due to economic distortions. By the early 1960s, such measurement might plausibly have been a staple of professional analysis, since the economy was riddled with potential sources of significant economic distortions. For example, from 1954-1963 the top marginal federal income tax rate on individuals in the United States was 91 percent; in 1964 it fell to 77 percent, and it was 70 percent from 1965-1980. The federal corporate tax rate was roughly 50 percent from 1954 until the end of the 1970s. Whether these high tax rates generated significant economic distortions is, of course, an empirical question -- but it is a question that economists might have seen as an obvious one to attempt to answer. Moreover, the early 1960s was the start of an era when applied econometrics was coming into its own, and empirical work was of a higher quality and profile than it had

13 Harberger (1971) argues that his deadweight loss triangles are more reliable and estimated on a sounder theoretical foundation than is GNP, an argument that those who are familiar with national income accounting will readily grant -- though from which they will derive cold comfort. GNP and its successor, GDP, are estimated on the basis of very scanty data, are unaffected by the distribution of income, and were never intended to capture national welfare, economic or otherwise. Nevertheless, GDP is probably the most widely quoted indicator of national economic performance.

previously been. There was a growing body of economic data, econometric techniques, and computing power, and there had been considerable development of the theory of welfare measurement. Nevertheless, in the early 1960s, economists had rather little to say about actual magnitudes of deadweight loss.

Harberger himself was quite willing to apply triangle methods to estimate the magnitudes of economic distortions, as his work indicates. Publication of Harberger's 1971 survey in the *Journal of Economic Literature* coincides with an accelerated use of triangle methods by scholars other than Harberger to evaluate the welfare effects of various distortions. It is clear that Harberger's papers influenced at least a portion of this work, in some cases by furnishing analytical models, in others simply by encouraging others. For example, Browning (1975, p. 247) opens his analysis of labor market distortions induced by the Social Security system with "Arnold Harberger's seminal work on the measurement of the welfare cost of taxation provides a technique which can be used to estimate the welfare cost of distortions in income-leisure choices" -- and Browning's paper then proceeds to do just that.

The impact of Harberger's work is difficult to measure precisely, but one revealing indicator is numbers of papers containing empirical estimates of Harberger triangles that are published in leading economics journals. For this purpose, I sampled twelve general-interest economics journals at decadal intervals between 1964, when Harberger (1964a) and (1964b) appeared, and 1994, thirty years later and the 150th anniversary of the publication of Dupuit's classic.[14] In 1964, exactly one paper in these twelve journals reports estimates of Harberger

14 The twelve journals are: the *American Economic Review, Canadian Journal of Economics, Econometrica, Economica, Economic Inquiry, Economic Journal, International Economic Review, Journal of Political Economy, Quarterly Journal of Economics, Review of Economics and Statistics, Review of Economic Studies*, and *Scandinavian Journal of Economics*. Three of these journals (the *Canadian Journal of Economics, Economic Inquiry*, and the *Scandinavian Journal of Economics*) changed names during the sample period; the names given are those as of 1994.

triangles.[15] The number of papers estimating the sizes of Harberger triangles rises to seven in 1974, and then to twelve in 1984, but falls to four by 1994. To be sure, these figures do not reflect publications in field journals, monographs and edited volumes, and numerous other professional outlets. It is also noteworthy that theoretical papers on deadweight loss measurement (of which there were many) are not counted in this tabulation. Nor is a simple count of published papers a compelling indicator of intellectual influence. But the numbers do reveal that empirical deadweight loss measurement was much more widely practiced after 1964. While the falling numbers between 1984 and 1994 may reflect the waning novelty of deadweight loss measurement -- since leading journals prefer to publish papers showcasing new methods of analysis -- it is nevertheless true that four papers published in 1994 constitutes considerable growth over the single effort of 1964.

Theories of Imperfect and Inefficient Economies.

The empirical measurement of Harberger triangles contributed in an indirect way to major theoretical developments in economics. The last 40 years have witnessed an enormous expansion in the subtlety and breadth of understanding of market failures and their remedies. In particular, the asymmetry of available information and the costliness of acquiring greater information in competitive markets -- together with the associated problems of moral hazard and adverse selection -- occupies a central place in modern economic theory. It is often theoretically possible for governments to rectify the problems associated with the breakdown of insurance markets, the labor supply distortions due to income tax and transfer schemes, and the costs associated with market signalling -– but doing so requires large infusions of resources from the government. With unlimited

15 The paper is Stern (1964), not Harberger (1964a), since it is Harberger (1964a) that describes the method of estimating deadweight loss triangles, while Harberger (1964b) -– not published in a journal -- that provides estimates. Following the work of Meade (1955), Stern estimates economic losses due to impediments to international trade,

resources, governments could provide universal insurance, replace existing taxes and transfers with uniform lump-sum payments, and finance the collection and dissemination of informational substitutes for market signals. Government revenue is available at a cost -- and the cost is measured by Harberger triangles. For modelling purposes, it is typically assumed that the efficiency costs of raising government revenue (as well as the associated political costs) make it infeasible for governments to intervene to correct widespread information-related distortions in large markets. Without empirical measurement of the efficiency costs associated with raising government revenue, it would be difficult to proceed confidently to analyze alternative ways of addressing these problems and the consequences of not doing so.

To be sure, Harberger triangles are not central to these arguments, nor is it common (still!) for research on market failures due to imperfect information to provide empirical estimates of associated deadweight losses. But it is reasonable to wonder whether the analysis of market distortions would be so compelling to the professional community in the absence of reliable information on the costs of raising government revenue.

In recent years, the deadweight loss associated with raising government revenue has played a central role in the theory of certain aspects of government behavior. The shadow cost associated with raising tax revenue affects numerous pricing-related decisions, as a matter of efficiency and possibly also in practice.[16] The marginal cost of public funds appears prominently in applications that include optimal regulation and government procurement (Laffont and Tirole, 1993; Laffont, 1994), optimal pollution control (Bovenberg and De Mooij, 1994), optimal provision of public goods (Atkinson and Stern, 1974) and principles of cost-benefit analysis (Drèze and Stern, 1990), to name just a few.

A very different type of market failure encourages rent-seeking behavior, and has been analyzed by

16 In 1991 the U.S. government modified its cost-benefit procedures to assign a shadow cost of $1.25 to every dollar of expenditures financed out of tax revenues.

Tullock (1967), Krueger (1974), Posner (1975) and many others over the last 30 years. Much of this early work on rent-seeking behavior was motivated by the *smallness* of the efficiency loss due to monopoly as calculated by Harberger (1954); there was a suspicion that this estimate did not capture the full efficiency cost of economic distortions due to monopoly. The rents associated with government regulations, monopolistic behavior, and other forms of property ownership are potentially enormous. Consider the monopoly case depicted in Figure 4. A monopoly restricts the quantity of its sales to $\mathbf{q}_1$, thereby selling its output for price $\mathbf{p}_1$ and generating monopoly rents equal to the area of the lightly-shaded trapezoid in the figure. The deadweight loss from the quantity restriction is given by the area of the darkly-shaded Harberger triangle in Figure 4. It is commonly the case that monopoly rents are many times larger than deadweight losses associated with monopoly pricing.

The work on rent-seeking identifies situations in which economic agents expend resources to obtain such rents, and explores how competitive pressures can produce situations in which the rents are largely or entirely dissipated. The magnitude of the inefficiency due to rent-generating market distortions then includes not only the Harberger triangle, but also the much larger adjacent trapezoid representing the rents available to monopolists and holders of import licenses and other sources of economic rent. Recent estimates of inefficiencies due to rent-seeking behavior of all types in the United States greatly exceed the combined sizes of commonly-measured Harberger triangles.[17]

Would there have been "Tullock trapezoids" without the development of Harberger triangles? It is difficult to say. But one should not understate the importance of being able to quantify a distortion, judge its reasonableness and its importance, and use that information as the basis of further theorizing.

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17 See, for example, Laband and Sophocleus (1992), who estimate annual U.S. expenditures on rent-seeking to be approximately $1 trillion in 1985. To be sure, this figure includes estimated costs of crime prevention, legal disputes, military expenditures, costs associated with lobbying, and imputed costs of obtaining government transfers – as well as more standard items such as expenditures to obtain monopoly positions and import licenses.

Why Harberger? Why Triangles?

At the end of the day, one might well ask why the familiar welfare triangles carry Harberger's name, and not, say, Dupuit's, or Jenkin's -- or, in this century, Hotelling's or Boiteux's. In fact, the phrase "Harberger triangle" was never used by Harberger. The earliest published reference to the "Harberger triangle" that I have found is Rosenberg (1969, p. 173). By 1980, the phrase "Harberger triangle" had sufficiently penetrated the economics lexicon that the survey of excess burden by Auerbach and Rosen (1980, p. 306) refers to "the familiar 'Harberger triangle;'" authors in the 1980s, such as Mervyn King (1983, p. 191), are sufficiently familiar to drop the quotation marks when they refer to Harberger triangles.

What accounts for this usage? The way in which Harberger's work differs from that of his predecessors is that it applies the triangle method to analyze actual distortions in the economy, including those arising from monopoly, trade barriers, and taxation. The techniques were (more or less) understood well before publication of these papers, but the prospect of actually using them was so daunting that other authors were reluctant to do so. Deadweight loss triangles did not need names because they were seldom referenced. What made Harberger's efforts so influential is that they identified straightforward methods that can be used in spite of the difficulty of measuring appropriate compensated demand curves, accounting for other distortions in the economy, and treating the general equilibrium nature of the problem. Furthermore, Harberger's work demonstrated the reliability of these methods. Viewed in this light, the appellation "Harberger triangle" is certainly more compelling than staples such as Say's law, Gresham's law, Giffen good, Marshallian demand curve, Roy's identity, the Laffer curve, and a host of other economic principles and regularities associated with the names of people who did not invent them, nor, in many cases, apply them correctly or consistently. Welfare triangles are "Harberger triangles" because Harberger's papers measured them, did so in a consistent manner, and assisted and encouraged a host of others to do likewise.

Is Harberger's method the "right" way to measure deadweight loss triangles? Well, no -- in part because no single method is exactly "right." We ask a lot of a deadweight loss calculation when there are so many inconsistent potential uses to which it might be put. There are alternatives to Harberger triangles with easier-to-love theoretical properties, and there are economists who will therefore always be critical of Harberger's work. It would be a mistake, however, to lose sight of the fact that, correctly or incorrectly, to a first approximation economists were not measuring deadweight loss triangles prior to Harberger. Without estimates, it was impossible to offer reliable answers to important questions about economic distortions. And without estimates, the theory of market failure lacked the empirical grounding that facilitates rapid progress.

Yes, but are they merely triangles? Real-world economies provide the economist with what seems to be a never-ending array of distortions and potential distortions. One of the lessons of analyzing triangles is that they rapidly transform into trapezoids when distortions in one market affect other distorted markets. Real-world economies with inefficient or less-than-benevolent governments, poorly defined property rights, and other market failures also may find their Harberger triangles becoming trapezoids.

References

Allais, Maurice, *A la recherche d'une discipline économique*, Tome I (Paris: Ateliers Industria, 1943); reprinted as *Traité d'economie pure* (Paris: Imprimerie Nationale, 1952).

Atkinson, Anthony B. and Nicholas H. Stern, Pigou, taxation and public goods, *Review of Economic Studies*, January 1974, 41 (1), 119-128.

Auerbach, Alan J., The theory of excess burden and optimal taxation, in Alan J. Auerbach and Martin Feldstein eds., *Handbook of public economics*, vol. 1 (Amsterdam: North-Holland, 1985), 61-127.

Auerbach, Alan J. and Harvey S. Rosen, "Will the real excess burden please stand up? (Or, seven measures in search of a concept)," NBER Working Paper No. 495, June 1980; reprinted in Harvey S. Rosen ed., *The fiscal behavior of state and local governments: Selected papers of Harvey S. Rosen* (Cheltenham, UK: Edward Elgar, 1997), 301-322.

Ballard, Charles L., John B. Shoven, and John Whalley, The total welfare cost of the United States tax system: A general equilibrium approach, *National Tax Journal*, June 1985, 38 (2), 125-140.

Ballard, Charles L., Don Fullerton, John B. Shoven, and John Whalley, *A general equilibrium model for tax policy evaluation* (Chicago: University of Chicago Press, 1985).

Boiteux, Marcel, Le "revenue distribuable" et les pertes économiques, *Econometrica*, April 1951, 19 (2), 112-133.

Bovenberg, A. Lans and Ruud A. De Mooij, Environmental levies and distortionary taxation, *American Economic Review*, September 1994, 84 (4), 1085-1089.

Breslaw, Jon A. and J. Barry Smith, A simple and efficient method for estimating the magnitude and precision of welfare changes, *Journal of Applied Econometrics*, July-September 1995, 10 (3), 313-327.

Browning, Edgar K., Labor supply distortions of social security, *Southern Economic Journal*, October 1975, 42 (2), 243-252.

Corlett, W.J. and D.C. Hague, Complementarity and the excess burden of taxation, *Review of Economic Studies*, 1953-54, 21 (1), 21-30.

Debreu, Gerard, The coefficient of resource utilization, *Econometrica*, July 1951, 19 (3), 273-292.

Debreu, Gerard, A classical tax-subsidy problem, *Econometrica*, January 1954, 22 (1), 14-22.

Diamond, Peter A. and Daniel L. McFadden, Some uses of the expenditure function in public finance, *Journal of Public Economics*, February 1974, 3 (1), 3-21.

Diewert, W. Erwin, Harberger's welfare indicator and revealed preference theory, *American Economic Review*, March 1976, 66 (1), 143-152.

Diewert, W. Erwin, The measurement of deadweight loss revisited, *Econometrica*, September 1981, 49 (5), 1225-1244.

Drèze, Jean and Nicholas Stern, Policy reform, shadow prices, and market prices, *Journal of Public Economics*, June 1990, 42 (1), 1-45.

Dupuit, Arsène Jules Étienne Juvénal, De la mesure de l'utilité des travaux publics, *Annales des ponts et chaussées*, 2nd series, 8, 1844; translated by R.H. Barback as On the measurement of the utility of public works, *International Economic Papers*, 2, 1952, 83-110; reprinted in Kenneth J. Arrow and Tibor Scitovsky eds., *Readings in welfare economics* (Homewood, IL: Richard D. Irwin, 1969), 255-283.

Harberger, Arnold C., Monopoly and resource allocation, *American Economic Review*, May 1954, 44 (2), 77-87.

Harberger, Arnold C., The corporation income tax: An empirical appraisal, in United States House of Representatives, Committee on Ways and Means, 86th Congress, 1st Session, *Tax revision compendium*. Vol. 1 (Washington, DC: U.S. Government Printing Office, November 1959a), 231-250.

Harberger, Arnold C., Using the resources at hand more effectively, *American Economic Review*, May 1959b, 49 (2), 134-146.

Harberger, Arnold C., The measurement of waste, *American Economic Review*, May 1964a, 54 (3), 58-76.

Harberger, Arnold C., Taxation, resource allocation, and welfare, in John F. Due ed., *The role of direct and indirect taxes in the federal revenue system* (Princeton, NJ: Princeton University Press, 1964), 25-70.

Harberger, Arnold C., Efficiency effects of taxes on income from capital, in Marian Krzyzaniak ed., *Effects of corporation income tax* (Detroit: Wayne State University Press, 1966), 107-117.

Harberger, Arnold C., Three basic postulates for applied welfare economics, *Journal of Economic Literature*, September 1971, 9 (3), 785-797.

Harberger, Arnold C., *Taxation and welfare* (Chicago: University of Chicago Press, 1974).

Hausman, Jerry A., Exact consumer's surplus and deadweight loss, *American Economic Review*, September 1981, 71 (4), 662-676.

Hausman, Jerry A. and Whitney Newey, Nonparametric estimation of exact consumer surplus and deadweight loss, *Econometrica*, November 1995, 63 (6), 1445-1476.

Henderson, Alexander, Consumer's surplus and the compensating variation, *Review of Economic Studies*, February 1941, 8 (2), 117-121.

Hicks, J.R., The rehabilitation of consumer surplus, *Review of Economic Studies*, February 1941, 8 (2), 108-116.

Hicks, J.R., Consumers' surplus and index numbers, *Review of Economic Studies*, Summer 1942, 9 (2), 126-137.

Hicks, J.R., The four consumer's surpluses, *Review of Economic Studies*, Winter 1943, 11 (1), 31-41.

Hicks, J.R. The generalised theory of consumer's surplus, *Review of Economic Studies*, 1945-46, 13 (2), 68-74.

Hicks, J.R., *Value and Capital*, 2nd ed. (Oxford: Oxford University Press, 1946).

Hotelling, Harold, Edgeworth's taxation paradox and the nature of demand and supply functions, *Journal of Political Economy*, October 1932, 40 (5), 577-616.

Hotelling, Harold, The general welfare in relation to problems of taxation and of railway and utility rates, *Econometrica*, July 1938, 6 (3), 242-269.

Irvine, Ian J. and William A. Sims, Measuring consumer surplus with unknown Hicksian demands, *American Economic Review*, March 1998, 88 (1), 314-322.

Jenkin, H.C. Fleeming, The graphic representation of the laws of supply and demand, and their application to labour, in Alexander Grant ed., *Recess studies* (Edinburgh, 1870); reprinted in Sidney Colvin and J.A. Ewing eds., *Papers, literary, scientific, &c. by the late Fleeming Jenkin*, Vol. 2 (London: Longmans Green, 1887), 76-106.

Jenkin, H.C. Fleeming, On the principles which regulate the incidence of taxes, *Proceedings of the Royal Society of Edinburgh*, Session 1871-1872, 618-631; reprinted in Sidney Colvin and J.A. Ewing eds., *Papers, literary, scientific, &c. by the late Fleeming Jenkin*, Vol. 2 (London: Longmans Green, 1887), 107-121.

Jevons, William Stanley, *The theory of political economy*, 4th ed. (London: Macmillan, 1911).

Kay, John A., The deadweight loss from a tax system, *Journal of Public Economics*, February 1980, 13 (1), 111-120.

Kay, John A. and Michael J. Keen, Measuring the inefficiencies of tax systems, *Journal of Public Economics*, April 1988, 35 (3), 265-287.

King, Mervyn A., Welfare analysis of tax reforms using household data, *Journal of Public Economics*, July 1983, 21 (2), 183-214.

Krueger, Anne O., The political economy of the rent-seeking society, *American Economic Review*, June 1974, 64 (3), 291-303.

Laband, David N. and John P. Sophocleus, An estimate of resource expenditures on transfer activity in the United States, *Quarterly Journal of Economics*, August 1992, 107 (2), 959-983.

Laffont, Jean-Jacques, The new economics of regulation ten years after, *Econometrica*, May 1994, 62 (3), 507-537.

Laffont, Jean-Jacques and Jean Tirole, *A theory of incentives in procurement and regulation* (Cambridge, MA: MIT Press, 1993).

Lipsey, R.G. and Kelvin Lancaster, The general theory of the second best, *Review of Economic Studies*, 1956-57, 24 (1), 11-32.

Marshall, Alfred, *Principles of economics*, 8th ed. (London: Macmillan, 1920).

McKenzie, George W. and Ivor F. Pearce, Exact measures of welfare and the cost of living, *Review of Economic Studies*, October 1976, 43 (3), 465-468.

Meade, James E. *The theory of international economic policy*, Vol. 2: *Trade and welfare, mathematical supplement* (London: Oxford University Press, 1955).

Mohring, Herbert, Alternative welfare gain and loss measures, *Western Economic Journal*, December 1971, 9 (4), 349-368.

Posner, Richard A., The social costs of monopoly and regulation, *Journal of Political Economy*, August 1975, 83 (4), 807-827.

Rosen, Harvey S., The measurement of excess burden with explicit utility functions, *Journal of Political Economy*, April 1978, 86 (2, part 2), S121-S135.

Rosenberg, Leonard Gerson, Taxation of income from capital, by industry group, in Arnold C. Harberger and Martin J. Baily eds., *The taxation of income from capital* (Washington, DC: Brookings, 1969), 123-184.

Shoven, John B., The incidence and efficiency effects of taxes on income from capital, *Journal of Political Economy*, December 1976, 84 (6), 1261-1283.

Shoven, John B. and John Whalley, A general equilibrium calculation of the effects of differential taxation of income from capital in the U.S., *Journal of Public Economics*, November 1972, 1 (3/4), 281-321.

Shoven, John B. and John Whalley, Equal yield tax alternatives: General equilibrium computational techniques, *Journal of Public Economics*, October 1977, 8 (2), 211-224.

Stern, Robert M., The U.S. tariff and the efficiency of the U.S. economy, *American Economic Review*, May 1964, 54 (3), 459-470.

Tullock, Gordon, The welfare costs of tariffs, monopolies, and theft, *Western Economic Journal*, June 1967, 5 (3), 224-232.

Vartia, Yrjö, Efficient methods of measuring welfare change and compensated income in terms of ordinary demand functions, *Econometrica*, January 1983, 51 (1), 79-98.

Walras, Marie Éspirit Léon, *Éléments D'économie politique pure, Ou théorie de la richesse sociale*, 4th ed. (Lausanne: Corbaz, 1926); trans. William Jaffé, as *Elements of pure economics, or the theory of social wealth* (Homewood, IL: Irwin, 1954).

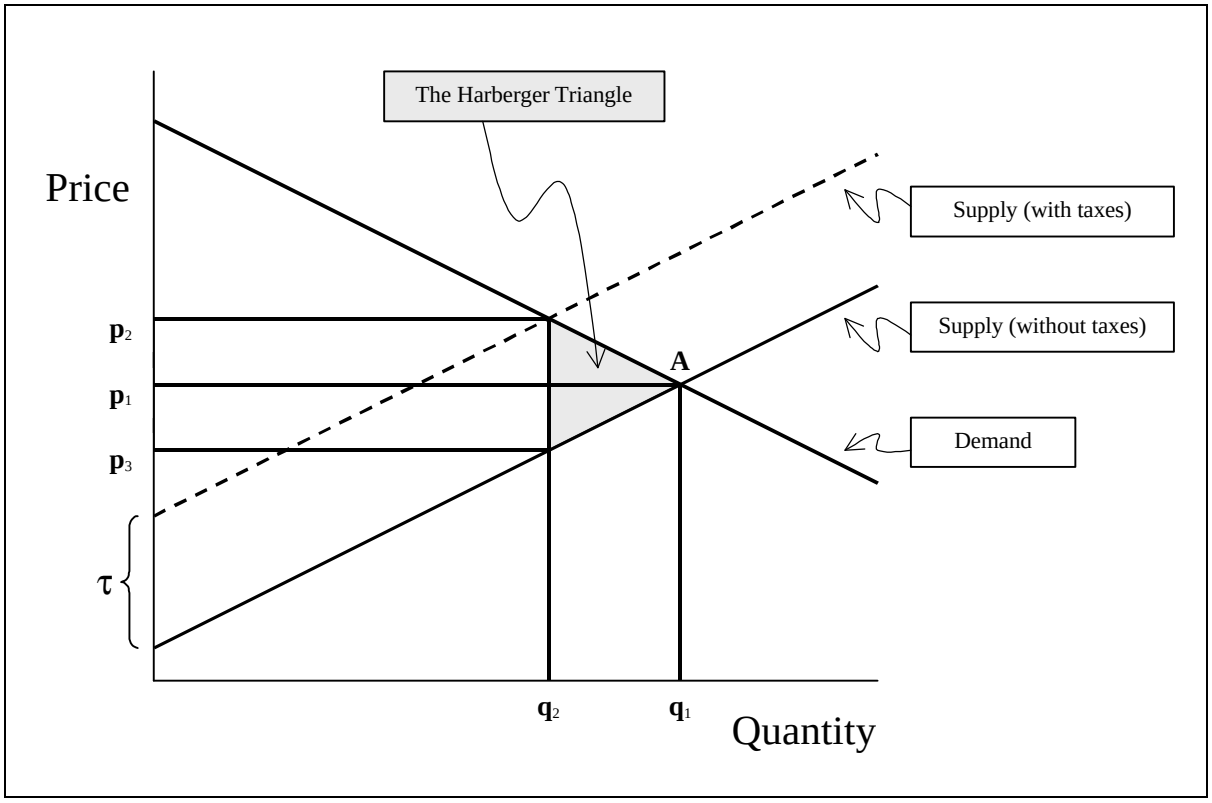

Figure 1: The Harberger Triangle

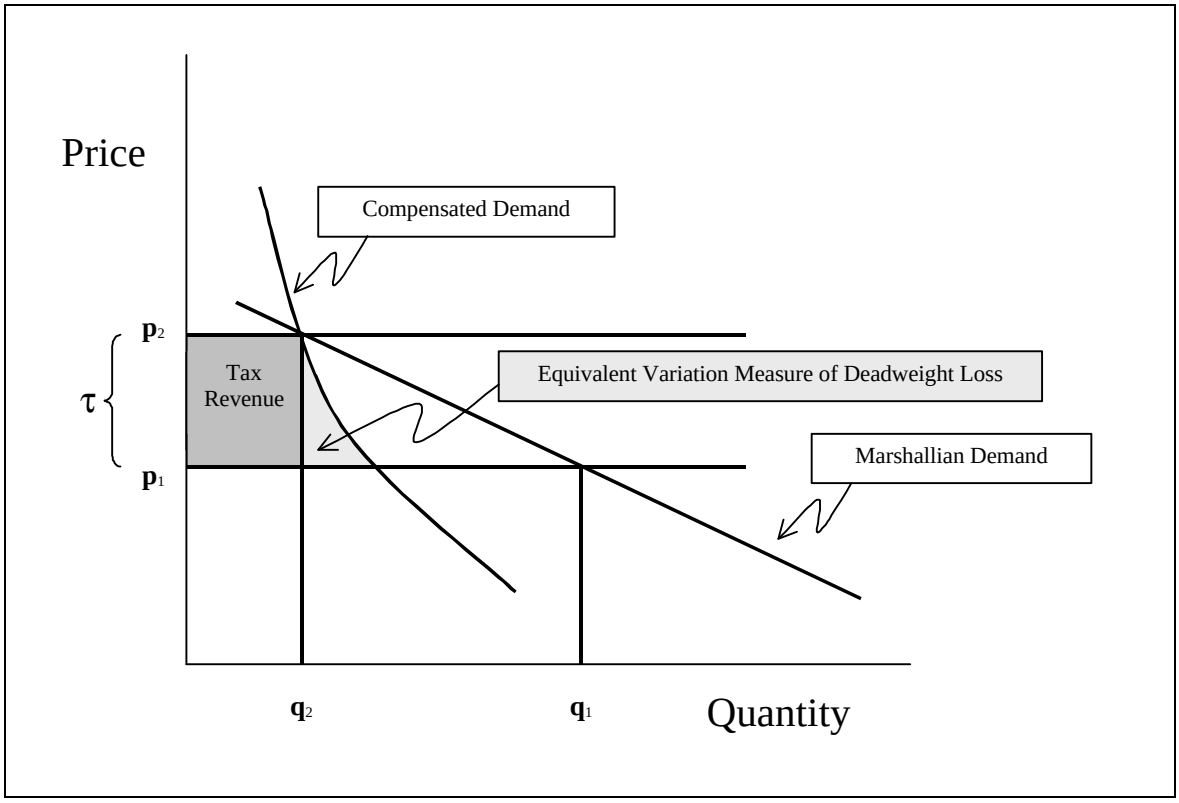

Figure 2: Equivalent Variation Measure of Deadweight Loss

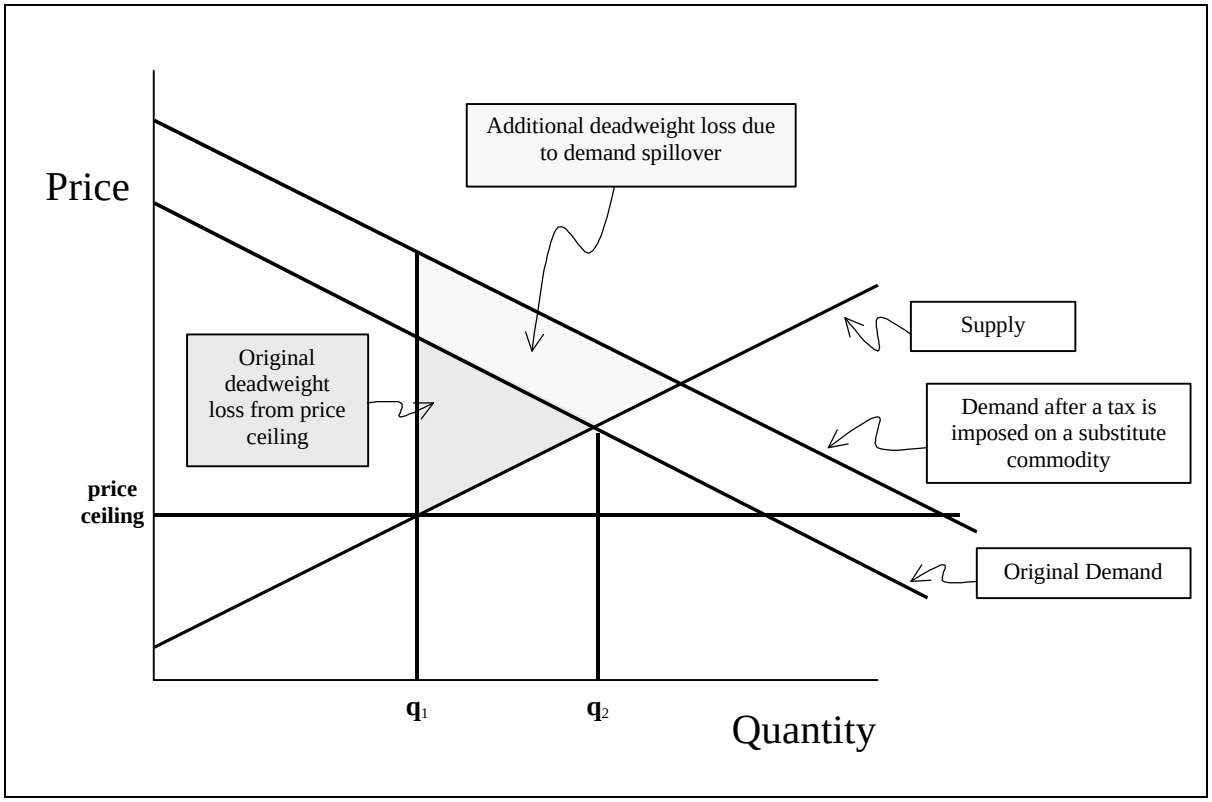

Figure 3: Welfare effect of demand spillover into a market distorted by a price ceiling

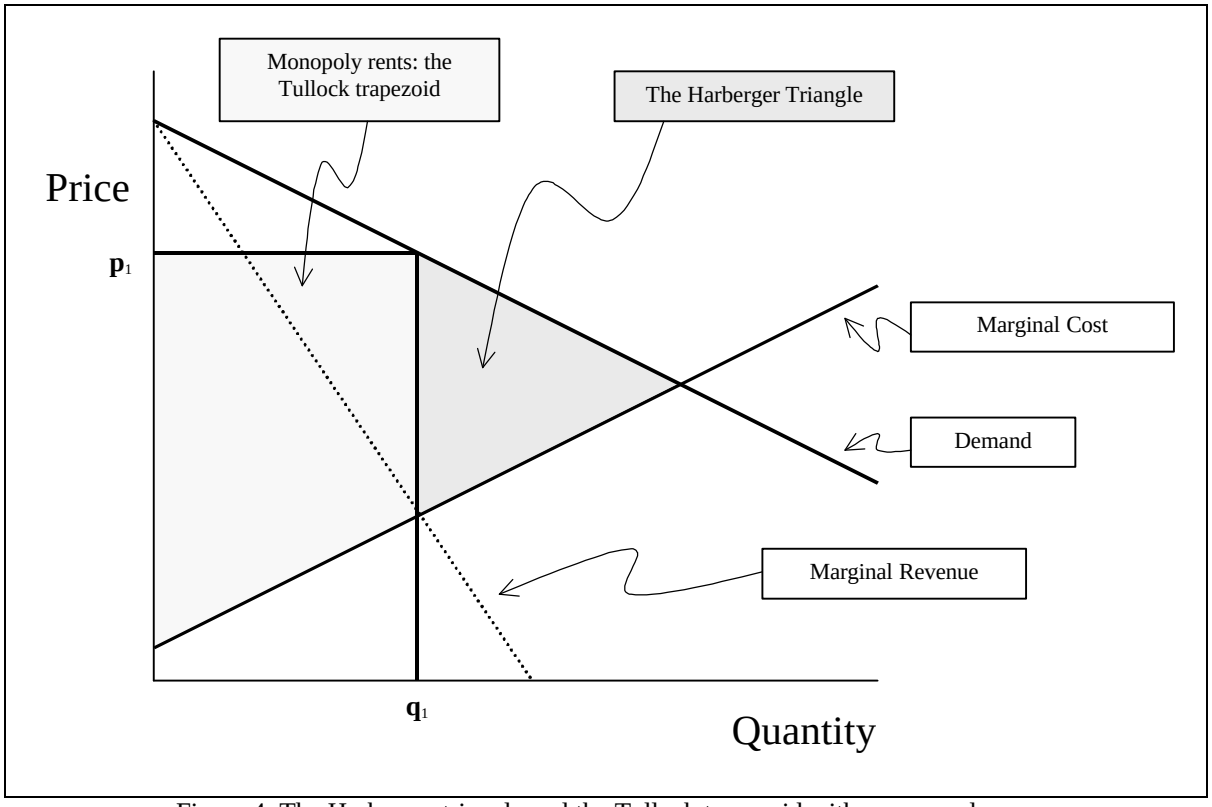

Figure 4: The Harberger triangle and the Tullock trapezoid with a monopoly