Applied Public Finance Meets General Equilibrium: The Research Contributions of Arnold Harberger

by

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ABSTRACT

This essay reviews Arnold Harberger's major research contributions, noting their place in the development of modern public finance and their implications for future research. Harberger triangles are used to calculate the efficiency costs of taxes, government regulations, monopolistic practices, and various other market distortions. Prior to the publication of Arnold Harberger's papers, economists very rarely estimated deadweight losses; such estimation is now common, the literature having expanded manyfold since the 1960s. Critical evaluation of deadweight loss estimates led to new theories of rent-seeking and other inefficiencies of economies with multiple distortions. Harberger's analysis of the general equilibrium incidence of the corporate income tax was the foundation of subsequent research on corporate taxation, as well as providing the basis for subsequent general equilibrium analysis of the incidence of other taxes. Harberger's contributions to the literature on project evaluation, economic development, international trade, and the likely directions of desirable tax reforms likewise advance their respective fields. What unifies this work is that the theoretical development is innovative and insightful, while remaining resolutely practical. Furthermore, these papers helped to transform the analysis of applied problems by using general equilibrium approaches to answer what had previously been cast as partial equilibrium problems.

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1. Introduction.

The study of public finance has changed greatly over the last fifty years, due in large part to the pathbreaking research of a small number of individuals. Since Arnold Harberger is a leading figure in this transformation, it is perfectly fitting that the National Tax Association this year honors him with its Dan Holland medal. The purpose of this essay is to offer a brief review of Arnold Harberger's major research efforts, noting their place in the development of modern public finance as well as their implications for the future of public finance research.

Two features of modern public finance research distinguish it from earlier efforts to answer many of the same questions. The first is the widespread application of general equilibrium reasoning and methods to address problems of practical importance; the second is the use of data to identify and measure magnitudes of critical interest. One of the remarkable aspects of Arnold Harberger's research career is that his work contributes importantly to both of these modern developments. The research of leading scholars typically initiates new lines of inquiry even as it answers old questions – and, as will shortly become apparent, this is a pattern that characterizes many of Harberger's contributions.

This review follows a thematic course. Section two reviews the literature on Harberger triangles, including Harberger's seminal contributions and the subsequent work for which they are responsible. Section three reviews Harberger's contributions to general equilibrium tax incidence analysis, and section four considers Harberger's research on project evaluation and other topics. Section five concludes by identifyng the "top ten" lessons of Arnold Harberger's research.

2. Harberger triangles.[1]

Harberger triangles appear whenever market prices are distorted by taxes, monopolistic practices, or other sources of inefficiency. The equilibrium of a competitive market has the feature that marginal consumption benefits equal marginal production costs; distortions, such as those introduced by excise taxes, drive wedges between marginal benefits and marginal costs, thereby preventing mutually beneficial transactions from taking place. Summing differences between the prices that consumers would pay, and the prices at which suppliers would provide goods, for all foregone transactions, indicates the welfare loss due to an excise tax, and is represented by the area of the "Harberger triangle." 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.

While the theory of deadweight loss measurement was well established by the 1950s, economists very rarely estimated deadweight losses prior to the appearance of Arnold Harberger's research. 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.

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

[1] This section draws heavily on Hines (1999).

demand schedules can be used to infer the welfare effects of price changes. Dupuit's insight was shared by Fleeming Jenkin (1871/72), who lived in England and was unaware of Dupuit's work of the 1840s. The intuition that Dupuit and Jenkin offered in deriving their welfare triangles is essentially unchanged today, though a number of details on which they were silent became the focus of more than a century of subsequent research.

One of the earliest questions was raised by Léon Walras (1874), who was concerned that the changing utility value of money (as prices change) 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. A practical defense of Dupuit's method was provided by Harold Hotelling (1938), who argued that it relies on properties of demand curves that they are likely to satisfy. Hotelling analyzed 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 noted that this problem disappears if the so-called "integrability conditions" are satisfied. 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 invoked 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.

Sir John Hicks (1941, 1942, 1943, 1945-46) 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. 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 described two methods of constructing demand curves that can be used to measure deadweight loss triangles; both maintain utility constant, but they differ because they are based on differing utility levels.

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. 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 noted 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." Subsequent authors, including Bioteux (1951), Debreu (1954), and Meade (1955), extended Hicks's analysis to settings in which initial prices are distorted and in which producer prices are endogenous to quantities sold.

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. Despite this potential, almost no one ever calculated the sizes of welfare losses from actual distortions to the economy. Harberger did so, and the results are useful and interesting. Harberger (1954) found that resource misallocation due to monopolistic behavior in U.S. industry generated an inefficiency equal to approximately 0.1 percent of U.S. GNP; that the U.S. corporate income tax generated distortions valued at 0.5 percent of GNP (1959a); that resource misallocation of various types reduced Chilean welfare by 15 percent (1959b); that distortions to labor-leisure choices induced by the U.S. personal income tax reduced welfare by 0.4 percent of GNP (1964b); and that all U.S. capital income taxes taken together were responsible for economic losses of 0.8 percent of GNP (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*.[2]

In his empirical work, Harberger calculated 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 used are therefore not Marshallian demands, since consumers receive tax rebates, nor are they Hicksian compensated or equivalent demands, since utilities change. These demand curves are slightly different – though, as Harberger (1971) noted, they generate welfare measures that are second-order approximations to those based on Hicksian

[2] These essays are reprinted, together with interpretive notes, in Harberger (1974).

demands. Rosen (1978) finds that Harberger-type measures of deadweight loss track compensated measures rather closely, but Hausman (1981) offers some examples in which the Harberger and compensated measures differ significantly.[3]

The measurement of 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.

Harberger (1964a) gently chided the economics profession for its reluctance to measure the welfare losses due to economic distortions. 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. Certainly the evidence (Hines, 1999) is that deadweight loss measurement was much more commonly practiced after the publication of Harberger's work than it ever was before.

[3] The issue arises because 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 (starting with Mohring, 1971) devoted to elucidating methods to do just that. Diewert (1976) and McKenzie and Pearce (1976) identify various features of welfare measures based on the demand curves used by Harberger.

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 – occupy 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 signaling – but doing so requires large infusions of resources from the government. With unlimited 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 modeling 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.

A very different type of market failure encourages rent-seeking behavior, and has been analyzed by 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 losses due to monopoly as calculated by Harberger (1954); these deadweight losses

were suspected of not capturing 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. The work on rent-seeking identifies situations in which economic agents expend resources to obtain these rents, and explores how competitive pressures can produce situations in which the rents are largely or entirely dissipated. The magnitude of this inefficiency includes, then, not only the Harberger triangle but the much larger adjacent trapezoid that represents the size of 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 (e.g., Laband and Sophocleus, 1992) greatly exceed the combined sizes of commonly-measured Harberger triangles.

The way in which Harberger's work differed from that of his predecessors is that it applied 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) well understood long before publication of these papers, but the prospect of actually using them was so daunting that other authors were reluctant to do so. 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 practical reliability of these methods.

3. General equilibrium tax incidence.

It is a commonplace observation that tax burdens need not coincide with obligations to remit tax payments to governments. For example, an *ad valorem* sales tax might be borne by

consumers, in the form of higher prices; by workers, in the form of lower wages; or by business owners, in the form of reduced after-tax profits. More generally, the distribution of tax burdens in individual markets – and therefore in partial equilibrium – is governed by relative elasticities of supply and demand.

Since tax policies commonly apply to many markets at once, partial equilibrium reasoning may yield misleading insights for the distribution of actual tax burdens. Instead, it is necessary to account for the simultaneous interactions between supplies and demands in many markets, thereby performing what is known as general equilibrium tax incidence analysis. This has the potential to be considerably more complex than is partial equilibrium tax incidence analysis. Partly as a result, it has been difficult to draw strong conclusions about the direction of general equilibrium tax effects, and general equilibrium reasoning was, until relatively recently, of limited usefulness for solving tax incidence problems.

Despite its complexity, the analysis of general equilibrium tax incidence had a rich history prior to Harberger's contributions. David Ricardo used an early form of such analysis to consider the impact of tariffs and various excise taxes.[4] The general equilibrium analytical apparatus was made more precise by the work of Walras and Francis Ysidro Edgeworth, along with subsequent authors. Edgeworth (1897) exhibited the power of general equilibrium reasoning by demonstrating the possibility that an excise tax on the output of a monopolist might actually reduce the final (tax-inclusive) price faced by consumers. Since this outcome is extremely counter-intuitive, and at odds with the implications of partial equilibrium notions of tax incidence, it raised alarms that partial equilibrium reasoning might lead analysts astray.

There remained the question of whether Edgeworth's conclusions were right, and if so, whether they carried implications for competitive markets. Hotelling (1932) settled the matter

by proving a result similar to Edgeworth's for competitive markets, though the economics profession has William Vickrey (1960) to thank for providing an intuitive explanation of the forces responsible for the Edgeworth-Hotelling Paradox. As is what we now know to be typical of models of this type, the counter-intuitive findings stem from the supply and demand repercussions of induced quantity adjustments. Thus, a sales tax that encourages consumers to purchase substitutes may (if the taxed good and its substitute commodity are also substitutes in production) so change the induced demand for intermediate inputs that the cost of producing the taxed good falls sufficiently that the consumer price falls as well.

Other examples of general equilibrium tax incidence reasoning appear in the work of James Meade (1955), Richard Musgrave (1959), and others. Meade analyzes the impact of multiple tax and trade distortions in systems in which exchange rates and relative prices adjust in general equilibrium to maintain market clearing and budget balance. Musgrave uses the implications of budget balance to identify tax structures that differ in assignment of obligations but that nevertheless entail identical incidence and incentive effects.

Harberger (1962) offers a major contribution to the general equilibrium tax incidence literature by considering that most vexing of questions, the incidence of the corporation income tax. Prior to the appearance of Harberger's article, it was widely believed that the burden of corporate taxes was borne by owners of capital, and in particular, owners of corporate capital. Harberger notes that capital market equilibrium requires that investors in corporations must expect to receive the same risk-adjusted returns as do investors in non-corporate assets. Consequently, the analytic task is to distinguish the effect of the tax on capital owners generally from its effect on everyone else. Harberger observes that the effect of the corporate tax on the welfare of capital owners can be inferred from its impact on capital demand, since policies that

[4] See Ricardo (1817), and its subsequent interpretation by Shoup (1960).

stimulate additional capital demand must raise the after-tax return to capital, while those that reduce capital demand have the opposite effect.

The corporate income tax has two, potentially offsetting, effects on capital demand, one a partial equilibrium effect, the other a general equilibrium effect. The partial equilibrium effect is to encourage corporations to substitute labor for capital inputs, thereby reducing capital demand; this was commonly understood to be the entirety of the effect of corporate taxes prior to the appearance of Harberger's article. The general equilibrium effect, analyzed by Harberger, stems from the induced reallocation of production in the economy. If the noncorporate sector of the economy uses capital more intensively than does the corporate sector (which is quite possible, since the noncorporate sector includes capital-intensive industries such as agriculture and real estate), then the reallocation of production increases the demand for capital. The net effect of the corporate tax on capital demand, and therefore on returns to owners of capital, thus depends on the combined effect of substitution and reallocation. Under these circumstances, it is possible for the introduction of a corporate tax actually to *increase* the after-tax returns to owners of capital, including owners of corporate capital.

The finding that corporate income taxation might increase the after-tax returns to owners of corporate stock is equivalent to saying that the burden of the corporate tax could be more than 100 percent shifted to labor. In his original article on the subject, Harberger (1962) estimated that, using reasonable simplifying assumptions and parameter values, the burden of the U.S. corporate income tax was in fact borne primarily by owners of capital, so that this paradoxical outcome did not materialize. In subsequently reconsidering this question in an era of much more mobile international capital flows, Harberger (1983) estimated that the burden of the U.S. corporate income tax is largely if not entirely borne by labor. The reasoning is that international

capital flows more or less require that corporate investments in the United States yield the same real after-tax rate of return available elsewhere in the world. Since labor is much less mobile internationally, it follows that the primary effect of higher U.S. corporate taxes might well be to reduce the after-tax wages of American workers, with after-tax corporate profits little affected.

Harberger's framework became the basis of a generation of empirical work studying the impact of the corporation income tax, starting with Krzyzaniak and Musgrave (1963), and including (among others) the contribution of Cragg, Harberger, and Mieszkowski (1967). While empirical studies have yet to reach a consensus on the incidence of the corporate income tax, there does appear to be a consensus in the years since 1962 that the tax must be analyzed in the general equilibrium landscape pioneered by Harberger. Indeed, since then public finance economists have never been quite satisfied with analyzing the incidence of any tax in partial equilibrium, unless such analysis is supplemented by general equilibrium considerations. Harberger's simple and elegant analysis of the corporate income tax demonstrated the usefulness and practicality of general equilibrium reasoning, thereby elevating general equilibrium analysis from what was mostly a collection of paradoxical results to the status of analytic mainstay.

4. Project evaluation and more.

Taxation is used to raise revenue for governments to spend, and exposure to actual government policies quickly convinces the analyst that guidelines for sensible spending policies are at least as desperately needed as are rules for efficient taxation. Of course, many of the same analytic issues arise in both contexts, since government policies inevitably entail tradeoffs between competing objectives, often involving inefficiencies due to price distortions from taxes or other policy instruments. Thanks partly to his broad exposure to problems in the developing

world, Arnold Harberger has been a major contributor to the literature on government project evaluation. This work has been devoted to the development of sound, theoretically-grounded principles that can actually be applied in practice.[5]

The object of much of Harberger's project evaluation work is to identify the rules governments should follow in the (ubiquitous) cases in which economies are heavily distorted. These distortions include labor market imperfections, deviations from marginal cost pricing in private industry, uncorrected externalities, and unfortunate government tax and regulatory policies that are not amenable to change. While it is difficult to summarize the variety of settings and problems that Harberger analyzes, the central theme of this work is that the solutions consist of judicious choices of shadow values and discount rates. These shadow values capture the impact of distortions in illustrative ways, but more importantly represent very practical methods of guiding efficient resource allocation.

Arnold Harberger's research includes contributions to many specific aspects of public finance in addition to his more general work on efficiency, incidence, and project evaluation. The topics he considers include the effects of taxation on saving and investment, the effects of taxation on the mining and petroleum extraction industries, the analysis of Ramsey-type optimal taxation, tax systems and international trade, and tax reform in developing countries. What unifies this and Harberger's other work is that it concerns the world in which we live. The theoretical development is innovative and insightful, while remaining resolutely practical. Moreover, these papers contain general equilibrium approaches to what had previously been cast as partial equilibrium problems. Arnold Harberger's earliest publications analyzed international trade issues, and while in his subsequent public finance research he branched into new topic areas, he maintained a healthy insistence on the use of applied general equilibrium analysis that

[5] Many of these papers are collected in Harberger (1972).

is characteristic of international economics. The field of public finance benefited enormously from importing this focus as embodied in Harberger's work.

5. The top ten lessons.

Arnold Harberger's research offers the field of public finance a cornucopia of important empirical findings and conceptual advances, and in so doing provides important lessons for researchers to follow. Quite apart from his substantive contributions, Harberger demonstrates the power of an approach that addresses significant problems drawn from experience and considered in the light of applied general equilibrium reasoning. It is challenging, but nevertheless possible, to distill from the body of Harberger's work a list of "top ten" lessons for those who wrestle with public finance problems. My own favorite list is available as Table 1.

Many of the "top ten" lessons are self-explanatory, though it is worth drawing attention to numbers seven, two and one, since they have clearly inspired Harberger's work and might serve the same function for other economists. Indeed, Harberger (1955, p. 293) summarized these issues well when, in commenting on a now-obscure paper by Henry Aubrey, he wrote:

> Let me announce at the outset my admiration for Mr. Aubrey's bold spirit. Though one may quarrel with the details of his paper and his approach, one cannot help but sense that he is grappling with real and important problems and doing so with great imagination and competence. More cautious minds would shrink from the task to which Mr. Aubrey has set himself, but I do not hesitate to assert that our knowledge would advance much more slowly if caution became our byword and the sureness of our conclusions a major goal.

And one might very well say the same of Arnold Harberger and his own work.

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Table 1
Top Ten Lessons from the Research Career of Arnold Harberger

Number	Lesson
10	Economics is a practical subject, and the economy as it exists is worthy of study.
9	It is OK to make reasonable simplifying assumptions in order to develop theories.
8	Data analysis does not have to be complicated in order to be informative and influential.
7	Important magnitudes need to be measured, even if it is challenging to do so and the obstacles are daunting.
6	Any function can be approximated by a Taylor series, and this approximation can be very useful.
5	Normative questions can be usefully analyzed without an explicit social welfare function.
4	Distortions are everywhere.
3	The economy is in general equilibrium.
2	The economist can make a difference.
1	Simple, powerful ideas rule the world.