Appendix 7: Deadweight economic loss caused by raising revenue for projects and programs

Government projects and programs can be financed by drawing on a variety of sources: taxes on incomes, payrolls, land, sales, domestic and overseas borrowing, petrol excise, mining royalties, stamp duties, parking fines, driving licences, reduced expenditure, and, ultimately, just by printing money. Table A7.2 provides a list of taxes, and Albon (1997) reviews a wide range of taxes imposed specifically by the states and territories.

Raising revenue from any of these sources will affect the economy in some way. Raising revenue is itself not costless, because of collection and compliance costs that add to the amount required to fund a project or program. Moreover, revenue-raising measures will impose opportunity costs on the community to the extent that they preclude activity or transactions that would otherwise have occurred, with consumer and producer surplus being forgone.

A simple illustration of the concept of deadweight loss is provided by Bates (2001, pp. 50–51), reproduced in Box A7.1.

Box A7.1: A simple example of the excess burden of taxation

The following example illustrates how a tax can impose an excess burden (or deadweight loss) by eliminating market transactions and the economic surplus associated with those transactions.

Let us suppose that Jack mows Jenny's lawn each week for $30, which is the going rate in the city where they live. Jenny would actually be prepared to pay Jack up to $33 to mow her lawn, taking into account the income she would forgo and the costs (including displeasure) she would incur if she mowed the lawn herself. Jack would be prepared to mow Jennys lawn for $28, because Jenny lives close to many of his other clients and the cost of mowing her lawn is, therefore, lower than for clients in another area, whom Jack regards as marginal to his business. This means that there is an economic surplus of $5 ($33 minus $28) associated with this transaction.

Now, consider what happens when the government introduces a tax of 30 per cent, which applies to the income that Jack earns from lawn mowing. To keep the example simple, we will assume initially that Jenny does not have to pay the tax on her own income.

After the tax is imposed, Jack tells Jenny that, in order to pay the tax, he will have to raise the price that he charges her to a minimum of $36.40 ($28 plus 30 per cent of $28). Jenny responds that the most she is prepared to pay is $33. Jack calculates that this would leave him with only $25.38 after paying the tax, which is not sufficient to compensate for the time involved in mowing Jenny's lawn. So, the result is that Jenny mows her own lawn and both Jack and Jenny have lower levels of well-being. No tax is collected, but the economic surplus of $5 is lost. This is the excess burden that is incurred by Jack and Jenny because the tax has discouraged a mutually advantageous transaction.

The rate of tax is an important factor determining whether or not the transaction continues to occur following introduction of the tax. It could be expected to continue with tax rates of up to almost 18 per cent — that is, at rates that would not entirely remove the economic surplus that makes the transaction mutually beneficial. Substitution possibilities are also important. If Jenny were unable to substitute her own services for Jack's by mowing the lawn herself, the initial economic surplus on the transaction would have been larger and she might have been willing to accept a pre-tax price of $36.40, or even higher. Similarly, if Jack's potential earnings in alternative occupations were a lot lower than in lawn mowing he might be prepared to continue to mow Jenny's lawn for a post-tax return of $25.38, or even less.

When Jack's clients also have to pay tax on their incomes, transactions with larger economic surplus are also eliminated. Let us suppose that, prior to introduction of the tax, Jenny's neighbour, Bill, has to work an additional 30 minutes at his job in the market economy in order to pay Jack $30 for mowing his lawn. Rather than mow his own lawn, Bill would be willing to work for up to an additional 50 minutes in the market economy. This means that there is an economic surplus of $22 ($50 minus $28) on Bill's transaction with Jack. If the tax applied only to income from lawn mowing, Bill would have to work for 36.4 minutes in order to pay Jack $36.40. When Bill also has to pay the tax, he would have to work for 52 minutes in order to earn the $52 he would require before tax in order to pay Jack $36.40 (and the tax authorities $15.60). This is not acceptable to Bill, however, so, like Jenny, he mows his own lawn. The tax results in loss of the $22 economic surplus on Bill's transaction with Jack.

Source: Bates (2001, p. 50–51)

Different financing arrangements have differential effects on social surplus, but all of them involve some element of deadweight loss. Even reducing government expenditure in other areas to finance a new project is likely to reduce benefits (e.g. social security payments) in some way. More efficient revenue measures entail lower loss of benefits in the form of social surplus for any given amount of revenue raised. A land tax, for example, is often regarded as being relatively efficient because the low price elasticity of demand results in a relatively lower loss of consumer surplus. If the land is owned primarily by foreigners, who are excluded from a 'national' standing in a cost-benefit analysis (CBA), the loss of social surplus would be even lower.

The relative efficiency of a revenue-raising measure — or, more specifically, a tax — is termed the marginal excess tax burden (METB). It is the ratio of the loss of social surplus (the deadweight loss) due to imposition of the tax, divided by the total amount of revenue collected. Such ratios can be calculated for various revenue-raising measures including, for example, a government bond issue (Campbell & Brown, 2003, ch. 10), royalties (Ergas & Pincus, 2012), land and other taxes (Cao et al., 2015). In the case of a tax with an METB of 1.30, for example, raising $1 in revenue would impose a cost of $1.30 on the economy.

A key question in CBA is whether costs should be adjusted by the METB — a form of shadow pricing — in order to take into account the wider economic effects of a project. Most textbooks indicate that an adjustment for the METB should be used (e.g. Brown & Campbell, 2003; Boardman et al., 2011), but this rarely occurs in practice. Moore et al. (2010) is one of the few exceptions. Boardman et al., (2011, p. 65) also draw attention to the fact that projects can generate revenue for the government. Society benefits because the additional revenue allows the government to avoid raising public funds for other projects through taxation, so the revenue should also be multiplied by the factor (1 + METB).

One valid reason for not including the METB in a CBA — apart from avoiding an undesired increase in the cost side of the estimate of net present value (NPV) — is likely to be that governments tend to fund projects from general revenue. It is not possible to attribute the expenditure on a project directly to any specific revenue-raising measure. However, Campbell and Brown (2003, p. 224) argue that:

> If the government is rational and informed it will use each of these three sources of funds [taxes, borrowing, printing money] up to the point at which its marginal cost is equal to the marginal cost of each of the other two. In this way the total cost of collecting any given quantity of public funds is minimised. This implies that if we work out the marginal cost of funds obtained through, say, taxation, we can assume that this is the marginal cost of public funds from any source. There is some evidence that governments are rational and informed in the way that we are assuming: there has recently been much less reliance on inflation to fund public expenditures than previously. The reason is not so much that the cost of this resource has risen but rather that governments are better informed of its costs in terms of economic instability and resource misallocation. Since bond finance eventually leads to higher taxes to pay for interest and principal repayments we may be on reasonably solid ground if we use the marginal cost of tax revenues to approximate the marginal cost of public funds.

Boardman et al. (2011, pp. 65–66) provide a simple numerical example of how METB is calculated from changes in labour supply. Campbell and Brown (2003, ch. 10) illustrate the calculation of deadweight loss for both government borrowing through a bond issue, and the deadweight loss of producer surplus due to an income tax.

A7.1 Estimates of deadweight loss due to taxes and other imposts

Conceptually two sources of deadweight loss may flow from higher taxation: through changes in consumption patterns and through changes in the supply of labour. Calculations of METB tend to focus on the labour supply effect, as it is not clear exactly how net consumption will be affected by the provision of a government project or program and the associated form of taxation.

Empirical studies have produced a wide range of values for the METB that may result from changes in labour supply (Table A7.1).

Table A7.1: Estimates of the marginal excess burden of taxation

Study (year)	Country	Estimated METB	Data	Tax used
Findlay and Jones (1982)	Australia	23% to 65%	1978–79	Labour income
Diewert and Lawrence (1995)	New Zealand	14% to 18%	1971/72–1990/91	Labour income; general consumption, motor vehicle consumption, import duties
Freebairn (1995)	Australia	2.6% to 72.7%	1993	Labour income
Campbell and Bond (1997)	Australia	19% to 24%	1988–89	Labour income
Bates (2001)	New Zealand	50%	Unstated	Labour income
KPMG Econtech (2010)	Australia	–8% to 92%	2008	See Table A7.2 below
Cao et al. (2015)	Australia	–10% to 75%	2007–08 and 2013–14	Company income, personal income, goods and services, land, stamp duty and conveyances

Source: compiled by George Argyrous from the sources cited

As might be expected, attempts to estimate the METB in Australia and New Zealand require specific assumptions, so that the results are 'very sensitive to the estimation model and the parameter assumptions' (Freebairn, 1995, p. 127). Key assumptions that affect these estimates are the particular tax that is assumed to be used to finance a public program, the rate and uniformity of the tax, and the elasticity of labour supply to changes in the after tax real wage rate.

Despite the range of estimates for the METB, the New Zealand Treasury's *Cost Benefit Analysis Primer* stipulates 'a rate of 20% as a default deadweight loss value in the absence of an alternative evidence based value' (2005, p. 18). The NZ Treasury adopts this default rate even though it acknowledges the wide range of estimates provided by Diewert and Lawrence (1994) and Bates (2001).

Similarly, the Australian Government's *Handbook of Cost-Benefit Analysis* cites Campbell (1997) to suggest an METB of 25 per cent (Department of Finance and Administration, 2006, p. 37).

Campbell's (1997) work provides a summary of the analysis in Campbell and Bond (1997), which found METB to range from 19–24 per cent. Their methodology was to construct a representative agent model for each of the 10 gross income deciles and then to simulate for each group the labour supply effects of a 1 per cent increase in marginal income tax rates. Their main conclusion is that 'a project proposed to be undertaken by the Australian federal government needs to have a benefit/cost ratio in the range 1.19–1.24 if it is to receive serious consideration' (Campbell & Bond, 1997, p. 32). Subsequent analysis by Campbell and Brown (2003, p. 229) adjusts these values to a range of 1.20–1.25.

It is worth noting that this analysis by Campbell and Bond (1997) drew upon data from 1988–89, and also from the findings of an earlier study by Apps and Savage (1989). This earlier study provided the parameters for labour supply elasticities from which the welfare loss from higher tax rates were calculated by Campbell and Bond. Apps and Savage used income data from 1981–82, and marginal income tax rates for the same period. Their analysis is based on a restrictive set of assumptions about the structure of households and the way that they allocate resources, including income, among their respective members. Specifically, they model the effects of tax rates by using data from 'couple income units with a male head aged 25–54 years earning labour income solely from wages and salary and working over 624 hours per year' (1989, p. 341).

Given these detailed assumptions for the estimates in Campbell and Bond (1997) it seems inappropriate that the Commonwealth Treasury should uncritically adopt an METB of 25 per cent, well over a decade from the data upon which Campbell and Bond base their analysis. Moreover, studies for Australia have shown a general decline in the METB over time, as income tax rates fall. Campbell and Bond's (1997) decades-old estimate would benefit from updating and re-estimation prior to further use.

A7.2 The use of METB estimates in CBAs

Many CBAs simply ignore the issue of METB altogether (e.g. Department of Infrastructure and Regional Development, 2011). Others (White et al., 2012; Abelson & Joyeux 2007) tend to cite Campbell and Bond (1997), although White et al. (2012) use a value of

10 per cent with no explanation for the difference between that and Campbell and Bond's estimates. Moore et al. (2010, p. 9) simply defer to the 'default deadweight loss recommended by the [New Zealand] Treasury' of 20 per cent.

Other CBAs may have applied the METB without a proper consideration of whether it is relevant or fit for purpose. For example, the *Independent Cost-benefit Analysis of Broadband and Review of Regulation Volume II – The Costs and Benefits of High-Speed Broadband* (Department of Communications, 2014, p. 42) applied a METB of 0.24 cents per dollar, which assumes that the full cost of each option is financed by labour income tax. The financing arrangements for the NBN, however, are through government-issued equity that would be repaid through user-charges; not through increases in tax. Bonds may generate a deadweight loss if they displace investors' consumption and because of the tax wedge on equity earnings (Campbell & Brown 2003, ch. 10) but there is no reason to believe that the METB value will be the same as that for tax increases.

A7.3 Issues for consideration

There are three key issues that are worth noting in arriving at a harmonised value for the METB:

- changes in the labour market and how these might affect labour supply elasticities
- changes in income tax rates and the distribution of tax collection
- greater awareness of the economic impact of various government programs.

One of the arguments for the use of METB in CBA is that higher tax rates create a labour supply disincentive, since they act in a way similar to a fall in the real wage rate. The labour supply response creates a net loss in welfare, and it is the value of this loss that empirical estimates of labour supply elasticities attempt to capture.

The nature of the labour market in Australia and New Zealand has changed dramatically since the 1980s. The classic single-earner/male-breadwinner household is not as common and there has been a noticeable shift from full-time to part-time and casual employment,

corresponding with a growth in employment for females (see Harding et al., 2009 for a detailed breakdown of these changes and implications for tax rates). Moreover, the labour supply effects of taxation changes vary across groups in the labour market (Creedy, 2003). Indeed for some groups, such as working wives, the labour supply curve might be backward bending. As Miller (1985) found in an early study for Australia, labour supply may increase for this group as the effective wage rates goes down. Many of the estimates for the METB listed in Table A7.1 avoid this issue by using a single representative household computable general equilibrium (CGE) model facing a single labour supply elasticity and marginal tax rate (see, for example, Cao et al., 2015, p. 3).

Calculating the METB to be applied to government programs also depends on the choice of tax assumed to be used to raise finance. For example, KPMG Econtech (2010, p. 5), using a CGE framework, provides the estimates in Table A7.2 for the marginal excess burden of taxation (see also Ballard et al., 1985, p. 136). Cao et al. (2015, p. 54) point out that different results for METB estimates for GST (8 versus 12 cents per dollar of revenue) may be due to differences in model calibration and data updates.

Table A7.2: Marginal excess burdens of Australian taxes (cents of consumer welfare per dollar of revenue)

Tax	Marginal excess tax burden
Tobacco excise	–8
Import duties	–3
Petroleum resource rent tax	0
Municipal rates	2
GST	8
Land taxes	8
Alcohol excise/wine equalisation tax	9
Fuel taxes	15
Stamp duties other than real property	18
Luxury car tax	20
Labour income tax	24
Conveyancing stamp duties	34
Motor vehicle registration	37

Tax	Marginal excess tax burden
Motor vehicle stamp duties	38
Corporate income tax	40
Payroll tax	41
Insurance taxes	67
Royalties and crude oil excise	70
Gambling taxes	92

Source: KPMG Econtech (2010, p. 5)

The sensitivity of the METB to the choice of tax is reinforced by Hayes and Porter-Hudak (1987), who show that, even for large excise taxes, deadweight loss can be small. Similarly, Diewert and Lawrence (1995) have shown, for New Zealand, that the METB only differed by up to 5 per cent between labour tax and consumption tax rates. Shifts in the tax base over time suggest a need to revise assumptions that feed into the calculation of METB.

Gabbitas and Eldridge (1998, p. 37) provide a similar range of estimates for some Australian state taxes.

Table A7.3: Marginal excess burden of state taxation in the presence of Commonwealth taxation and externalities, Australia

State tax	METB
Leaded petrol	6
Unleaded petrol	4
Diesel	4
Tobacco	28
Normal strength beer	14
Low alcohol beer	15
Wine	12
Spirits	58

Source: Gabbitas, O. and Eldridge, D. 1998, *Directions for State Tax Reform*, Productivity Commission Staff Research Paper, AusInfo, Canberra, May

These wide variations in METB have led the Victorian Department of Treasury and Finance (2013, p. 51) to adopt a default METB of 1.08, on the basis that the government could finance its projects from the most efficient state tax source (i.e. land tax).

Noticeably, the rates in Table A7.3 are lower than those they calculate without factoring in externalities that flow from the activities being taxed. This reinforces the point made by Boardman et al. (2011) that the welfare consequences of higher tax rates depend on the nature of the activities upon which these tax rates fall. For example, they argue that if taxes are increased on activities that have a large negative externality, they actually may be welfare improving.

The calculation of METB, especially when conducted through CGE models such as KPMG Econtech (2010), rest on the assumption that the economy operates, or at least tends to operate over the long run, at the full employment level. If this is not the case, then increases in public spending may lead to higher than otherwise output levels, which may at least partially generate the tax revenue to fund the program. For example, programs being analysed through a CBA may roll out during a period of the business cycle when they generate a net increase in output and tax revenue. As Freebairn (1995) illustrated, the existence of involuntary unemployment affects estimates of the METB.

A7.4 Conclusion

Estimates of deadweight loss are fraught with assumptions and data issues. They are also influenced by the specific type of revenue-raising instrument being used and various flow-on effects that may not be immediately obvious in a partial equilibrium analysis.

Conceptually at least, estimates of deadweight losses should be conducted on a project-specific basis. The cost of doing so, however, would be prohibitive. This factor is probably the reason why studies that incorporate the opportunity costs of raising revenue tend to use estimates conducted by others as 'plug-in' values.

Given the essentially 'rubbery' nature of estimates of deadweight loss, jurisdictions should consider a more harmonised approach that includes the following issues:

- the extent to which deadweight losses should be included in CBA
- the desirability of agreement on deadweight loss factors for a number of the more common revenue-raising instruments
- an agreed approach for easy updating of METB estimates between periodic major reviews.

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