Equity, efficiency and urban development impacts of alternative tax regimes to fund local infrastructure

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Abstract

It is well recognised that a capital value tax (which taxes the value both of land and improvements) discourages development whereas a land tax provides no such discouragement. A related literature (beginning with JS Mill) analyses the properties of a 'betterment' tax based on the uplift (betterment) in property values that results from a new infrastructure investment. This paper analyses equity, as well as efficiency, outcomes that arise when funding a new infrastructure development through different types of tax. A spatial equilibrium model is used to analyse urban development impacts that occur when using either a land tax or a labour tax (or, equivalently a consumption tax which could include taxation of improvements). A partial equilibrium model, that takes city population as given, is then used to delve deeper into equity and efficiency implications of funding new infrastructure through: (i) a land tax, (ii) a capital value tax, and (iii) a betterment tax. The analyses demonstrate not only the efficiency advantages of land value and betterment taxes relative to a capital value tax, but also equity and political economy advantages of a betterment tax over Henry George's 'single tax' on land value.

Keywords: Land tax; capital value tax; betterment tax; labour tax; urban development; equity; efficiency

JEL codes: H21; H22; H24; H54

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1 Introduction

A land tax has long been recognised as an efficient tax through which central or local government can fund its expenditures (Quesnay, 1758;[1] Smith, 1776;[2] Mill, 1865;[3] George, 1879). George favoured a single (flat) tax on all land values. Specifically, he advocated:

> *"the simple and easy method of abolishing all taxation save that upon land values. ... A consideration of the effects of the change proposed then shows that it would enormously increase production; would secure justice in distribution; would benefit all classes; and would make possible an advance to a higher and nobler civilization."*[4]

John Stuart Mill (1865), by contrast, advocated a tax levied only on the increment to land value above the level holding at a particular time. He argued that that the increment in land values is due to general societal influences, such as better infrastructure, or even just to population growth, rather than being the result of the landowner's efforts. Mill's view that the tax should apply only to this increment in land value in part reflected a desire to protect existing property rights (so the tax is not placed on the pre-existing value of land) and, in part, reflected a belief that taxing the increment in land value is both efficient and equitable. Consequently, Mill (p.573) argued :

> *That the future increment to rent should be liable to special taxation; in doing which all injustice to the landlords would be obviated, if the present market-price of their land were secured to them ... With reference to such a tax, perhaps a safer criterion than either a rise in rents or a rise of the price of corn, would be a general rise in the price of land."*

A capital value tax, which taxes both the value of the land and any structure (improvement) on it, discourages development whereas a land value tax provides no discouragement for development. A tax on land values therefore contributes to greater urban intensification relative to a capital value tax (Gemmell et al., 2019). A related literature regarding infrastructure funding analyses the properties of a 'betterment' tax levied on the uplift (betterment) in property values arising from a new infrastructure investment (Coleman and Grimes, 2010). In this case, only the increment in land value is taxed rather than the full land value as is the case with a standard land value tax.

This paper analyses urban development, efficiency and equity outcomes that arise when funding a new infrastructure development through alternative types of tax. Many theorists over the past three centuries have recognised that the value of local infrastructure and other

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[1] In his *Tableau économique*, Quesnay distinguished three classes of people: landowners, cultivators and merchants. He posited that a tax on cultivators is harmful since it discourages production, arguing instead that tax should be applied to landowners since they have no incentive to reduce production. While no copies of the *Tableau* remain, his views on taxation of land are cited by Smith (1776).

[2] See Smith (1776) Book I, Chapter XI.

[3] See Mill (1865) Book 5, Chapter 2, §5.

[4] See George (1879) (Standard Ebooks, Kindle Edition. Kindle Locations 132-134).

amenities is impounded in the value of land (Ricardo, 1817). Today, this insight is a mainstay of the urban economics literature. Rosen (1979) and Roback (1982) pioneered the modern formulation of this approach showing that the value of new infrastructure is incorporated into the price of land serviced by that infrastructure. Taxing the land value which impounds the value of services provided by the infrastructure is therefore one way that can be used to fund the provision of such services.

The difference between Mill's betterment tax approach and George's single land value tax is more subtle than the difference between land and capital value taxes, but some of these subtleties have not hitherto been well drawn out, especially with respect to equity consequences of these different forms of tax.

We draw out both equity and efficiency (including urban development) implications of alternative tax regimes that may be used to fund local infrastructure. In prior work, Lennox (2023) included eight separate taxes in a dynamic spatial model that was used to simulate land use and other impacts of an urban transport project. While his simulated example used land tax as the infrastructure funding mechanism, his modelling did not compare urban development impacts under a land tax relative to those that would occur under other forms of taxation. Furthermore, his model is unable to isolate equity impacts of alternative forms of taxation at the individual level though he draws out implications at the regional level depending on whether landowners live in the affected region or not.

Rather than developing a highly specific model as in Lennox (2023), the analysis here adopts a framework which provides general insights into the impacts of infrastructure investments when funded through alternative taxation regimes. Section 2 uses a spatial equilibrium approach, contrasting the urban development implications of funding infrastructure variously through a land tax or through a wage tax (or, equivalently, a consumption tax). In this analysis, the city is treated as a single unit (i.e. the model abstracts from intra-city variations so, as in Lennox's modelling, equity implications cannot be drawn at the individual level). Section 3 adopts a partial equilibrium approach which coincides with a special case of the general equilibrium spatial approach that takes population of a city as given.[5] The partial equilibrium model is used to analyse intra-city equity and efficiency implications of using different taxation regimes to fund new infrastructure. Three types of taxes are compared: (i) a land value tax, (ii) a capital value tax (which is a combination of a land tax and a specific tax on consumption services from the dwelling structure), and (iii) a betterment tax levied solely on land value uplift. Unlike the spatial equilibrium approach, this analysis is able to analyse equity consequences in some detail. It also identifies some political economy issues which imply that use of a Georgist land tax could stifle, rather than promote, city development. Section 4 provides reflections on implications of the analyses for local taxation policies.

[5] As shown in the general equilibrium spatial model in section 2, population of a city remains constant when the present discounted value of benefits of a new infrastructure investment equals its costs.

2 Spatial equilibrium model

2.1 Model specification

The reduced form general equilibrium model in Grimes (2020), which builds on that of Overman et al. (2010), demonstrates the effect of a city-specific infrastructure development on the city's population, wages and land prices. That model, which abstracts from taxes, assumes spatial equilibrium (i.e. equal utility across cities). It comprises three equations respectively for: wages, amenity benefits and house prices. Each variable is a function of the city's population and of infrastructure servicing the city. Population (which is assumed to be a fixed multiple of the labour force[6]) adjusts across cities to equalise utility.

The model is extended here to four equations with the inclusion of an expression for the city's land area. It is used to show the differential effect of a land tax (levied on landowners) versus a distortionary tax (levied on local residents), where the tax is used to fund incremental local infrastructure. Within this representative agent setting, the efficiency and urban development advantages of a land tax are apparent; however, certain equity issues arise.

The model comprises relationships for gross (pre-tax) wages (w), gross land rents (r), amenities accruing to residents (a), and city area (c). Gross wages reflect the outcome of a production function defined over labour and local infrastructure, with parameters reflecting whether firms have increasing, constant or decreasing returns to scale. Amenities are a function of population size (with a positive or negative relationship depending on whether congestion effects outweigh amenity-enhancing aspects) and infrastructure (which is assumed to have a positive impact). Hence both w and r are functions of the labour force (L) and infrastructure services (I).[7] Rents are related positively to the labour force and to infrastructure, and negatively to the city area; the latter reflects the potential for higher rents when city area is restricted. City area is a function of the labour force and infrastructure, with planning and geographical constraints influencing the relevant parameters.[8]

The resulting relationships, together with signs of partial derivatives indicated by theory (where ± 0 indicates that the sign is indeterminate), are therefore as follows:

$$w = W(L, I) \qquad [W_L \pm 0, W_I \geq 0] \tag{1}$$

$$a = A(L, I) \qquad [A_L \pm 0, A_I \geq 0] \tag{2}$$

$$r = R(L, I, c) \qquad [R_L > 0, R_I \geq 0, R_c \leq 0] \tag{3}$$

[6] To keep the model tractable, labour is assumed to be supplied perfectly inelastically by residents.

[7] Infrastructure services are assumed to be proportional to the infrastructure stock which is rented to the local government by an external provider; it is assumed that tax revenue (a flow) equals the flow of rented infrastructure services.

[8] For instance, we may posit that $c = L^{\alpha}$ where $0 \leq \alpha \leq 1$; for a highly constrained city, α may be close to 0 while a city on a flat plain with few planning constraints may have α close to 1. In general, we posit that $c_L > 0$ and $c_{LL} < 0$. City area may further be conceptualised with the addition of a height dimension (i.e. city volume) so that an increase in c could reflect greater density of the city rather than (or as well as) a greater footprint.

$$c = C(L, I) \qquad [c_L > 0,\ c_I \geq 0] \tag{4}$$

The local authority chooses its level of infrastructure provision and has two choices of how to fund its infrastructure costs: (i) a proportional tax on gross wages (t^w) or a proportional tax on land rents (t^r); the latter is borne by the landowner. In each case, the tax revenue must equate to the flow (i.e. cost) of infrastructure services. Thus t^w or t^r are set according to (5a) or (5b) respectively:

$$t^w = \frac{I}{wL} \tag{5a}$$

$$t^r = \frac{I}{rc} \tag{5b}$$

Utility of residents (u) is defined positively over amenities and after-tax wages, $w^* \equiv (1 - t^w)w$, and negatively over rents;[9] in equilibrium, utility equals that in a reference city ($\bar{u}$) through spatial equilibrium:[10]

$$u = U(a, w^*, r) = \bar{u} \qquad [U_a > 0, U_{w^*} > 0,\ U_r < 0] \tag{6}$$

We use the model outlined in expressions (1) – (6) to analyse the urban development outcomes represented by population (and labour force) changes of an infrastructure investment when funded either by a labour tax (section 2.2) or a land value tax (section 2.3). Section 2.4 discusses equity issues implied by these analyses.

2.2 Labour tax

Initially, consider the impact of an infrastructure investment in the presence of a labour tax. A tax on wages in this setting is equivalent to a tax on consumption (Stiglitz and Rosengard, 2015). The consumption tax could either be placed on all consumption or on a subset of consumption items since, in either case, the resident population (which has inelastic labour supply) must pay the quantum of taxes required to fund the infrastructure investment.

We take the total derivative of (6) after substituting in expressions (1), (2), (3), (4) and (5a) into the utility function to obtain the impact of an infrastructure investment (dI) on population (and labour force) (dL):[11]

$$\frac{dL}{dI} = -\frac{U_a A_I + U_{w^*} W_I - \frac{1}{L} U_{w^*} + U_r R_I + U_r R_c C_I}{U_a A_L + U_{w^*} W_L + \frac{I}{L^2} U_{w^*} + U_r R_L + U_r R_c C_L} \tag{7}$$

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[9] Utility is also defined over the price of traded goods, but these are assumed to be equal across space through the law of one price, so are not included explicitly in the utility function. Note that the utility function in (6) is specified more generally than that in Overman et al. (2010) and Grimes (2020) which each assumed a specific functional form.

[10] Note from (5a) that $t^w w = \frac{I}{L}$; hence the utility function can be written as: $U\left(a, w - \frac{I}{L}, r\right)$. Prior to equilibrium being reached following a new infrastructure investment, we will observe a migration inflow [outflow] if utility is initially raised [lowered] by the investment.

[11] Note that $d\bar{u}=0$ since the reference city utility is held constant. Expression (7) uses the fact that from (4), $dc = C_L dL + C_I dI$. All derivatives are evaluated at their initial values.

Neither the numerator nor the denominator of (7) is unambiguously signed so we do not have a general conclusion as to whether an infrastructure investment leads to an expanded city population. This ambiguity reflects the result of Coleman and Grimes (2010) that a project with a benefit: cost ratio greater [less] than unity leads to an enhancement [diminution] of property values. If we assume that a local council only chooses to invest in new infrastructure if it initially raises utility above $\bar{u}$ then, by definition, $\frac{dL}{dI} > 0$. Given the partial derivatives indicated in expressions (1) to (4), this outcome is likely to reflect a positive numerator and a negative denominator. The first two terms in the numerator are expected to be positive (i.e. new infrastructure raises both amenities and wages) as is the final term (i.e. the new infrastructure facilitates an expansion in city area). These positive impacts are offset by the negative effects of the rises in taxes and rents (reflected in the third and fourth terms). A negative denominator is more likely in the presence of decreasing returns to scale in production ($W_L < 0$), congestion externalities ($A_L < 0$) and upward impacts on rents arising from population expansion. This latter effect is offset to some extent by an expansion in city area which places downward pressure on rents. The impact of labour taxes (via the third term in the denominator) also provides some counteracting effect.

Overall, the key implication of (7) is that an infrastructure investment is likely to lead to an expansion of city population (and area) if it boosts amenity values and productivity. The infrastructure investment also enhances population size where it facilitates expansion in the city's area.

2.3 Land tax

A land tax is levied on landowners, no matter whether they initially live in the city or elsewhere. Furthermore, it makes no difference whether an initially resident landowner emigrates since migration provides them with no benefit given that they must pay the tax wherever they are located. (If the landowner does not pay the tax, their land can be confiscated to pay the outstanding tax bill.) In this circumstance, the third terms in each of the denominator and numerator disappear from (7) which is replaced by:

$$\frac{dL}{dI} = -\frac{U_a A_I + U_{w^*} W_I + U_r R_I + U_r R_c C_I}{U_a A_L + U_{w^*} W_L + U_r R_L + U_r R_c C_L} \tag{8}$$

The numerator of (8) is unambiguously larger than that of (7) while the denominator is unambiguously smaller. Hence, the (positive) impact on population size (and city area) of an infrastructure investment is unambiguously larger with a land tax than with a labour tax. Essentially, the labour response to the infrastructure investment is larger when the increased return to labour following the investment is not taxed. Accordingly, any move from a land tax to a tax that involves taxation on the resident population must reduce the positive effect of an infrastructure investment on city expansion.

Recall that a labour tax is equivalent to a consumption tax on one or more consumption goods. One of these goods is the service derived from the structure of a dwelling. Hence, a capital value tax – i.e. a tax levied on the structure and the land – must result in reduced responsiveness of city size to infrastructure investment relative to the response under a land tax. A local tax on wages or on consumption other than property services further reduces the responsiveness of city size to an infrastructure investment since the land component of property is no longer being

used to form part of the taxation base (as it does with a capital value tax). The key lesson from expressions (7) and (8) is therefore that the responsiveness of city size to an infrastructure investment is greatest with a land tax, followed by a capital value tax, followed by a tax on wages or general consumption.

2.4 Equity impacts

The representative agent model outlined above hides potential equity impacts of the choice between taxation types. A newly implemented or expanded land tax is borne by landowners who may or may not be residents of the city. Infrastructure that has gross benefits to residents will therefore certainly benefit non-landowning residents when funded by a land tax, while leading to a loss of utility for landowners who are not city residents.[12] A landowning city resident will receive gross benefits, but these benefits may be less than their incremental tax cost to the landowner unless the aggregate benefit: cost ratio (BCR) of the project is sufficiently high to allow resident landowners' gross benefits to exceed their taxation cost. For instance, if half the city's population comprises landowners, who each own an equal share of the city's area (the other half of the population being renters), the BCR needs to exceed two for landowners to be net beneficiaries of a new infrastructure investment funded by a land tax.

In addition to this equity issue, a potential inefficiency arises when decisions about a new infrastructure project, that is partly or fully funded by a land tax, is based on the vote of residents. The greater is the number of absentee landowners and/or the greater the concentration of landowners (and hence the greater the proportion of renters) within the city, the greater is the likelihood that residents will democratically vote for a project with negative net benefits. This result arises because renters receive the gross benefits but none of the costs of the project (which are instead impounded in a reduction in land values). The potential for this political economy aspect to facilitate the undertaking of an inefficient infrastructure project does not appear to be widely recognised in the literature relating to land taxes; however, it is potentially a justification for allowing absentee landowners, as well as residents, to vote in local council elections. Even then, the number of absentee landowners may be too small to ensure that only projects with BCR>1 proceed.

In addition to these concerns, a range of equity issues arises in relation to different forms of property taxes. These additional matters are highlighted in the next section.

3 Partial equilibrium model

3.1 Outline

We extend the analysis of equity impacts of the local tax regime within a partial equilibrium model of a city that has heterogeneous neighbourhoods and houses. To focus the analysis, it is assumed that all properties are owned by their resident household, so we abstract from issues of absentee landowners and of landlords versus renters. City population is assumed constant, which corresponds to the spatial equilibrium case in which city utility equals reservation utility and in which a new infrastructure investment (funded at the city level) has a BCR=1 so that resident utility is unchanged by the investment.

[12] Lennox (2023) draws a similar conclusion from his aggregate model.

Initially, two alternative forms of property tax to fund local council expenditures are considered: a land value tax levied on the (post-tax) market value of the land, and a capital value tax levied on the (post-tax) market value of the land plus improvements. A capital value tax mirrors aspects of a wage tax (or a broader consumption tax) since it is levied, in part, on local non-tradeable consumption (i.e. on the property's improvements). Subsequently, the analysis is extended to include consideration of a betterment tax levied on land value uplift that is used to fund an infrastructure investment.

The city comprises properties with differing (pre-tax) land values (per hectare) reflecting neighbourhood effects (e.g. land values that reflect incomes of neighbours) and/or the quality of localised amenities. Land area is the same for each property and improvement values are given by history. In examples that follow, we illustrate the general results with a two-house case comprising houses with identical improvements where one house is situated in a 'wealthy' suburb and the other in a 'modest' suburb (i.e. suburbs with high versus low land values respectively).

All place-based attributes – both benefits and costs – are impounded in the value of land. Hence, the land price, *inter alia*, incorporates the present discounted value of the tax levied on the land. This means that any change in the tax rate affects the market price of the land which, in turn, affects the tax payable. These interactive effects are included in the model that follows. For clarity, we refer to 'hedonic land value' as the value of the land that would hold if there were no tax placed on it, while 'actual land value' (i.e. the taxable value) is the value of the land after taking account of taxes levied on the land.

While our principal focus is on the funding of new infrastructure, we first look at impacts of land value versus capital value taxes in a base case in which local council expenditures (including on infrastructure) are fixed. Section 3.2 analyses the equity outcomes of a land tax versus a capital value tax for this case, while section 3.3 discusses urban development implications of the two tax regimes. Section 3.4 then analyses the case of central interest in which council embarks on additional infrastructure expenditure that may be funded by a land tax, a capital value tax or a betterment tax.

3.2 Static case: Equity implications

Consider a council that must raise present discounted value (pdv) of revenue, R, through property taxes. It has two choices of property tax regime: (1) a land tax levied on the actual (post-tax) market value of land at rate, t^L, or (2) a capital value tax levied on the actual (post-tax) market value of land plus improvements at rate, t^C.[13] The hedonic (pre-tax) value of land for house i is denoted LVH_i, improvements are denoted IV_i and hedonic (pre-tax) capital value is denoted CVH_i $(= LVH_i + IV_i)$. Tax paid on house i under a land value tax is denoted T_i^L and under a capital value tax, T_i^C. Actual (post-tax) land values under a land value tax and under a capital value tax are denoted LVA_i^L and LVA_i^C respectively while the respective actual (post-tax) capital values are denoted CVA_i^* $(= CVH_i - T_i^*)$ where a superscript $*$ denotes the form of tax (L or C). In the following, a subscript s denotes the sum of values across all properties.

[13] These rates represent the discounted present value of the tax rate; for instance, a tax rate of 1% p.a. (levied at the end of each year) with a discount rate of 5% p.a. equates to a pdv tax rate of 0.20.

Since the property tax is impounded into the value of the land, and given that the sum of all property taxes equals the council's revenue requirement, we have:

$$LVA_s^* = LVH_s^* - R \tag{9}$$

Recall that the tax rates apply to actual rather than hedonic property values, so the respective tax rates under the two property tax systems are given by:

$$t^L = R/(LVH_s - R) \tag{10}$$

$$t^C = R/(LVH_s + IV_s - R) \tag{11}$$

The tax paid by household i under each tax regime is given respectively by:[14]

$$T_i^L = t^L LVH_i/(1 + t^L) \tag{12}$$

$$T_i^C = t^C(LVH_i + IV_i)/(1 + t^C) \tag{13}$$

Solving for each tax rate gives the tax paid on each house under the two regimes as:

$$T_i^L = \frac{LVH_i}{LVH_s}R \tag{14}$$

$$T_i^C = \frac{(LVH_i + IV_i)}{(LVH_s + IV_s)}R \tag{15}$$

From (14) and (15), the tax paid for each house depends on its proportion of total hedonic land value under a land value tax, or its proportion of total capital value under a capital value tax. Tax paid on house i is higher under a land value tax than under a capital value tax if the ratio of its hedonic land value relative to the city's total land value exceeds that of its hedonic capital value relative to the total hedonic capital value of the city, and vice versa. It is therefore an empirical matter as to whether houses in wealthy (or modest) neighbourhoods prefer a capital value tax or a land value tax.

As a thought experiment, consider two identical structures (i.e. identical improvement values) where one property is in a wealthy neighbourhood with expensive land and one is in a poorer area with modest land prices. In this case, the household in the wealthy area will pay a lower share of property taxes under a capital value tax while the household in the modest area will pay a lower share of property taxes under a land value tax. In this situation, the household in the wealthy neighbourhood will prefer a capital value tax while the household in the modest area will prefer a land tax. Consistent with this example, evidence from New Zealand indicates that, at a country-wide level, land values are a higher proportion of capital values in higher income neighbourhoods (where land is expensive) relative to poorer neighbourhoods, although this pattern is less evident at the individual city level (McLuskey et al., 2006).

The top panel of Table 1 provides an illustrative example of the differential effects of land value versus capital value taxes according to house characteristics. In the example, each house has improvements of 500 ($'000) but the house in the wealthy suburb has land value of 700 while the modest suburb house has land value of 300. The council revenue requirement is 400 which is sourced from the two houses using either a land value tax or a capital value tax. Relative to a zero-tax situation, implementation of a capital value tax reduces each house's capital value by

[14] Expression (12) is obtained by noting that $T_i^L = t^L LVA_i^L = t^L(LVH_i - T_i^L) = t^L LVH_i/(1 + t^L)$; and similarly for expression (13).

20%. By contrast, with a land tax, the capital value of the wealthy and modest homes reduce by 23% and 15% respectively. Hence, in this example, the land value tax is more progressive if lower income people live in more modest neighbourhoods (and if the ratio of land to capital value is lower in modest neighbourhoods).

3.3 Urban development implications

One inefficiency that has been highlighted with respect to capital value taxes is that such taxes discourage development, whether of greenfields sites or through intensification. To illustrate the issue, we analyse the consequences if one property owner were to consider adding an extra unit on their land. The previous example is used as the base case, with the property owner's new structure costing 500. The property is only a tiny proportion of the city, so the development decision does not change either the land value tax rate or the capital value tax rate.

This example is illustrated in the second panel of Table 1. With a land value tax, the tax payment of a household following the development (in either suburb) will remain unchanged, since the value of improvements is irrelevant in determining the tax paid. Therefore, provided the developer can find a buyer for the unit who is willing to pay more than 500 for it, they will profit by adding the unit.

With a capital value tax, the extra rates paid for an improvement worth 500 is 125 (in this example). A buyer who values the addition (prior to the cost of rates) at less than 625 will offer the developer less than 500 (i.e. the cost of the structure) since they will have to pay tax valued at 125. Hence, the property owner will only profit from the addition if they can find a buyer who values the unit at more than 625. If no buyer values the property at an amount equal to the cost of construction plus the present discounted value of additional taxes, the addition will not be built. This situation contrasts with the land tax case in which the addition will be built provided there is a buyer who wishes to purchase the unit at a price that simply exceeds the cost of construction. The negative effect of a capital value tax relative to a land tax on urban development is clear.

This constraining effect of a capital value tax relative to a land value tax is well-known. It is a prime reason that a land value tax is preferred to a capital value tax if the aim is to encourage efficient urban development. However, there are some complications that make this argument a little less clear-cut.

First, a new buyer may place a high value on the services provided by the council that are funded out of the property tax (Tiebout, 1956). If so, it increases the likelihood that the developer can find a buyer who is prepared to pay the cost of the structure plus the cost of future taxes. Nevertheless, development is still more likely to proceed with a land tax than with a capital value tax.

Second, the extra unit may bring forth extra expenses for the council through additional rubbish collection, sewerage treatment, road maintenance, etc. associated with a population increase. If this is the case, then the development advantage afforded by a land tax (without any other accompanying payment mechanism) may disappear. The council's tax revenues need to increase, and this occurs under a capital value tax but not under a land value tax. The land tax does not contribute to the marginal cost of providing the required extra services. Whether or not a capital value tax is appropriate in this situation depends on how the marginal costs for the

council arising from the new unit compare with the existing average cost per unit. If they are equal, then the capital value tax is appropriate and the land value tax inappropriately fails to tax the development of the extra unit. Conversely, if the marginal cost to council of the extra unit is lower than the average cost (for instance, owing to economies of scale), then the capital value tax is inappropriate. Instead, a land value tax accompanied by a uniform charge per household to meet the extra services may be the efficient option.

3.4 Infrastructure and betterment

Now consider a council infrastructure development, funded by property taxes, which raises the amenity value of both properties. The rise in amenity values raises the hedonic value of the land. The new infrastructure can be funded by one of three mechanisms (i) a land tax, (ii) a capital value tax, or (iii) a betterment tax levied on the increment to hedonic land value (i.e. 'value uplift') that arises from the infrastructure investment. Each of these taxes will affect the actual capital value of a house differently.

To see how the infrastructure project affects capital values under a land tax, consider a new investment that costs the council, I. Thus the council's new revenue requirement is $R + I$. The project increases the hedonic land value for house i by $\alpha_i I$ and hence increases total hedonic value in the city by $\alpha_s I$, where $\alpha_s = 1$ in the case where BCR=1. The post-investment hedonic value of house i is now $LVH_{i1} = LVH_{i0} + \alpha_i I$ where the numerical subscripts refer to the post-investment (1) and pre-investment (0) periods respectively. From (14), the post-investment tax liability of house i is:

$$T_{i1}^{L} = \frac{LVH_{i0}+\alpha_i I}{LVH_{s0}+\alpha_s I}(R + I) \tag{16}$$

Hence the post-investment actual value of house i (which equals its hedonic land value plus (unchanged) improvement value minus its tax liability) becomes:

$$LVA_{i1}^{L} = LVH_{i0} + \alpha_i I + IV_{i0} - \frac{LVH_{i0}+\alpha_i I}{LVH_{s0}+\alpha_s I}(R + I) \tag{17}$$

Differentiating (17) with respect to I gives expression (18) which describes how the actual capital value is affected by a new infrastructure project that is financed by a land tax:

$$\frac{\partial CVA_i^L}{\partial I} = \alpha_i \left(1 - \frac{R+I}{LVH_{s1}}\right) - \frac{LVH_{i1}}{LVH_{s1}}(1 - \alpha_s \frac{R+I}{LVH_{s1}}) \tag{18}$$

If BCR=1 (and hence $\alpha_s = 1$), expression (18) simplifies to:

$$\frac{\partial CVA_i^L}{\partial I} = (\alpha_i - \frac{LVH_{i1}}{LVH_{s1}})(1 - \alpha_s \frac{R+I}{LVH_{s1}}) \tag{19}$$

Hence, with a land tax where BCR=1, the capital value of house i increases (decreases) where its increment to hedonic value is greater (less) than its share of the increased land tax required to fund the infrastructure. That share will reflect its overall land value including its pre-infrastructure land value. Thus, in the case of a project that has a BCR=1 and which affects the hedonic values of all properties equally, a house with high pre-existing land value will suffer a fall in actual (post-tax) capital value while houses with low pre-existing land values will experience a rise in actual capital value.

From (18), the likelihood of a fall in capital value is lessened where the house with high land value has a relatively high α_i, i.e. experiences a disproportionately high addition to its hedonic

value. The likelihood of a fall in capital value is also lessened when $\alpha_s > 1$ which corresponds to a project that has BCR>1.

Similar results occur with a capital value tax. In this case, the expressions that correspond to (18) and (19) become:

$$\frac{\partial CVA_i^C}{\partial I} = \alpha_i \left(1 - \frac{R+I}{CVH_{s1}}\right) - \frac{CVH_{i1}}{CVH_{s1}}(1 - \alpha_s \frac{R+I}{CVH_{s1}}) \quad (20)$$

and, where BCR=1:

$$\frac{\partial CVA_i^C}{\partial I} = (\alpha_i - \frac{CVH_{i1}}{CVH_{s1}})(1 - \alpha_s \frac{R+I}{CVH_{s1}}) \quad (21)$$

From (21), with a capital value tax and with BCR=1, the capital value of house i increases (decreases) where its increment to hedonic value is greater (less) than its share of the increased capital tax required to fund the infrastructure. The same corollaries apply as with the land tax where BCR>1 and/or when α_i is relatively high.

The important results from expressions (18) - (21) are that, under both a land tax and a capital value tax, a house may fall in value when an infrastructure project is funded by a proportionate property tax even when BCR>1. Under a betterment tax, by contrast, only the land value uplift is taxed so, provided the infrastructure project has a BCR≥1, the value of a house does not fall as a result of the project; and it will rise when BCR>1.

In the case of a betterment tax, the impact of an infrastructure project on house value is given by expression (22), where superscript B indicates a betterment tax:

$$\frac{\partial CVA_i^B}{\partial I} = \frac{\alpha_i}{\alpha_s}(\alpha_s - 1) \quad (22)$$

Thus, in the case of a betterment tax, if BCR=1 (i.e. $\alpha_s = 1$) each property will bear a tax that is equal to its change in hedonic value, so its capital value remains constant. If $\alpha_s > 1$, then provided $\alpha_i > 1$ (i.e. provided the hedonic value of the house rises as a result of the project) then its capital value will rise.[15]

To illustrate the differential effects of the three taxes, assume a project is undertaken which provides marginal hedonic benefit per property of 50, and further assume that the project has a BCR=1 so that there should be no change in city population. The council needs to raise an extra 50 in rates on average per property to pay for the infrastructure. This example is illustrated in the final panel of Table 1.

The effect on tax payments and property values depends on whether the additional tax is levied on the absolute land and/or capital value, or on the betterment value. Recall that a traditional land or capital value tax is levied on the total (or average) value of the property whereas the betterment tax is levied on the (marginal) change in value induced by the infrastructure.

In the example here, a betterment tax – which corresponds to John Stuart Mill's conception of a land tax – results in no change to actual land value or capital value for either property. This result is consistent with the outcome shown in expression (22).

[15] Note that these results assume that houses which suffer a fall in hedonic value receive a commensurate property tax decrease (i.e. a 'lesserment' payment).

With a standard land value tax (levied on total land value), the house in the wealthy (modest) suburb pays more (less) than the increment of 50 in hedonic value. In our example, tax of the wealthy suburb house rises by 61 while tax for the house in the modest suburb rises by just 39. Consequently, even though both properties experience equal hedonic gains from the added infrastructure, the wealthier property suffers a loss in overall value whereas the property in the modest suburb gains in value. The logic of the single tax falls short in this case since the added infrastructure cost is levied on the total value of land rather than on the increased (marginal) value of land. A similar result occurs with a capital value tax for the same reason. In our example, capital value taxes increase by 58 and 42 respectively for the wealthy and modest properties, so the wealthy property falls in value and the modest property's value increases.

The fact that the land tax remains economically efficient in these cases (since the land is still in fixed supply) is not reassuring. The inequity experienced by the wealthy household – where the extra tax exceeds the benefit to the household of the new infrastructure – creates a political economy problem. Households in the wealthy area will oppose developments for which their tax burden increases more than the hedonic value of the development.

In practice, for a host of political economy reasons (e.g. probability of voter turnout), wealthy households tend to have greater influence over local authority policymakers than do poorer households. As Mangioni (2016) states in describing the inability of Australian states to reform land taxes, the land tax is salient – i.e. it is prominent in the minds of people who have to pay it. Similarly, in New Zealand, property owners who pay local authority taxes ('rates') have lower trust in their local council than do renters who do not directly pay rates (Roskruge et al., 2013). Given these considerations, the rational opposition of people in wealthy neighbourhoods to developments that might have city-wide benefits may stifle developments that are funded by a conventional land value tax or capital value tax.

The inequity caused by adoption of either a land value or a capital value tax to fund new infrastructure (or other new amenities) has not been widely recognised in the existing tax literature. Quite simply, Henry George's 'single tax' on land value is not structured appropriately to fund the marginal costs of new council activities.

A formal betterment tax, which is consistent with John Stuart Mill's conception of a land tax that taxes only incremental gains above an existing threshold, is instead the appropriate form of property tax for this purpose. Rather than taxing at the average value of land, a betterment tax is a tax at the margin. A betterment tax is also a suitable tax to employ when dealing with (actual or prospective) rezoning of land, for instance from rural to urban use. Rezoning can result in a considerable rise in land value (Grimes and Liang, 2009). This rise in value is due to a community decision to rezone rather than to a personal decision by the landowner. As argued by Mill, from an equity perspective, it is reasonable for the community to benefit from this decision through a betterment tax levied on the rezoned land; furthermore, no property owner is disadvantaged in this situation relative to the pre-rezoning state. Meanwhile, the tax has no efficiency consequences since it does not affect the quantity of rezoned land.

Table 1: Illustrative examples

	WEALTHY SUBURB	MODEST SUBURB
BASE CASE		
Initial house characteristics		
Land value	700	300
Improvements	500	500
Capital value	1200	800
Land value tax		
Tax paid	280	120
% change in capital value (relative to zero tax)	-23%	-15%
Capital value tax		
Tax paid	240	160
% change in capital value (relative to zero tax)	-20%	-20%
URBAN REDEVELOPMENT		
Added improvement cost	500	500
Land value tax		
Extra tax paid	0	0
Required buyer valuation	≥500	≥500
Capital value tax		
Extra tax paid	125	125
Required buyer valuation	≥625	≥625
COUNCIL-INDUCED BETTERMENT (BCR=1)		
Hedonic value increase	50	50
Land value tax		
Increase in tax paid	61	39
Change in capital value	-11	11
% change in capital value	-0.9%	1.4%
Capital value tax		
Increase in tax paid	58	42
Change in capital value	-8	8
% change in capital value	-0.7%	1.0%
Betterment tax		
Increase in tax paid	50	50
Change in capital value	0	0
% change in capital value	0%	0%

Note: The base case is calibrated for a council revenue requirement = 400.

4 Reflections for local tax policy

Milton Friedman is quoted as saying: "*The least bad tax is the property tax on the unimproved value of land, the Henry George argument of many, many years ago.*" (Blaug, 1980). From an efficiency perspective in a static economy, this statement has merit. However, the analyses presented here indicate that George's 'single tax' on land faces several issues when used as a method to fund a new infrastructure project.

The spatial equilibrium analysis establishes that an infrastructure project that is funded through land taxes induces greater city development (i.e. population growth) relative to growth under a capital value tax which, in turn, induces greater city development relative to a local wage or general consumption tax. However, there is an incentive for a majority of residents to adopt inefficient projects (i.e. projects with BCR<1) under a land tax when some properties are owned by landlords, and especially by absentee landowners (who do not live in the city). This is the case even if landowners have the right to vote on projects since, if they each only have one vote, they are likely to be outnumbered by local residents who experience gains from new infrastructure without bearing the costs.

The partial equilibrium analysis points to additional political economy difficulties of both a land tax and a capital value tax, even when residents each own their own property. Land and capital value taxes are a tax on the average (or total) value of a property whereas a new infrastructure project provides a marginal change to a property's value. If there are heterogeneous pre-existing land (or capital) values, owners with valuable pre-existing properties bear a disproportionately high marginal tax liability to fund new infrastructure. Thus, under both land and capital value taxes, a coalition of 'wealthy' property owners may oppose projects even when those projects increase the hedonic value of their land and have a BCR>1. The reason is that the tax liability for owners of pre-existing high value properties may increase by more than their hedonic land value resulting in a fall in their actual property value.

A betterment tax (i.e. a tax on value uplift), in contrast, is a tax on the marginal value of land. Provided the infrastructure project increases the hedonic value of a house, the owner experiences a rise in actual property value in all cases where BCR>1. The reason is that the new tax liability will be less than their increase in hedonic value. Unlike the case of a land tax, there is no reason for a rational resident to oppose any infrastructure development which increases the hedonic value of their house (even slightly) and which has a BCR>1. A betterment tax, which is consistent with JS Mill's conception of a land tax, is therefore a more efficient mechanism than George's 'single tax' to fund an infrastructure investment.

In practice, valuation of land value uplift may be more challenging than valuation of land as a whole: a small absolute (dollar) error in valuing the full land value makes little difference to the tax liability under a land or a capital value tax (which taxes total value) but makes a much larger difference to the tax liability for a specific house when (the marginal) value uplift is being taxed. This practical challenge may provide an explanation for why betterment taxes are not more widely adopted. In this situation, if a land tax is instead adopted, it may be appropriate to have mechanisms in place to ensure that only projects with BCR≥1 are approved. One approach that has been utilised across multiple jurisdictions is to place final decision-making powers over major projects at a higher level of government (e.g. a state government approving major municipal projects) to prevent the 'tyranny of the resident majority' prevailing over landowners when a land tax or a capital value tax is adopted. Whether adoption of a land tax coupled with this decision-making process has net benefits relative to the theoretical benefits (but potential practical challenges) of a betterment tax is worthy of further theoretical and empirical investigation.

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