Post-Corona Balanced-Budget Super-Stimulus: The Case for Shifting Taxes onto Land[*]

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Abstract

Using a quantitative model of the US economy, we show that higher land asset value taxes (LAVT), balanced by reductions in distortionary income taxes, can stimulate the economy without further deficits. The value of land is approximately equal to that of capital in the US and several other economies, so that the tax base is very large. An LAVT increase from 0.55% to 5.55% raises output and welfare by 14.8% and 3.4%. Gains from taxing land and capital equally are half as large. Gains from taxing land at 20% are twice as large, while all income taxes can be abolished.

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1. Introduction

The 2020/2021 COVID-19 crisis caused a drastic plunge in economic activity, and many economies subsequently struggled to recover. Fiscal authorities responded with large deficits to support businesses and individuals, but this put strains on public finances, which were already suffering from the aftermath of the 2008 Global Financial Crisis (GFC). There is a perception that there is very little remaining scope to provide fiscal stimulus through further deficits. This paper argues that a powerful fiscal stimulus can be engineered without additional deficits, by instead shifting the burden of taxation away from productive labor and capital, and onto land. This tax reform could raise very large *revenues*, because the tax base is very large, it would be *non-distortionary*, in fact its stimulus is due entirely to a massive reduction in distortions to economic incentives, and it would be as *fair* as any tax reform could hope to be, while the many winners could easily afford to compensate those suffering any residual unfairness.

In a representative household model calibrated to the US economy for 2015, including a very detailed decomposition of the fiscal accounts, we show that a baseline policy that increases the tax rate on the capitalized asset value of land from around 0.55% at present to around 5.55%, over a period of 20 years – and assuming corresponding balanced-budget tax cuts on asset and labor incomes – would spur very large output and welfare gains of 14.8% and 3.4%. These benefits are increasing in the tax base of the land tax, the targeting of tax cuts to capital income taxes, and the elasticity of labor supply. We then compare the baseline to a more commonly discussed wealth tax that increases taxes on both land and capital asset values in equal measure while raising the same revenue, and find that output and welfare gains are much smaller at 6.9% and 1.9%. We also compare the baseline to a tax reform that increases the tax rate on land asset values to 20% and thereby raises 55% of total tax revenue, while consumption taxes, at a rate of 12.2%, raise the needed additional revenue in the least distortionary way. The output and welfare gains of this reform equal 26% and 5.2%.

Even our more modest baseline of a 5.55% land asset value tax would represent a very large tax reform, but it would not be unprecedented. As discussed by Wallis (2000), in the US the period between 1839 and 1933 was dominated by local governments that financed themselves predominantly through property taxation. By 1902 property taxes had come to account for 73% of all local revenues, 57% of all state revenues, and 42% of overall revenues.

Our paper distinguishes between *land rental value taxation (LRVT)* – a tax on a flow, the annual rental value of land, which excludes gains due to price appreciation (reflecting current practice in taxing rental incomes) – and *land asset value taxation (LAVT)* – a tax on a stock, the capitalized value of future after-tax rental values, which includes gains due to price appreciation. The LAVT, but not the LRVT, is therefore a tax on Haig (1921) - Simons (1938) comprehensive income, the sum of current income and appreciation gains. Given the high observed share of appreciation gains in overall returns to land, LRVT has a smaller tax base, and thus also a lower potential to stimulate the economy. After demonstrating this, we focus our remaining analysis on LAVT.

We acknowledge that the term "value" in "rental value" and "asset value" might be considered problematic in the context of incomes from land, because the classical concept of "value" is linked to a corresponding cost or effort, such as work or saving. Land however bestows a property right to a part of economic output without any corresponding cost or effort, so that rents represent unearned income. For land, the three principal sources of unearned income and value are favorable location, adjacent public services, and nearby private development. Several studies list other types of unearned income, including Schwerhoff et al. (2020), Tideman and Mecherikunnel (2021), Stiglitz (2015a), and Gaffney (2009).

A key input into our analysis is the computation, for the US but also for a number of other important economies, of the share of land and other non-produced assets in the overall value of physical assets, which equal non-produced plus produced assets. This matters because one reason why the economics profession has not been paying sufficient attention to the possibilities raised in this paper is the frequently held but incorrect perception that the tax base of land taxes is small.[1] We approximate the US land share by subtracting the BEA stock of physical capital from the Fed Flow of Funds net worth of households and nonprofit organizations. By this measure, in the US land accounts for a very large 51.1% of the stock of nonfinancial assets – and several percentage points more if we take into account wealth held by foreigners and by top earners, and shortcomings of the BEA data (see Section 7.1). We corroborate these magnitudes by computing, using an OECD database, land shares for nine other industrialized economies that produce data of much higher quality and detail. For virtually all countries covered, the land share lies between 40% and 60% of total physical assets. We find that when we simulate our tax reforms with a 40% rather than a 51.1% steady state land share, this makes a quantitative difference, but the reforms' benefits remain very large.

We show that the relationship between the *size* of the increase in the land tax rate and the resulting gain in output is monotonically increasing but tapers off as the tax rate rises. However, for the LAVT the incremental benefits remain large up through tax rates of 10%-20%. We argue that a slow *implementation speed* of land tax increases may be desirable because it ensures a smoother adjustment of land prices on impact, and because of the need to ensure that the cash flows of landholders are initially not greatly impacted, thereby allowing them to continue to service previously incurred loans.

Nevertheless, there is a remaining trade-off, between very large but gradual output increases and immediate land price decreases, that can be moderated, but not eliminated, by a slower im-

[1] For an example, see Krugman and Wells (2006).

plementation speed. The initially moderate cash flow effects on landlords, and the cuts in taxes on incomes that have positive cash flow effects, are therefore essential to maximize political support. Relief measures for the small share of taxpayers that initially experience cash-flow problems are discussed in Section 5.

There are three considerations that make facing up to such transitional costs more than usually worthwhile at the current juncture. First, all tax increases face transitional costs, and this reform has better longer-term prospects than virtually any other. Second, projections for future fiscal deficits and debt are now worrying in many economies, and this reform provides a realistic medium- and longer-term prospect for overcoming such difficulties. Third, part of the faster growth of China may have been due to the fact that ultimately the Chinese state owns all land in the country, and merely leases it out for private use. Therefore, it can ensure that the lease receipts are used to support public infrastructure and to keep distortionary taxes low. A LAVT would enable the West to provide similar positive incentives, and to thereby support its continued competitiveness.

The rest of the paper is organized as follows. Section 2 presents the history of the idea of land taxation. Section 3 discusses the key theoretical ideas. Section 4 presents US and international data on land asset values. Section 5 discusses practical experiences and issues with land taxation. Section 6 lays out the theoretical model. Section 7 presents its calibration. Section 8 quantitatively evaluates various tax reforms using this model. Section 9 concludes.

2. History

2.1. Ethics

The ethical foundations of land taxation are discussed by Foldvary (1999). He explains that Locke's (1690 [1947]) ethical premise of equality among human beings implies self-ownership, which extends to ownership of labor and the products of labor, including capital. The government should therefore only tax labor and capital under strict conditions. But self-ownership does not extend to land, since land is not produced by labor. Ethically, human beings are in an equal moral position with respect to the benefits of land, the common heritage of humanity. To establish equal benefits, it is sufficient to establish equal ownership of its natural rent through land taxation. Rights of control (use and exchange) of land, and therefore of its efficient improvement through individual labor and capital accumulation, can be left to the individual. This reform would therefore remain compatible with the important role of property rights for productive investment (North (1991, 1994)).

Ethical considerations are also behind the most common counterargument against taxing land, which is that established institutions have long ago assigned land rights to individuals, and that a sudden tax-based reduction of land asset values represents discrimination and confiscation. If the argument is that land taxes should therefore be avoided altogether, it needs to be recognized that the same argument can be made against any change in public policy, which almost invariably entails winners and losers. Such thinking was once used in defense of the maintenance of slavery (Gaffney and Harrison (1994)). If the argument is instead that compensation should be paid to the losers, this can indeed be part of a tax reform, but Advani et al. (2020) and Tideman (1994) show that very strict principles should apply to ensure justice and to prevent rent-seeking.

2.2. Economics

The writings of the French Physiocrats (Quesnay (1963 [1756])) likely brought the efficiency of taxes on land to the attention of Adam Smith (1937 [1776]). Other 19th century advocates of land taxation include David Ricardo (1911 [1817]), James Mill (1824), John Stuart Mill (1884), and Henry George (1960 [1879]).[2] Partly under the influence of such thought, land taxation came close to becoming reality in the UK in Lloyd George's "People's Budget" of 1909. It did not succeed because the required valuation of all British land was still incomplete at the outset of World War I, and changing political coalitions after the war made it impossible to complete it (Douglas (1999)).

Gaffney (1994, 2009) and Gaffney and Harrison (1994) discuss that classical economists had treated output as the product of labor, capital, and land, but that towards the end of the 19th century analytical frameworks started to merge land into capital. This is still the dominant approach used today, both in economic theory and in the national accounts. As also argued by Stiglitz (2015a), this has long served to obscure important insights, which include the benefits of taxing land.[3] Stiglitz (2015a) especially emphasizes the need to understand the role of rents in explaining why wealth has grown so much more rapidly than physical investment in recent decades. For related empirical evidence, see Knoll et al. (2017).

Ramsey (1927), Pigou (1928), and Stiglitz (1986) showed that taxes should be inversely proportional to supply and demand elasticities. This leads directly to capital as the worst tax base (Judd (1985), Chamley (1986)) and land as the best tax base.

In recent policy reviews there has sometimes been little inquiry into the effects of shifting taxes from labor and capital onto land. For example, Boadway et al. (2010) do mention the advantages of land taxes in principle, but in their policy proposals they only advocate very limited property taxes. The report of the UK Wealth Tax Commission (Advani et al. (2020)) only discusses wealth taxes. But chapter 16 of the Mirrlees Review (Institute for Fiscal Studies and Mirrlees (2011)), the most comprehensive and rigorous review of UK taxation undertaken for many decades, argues in favor of the taxation of land: "This is such a powerful idea, and one that has been so comprehensively ignored by governments, that the case for a thorough official effort to design a workable system seems to us to be overwhelming."

[2] Andelson and Gaffney (1979) and Blaug (2000) provide very good summaries of George's thought.

[3] However, this was and is far from universal. Marshall, Walras, Samuelson, Friedman, Tobin, Buchanan, and Solow all made statements supporting land taxation.

In the academic literature, Tideman et al. (2002), in the spirit of the current paper, separate land and capital as two different factors of production, and conclude that a shift to land taxes would produce large output gains. Stiglitz (2015c) finds that land taxes can increase real wages and real output, while contributing to reducing inequality. Bonnet et al. (2021) also conclude that land taxation would be beneficial. Their paper uses a Judd-Chamley model with capitalists and workers, output is produced using capital and labor, capital is in endogenous supply, and land enters utility functions. Our paper uses a neoclassical growth model with a representative household (and one variant with capitalists, workers and landlords), output is produced using capital, labor and land, and both labor and capital are in endogenous supply.

3. Theory

3.1. Concepts

Land is taken to mean the entire material universe excluding people and their products, including land, water, air, sunlight, and the electromagnetic spectrum. Like the Mirrlees Review, we propose that if a land tax is introduced, both business/agricultural land and residential land should be subject to it, and we will therefore not distinguish between the two in our discussion.

The rental and asset values of a developed site consist of the values of land and of the overlaying produced immovable capital. We will use the terminologies property or real estate to denote the combination, the terminologies structures, buildings or improvements to denote the produced immovable capital, and the terminology land to denote the entire non-produced material universe.

The *net return (or rental) of land* is the actual income realized by a particular owner, and will be at best equal to, but generally less than, the *rental value of land*, which is the opportunity cost of leaving an unused site unused, or alternatively, the flow rental income that is available from a site if it is put to its "highest and best use". The "present value of planned net income" *(PVPNI)* is the present discounted value of net returns of land from the particular, and possibly suboptimal, current use, while the *asset value of land* is the present discounted value of future rental values of land, or the market value of land in its "highest and best use". The rental or asset values of land, unlike the rental of land and the PVPNI, are proper bases for a land tax, because the highest and best use of a site is independent of the actions of the taxpayer, thereby making the tax a lump-sum tax.[4] This tax does not affect the total rental paid by users of land, it only affects the division of this rental between payments to the landlord and payments to the government.

3.2. Analytics

Assume that one period represents one year, that the net real interest rate r is constant, that land rental values y_t accrue at year-end and grow at the constant annual rate g, and that taxes

[4] See Gaffney (1971) and Arnott (2005) for other, more complex ways to make property taxes neutral.

become due at year-end. Thus, in the absence of taxes, the asset value of land at time t is given by

$$V_t = \sum_{s=0}^{\infty} \frac{y_{t+s}}{(1+r)^{s+1}} = \sum_{s=0}^{\infty} \frac{y_t\,(1+g)^s}{(1+r)^{s+1}} = \frac{y_t}{r-g} = \frac{y_t + gV_t}{r} \ , \tag{1}$$

while in the presence of an annual land asset value tax (LAVT) at a rate of τ it is given by

$$V_t = \sum_{s=0}^{\infty} \frac{y_{t+s} - \tau V_{t+s}}{(1+r)^{s+1}} = \frac{y_t}{r+\tau-g} = \frac{y_t + (g-\tau)\,V_t}{r} \ . \tag{2}$$

Note that the rental value y_t is not affected, *ceteris paribus*, by the introduction of a LAVT.[5] The only effect of the LAVT is therefore that the owners of the land, on the day the tax is announced, suffer a windfall loss, while after the announcement there is no further burden on any new site owner (Foldvary (2005)). The windfall loss equals the present discounted value of government tax receipts, so that an LAVT is economically equivalent to the government appropriating an equity share in the land. If the proceeds of the tax are used to reduce distortionary taxes, efficiency gains imply that y_t grows from y_{pre} to y_{post}, and in this case the windfall loss is reduced, and the land price drops by less. Finally, to show that a LAVT taxes both current rental income y_t and the current unearned increment (unrealized gains due to price appreciation) gV_t as they accrue, and at the same rate (see Gaffney (2009)), we can rewrite (2) as $V_t = (y_t + gV_t) / (r+\tau)$.

3.3. Financial Sector

Hudson (2012, 2018) and Schwerhoff et al. (2020) argue that bank credit is a major driver of increases in house prices, and Favara and Imbs (2015) provide detailed empirical evidence to support this. Land taxation at a high enough rate would therefore improve financial stability by substantially reducing the tendency of land values to fuel and be fuelled by lending booms.

Any reform would have to ensure that banks that have extended mortgages retain the ability to service their existing liabilities. This can be accomplished, in part, by phasing the tax in gradually. With this, while collateral values would immediately drop, the cash flows of borrowers would initially be affected much less, so that they could continue to make their loan payments.

3.4. Environment

Harrison (1989, 2012) argues that the failure to make people pay rent for access to, or possession of, natural resources is at the heart of all major environmental problems. Beck (1999) (see also Gaffney (1976)) emphasizes that balanced-budget land value taxation, which combines an increase in land value taxes with a decrease in taxes on productive activity (including taxes on improvements) shares many characteristics with ecological tax reform (ETR), which combines an increase in taxes on consumption of natural resources with a decrease in taxes on productive activity.[6] Both taxes discourage idle land speculation, and the underuse, waste, and sprawling development of sites.

[5] Inaccuracies in the assessment of a lump-sum tax do not affect efficiency, but of course they may affect distribution.
[6] For an in-depth treatment of ETR, see Hamond (1997).

4. Data

Two objections against land taxes concern the tax base, the value of land, namely that it is either unobservable, or observable but too small. This section uses data from a recently created OECD database, and a presentation of modern estimation methods, to argue that these objections are obsolete. Valuation methods are constantly improving, and the tax base is very large.

4.1. Source

The annual data in Figure 1 were obtained from the OECD statistical database, Table 9B, Balance Sheets for Non-Financial Assets.[7] This database first divides **assets** into financial assets (which correspond to other agents' liabilities) and non-financial assets (which do not), second it divides **non-financial assets** into produced assets and non-produced assets, and third it divides **non-produced assets** into land and mineral and energy reserves. Our main object of interest is the ratio of non-produced assets to non-financial assets. The figures are reported for the total economy, except where data are only available for households.

4.2. Methods

Eurostat-OECD (2015) discuss four different methods for estimating the value of land. Method 1 is the *direct cadastral* approach, which takes a physical inventory of parcels of land and multiplies the area of each by an appropriate price per unit of area. This is the dominant method worldwide for estimating the value of land without structures. It is used for all land types by several important economies, including Japan, South Korea, and Taiwan Province of China. Method 2 is the *land residual* approach, which subtracts the value of structures, mostly estimated by the permanent inventory method, from the combined value of property. This is the dominant method worldwide for estimating the value of land with structures, because it is comparatively easy to implement. Its conceptual flaws will be discussed in Section 4.5. Method 3 is the *land-to-structure ratio* approach, which derives the value of land indirectly by multiplying the value of each structure by its LSR. It can only be used to estimate the value of land underlying structures, and is used most extensively by Canada. Method 4 is the *hedonic* approach, which uses a hedonic regression model to estimate separate price indices for land and structures while controlling for the characteristics of each parcel. It derives the total value of land by multiplying the land price index by the area of land. The hedonic approach has not yet been used nationwide by any country. But it has been used in many individual studies and at the sub-national level.

[7] Available at https://stats.oecd.org/Index.aspx?DataSetCode=SNA_TABLE9B.

4.3. Results

Figure 1 displays the shares of non-produced assets in non-financial assets for nine economies.[8] For seven of them we display the total economy (excluding government) land share. For the remaining two, the data are only sufficient for the household sector land share.

The data for Australia[9] and Canada are based on very detailed estimation methodologies. In both cases there has been a large increase in the land share since the early 1990s, from around 30% to around 40%-45%. When we include the value of mineral resources, the share reaches 50% towards the end of the sample period. For the UK, the land share starts at around 40% in the mid-1990s and ends close to 60% prior to the 2008 GFC and again more recently, after a dip during the crisis.[10] Japan and South Korea have the most highly developed estimation methodologies, mainly because significant taxes are already being levied on land. In South Korea, the land share has fluctuated around 55% between the mid-1990s and today. Japanese land shares were around 60% in the early 1990s, and subsequently declined and stabilized at a little under 50%. The data series for France starts in 1978. We observe a declining land share in the 1980s and 1990s, followed by a very rapid increase starting in the late 1990s. Recent land shares have fluctuated around 45%. Finally, recent household sector land shares have been 50% in Italy and 75% in Spain. The only major outlier in the OECD data is Germany, whose land share has fluctuated around 30%.

To summarize, in the majority of cases land and other non-produced assets account for around 50% of non-financial assets. The implication is that half of the returns that are usually attributed to "capital" are in fact received by non-produced assets. The potential for shifting the burden of taxation from labor and produced assets to non-produced assets is therefore very large, especially if capital gains are taxed as well.

There have been many earlier attempts to determine the tax revenue potential of land taxes. They were done without the benefit of the higher-quality data now available, but nevertheless reach similar conclusions. This includes Banks (1989a) for the UK, Dwyer (2003), Kavanagh (2007), Putland (2013, 2018), and Prosper Australia (2013) for Australia, and Netzer (1966), Manvel (1968), Gaffney (1970a), Cord (1985), Miles (1990), Rybeck (2000), and Larson (2015) for the US.

4.4. Incomplete Coverage of the Tax Base

Gaffney (2009) provides a long list of reasons why commonly used US data sources are downwardly biased in estimating land rental and land asset values. For land asset values, the main issues (out of 31 in total) listed by Gaffney (2009) are: (1) Failure to apply the building-residual

[8] Kumhof et al. (2021) show data for an additional 7, mostly smaller, economies, and a more detailed sectorial breakdown.

[9] Australia has a state-based annual land tax on unimproved land values (Lunde and Whitehead (2021)).

[10] The overwhelming importance of land for the level and growth of UK wealth is also emphasized in Government Office for Science (2015) and Office for National Statistics (2018).

method instead of the land-residual method (see Section 4.5). (2) Assessment on the assumption that current (often suboptimal) uses will be permanent. (3) Lag of assessments behind rising land and falling building values. (4) Use of the capitalized income method for assessing business properties, despite them not being in their optimal or any use (e.g. vacant lots and downtown parking lots). For land rental values, the main issues are: (1) Excessive depreciation, including multiple re-depreciations after sales to new owners (see Gaffney (1970b), O'Connell (1985)). (2) Classifying the resulting excess of sales prices over remaining undepreciated values as (low-tax) capital gains rather than hidden rents. (3) Depreciation of land (which does not depreciate) as well as buildings because of arbitrariness in the allocation of land and building values. (4) Omission of imputed rents on owner-occupied residential land. (5) Misposting of all internalized rents on owner-occupied commercial land as profits rather than rents. (6) Underreporting of capital gains. (7) Reporting of mortgage interest as interest rather than rent. (8) Reporting of all corporate profits as returns to capital rather than rent. These biases can lead to highly misleading conclusions, a point also emphasized by Assa (2016).

4.5. Inadequacy of the Land Residual Method

4.5.1. Data

For asset values, the US Flow of Funds, Federal Reserve Statistical Release Z.1, Table B.101, reports households' and nonprofit organizations' total value of real estate and, as a memo item, the replacement cost value of structures. The land-residual method calculates the value of land by deducting the latter from the former.

For rental values, the BEA National Income and Product Accounts (NIPA) merely report the income that individuals whose major business is not real estate declare on their tax returns as being paid by tenants, after subtracting depreciation and interest. Commercial real estate investors are defined as earning profits, not rents, again after subtracting depreciation and interest.

4.5.2. Problem

The land-residual method starts out by estimating the property's market value, and then subtracts the value of buildings, based on construction costs, to obtain the value of land. The alternative building-residual method subtracts the value of land, based on its highest and best use, to obtain the value of buildings. Vickrey (1999), Helm (2012) and Tideman (1999) show that the building-residual method establishes the correct base for a LAVT. Hudson (2001, 2010, 2012) shows that the land residual method gives rise to serious biases. First, it cannot generate *spatially* homogenous valuations - for example, in reality land prices rise and fall equally for parking lots and skyscrapers in the same neighborhood. Second, its explanation of real estate prices *over time* is problematic, including the fact that land asset values can drop below zero, including at the national level. Third, it misattributes the *source* of increases in real estate values, which are not mainly driven by construction costs, specifically structures that have been built in the past at lower cost, but instead by demand for site values ("location, location, location"), specifically improved amenities or easier credit, often accompanied by an intention to tear down the old buildings.

The main conceptual problem with the land-residual method is that it attributes a cost of production value to structures fixed to a particular location, even though the structures cannot be removed and traded. This misses the distinction between cost of production and value in use. While these may be similar for new structures, changing circumstances over the long life of a structure give rise to locational obsolescence, whereby the growing value of the site has cannibalized part of, or more than part of, the residual building value. This can imply a small land asset value when it is defined as the residual, even though a physically excellent building on such a site can be economically worthless. BEA data do not account for locational obsolescence, even though it has a far greater effect on the relative values of land and buildings than wear and tear (Gloudemans (2002)).

The key is that structures cannot be attributed any value independently of their location, so that the land asset value must be estimated first, with the value of structures *in that location* as a residual. Another way of arguing this point is to note that to ask what a site would sell for if bare, and to define site value accordingly, is not a hypothetical question, since that state can be achieved. In contrast, a definition of the value of fixed structures based on what they would fetch if they were *not* fixed is based on an entirely hypothetical question.

4.5.3. Solution

A sizeable literature has found that it is possible to determine land asset values with satisfactory accuracy, see Gloudemans (2000), Bell et al. (2009), Henry et al. (2009) and Institute for Fiscal Studies and Mirrlees (2011). As documented in Brunori and Carr (2002) and Bourassa (2009), mechanisms for the separate valuation of land and improvements are mostly already in place in the US, with 220 out of 226 local taxing authorities, and 20,000 licensed assessors, valuing land and improvements separately. The valuation techniques are very well established, and have long been summarized in manuals for land appraisers (Gwartney (1999), Bell et al. (2009), International Association of Assessing Officers (1997)). The most modern techniques combine attributes of the building-residual and hedonic approaches.

An early example is the work of Ward et al. (1999, 2002) on computer assisted mass appraisal (CAMA) regression methods. Essential CAMA tools are (i) sales comparison and sales proxy data, (ii) geographic information systems (GIS), a computer software that manipulates spatial information, and (iii) global response surface analysis (GRSA), a mathematical technique that uses GIS to measure the distance to multiple sold properties. Recent decades have seen the rapid development of mass valuation techniques (McCluskey et al. (2013), Almy (2014)), and of comprehensive international support for land administration (Enemark et al. (2014)). Previous arguments against land taxation based on administrative costs (Skinner (1991)) therefore appear outdated. The end product for a geographical area is a smooth land value map that can be used to value any site within the boundary of that area. There is an active literature on land value maps - recent examples include Kolbe et al. (2015) and Cellmer et al. (2018).

While a combination of the building-residual and hedonic methods offers the best available approach, even this tends to underestimate the potential tax base of land taxes. The reason is the very slow turnover in property markets, of 5% or less per annum, compared to goods markets where turnover is close to 100%. This means that 95% or more of landowners in effect sell or rent to themselves, while assessors need to rely on the small active market to estimate the value of the whole. The problem is that this active market records the willingness to pay (WTP) of buyers faced with sellers that are unable to hold out, and that this WTP is often far lower than the willingness to accept (WTA) among holdout landowners (Gaffney (2009)).

5. Practical Experiences and Issues

The cross-country empirical studies of Arnold (2008), Arnold et al. (2011), and OECD (2010) find that corporate income taxes are most harmful to growth, followed by personal income taxes and consumption taxes, with recurrent taxes on immovable property least harmful. Their quantitative conclusions are broadly consistent with our model-based analysis.

Andelson (2000) and Dye and England (2009, 2010) summarize cross-country evidence for the positive effects of land taxes. Similarly, IMF (2010, 2013), Norregaard (2013) and Blöchliger (2015), advocate property taxation as the best tax to boost growth. The UK's All-Party Parliamentary Group on Land Value Capture (2018) advocates taxing land.

Slack and Bird (2014) (see also Brys (2011)) discuss typical practical obstacles to a successful property tax reform, and ways to overcome them. Perhaps the most frequently cited problem is cash-flow problems for a subset of taxpayers. We will find that a LAVT has overwhelmingly positive effects for households whose main income sources are labor or capital, and that the only sufferers are households whose income comes overwhelmingly from land. Lewis (1980), Geisler (1993, 1995), and Bucks et al. (2006) provide some data: First, the top 5% of US landowners own 75% of privately owned land, while the bottom 78% of landowners own only about 3% (this has become even more extreme after the GFC). Second, for the top 10% of the wealth distribution, real property holdings account for only about 15% to 20% of their wealth, while real estate is typically the largest wealth component for the bottom 90%. The main concern would therefore be a group that accounts for only a small share of total landholdings (the famous cash-poor widow). The literature has discussed a number of policies for such cases. Tax deferral schemes are not popular because they leave property encumbered for the occupants' heirs (Bird and Slack (1978)). Alternatives are tax reductions for liabilities that exceed some specified percentage of income (Johannesson-Linden and Gayer (2012)), universal homestead exemptions, and phase-ins (Blöchliger and Vammalle (2012)). Because the affected landholdings would be so small, the fiscal cost would be limited.

The potentially high cost of administering a system of land taxation is also frequently cited. However, the current tax system is highly complex and subject to high costs of its own (Foldvary (2005)). Government Accountability Office (2005) and Tax Foundation (2005) estimate the US tax compliance burden at between 1% and 2.5% of GDP, excluding the costs of tax planning and tax litigation. This potentially allows very large savings when existing taxes are replaced by land taxes. The main cost of developing a system of land taxation is the need for an adequate appraisal system. The separate determination of a site's land and structures values is already routinely done in the US, because it is required by tax authorities, insurers, and banks. Institute for Fiscal Studies and Mirrlees (2011), Boadway et al. (2010) and Dye and England (2009) argue that the difficulties in establishing an efficient system of land appraisal would not be insurmountable, pointing to the experience of several countries that have already done this.

6. Model

The model economy consists of a representative firm, a government, and either a representative household or separate groups of workers, capitalists and landlords. One period represents one year. The economy grows at the exogenous and constant rate of technological progress $x = T_t/T_{t-1}$, where T_t is the level of technology. We normalize all growing variables by technology, with a check above a variable indicating the normalized variable. The price of output is the numeraire.

Our model distinguishes between marginal and average income tax rates. This ensures consistency with two sets of evidence. First, marginal rather than average tax rates affect economic incentives (Padovano and Galli (2002)). Second, average rather than marginal tax rates affect budgets and thereby the scope for shifting the tax burden between incomes and land.

6.1. Representative Household

Households consume c_t, supply labor ℓ_t to firms, and hold physical capital k_t and land a_t. Their income consists of after-tax wages, the after-tax returns to physical capital and land, and net lump-sum transfers Υ_t. The wage rate is denoted by w_t, the rentals of capital and land by r_t^k and r_t^a, and the relative price of land by p_t. Households are subject to six different taxes that we will match to US data. The tax rates on the values of capital and land are $\tau_{p,t}^k$ and $\tau_{p,t}^a$, the marginal tax rates on labor and on the rentals of capital and land are $\tau_{\ell,t}$, $\tau_{k,t}$ and $\tau_{a,t}$, and the marginal tax rate on consumption is $\tau_{c,t}$.

The marginal tax rates on labor and on the rentals of capital and land exceed the respective average tax rates. We assume that the marginal tax rate is only levied on the portion of income that exceeds the calibrated thresholds $\tilde{\ell}_t$, $\tilde{k}_t$ and $\tilde{a}_t$, which are taken as given by households. Fiscal policy ensures that the ratio of marginal to average tax rates stays constant. The marginal tax rate on labor is levied on $w_t\ell_t - \tilde{\ell}_t$, and the threshold is $\tilde{\ell}_t = \psi_\ell w_t \ell_t$. Similarly, the marginal tax rate on capital is levied on $\left(r_t^k - \delta - \tau_x - \tau_{p,t}^k\right) k_{t-1} - \tilde{k}_t$, where δ, τ_x, and $\tau_{p,t}^k$ are allowances deducted from the rental of capital in accordance with the tax code, with δ the rate of physical depreciation, τ_x the (constant) rate of excess depreciation allowance, and $\tau_{p,t}^k$ the tax rate on the value of capital. In this case, the threshold is given by $\tilde{k}_t = \psi_k \left(r_t^k - \delta - \tau_x - \tau_{p,t}^k\right) k_{t-1}$. Finally, the marginal tax rate on land is levied on $\left(r_t^a - p_t\tau_{p,t}^a\right) a_{t-1} - \tilde{a}_t$, and the threshold is given by $\tilde{a}_t = \psi_a \left(r_t^a - p_t\tau_{p,t}^a\right) a_{t-1}$.

Households maximize lifetime utility subject to a sequence of budget constraints. We assume GHH preferences (Greenwood et al. (1988)), which have been used extensively to match empirical regularities (see e.g. Raffo (2008) and Schmitt-Grohe and Uribe (2008)). See Diamond (1998) for an early example of the use of GHH preferences in the literature on optimal taxation. We have the following lifetime utility maximization problem:

$$\max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{u_t^{1-1/\sigma}}{(1-1/\sigma)} \quad , \quad u_t = c_t - \kappa T_t \frac{\ell_t^{1+\frac{1}{\theta}}}{1+\frac{1}{\theta}} \ , \tag{3}$$

with $\check{u}_t = \check{c}_t - \kappa \ell_t^{1+\frac{1}{\theta}} / \left(1+\frac{1}{\theta}\right)$. This utility function features an intertemporal elasticity of substitution in consumption of $\sigma u_t / c_t$ and a labor supply elasticity of θ. The budget constraint is

$$\begin{aligned} k_t + p_t a_t \quad = \quad & k_{t-1}\left(1-\delta-\tau_{p,t}^k\right) + r_t^k k_{t-1} - \tau_{k,t}\left(r_t^k - \delta - \tau_x - \tau_{p,t}^k\right)\left(k_{t-1} - \tilde{k}_t\right) \\ & + p_t a_{t-1}\left(1-\tau_{p,t}^a\right) + r_t^a a_{t-1} - \tau_{a,t}\left(r_t^a - p_t\tau_{p,t}^a\right)\left(a_{t-1} - \tilde{a}_t\right) \\ & + w_t\ell_t - \tau_{\ell,t} w_t \left(\ell_t - \tilde{\ell}_t\right) + \Upsilon_t - c_t\left(1+\tau_{c,t}\right) \ , \end{aligned}$$

and capital accumulation is $k_t = (1-\delta) k_{t-1} + I_t$, where I_t is physical investment. The multiplier of the household budget constraint is λ_t, and $\check{\lambda}_t = \lambda_t T_t^{\frac{1}{\sigma}}$. Then the first-order conditions for consumption, labor, land, and capital are

$$(\check{u}_t)^{-\frac{1}{\sigma}} = \check{\lambda}_t \left(1+\tau_{c,t}\right) \ , \tag{4}$$

$$(\check{u}_t)^{-\frac{1}{\sigma}} \kappa \ell_t^{\frac{1}{\theta}} = \check{\lambda}_t \check{w}_t \left(1-\tau_{L,t}\right) \ , \tag{5}$$

$$1 = \beta x^{\left(1-\frac{1}{\sigma}\right)} \frac{\check{\lambda}_{t+1}}{\check{\lambda}_t} \frac{\check{p}_{t+1} + \check{r}_{t+1}^a - \tau_{p,t+1}^a \check{p}_{t+1} - \tau_{a,t+1}\left(\check{r}_{t+1}^a - \check{p}_{t+1}\tau_{p,t+1}^a\right)}{\check{p}_t} \ , \tag{6}$$

$$1 = \beta x^{\left(-\frac{1}{\sigma}\right)} \frac{\check{\lambda}_{t+1}}{\check{\lambda}_t} \left(1 - \delta + r_{t+1}^k - \tau_{p,t+1}^k - \tau_{k,t+1}\left(r_{t+1}^k - \delta - \tau_x - \tau_{p,t+1}^k\right)\right) \ . \tag{7}$$

6.2. Heterogeneous Households

For this model variant, we use the subscript z to index variables pertaining to landlords, capitalists and workers. For firms and government, the model remains unchanged. We have the lifetime utility maximization problems

$$\max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_z^t \frac{u_{z,t}^{1-1/\sigma_z}}{(1-1/\sigma_z)} \quad , \quad u_{z,t} = c_{z,t} - \kappa_z T_t \frac{\ell_{z,t}^{1+\frac{1}{\theta}}}{1+\frac{1}{\theta}} \ , \ z \in \{a, k, \ell\} \ . \tag{8}$$

Workers do not hold capital or land and only supply labor, capitalists hold all of the economy's capital and supply labor, and landlords hold all of the economy's land and supply labor. We allow for different σ_z, to allow us to calibrate identical steady state intertemporal elasticities of substitution despite differences in steady state consumption and labor, and different κ_z, to allow us to independently calibrate each group's steady state labor supply. Each group receives equal hourly wage rates, and equal per capita lump-sum distributions from the government. The optimality conditions for consumption, labor, land, and capital are

$$(\check{u}_{z,t})^{-\frac{1}{\sigma_z}} = \check{\lambda}_{z,t} \left(1 + \tau_{c,t}\right) \ , \ z \in \{a, k, \ell\} \ , \tag{9}$$

$$(\check{u}_{z,t})^{-\frac{1}{\sigma_z}} \kappa_z \ell_{z,t}^{\frac{1}{\theta}} = \check{\lambda}_{z,t} \check{w}_t \left(1 - \tau_{L,t}\right) \ , \ z \in \{a, k, \ell\} \ , \tag{10}$$

$$1 = \beta_a x^{\left(1-\frac{1}{\sigma_a}\right)} \frac{\check{\lambda}_{a,t+1}}{\check{\lambda}_{a,t}} \frac{\check{p}_{t+1} + \check{r}_{t+1}^a - \tau_{p,t+1}^a \check{p}_{t+1} - \tau_{a,t+1}\left(\check{r}_{t+1}^a - \check{p}_{t+1}\tau_{p,t+1}^a\right)}{\check{p}_t} \ , \tag{11}$$

$$1 = \beta_k x^{\left(-\frac{1}{\sigma_k}\right)} \frac{\check{\lambda}_{k,t+1}}{\check{\lambda}_{k,t}} \left(1 - \delta + r_{t+1}^k - \tau_{p,t+1}^k - \tau_{k,t+1}\left(r_{t+1}^k - \delta - \tau_{x,t+1} - \tau_{p,t+1}^k\right)\right) \ . \tag{12}$$

6.3. Firms

Firms choose optimal inputs for a nested CES production function in hours h_t, capital K_t and land A_t. There is both labor-augmenting and land-augmenting[11] technological progress. We will assume that both types of technology grow at the same rate x. This ensures the existence of a balanced growth path, and it ensures that a large part of the return to land consists of appreciation gains. In the model, a tax on land falls on the actual rental or the actual market price. However, with optimizing firms and households, the actual rental (or market price) equals the rental value (or asset value), with land in its highest and best use. The production function for aggregate output y_t and the capital-labor aggregate m_t are

$$y_t = \left((\omega)^{\frac{1}{\xi}} \left(T_t A_t\right)^{\frac{\xi-1}{\xi}} + (1-\omega)^{\frac{1}{\xi}} \left(m_t\right)^{\frac{\xi-1}{\xi}}\right)^{\frac{\xi}{\xi-1}} \ , \ m_t = \left(K_t\right)^{\alpha} \left(T_t h_t\right)^{1-\alpha} \ . \tag{13}$$

The optimality conditions for hours, capital and land are standard.

[11] Investigations of land-saving technological progress are common in the economic history and agricultural economics literatures (see Gurgel et al. (2011), Bustos et al. (2016), Wilde (2013)). See also Stiglitz (2015b,c).

6.4. Government

Government spending on goods and services g_t and government transfers Υ_t are exogenous and grow at the constant rate of technological progress. Government spending equals a fixed fraction of steady state output, $\check{g}_t = s_g \bar{y}$. Government tax revenue is

$$\begin{aligned} \check{\tau}_t \;=\; & \tau_{k,t}\left(1-\psi_k\right)\left(r_t^k-\delta-\tau_x-\tau_{p,t}^k\right)\left(\check{k}_{t-1}/x\right) \\ & +\tau_{a,t}\left(1-\psi_a\right)\left(\check{r}_t^a-\check{p}_t\tau_{p,t}^a\right)a_{t-1}+\tau_{\ell,t}\left(1-\psi_\ell\right)\check{w}_t\ell_t \\ & +\tau_{c,t}\check{c}_t+\tau_{p,t}^k\left(\check{k}_{t-1}/x\right)+\tau_{p,t}^a\check{p}_t a_{t-1}\ . \end{aligned} \tag{14}$$

The government adjusts the components of tax revenue to ensure a balanced budget, $\check{g}_t + \check{\Upsilon}_t = \check{\tau}_t$. In our simulations, the government carries out tax reform by exogenously varying either the tax rate on land rental income $\tau_{a,t}$ (LRVT) or the tax rate on land market value $\tau_{p,t}^a$ (LAVT). The government maintains budget balance by adjusting the tax rate on capital income $\tau_{k,t}$, and adjusting other tax rates τ_o proportionally, $\left(\tau_{o,t}-\bar{\tau}_o\right)/\bar{\tau}_o = \left(\tau_{k,t}-\bar{\tau}_k\right)/\bar{\tau}_k$.

6.5. Market Clearing

The market clearing conditions for labor/hours, capital (normalized) and land are $h_t = \ell_t$, $\check{K}_t = \check{k}_{t-1}/x$, and $A_t = a_{t-1} = \bar{a}$, where $\bar{a}$ is an exogenous constant. The market clearing condition for output is

$$\check{y}_t = \check{c}_t + \check{I}_t + \check{g}_t\ , \tag{15}$$

while GDP equals output plus consumption taxes $\check{y}_t = \check{c}_t(1+\tau_{c,t}) + \check{I}_t + \check{g}_t$. Our simulations will show a Fisher-weighted index of GDP.

6.6. Welfare

The welfare criterion is the compensating consumption variation (CCV) based on the lifetime utility of the representative household

$$\check{\mathcal{W}}_t = \check{u}_t^{\frac{\sigma-1}{\sigma}} / \frac{\sigma-1}{\sigma} + \beta x^{\frac{\sigma-1}{\sigma}} \check{\mathcal{W}}_{t+1}\ , \tag{16}$$

where the CCV η is given by the percentage increase in initial steady state consumption that would make the household indifferent between that steady state and $\check{\mathcal{W}}_t$.

7. Calibration

The calibration is based on US data. One period equals one year. The calibration of preferences and some aspects of technologies relies on the literature. The calibration of balance sheet and tax data is based on BEA and FRED data. For internal consistency, taxes are calibrated for the single year 2015, but 2010-2018 data demonstrate that 2015 is representative of the entire decade.

7.1. Representative Households

The steady state real growth rate equals 2% per annum. The steady state ratio of pre-tax consumption to GDP equals 65.17%. For preferences, the steady state labor supply is normalized to 1, the steady state intertemporal elasticity of substitution in consumption equals 0.5, and the labor supply elasticity equals 0.75. The latter is between the value of 1 frequently used in the business cycle literature, and the value of 0.5 frequently arrived at in microeconomic studies (Reichling and Whalen (2012)). For technologies, the steady state price of land is normalized to 1, the elasticity of substitution between capital and labor is fixed at 1 based on Chirinko (2008) and Rognlie (2015), and the elasticity of substitution between land and capital/labor ξ is fixed at 0.8 based on Thorsnes (1997), Ahlfeldt and McMillen (2014), and Rognlie (2015).

Table 1 allocates 2015 tax revenue among the six taxes of our model.[12]

Table 1. US Tax Revenue by Source in 2015 (in billion US dollars)

(Source: NIPA Tables 3.2 and 3.3)				
Source	**Federal**	**State& Local**	**Total**	**Allocation**
Individual Income Tax	1,532.6	374.5	1,907.1	Labor, Land & Capital Income
Sales Tax		374.2	374.2	Consumption
Property Tax		490.4	490.4	Land & Capital Value
Corporation Income Tax	329.1	56.2	385.3	Land & Capital Income
Customs Duty	38.1		38.1	Consumption
Social Insurance	1,190.8	19.2	1,210.0	Labor Income (partial tax)

Table 2 shows the components of 2015 US National Income.

Table 2. US National Income by Component in 2015 (in billion US dollars)

(Source: NIPA Table 1.12)	
Component	**Amount**
National Income	15,784.6
Employees' Compensation	9,699.4
Proprietors' Income	1,423.0
Rental Income	649.0
Corporate Profits	2,060.5
Net Interest & Miscellaneous	585.8
Taxes on Production and Imports	1,275.2

Table 3 first matches the sum of national income and the capital consumption allowance of \$18,604.3bn to GDP of \$18,238.3bn. The difference of -\$366.0bn, which consists of individually small items, is allocated proportionally among non-labor incomes, as these are measured with less

[12] The description of Social Insurance payments as partial labor income taxes is based on the fact that benefits rise with payments, but not in the amount of payments.

precision than labor incomes. The table also proportionally allocates proprietors' income between asset income and labor income, a common procedure also followed by Rognlie (2015).

Table 3. Labor and Asset Income derived from National Income (in billion US dollars)

(Source: Authors' Calculations)		
Category	**Reported**	**Adjusted**
Rental Income	649.0	
Corporate Profits	2,060.5	
Net Interest & Miscellaneous	585.8	
Taxes on Production & Imports	1,275.2	
Total Asset Income	4,570.5	4,807.3
Labor Income	9,699.4	10,639.2
Asset + Labor Income	14,269.9	15,446.6
Proprietors' Income (PI)	1,423.0	
Capital Consumption Allowance	2,911.4	2,791.7
Total	18,604.3	18,238.3
GDP	18,238.3	18,238.3

Values of Land and Capital: The value of total private fixed assets is taken from the FRED table "Households and Nonprofit Organizations; Net Worth, Level, Billions of Dollars, Quarterly, Not Seasonally Adjusted", and the value of private fixed capital assets is taken from the BEA NIPA table "Changes in Net Stock of Produced Assets". The average stocks between the ends of 2014 and 2015 equal \$89,086.6bn and \$43,562.1bn, and the difference of \$45,524.5bn is our estimate of the value of land, which therefore accounts for 51.1% of the value of total private fixed assets. This is likely an underestimate: First, US net foreign liabilities averaged \$7,202.2bn, which suggests adjusting upwards the total value of assets (partly held by foreigners), leading to a land share of 54.8%. Second, the Fed's estimate of private net worth excludes the wealth of the richest. The Fortune magazine 2015 wealth of the 400 richest families equals \$2,338.0 trillion, which again suggests adjusting upwards the total value of assets, leading to a land share of 55.8%. Third, the BEA uses the land residual method, which undervalues land and overvalues capital. We nevertheless choose the unadjusted and most conservative figure of 51.1%.[13] Figure 2 shows the US land share between 1952 and 2018. The initial steady state of the model matches the implied 2015 ratios of capital and land to GDP of 238.8% and 249.6%. The model depreciation rate is set to equal the ratio of the capital consumption allowance to the value of the capital stock.

Allocation of Taxes to the Six Model Categories: The consumption tax rate of 3.47% is calibrated as the ratio of consumption tax collections (Table 1) to pre-tax consumption. Table 4 shows the derivations for the remaining taxes. The yellow shaded entries are either taken directly

[13] This happens to be consistent with the calibration of Knoll et al. (2017), who argue (also using data based on the land residual method) that 50% is a reasonable assumption, and with the recent estimates of the American Enterprise Institute (2020).

from 2015 data or from the calculations in Tables 1-3. The orange shaded entries pertain to the allocation of total taxes between taxes on labor and assets, which are performed going from top to bottom in the first three data columns. The red shaded entries pertain to the allocation of taxes on assets between taxes on capital and land, which are performed going from bottom to top in the remaining two data columns. The green shaded entries are model inputs.

We subtract the capital consumption allowance of \$2,791.7bn from GDP of \$18,238.3bn to obtain factor cash incomes of \$15,446.6bn, and then divide these into \$10,639.2bn for labor (Table 3) and \$4,807.3bn for assets. The combined income share of land and capital, which is matched by the model, equals 41.67%. The taxation of assets begins with property taxes of \$490.4bn (Table 1), which are allocated proportionally between land and capital. The implied tax rates, which are matched by the model, are 0.55%.

To allocate income taxes, we need to first subtract items outside the income tax base. For asset incomes, this includes property taxes of \$462.2bn and excess depreciation of \$245.3bn (NIPA Table 7.6, line 3). The model's rate of excess depreciation of capital therefore equals 0.56%. The remainder of \$4,071.6bn is the base for the corporation income tax of \$385.3bn (Table 1). Net asset income after corporation income tax equals \$3,686.3bn. For labor incomes, employers' social insurance payments of \$569.4bn (NIPA Table 2.1, line 9) are included in compensation of employees but are not subject to income tax and therefore need to be deducted, so that the tax base equals \$10,069.8bn. Income tax rates on asset owners are greater than on labor, because the income tax is progressive. Tideman et al. (2002) found that the average tax rate on asset incomes is 62% greater than that on labor incomes. We therefore multiply the asset tax base by 1.62. The individual income tax of \$1,907.1 (Table 1) is then allocated in proportion to labor income and adjusted asset income, yielding labor income taxes of \$1,197.1bn and asset income taxes of \$710.0bn.

Labor income is subject to additional social insurance taxes of \$1,210.0bn (Table 1), consisting of a 10.6% tax for old-age social insurance OASI, a 1.8% disability insurance DI, and a 2.9% hospital insurance HI (Medicare). Social Security Administration (2016) shows that 83% of earnings have been taxable at the full 15.3% rate, with 17% only taxable at the 2.9% rate. HI and DI are fully taxes, because future individual benefits do not increase with tax payments. But this is not true for OASI payments, and Tideman et al. (2002), based on Feldstein and Samwick (1992), estimate that 68.9% of OASI payments are taxes. We approximate the share of OASI payments by (0.83*0.106)/(0.83*0.153+0.17*0.029)=0.667. The share of total social insurance payments that are taxes is therefore 0.667*0.689+(1-0.667)=0.793, so that social insurance payments that are taxes are \$959.0bn.

To compute the final return to assets, we need to add back both the excess depreciation allowance of \$245.3bn and gains due to land price appreciation. Because reliable data on nationwide land price gains are difficult to obtain, we calibrate land price gains in a model-consistent way as the product of the 2% growth rate and the stock of land, yielding a gain of \$910.5bn.[14] This yields the actual return to assets after all taxes of \$4,132.1bn.

Next we allocate asset income and taxes on assets between capital and land (red shaded entries in Table 4). The allocation formula for the \$4,132.1bn return to assets is based on equating the marginal returns to land and capital. We obtain after-tax land income of \$2,047.1bn and after-tax capital income of \$2085.1bn, at an equalized rate of return on both asset classes of 4.18%.

Subtracting land gains and capital excess depreciation yields the accounting incomes of \$1,136.6bn for land and \$1,839.8bn for capital. Allocating individual income taxes in proportion to these totals yields \$271.1bn for land and \$438.8bn for capital, and pre-tax incomes of \$1,407.7bn for land and \$2,278.6bn for capital. Allocating corporation income taxes on the basis of these totals yields corporation income taxes of \$147.1bn for land and \$238.2bn for capital,[15] and incomes before corporation income taxes of \$1,554.8bn for land and \$2,516.8bn for capital. Adding back the excess depreciation allowance and property taxes yields \$1,805.4bn for land and \$3,001.9bn for capital.

Average tax rates: The average labor income tax rate is the ratio of labor income taxes to labor income, which equals 11.25%. The average social insurance tax rate is the ratio of the tax part of social insurance to labor income, or 9.01%. The average individual income tax rates on land and capital equal 17.44%, and the average corporation income tax rates on land and capital equal 9.46%, which leads to average overall income tax rates on land and capital of 26.90%.

Marginal tax rates: To calculate marginal individual income tax rates, we follow Prescott (2004), who multiplies average individual income tax rates by a factor of 1.6 to obtain marginal rates, based on the fact that this results in the marginal income tax rate obtained using the Feenberg and Coutts (1993) methodology for the US. The implied marginal individual income tax rates are 18.00% for labor income and 27.90% for land and capital income. We treat the corporation income tax as a proportional tax, so that marginal corporation income tax rates on land and capital equal average corporation income tax rates. Due to the simplicity of its rate structure the marginal social insurance tax rate can be computed directly as 8.65%. This is quite close to the average social insurance tax rate of 9.01%.

This allows us to calibrate the remaining six tax-related calibration targets of our model. First, the steady state marginal tax rates on labor income, land income and capital income are obtained by summing up the above marginal tax rates, to obtain 26.65%, 37.36% and 37.36%. This is made consistent with a balanced budget by adjusting the steady state level of lump-sum transfers. Second, we match the ratios of labor, land and capital income taxes to GDP, which equal 11.82%, 2.29% and 3.71%, by adjusting the average-to-marginal proportionality factors.

[14] Land gains at the rate of real economic growth tend to underestimate actual land gains during periods of easy credit. To the extent that this is the case here, our calibration will understate the share of the return to land derived from (low- or zero-tax) appreciation gains and overstate the returns coming from (high-tax) land rentals.

[15] Incidentally, this calibration exercise makes it clear that the corporation income tax is not a textbook example of a tax on capital income, a highly inefficient tax. In fact around 40% of it is a rent tax, a highly efficient tax.

Table 4. Allocation of Taxes - 2015 US Data

(Source: Authors' Calculations)

	Total	Labor	Assets	Land	Capital
Gross Domestic Product	18,238.3				
- Capital Consumption	2,791.7				
= Factor Incomes	15,446.6	10,639.2	4,807.3	1,805.4	3,001.9
- Property Taxes	490.4		490.4	250.6	239.8
= Return after Property Taxes	14,956.2	10,639.2	4,316.9	1,554.8	2,762.1
- Excess Depreciation	245.3		245.3		245.3
= Corporation Income Tax Base	14,710.9	10,639.2	4,071.6	1,554.8	2,516.8
- Corporation Income Tax	385.3		385.3	147.1	238.2
= Return after Corporation Income Taxes	14,325.6	10,639.2	3,686.3	1,407.7	2,278.6
- Employers' Social Insurance	569.4	569.4			
= Individual Income Tax Base	13,756.2	10,069.8	3,686.3	1,407.7	2,278.6
(Adjusted Individual Income Tax Base)	16,041.7	10,069.8	5,971.8		
- Individual Income Tax	1,907.1	1,197.1	710.0	271.1	438.8
(Total Social Insurance)		1,210.0			
- Tax Portion of Social Insurance		959.0			
= Accounting Return after All Taxes			2,976.4	1,136.6	1,839.8
+ Land Gain and Excess Depreciation			1,155.8	910.5	245.3
= Actual Return after All Taxes	12,615.2	8,483.1	4,132.1	2,047.1	2,085.1
Asset Stocks / GDP				249.6%	238.8%
Marginal Return to Assets				4.18%	4.18%
Property Tax Rate				0.55%	0.55%
Income Tax Base		10,639.2		1,554.8	2,516.8
Individual Income Tax					
Collections		1,197.1		271.1	438.8
Average Tax Rate		11.25%		17.44%	17.44%
Marginal Tax Rate		18.00%		27.90%	27.90%
Corporation Income Tax and Soc. Ins. Tax					
Collections		959.0		147.1	238.2
Average Tax Rate		9.01%		9.46%	9.46%
Marginal Tax Rate		8.65%		9.46%	9.46%
Total Income Tax Marginal Rate		26.65%		37.36%	37.36%
Income Tax Revenue / GDP		11.82%		2.29%	3.71%

7.2. Heterogeneous Households

Steady state intertemporal elasticities of substitution in consumption and labor supply elasticities are set to be equal across groups at 0.5 and 0.75. Most other parameters and calibration targets remain unchanged. We normalize the steady state labor supply of workers to 1. In our model landlords and capitalists own the entirety of fixed assets. In the data,[16] the top 20% of US income earners own the vast majority of fixed assets, and account for around 60% of total income. We therefore fix the combined population share of landlords and capitalists at 20%, and we fix the combined steady state income share of landlords and capitalists at 60%. Because we do not have detailed information to allow us to distinguish between landlords and capitalists, we make two reasonable symmetry assumptions. First, we equalize their steady state per capita labor supplies, and second, we equalize their steady state per capita pre-tax incomes.

In the resulting steady states, the population shares of landlords, capitalists and workers are 7.5%, 12.5%, and 80%. Steady state labor supplies of landlords and capitalists equal 290% of workers. Because the hourly wage is equal for all labor types, the difference, which is due to the calibration of labor supply preference parameters, represents quality-adjusted labor. Finally, steady state per capita consumption of landlords and capitalists equals 450% and 380% of workers. As a result, marginal utilities differ significantly across agents.

8. Results

Section 8.1 studies the impact of an increase in land rental value taxes LRVT. Section 8.2 studies the impact of an increase in land asset value taxes LAVT. Section 8.3 performs sensitivity analysis for LAVT. Section 8.4 studies an increase in wealth taxes and an increase in LAVT to 20%. In each case the tax reform is phased in linearly over 20 years, to reflect its likely gradual implementation in practice. In the figures black lines represent a land share of 51.1%, red lines of 40%, and green lines of 60%. Table 5 gives an overview of the key quantitative results.

8.1. Land Rental Value Taxes (LRVT)

Figure 3 and line 1 of Table 5 study an increase in the marginal tax rate on the rental income of land, from its initial steady state value of 37.4% to a final value of 97.4%. Asset value tax rates are left unchanged, while the remaining income and consumption taxes are reduced in proportional fashion to balance the budget. The tax rate on capital income eventually drops from 37.4% to 24.7%, the tax rate on labor income from 26.7% to 17.6%, and the consumption tax rate from 3.5% to 2.3%. These tax cuts total around 8% of GDP, and are balanced by increased tax revenue from the LRVT (5% of GDP), and by the fact that spending is held constant relative to trend while

[16] See the World Inequality Database, available at https://wid.world/.

GDP increases (3% of GDP). Because of the eventually nearly 100% tax rate on the land rental income, the price of land drops by 94.3% in the long run. The real effects are large, with pre-tax consumption eventually rising by 13.5%, investment by 21.5%, and output by 10.8%. The welfare gain equals 2.7%.

In line 2 of Table 5, the budget is instead mainly balanced through cuts in capital income taxes. The decline in the land price is similar, while the welfare and output gains are significantly larger, at 3.4% and 15.0%. The reason is the especially distortionary nature of capital income taxes.

Table 5. Key Quantitative Results

		Welfare	Output	Land Price	Land Tax Share
LRVT					
1	+60pp & lower $\tau_k, \tau_\ell, \tau_c$	+2.7%	+10.9%	-94.3%	35.8%
2	+60pp & mainly lower τ_k	+3.4%	+15.0%	-94.0%	38.2%
LAVT					
3	+5pp & lower $\tau_k, \tau_\ell, \tau_c$	+2.8%	+11.1%	-44.7%	36.1%
4	+5pp & mainly lower τ_k	+3.4%	+14.8%	-37.9%	38.2%
Sensitivity Analysis w.r.t. Line 4 Baseline					
5	Smaller reform = +1.45pp	+1.8%	+7.4%	-9.3%	24.7%
6	Labor supply elasticity = 1	+4.5%	+20.8%	-32.0%	41.2%
7	Heterogeneous households	+6.4%	+14.8%	-37.9%	38.2%
Alternative Benchmarks					
8	Wealth Tax	+1.9%	+6.9%	-17.0%	27.4%
9	20% LAVT	+5.2%	+26.0%	-74.4%	55.2%

8.2. Land Asset Value Taxes (LAVT)

Line 3 of Table 5 studies a 5 percentage point increase in the LAVT rate, from 0.55% to 5.55%. The tax rate on the value of capital is left unchanged, while the income and consumption tax rates are reduced in proportion to balance the budget, as for line 1. The tax rates on asset incomes eventually drop from 37.4% to 24.6%, the tax rate on labor income from 26.7% to 17.5%, and the consumption tax rate from 3.5% to 2.3%. These are very similar numbers to the LRVT case in line 1. The welfare (+2.8%) and output (+11.1%) effects are also of a very similar magnitude. Consumption and investment eventually rise by 13.8% and 22.0%. The main difference to the LRVT case is that the price of land only drops by 44.7% instead of 94.3%.

Figure 4 and line 4 of Table 5 study the same LAVT increase, but now accompanied mainly by cuts in capital and land income taxes.[17] Tax rates on asset incomes eventually drop from 37.4% to 9.5%, and the tax rate on labor income from 26.7% to 16.7%. The price of land drops by 37.9% in the long run. The welfare (+3.4%) and output (+14.8%) effects are significantly larger than for

[17] A cut in land income taxes raises the value of land, and thereby revenue collection through the LAVT. This in turn permits larger drops in other income and consumption taxes.

line 3. Consumption and investment eventually rise by 17.5% and 36.4%. For the remainder of our analysis we will treat this tax reform as our baseline.

Figure 5 shows the relationship between different long-run LAVT rates, on the horizontal axis, and long-run changes in three key variables, on the vertical axes. The solid lines show results for the reform in line 3 of Table 5, and the dashed horizontal lines show the results for the reform of line 4 of Table 5. The top, middle and bottom panels show long-run increases in LAVT revenue[18], gains in output, and drops in land prices. The top panel shows an initially steep but then flattening LAVT Laffer curve. The flattening is due to reductions in the land price that reduce the tax base, thereby reducing the increments in LAVT revenue that can be applied towards further reductions in other taxes. Because the latter are responsible for the output gains of the tax reform, output gains mirror the Laffer curve, with initially rapidly rising gains at low LAVT rates, and increasingly smaller gains at higher LAVT rates. Incremental land price drops are sharpest for the initial increases in the LAVT rate, and then become smaller.

8.3. Sensitivity Analysis

Line 5 of Table 5 studies a LAVT increase to only 2% by the end of the phase-in period. The reason for a smaller reform could be policymaker concerns with the initial drop in land prices. Land prices now only drop by 14.9% in the short run and 9.3% in the long run. But policymakers need to manage a clear trade-off, because long-term output and welfare gains drop to only 7.4% and 1.8%, approximately half of the baseline.

Next we study the dependence of our results on key structural parameters. The elasticity of substitution of land in production ξ, and the intertemporal elasticity of substitution in consumption,[19] which depends on σ, have only small effects on the results. The labor supply elasticity in preferences θ has large effects. We have compared the baseline of 0.75 to the alternatives of 0.5 and 1.0. While the long-term welfare and output gains under the baseline calibration equal 3.4% and 14.8%, with $\theta = 0.5$ they equal 2.4% and 9.9%, and with $\theta = 1.0$, shown as line 6 of Table 5, they equal 4.5% and 20.8%. The reason is that with a higher elasticity labor supply responds more strongly to the improved work incentives due to lower labor income taxes.

Figure 6 and line 7 of Table 5 study the baseline LAVT reform of line 4 of Table 5 but for an economy with separate groups of workers, capitalists and landlords. The long-run output gains and land price drops are nearly identical to those of the baseline, but population-weighted welfare gains increase from 4.3% to 6.4%. The reason is that the tax reform distributes the gains to those households with the largest marginal utilities of consumption (and of wealth), namely workers, the greatest potential to grow the economy through capital accumulation, namely capitalists, and the

[18] LAVT revenue is in this case scaled by pre-reform GDP for easier interpretation of the magnitudes.

[19] While the final steady states are nearly identical with different intertemporal elasticities, the time it takes to reach the steady state is appreciably longer/shorter under a low/high intertemporal elasticity.

greatest population share, namely 92.5%.

Identical GHH preference calibrations imply identical percent increases in labor supplies, and the welfare differences across groups are due to differences in consumption responses. Landlords are disproportionately affected by the drop in post-tax rental income so that, unlike the other groups, their consumption drops. The drop equals 14.7% after 20 years, but only 4.3% in the long run, when the economy becomes so productive that their pre-tax rental incomes and after-tax labor incomes increase very significantly. At the same time, consumption of capitalists and workers increases by 22.6% and 23.7%, respectively, as they benefit from the very large reduction of tax disincentives to save and work. Therefore, compensation of landlords would not be difficult to finance, particularly because in the real world a large number of landlords are simultaneously capitalists (and workers) and may not suffer any net losses. We quantify this trade-off by specifying a capitalist-landlord hybrid agent, who simultaneously invests in land and capital (including structures on the land). This agent experiences after-tax income losses on his land holdings but after-tax income gains on his capital holdings. To suffer overall income losses, 86% or more of his investments would have to be in land. We recall our earlier discussion of US data, where we found that the group that suffers net losses from shifting taxes onto land is likely to be very small.

8.4. Alternative Benchmarks

Figure 7, and line 8 of Table 5, study a wealth tax, where the tax rates on the values of land and capital are raised by 2.5 percentage points each, thereby raising nearly identical revenue to the LAVT of Figure 4, and line 4 of Table 5. Accompanying tax cuts are again mainly on asset incomes, with smaller labor tax cuts. While the drop in labor income taxes leads to a broadly comparable increase in labor supply, the net effect of higher taxes on capital values and lower taxes on capital incomes is broadly neutral for investment and the capital stock, which remains almost unchanged. As a result, gains in welfare (+1.9%) and output (+6.9%) are approximately half of those of the baseline tax reform. Taxing all wealth is therefore clearly inferior to taxing only land.[20]

Figure 8, and line 9 of Table 5, study a tax reform that raises the LAVT to a much higher value than in the baseline. Figure 6 has shown that, due to the flat shape of the Laffer curve at high tax rates, it is not possible to raise all tax revenue through LAVT. Extremely high LAVT rates may also be politically too difficult to implement. We therefore assume that the LAVT rate cannot exceed 20%. We set the land income tax rate to zero to maximize the tax base of the LAVT, and optimize welfare subject to the further constraint that the capital income tax rate equals zero, because a welfare criterion cannot separately determine the optimal tax rates on both the value and income of capital. We optimize over the remaining tax rates $\tau^a_{p,t}$, $\tau^k_{p,t}$, $\tau_{\ell,t}$ and $\tau_{c,t}$, subject

[20] Another likely problem with wealth taxes would be increased capital flight to tax havens, see Alstadsaeter et al. (2018). If taxes on land were increased and the revenue used to lower taxes on physical capital, capital flight would decrease.

to the condition that tax rates cannot become negative. We find that maximization of household welfare requires $\tau^a_{p,t} = 0.2$, $\tau^k_{p,t} = 0$, $\tau_{\ell,t} = 0$, and a time-varying, budget-balancing consumption tax rate that in the long run reaches $\tau_{c,t} = 0.122$. The reason for the last two results is that the consumption tax is less distortionary than the labor income tax. The tax revenues raised by the LAVT and consumption taxes account for 55.2% and 44.8% of overall tax revenue. The welfare gains (+5.2%) are approximately 50% larger than for the baseline tax reform, and the output gains (+26.0%) are almost 100% larger. However, the land price drops by 74.4%.

9. Conclusion

The world economy has suffered a number of large negative shocks that have both reduced growth and increased government deficits and debt. Governments are searching for means to stimulate their economies while continuing to support existing levels of spending and debt service. As a result, many radical fiscal policy options that might have been inconceivable during normal times now deserve another look. This paper proposes one such policy – to shift taxes away from the incomes of capital and labor, in other words away from productive endeavours, and towards the value of land, in other words towards unearned incomes. The stimulus effects of this policy would be extremely large, the stimulus would be structural and therefore permanent rather than merely countercyclical, and there would be no need to increase deficits any further. The data show that the tax base for a land tax is very large, and its practical feasibility is much greater now than a few decades ago because of the rapid advance of mass appraisal techniques.

Our final simulation has shown just how far the stimulus effects could be taken in the limit. Taxation could raise just over half of all tax revenue through a tax on the current asset value of land, while raising the remainder by a consumption tax of around 12%. Income taxes could be completely abolished, and as a result welfare and output would increase by 5.2% and 26.0%. But even a more modest reform, with a land asset value tax of 5.5%, balanced mostly by tax cuts on capital incomes, offers extremely large gains in welfare and output, at 3.4% and 14.8%. We can do no better than repeating the conclusion of the UK Mirrlees Review (Institute for Fiscal Studies and Mirrlees (2011)), which applies to many economies and governments: "This is such a powerful idea, and one that has been so comprehensively ignored by governments, that the case for a thorough official effort to design a workable system seems to us to be overwhelming."

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Figure 1. OECD: Shares of Nonproduced Assets in Total Assets

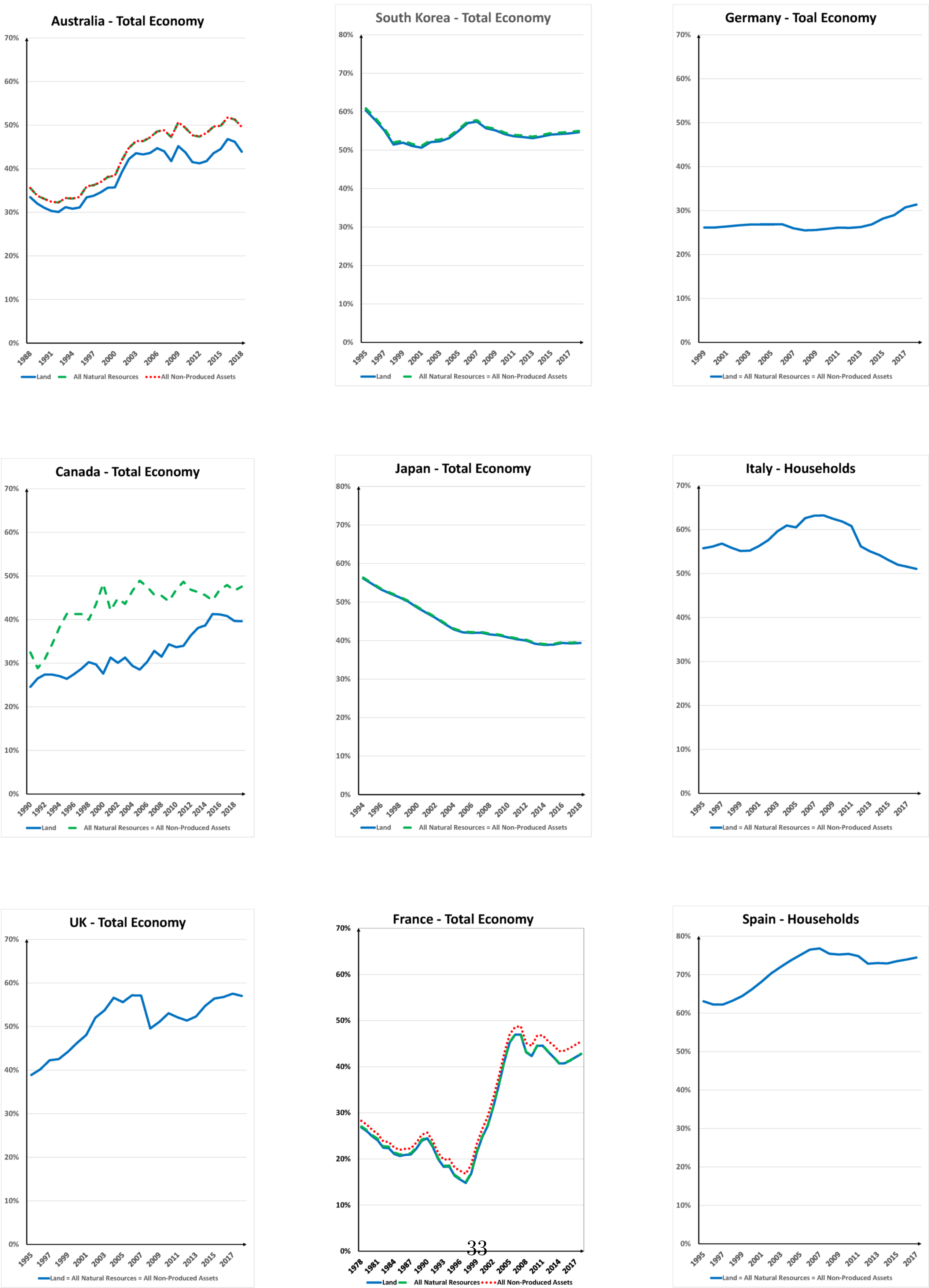


Figure 2. FRED/BEA: US - Share of Nonproduced Assets in Total Assets

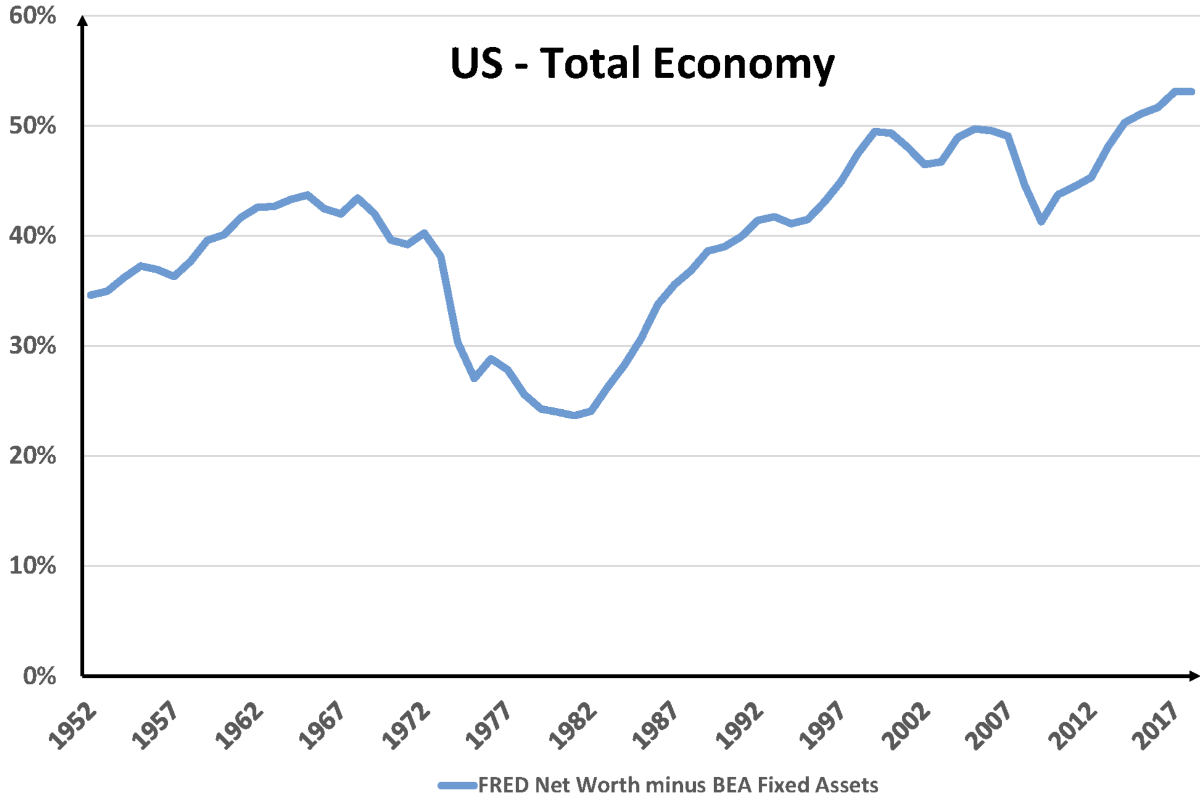
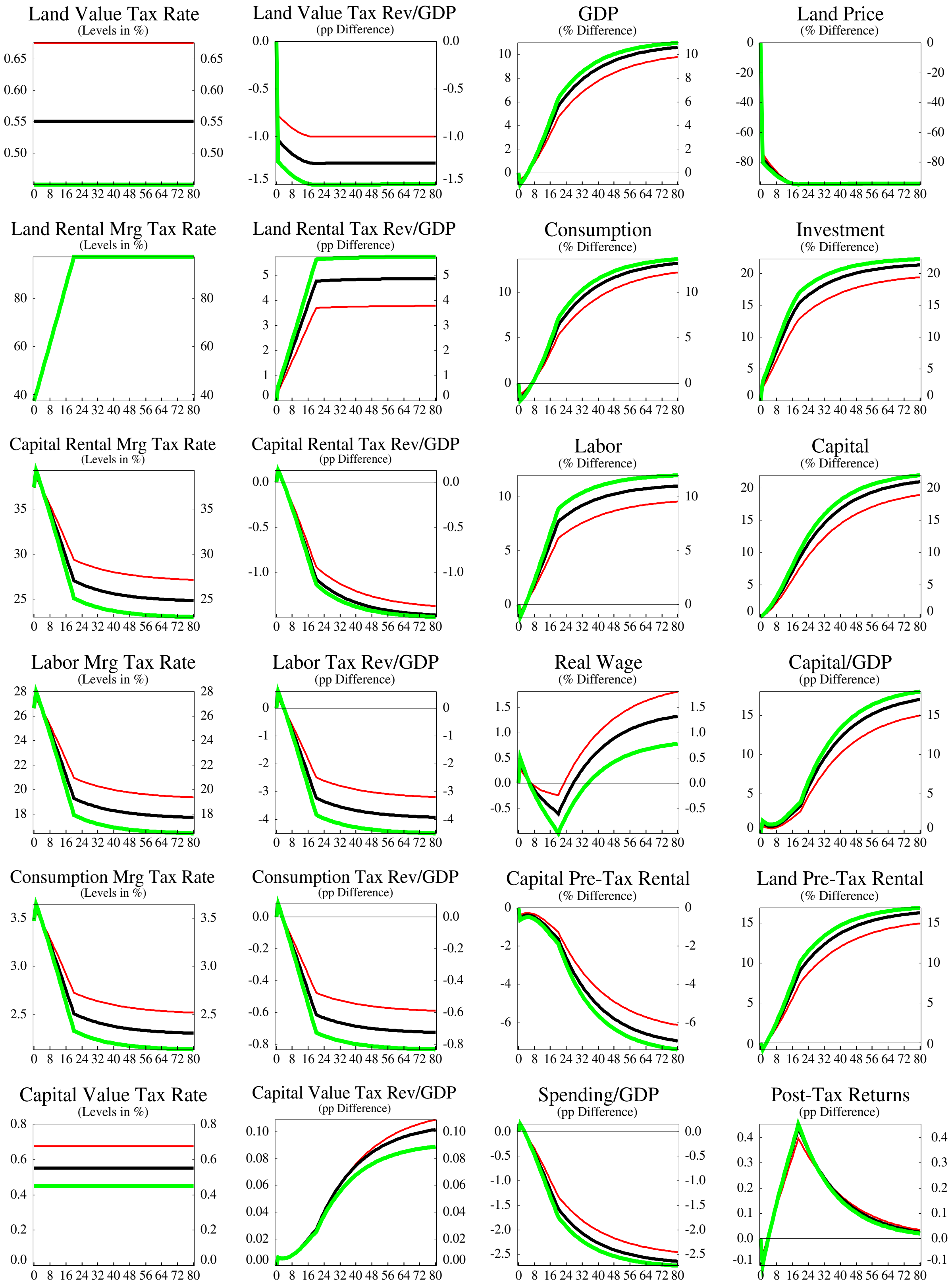
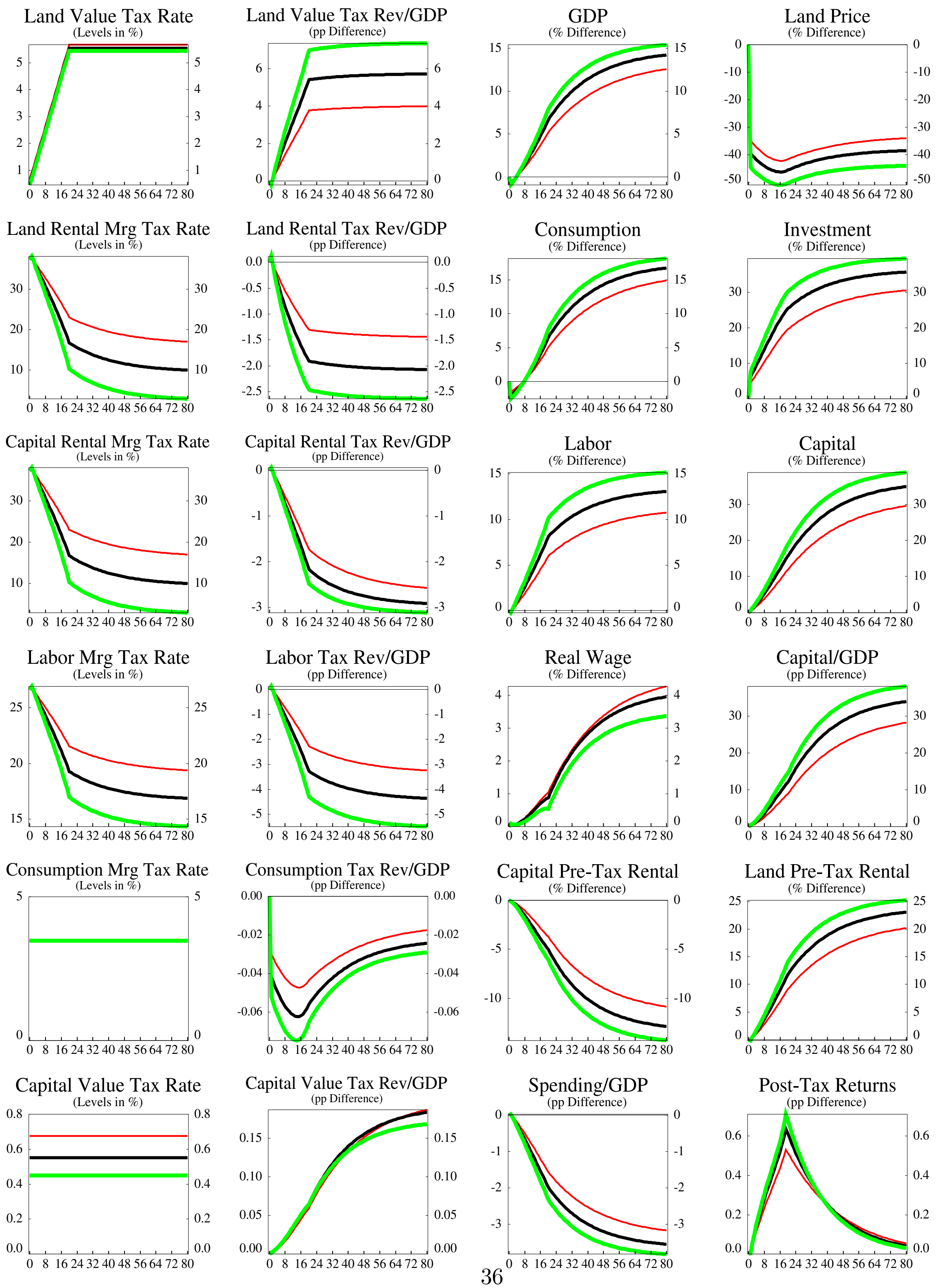


Figure 3. LRVT Increase of 60 Percentage Points and Lower Taxes on K, L and C



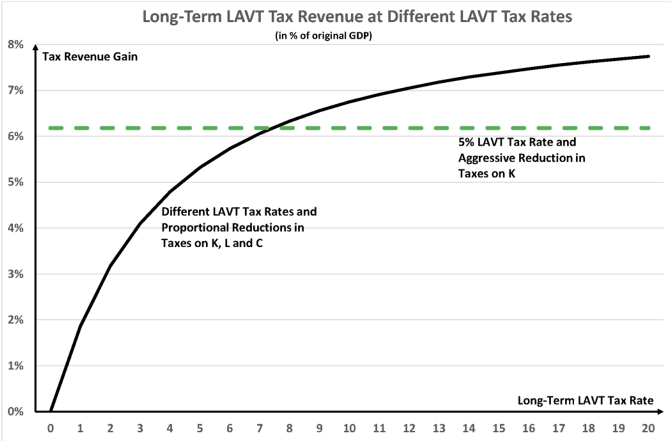
(land shares: thin red lines = 40% / medium black lines = 51.1% / thick green lines = 60%)

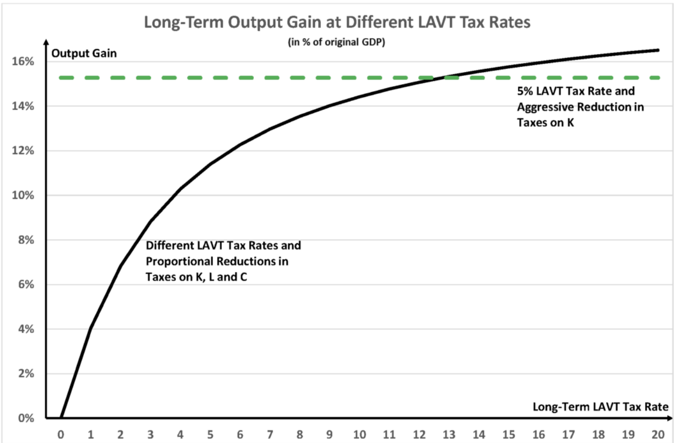
Figure 4. LAVT Increase of 5 Percentage Points and Lower Taxes Mainly on K



(land shares: thin red lines = 40% / medium black lines = 51.1% / thick green lines = 60%)

Figure 5. LAVT Laffer Curve and Implied GDP and Land Price





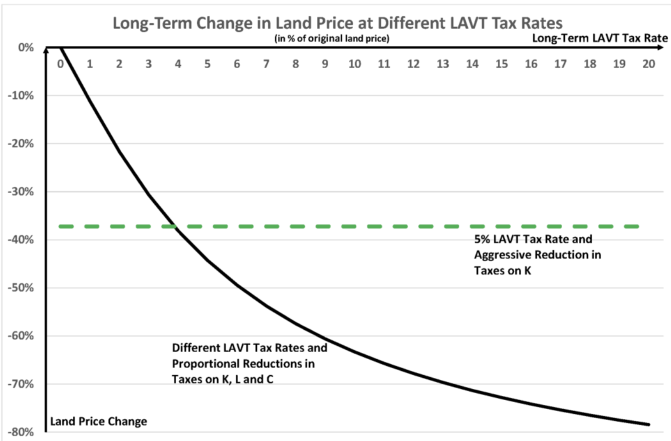
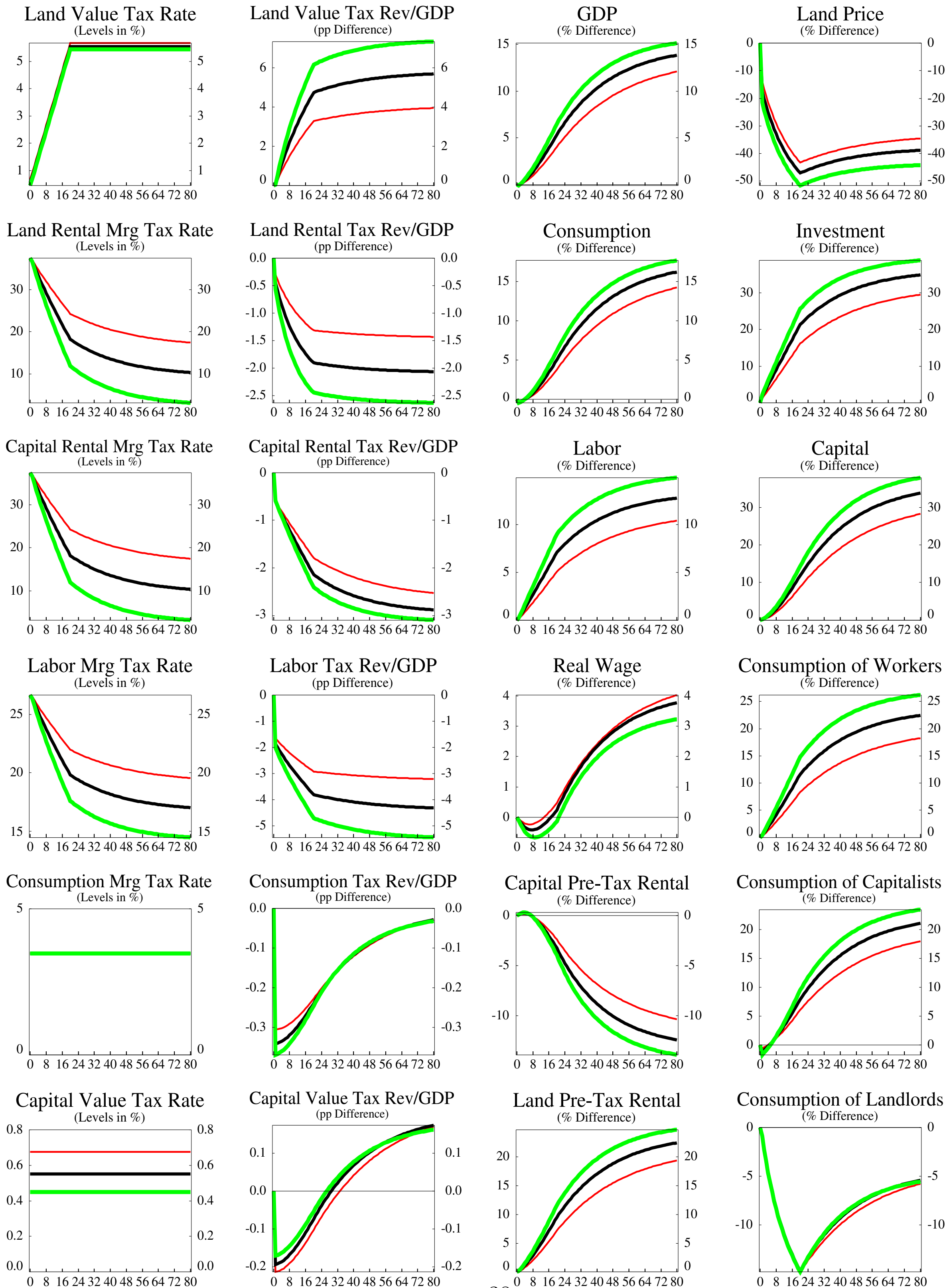
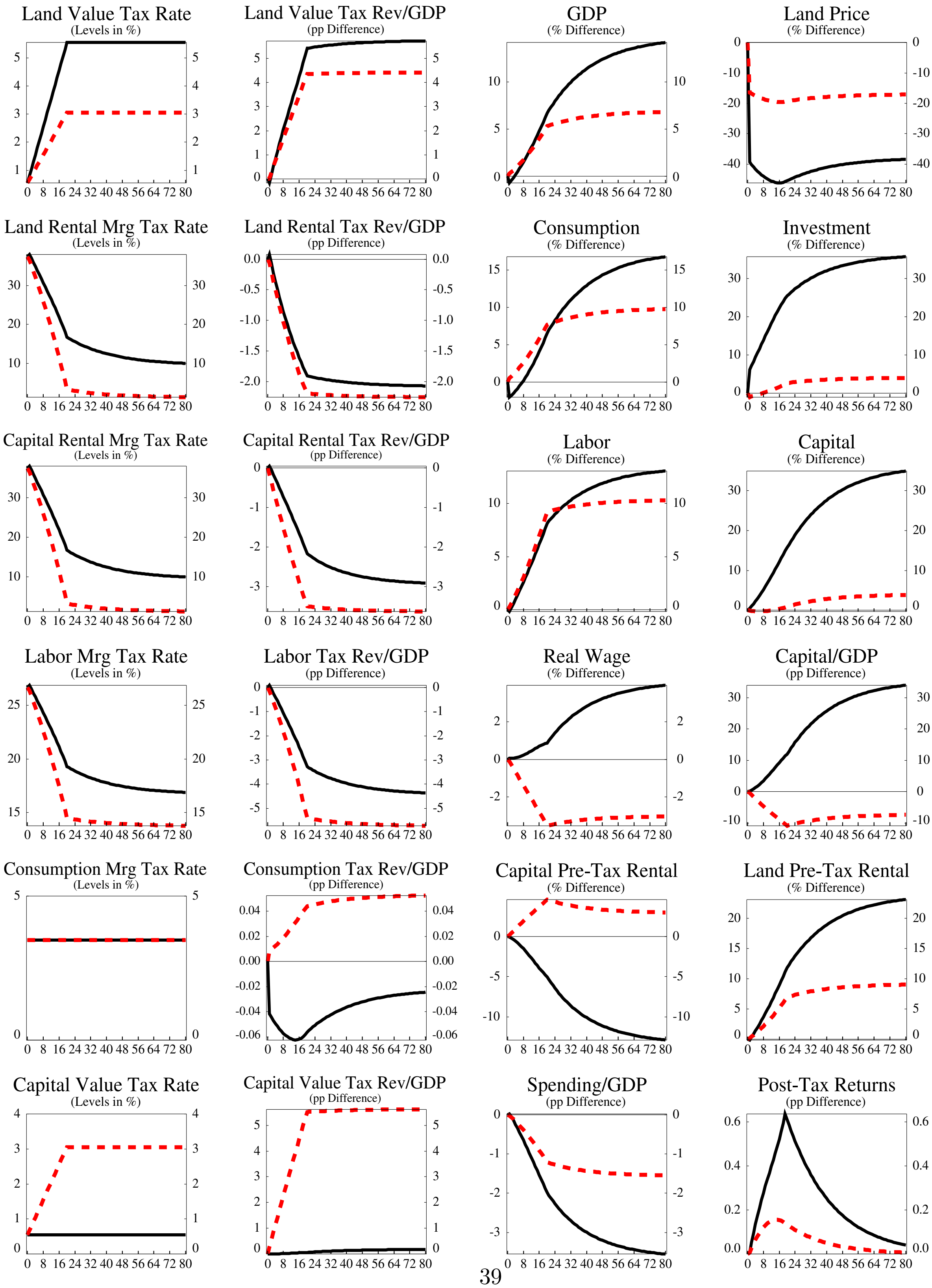


Figure 6. LAVT Increase of 5 Percentage Points with Workers, Capitalists and Landlords



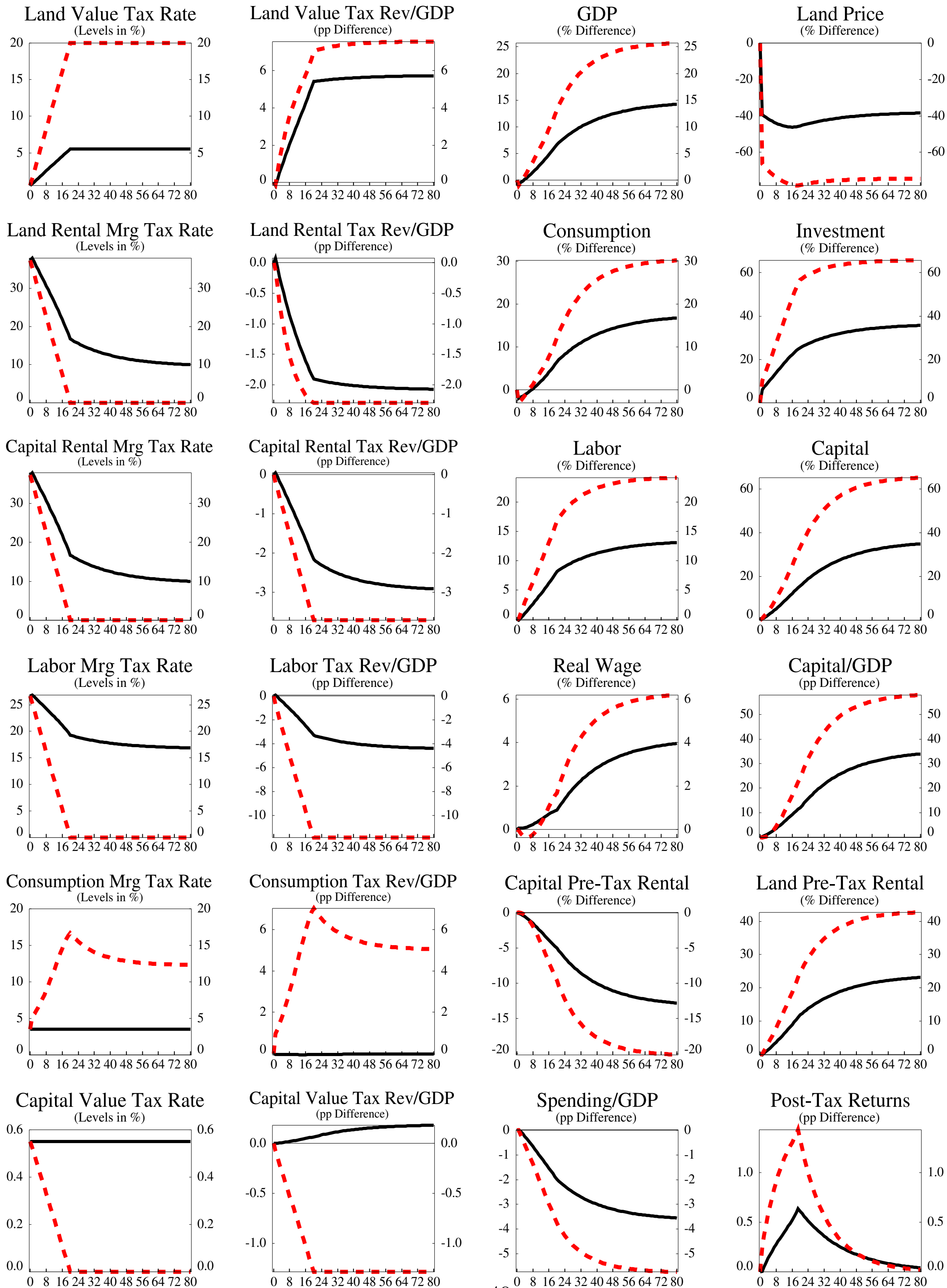
(land shares: thin red lines = 40% / medium black lines = 51.1% / thick green lines = 60%)

Figure 7. LAVT Baseline versus Wealth Tax



(solid black lines = LAVT baseline / dashed red lines = wealth tax)

Figure 8. LAVT Baseline versus 20% LAVT



(solid black lines = LAVT baseline / dashed red lines = 20% LAVT, other taxes optimized)