Optimal rent taxation*

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Abstract

Economic rents have long been identified as an efficient base for taxation. In addition, the recent literature documents that rent yielding assets are highly concentrated among the rich. Rent taxation thus seems attractive for both efficiency and equity reasons. Nevertheless, rent taxation remains a marginal topic in academic economics and for policy makers. We suggest bridging this gap by subjecting economic rents to an optimal taxation analysis. When considering that households can be heterogeneous both with respect to their wealth and with respect to their portfolio composition (regarding shares of capital and rent yielding assets) we find that equity considerations may require rents to be taxed at less than 100%. When the portfolio composition among households is similar, however, rent taxation is much more desirable than labor taxation under a standard social welfare function.

JEL classification: D31, D33, H21, H24

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1 Introduction

Progressive income taxation as in Mirrlees (1971) has received a great amount of attention by economists as a response to inequality and as an approach to redistribution. Recently, authors such as Piketty (2014) have pointed out that a strong concentration of wealth is a major source of inequality, which cannot be addressed by progressive income taxation. Stiglitz (2015) refines this analysis by pointing out that a major driver of the concentration in wealth is an acceleration in rent income and that models which equate wealth and capital are therefore insufficient to understand increasing inequality.

The high concentration of rents and the disproportionate increase in rents identified in the recent literature suggest that rent taxation could be an ideal tool of redistribution. As a nondistortionary form of taxation it is much better suited for redistribution than capital taxes. Nevertheless, rent taxation is a marginal topic, both in academic economics and in policymaking. Textbooks on public economics and public finance hardly even mention it.

This paper aims at bridging the gap between the conceptual appeal and the practical irrelevance of rent taxation. As a first step, we outline the scope that a theory of optimal rent taxation could have and point out the most important efficiency and equity effects of rent taxation, which have been identified, but not incorporated into a comprehensive taxation theory. Rents can be classified into "exploitation rents", which should be addressed by competition policy, and naturally arising rents, which should be subjected to optimal taxation. While vertical heterogeneity (households with different levels of wealth) is frequent in taxation models, rent taxation in addition requires the consideration of horizontal heterogeneity (households with different compositions of wealth), since a rent tax claims different shares of household wealth for the government when portfolio composition varies.

As a second step, we propose an optimal taxation model to identify the ideal equity-efficiency tradeoff of taxing rents. This model allows for the efficiency gains associated with taxing a fixed factor. As a consequence, the optimal rent tax is 100% when either social welfare is linear in consumption or when households are homogeneous in their asset portfolios. This homogeneity can refer to equal capital holdings, equal holdings of rent yielding assets or equal capital-rent ratios. At the same time the model allows for both vertical and horizontal heterogeneity. Due to this feature, the optimal rent tax can be less than 100% for reasons of equity.

The potential efficiency gain of taxing rents was described already by Adam Smith. However, as Fane (1984) points out, the tax is not neutral unless it is fully compensated. If the tax revenues are not used for compensating those who are taxed, income and portfolio effects can occur (Feldstein et al., 1977; Petrucci, 2006). Further, it can shift welfare between trade partners (Eaton, 1988) and require portfolio adjustments due to changed risk profiles (Coulson and Li, 2010). In spite of not being neutral, rent taxes are efficient since they do not distort the supply of the tax base. In addition, the adjustments to the rent tax can actually be welfare increasing (Edenhofer et al., 2015) and rent taxes can have environmental benefits (Franks et al., 2015; Kalkuhl and Edenhofer, 2016).

While Piketty (2014) and Stiglitz (2015) analyze the role of rents for equity, there is hardly any analysis of the effect of rent taxation on equity. Koethenbuerger and Poutvaara (2009) consider the effect of rent taxation on intergenerational equity, but assume generations to be perfectly homogeneous. For the intragenerational effect, there are empirical studies on the effect of a switch from property to land value taxation (Plummer et al., 2010; Choi and Sjoquist, 2015) among property owners. We go beyond both strands of the literature by designing a model, which captures both the efficiency effect of rent taxation and its distributional effects on households with portfolios of different size and composition.

One obstacle to rent taxation is the measurement of the rents. When a piece of land with buildings on it yields a given amount of income for example, there is no direct way of measuring which share of the income results from the capital investment and which part is a land rent. In spite of this difficulty, governments did find ways of approximating rents, and in particular land rents, sufficiently precisely (Mirrlees et al., 2011). Similarly, the taxation of nonrenewable resources requires careful design, but can be realized (Lund, 2009).

A full understanding of the efficiency and equity effects of rent taxation is a broad area of research. In Section 3 we trace out the scope which such an area can have by defining rents and by delimiting which aspects of rents can adequately be address with taxation. Section 4 reviews the different efficiency and equity effects in the literature, for which a theory of rent taxation will have to determine the interactions and relative importance. In Section 5 we propose a model on one particular, but important, equity-efficiency tradeoff. It shows that rent taxation can have positive efficiency and equity effects, but that households with a high share of rents in their asset portfolio may be affected disproportionally. Section 6 concludes.

2 Empirical evidence on the importance of rents for inequality

2.1 State of rent taxation

Even though rent taxation is an efficient source of taxation, its potential is far from fully used. Land value taxes are often suggested as a source of municipal revenue, but only Denmark has embraced this idea so far (Walters, 2013; Fernandez Milan et al., 2016). Resource rents are taxed to some extent, but taxation also remains far below the potential (Garnaut, 2010).

2.2 Trends in rent income

When rent income is highly concentrated among wealthy households, a long term trend towards higher rent income would increase inequality. In this section we provide evidence that, indeed, rent income is increasing faster than other sources of income and that the most wealthy households benefit from this most. The basic idea was formulated already by David Ricardo (1817): The value of a fixed factor (land in particular) increases disproportionally with economic growth. This benefits the relatively few owners of the factor and increases inequality.

Piketty (2014) documents a strong increase of the capital/income ratio in France and Britain during the 20th century back to the levels where it had been in the 18th and 19th century, see Figure 3.2 in Piketty (2014) in particular. He identifies this development as a source for increasing inequality in society, because wealth is much more concentrated than income. While the capital/income ratio increased, the composition also changed drastically. Housing capital gained strongly in relative value. The variable "housing" in Piketty (2014), however, mixes the land and building value, so that we need further sources to pin down the sources of the increase in the capital/income ratio.

Bonnet et al. (2014) show that the increase in the capital/income ratio is driven almost exclusively by increases in housing value. Knoll et al. (2017) break down the housing value into its components using historical data for land prices. For five countries (Australia, Belgium, Japan, Great Britain, Switzerland) empirical data are presented. For a larger sample of countries, land prices are imputed using a production function for housing. The empirical and imputed data are very close for the countries where both types of data are available. They show "a sharp run-up of land prices in the past three decades". The median for the contribution of land price increases in explaining house price growth is 83%.

2.3 The distribution of rent ownership

Concerning the distribution of ownership, a survey of private households presented in Bundesbank (2016) shows that in Germany, the ownership of real estate is very strongly concentrated among the top 10% of most wealthy households. 67% of them own real estate apart from their primary residence with an average value of more than three times that of the second decile. In the UK, Finland, Italy and the US, the top 10% own between 40% and 60% of the net housing wealth (Cowell et al., 2017). It should be noted, however, that these numbers concerning housing do not include land ownership of households through ownership of companies.

Stiglitz (2015) gives examples of exploitation rents worth trillions of dollars each. These exploitation rents are the purchase of drugs by the US government above market prices, the giving away of natural resources below competitive prices, predatory lending, abusive credit card practices, market manipulation based on imperfect and asymmetric information, insider trade etc. He further claims that this "contributed to both the inequalities at the top and the bottom". It thus appears that the combination of increasing rents and a high concentration of rents among the most wealthy individuals applies to exploitation rents as well. Reliable numbers, however, are not available.

3 The scope of rent taxation theory

An analysis of rent taxation requires a precise definition of the term, but also an understanding of the limits of taxation compared to other government approaches to influence rents in the interests of social welfare. In this section we propose a scope of what rent taxation should address.

3.1 Definition of rent

The precise meaning of the term economic rent has been subject to debate (Brown, 1941; Mishan, 1959; Currie et al., 1971). Modern public economics settled for an economic rent being, "the excess amount earned by a factor over the sum necessary to induce it to do its work" (Wessel, 1967; Segal, 2011).

Piketty (2014) gives two more definitions of a rent, one more general, one more narrow than the one used in public economics, see Figure 1. The one used in his book is the more

general one, "income on capital, whether in the form of rent, interest, dividends, profits, royalties, or any other legal category of revenue, provided that such income is simply remuneration for ownership of the asset, independent of any labor". The definitions of "rentier" in dictionaries refer to this definition of the word rent.

According to Piketty (2014) the meaning of the word rent shifted over time and is now often used "to denote an imperfection in the market (as in "monopoly rent"), or, more generally, to refer to any undue or unjustified income". This explains why "the words 'rent' and 'rentier' took on highly pejorative connotations in the twentieth century". This meaning of rent is termed "exploitation rent" by Stiglitz (2015).

Piketty (2014) uses a broad definition of rent, because the book is concerned with wealth inequality. In this paper we are concerned with a specific type of assets, those which yield rents in the sense of public economics. In the remainder of the article we therefore use the definition for rent given by Wessel (1967).

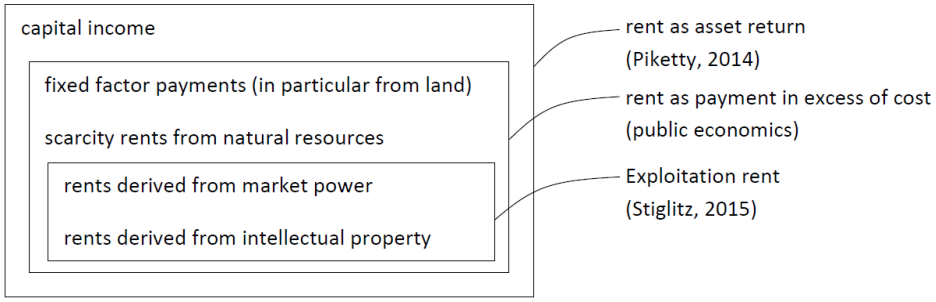

Figure 1: Definitions of rent

3.2 Competition policy versus taxation

Economic rents can be created artificially through rent-seeking or they can arise naturally. The artificially created rents have been termed as exploitation rents by Stiglitz (2015) since they are created through the exploitation of market power or political power. There is ample evidence that exploitation rents are created intentionally by politicians (Mian et al., 2010; Benmelech and Moskowitz, 2010; Duchin and Sosyura, 2012), a phenomenon famously described by Stigler (1971). Political rent creation often works through excluding competitors Djankov et al. (2002), so that these rents could also be termed exclusion rents. Apart from the obvious distributional implications, rent-seeking activities also reduce aggregate efficiency (Scharfstein and Stein, 2000; Svensson, 2000; Torvik, 2002). As politicians create these rents

intentionally, it may be naive to attempt resolving the problem through regulation. Djankov et al. (2002), however, show that better institutions, and democracy in particular, are more successful in reducing political rent creation.

Rents created through market power or political power can thus have harmful distributional and efficiency effects. The literature on endogenous growth, however, points out that it also has a beneficial effect by providing the resources for investments into research and development (Grossman and Helpman, 1991; Aghion and Howitt, 1992). It is thus not optimal to abolish market power so completely that no innovation can be financed. The socially optimal degree of artificial rents therefore must be determined by competition policy.

A substantial amount of rents arise naturally. A prominent type of natural rents are production factors in fixed supply like land and nonrenewable resources. Another important type of natural rent is natural monopolies arising in industries with barriers to market entry like high fixed costs or network effects. For the reasons described in Section 4.1 it would enhance efficiency to tax these rents. However, the assets yielding these rents are distributed very unevenly in society, so that taxation would have strong distributional implications. The seminal papers Mirrlees (1971) and Chamley (1986) on income and capital taxation carry titles referring to "optimal income/capital taxation". In Section 5 we propose a model to extend this approach of determining taxes according to an optimizing equity-efficiency tradeoff to rent taxation.

While production factors like land and natural resources are certainly scarce and thus receive a scarcity rent, it would be a simplification to consider them fixed. Lichtenberg (1989), Gurgel et al. (2011) and Bustos et al. (2016) describe technical change which has a land-augmenting effect. For resources it has been shown that the simple Hotelling (1931) model does not hold, because technological changes makes increasingly more resources available (Lin and Wagner, 2007; Hart and Spiro, 2011; Atewamba and Nkuiya, 2017). This calls for a careful distinction between the part of the return which reflects scarcity and the part which is a return to the investment into technical change. Taxing the proceeds of technical change would be distortionary just like other taxes on productive investments.

For urban land, the value of the land is due to agglomeration effects, that is from capital investments. The "land value" for one piece of land thus ultimately measures the positive externality created by capital investments on neighboring pieces of land. So even when the size of the land is considered fixed, the value of the land depends on investments. A taxation

of land value would thus be distortionary.

Alterman (2012) and the contributions to Ingram and Hong (2012) distinguish natural rents by their source of value. While "there seems to be a consensus among scholars that public investment costs should be at least partially covered by the financial benefits that these investments generate" these authors also claim that "the value related to the original productivity of the land paid for by the owner and the increment in value generated by private land improvements should remain in private hands" (Ingram and Hong, 2012, p.4). In the context of optimal taxation, such a distinction by the origin of an asset is not meaningful. Instead, the degree of taxation depends only on the effect of taxation for equity and efficiency.

Based on these observations, we propose three guidelines for dealing with rents. First, we should distinguish between artificially created rents, for which the optimal size needs to be determined, and naturally arising rents, for which the size is given and for which ownership needs to be allocated optimally. Second, the taxation of rents must be preceded by a careful analysis of which part of a given income is indeed a rent in the sense of the definition by Wessel (1967). Third, the origin of rents, whether created by the government or privately, should not matter for taxation.

4 Efficiency and equity effects of rent taxation

The literature has identified a number of efficiency effects of rent taxation and started exploring equity effects. A theory of rent taxation would require putting these effects into context and determining relevant interactions and tradeoffs. Here we present the breadth of the currently available research before analyzing one important tradeoff in detail in the next section.

Given that rent taxation is known to be non-distortionary, why does it have equity effects at all? The value of a rent yielding asset is given by the discounted sum of expected future rents. The permanent introduction of a rent tax, which taxes fraction x of the rent, thus reduces the asset value by the same faction, x (Oates and Schwab, 2009). The introduction of a rent tax is thus equivalent to a (partial) expropriation of asset owners.

It is natural to consider compensating the affected households for the expropriation. In fact, *compensated* taxation is meant when rent taxation is described as non-distortionary. Fane (1984) describes what the government needs to do in order to fully compensate the land owners: It needs to issue government bonds of the same value as the expropriated land,

give the bonds to the households and use the land tax revenue to pay the interest on the bonds. This compensation scheme, however, would completely neutralize the efficiency gains of rent taxation. Compensation in this sense is a useful theoretical consideration, but is not meaningful to implement in practice. Consequently, the introduction of rent taxation has distributional implications.

4.1 Efficiency effects

Rents can be taxed by two forms of taxes, value and unit taxes. This difference in the tax base has implications for the surplus of the owner of the rent yielding asset and for the supply of the asset. Figure 2, left panel, shows the situation without taxes. The total amount of the asset ($\bar{L}$) is sorted from highest to lowest value (V). The shaded area is the rent received by the asset owner. The central panel shows the case of a value tax, in this case roughly 50%. Half of the rent remains with the asset owner and the other half is taken by the government through the taxes (dotted area). The right panel illustrates the case of a unit tax. Only the assets with a high value (up to L_1) remain in use.

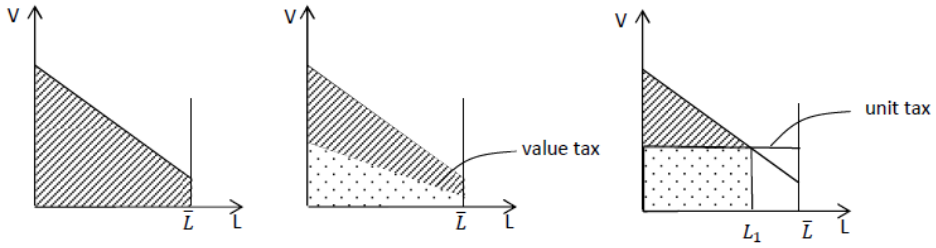

Figure 2: Value and unit taxes

In the case of land as the rent yielding asset it is not straightforward to determine which part of the total value is due to the land itself and which part is due to the capital, which has been invested on it. This distinction is important since the capital stock requires investment and investment is discouraged by taxation. The supply of land by contrast is not discouraged by taxation unless the tax rate exceeds 100%. In spite of the complexity of disentangling the value of the land from the value of the capital stock, it has been found that it is possible to determine land value with satisfactory accuracy, see Bell et al. (2009) and Mirrlees et al. (2011), Chapter 16. In addition, Chapman et al. (2009) shows theoretically that inaccurate assessments of land value have only minor consequences for efficiency. From a practical point of view, land value taxation is thus feasible.

Value taxes on rent yielding assets provide a non-distortionary form of taxation and are thus a more efficient form of taxation than distortionary taxes like labor and capital taxes. This was pointed out already by Adam Smith and Henry George, see Mattauch (2015) for a review on the insights of the early economists. Oates and Schwab (2009) provide a brief theoretical summary of this argument. In addition to being an efficient source of taxation, rent taxation has the potential of increasing capital investments through the "portfolio effect" (Feldstein et al., 1977). When capital is underaccumulated, the portfolio effect provides a second type of efficiency gain from rent taxation (Edenhofer et al., 2015). When the economic use of a rent yielding asset produces an environmental externality, then a unit tax spares marginal units of the asset from productive use, thus creating a third type of efficiency gain from rent taxation through environmental benefits. Examples for this are fossil fuels (Franks et al., 2015), which contribute to climate change and land use (Kalkuhl and Edenhofer, 2016), which can cause harmful deforestation. Finally, value taxes on land might be a way of countering the negative effect of unequal land ownership on development as identified in Galor et al. (2009).

Next to the positive effects of rent taxation for efficiency, there could also be negative effects of rent taxation for some kind of rents. Hellwig and Irmen (2001) show that infra-marginal rents could be used for investments into technology. In this way endogenous growth would be possible without any kind of market power. When rents are used in this way for socially beneficial investments, taxing rents might thus not be desirable.

4.2 Intergenerational equity

For the intergenerational effect, consider the model of Feldstein et al. (1977). There are two generations alive at a given point in time, young and old. The young generation works, the old generation owns land and lives of the land rent as well as capital income. The introduction of the land rent can redirect saving efforts from purchasing land towards purchasing capital, so that households invest more in capital. A land tax can thus correct an underaccumulation of capital and thus move the economy to a more efficient equilibrium.

Koethenbuerger and Poutvaara (2009) point out that this analysis abstracts from the effects of this policy on the old generation at the time of the introduction of the policy: They loose a fraction of their savings for old age. However, there is a second effect involved: If the land rent tax is used to lower labor taxes, the young generation works more and thus

increases the gross land rent. Under certain conditions, the effect of a higher land rent tax might even be compensated by the higher gross land rent, so that no additional burden will be placed on the currently old generation.

4.3 Intragenerational equity, part I: vertical equity

Feldstein et al. (1977) and Koethenbuerger and Poutvaara (2009) distinguish between the young and old generation, but within a generation all households are assumed identical. Stiglitz (2015), by contrast, highlights the role of heterogeneity in wealth and, more specifically, in land ownership. Investigating increasing inequality he conjectures "that much of the increase in inequality is associated with the growth in rents": When land is distributed unequally in society any policy which affects the value of land has distributional consequences.

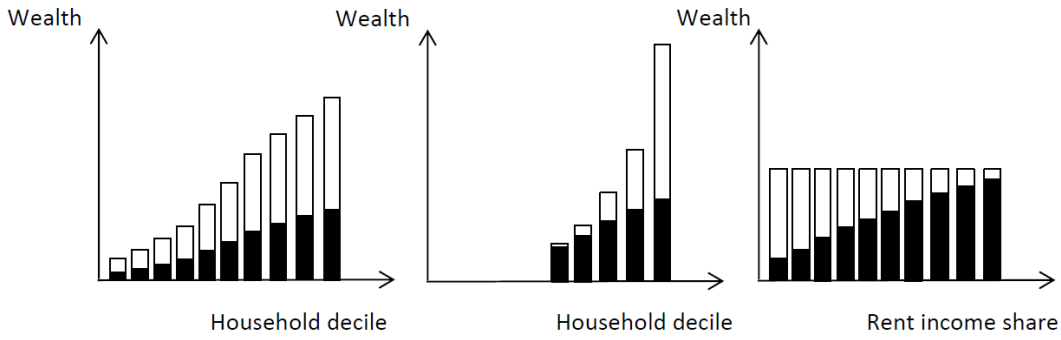

Figure 3: Conceptional illustration of different scenarios of wealth distribution. Wealth can take the form of capital (white) and rent yielding assets (black). Scenario with equal (left panel) and unequal (center panel) vertical distribution, as well as unequal horizontal (right panel) distribution.

Tax equity can be distinguished in vertical equity, that is the progressivity of a tax, and horizontal equity, which says that "people in equal positions should be treated equally" (Musgrave, 1959). This distinction is illustrated in Figure 3. Rent taxation would raise no equity issue if the share of rents would be proportional to total wealth as in the left panel. In this case taxing a certain share of rents would reduce the wealth of all households equally. Equal rent shares would be an unlikely coincidence, however. The central panel illustrates the hypothetical case where the middle class owns a high share of their wealth in rent yielding assets. In this case, they would bear the highest burden of the introduction of rent taxes.

Concerning vertical equity, "data on land ownership is poor in most jurisdictions, making

it difficult to assess whether a land value tax[1] would be progressive" (Plummer, 2009). Bucks et al. (2006) provide some evidence according to which land ownership in the US increases in absolute amount in wealth but decreases in relative terms. The main reason is that the largest asset of a household is typically the primary residence. The center panel of Figure 3 captures such a pattern in a stylized way. The top 1 percent own only around 9 percent of wealth in real estate (Geisler et al., 1995). According to this evidence, a linear land rent tax would be regressive. While land ownership might not grow proportionally with wealth, households with similar wealth may hold very different shares of their wealth in land. This is illustrated in the right panel of Figure 3. For rent yielding assets other than land (including natural resource rents and natural monopolies), there appears to be no data on the distribution of ownership across households at all.

4.4 Intragenerational equity, part II: horizontal equity

A tax on rent yielding assets would treat all households with the same amount of these assets equally. However, when there are households which hold different shares of their wealth in rent yielding assets, the government would practically expropriate different shares of their wealth. The comparison of households with equal wealth is the relevant category since Rosen (1978) specifies that the equal position of the definition of horizontal equity is "defined in terms of some observable index of ability to pay such as income, expenditure, or wealth."

Musgrave et al. (1990) notes that "for the more realistic case of limited policy options, vertical and horizontal equity goals may conflict so that a trade-off will be needed." The right panel in Figure 3 illustrates this, by "zooming into" one of the wealth deciles of the center panel. If a high rent tax would be beneficial for vertical equity, the different households of equal wealth in the right panel would lose very different shares of their total wealth.

As for vertical equity, there are no empirical results on the effect of rent taxation on horizontal tax equity. For property taxes (where both the land and improvements are taxed), Gary and Barrett (2005), Cornia and Slade (2006) and Sirmans et al. (2008) find that horizontal equity is a concern. Similarly, Plummer et al. (2010) identify horizontal equity problems for a hypothetical policy of replacing a uniform property tax with a land value tax. These studies, however, are concerned with comparing the taxes to be paid with the market value of the taxed property. They do not compare the taxes to be paid by an individual with the

[1]Notice that there is a difference between a land value tax and a land rent tax. Their economic effects, however, are identical (Oates and Schwab, 2009).

wealth of the individual.

5 Model

We illustrate an important equity-efficiency trade-off of rent taxation with an analytical model. Consider a small open economy, where households own labor L_i, capital K_i and rent yielding assets A_i. The rent yielding assets include land in particular. Since the economy is small the respective factor prices are not affected by decisions in the economy. We chose the units of the production factors in such a way that prices equal one.

Household i derives utility from consumption C_i and disutility from Labor L_i,

$$U_i = U(L_i, C_i), \quad U_C, -U_L \geq 0 \; . \tag{1}$$

Household i receives income according to how much of the production factors it supplies. Taxes are given by τ_j. Although it is not modeled here explicitly, capital supply is elastic. Based on Chamley (1986) and Judd (1985) we therefore assume that the capital tax is zero. Consumption is thus given by

$$C_i = (1 - \tau_L)L_i + K_i + (1 - \tau_A)A_i \; . \tag{2}$$

The price for the final good is normalized to 1. Maximizing utility (1) with respect to the budget constraint (2) yields the first order condition of the household,

$$-\frac{U_L}{U_C} = (1 - \tau_L) \; . \tag{3}$$

The government needs to finance a fixed budget $\bar{G}$,

$$\bar{G} = \sum_{i=1}^{N} (\tau_L L_i + \tau_A A_i) \; . \tag{4}$$

In order to ease the formulation of the propositions below, we assume that government spending exceeds the value of rents, $\bar{G} \geq \sum_{i=1}^{N} L_i$. Rent taxation is limited by 100%,

$$\tau_A \leq 1 \; , \tag{5}$$

since a higher tax rate would make it unprofitable to own rent yielding assets.

The objective of the government is given by a social welfare function in standard Bergson-Samuelson formulation,

$$SWF = \sum_{i=1}^{N} \Psi(U_i), \quad \Psi'(U_i) > 0, \ \Psi''(U_i) < 0 \ . \tag{6}$$

We assume $\lim_{U\to\infty} \Psi'(U) = 0$. The government can use taxes on labor and rent yielding assets to maximize social welfare.

5.1 General utility function

As a first step we determine the optimal tax rule with the general utility function.

Proposition 1 *Let the constraint $\tau_A \leq 1$ be not binding. Then the policy rules for optimal rent and labor tax are given by*

$$\frac{\sum_{i=1}^{N} \Psi' \frac{-U_{L_i}}{(1-\tau_L)} L_i}{\sum_{i=1}^{N} \Psi' U_{C_i} A_i} = \frac{\sum_{i=1}^{N} \left(L_i - \tau_L \frac{dL_i}{d(1-\tau_L)} \right)}{\sum_{i=1}^{N} A_i} \ , \tag{7}$$

$$\bar{G} = \sum_{i=1}^{N} (\tau_L L_i + \tau_A A_i) \ . \tag{8}$$

Proof

Let $V_i = V(\tau_L, \tau_A) = U(L_i^*, C_i^*)$ be the indirect utility function, where the asterisks denote optimized consumption and leisure. By Roy's identity we have $\frac{\partial V_i}{\partial \tau_A} = -\varphi_i A_i$ and $\frac{\partial V_i}{\partial \tau_L} = -\varphi_i L_i$, where φ_i is the private marginal utility of income of the household. From the household maximization we have $\varphi_i = U_{C_i} = -\frac{U_{L_i}}{(1-\tau_L)}$. The government maximization problem is given by

$$\max_{\tau_L, \tau_A} \mathfrak{L} = \sum_{i=1}^{N} \Psi(V_i) + \lambda \left[\tau_L \sum_{i=1}^{N} L_i + \tau_A \sum_{i=1}^{N} A_i - \bar{G} \right] + \mu[\tau_A - 1] \ . \tag{9}$$

First order conditions are thus given by

$$\frac{\partial \mathfrak{L}}{\partial \tau_L} = \sum_{i=1}^{N} \Psi' \frac{U_{L_i}}{(1-\tau_L)} L_i + \lambda \sum_{i=1}^{N} \left(L_i - \tau_L \frac{dL_i}{d(1-\tau_L)} \right) = 0 \,, \tag{10}$$

$$\frac{\partial \mathfrak{L}}{\partial \tau_A} = -\sum_{i=1}^{N} \Psi' U_{C_i} A_i + \lambda \sum_{i=1}^{N} A_i + \mu = 0 \,, \tag{11}$$

$$\mu(\tau_A - 1) = 0 \,. \tag{12}$$

From $\tau_A < 1$ we have $\mu = 0$. Eliminating λ from equations (10) and (11) yields the first of the policy rules. □

The result is intuitive. Equation (7) says that the ratio of the marginal effect on social welfare of the two taxes (left side) must equal the ratio of the marginal contributions to the government budget (right side). Equation (8) is a reformulation of the budget constraint.

The importance of the result is that in general, the optimal rent tax is neither equal to zero (as found in practice in many cases) nor equal to one (as claimed by "Georgists"). The reason is that households have different welfare weights to the social planner. Taxing away the assets of a household with high welfare weight (that is a household with a low asset endowment) is not optimal. The government thus has to determine the optimal equity-efficiency tradeoff of rent taxation.

5.2 Quasi-linear utility

The general tax rule in equation (7) allows for an income effect, meaning in particular that rent taxation affects labor supply directly through changes in income. This effect makes it impossible to derive further analytical results. In order to carry the analysis further we therefore assume that utility takes quasi-linear form in the following,

$$U(L_i, C_i) = C_i - u(L_i), \quad u'(L_i) < 0, \; u''(L_i) > 0. \tag{13}$$

These preferences exclude the income effect.

For this utility function, we have $U_{C_i} = 1$ and $-U_{L_i} = (1 - \tau_L)$. With this we can rewrite equation (7) as

$$\frac{\sum_{i=1}^{N} \Psi' \frac{1}{N} \sum_{j=1}^{N} A_j}{\sum_{i=1}^{N} \Psi' A_i} = \frac{L - \tau_L \frac{dL}{d(1-\tau_L)}}{L} \tag{14}$$

We dropped the index of labor supply since labor supply is now independent of the income

of household i.

In the following we will use equation (14) to determine the optimal level of rent taxes in certain special cases. As a first case we assume that social welfare is linear in household utility, meaning that Ψ' is a constant.

Proposition 2 *Let social welfare be linear in household utility. Then full rent taxation* $\tau_A = 1$ *is optimal.*

Proof

Assume that the constraint $\tau_A = 1$ is not binding. If social welfare is linear in consumption then Ψ' is constant. It can thus be eliminated from equation (14). This allows further simplifications until the equation $\frac{dL}{d(1-\tau_L)} = 0$ remains. Since we assumed $u'(L_i) < 0$, this is a contradiction. Thus $\tau_A = 1$ must be binding. □

The result illustrates that when the government is not concerned with inequality then non-distortionary rent taxation is always preferable to distortionary taxation, in this case labor taxation. The proposition shows that full rent taxation is optimal if only efficiency aspects of taxation are considered and equity effects are excluded. The exclusion of equity effects requires social welfare to be linear in consumption.

Next we come to the case where the government is concerned with inequality, but where the only inequality is in land yielding assets. This case can be represented by the assumption that all households own the same amount of capital, $K = K_i \; \forall i$.

Proposition 3 *Let all households hold equal amounts of capital. Then full rent taxation* $\tau_A = 1$ *is optimal.*

Proof

Assume that the constraint $\tau_A \leq 1$ is not binding. Then we can use Proposition 1 with equation (14) as the tax rule. L is a concave function, so that we have $L' > 0$. From this it follows that $\frac{(L-\tau_L L')}{(L+(1-\tau_L)L')} < 1$.

Further, we have that Ψ is a concave function. From this it follows that ψ' is a monotonically falling function in C. Since all households own the same amount of capital and choose the same amount of labor supply, their consumption levels vary only by the amount of assets owned. Therefore, $\psi' U'$ is also a monotonically falling function in rent yielding assets A_i.

For a monotonically function f we have $\sum_{i=1}^{N} f(x_i) \frac{1}{N} \sum_{j=1}^{N} x_j > \sum_i f(x_i) x_i$ (proof below). Therefore, $\sum_{i=1}^{N} \Psi' \frac{1}{N} \sum_{j=1}^{N} A_j > \sum_{i=1}^{N} \Psi' A_i$ so that $\frac{\sum_{i=1}^{N} \Psi' \frac{1}{N} \sum_{j=1}^{N} A_j}{\sum_{i=1}^{N} \Psi' A_i} > 1$. Taken together

we have shown that equation (14) is a contradiction. Therefore $\tau_A \leq 1$ is binding.

It remains to show the inequality. Consider a monotonically falling function $f(x)$ and a set of ordered real numbers, $\{x_i\}_{i=1}^N$. Then $0 < f(x_1) - f(x_2) = f(x_1)\frac{x_2-x_1}{2} - f(x_2)\frac{x_2-x_1}{2} = f(x_1)\left(\frac{x_1+x_2}{2} - x_1\right) - f(x_2)\left(x_2 - \frac{x_1+x_2}{2}\right) = f(x_1)\frac{x_1+x_2}{2} + f(x_2)\frac{x_1+x_2}{2} - f(x_1)x_1 - f(x_2)x_2$. Further, assume that $\sum_{i=1}^n f(x_i)\frac{1}{n}\sum_{j=1}^n x_j > \sum_{i=1}^n f(x_i)x_i$. Then $\sum_{i=1}^{n+1} f(x_i)\frac{1}{n+1}\sum_{j=1}^{n+1} x_j - \sum_{i=1}^{n+1} f(x_i)x_i = \sum_{i=1}^{n+1} f(x_i)[\frac{1}{n+1}\sum_{j=1}^{n+1} x_j - x_i] = \frac{n}{n+1}\sum_{i=1}^{n+1} f(x_i)\frac{1}{n}[\sum_{j=1,j\neq i}^{n+1} x_j - nx_i] = \frac{n}{n+1}[\sum_{i=1}^{n} f(x_i)\frac{1}{n}[\sum_{j=1,j\neq i}^{n+1} x_j - nx_i] + \sum_{i=1}^{n} f(x_i)\frac{1}{n}(x_{n+1} - x_i) + f(x_{n+1})\frac{1}{n}(\sum_{i=1}^{n} x_i - x_{n+1})] = \frac{n}{n+1}[\sum_{i=1}^{n} f(x_i)\frac{1}{n}[\sum_{j=1,j\neq i}^{n+1} x_j - nx_i] + \sum_{i=1}^{n}(f(x_i) - f(x_{n+1}))\frac{1}{n}(x_{n+1} - x_i)] > 0$. This proves the inequality by induction. □

Under the assumption of equal holdings of capital, the only remaining heterogeneity among households is that in rent yielding assets. Taxing these assets fully is efficient, but it also insures full equality in consumption. It thus also has positive effects for equity. The equity effect results, because high rent taxes imply lower labor wages, which benefits all households in the same way.

The result thus depends on the assumption that all households have an equal capacity to earn labor income. In a model with different labor productivities such a proposition would not hold. To see this consider a household with zero labor productivity, but positive holdings in rent yielding assets. Full taxation of rent yielding assets would expropriate the asset holdings without returning anything to the household, since the household does not benefit from lower labor taxes.

Next, we consider the opposite case of Proposition 3 in terms of heterogeneity.

Proposition 4 *Let all households hold equal amounts of the rent yielding assets. Then full rent taxation $\tau_A = 1$ is optimal.*

Proof

The proof works in the same way as that of Proposition 3. Using the equality of asset holdings the left side of equation (14) simplifies to equal 1, which is again incompatible with the expression on the right. □

In this case the intuition is that all households pay the same amount (in the form of rent taxes), and receive the same amount (in the form of lower labor taxes). The more efficient nature of the rent tax is thus decisive since households pay less in rent taxes than they receive in the form of higher net labor earnings. As in Proposition 3, however, the result depends

on the modeling assumption that all households benefit from the revenue recycling the same way.

Next, we come to the case of identical portfolios. This case is highly significant, since households which are homogeneous in preferences, but heterogeneous in wealth will have asset portfolios of different size, but equal composition.

Proposition 5 *Let all households own the same ratio of capital to rent yielding assets,* $\alpha = \frac{K_i}{A_i}\ \forall i$. *Then full rent taxation* $\tau_A = 1$ *is optimal.*

Proof

The proof works again in the same way as that of Proposition 3. Notice that total asset holdings can be written as $K_i + A_i = \alpha A_i + A_i = (1+\alpha)A_i$. Therefore, as above ψ' is a monotonically falling function in A_i. □

The case of equal portfolios means that all households loose the same share of total wealth to asset taxation. Since the tax revenue is recycled to all households equally, this redistributes from rich to poor households. As in the case of equal capital holdings rent taxation is thus beneficial in terms of both efficiency and equity so that it should be used to the largest possible extent.

Propositions 2 to 5 have highlighted cases where full rent taxation is optimal. However, the optimal tax system can require less than full rent taxation whenever asset portfolios are highly heterogeneous. We illustrate this in the next proposition.

Proposition 6 *Let* N *be large. Then there is a distribution of assets for which* $\tau_A < 1$ *is optimal.*

Proof

Let (τ_A, τ_L) be a set of taxes such that $0 \leq \tau_A < 1$, $\tau_L < 1$ and the government budget constraint is fulfilled (we assume that such a set of taxes exists). Consider the situation where $A_1 = 1, K_1 = 0$, $A_i = 0\ \forall i \neq 1$ and where all households except household 1 hold an equal amount of capital K. For $K = 0$ we have $\frac{\sum_{i=1}^{N} \Psi' \frac{1}{N} \sum_{j=1}^{N} A_j}{\sum_{i=1}^{N} \Psi' A_i} > 1 > \frac{L - \tau_L L'}{L + (1-\tau_L)L'}$ by Proposition 3. Further we have $\lim_{K\to\infty} \frac{\sum_{i=1}^{N} \Psi' \frac{1}{N} \sum_{j=1}^{N} A_j}{\sum_{i=1}^{N} \Psi' A_i} = \frac{1}{N}\Psi'((1-\tau_L)L(1-\tau_L) + (1-\tau_A))$ (where we used $\lim_{U\to\infty} \Psi(U) = 0$) and $\frac{d}{dK}\frac{L-\tau_L L'}{L+(1-\tau_L)L'} = 0$. Therefore, there is a value K^* for which equation (14) holds with equality. □

Proposition 6 has a simple intuition. In an economy where a few households own only rent yielding assets and others are very rich in capital it is not optimal to tax the relatively poor

rent owners. For distributional reasons it can be optimal to use distortionary labor taxation instead of non-distortionary rent taxation (if government expenses are not covered with the rent taxes).

Taken together, the propositions illustrate that there are situations, in which it is optimal to tax rents fully and other situations where distributional concerns call for less than full rent taxation. In the case modeled here, the decisive feature is the heterogeneity in asset holdings among households. Other heterogeneity, in particular in labor productivity, might also justify less than full rent taxation.

6 Conclusion

The proposed categorization of rent types can be used to derive a comprehensive set of policy implications. Exploitation rents should be minimized with competition policy. These rents limit competition and bind productive means without creating value. Rents that arise naturally should (i) be distinguished from capital since taxing them has very different effect, but should also (ii) be treated like labor and capital in the sense that they should be taxed in a way that maximizes social welfare. Model results show that the degree of rent taxation should depend on the heterogeneity of household portfolios with respect to capital and rent yielding asset shares. A distinction of rents by the source of their value (as applied in the literature on "value capture") is not meaningful for the maximization of social welfare.

This differential treatment of rent income could reconcile three different perspectives on rent taxation. The first perspective is libertarianism, which points out that rent income is the return to an investment and that the government should thus refrain from expropriating it. This concern is addressed when the government gives due consideration to the equity effects of taxing rent income. The second perspective is Georgism, which points out the efficiency of taxing rents. This idea is addressed by giving consideration to the efficiency effect of taxing rent income. The third perspective is the concern for inequality as expressed by Piketty (2014). This aspect is addressed by considering the positive distributional effect of taxing economic rents.

From a practical perspective a meaningful equity-efficiency analysis of the government would require data on the vertical and horizontal distribution of capital and rent yielding assets. That is, the government needs to know how the share of rents increases with total wealth and how the share of rents varies among households with equal wealth. Rent taxation,

which is aimed at improving social welfare thus requires much more detailed data than is available at present.

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