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Abstract

Consumption taxes are often considered as the most regressive component of the tax system. However, there are only few estimates, and even fewer international comparisons, of the redistributive impact of consumption taxes in the literature, due to scarce data on household expenditures. We use household budget and income surveys and microsimulation to provide consistent estimates of the regressivity of consumption taxes for a large panel of countries and years. We propose a new method for imputing household consumption expenditure across countries: this can be applied to any dataset that contains income information and potentially other socio-demographic variables. We stress that using housing rents, when available, to impute household consumption and compute consumption taxes significantly improves the accuracy of the model. We have three results. First, there is a 1 to 2 ratio between the propensities to consume of the top decile (between 50% and 70% of income) and that of the bottom decile (over 100% of income) in every country. Second, consumption taxes produce a significant rise in the Gini coefficient of income inequality (between 0.01 and circa 0.05 points), but of much smaller size than the positive redistribution from direct taxes and transfers. Last, cross-country differences in the distributive effect of consumption taxes are mainly explained by different tax rates (from 7% to 30% in our sample), rather than variations in the distribution of consumption, as the propensity to consume declines sharply with income everywhere.

Keywords: Consumption taxes; Redistribution; Income inequality; Microsimulation. *JEL classification*: D31; H23; I38.

1 Introduction

The distributive effect of consumption taxes is the blind spot in the comparative study of redistribution systems. Consumption taxes globally account for 30% of government revenue in developed economies, and there is a positive cross-country correlation between the level of consumption taxes and the size of the welfare state (Lindert, 2004; Kato, 2003). However, consumption taxes are also considered to be unfair, as they are a flat tax on consumption expenditure, and the share of income spent on consumption falls with income (Warren, 2008). The motivation of our work here is to evaluate the impact of consumption taxes on inequality, and the extent to which they counteract the redistribution effected by other socio-fiscal tools.

The analysis of consumption taxes and inequality requires a considerable amount of data: detailed data on household expenditures and income, as well as precise data on the statutory tax rates applied to different types of goods (excise taxes, sales taxes, and various VAT rates). Most work on the redistributive effect of socio-fiscal systems therefore actually leaves consumption taxes out of the equation (see, for instance, Guillaud, Olckers, and Zemmour 2020; Causa and Hermansen 2017 and Piketty and Saez 2007). When consumption taxes do appear, the research that focuses on international comparisons typically relies on the Euromod microsimulation tool (for example, Figari and Paulus 2015; Decoster et al. 2010;

O'Donoghue, Baldini, and Mantovani 2004), with the resulting limitation of the analysis to European countries. A second option is to use aggregate imputations of consumption taxes, as recently adopted in the work carried out by the Distributional National Accounts (DINA) project. This approach, however, estimates consumption by income group, by applying synthetic saving rates to disposable income. The estimated consumption is then assumed to be entirely taxed (see Piketty, Saez, and Zucman 2018 for the United States, and Bozio et al. 2018 for France). We here take a step forward in this research area by producing reliable estimates of the consumption taxes paid at the household level. We propose a straightforward method for the imputation of missing consumption data. Applying effective consumption tax rates to this consumption data produces an accurate international comparison of the impact of consumption taxes on inequality in 26 countries over 25 years going from 1979 to 2013, producing a total of 126 datasets.

The method we use is innovative and surprisingly simple. Starting from micro-data on expenditure and income in household budget surveys, and harmonized by the Luxembourg Income Study (LIS), we construct a simulation model of household consumption by income level, which allows us to obtain predictions of the distribution of the propensity to consume for all countries. Once we have this distribution, we apply a homothetic transformation of the data to match macroeconomic aggregates. After testing the robustness of our model, we show that the composition of the household consumption basket is not required for the accurate estimation of the distributive effect of consumption taxes. On the other hand, we do require data on household income and composition, which systematically appear in cross-country micro-datasets. While consumption data are rather scarce in international datasets, household income data often include specific information on housing costs (including imputed rents). We show that, where such data are available, this information can be exploited and thus clearly increase the predictive power of the model. Our empirical approach produces accurate estimates of consumption. We compare the distribution of consumption taxes and income, and evaluate the effect of the former on income inequality.

We show that (1) the effective consumption tax rate on the income of individuals in the bottom decile of equivalized income is twice that of households in the top income decile; (2) the anti-redistributive effect of consumption tax is significant, and reduces the positive effect of direct redistribution (from direct taxes and transfers, excluding pensions) by one third on average in our sample; and (3) the average consumption tax rate implemented within each country is the main explanation of the (large) variation in this anti-redistributive effect across countries.

2 Literature

While there is significant redistribution using the revenue from consumption taxes, the direct anti-redistributive effect of their imposition has rarely been assessed. This latter effect is determined by the tax-rate structure, and household consumption patterns and average propensity to consume. This likely differs significantly from one country to another, as there is great cross-country variation in both the level of consumption taxes and the consumption behavior of households.

2.1 The determinants of regressivity in consumption taxes

The amount of consumption tax paid by each household depends on both the overall level of its consumption and the type of goods and services consumed. The distribution of tax rates across the population therefore reflects both the household propensity to consume and the basket of goods consumed, with the latter influencing the average effective rate applied to total household expenditure.

Regarding the first factor, it is widely thought that the propensity to consume falls with household income. If this is so, for a given tax rate, the relative amount of consumption tax paid by the household also falls with income. This is the main reason why consumption taxes are considered to be regressive. Second, for a given propensity to consume, each household's effective tax rate will depend on the bundle of goods and services it chooses to purchase. There is no clear evidence of the way in which this 'bundle effect' affects the distribution of tax rates across income levels.

There have been a series of empirical analyses of this question, making use of detailed household budget surveys, and using statutory tax-rate information for different types of goods and services.[1] Some of these analyses are at the country level, for instance Savage (2017) for Ireland, and Boutchenik (2015); Dauvergne (2012); Ruiz and Trannoy (2008) for France. Others use Eurostat data and Euromod microsimulation tools to compare different countries (Figari and Paulus, 2015; Decoster et al., 2010; O'Donoghue, Baldini, and Mantovani, 2004). This literature concludes that the bundle effect on the effective tax rate on household consumption is only limited, as compared to the other effects that are the falling propensity to consume and share of rents.

In France, VAT is slightly progressive (one point higher for the top decile than for the bottom: see Boutchenik, 2015), but this is offset by regressive excise taxes so that the total tax rate on consumption is almost flat (Dauvergne, 2012; Ruiz and Trannoy, 2008). In Ireland, Savage (2017) finds, using observational data, that the profile of all consumption taxes is slightly regressive (two points higher for the bottom than for the top decile, and three points higher for deciles 2 to 4).

Using a larger sample of countries, O'Donoghue, Baldini, and Mantovani (2004) also find that VAT rates on consumption are slightly progressive (zero to two points higher for consumption in the top decile) in each of the 12 European countries considered; on the contrary, excise taxes are regressive everywhere (zero to three points difference). They overall find that consumption tax rates decline over consumption (and are thus regressive), but that the difference between the top and bottom deciles is under one point in 8 out of the 12 countries, and between one and two points in France, Italy, Portugal and the United

[1] As the national legislation on consumption taxes is sometimes very complex, the imputation of the tax rate for different goods is generally simplified: the analyses distinguish between a few dozen groups of goods and services and apply a tax rate to each, even if in practice the legislation can be much more detailed. However, this type of approach is by far the most precise evaluation we have of the bundle effect.

Kingdom. Applying the same method to more-recent data, Decoster et al. (2010) and Figari and Paulus (2015) find the opposite result: a slightly-increasing tax rate on consumption. In the former, the top decile pays between 0.5 (UK) and 2.6 points (Belgium) more than the bottom decile; in the latter this range is between 0.4 (UK) and 1.6 points (Belgium).

Thus, while there is no consensus over the sign of the bundle effect, which likely also varies across countries and over time, there is agreement in the literature that it is a third-order effect, coming after the decreasing propensity to consume and the share of housing rents in household budgets that affects the scope of taxable consumption.

We will here neglect the bundle effect but do address housing rents, which are not subject to consumption tax: we apply a constant tax rate to non-rent consumption. We then test the sensitivity of our results to this assumption in Appendix B.3, which considers a consumption tax rate that varies by income group.

2.2 Issues in measuring consumption taxes

Unlike payroll or income taxes, which can be measured at the individual level with administrative data, consumption taxes such as sales taxes or value-added taxes are not registered at the individual level. It is not therefore straightforward to establish the consumption taxes a household pays. The most-common way of measuring this amount relies on consumption data and microsimulation techniques: with information on household consumption and the country's tax system, the consumption taxes paid by the household can be derived.

There are three main issues with this technique. The first is the definition of the tax rate on consumption that is to be applied to consumption expenditure. Second, it is useful to ask, in the context of comparing the redistribution of fiscal systems in a cross-country fashion, whether micro-data from different national surveys can be compared directly or if they should be harmonized with National Accounts. Last, as consumption data are costly to collect and may be missing for some countries, we may need to turn to imputation. We consider these three in turn below.

Measuring the tax rate on goods and services. There are two competing ways of calculating the effective tax rates on consumption in a cross-country perspective. The first consists in using legal statutory tax rates (e.g. Figari and Paulus, 2015; Decoster et al., 2010; O'Donoghue, Baldini, and Mantovani, 2004). This has the advantage of being an exact method, provided that we can decompose the household's consumption bundle in order to apply the corresponding tax to each good. This method is not feasible in practice when carrying out cross-country comparisons over a number of years, as it requires the detailed analysis of each country's legislation in every year of interest. Moreover, the application of the correct tax rates according to the nature of the good or service purchased requires consumption data to be broken down into very fine categories. Existing consumption databases rarely exhibit this level of precision.

The second method is the calculation of implicit tax rates (Eurostat, 2016; Carey and Tchilinguirian, 2000; Mendoza, Razin, and Tesar, 1994). These are calculated using National

Accounts data on household consumption and government tax revenue, and produce average tax rates for each country-year: the ratio

$$\tau = \frac{consumption\ tax\ revenue}{taxable\ consumption}$$

is the effective household tax rate on consumption.[2]

The need for recalibration for international micro-data comparisons. There is always a gap between micro-data from surveys and aggregate National Accounts data. In this case, as we use individual income and consumption data in order to estimate the impact of consumption taxes, we want to make sure that the amounts can be compared across countries. National Accounts, as they are standardized, are more fit for international comparisons. The propensities to consume calculated at the national level do indeed vary significantly between countries, as measured in National Accounts. These differences, however, do not always appear in micro data.

We therefore combine micro- and macro-level data in order to produce information on the distribution of income and consumption within each country-year that is comparable at the international level. Many other researchers (e.g. Piketty, Saez, and Zucman 2018) have noted this discrepancy between micro and macro-data, and have dealt with it in a similar manner.

Imputation of consumption. Data on consumption is rarer than data on income, and it is even rarer that both appear in micro datasets. In order to produce estimates of the distributive impact of consumption taxes for a wide range of countries, we set out an imputation model for consumption expenditure, based on household income and socio-economic characteristics.

Our database contains information on different countries over multiple years. Consumption data is not always available in every year in some countries, and others have no consumption data. The challenge is then to design a model that can be calibrated on available consumption data, and then used to impute consumption when missing. This model has to be independent of the country and the year in which it is applied.

3 Method and data

Starting from cross-country micro-level databases on income and consumption, we estimate the amount of consumption taxes paid by each household. This allows us to define the

[2] Mahler, Jesuit et al. (2018) opt for an intermediate method: they apply the "standard" statutory tax rate to household consumption, adjusted by the actual tax revenue calculated from OECD data. This approach is close to ours, except that the adjustment does not take into account that a considerable portion of the final consumption recorded in OECD data is not subject to taxation (e.g. rent, and some parts of public consumption such as health and education).

household tax-to-income ratio as the ratio of consumption taxes paid to household income. This section presents the method and the data used in order to produce consistent estimates of the distribution of tax-to-income ratios over different country-years.[3]

3.1 Data

We use micro-level data from surveys on income and consumption in order to calculate households' propensities to consume. Implicit tax rates on consumption are calculated via National Accounts data on consumption-tax revenue and household consumption. National Accounts data on household consumption and income are also used in order to scale the micro data.

The Luxembourg Income Study (LIS) is a cross-national data center that collects survey and administrative data on household income, wealth, consumption, and other socio-economic characteristics. In most countries, the micro data comes from national household budget surveys carried out by National Statistical Institutes. This data is then harmonized by the Luxembourg Income Study.[4]

The initial dataset includes over 200 country-years, with more than 30 countries over the 1967 to 2016 period. Household consumption data is only available in about one quarter of those datasets. When consumption is not available, we impute it, as described in Section 3.2.

From consumption data, whether observed or imputed, we then need additional macro-data in order to calculate consumption taxes at the household level. This macro data, taken from National Accounts data in each country-year, is used for two reasons: the first is to scale the micro data on consumption and expenditure so that it is consistent with National Accounts, and thus comparable across countries. The second is to calculate consumption-tax rates, based on tax revenues and total consumption. These data, available from OECD Statistics, are produced by National Statistical Institutes.[5] They cover not only OECD member countries, but also a number of other cooperating countries. This National Accounts data is not available for all of our country-years.

At the end of the day, we apply our method to 82 country-years for which we are able to calculate the effect of consumption taxes, covering 20 countries and 17 different years ranging from 1979 to 2013. We also use a lighter version of our simulation model, that is slightly less accurate but requires less data (in particular, it does not require rents data) in order to simulate consumption taxes on 44 additional country-years, making a total of 126 country-years, covering 26 countries. The complete list of countries and years in our analysis, as well as the estimation method used for each of them, appears in Appendix E.

[3] The code that was used to build our cross-country dataset, as well as the main indicators and percentile data presented in this paper are available online. They can be viewed and downloaded at https://doi.org/10.5281/zenodo.4291984.

[4] For more information, see http://www.lisdatacenter.org/about-lis/.

[5] See http://stats.oecd.org.

3.2 Method

We use microsimulation to produce estimates of the consumption taxes paid by households: this requires information on households' consumption expenditures as well as on the taxes on consumption. Having calculated the consumption taxes paid, we can define the tax-to-income ratio (TIR) for a household i in country c at year t:

$$TIR_{i,ct} = \frac{\tau_{ct} \cdot consumption_i}{disposable\ income_i} = \tau_{ct} \cdot prop_i \tag{1}$$

where τ_{ct} is the effective tax rate on consumption in country c at year t, and $prop_i$ is household i's propensity to consume, i.e. the share of disposable income that is actually spent.

The distribution of this measure according to income reveals the regressivity of consumption taxes in the country-year. The more the TIR falls with income, the more regressive are consumption taxes.

We can similarly define post-tax disposable income as the disposable income once consumption taxes have been paid:

$$\text{post-tax income}_i = (1 - TIR_{i,ct}) \cdot \text{disposable income}_i \tag{2}$$

We present below the method used to calculate the propensities to consume and make them consistent across country-years; we then define the implicit tax rates on consumption used to simulate consumption taxes. Last, we describe the imputation strategy when consumption data is missing.

3.2.1 Definition of the propensity to consume

Households' propensities to consume, which are the household-level term in Equation (1), represent the share of income that is effectively spent on goods and services. This is calculated at the household level using budget survey data, and is defined as the ratio of taxable consumption to disposable income. Thus, for every household i:

$$prop_i = \frac{taxable\ consumption_i}{disposable\ income_i}$$

Taxable consumption includes all monetary expenditure, but excludes rents, which are not subject to consumption taxes.[6] Rents represent a higher share of income at the lower end of the income distribution. Therefore, including rents in taxable consumption, as most international comparisons do, produces a slight overestimation of the regressive effect of consumption taxes (see Appendix B.2). While our core model sticks to this definition of taxable consumption, we also produce estimates for a larger set of countries where rents are not subtracted from consumption (results with the lighter model are presented in Appendix C).

Disposable income is the amount of money that households have available for spending after accounting for direct taxes, social-security contributions, and monetary transfers. All

[6] Loan repayments are considered as savings, not consumption.

monetary variables are equivalized according to the OECD standard: income and consumption are divided by the square root of the number of household members.

We can define the aggregate propensities to consume for each country c at year t, based on the aggregate values of consumption and income in National Accounts:

$$P_{c,t} = \frac{C_{c,t}}{I_{c,t}}$$

In order to render the distribution of the propensities to consume consistent with National Accounts, the micro-data on consumption and income is scaled according to these aggregates. After this homothetic transformation, we have:

$$\sum_{households\ i} taxable\ consumption_i = C_{c,t}$$
$$\sum_{households\ i} disposable\ income_i = I_{c,t}$$

The combination of these two types of data allows us to use micro-data to estimate the distribution of consumption over income, while the relative average levels of income and consumption are scaled to match National Accounts.[7] See Appendix A.1 for details of the economic aggregates used for this scaling.

3.2.2 Implicit effective tax rates

Consumption taxes include value-added-taxes (VAT), excise taxes, and other taxes on goods and services. To account for all of these taxes and their average respective weights in consumption, we calculate an implicit tax rate based on national tax revenue and domestic consumption. That is, we do not rely on the statutory rates but rather on tax revenue and consumption data from National Accounts.

For each country-year, we calculate the ratio of consumption-tax revenue to the amount of taxable consumption: this defines the average effective tax rate on consumption paid by households. For each country c at year t, this effective tax rate on consumption is

$$\tau_{c,t} = \frac{consumption\ tax\ revenue}{domestic\ monetary\ consumption}$$

This definition of implicit tax rates is based on previous research (Eurostat, 2016; Carey and Tchilinguirian, 2000; Mendoza, Razin, and Tesar, 1994), with some small improvements regarding the evaluation of domestic monetary consumption: we take into account the fact that the value of housing (whether paid by tenants or imputed to homeowners) and some part of public consumption do not produce consumption-tax revenue. See Appendix B.1 for details on the method used to calculate the tax rates.

[7] The method of homothetic scaling relies on the assumption that the under-reporting of consumption is approximately independent of individual characteristics.

This implicit tax rate, which averages all of the different rates on specific products, is thus the same for all households in a country-year. Based on the discussion in Section 2.1, we argue that the effect of different bundles of goods and intermediate VAT rates is of third order compared to the decreasing propensity to consume and the falling share of rent in income. We show in Appendix B.3 that consumption-tax rates that increase with income in proportions consistent with the literature have a smaller effect than decreasing propensities to consume and a falling share of rent in consumption.

3.2.3 The imputation of consumption

We use a regression model to impute consumption from household characteristics when consumption data is not available. The key issue here is that the distribution of consumption has to be imputed in entire country-year datasets in which there are no expenditure observations. We therefore require a model that is generic enough to be calibrated on some countries and then used for others: this, in particular, has to be independent of cross-country differences in median incomes.

We proceed by applying medianization to all of the monetary variables (including income, consumption and the value of housing). As such, all monetary variables are expressed as a proportion of the median values in country c at year t. The **medianized disposable income** of household i is thus:

$$\widehat{income}_i = \frac{income_i}{\text{median}_{c,t}(income)}$$

The underlying assumption is that the relations between medianized consumption and medianized income are similar across countries, conditional on other individual determinants of consumption. We apply a generalized linear model with a logarithmic link, where medianized consumption depends on medianized household disposable income, the medianized value of its housing and other socio-demographic variables X_i such as the number of household members and the ownership status of the household.[8]

$$\widehat{income}_i + \widehat{housing}_i + X_i \;\rightarrow\; \widehat{consumption}_i \tag{3}$$

The value of housing is defined as the total cost of housing, including rents and utilities, as well as imputed rents for occupying owners. The cost of housing often appears in income databases (it is present in 60% of our datasets), and is a very good proxy of the standard of living in addition to income.[9] While we here include this independent variable, it should be noted that models (such as our lighter model) without housing expenditure also produce quite

[8]See Appendix A.3 for an extensive description of the model. In this appendix, we also propose the simplest possible model (Model 0), which produces consumption values using only medianized income as the explanatory variable. This model, which produces satisfactory distributions of consumption, can be applied on datasets with little socio-demographic information, such as fiscal data.

[9]Moreover, while income can be subject to considerable transitory shocks that do not feed through to consumption, housing expenditure is smoothed, as consumption is expected to be.

satisfactory results (see Appendix B.4). Nevertheless, we only present here the results from observed consumption (if rents are specified) or imputations from the core model (except where indicated, such as the USA for which we have to use the lighter model of imputed consumption). For clarity, we show the results for the latest year available in each country.

4 Results

4.1 The accuracy of imputed consumption

We use the model above to impute consumption in every dataset where it is missing but which includes income and other relevant socio-economic determinants variables. The relationship between the propensity to consume and income in the imputed consumption data is very similar to that calculated using observed consumption data. *In fine*, the same model seems to be applicable over a wide range of country-years, and the shape and downward slopes of the curves fit the data well. Figure 1 shows the results from nine imputation models using cross-validation: each model excludes the country for which consumption is estimated. For example, imputed consumption in Australia in 2010 comes from a regression model estimated on every country but Australia. The imputation model also produces reliable estimates of the post-tax Gini coefficients (Figure 2).

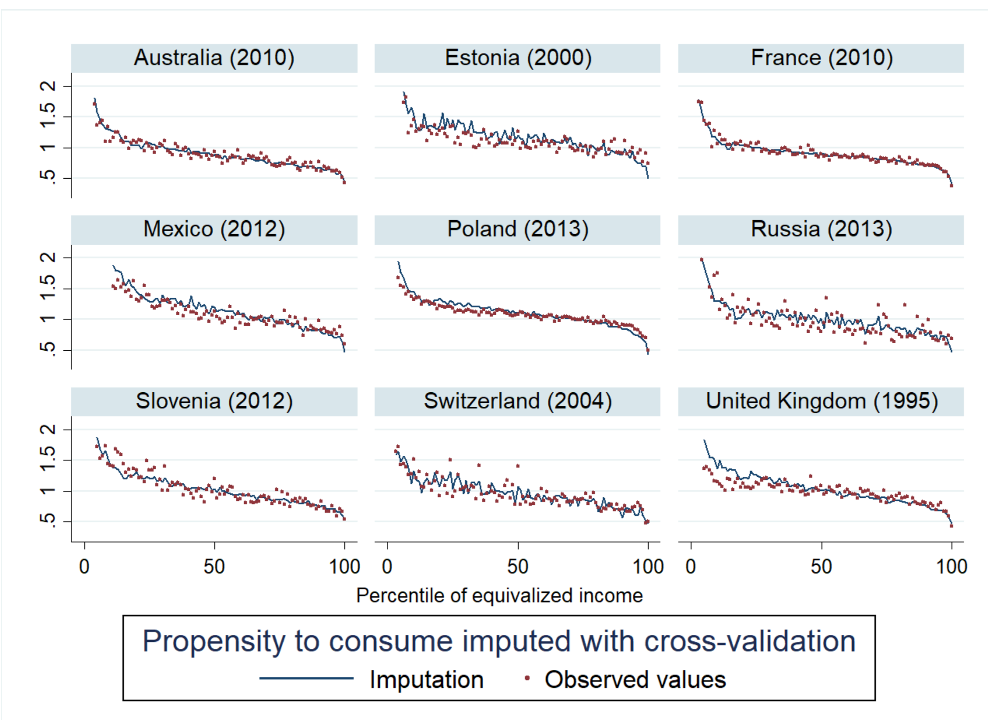

Figure 1: The estimated and observed propensities to consume, using cross-validation.

We show that including the total cost of housing as an independent variable significantly increases imputation quality.[10] This is what we do in the core model (Model 2) (see Appendix A.3). On average, models that include housing costs explain 33% more of the variance in consumption than those using only income (see Appendix B.4). However, for a few country-years this housing information is not available. In this case, we use imputations from the lighter model (Model 1), in order to increase the coverage of our international comparisons (see Appendix E for the list of the datasets used).

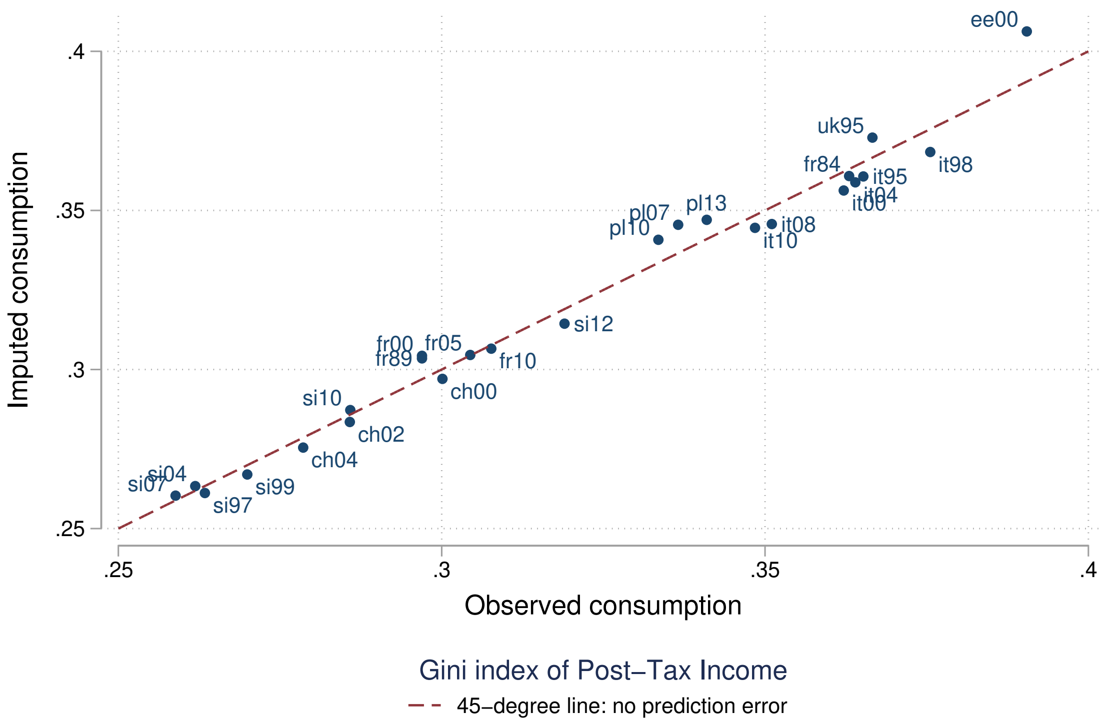

Figure 2: The observed and predicted Gini coefficients of post-consumption-tax income.

4.2 Results for consumption taxes

4.2.1 The tax-to-income ratio of the 10% richest is less than half that of the 10% poorest

The first results that we present here refer to the global tax-to-income ratios for each percentile of income. We find that, in all countries and years, propensities to consume decrease with the percentile of income. In general, consumption exceeds disposable income in the first percentiles, indicating significant dissaving. On the contrary, households in the highest percentiles of equivalized income consume about 50-60% of their income.

Tax-to-income ratios follow the same downward slope (Figure 3). Consumption taxes are therefore significantly regressive: in France in 2010, the poorest households paid over

[10] The total cost of housing includes both monetary and non-monetary expenditure (e.g. imputed rents).

20% of their disposable income in consumption taxes, while this figure was under 10% in the richest households. The curve in Germany is very similar, both in level and slope. The estimated regressivity is slightly lower in France, as the consumption-propensity curves cross at the middle of the income distribution. The slope is also similar in other countries, even though the levels are different: in Denmark, the tax-to-income ratio is over 30% for half of households, while it is under 10% for most households in the United States. In most countries, the tax-to-income ratio of the richest 10% is under half of that of the poorest 10%.

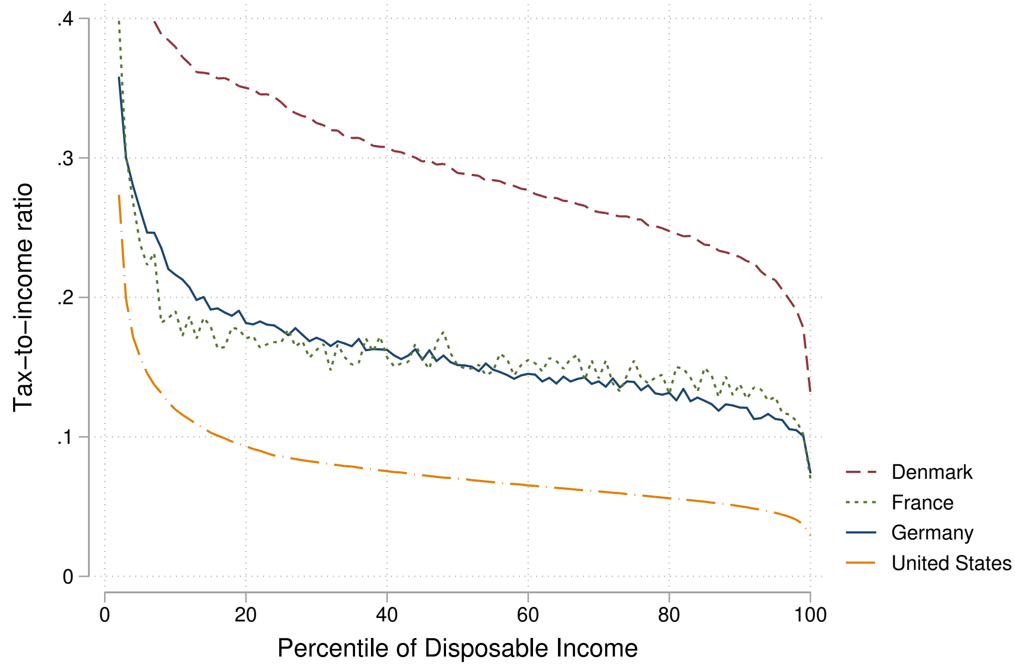

Figure 3: Tax-to-income ratios in Germany, Denmark, France and the United States.

Notes: The horizontal axis lists the percentiles of household disposable income. The vertical axis shows the tax-to-income ratios. The results for the US come from the lighter model.

4.2.2 The anti-redistributive effect of consumption taxes is between 1/5 and 1/3 of the size of direct redistribution

We measure the distributive effect of consumption taxes using synthetic measures of income inequality and progressivity. We first show that the effect of consumption taxes on income inequality is significant, but much smaller in magnitude than that of direct socio-fiscal redistribution. We then decompose this distributive effect into its horizontal and vertical components, and show that the largest part of the between-country differences come from the differences in consumption-tax rates.

We measure the distributive impact of consumption taxes by defining post-tax disposable income:

$$\begin{aligned}\text{post-tax income} &= \text{disposable income} - \text{consumption taxes}\\ &= \text{market income} + \text{transfers} - \text{direct taxes} - \text{consumption taxes}\end{aligned}$$

In Figure 4, we compare the Gini coefficients for four concepts of income: market income (income from labour, capital and pensions); gross income (market income after transfers); disposable income (gross income after direct taxes); and post-tax income (disposable income minus consumption taxes). These income concepts, similar to those in Guillaud, Olckers, and Zemmour (2020), allow for a sequential analysis of redistribution, and enable consistent comparisons of redistribution over the whole population between countries with different social security and pension regimes.[11]

Inequality is lower for post-tax income than for market income, and higher than for disposable income. Consumption taxes produce greater inequality, but of smaller size than the reduced inequality due to the remainder of the socio-fiscal system. In almost all countries, the Gini coefficient of post-tax income is closer to that of disposable income than to that of market income.[12]

We define the redistributive effect of consumption taxes as the difference in income inequality between disposable and post-tax disposable income, using the following index of effective redistribution:

$$\Delta G = G_{dhi} - G_{dhi-tax}$$

where G_{dhi} ($G_{dhi-tax}$) is the Gini coefficient on pre-tax (post-tax) disposable income. This measure is positive for a progressive tax and negative for a regressive tax. We expect a negative value for consumption taxes, corresponding to greater income inequality.

Figure 5 shows that the anti-redistributive effect of consumption taxes is between 0.010 and 0.056 Gini points, with the figure for most countries being in a range between 0.015 and 0.035. The anti-redistributive effect is thus significant, and large enough to change the income-inequality ranking between countries with similar levels of disposable-income inequality but different distributions of the propensities to consume and consumption-tax rates. For example, the Netherlands has greater disposable-income inequality than Denmark (Gini figures of 0.261 and 0.251), but post-tax income inequality is lower (0.288 and 0.298: see Figure 4). This is mainly due to the high VAT rate in Denmark (25%, with only few reduced rates), while that rate in the Netherlands is lower (21%, with a 9% reduced rate applied to many common products).

[11]These income concepts are defined to avoid common biases in cross-country comparisons: i) Market income includes all types of pension, so that that pensioners in public-pension countries do not appear artificially poor at the Market income stage, and ii) Pre-tax labour income includes imputed employer contributions (as the divide between employer and employee contribution is largely artificial, and varies greatly across countries, so that including only employee contributions in labour income significantly biases the measure).

[12]The sole exceptions are countries that have high initial income inequality (and thus very regressive consumption taxes) combined with either little redistribution via direct taxes and transfers or high consumption tax rates.

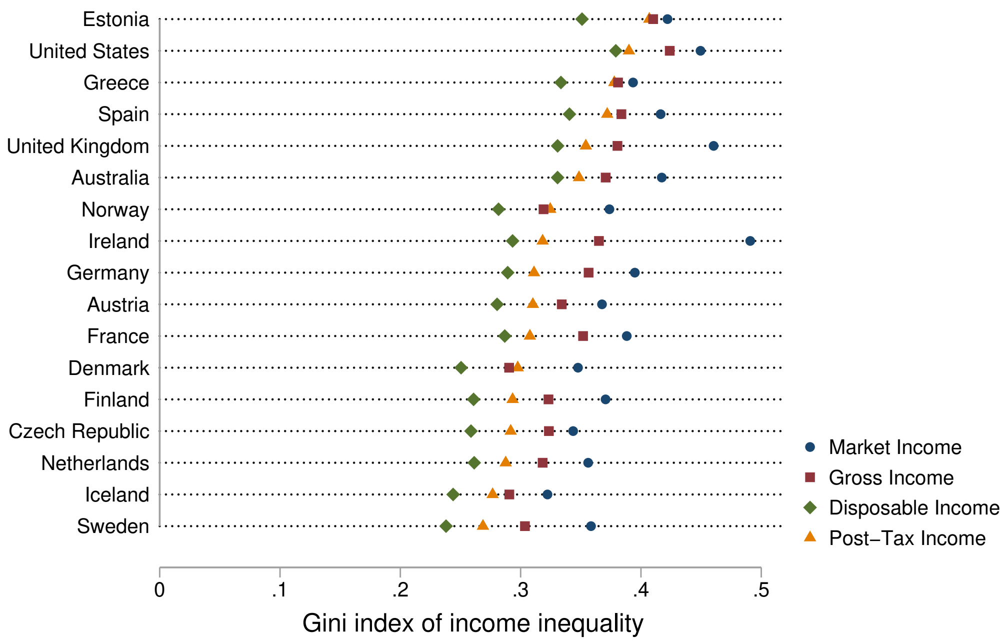

Figure 4: The Gini coefficients on market, gross, disposable and post-tax income.

Note: Market, gross and disposable income are defined as in Guillaud, Olckers, and Zemmour (2020). Results for the United States, Australia, Norway and Sweden come from the lighter model.

On average in our sample, the increase in income inequality due to consumption taxes is equal to one third of the total redistribution from taxes and transfers. In a few countries such as Estonia and Greece, where redistribution is quite low, the increase in inequality exceeds half of the total direct redistribution effect. In others, such as Australia, France, Germany, Ireland, the United Kingdom and the United States, it is under one quarter of total direct redistribution. Consumption taxes exceed half of the redistribution from direct taxes, and sometimes even all of the redistribution from these taxes in countries with low direct taxes (such as Ireland and the United Kingdom) or high consumption taxes (such as Denmark or Norway).

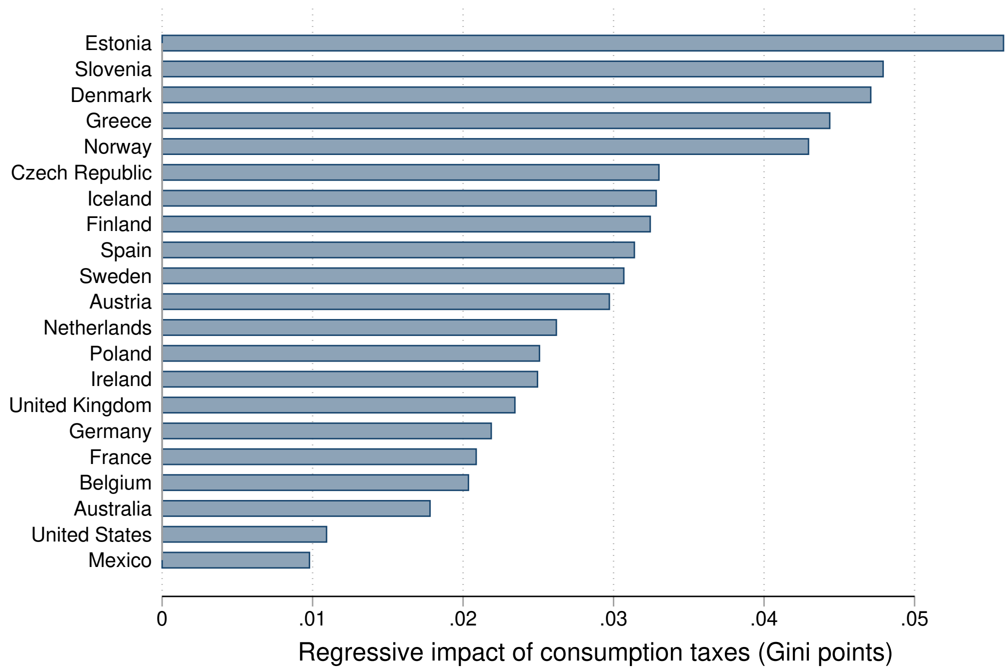

Figure 5: The estimated rise in the Gini coefficient due to consumption taxes.

Note: The results for the United States, Australia, Norway and Sweden come from the lighter model.

4.2.3 The redistribution effect is mainly driven by the tax rate

We here investigate the drivers of the different redistributive effects of consumption taxes across countries: Are these completely explained by the average tax rate, as in the example of Denmark and the Netherlands above? Or do they also reflect more- or less-unequal distributions of the propensities to consume? To answer these questions, we decompose the indicator of the redistributive effect.

Effective redistribution can be decomposed into vertical redistribution, measured by the Reynolds-Smolensky index RS, and horizontal redistribution, measured by the reranking index Re (see Appendix D.1 for details):[13]

$$\Delta G = RS - Re$$

While the former measures the redistribution due to the regressivity of taxes, the latter is orthogonal to the income distribution: it represents the redistribution effected between households with the same disposable income. In practice, vertical redistribution constitutes most of the redistributive effect of consumption taxes (see Figure D.1.a).

[13]Under these definitions, the Reynolds-Smolensky and Kakwani indices are negative if there is an increase in income inequality (the redistributive effect is negative). We however present the absolute values of these coefficients in the following figures.

As shown in Kakwani (1977), the RS index is itself the product of two terms, respectively linked to the regressive nature of the tax and its average rate:

$$RS = K \cdot \frac{TIR}{1 - TIR} \tag{4}$$

Here TIR is the global tax-to-income ratio, defined as average consumption taxes paid over average disposable income, and K is the Kakwani index, a measure of the regressivity of consumption taxes (see Appendix D.2). Vertical redistribution can then be decomposed into one distributional parameter and one macro-level parameter. The Kakwani index is determined by the population pattern of consumption and income, and is not a policy parameter. On the other hand, the tax rate can be tuned by the policy-maker.

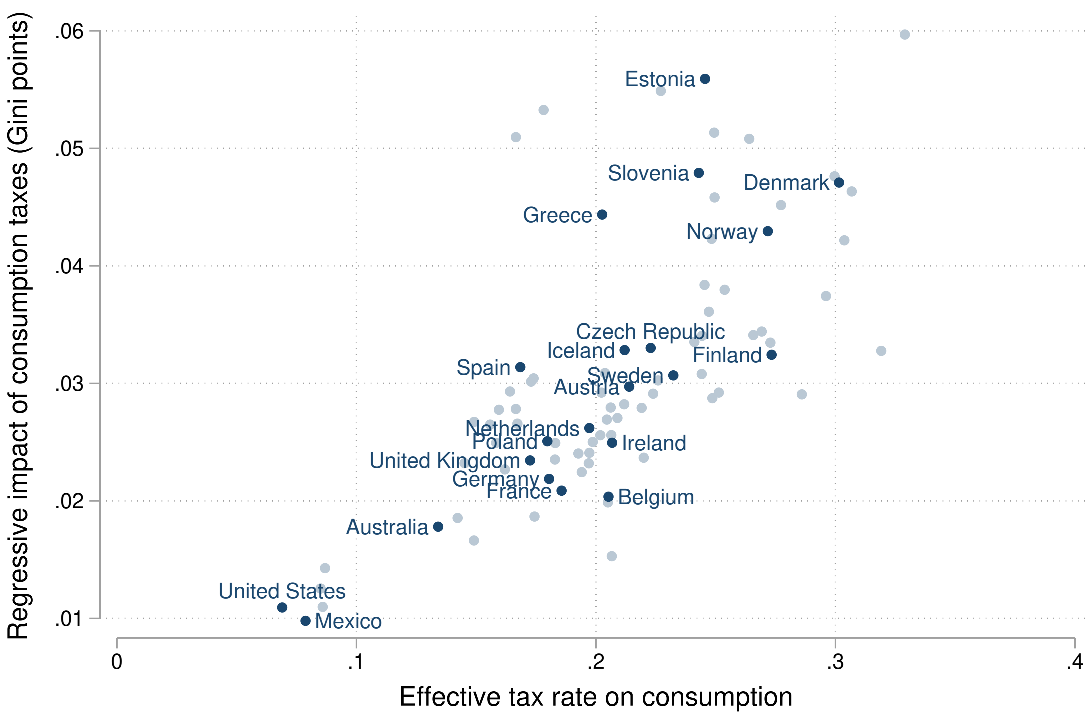

Figure 6: The redistributive impact is mainly driven by the tax rate.

Notes: The horizontal axis shows the effective tax rate on consumption. The vertical axis shows the regressive impact of consumption taxes, measured in Gini points. Only the last year for each country is shown in plain color, other years are shown with transparency. The results for the United States, Australia, Norway and Sweden come from the lighter model.

We can see in Figure 6 that the tax rate explains most of the redistributive effect between countries. Comparing Denmark to the USA, for instance, one can see that the sharp increase in inequality in Denmark (+0.05 Gini points) is five times that in the USA (+0.01 Gini points): this difference is driven by a high average tax rate on consumption in Denmark (30%), which amounts almost five times the effective tax rate in the USA (7%).

On the other hand, the differences in redistribution between countries with the same average rate can be explained by different levels of tax regressivity. In Figure 7, it can be seen that the significant anti-redistributive impact of consumption taxes in Slovenia, for example, reflects the regressive nature of the tax. While the effective tax rate is of the same order as that in Sweden, for instance, their substantial income inequality produces considerable inequality in consumption and saving rates.

In practice, we see that the Kakwani index of regressivity varies only little, as compared to the variation in global TIRs. We calculate the Kakwani indices in all the datasets with consumption information, whether or not consumption taxes can be computed (77 country-years). Approximately half of the Kakwani indices lie between -0.10 and -0.15, and almost all lie between -0.05 and -0.20 (see Figure D.2.a). Vertical redistribution is then mainly driven by the tax rate, as the Kakwani indices are fairly similar to each other.[14]

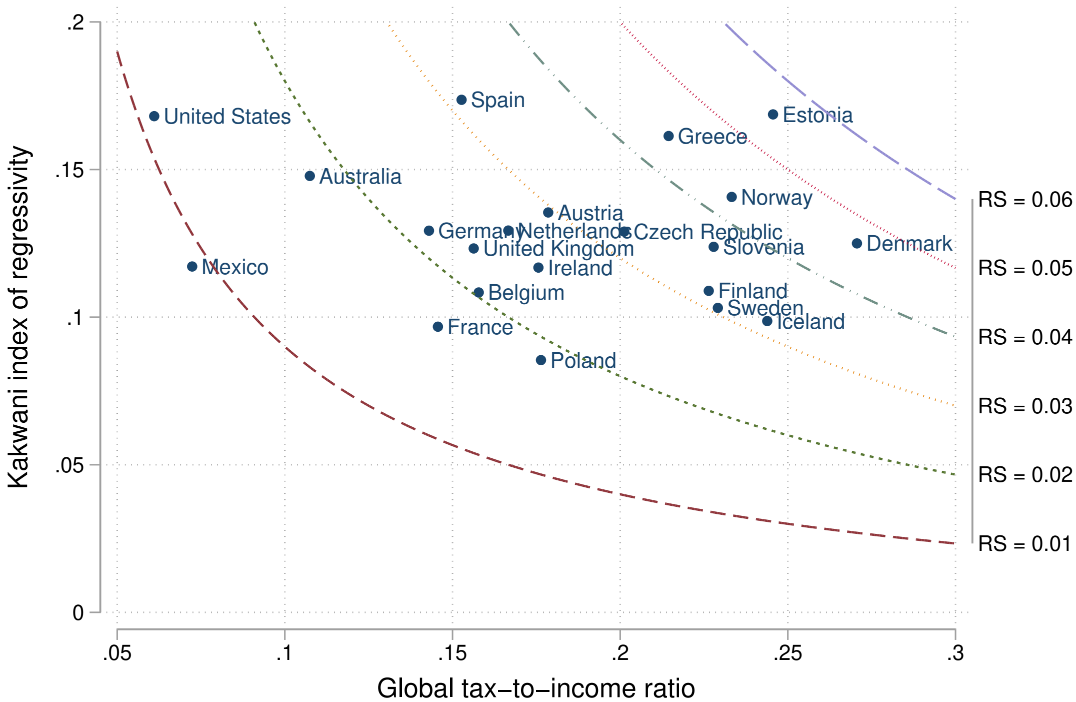

Figure 7: The Kakwani index of regressivity varies only little.

Notes: The horizontal axis shows the global tax-to-income ratios. The vertical axis shows the Kakwani indices. The curves are isolines of vertical redistribution (the Reynolds-Smolensky index): the further to the North-East of the graph, the greater the effect of consumption tax on inequality. The results for the United States, Australia, Norway and Sweden come from the lighter model.

[14]Imputation produces a similar range of Kakwani indices in the datasets without consumption information: most lie between -0.10 and -0.15. The absolute difference between the Kakwani index calculated from imputed data and that from observed data is under 0.055 in 90% of country-years, and larger errors are found only in high income-inequality countries such as South Africa, India and Mexico.

5 Discussion

Consumption taxes raise considerable revenue, but add to income inequality. The distributive effect of consumption taxes is a surprising blind spot in international comparisons of redistribution. No research has undertaken micro-data work over a substantial number of countries (26) and years (25), as we do here. We have evaluated the impact of consumption taxes on inequality to see how this tax may counter the redistribution resulting from other social and fiscal tools.

This analysis is a continuation of previous research decomposing the distributive impact of direct taxes and transfers across developed economies, showing that both tax progressivity and the average tax rate have substantial impacts on redistribution (Guillaud, Olckers, and Zemmour, 2020). We add another block to the analysis of tax and transfer systems, by taking into account the effect of indirect taxation on the distribution of net disposable income. We also present a tool for the imputation of the distribution of consumption when this data is not directly available. Our model can be used on any micro-level dataset that contains only income, or income and standard socio-economic variables. We consider this to be a major contribution to the field, as it solves the issue of including consumption taxes in international or intertemporal comparisons of monetary redistribution.

We have shown that the anti-redistributive impact of consumption taxes (including value-added-taxes, sales taxes, excise taxes, and taxes on specific goods and services) is limited, and in any case far from offsetts the positive effect of direct taxes and transfers on inequality-reduction. The impact of consumption taxes on inequality is determined by two variables of a different nature: a behavioral variable, the propensity to consume (which falls with income in all countries, with little international variation), and a more political one, which is the average effective rate (with much greater variation in our sample, in the range of one to three). We show that the redistributive effect of consumption taxes varies greatly from one country to another due to the political parameter of the average rate. As such, countries with significant anti-redistributive effects of consumption taxes are those that have chosen to implement high tax rates. Denmark is a sound example of this kind of choice, which allows it to fund a large welfare state.

As has already been noted in the literature, countries with high levels of tax revenue and redistribution (in cash and in kind) do not put all of the tax burden on the upper end of the income distribution, and tend to have moderate tax progressivity (Kato, 2003; Lindert, 2004; Guillaud, Olckers, and Zemmour, 2020). The analysis of tax consumption reinforces this diagnosis. Even so, consumption taxes can be part of redistributive policies at the national level: under loose assumptions regarding the distribution of public goods, greater public good or service provision financed by an increase in consumption taxes will in fact increase equality among households (as the lower inequality due to public goods will offset the regressivity of the consumption tax that helps finance them).

References

Blasco, Julien, Elvire Guillaud, and Michaël Zemmour. 2020. "Data on the Impact of Consumption Taxes on Income Inequality." https://doi.org/10.5281/zenodo.4291984.

Boutchenik, Béatrice. 2015. "Les effets redistributifs de la taxe sur la valeur ajoutée." Tech. rep., Conseil des prélèvements obligatoires.

Bozio, Antoine, Bertrand Garbinti, Jonathan Goupille-Lebret, Malka Guillot, and Thomas Piketty. 2018. "Inequality and redistribution in France, 1990-2018: Evidence from post-tax distributional national accounts." *WID.world Working Paper Series* 2018/10.

Carey, David and Harry Tchilinguirian. 2000. "Average effective tax rates on capital, labour and consumption." *OECD Economics Department Working Paper* 258.

Causa, Orsetta and Mikkel Hermansen. 2017. "Income redistribution through taxes and transfers across OECD countries." *OECD Economics Department Working Papers* 1453.

Dauvergne, Roy. 2012. *Qui paye les taxes indirectes en France ?* Master's thesis, Paris School of Economics.

Decoster, André, Jason Loughrey, Cathal O'Donoghue, and Dirk Verwerft. 2010. "How regressive are indirect taxes? A microsimulation analysis for five European countries." *Journal of Policy Analysis and Management* 29 (2):326–350.

Eurostat. 2016. *Taxation Trends in the European Union*. Publications Office of the European Union.

Figari, Francesco and Alari Paulus. 2015. "The distributional effects of taxes and transfers under alternative income concepts: The importance of three "I" s." *Public Finance Review* 43 (3):347–372.

Guillaud, Elvire, Matthew Olckers, and Michaël Zemmour. 2020. "Four levers of redistribution: The impact of tax and transfer systems on inequality reduction." *Review of Income and Wealth* 66 (2):444–466.

Kakwani, Nanak C. 1977. "Measurement of tax progressivity: An international comparison." *Economic Journal* 87 (345):71–80.

Kato, Junko. 2003. *Regressive Taxation and the Welfare State: Path Dependence and Policy Diffusion*. Cambridge University Press.

Lindert, Peter H. 2004. *Growing Public: Volume 1, the Story: Social Spending and Economic Growth since the Eighteenth Century*. Cambridge University Press.

LIS. 2019. "Luxembourg Income Study (LIS) Database." http://www.lisdatacenter.org. (multiple countries; accessed May to August 2017 and June to December 2019). Luxembourg: LIS.

Mahler, Vincent A, David K Jesuit et al. 2018. “Indirect taxes and government inequality reduction: A cross-national analysis of the developed world.” *Journal of Income Distribution* 26 (2):1–26.

Mendoza, Enrique G, Assaf Razin, and Linda L Tesar. 1994. “Effective tax rates in macroeconomics: Cross-country estimates of tax rates on factor incomes and consumption.” *Journal of Monetary Economics* 34 (3):297–323.

O’Donoghue, Cathal, Massimo Baldini, and Daniela Mantovani. 2004. “Modelling the redistributive impact of indirect taxes in Europe: an application of EUROMOD.” *EUROMOD Working Paper* EM7/01.

Piketty, Thomas and Emmanuel Saez. 2007. “How progressive is the US federal tax system? A historical and international perspective.” *Journal of Economic Perspectives* 21 (1):3–24.

Piketty, Thomas, Emmanuel Saez, and Gabriel Zucman. 2018. “Distributional national accounts: Methods and estimates for the United States.” *Quarterly Journal of Economics* 133 (2):553–609.

Ruiz, Nicolas and Alain Trannoy. 2008. “Le caractère régressif des taxes indirectes : les enseignements d’un modèle de microsimulation.” *Economie et statistique* 413 (1):21–46.

Savage, Michael. 2017. “Integrated modelling of the impact of direct and indirect taxes using complementary datasets.” *The Economic and Social Review* 48 (2):171–205.

Warren, Neil. 2008. “A review of studies on the distributional impact of consumption taxes in OECD countries.” *OECD Social, Employment and Migration Working Paper* 64.

Appendix

A Method

The code that was used to build our cross-country dataset, as well as the main indicators and percentile data presented in this paper are available online. They can be viewed and downloaded at `https://doi.org/10.5281/zenodo.4291984`. If reused, data shall be cited as (Blasco, Guillaud, and Zemmour, 2020).

A.1 Scaling with National Accounts

The second term in Equation (1) reflects households' propensities to consume. Taxable consumption includes all monetary expenditure, excluding rents, as these are not subject to consumption taxes. Moreover, loan repayments are considered as savings, not consumption. We can write

$$prop_i = \frac{hmc_i - rents_i}{dhi_i}$$

where hmc is household monetary consumption, $rents$ is household expenditure on rents and dhi is disposable household income.

Disposable income is the amount of money that households have available for spending after income taxes, social-security contributions and transfers have been accounted for.

After some pre-processing of the data (equivalization, bottom-coding), the propensities to consume are scaled according to National Accounts data. In order to carry out international comparisons, the micro-data is transformed to reflect national-level consumption and income. Conceptually, this means that micro-data are used to obtain the shape of consumption (its distribution as a function of income), while the total levels of income and consumption are matched to National Accounts.

$$scaled\ prop_{c,t,i} = scaling_{c,t} \cdot prop_{c,t,i}$$

$$scaling_{c,t} = \frac{CH - R}{I - R_{imputed}} \cdot \frac{\sum_i dhi_i}{\sum_i hmc_i - rents_i}$$

where:

- CH is household final consumption expenditure[15]
- $R = R_{actual} + R_{imputed}$ are the actual and imputed housing rents

[15] When this figure was not available, we used household expenditure and income including those of non-profit institutions serving households.

- I is household gross disposable income
- $R_{imputed}$ are imputed rents for occupying owners

In National Accounts, the housing services that owners produce for themselves are included in both consumption expenditure and household income. We thus remove these terms from the scaling factor of the propensities to consume. Where rents are not separable between actual and imputed rents, an average correction coefficient is applied.

A.2 The definition of the effective tax rate

We define tax rates implicitly: instead of using official statutory rates that do not reflect the average rate at which households' consumption is taxed, we use tax revenue and consumption data from National Accounts. For each country-year, we calculate the ratio of consumption-tax revenue to the amount of taxable consumption. This defines the average effective tax rate on consumption paid by households.

We rely on previous research on implicit tax rates (see Appendix B.1), and try to improve the existing definitions by taking the effective tax rate as follows:

$$\tau_{c,t} = \frac{consumption - tax\ revenue}{C - CGW - R}$$

where *consumption – tax revenue* includes all revenue from consumption taxes, including value-added-taxes (or sales taxes, if applicable), excise taxes, taxes on specific services, etc. According to the nomenclature in `stats.oecd.org`, this includes:

- General taxes on goods and services (including VAT)
- Taxes on specific goods and services
  - Excise taxes
  - Profits of fiscal monopolies
  - Customs and import duties
  - Taxes on specific services
  - Other taxes on specific goods and services
- Taxes on the use of goods and performances

C is the total final consumption expenditure (private consumption and the consumption of general government). The CGW figure corresponds to the wages of the employees paid by the general government, and $R = R_{actual} + R_{imputed}$ are the actual and imputed housing rents.

It is important to note that the "final consumption expenditure of households" includes the actual rents that tenants pay and the imputed rents that occupying owners pay themselves. This should be removed from the denominator, as it generates no tax revenue.

The government does not purchase its entire consumption. In order to account for the share of its consumption that is self-produced (and thus does not generate tax revenue), we remove the term CGW from the denominator, as per Mendoza, Razin, and Tesar (1994).

For each country-year, we calculate tax rates according to the definition above, as well as two common definitions in the literature (see Appendix B.1 for the values and the comparison with other definitions).

We can then calculate the tax ratio for each household i in country c at year y:

$$TIR_i = \tau_{c,t} \cdot scaled\ prop_{c,t,i} = \tau_{c,t} \cdot \underbrace{\frac{CH - R}{I - R_{imputed}}}_{macro\ data} \cdot \underbrace{\frac{\sum_i dhi_i}{\sum_i hmc_i - rents_i} \cdot prop_i}_{micro\ data}$$

A.3 The consumption-imputation model

We construct three nested models, depending on the information available in the dataset.[16] The first is a generalized linear model where the only explanatory variables are household medianized disposable income and a dummy variable $\mathbb{1}_{nonpov}$ for the household being above the monetary-poverty threshold. This latter is defined as 60% of median equivalized income. Given our medianization, a household is poor if its medianized disposable income is below 0.6. We add this variable to reflect that, at the lowest income levels, consumption tends to be less correlated (or even uncorrelated) with income. In order to ensure the continuity of the consumption function with income, this dummy variable is multiplied by $\log(\widehat{dhi}) - \log(0.6)$, which equals zero when the income of the household is exactly equal to the monetary-poverty threshold. The estimated equation is thus:

$$\begin{gathered} \log\left(\mathbb{E}\ \widehat{hmc}\right) = \alpha_0 + \beta_0 \log(\widehat{dhi}) + \beta_1 \mathbb{1}_{nonpov}\left(\log(\widehat{dhi}) - \log(0.6)\right), \\ \widehat{hmc} \sim \text{Normal} \end{gathered} \tag{Model 0}$$

We do not use this first model (Model 0) but we make the resulting coefficients available, as it can be used to produce a satisfactory distribution of consumption on any other national dataset that contains few socio-demographic variables other than income, such as fiscal data for example. The next model contains the same explanatory variables, as well as a small number of socio-demographic determinants (the number of household members and the conjugal status of the head of the household). We estimate the following equation.

$$\begin{gathered} \log\left(\mathbb{E}\ \widehat{hmc}\right) = \alpha_0 + \beta_0 \log(\widehat{dhi}) + \beta_1 \mathbb{1}_{nonpov}\left(\log(\widehat{dhi}) - \log(0.6)\right) + \Gamma^\intercal X_1, \\ \widehat{hmc} \sim \text{Normal} \end{gathered} \tag{Model 1}$$

In the core model (Model 2), we add the ownership status of the household and another monetary variable, the total imputed or effective cost of housing. This can correspond to the actual housing cost for the household or the non-monetary consumption for housing services

[16] To reduce heterogeneity between countries, several countries with the most-extreme income distributions were removed from the training sample. These are countries with high income inequality or very low median income, as compared to the rest of the sample. The countries that are used in the regression are listed in Appendix E.

(e.g. imputed rents for occupying owners). This variable is much more widely-available in household surveys than total consumption, and is a good proxy for household standard of living. It should therefore provide valuable information regarding household consumption. The second model is then:

$$\begin{aligned} \log\left(\mathbb{E}\,\widehat{hmc}\right) &= \alpha_0 + \beta_0 \log(\widehat{dhi}) + \beta_1 \mathbb{1}_{nonpov}\left(\log(\widehat{dhi}) - \log(0.6)\right) \\ &\quad + \delta \log(\widehat{housing}) + \Theta^{\intercal} X_2, \\ \widehat{hmc} &\sim \text{Normal} \end{aligned} \tag{Model 2}$$

The results of these three models appear in Table A.3.a.

We use the regression results to impute medianized values of household monetary consumption. These are then scaled using National Accounts data in order to be comparable with the observed values, as in Section 3.2.1.

Table A.3.a: Coefficients (with standard errors) of the regression models for the imputation of medianized consumption. The models are Generalized Linear Models with logarithmic link and Gaussian error.

Variable	Model 0		Model 1 "Lighter model"		Model 2 "Core model"	
Constant	**-7.68**	(0.39)	**-2.02**	(0.51)	**-16.08**	(0.61)
Logarithm of medianized income	**27.92**	(0.66)	**26.61**	(0.66)	**4.61**	(0.66)
Logarithm of medianized income interacted with income above poverty threshold	**29.89**	(0.70)	**30.83**	(0.69)	**41.06**	(0.71)
Logarithm of housing costs[1]					**32.75**	(0.14)
Number of household members (Ref. = *1 member*)						
2 members			**-5.16**	(0.33)	-0.50	(0.45)
3 members			**-4.64**	(0.33)	**2.76**	(0.46)
4 members			**-3.66**	(0.33)	**4.45**	(0.46
5 members			**-6.64**	(0.36)	**2.87**	(0.48)
6 members or more			**-9.57**	(0.37)	**2.64**	(0.50)
Conjugal status of head of household (Ref. = *Single*)						
Living with a partner			**-6.60**	(0.21)	**-7.60**	(0.28)
Ownership status of household (Ref. = *Resident owner*)						
Rented housing					**5.07**	(0.24)
Free housing					**-3.12**	(0.54)
Included datasets	47		47		30	
Individual-level observations	626,258		626,258		305,083	

[1] Housing costs include imputed rents for resident owners.
All coefficients and standard errors are multiplied by 100 for ease of reading.
Coefficients in **bold** are significant at the 0.05 level.

B Robustness checks

B.1 Different definitions of the effective tax rate

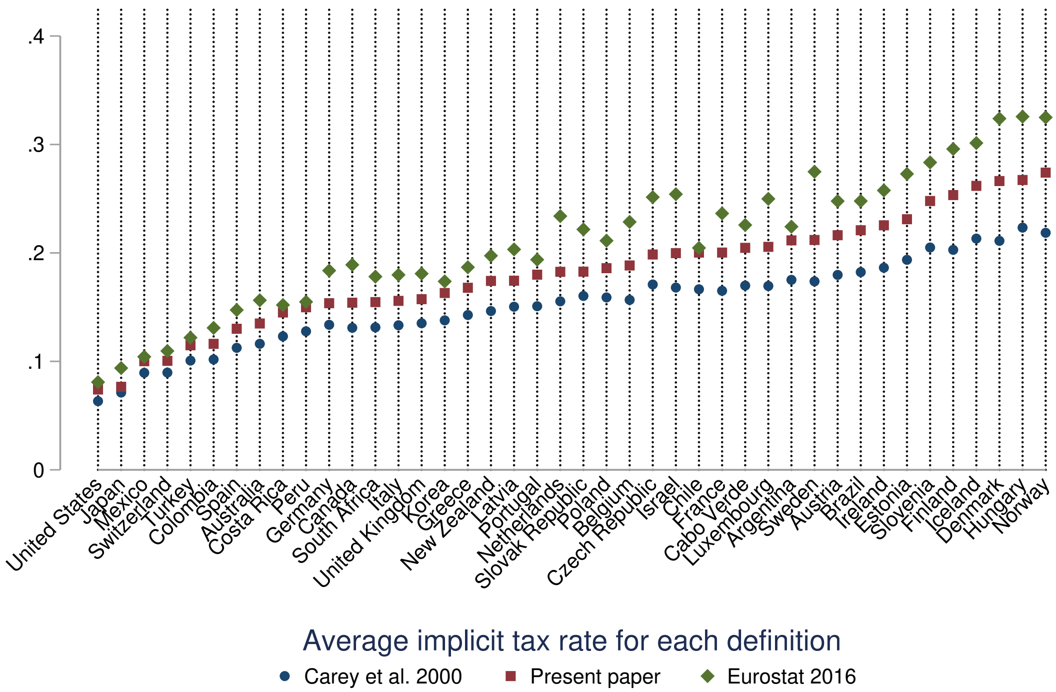

Figure B.1.a: Average implicit tax rates on consumption in each country.

There are two main definitions of the implicit effective consumption tax rate in the economic literature, as described in Eurostat (2016) and Carey and Tchilinguirian (2000), both inspired by Mendoza, Razin, and Tesar (1994). We draw on these contributions in order to propose the following definition:

$$\tau_{c,t} = \frac{consumption - tax\ revenue}{C - CGW - R}$$

where *consumption – tax revenue* includes all revenue from consumption taxes, including value-added-taxes (or sales taxes if applicable), excise taxes, taxes on specific services, etc. $C = CP + CG$ is total final consumption expenditure (private consumption and the consumption of general government). CGW are the wages of employees paid by the general government, and $R = R_{actual} + R_{imputed} =$ are actual and imputed housing rents.

The different possible definitions of the implicit tax rates are based on different definitions of taxable consumption. For example, the definition in Eurostat (2016) relies on a narrower taxable base, covering only private consumption

$$\tau_{c,t} = \frac{consumption - tax\ revenue}{CP} \tag{5}$$

while the definition in Carey and Tchilinguirian (2000) considers a broader definition, over all consumption

$$\tau_{c,t} = \frac{consumption - tax\ revenue}{C} \tag{6}$$

The choice of whether to remove rents from the denominator depends on the definition of taxable consumption in the micro-data. As we account for rents not being subject to consumption taxes by removing them from the micro-data on consumption, we subtract rents from the denominator of the implicit tax rate. If we do the same for the two alternative definitions described above, our definition of the implicit consumption tax rate is thus structurally bounded above by the tax rate in definition (5) and below by that in definition (6) (see Figure B.1.a). These alternative definitions can be used for robustness checks. When the tax rate cannot be calculated according to our definition due to missing values, we impute the rates using a regression model based on the other two rates.

B.2 Estimated regressivity is mitigated when taking rents into account

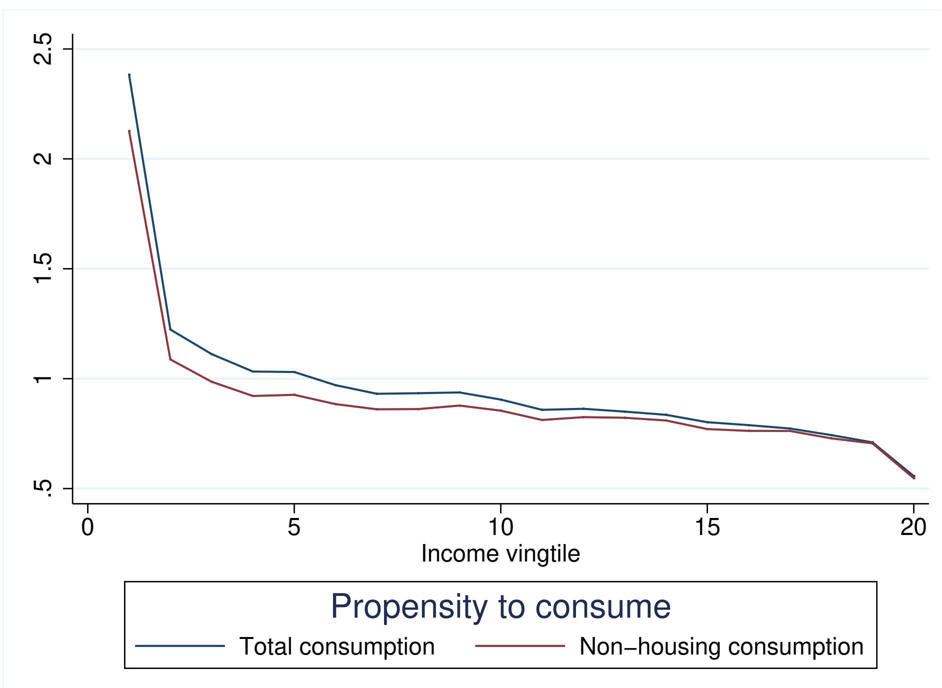

Figure B.2.a: Housing rents represent a higher share of consumption at the bottom of the income distribution (e.g. France 2010 as shown here)

Our method allows us to account for housing rents not being subject to consumption taxes. Housing rents are an important part of household consumption, and represent a higher share of consumption for poorer households (Figure B.2.a). As a result, the downward slope in the propensities to consume becomes less pronounced when rents are removed from

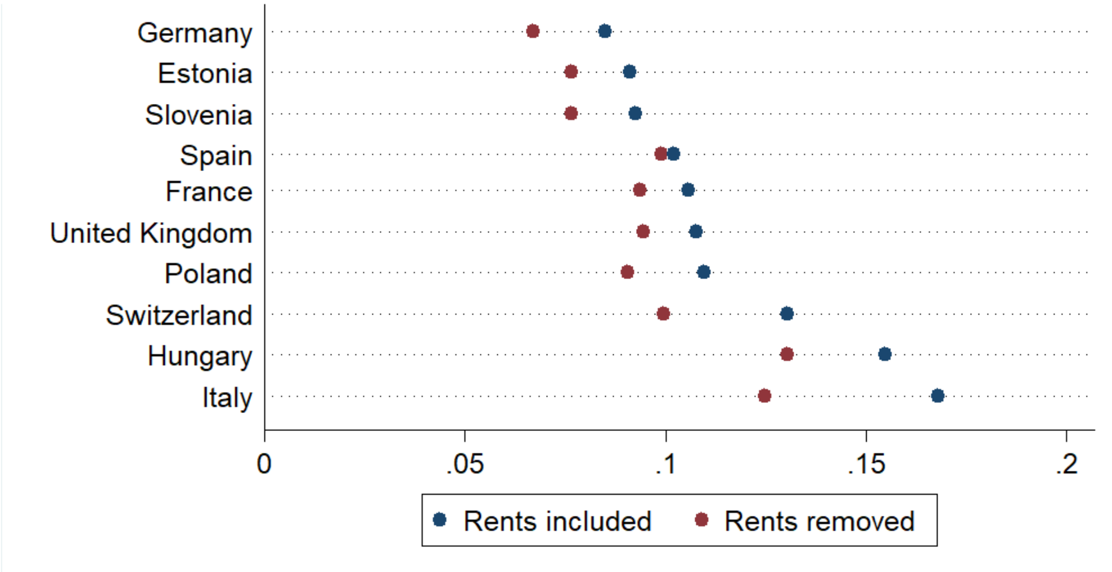

Figure B.2.b: The mean value of the Kakwani index according to whether taxable consumption includes housing rents

total consumption. We can therefore conclude that micro-simulation methods that apply tax rates to total consumption (including housing rents) somewhat overestimate the regressivity of consumption taxes.

In order to maximize our country-year coverage, we define another version of the effective tax rate, where actual housing rents are not deducted from private consumption in the denominator. This definition is used in our lighter model, where micro-data on consumption is not separable between housing rents and other consumption. This lower rate will be applied to a higher consumption figure.

$$\tau_{wr} = \frac{consumption - tax\ revenue}{CP - R_{imputed} + CG - CGW}$$

As shown in Figure B.2.b, estimated regressivity is lower when housing rents are taken into account, and removed from consumption: the absolute value of the Kakwani index of regressivity, and thus the anti-redistributive effect, is reduced by up to 20% in some countries.

B.3 Progressive consumption-tax rates: A test of the bundle effect

Many countries enforce reduced VAT rates for some goods, either in order to boost certain economic sectors or mitigate the burden of consumption taxes on the least-affluent households. On the other hand, some goods, such as oil or alcohol, are more heavily taxed.

These variations in statutory tax rates can affect the overall progressivity of the tax, as baskets of goods differ across the income distribution. As a robustness check, we consider two scenarios where the effective tax rate on consumption rises with income. These situations would occur were tax rates specifically designed to make consumption taxes more progressive, as is generally the case for VAT.[17] In these scenarios there is a deviation from the median effective tax rate that depends linearly on the income percentile. In the intermediate scenario, the first percentile of income enjoys a 0.5 percentage-point lower effective tax rate than the median household, while the last percentile faces a 0.5-point higher tax rate, so that there is a one percentage-point difference between the effective tax rates for the poorest and richest households. We also consider a more-extreme scenario where this gap between the effective consumption tax rates is two percentage points. Those gaps are in line with national case studies that calculate effective tax rates depending on income.

Figure B.3.a shows the distribution of tax-to-income ratios by percentiles of income. This allows us to compare different situations, from the least to the most progressive. In the first situation, we assume that all goods and services (including housing) are taxed at the same effective tax rates for all households. The regressive pattern then comes exclusively from the propensity to consume. In the second curve, consumption taxes are applied only to non-rent consumption, which mitigates the regressive pattern (as seen in Appendix B.2). The third and fourth curves introduce progressive consumption taxes according to the intermediate and more-extreme scenarios.

The curves turn out to be very similar: this confirms that the "decreasing propensity to consume" is the first-order effect. Simulating aggregate consumption for each household allows us to capture most of the regressivity of consumption taxes. When we add that rents are not uniformly distributed, but rather more important at the bottom of the income distribution, the regressive outcome estimated with a uniform effective tax rate is even closer to the two progressive tax-rate scenarios.

The first and last curves yield the upper and lower bounds for the regressivity of consumption taxes. We know that using the same effective tax rate for every household, and not considering that housing is exempt from consumption taxes, actually overestimates the regressivity of consumption taxes. On the other hand, taking housing rents into account and applying strong progressivity to effective consumption tax rates produces a lower bound for the regressive effect. We can see that even in the extreme scenario tax-to-income ratios remain strongly regressive.

The same can be said regarding measures of redistribution and inequality. Figure B.3.b shows that a constant effective tax rate on total consumption produces the highest post-tax Gini coefficient (overestimating actual income inequality). Adding housing-rent information captures most of the difference between the latter and both progressive scenarios. In every case, all of these measures of post-tax income inequality are much closer to one another than to the inequality in disposable income. Qualitatively, the anti-redistributive effect continues to be significant, and the first and simplest measure provides a quite tight upper bound.

[17] Excise taxes, on the other hand, are generally regressive.

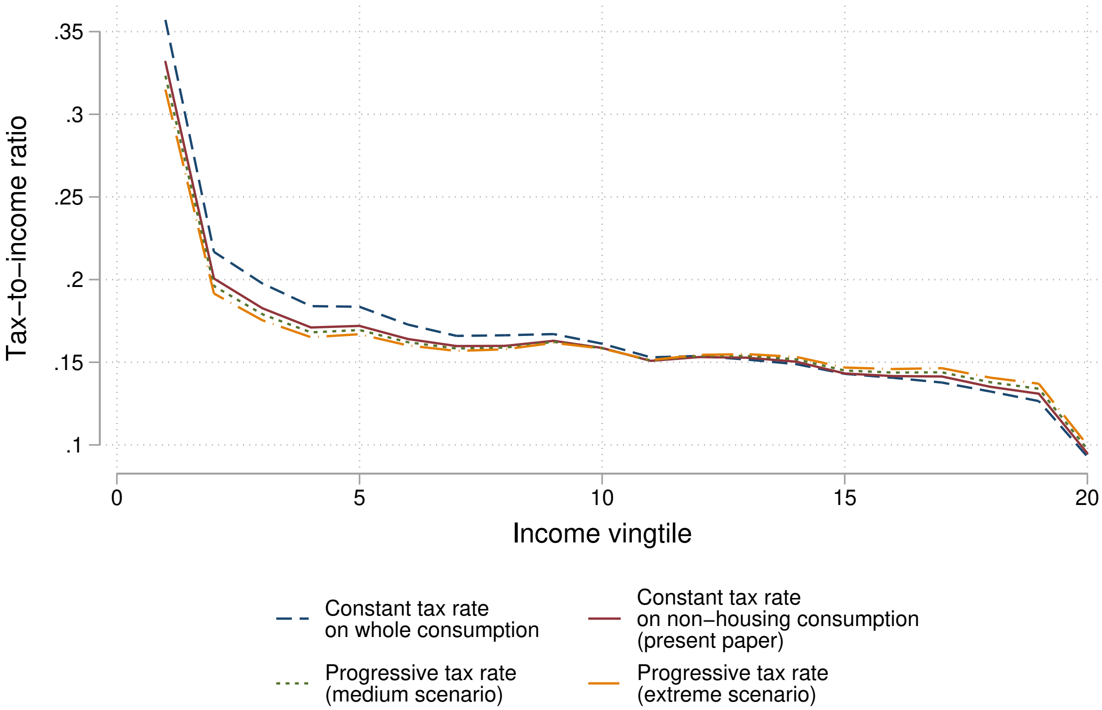

Figure B.3.a: The tax-to-income ratios in France in 2010.

Note: Medium scenario: 1 pct-point difference between the effective consumption-tax rates of the richest and poorest. Extreme scenario: 2 pct-points difference in the same tax rates.

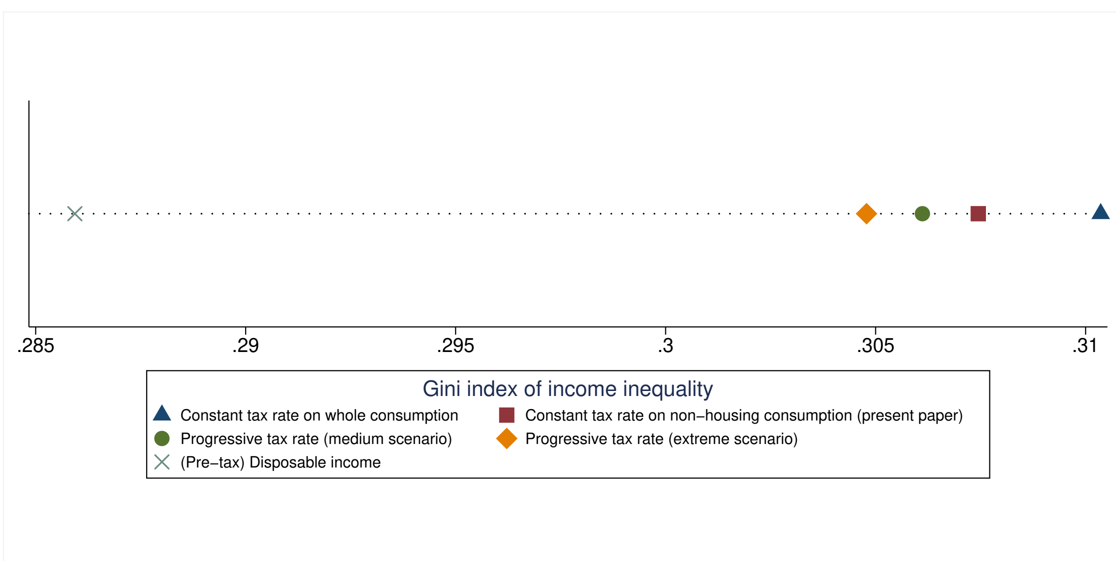

Figure B.3.b: The Gini indices of income inequality in France in 2010.

Note: Medium scenario: 1 pct-point difference between the effective consumption-tax rates of the richest and poorest. Extreme scenario: 2 pct-points difference in the same tax rates.

B.4 The imputation error in consumption depends on the model

The initial LIS dataset contains 77 country-years where consumption data is available. We can apply our consumption imputation models to these datasets and compare the accuracy of imputation for different models. Figure B.4.a shows the R^2 coefficient for the 57 country-years where the imputed and observed values of consumption can be compared. Of the 57 country-years for which we impute consumption with both (Model 1) and (Model 2), model 2 increases the explained variance in 54 of them. The average rise is 33%, as measured by the R^2 coefficient. Overall, the average R^2 coefficient in model 2 is 0.45, over 0.36 in 75% of country-years, and over 0.56 in one quarter of our observations.

This shows that the "cost of housing" explanatory variable, which is the main difference between the two models, provides significant additional information for the imputation of household consumption.

However, the imputation from (Model 1), used in the lighter model, yields also satisfactory Gini coefficients, as can be shown in Figure B.4.b.

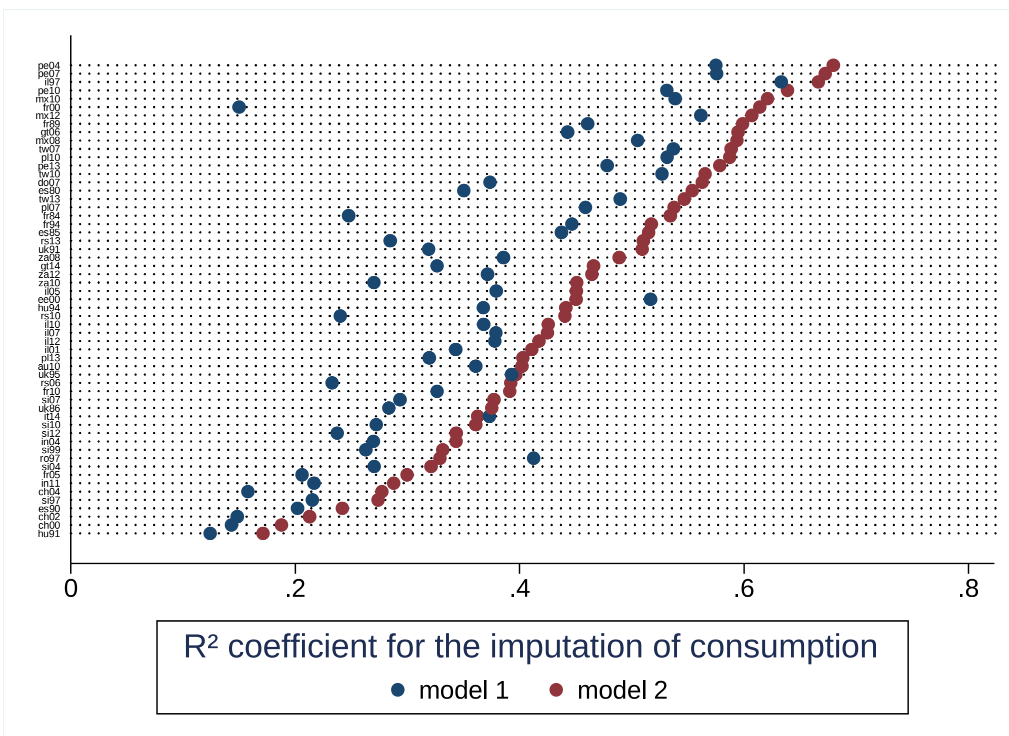

Figure B.4.a: The explained variance in the two imputation models for various countries

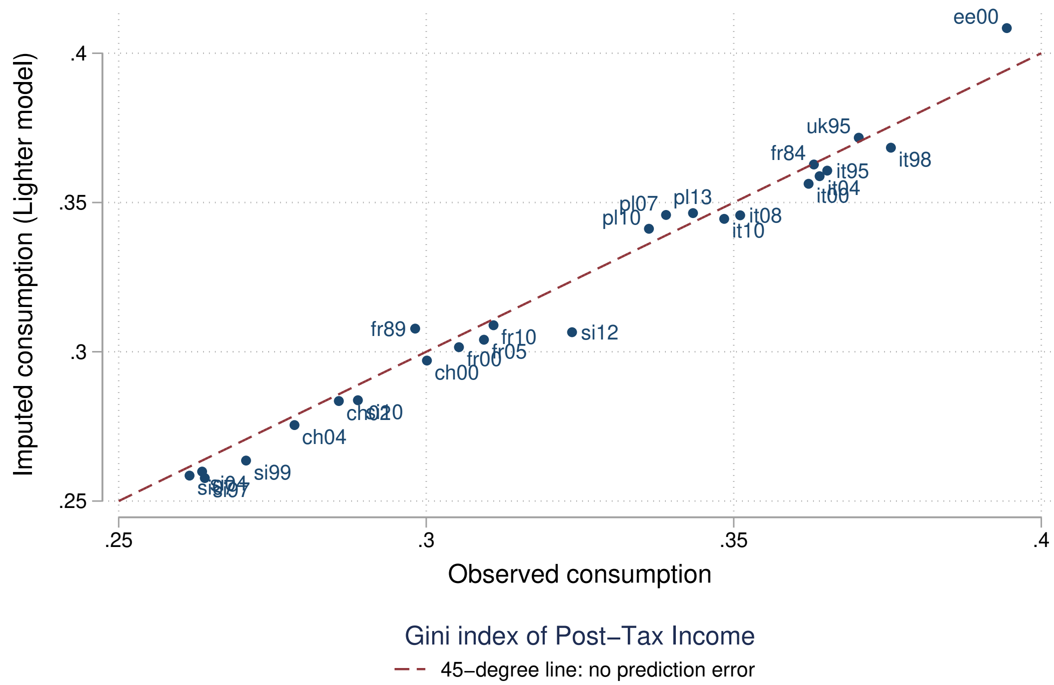

Figure B.4.b: The observed and predicted Gini coefficients of post-tax income, for the lighter model

C Results with the lighter model

Although we only present the results from our core model in the main part of this article, we show here a few results from the lighter model, including 126 observations covering 26 countries. We see in Figure C.0.a that the range of the effect of consumption taxes is similar to that with the core model.

Moreover, the lighter model shows even more clearly that the anti-redistributive impact of consumption taxes is mainly driven by the tax rate, as shown in Figure C.0.b.

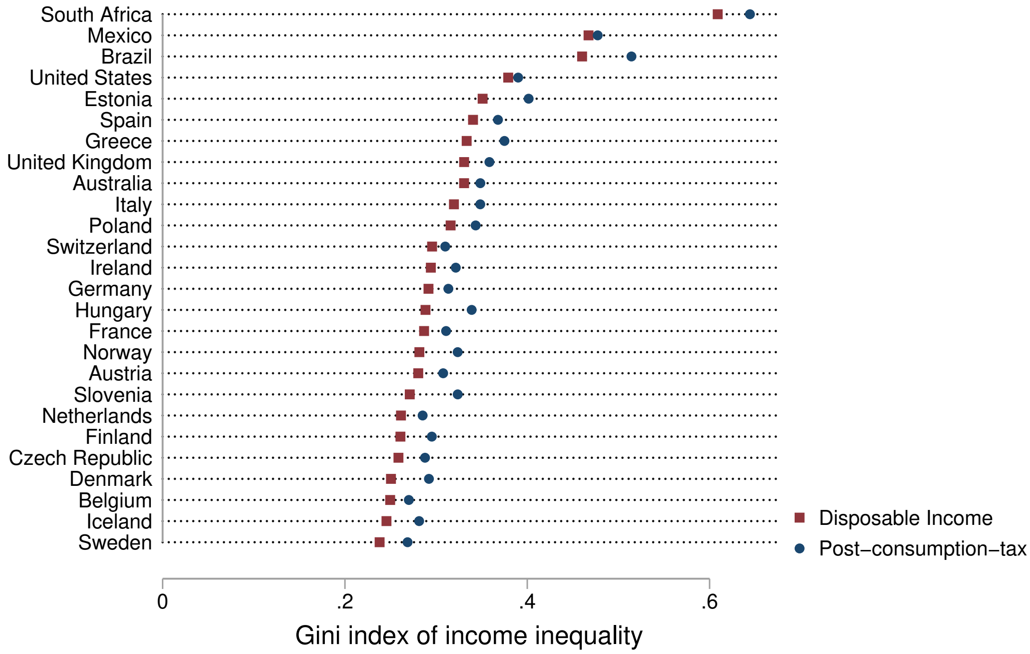

Figure C.0.a: Gini coefficients of income inequality for disposable income and post-consumption-tax income, with the lighter model

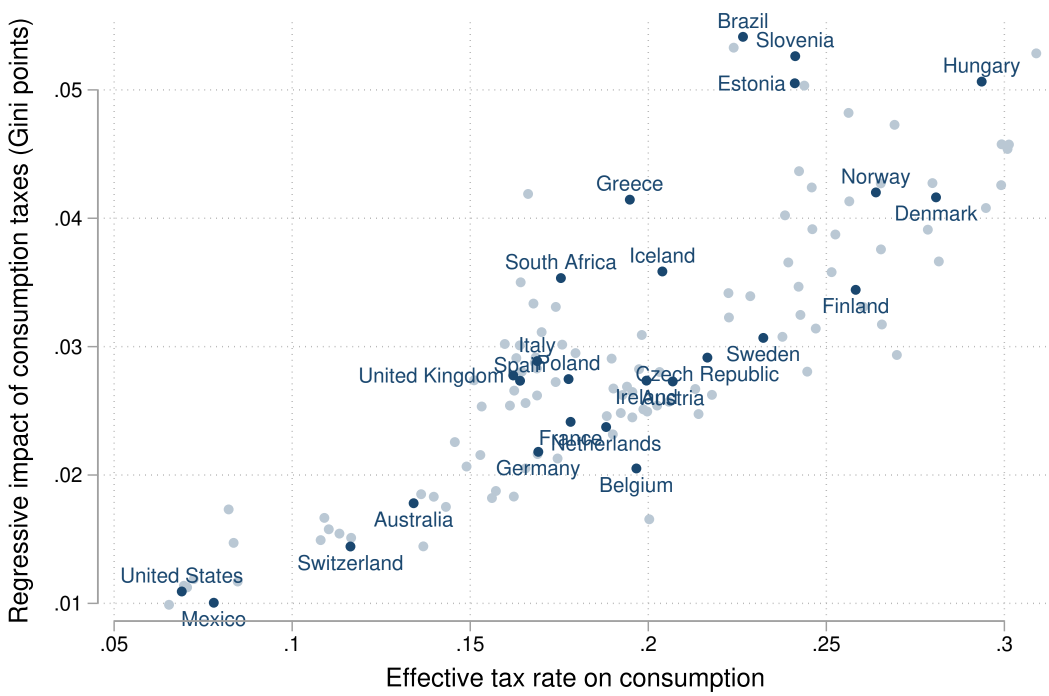

Figure C.0.b: The link between effective consumption tax rate and impact of consumption tax on inequality is confirmed

D The decomposition of the redistributive effect

D.1 Vertical and horizontal redistribution

The effective redistribution of a tax or a transfer can be decomposed into vertical redistribution, as measured by the Reynolds-Smolensky index (RS), and horizontal redistribution, given by the re-ranking index (Re):

$$\Delta G = G_{dhi} - G_{dhi-tax} = RS - Re \tag{7}$$

Vertical redistribution refers to the amount of tax that is distributed in a progressive or regressive way as a function of income. One measure of vertical redistribution, the Reynolds-Smolensky index, is defined as follows (Kakwani, 1977):

$$RS = G_{dhi} - C(dhi - tax, dhi)$$

where G_{dhi} is the Gini index of pre-tax income and $C(dhi - tax, dhi)$ is the concentration index of post-tax income ranked by pre-tax income. This term is thus relatively close to the Gini coefficient for post-tax income.

Horizontal redistribution is the amount of redistribution that is orthogonal to the distribution of income. The re-ranking index of horizontal redistribution is a measure of the amount of redistribution that is not due to tax regressivity, but rather inequality that is created between individuals in the same income range. This is defined as follows:

$$Re = G_{dhi-tax} - C(dhi - tax, dhi)$$

By definition, the re-ranking Re is non-negative, so by Equation (7) the Reynolds-Smolensky index is an upper bound for effective redistribution (when effective redistribution is positive) and is a measure of the maximum feasible redistribution if no re-ranking resulted from the tax or the transfer. In our case, if redistribution is negative, then the RS index is a lower bound for the anti-redistributive effect (in absolute value). The rise in income inequality due to taxes is thus the sum of the vertical anti-redistribution and the re-ranking due to the variation in propensities to consume between households at the same levels of income. In practice, the Reynolds-Smolensky index is close to the difference in the Gini coefficients (see Figure D.1.a): re-ranking generally accounts for less than 20% of the impact on inequality.

D.2 The Kakwani indices of regressivity

We have seen in Equation (4) that the vertical redistribution from consumption taxes can be viewed as the product of two independent terms: regressivity, a micro-level term linked to propensities to consume that fall with income, and the consumption-tax rate, a macro-level term:

$$RS = K \cdot \frac{TIR}{1 - TIR} \tag{4}$$

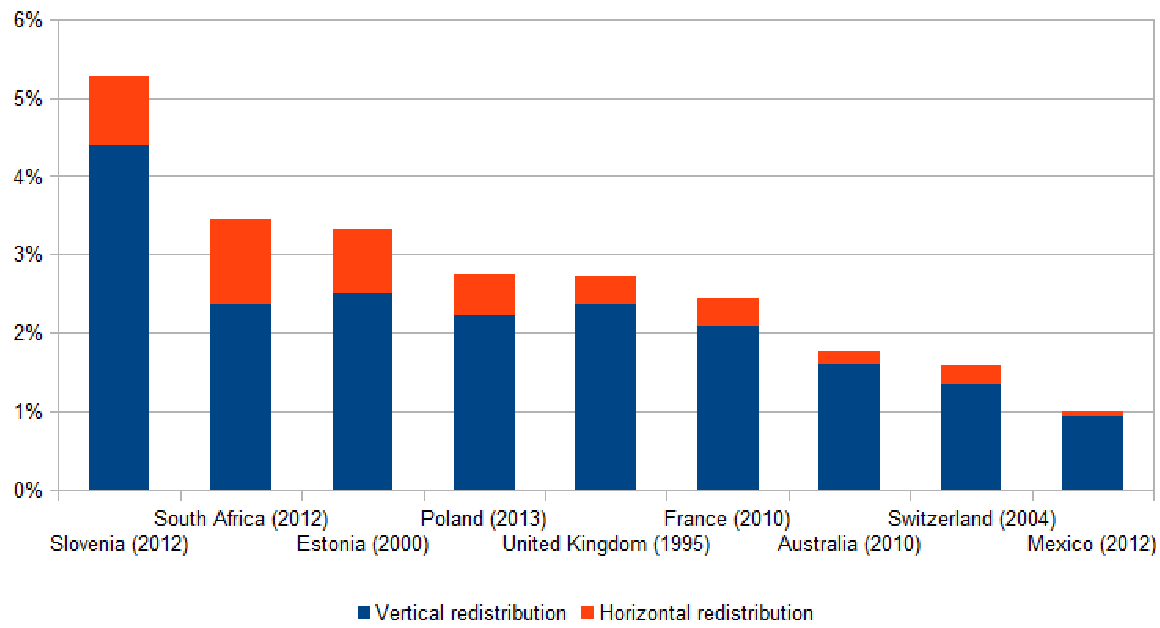

Figure D.1.a: The decomposition of redistributive effect

We measure the regressivity of consumption taxes by the Kakwani index. This reflects how concentrated taxes are at one or the other ends of the income distribution. It is equal to the difference between the concentration index of the tax relative to (pre-tax) disposable income and the Gini coefficient of disposable income (Kakwani, 1977). Namely:

$$Kakwani(tax, dhi) = C(tax, dhi) - Gini(dhi)$$

The concentration index $C(tax, dhi)$ is a measure of the extent to which the distribution of the tax payments is skewed towards the highest incomes. It takes on values [-1;1], with -1 indicating that all the tax payments are concentrated on the poorest individual, and 1 that these are concentrated on the richest individual. By subtracting the Gini index of income, the sign of the Kakwani index provides a simple piece of information: a positive Kakwani value means that the tax payments are more heavily concentrated towards the highest percentiles of income than is income itself, so that the tax is progressive. On the contrary, a negative Kakwani index reveals that the distribution of tax payments is less skewed to the right than is the distribution of income, so that the tax is regressive. For consumption taxes, we expect negative Kakwani indices.[18]

For one fixed tax rate, we can make assumptions on the Kakwani index and thus have a range of possible RS index values, based on Equation (4). When the Kakwani indices are derived from imputed consumption values, this will be useful to provide upper and lower bounds on the possible RS values.

[18]In the subsequent figures, we plot the absolute values of the RS and Kakwani coefficients.

We calculate the Kakwani index for all the datasets where consumption data is available (i.e. 77 country-years): the results are summarized in Figure D.2.a. Approximately half of Kakwani indices lie between -0.10 and -0.15, and almost all between -0.05 and -0.20.

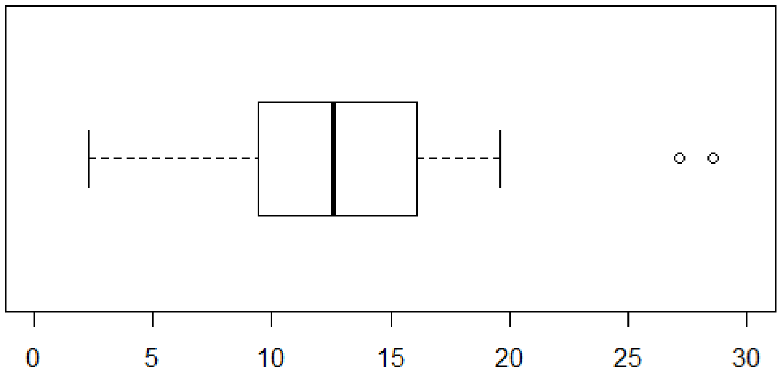

Figure D.2.a: The distribution of the Kakwani index on 77 datasets (x100)

Based on the different tax rates that we calculated earlier, we can now provide bounds for the possible values of the RS index. As summarized in Figure D.2.b, most values for the Reynolds-Smolensky index will lie between -0.02 and -0.08.

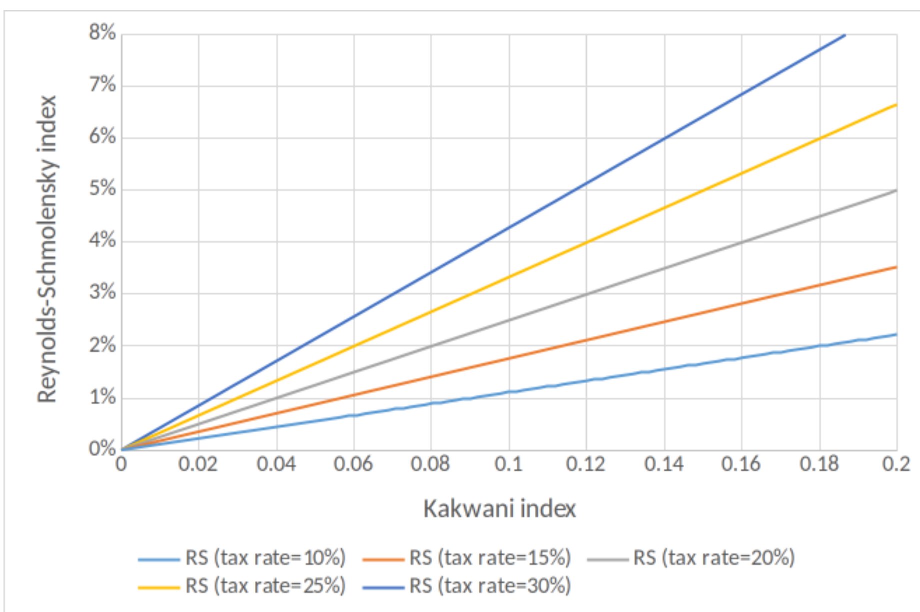

Figure D.2.b: The value of the Reynolds-Smolensky index depending on the tax rate and the Kakwani index

E Country and year coverage

To carry out the calibration of our imputation models of consumption data, 47 datasets from the following 12 countries are used: Estonia (2000), France (1978, 1984, 1989, 2000, 2005, 2010), Germany (1973, 1978, 1983), Hungary (1991, 1994), Italy (1995, 1998, 2000, 2004, 2008, 2010, 2014), Poland (2007, 2010, 2013), Slovenia (1997, 1999, 2004, 2007, 2010, 2012), South Korea (2006, 2008, 2010, 2012), Spain (1980, 1985, 1990), Switzerland (2000, 2002, 2004), Taiwan (1981, 1986, 1991, 2007, 2010, 2013) and the United Kingdom (1986, 1991, 1995).[19]

As described in Table E.0.a, we estimate the regressivity of consumption taxes for 126 LIS datasets, spanning 26 countries over 25 years, going from 1979 to 2013. Among those, 82 country-years are part of the core model, that is the model which provides the most accurate estimates of the effect of consumption taxes on inequality. For years marked with an * in the table, information on rents is missing, so the lighter model is used: for those 44 additional country-years, the regressivity of consumption taxes is slightly overestimated. Among those 126 country-years, 36 estimates come from observed data on consumption, and 90 come from imputed consumption data.

For each country presented in this paper, we use the latest year available under the core model, except for Australia, Norway, Sweden and the United States, where we use the lighter model. When observed consumption data is available, these are the figures that we use.

[19] For some of those datasets, tax data or other necessary National Accounts data is not available (South Korea and Taiwan, for instance). They therefore do not appear in the rest of the analysis and are not listed in Table E.0.a.

Table E.0.a: Country and years used in the study

Country	Years with observed data	Years with imputed data
Australia	2010*	1981*, 1985*, 1989, 1995, 2001, 2003, 2008
Austria		1997*, 2000, 2004, 2007, 2010, 2013
Belgium		1997
Brazil		2013*
Czech Republic		1996*, 2002*, 2004, 2007, 2010, 2013
Denmark		1995*, 2000*, 2004, 2007, 2010, 2013
Estonia	2000	2004, 2007, 2010, 2013
Finland		1995, 2000, 2004, 2007, 2010, 2013
France	1984, 1989, 1994*, 2000, 2005, 2010	
Germany		2000, 2004*, 2007*, 2010*, 2013
Greece		1995*, 2000*, 2004, 2007, 2010, 2013
Hungary	2005*, 2007*, 2009*, 2012*	
Iceland		2004, 2007, 2010
Ireland		2004, 2007, 2010
Italy	1995*, 1998*, 2000*, 2004*, 2008*, 2010*	
Mexico	2008, 2010, 2012	2004
Netherlands		2004, 2007, 2010, 2013
Norway		1979, 1986*, 1991, 1995, 2000, 2004
Poland	2007, 2010, 2013	1995, 1999, 2004
Slovenia	1997, 1999, 2004, 2007, 2010, 2012	
South Africa	2008*, 2010*, 2012*	
Spain		2000, 2004*, 2007, 2010, 2013
Sweden		1995*, 2005*, 2000
Switzerland	2000*, 2002*, 2004*	2007*, 2010*, 2013*
United Kingdom	1995	1999, 2004, 2007, 2010, 2013
United States		2000*, 2004*, 2007*, 2010*, 2013*

Notes: For years marked with an * in the table, information on rents is missing, so the lighter model is used to estimate the regressivity of consumption taxes.