Income Taxation: A Cross-Country Comparison*

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Abstract

This paper studies income taxes using micro-data from the Luxembourg Income Study. We show that income tax systems worldwide are approximated remarkably well by a two-parameter log-linear effective tax function. Then, we estimate country-and-year-specific effective tax functions to compare average taxation and income tax progressivity across countries and over time. Our results provide several insights into the nature of income tax systems. First, we show a positive association between a higher average level of taxation and greater progressivity. Second, we show that progressivity has significantly changed over the last forty years in all countries we study. Third, we discover a positive association between progressivity and economic development, with wealthier countries exhibiting higher income tax progressivity. Finally, we observe variations in progressivity across different family structures, with married couples with children experiencing the highest progressivity and childless singles facing the lowest.

Keywords: Taxation; Income tax progressivity; Family structure
JEL Codes: E62, H20, H30

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1 Introduction

Income tax systems are inherently complex. Income taxes depend on statutory tax rates, deductions, credits, and the manner in which taxpayers file their returns. The complexity escalates when comparing income tax systems across countries, where policies and institutions can vary substantially. However, accurately measuring key features of an income tax system is crucial for both economists and policymakers. On the one hand, economists need a precise characterization of the tax system as input to study the role of tax policy in economic behavior both at the individual and aggregate levels. On the other hand, policymakers need an accurate assessment of the tax progressivity to design redistribution and social insurance policies.

Given the importance of accurately measuring the tax system, this paper has two main objectives. First, we aim to systematically describe and compare the effective income taxes paid by taxpayers over time and across countries, and how it varies with levels of economic development and family structures. Second, we aim to provide estimated effective tax functions that can be incorporated into structural models to answer questions related to redistribution, the impact of income taxes on economic behavior, and others.

We use household-level microdata from the Luxembourg Income Study (LIS) Database to achieve these goals. Several reasons make LIS the ideal dataset for our analysis. First, it covers many countries and spans a long period of time. Second, it harmonizes data across countries, facilitating comparisons of variables across countries and over time. Finally, it contains detailed information on labor and capital income, public social benefits, taxes, contributions, demographic characteristics, employment, and consumption. We use this rich dataset to estimate effective income tax functions for over thirty countries spanning the last forty years. Effective income tax functions characterize the empirical relationship between taxes paid and pre-tax income and summarize the intricacies of income tax systems using a parsimonious functional form. Specifically, we use the log-linear tax function pioneered by Feldstein (1969) and popularized by Benabou (2000) and Heathcote, Storesletten, and Violante (2017) to quantify the average level of taxation and the degree of progressivity of income tax systems worldwide.

Our findings can be summarized as follows. First, we show that the log-linear tax function is not only a good approximation of the US income tax system as demonstrated by Heathcote, Storesletten, and Violante (2017), but also income tax systems worldwide. In particular, we show that this tax function can almost entirely explain the variation in post-tax income in all countries and years in our sample. Because of their excellent approximation quality, our estimated tax functions can be used in any macroeconomic model requiring a parsimonious characterization of the income tax system of the country it is studying.

Second, we document a positive correlation between income tax progressivity and the average level of taxation. Notably, throughout all years in our sample, countries with a higher degree of progressivity also impose a higher average level of income taxation. We show that wealthy northern-European countries such as Germany and the Netherlands consistently exhibit some of the highest progressivity and average tax rates over time. We also find that some countries (such as Brazil, Colombia, and Peru) do not present effective income taxes despite having progressive statutory income tax systems.

Third, the analysis reveals dramatic changes in progressivity over the last forty years across most countries in our sample. For instance, progressivity in the United States in 2018 is about 40% lower than in 1980. Similarly, progressivity in the United Kingdom and Canada decreased by 33% and 25%, respectively, between 1995 and 2018. These changes in progressivity coincide with changes in the average level of taxation reflecting income tax reforms. For example, in Spain, progressivity declines between 2007 and 2010, while the average tax rate also drops due to the tax cuts implemented by the Spanish government during the Great Recession.

Fourth, we show a positive relationship between income tax progressivity and economic development. In particular, we proxy economic development by median pre-tax income and GDP per capita and find that the wealthiest countries (such as Belgium, Germany, and the Netherlands) display the highest income tax progressivity. Despite this general trend, we also find large dispersion in progressivity between countries with similar levels of economic development. For instance, in 2013, Belgium and the United States have nearly identical median pre-tax income, but Belgium's progressivity is three times as large as that of the United States.

Finally, we document significant differences in progressivity across family structures. Here, we estimate tax functions separately for four groups of families: married couples with children, married couples without children, single parents, and childless singles. We show that over the last forty years, in all countries, the share of married couples with children has decreased while that of childless singles has increased. We also show that conditional on the presence of children, progressivity varies significantly by marital status. In particular, the progressivity for married couples without children is, on average, 25.3% larger than that of childless singles. At the same time, the progressivity for married couples with children is, on average, 26.4% larger than that of single parents. Then, conditional on marital status, the presence of children also leads to considerable changes in progressivity. On average, progressivity for married couples with children and single parents is 18.5% and 5% higher than that for married couples without children and childless singles, respectively. Overall, our results suggest that childless singles face the lowest progressivity across countries and over time, while married couples with children enjoy the highest.

Our paper offers several contributions. First, we provide a parsimonious method for comparing income tax systems across countries using a two-parameter log-linear tax function. Second, we estimate these tax functions over time, thereby capturing the evolution of income tax systems worldwide. Third, we separately estimate tax functions by family structure, taking into account the different tax treatments for families with and without children or with different marital statuses. Finally, we make our estimated tax functions available for researchers interested in approximating the income tax system in their structural models.

The remainder of the paper is organized as follows. Section 2 positions our paper within the context of the relevant literature. Section 3 outlines our tax function and estimation strategy. Section 4 describes the LIS data, our sample selection, and the income definitions for our tax functions. Section 5 presents evidence supporting the fit of our tax function and discusses the evolution of the average level of taxation and progressivity across countries and time. Section 6 examines the relationship between progressivity and economic development. Section 7 presents effective tax functions by family structure. Section 8 concludes.

2 Related Literature

Our paper relates to three branches of the literature. First, it connects to the rich literature on approximating the income tax and transfer system with a log-linear function of post-tax income on pre-tax income. The "log-linear approach" was pioneered by Feldstein (1969) and Benabou (2000) and widely popularized by Heathcote, Storesletten, and Violante (2017). While there are various approaches to modeling the income tax and transfer system, these papers authors advocate for the log-linear specification due to its simplicity—requiring only two parameters which can be estimated by ordinary least squares—and its excellent fit to the data.[1]

Numerous papers have used the log-linear tax function to study the income tax and transfer system in the United States. Heathcote, Storesletten, and Violante (2020) uses data from the Congressional Budget Office to study tax progressivity between the late 1970s and 2016. They find that the level of progressivity in 2012–2016 is the same as in 1979–1983. Wu (2021) uses CPS data to study the evolution of tax progressivity between 1978 and 2016. He finds that the income tax in the US has become less progressive since the late 1970s. Fleck, Heathcote, Storesletten, and Violante (2021) use CPS data to study the progressivity of the tax and transfer system at the US state level. They estimate effective tax functions for each of the 50 states and find substantial heterogeneity in progressivity across states. Finally, Borella, De Nardi, Pak,

[1]There are numerous ways of modeling the tax function, ranging from a simple proportional tax on income to the arctangent tax function in Kurnaz and Yip (2020), passing through the popular three-parameter tax function of Gouveia and Strauss (1994).

Russo, and Yang (2022) use PSID data to study the evolution of effective tax rates between the late 1960s and 2016. They find substantial variation in the average level of taxation and income tax progressivity, both over time and across marital status.

A handful of recent papers have applied the log-linear tax function to countries other than the US. García-Miralles, Guner, and Ramos (2019) use administrative tax data for Spain to study the distributions of pre- and post-tax income and tax liabilities between 2002 and 2015. They find that the log-linear tax function approximates the Spanish personal income tax system well. Kaas, Kocharkov, Preugschat, and Siassi (2020) study homeownership in Germany and show that the log-linear tax function provides a good approximation of the German income tax and transfer system. Tran and Zakariyya (2021) uses the log-linear tax function to study the evolution of income tax progressivity in Australia after 1999.

Second, our paper connects to the literature on cross-country comparisons of tax progressivity. Chang, Chang, and Kim (2018) study optimal income taxation in 32 OECD countries. They estimate income tax progressivity using a log-linear tax and transfer function, although they do not study the evolution of taxes over time or across family structures. Holter, Krueger, and Stepanchuk (2019) argue that income tax progressivity is a crucial determinant of the additional tax revenue governments can generate by increasing the level of labor income taxes. They use a log-linear tax function and compare progressivity measured by the progressivity wedge across OECD countries between 2000 and 2007.[2] They find substantial heterogeneity in tax progressivity, with the most progressive taxes in Denmark and the least progressive in Japan. De Magalhaes, Martorell, and Santaeulalia-Llopis (2019) use micro-data to estimate and compare the progressivity of tax-and-transfer systems in 20 countries. Ayaz, Fricke, Fuest, and Sachs (2021) studies how optimal income taxes should respond to an increase in public debt in five European countries. They find that income taxes should be less progressive in response to increased fiscal pressure. Bick, Fuchs-Schündeln, Lagakos, and Tsujiyama (2022) analyzes how structural changes in labor supply affect cross-country differences in hours worked. They estimate log-linear tax functions for childless singles in numerous OECD countries but do not study the evolution of income taxes over time.

Third, our paper relates to the literature on income taxation by family structure. Most studies in this literature have focused on the differences in income taxation between married couples and singles. Guner, Kaygusuz, and Ventura (2012) studies tax reforms taking into account the large changes in female labor supply and demographic structure that occurred in

[2]The progressivity tax wedge between two arbitrary incomes $y_2 > y_1$ is given by

$$PW(y_1, y_2) = 1 - \frac{1 - T'(y_2)}{1 - T'(y_1)},$$

and measures how marginal tax rates increase between the two income levels.

the USA over the last decades. Guner, Kaygusuz, and Ventura (2014) estimate and compare tax functions using a wide variety of functional forms to systematically describe how income taxes in the USA in 2000 varied by income, marital status, and the number of children in a household. Malkov (2022) studies the optimal income taxation of couples and singles in the USA. He estimates log-linear tax functions for the USA and argues that, compared to the current system, the government should decrease progressivity for couples and increase it for singles.

3 The Tax Function

3.1 Log-Linear Tax Function

Following Feldstein (1969), Benabou (2000), Heathcote, Storesletten, and Violante (2017), and Borella, De Nardi, Pak, Russo, and Yang (2022), we model taxes T on total income Y as:

$$T(Y) = Y - (1-\lambda)Y^{1-\tau}, \tag{1}$$

The associated average and marginal tax rates are given by:

$$\frac{T(Y)}{Y} = 1 - (1-\lambda)Y^{-\tau}, \tag{2}$$

$$T'(Y) = \frac{\partial T(Y)}{Y} = 1 - (1-\lambda)(1-\tau)Y^{-\tau}, \tag{3}$$

Equation (2) shows that the parameter λ corresponds to the average tax rate when income is equal to 1 unit and thus captures the notion of the level of taxation in the economy. The parameter τ captures the degree of progressivity of the income tax system. In particular, the elasticity of post-tax income with respect to pre-tax income, $\partial \log(Y - T(Y))/\partial \log(Y)$, is equal to $1-\tau$. The tax system is progressive when $\tau > 0$, regressive when $\tau < 0$, and flat with marginal and average tax rates set at λ when $\tau = 0$. Taking logs of Equation (1) yields:

$$\log(Y - T(Y)) = \log(1-\lambda) + (1-\tau)\log(Y). \tag{4}$$

3.2 Estimation Strategy

We estimate Equation (4) by regressing the logarithm of post-tax income on a constant and on the logarithm of pre-tax income in each country and in each wave.

$$\log(\text{after-tax income})_{i,c,t} = \alpha_{c,t} + \beta_{c,t}\log(\text{pre-tax income})_{i,c,t} + \varepsilon_{i,c,t}, \tag{5}$$

where the dependent and independent variables are the log after-tax income and log pre-tax income for household i of country c in wave t. We allow for country-wave-specific regression coefficients $\alpha_{c,t}$ and $\beta_{c,t}$. We run weighted regressions using the LIS-provided household-level cross-sectional weights to obtain results representative of the whole population of each country in each wave. The OLS estimates are denoted by $\hat{\alpha}_{c,t}$ and $\hat{\beta}_{c,t}$.

We compute the parameter λ from the estimated constant and the parameter τ from the estimated coefficient on the log of pre-tax income. In particular, comparing the regression equation (5) with the log-linear tax function (4) shows that

$$\hat{\lambda}_{c,t} = 1 - \exp\left(\hat{\alpha}_{c,t}\right), \quad \text{and} \quad \hat{\tau}_{c,t} = 1 - \hat{\beta}_{c,t}.$$

Thanks to our large sample size, the tax parameters are tightly estimated, and the confidence intervals are very narrow.[3] Moreover, in Section 5.1, we show that this tax function fits the data remarkably well.

4 Data

4.1 The Luxembourg Income Study (LIS)

We use micro-data from the Luxembourg Income Study (LIS) Database. LIS collects and harmonizes micro-data from 55 countries starting in the 1970s. LIS combines well-known datasets, such as the Current Population Survey for the United States and the German Socio-Economic Panel for Germany, and provides an aggregated micro-dataset that includes labor and capital income, public social benefits, private transfers, taxes and contributions, demography, employment, and consumption. Ravallion (2015) provides a detailed overview of the LIS dataset, details its development over time, and discusses some data limitations.

Numerous papers have used LIS. Among others, De Nardi, Ren, and Wei (2000) uses it to study income redistribution policies and the trade-off between redistribution and inefficiency. Chiuri and Jappelli (2010) uses LIS data to analyze the patterns of homeownership for older adults across OECD countries. Laun and Wallenius (2016) uses LIS to assess the role of social insurance for the cross-country differences in the labor supply of older workers. Chang, Chang,

[3] We construct the 95% confidence intervals as

$$\left[1 - \exp\left(\hat{\alpha}_{c,t} + 1.96 \times \hat{se}(\alpha)_{c,t}\right), 1 - \exp\left(\hat{\alpha}_{c,t} - 1.96 \times \hat{se}(\alpha)_{c,t}\right)\right]$$

for λ, and

$$\left[1 - \left(\hat{\beta}_{c,t} + 1.96 \times \hat{se}(\beta)_{c,t}\right), 1 - \left(\hat{\beta}_{c,t} - 1.96 \times \hat{se}(\beta)_{c,t}\right)\right]$$

for τ.

and Kim (2018) uses LIS to estimate a tax and transfer function for 32 OECD countries and compare the observed level of progressivity with the optimal one stemming from an optimal income taxation problem.

4.2 Sample Selection

We use 11 LIS waves spanning from the early 1970s to 2019. Although LIS covers 55 countries in total, the number of countries observed in each wave varies. For instance, LIS includes the United States since the first wave in the 1970s but records information about Japan only starting in 2008. We start from all the countries available in a specific wave and select those for which we have data on all the inputs we need to estimate our tax function: gross household income, income taxes, and public social benefits. For this reason, we have to exclude countries like Mexico, which is in the LIS dataset starting from the second wave but only reports after-tax income.

Then, to ensure a consistent and comparable time unit across countries, we operate at the wave level.[4] Thus, when we observe a country for more than one year in a wave, we pool these years into the same wave to estimate the tax function for that wave.[5] Thus, the number of countries in our final sample varies by wave, ranging from a minimum of 5 countries in the first wave to a maximum of 31 countries in wave 8. However, we observe four countries for all 11 LIS waves: France, Germany, the United Kingdom, and the United States.

For each country-wave pair, we select working-age households whose head is aged 25 to 60. Then, we restrict our attention to "standard" households, comprising (1) one-person households; (2) married couples without children; (3) married couples with children; and (4) single parents. Therefore, we exclude households in which other relatives or non-relatives cohabit with the four groups described above. We select only standard households to have comparable households across countries. Figure 1 shows that most households with heads aged between 25 and 60 qualify as "standard." When we pool all countries and waves together, the mean share of standard households is 89 percent, and the median is 91.4 percent.

Table A-1 in Appendix I.1 shows the countries in our sample, the waves we observe them in, and the number of observations in each country and wave. Our final sample consists of 7,625,531 household-wave observations for 37 countries, observed over different waves.

[4]Table A-1 in Appendix I.1 shows the mapping from wave number to calendar year.

[5]LIS combines country-specific waves from different years in the same LIS wave. For instance, the first LIS wave includes CPS data for the USA for each year between 1979 and 1982 but covers the 1979 French Tax Income Survey only.

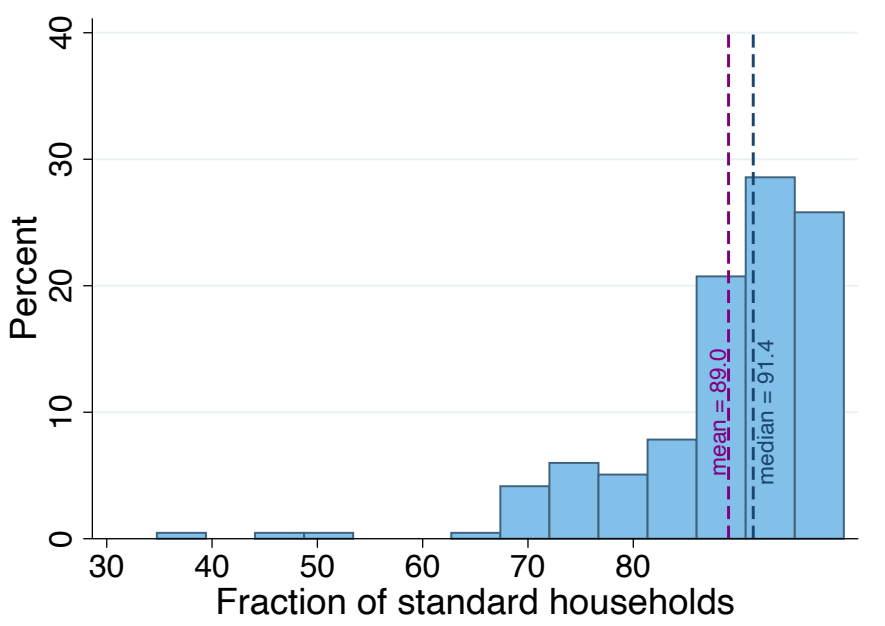


Figure 1: Share of households with heads between 25 and 60 that qualify as "Standard" Households. Results for all countries and all waves in our sample.

4.3 Income Definitions and Adjustments

Our results on effective taxes depend crucially on the definitions of pre-and-post-tax income. Household pre-tax income is given by the sum (for the head and the spouse, if present) of labor income, capital income, pensions, public social benefits, and private transfers, while post-tax income is defined as pre-tax income minus income taxes and social security contributions. Taxes are defined as compulsory payments to the government based on the current income earned.[6,7] Public social benefits include transfers from government insurance and assistance programs. Appendix I.2 describes the income components in detail.

Our pre-tax and post-tax income definitions are very close to the one in Borella, De Nardi, Pak, Russo, and Yang (2022) and allow us to interpret the parameter λ from Equation (1) as the average tax rate (for a given income level) and τ as a measure of the progressivity embedded in income taxes alone.

The monetary quantities that make up our income definitions need to be adjusted to be comparable across waves and countries. First, we need Consumer Price Indices (CPIs) to compare real amounts over time within a country. Second, we need Purchasing Power Parity indicators (PPPs) to compare real amounts across countries. Using 2017 as the base year, the

[6]For the United States, taxes include both federal income taxes and state income taxes.

[7]Taxes on current income as defined by LIS exclude direct taxes on windfall incomes such as inheritances, profits, and capital gains.

adjustment factor for country i in wave t is computed by LIS as:

$$LISPPP_{i,t} = \left(\frac{CPI_{i,t}}{100}\right) PPP_{i,2017},$$

To convert monetary quantities into 2017 USD PPP, we divide nominal amounts in each country and wave by the corresponding LIS PPP. All financial quantities reported in the paper are measured in 2017 USD PPP, which we refer to, for convenience, as 2017 dollars.

5 Effective Income Taxes

5.1 Fit of the Tax Function

As Heathcote, Storesletten, and Violante (2017) shows, the log-linear tax function in Equation (1) is a good approximation of the US federal income tax system. In this section, we show that the log-linear tax function is a good approximation of the income tax systems in all the countries in our sample.

First, in Figure 2, we show that our log-linear tax function is a remarkably accurate approximation of the income tax system in all the countries in our sample in wave 10 (corresponding to 2015-2017).[8] In particular, we plot the logarithm of post-tax income as a function of the logarithm of pre-tax income. To draw these graphs, we first select our sample of standard households with heads aged between 25 and 60, and then we construct weighed percentiles by country and wave. These graphs show that the relationship between post-tax income and pre-tax income is approximately log-linear in each country we consider and at all points of the log pre-tax income distribution, except for the first percentile.

Second, in Figure 3, we show that the R^2 from the regressions we use to estimate our tax functions is remarkably high. In particular, we run the regression in Equation (4) wave-by-wave and country-by-country, and we report the distribution of the R^2 from these regressions. The distribution is significantly skewed to the right and has a mean of 0.976 and a median of 0.984. Even in the thin left tail, the R^2 is larger than 0.85, meaning that, at its worst, the log-linear tax functions still explain over 85 percent of the variation in post-tax income. In particular, the lowest R^2 is 0.86 and corresponds to Italy in wave 6. The results on R^2 corroborate our finding that a log-linear tax function approximates well the income tax systems of the countries in our sample. In Appendix I.4, we show that the validity of our results on the goodness-of-fit of our

[8] Due to space limitation, we show six countries in the main text. We show the fit of the tax function for the remaining countries in wave 10 in Appendix I.3. The results for waves other than wave 10 are available upon request.

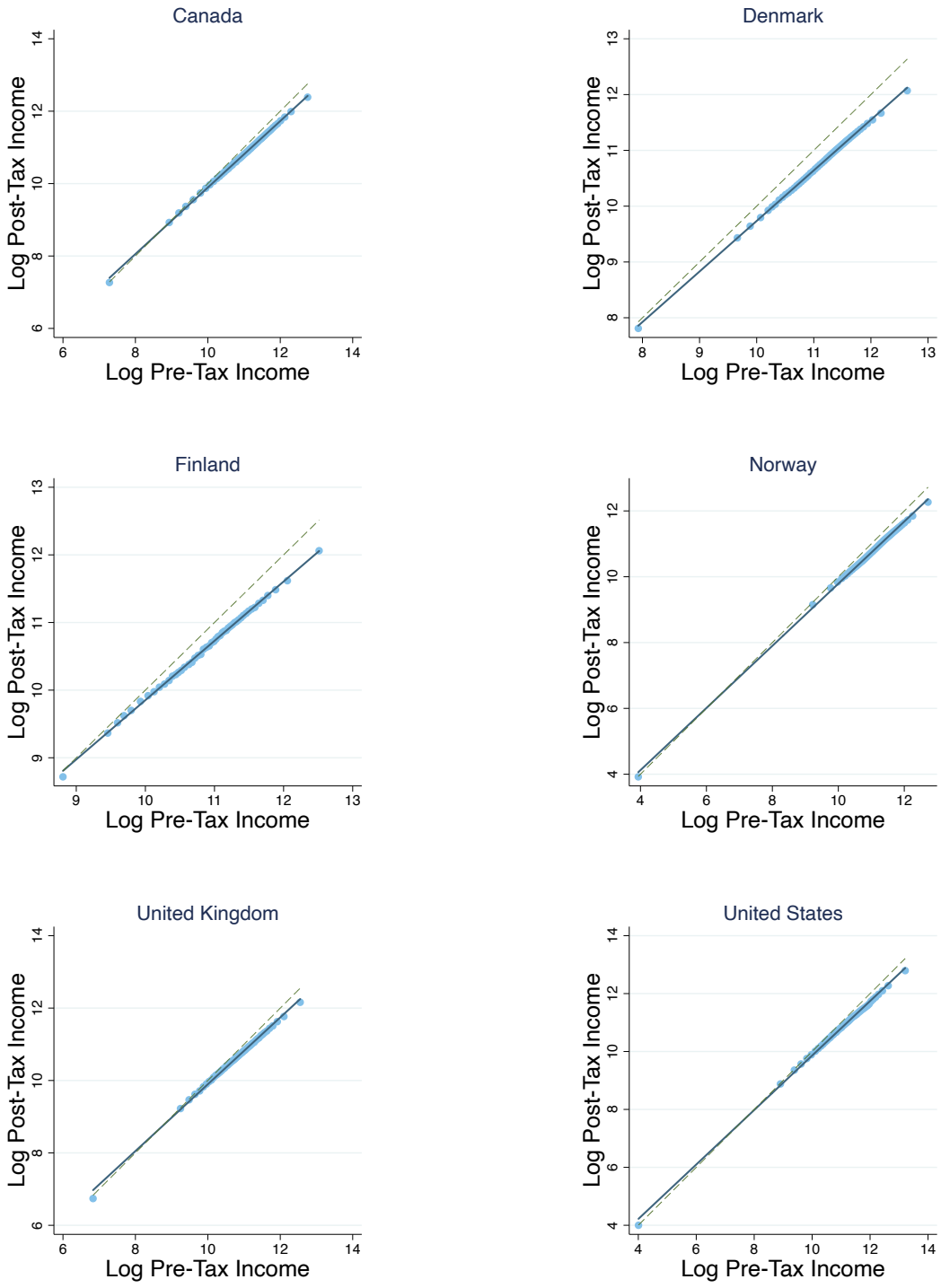


Figure 2: Log post-tax income as a function of log pre-tax income, Wave 10. Post-tax income is defined as pre-tax income minus income taxes. Each dot is a percentile of the log pre-tax income distribution. The dashed line is the 45-degree line. The solid line is the OLS fitted line.

tax function is not challenged by the imputation and simulation procedures used by LIS and the country-specific datasets that LIS utilizes.

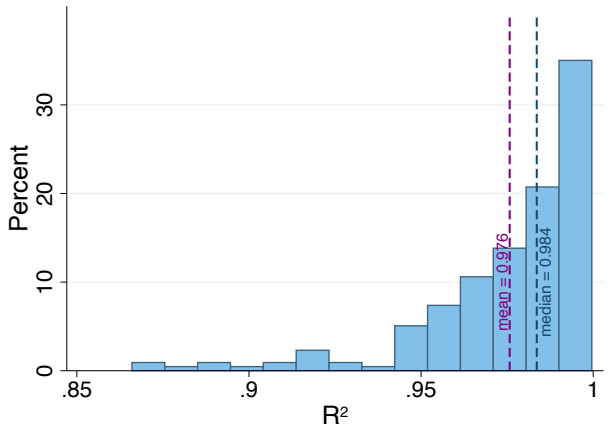


Figure 3: Distribution of the R^2 from year-by-year and country-by-country regressions of log post-tax income on log pre-tax income.

5.2 Effective Income Taxes Across Countries

After establishing that the log-linear tax function is a good approximation of the income tax systems of the countries in our sample, we can discuss our estimated effective tax functions.

We start by comparing the average level of taxation and progressivity across countries. In Figure 4, we plot the estimated tax parameters for waves 1, 5, and 11. We present the results for the remaining waves in Appendix II. In Figure 4, we plot progressivity, as measured by the parameter τ, as a function of the average tax rate for the median household in each country, that is, the household earning the median pre-tax income in each country.[9] This figure also displays the pre-tax median income in each country and in each of the waves we consider. Figure 4 shows that, for example, in wave 11 (corresponding to 2019,) the average tax rate in the USA is about 17%, corresponding to a median pre-tax income of about $77,000 and a progressivity parameter τ equal to 0.04.

Figure 4 displays several interesting facts. First, a higher degree of progressivity is associated with a higher average tax rate for the median household. This positive correlation is present in each wave and shown by the positively-sloped fitted lines in Figures 4, A-4, A-5, and A-6.

[9]One can obtain the "raw" parameter λ using the values of the average tax rate, progressivity, and median income we show here. In particular, letting $\hat{\lambda}$ denote the average tax rate and y denote the median pre-tax income, the corresponding λ is obtained as:

$$\lambda = 1 - \frac{1 - \hat{\lambda}/100}{y^{-\tau}}.$$

Second, Figure 4 shows that higher-income northern-European countries such as Germany (DE) and the Netherlands (NL) display some of the highest progressivity and average tax rate in every wave. For instance, Germany displays some of the highest levels of progressivity and average tax rate in waves 1, 5, and 10. In particular, the average tax rate in these waves is 21.3%, 28.6%, and 28.1%, while the corresponding progressivity parameter τ is 0.08, 0.15, and 0.12. Similarly, Belgium (BE) and the Netherlands (NL) consistently appear among the countries with the highest levels of average taxation and progressivity. This finding is consistent with several previous studies. Chang, Chang, and Kim (2018) finds that Germany and Netherlands have some of the highest levels of progressivity in 2016, while Holter, Krueger, and Stepanchuk (2019) shows that this is true also in the period between 2000 and 2007.[10]

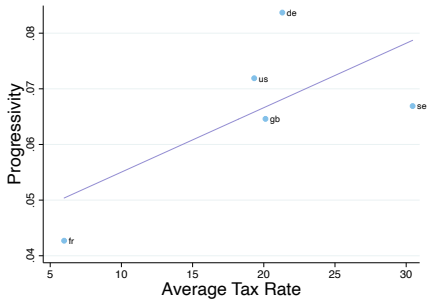
Third, while there is significant variation in the tax system of rich countries with similar median incomes, countries with lower median incomes tend to have similar income tax systems. For instance, in wave 11, Canada and Germany have almost identical median incomes but dramatically different average tax rates and progressivity levels. In particular, in wave 11, the median income in Canada is \$64,952, while the one in Germany is \$64,867. However, the average tax rate in Canada is 17.74%, while the one in Germany is over 10 percentage points higher and equal to 28.11%. Similarly, the progressivity parameter τ is 0.08 in Canada and rises to 0.12 in Germany. In turn, in wave 5, China and Colombia have very low median incomes and remarkably similar tax systems. In particular, they have a median income of \$5,109 and \$6,616, respectively, with a corresponding average tax rate of 3.59% and 2.21%, and a progressivity parameter τ equal to 0.01 in both countries.

Finally, numerous countries with progressive statutory income taxes do not exhibit progressive effective taxes. For example, Brazil, Colombia, Peru, and the Republic of Korea have progressive statutory income taxes, but their effective tax system is almost flat in all waves.

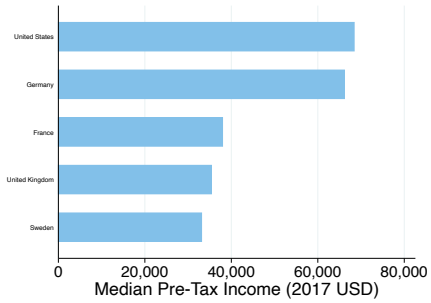
5.3 Effective Income Taxes Over Time

To complete our description of income tax systems, we present the evolution of the average tax rate for the median household and income tax progressivity over time. In what follows, we discuss the results for six countries and display the remaining ones in Appendix III. Table Table A-5 in Appendix II presents the evolution of pre-tax median income over time.

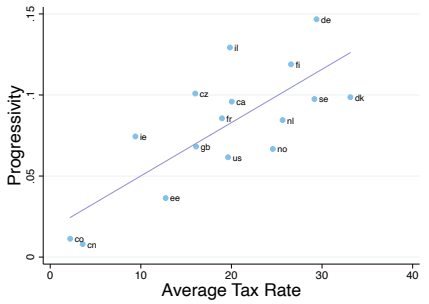
[10] Although Chang, Chang, and Kim (2018) use LIS data for 2016, their progressivity estimates are substantially higher than ours for every country. This is because they estimate a tax and transfer function and, therefore, their parameter τ reflects the progressivity embedded in the tax and transfer system rather than in income taxes alone. Thus, we expect their estimates to be higher than ours. Table 1 in Heathcote, Storesletten, and Violante (2020) also shows that using a tax and transfer function leads to higher estimates of progressivity than using a tax function.



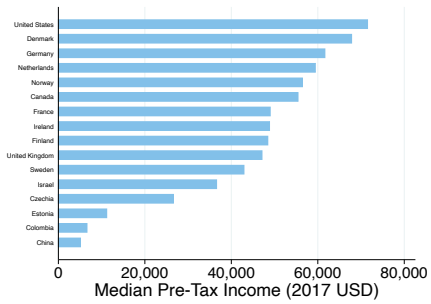
(a) Wave 1, 1980



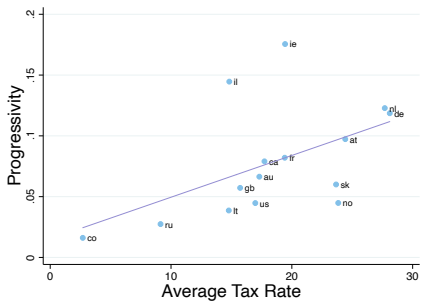
(b) Wave 1, 1980



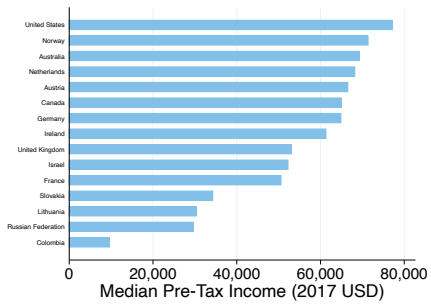
(c) Wave 5, 2000



(d) Wave 5, 2000



(e) Wave 11, 2019



(f) Wave 11, 2019

Figure 4: Tax Parameters Across Countries. Panels on the left: progressivity as a function of the average tax rate in a given wave. The average tax rate is evaluated at the median income of each country. The solid lavender line is the OLS fitted line. Panels on the right: pre-tax median income measured in 2017 USD PPP.

Numerous factors affect effective taxation over time. First, tax laws determine the levels of statutory taxation, and thus tax reforms translate into changes in effective taxation. Second, taxpayers' behavior influences effective taxation, as people can change their labor choices based on the incentives or disincentives provided by the tax laws. Finally, the business cycle affects tax laws and labor choices and thus affects effective taxation. While disentangling the effect of each of these factors on effective income taxes goes beyond the scope of our paper, we can still observe interesting patterns in Figure 5.

First, we observe interesting dynamics in the average tax rate for the median household. In Canada, Denmark, Finland, Norway, and the United States, the average tax rate has remained relatively stable over the past 40 years, despite a general increase in median income. For instance, the average tax rate in Canada is 17.79% in 1985 (corresponding to a median income of $ 58,589) and 17.74% in 2019 (for a median income of $ 64,952). Then, in the United States, the average tax rate has its largest reduction between 2000 and 2010, when it drops from 19.63% to 16.52%. This decline is due to the reduction in median income over those years and the 2001 and 2003 income tax reforms collectively known as the "Bush tax cuts" (see Borella, De Nardi, Pak, Russo, and Yang (2022) for a more in-depth description of these reforms and their effects on the effective tax burden.) In turn, the average tax rate for the median household has changed substantially in the United Kingdom. It increases between 1980 and 1990, despite the substantial reductions in income taxes carried out by Margaret Thatcher's government (see Daunton (2017) for a description of the Thatcher tax reforms.) It then decreases markedly between 1990 and 1995 and remained stable ever since. The figures in Appendix III also show interesting dynamics. Figure A-7 shows that progressivity in Australia decreases between 2005 and 2010 and increases between 2010 and 2015. Our results are remarkably close, in both levels and trends, to those in Tran and Zakariyya (2021), which estimates progressivity for Australia using a log-linear tax function and the Household, Income and Labour Dynamics in Australia Survey (HILDA). They argue that the decrease in progressivity between 2005 and 2010 is due to an increase in the top income threshold in 2006, which results in a tax cut for high-income taxpayers. Then, Figure A-10 shows that the average tax rate in Spain decreases between 2008 and 2010, increases between 2010 and 2013, and then drops again between 2013 and 2016. These movements are consistent with the reforms in the Spanish income tax described in García-Miralles, Guner, and Ramos (2019). In particular, the Spanish government cut taxes after the Great Recession in 2008, raised them between 2010 and 2012 to contrast a fall in GDP, and cut them again in 2015 after the economic recovery following the Great Recession.

Second, we observe significant changes in the level of income tax progressivity across countries. To fix the scale of these changes, recall that the elasticity of post-tax income to pre-tax income is $1 - \tau$. Thus, a change in 0.01 in τ implies a one percentage point change in the response of post-tax income to the pre-tax one. The United States sees a general decrease in

progressivity over the last 40 years. In particular, progressivity in 2018 was about 40 percent lower than in 1980. The decrease in progressivity in the United States between 1980 and 2018 is consistent with the findings of Wu (2021) and Borella, De Nardi, Pak, Russo, and Yang (2022). The United Kingdom and Canada display a similar evolution of progressivity: it increases between 1985 and 1995 and then declines. Compared to its 1995 level, progressivity in 2018 is a third lower in the United Kingdom and a quarter lower in Canada. Progressivity increases in the Scandinavian countries between 1990 and 1995 but then shows different dynamics. In Denmark, progressivity grows until 2000, decreases markedly between 2000 and 2006, rebounds, and stabilizes after 2010. In Norway, in turn, it grows until 2004 but declines after then and, in 2018, is about half the size of 2004. Finally, progressivity declines between 1995 and 2013 but rebounded to its 2000 level in 2018. In Finland, finally, progressivity drops between 1995 and 2004, is relatively stable until 2013, and increases between 2013 and 2016.

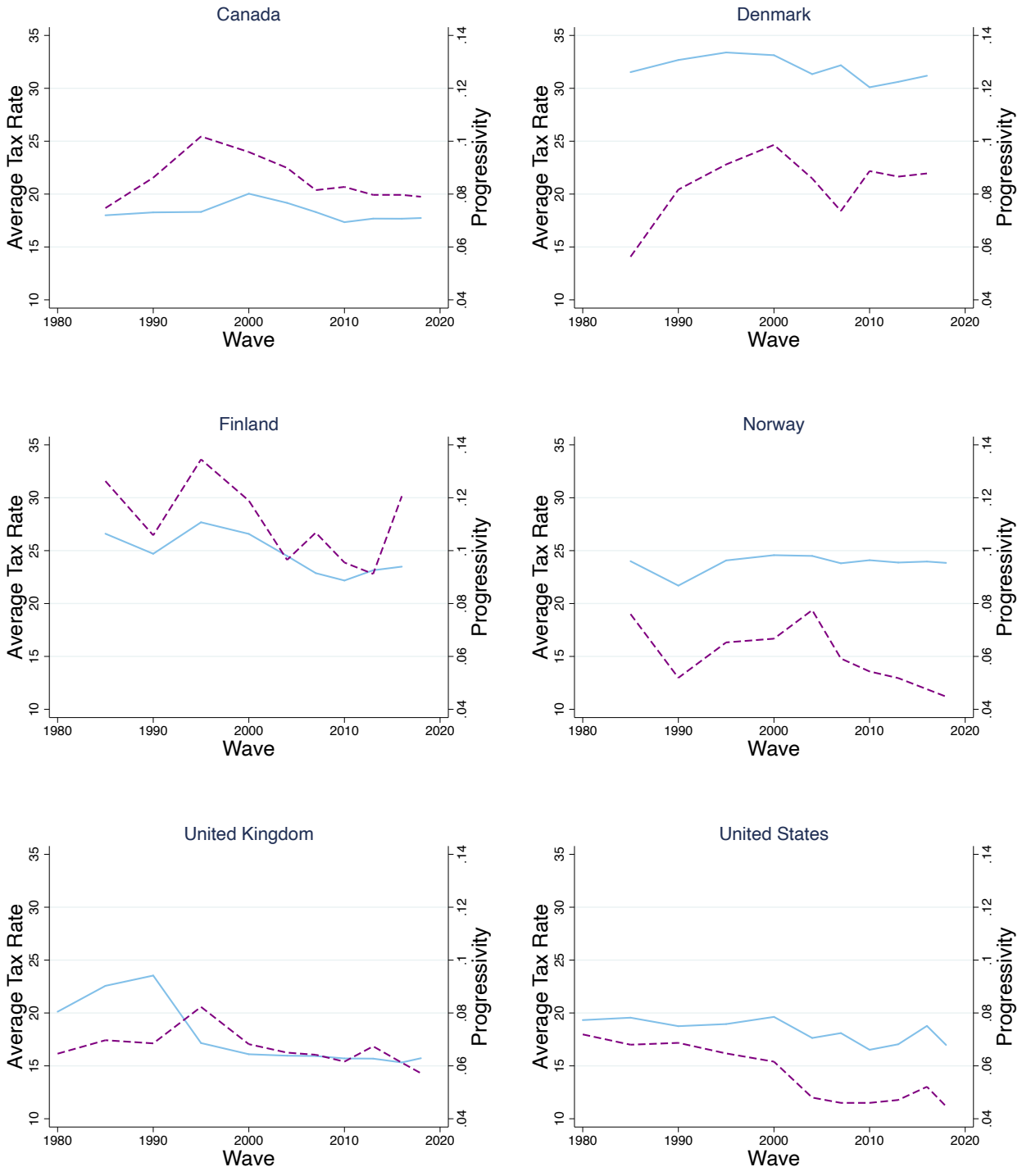


Figure 5: Average tax rate and progressivity over time. The solid blue line is the average tax rate for the median household in each year. The dashed purple line is the progressivity parameter τ.

6 Progressivity and Development

In Section 5.2, we have shown that richer countries exhibit a higher level of progressivity and average taxation. In this section, we further investigate the relationship between income tax progressivity and economic development. In particular, we proxy economic development by median pre-tax income and plot its relationship with income tax progressivity in Figures 6 and 7.

These figures show that richer countries also display higher income tax progressivity. While the intensity of this association (i.e., the slope of the fitted line) changes over time, it is always positive except for Wave 2 (corresponding to 1985). Countries such as Belgium, Germany, and the Netherlands consistently rank among the wealthiest countries and have the highest degree of income tax progressivity.

To check the robustness of the positive relationship between progressivity and development, in Appendix IV, we plot progressivity as a function of median income and GDP per capita from the Penn World Tables (see Feenstra, Inklaar, and Timmer (2015) for a description of the Penn World Tables). This comparison shows that, except for Waves 1 and 3, the results obtained using GDP per capita line up closely with those obtained using median income. In particular, Figures A-12-A-14 confirm that there is a consistently positive relationship between progressivity, median income, and GDP per capita after Wave 4 (corresponding to 1995). This result is consistent with Bick, Fuchs-Schündeln, Lagakos, and Tsujiyama (2022), which finds that higher GDP-per-capita countries also display higher income tax progressivity.

Figures 6 and 7 also show large differences in progressivity across countries with similar median income levels. For instance, in Wave 9, many countries have a median income between 60,000 and 70,000 dollars but display vastly different progressivity levels. In this wave, Belgium (BE) and The United States (US) have a median income of $65,999 and $65,500, respectively. However, Belgium's progressivity is three times as large as that of the United States. In turn, numerous countries have considerably different median income levels but similar income tax progressivity. For instance, in Wave 9, Czechia (CZ,) Israel (IL,) France (FR,) and Canada (CA) display the same level of progressivity, even though Canada's median income is almost twice as large as Czechia's.

Finally, our results can be compared to those of De Magalhaes, Martorell, and Santaeulalia-Llopis (2019). They document a negative correlation between the level of transfer progressivity and the stage of economic development, as proxied by GDP per capita. The difference between our results and theirs is due to the fact that they study the progressivity of the tax and transfer system rather than that of taxes alone.

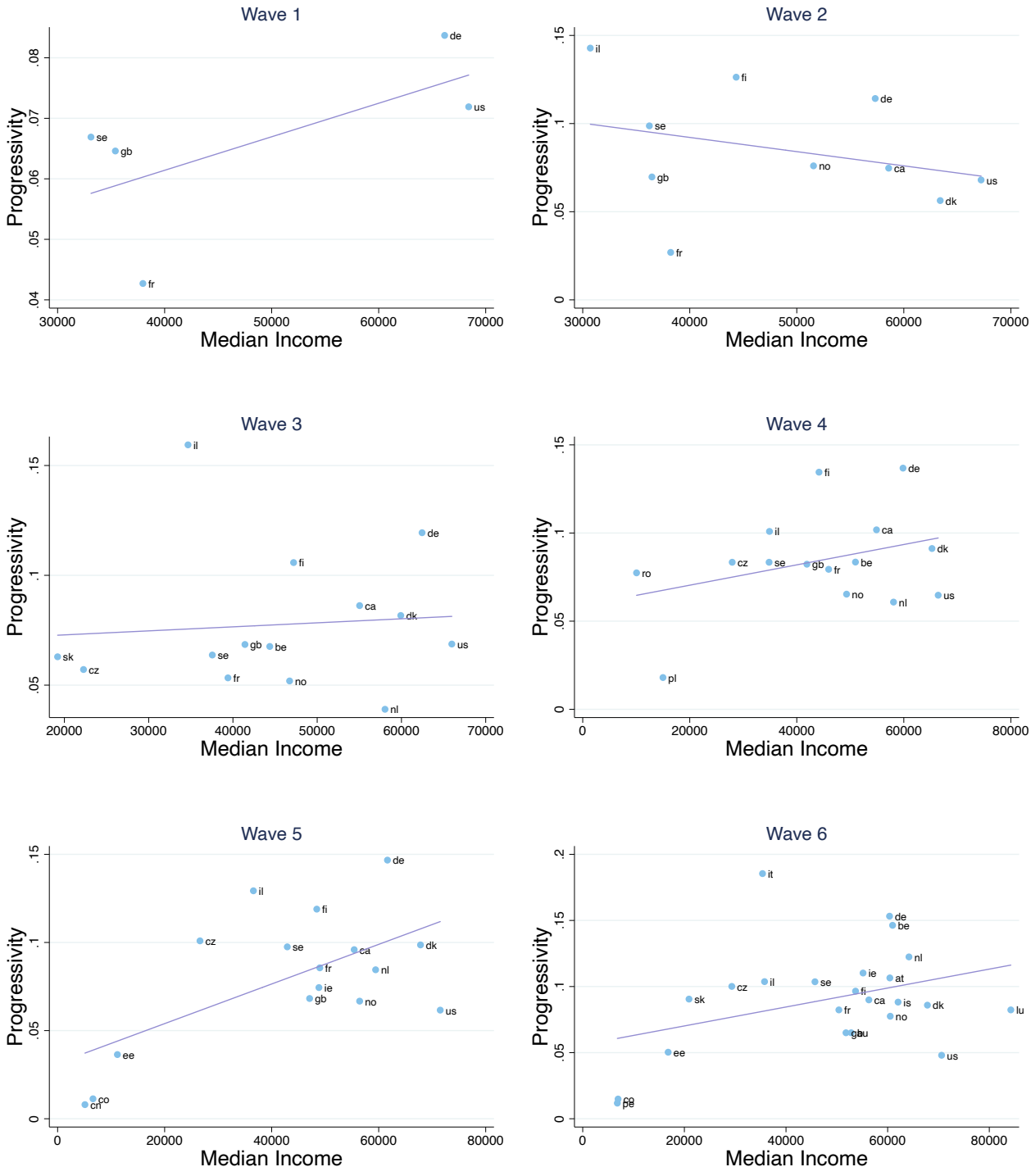


Figure 6: Progressivity as a function of median income. Progressivity is measured by the parameter τ. Income is measured in 2017 USD PPP. The solid lavender line is the OLS fitted line.

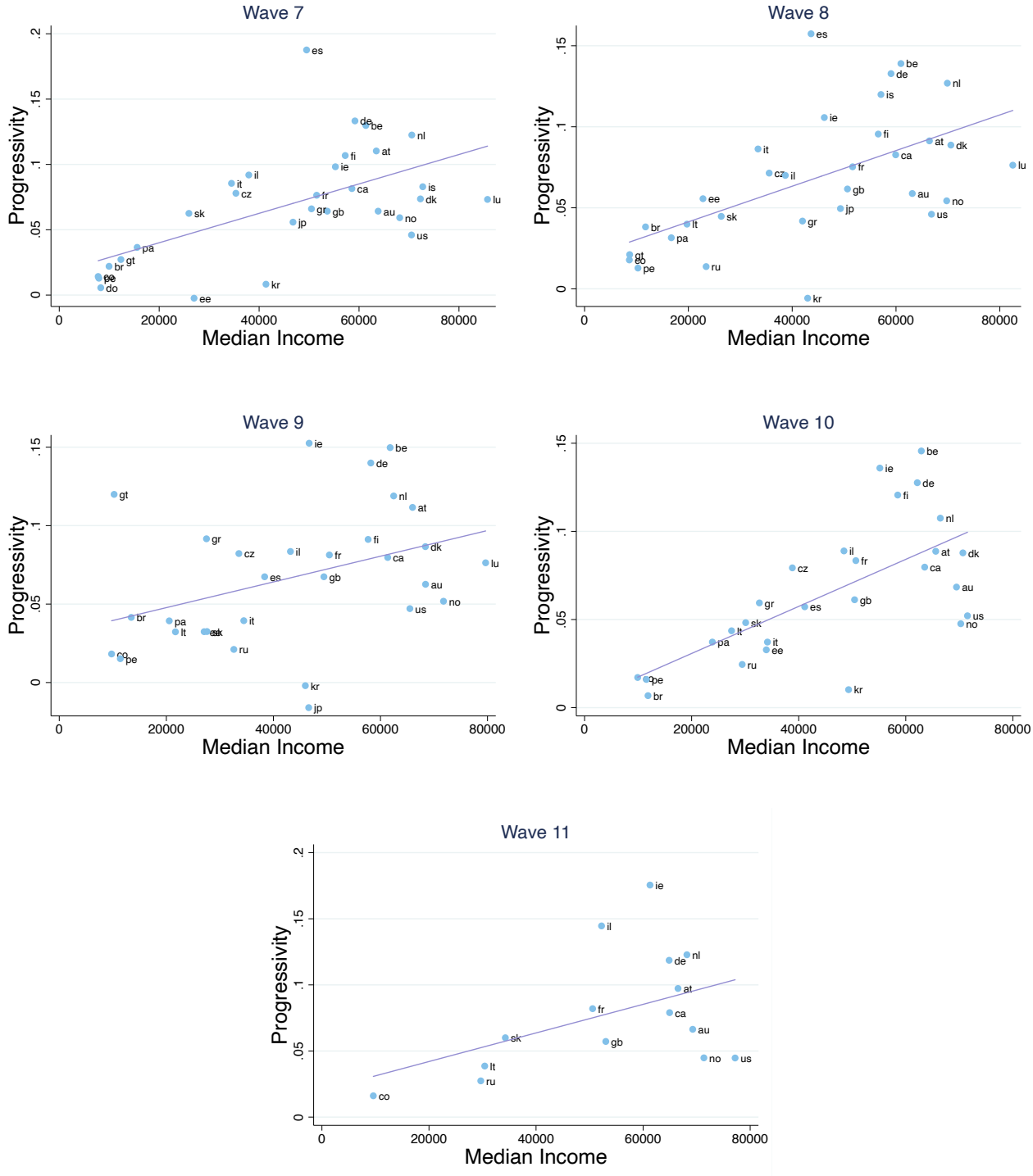


Figure 7: Progressivity as a function of median income. Progressivity is measured by the parameter τ. Income is measured in 2017 USD PPP. The solid lavender line is the OLS fitted line.

7 Progressivity and Family Structure

In the previous sections, we focused on standard households to get a comprehensive view of the dynamics of income tax progressivity. In this section, we estimate progressivity by family structure to assess whether it differs across household types. We first present descriptive statistics about household composition in our sample, and then we estimate income tax progressivity separately by family structure.

7.1 Household Composition

We split our sample into the four categories that make up our notion of a standard household: (1) Married couples with children; (2) Married couples without children; (3) Single Parents; (4) Singles without children.

In Figure 8, we display the dynamics of household composition for six countries in our sample. The results for the remaining countries in our sample are in Appendix V. These figures highlight several interesting trends.

First, across all countries, the fraction of married couples with children decreases significantly over time, while the share of married couples without children is either stable or increasing. For instance, in 1985, half of the Norwegian households are married with children, while only 11 percent are married without children. By 2018, the fraction of couples with children declines to 35 percent, while the fraction of married couples without children increases to 15 percent. In Figure A-15 in Appendix V, we show a similar decline for Germany. In particular, while 57% of German households are married with children in 1980, only 35% are in 2018. In turn, the share of married couples without children rises from 19% in 1980 to 22% in 2018.

Second, the share of singles without children has increased in most countries, while the fraction of single parents is relatively stable. For instance, the share of singles in the United States goes from 15% in 1980 to 22% in 2018 while the fraction of single parents only rises from 12% to 13% between the same years. Figure A-15 in Appendix V shows that the rise in the share of singles is particularly pronounced for European countries such as France and Germany. In particular, the fraction of singles in France more than doubles between 1980 and 2018, going from 13% to 28%. This is accompanied by a similar increase in the share of single parents, which rises from 6% in 1980 to 14% in 2018. In Germany, these changes are even larger. Between 1980 and 2018, the shares of German singles and single parents rise from 14% and 4%, respectively, to 32% and 9%.

These results highlight the shift from being married and having children to either not having children or, in large part, not being married. These trends are consistent with the decline in

marriage and fertility rates experienced by numerous countries worldwide and documented by numerous studies in the literature. For instance, Boldrin, De Nardi, and Jones (2015) shows that fertility rates decreased in Europe and the USA during the 20th century. OECD (2019) confirms this finding for OECD countries and shows that the number of children per woman declined from 2.8 in 1970 to 1.7 in 2016. It also shows that marriage rates have declined significantly in most OECD countries over the last twenty years. Finally, Ahn and Sánchez-Marcos (2020) document large decreases in the fertility rates of numerous European countries.

7.2 Progressivity by family structure in the Cross-Section

In light of the demographic changes described in the previous section, we now estimate progressivity separately by family structure. In Figure 9, we plot our estimated progressivity in selected countries and waves. We present the results for the remaining countries and waves in Appendix VI.

Our results highlight several interesting patterns. First, we observe large and significant differences in progressivity by family structure in all countries and years. In Figures 9 and A-18, we report the point estimates for the progressivity parameter τ and the 95% confidence intervals. These figures show that our tightly estimated progressivity parameter significantly differs across family structures.

Second, conditional on the presence of children, progressivity varies by marital status. In particular, the progressivity for married couples without children is 25.3% higher, on average, than that of childless singles. In turn, the progressivity of married couples with children is 26.4% larger, on average, than that of single parents. A few notable examples are Norway in 1995, where the progressivity for married couples without children is 3.5 times that of childless singles, and the United States in 2010, where the progressivity of married couples with children is more than double that of single parents. The differences in progressivity by marital status are due to the marriage bonuses embedded in joint taxation (which applies to countries such as France, Germany, Ireland, Spain, Switzerland, and the United States), different statutory taxation by marital status, and different credits and deductions that apply to legally married couples.

Third, conditional on marital status, the presence of children leads to large changes in progressivity. In particular, on average, the progressivity for married couples with children is 18.5% higher than that of married couples without children. The difference in progressivity between single parents and childless singles is smaller, but the one for single parents is still 5.9% higher on average than that of childless singles. Figure 9 shows that, for instance, in 1985, the progressivity for Danish married couples with children is more than double that of married

Figure 8: Household composition by wave for selected countries in our sample. Each share is computed by dividing the number of households with the corresponding family structure by the number of total households in the given country and year.

couples without children, while, in 2010, the progressivity of British single parents is 1.5 times that of childless singles. One reason behind these differences is that, in most countries, families with dependent children enjoy higher credits and deductions than their childless counterparts.

Fourth, although there are numerous differences across countries and waves, a stable pattern emerges. In particular, for the majority of our country-wave observations, childless singles face the lowest progressivity, while married couples with children enjoy the highest. In Figure 9, for instance, married couples with children display the highest progressivity in most countries and waves.

Finally, our results can be compared to previous ones in the literature. Guner, Kaygusuz, and Ventura (2014) estimates progressivity in the United States in 2000 for married and single households with and without children. They find that, regardless of the presence of children, married couples enjoy higher progressivity than singles. Our results for the United States in wave 5 (corresponding to 2000) confirm this finding. In particular, Table A-7 shows that the progressivity for married couples without children is 1.4 times that of childless singles, while the one for married couples with children is almost double that of single parents. Malkov (2022) uses an optimal income taxation approach to conclude that married couples in the United States should be taxed less progressively than singles. Our estimates suggest that the current US tax system does the opposite since, regardless of the presence of children, married couples enjoy higher progressivity than singles in all waves.

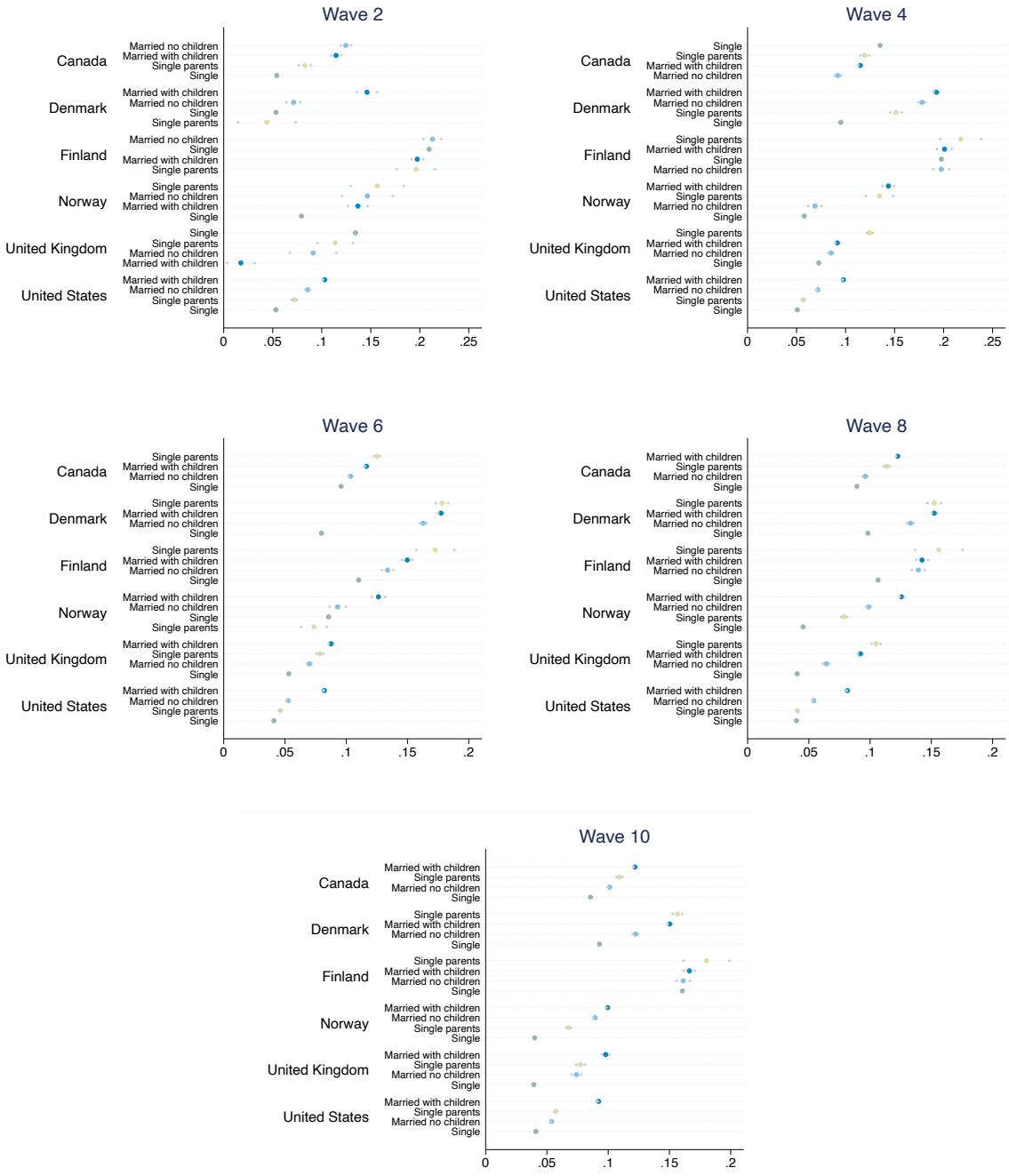


Figure 9: Income tax progressivity by family structure. Blue dots are the point estimate for the progressivity parameter τ, and gray diamonds mark the 95% confidence interval. For each country and wave, family structures are ranked and shown in ascending order of progressivity.

7.3 Progressivity by family structure over Time

In this section, we study the evolution of progressivity by family structure over time. Figure 10 plots the dynamics of progressivity in Canada, Denmark, Finland, Norway, the United Kingdom, and the United States. Figures A-19 and A-20 in Appendix VII report the results for the remaining countries in our sample.

Although the dynamics of progressivity vary considerably across countries, several common trends emerge from our results. First, the presence of children in the family is associated with the highest degree of progressivity. In particular, in most countries and consistently over time, married couples with children and single parents enjoy the highest progressivity. For instance, Figure 10 shows that, between 1980 and 2018, income taxation is more progressive for Danish married couples with children and single parents than for childless couples and singles. The United States displays a similar evolution of progressivity. In particular, married couples with children enjoy the highest progressivity every year between 1985 and 2018. Our results for the United States are consistent with those from Borella, De Nardi, Pak, Russo, and Yang (2022), which shows that, between 1970 and 2016, married couples face a more progressive federal income tax system than singles.

Second, childless singles tend to face the lowest level of progressivity. For instance, Figure 10 shows that, between 1980 and 2018, childless singles consistently face the lowest progressivity in Denmark, Norway, and the United States. Figures A-19 and A-20 show that this result holds for the vast majority of countries in our sample, with a few exceptions. In particular, progressivity is the highest for childless singles in Greece between 2010 and 2013, in Israel in 2018, in the Netherlands between 2007 and 2010, and in the Russian Federation between 2010 and 2018.

Finally, there are several common trends over time. Between 1990 and 1995, we estimate an increase in progressivity in most countries in our sample. This is particularly notable for Denmark and France, where progressivity increases for all family structures, and for single parents, whose progressivity rises for all countries in our sample except for Sweden and the United States. Then, we observe a decrease in progressivity for all groups between 2000 and 2007. Single parents are the most affected group, as their progressivity declines in almost every country. Finally, progressivity rebounds for all groups between 2010 and 2013 and increases for married couples without children especially.

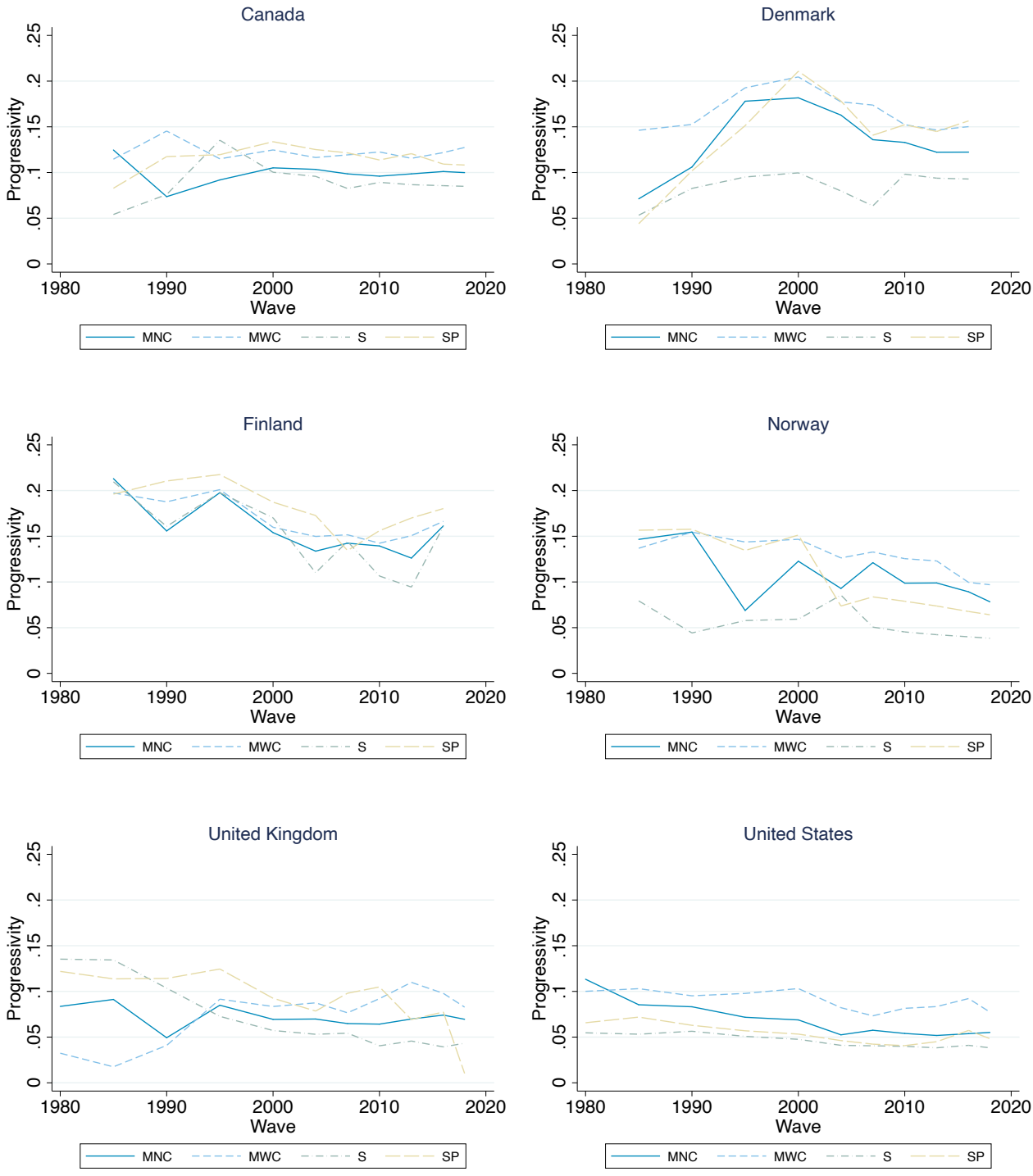


Figure 10: Income tax progressivity by family structure over time. MNC denotes married couples without children, MWC married couples with children, S singles without children, and SP single parents.

7.4 Summarizing the Effect of Family Structure on Income Taxes

To summarize the effect of family structure on effective incomes taxes, we use the following regression:

$$y_{h,c,t} = \sum_{h} \beta_h \mathbb{I}\{\text{household type} = h\} + \gamma_{c,t} + \varepsilon_{h,c,t},$$

Where the dependent variable $y_{h,c,t}$ is a variable of interest (for example, the tax function parameters $\lambda_{h,c,t}$ and $\tau_{h,c,t}$ for household type h in the country c at wave t,) β_h captures the household-type fixed effects, and $\gamma_{c,t}$ denotes the country-wave fixed effects. We set childless singles as the base group and normalize the levels of the country-wave fixed effects so that the constant term represents the average level of the dependent variable in the base group.

We report the regression results in Table 1. We consider four dependent variables: the tax function parameters, $\lambda_{h,c,t}$ and $\tau_{h,c,t}$, and the average and marginal tax rate for a household with median income in each country-wave-household-type group. For each of these four dependent variables, we compare the estimated household-type fixed effects, β_h, across family structures. In particular, the household-type fixed effects capture the difference in the outcome variable between each group and the base one. For instance, $\beta_h = 0.012$ for couples without children in Column (2) of Table 1 means that the difference in the progressivity parameter τ between married couples without children and childless singles (the base group) is 0.012.

Column (1) of Table 1 shows that the tax function parameter λ (which captures the average level of taxation) is largest for singles, smaller for couples without children, even smaller for single parents, and is the smallest for couples with children. As we discussed in Section 3, conditional on the income level, a higher λ implies a higher average level of taxation. Therefore, our results suggest that childless singles face the highest average level of taxation, while married couples with children face the lowest.

Column (2) reports the estimates of the household-type fixed effects when we use the progressivity parameter as the dependent variable in the regression. These results confirm that childless singles face the lowest progressivity, while married couples with children enjoy the highest.

The results in Column (1) allow us to compare families with a different structure but with the same pre-tax income. To make our comparison across family structures more meaningful, we report the regression results for the average and marginal tax rates for a median household in its respective group in Columns (3) and (4). The very small household-fixed effect for couples with children in Column (3) highlights that the median couple with children pays a very similar average tax rate to the median single household. Column (3) also shows that a median single household is subject to an average tax rate of 18.2%, while a median couple with children faces

	(1)	(2)	(3)	(4)
	λ	τ	Average	Marginal
Childless singles (base)	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Couples without children	-0.327**	0.012***	0.018***	0.025***
	(0.130)	(0.003)	(0.002)	(0.003)
Couples with children	-0.779***	0.021***	0.004**	0.021***
	(0.130)	(0.003)	(0.002)	(0.003)
Single parents	-0.513***	0.010***	-0.054***	-0.040***
	(0.130)	(0.003)	(0.002)	(0.003)
Constant	-1.260***	0.083***	0.182***	0.247***
	(0.092)	(0.002)	(0.001)	(0.002)
Country-Wave FE	Yes	Yes	Yes	Yes
Observations	868	868	868	868
R-squared	0.64	0.81	0.96	0.95

Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01

Table 1: The effect of family structure on effective income taxes.

Notes: This table reports the estimates of the household-type fixed effects. Column (1) reports the results for the tax parameter λ, (2) for the tax parameter τ, (3) for the average tax rate facing a median-income household, and (4) for the marginal tax rate facing a median-income household. We set childless singles as the base group.

an average tax rate of 18.6%. Single parents are subject to the lowest average tax rate, which is 5.4 percentage points lower than that for singles. At the same time, couples without children pay the highest average tax rate, which is 1.8 percentage points higher than the one for singles.

Finally, Column (4) reports the results for the marginal tax rate for the median household in each group. Similarly to what we observe in Column (3), these results show that single parents pay the lowest marginal tax rate, whereas couples without children pay the highest. In particular, median single parents are subject to a marginal tax rate of 20.7%, while median couples without children face a marginal tax rate of 27.2%.

8 Conclusions

We studied income taxes worldwide by estimating effective income tax functions over the last forty years. We showed that a two-parameter log-linear effective tax function approximates

income tax systems worldwide remarkably well. We analyzed the dynamics of average taxation and progressivity and showed that higher taxation is positively correlated with greater progressivity. We also provided evidence that progressivity changed significantly across countries between 1980 and 2016. We also reported a positive relationship between income tax progressivity and economic development. Finally, we showed that progressivity varies across family structures and that marriage and the presence of children in the family lead to higher progressivity.

A crucial contribution of our paper is estimating effective income tax functions by country, year, and family structure. We first showed that our tax functions provide an excellent approximation of their respective tax systems. Hence, they can be readily used in structural models to answer numerous macroeconomic questions.

Second, we documented a considerable variation in average taxation and progressivity across countries and years. We showed a positive association between average taxation and progressivity, with Northern-European countries such as Germany and the Netherlands imposing the highest average tax rate and progressivity. We also showed a considerable variation in progressivity over the last forty years for most countries in our sample.

Third, we showed that progressivity varies significantly across levels of economic development. We proxied development by median pre-tax income and GDP per capita and documented that wealthier countries display higher progressivity.

Finally, we documented large and significant differences in progressivity by family structure. We estimated separate tax functions for four types of households and showed that marriage and the presence of children lead to higher progressivity. In particular, we showed that, across countries and years, childless singles face the lowest progressivity while married couples with children enjoy the highest.

We conclude our paper with one caveat about interpreting and comparing our results to those in the literature. Our analysis focused on the progressivity embedded in income taxes alone rather than the whole tax and transfer system. In many countries, however, transfers play a key role in progressivity and redistribution. Hence, tax and transfer functions (which include some or all transfers in their measure of pre-government income) may lead to vastly different estimates of progressivity than ours. Our approach is suitable for those interested in analyzing the progressivity embedded in income taxes and those wanting to incorporate a tax function in their structural models and model transfers separately.

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APPENDICES FOR ONLINE PUBLICATION

I LIS data

I.1 Details on Our Sample

Country	**Code**	**Wave 1** 1980	**Wave 2** 1985	**Wave 3** 1990	**Wave 4** 1995	**Wave 5** 2000	**Wave 6** 2004	**Wave 7** 2007	**Wave 8** 2010	**Wave 9** 2013	**Wave 10** 2016	**Wave 11** 2019
Australia	au						7,375	5,844	10,121	8,381	9,812	8,149
Austria	at						9,355	11,046	11,491	10,653	10,670	6,865
Belgium	be			4,789	4,636		10,183	11,579	10,264	10,836	10,360	
Brazil	br							70,845	135,253	65,621	86,448	
Canada	ca		7,094	12,464	23,850	70,294	49,255	45,803	42,267	45,330	57,776	25,089
China	cn					12,155						
Colombia	co					101,550	224,936	270,445	360,223	356,371	351,783	228,934
Czechia	cz			9,828	16,700	4,768	2,501	6,149	4,693	3,980	4,388	
Denmark	dk		7,404	7,784	46,532	49,301	50,183	51,713	50,175	50,256	50,093	
Dominican Republic	do							4,346				
Estonia	ee					3,396	2,170	2,476	2,484	2,827	3,117	
Finland	fi		8,580	8,677	6,632	7,527	7,627	7,004	5,968	6,850	6,116	
France	fr	22,189	25,588	19,188	40,924	184,623	64,755	65,597	92,296	87,391	84,209	26,883
Germany	de	29,367	38,192	18,651	23,690	37,109	22,242	20,196	32,372	33,706	33,336	12,368
Greece	gr							3,054	2,659	3,854	9,577	
Guatemala	gt							7,737	7,483	6,505		
Iceland	is						1,981	1,960	2,002			
Ireland	ie					3,059	9,013	7,841	7,483	8,938	7,550	2,196
Israel	il		3,199	3,271	3,137	7,766	12,134	11,929	11,717	17,247	16,706	5,474
Italy	it						4,120	3,927	3,880	3,404	2,997	
Japan	jp							1,399	1,172	942		
Lithuania	lt								7,365	6,778	6,635	2,342
Luxembourg	lu						2,461	2,746	3,726	2,527		
Netherlands	nl			2,953	3,582	2,966	6,686	7,069	6,831	6,491	21,041	6,811
Norway	no		2,879	4,920	6,366	9,590	8,833	133,489	136,934	142,070	145,059	152,910
Panama	pa							6,801	6,868	6,055	5,624	
Peru	pe						9,923	11,822	11,134	15,250	18,826	
Poland	pl				19,318							
Republic of Korea	kr							17,540	7,709	7,189	5,495	
Romania	ro				34,508							
Russian Federation	ru								8,567	50,219	150,981	62,965
Slovakia	sk			9,920			3,187	3,061	2,877	5,593	7,545	2,386
Spain	es							6,923	6,797	6,186	6,805	
Sweden	se	7,302	6,570	8,645	9,522	8,699	9,839					
United Kingdom	gb	3,889	3,955	4,026	58,703	74,064	51,621	45,040	41,549	34,511	32,489	10,558
United States	us	37,907	33,734	68,128	156,838	211,945	145,505	143,646	138,279	119,357	119,007	71,083
Total obs.		100,654	137,195	183,244	454,938	790,167	715,885	989,027	1,172,639	1,125,318	1,264,445	625,013
Total countries		5	10	14	15	17	23	30	31	30	27	15

Table A-1: Countries in our sample, associated ISO code, and number of observations in each wave. Blank cells denote waves for which we do not have the data we need to estimate tax functions for a certain country.

I.2 Income Components

We take the components which define our measures of pre-tax and post-tax income directly from LIS. Therefore, we report the LIS definitions here.[11]

Labor income. Total income from the labor of all household members, including cash payments and value of goods and services received from dependent employment, profits/losses and value of goods from self-employment, as well as the value of own consumption.

Capital income. Cash payments from property and capital (including financial and non-financial assets), including interest and dividends, rental income and royalties, and other capital income from investment in self-employment activity. It excludes capital gains, lottery winnings, inheritances, insurance settlements, and all other forms of one-off lump sum payments.

Pensions. Total pension income from all pillars (private, occupational, public), all types (insurance, universal, assistance), and all functions (old-age, disability, survivors). Includes voluntary individual pensions, mandatory individual pensions, occupational pensions, employment-related public pensions, universal pensions, and assistance pensions.

Public social benefits. Cash Social Security transfers (excluding public pensions) stemming from insurance, universal or assistance schemes, and in-kind social assistance transfers.

Private transfers. Cash transfers and value of in-kind goods and services of a private nature that do not involve any institutional arrangement between the individual and the government or the employer. Includes transfers provided by non-profit institutions, other private persons/households, and other bodies in the case of merit-based education transfers.

Income taxes and contributions. Income taxes and Social Security contributions paid. Expenditures on income taxes are defined here as compulsory payments to the Government based on the current income earned, including both the amount withheld at source and the amount directly paid at the moment of the tax adjustment. Social security contributions are payroll taxes from wage and salary workers for the first and second pillars of social insurance: social security, health plans, unemployment insurance, etc.

[11] These definitions can also be found in the codebook at: https://www.lisdatacenter.org/wp-content/uploads/files/data-lis_codebook.pdf

I.3 Fit of the Tax Function in Wave 10

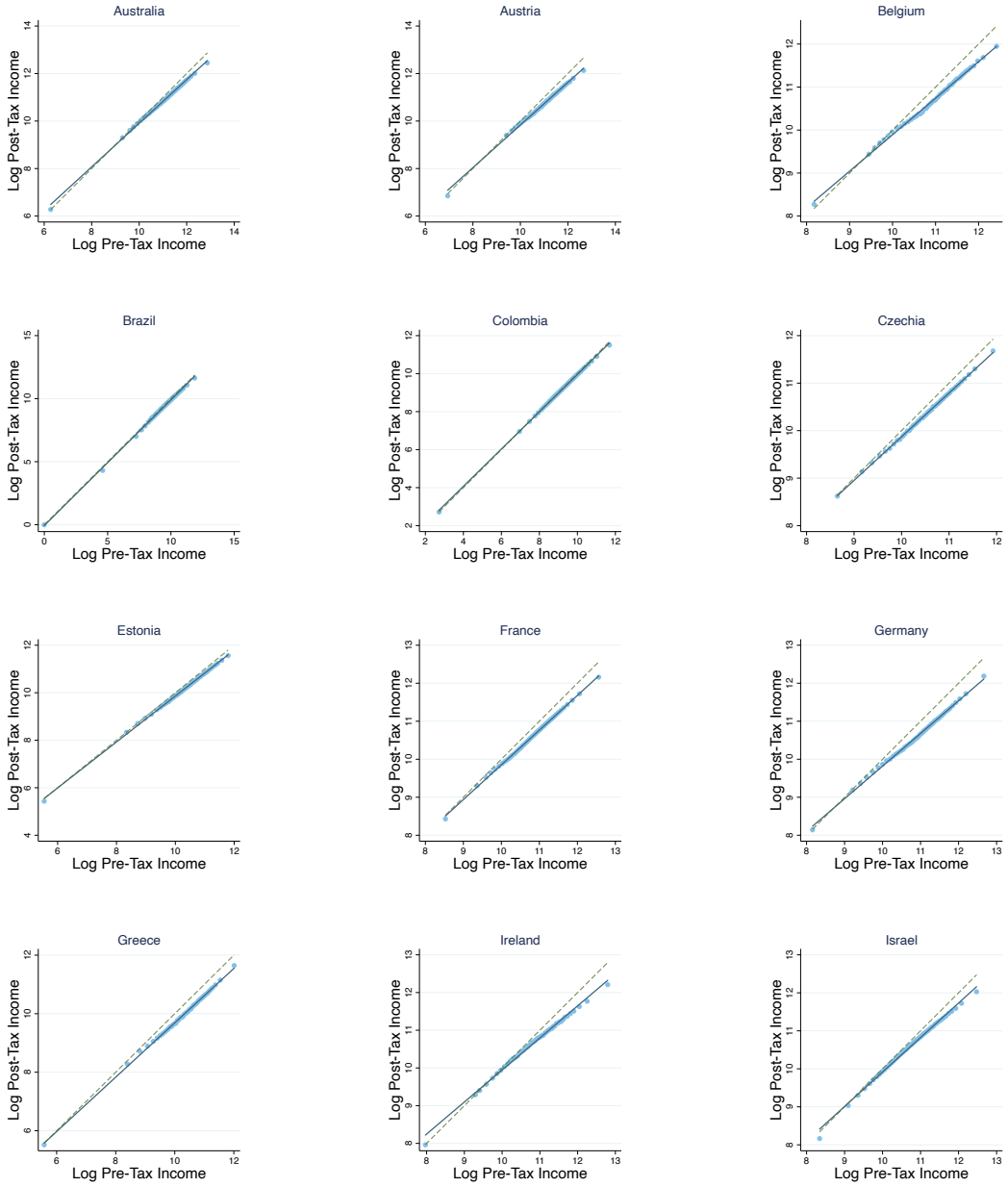


Figure A-1: Log post-tax income as a function of log pre-tax income, Wave 10. Post-tax income is defined as pre-tax income minus income taxes. Each dot is a percentile of the log pre-tax income distribution. The dashed line is the 45-degree line. The solid line is the OLS fitted line.

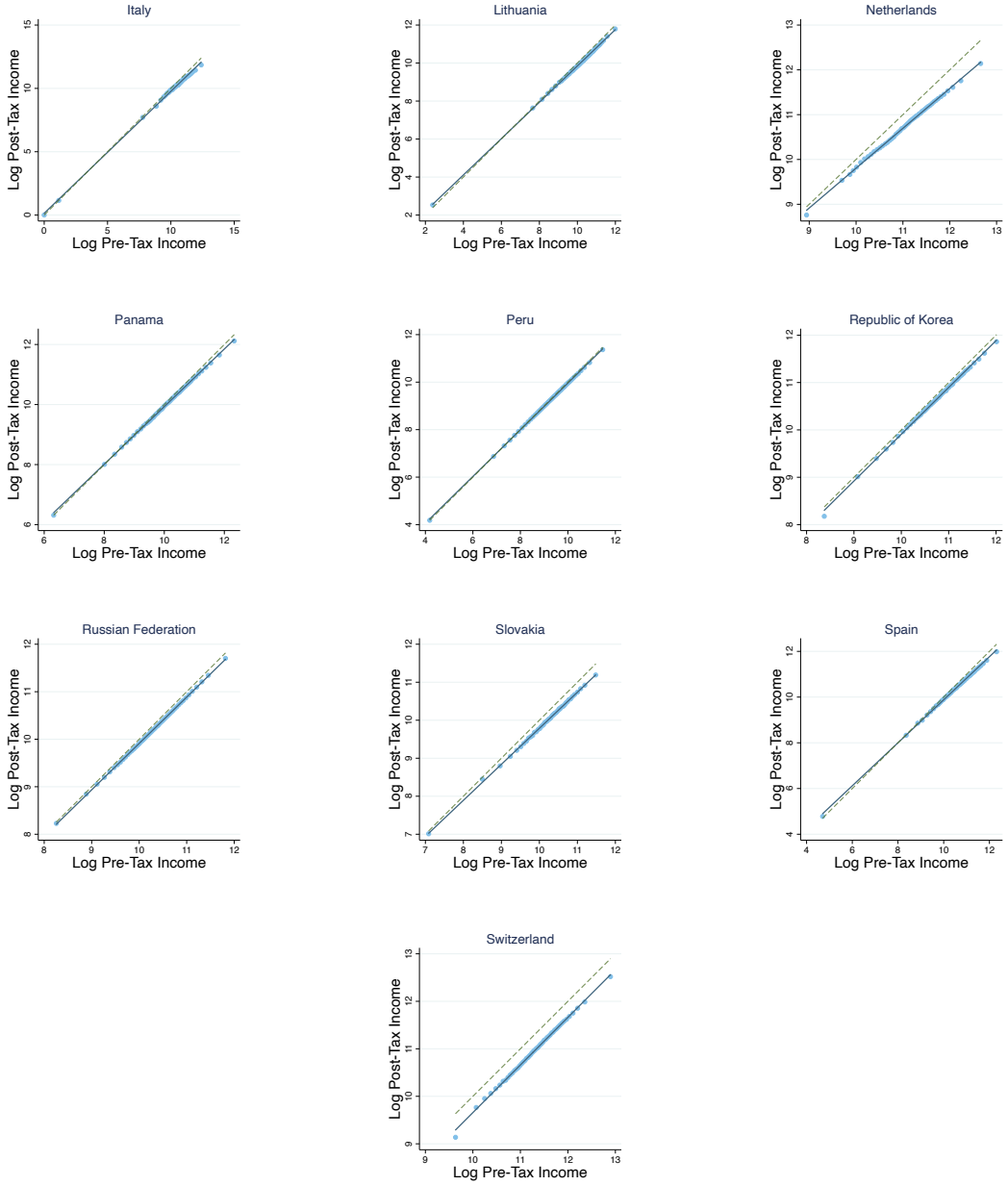


Figure A-2: Log post-tax income as a function of log pre-tax income, Wave 10. Post-tax income is defined as pre-tax income minus income taxes. Each dot is a percentile of the log pre-tax income distribution. The dashed line is the 45-degree line. The solid line is the OLS fitted line.

I.4 Details on Imputation

While for numerous countries, such as Canada, Norway, and the United Kingdom, information on income taxes and social contributions is directly observed, for several other countries, such as Australia, Israel, and the United States, income taxes and social contributions are either imputed or simulated based on available information. Table A-2 shows whether taxes and contributions are imputed in each country and wave. Unless the imputation procedures rely on a log-linear tax function similar to ours, our goodness-of-fit measures are not overestimated. To our knowledge, neither LIS nor any country-specific dataset uses a log-linear tax function to impute income taxes. Instead, they use more complex micro-simulations methods. For example, the data on income taxes for the United States come from the Annual Social and Economic Supplement (ASEC) of the Current Population Survey (CPS). It uses the Census Bureau's tax model, a micro-simulation model comparable to NBER's TAXSIM, to compute federal income taxes based on information from the CPS, the Internal Revenue Service, the American Housing Service, and the State Tax Handbook.

Figure A-3 confirms that imputation does not affect our results. Here we plot the distribution of R^2 obtained when we exclude from our sample all countries and waves for which taxes and social contributions were imputed rather than observed directly. This graph shows that the mean and the median of the distribution of R^2 obtained when we exclude imputed values are the same as the ones for the overall sample.

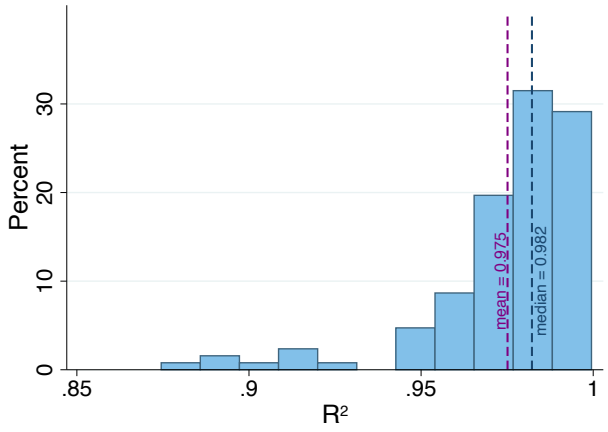
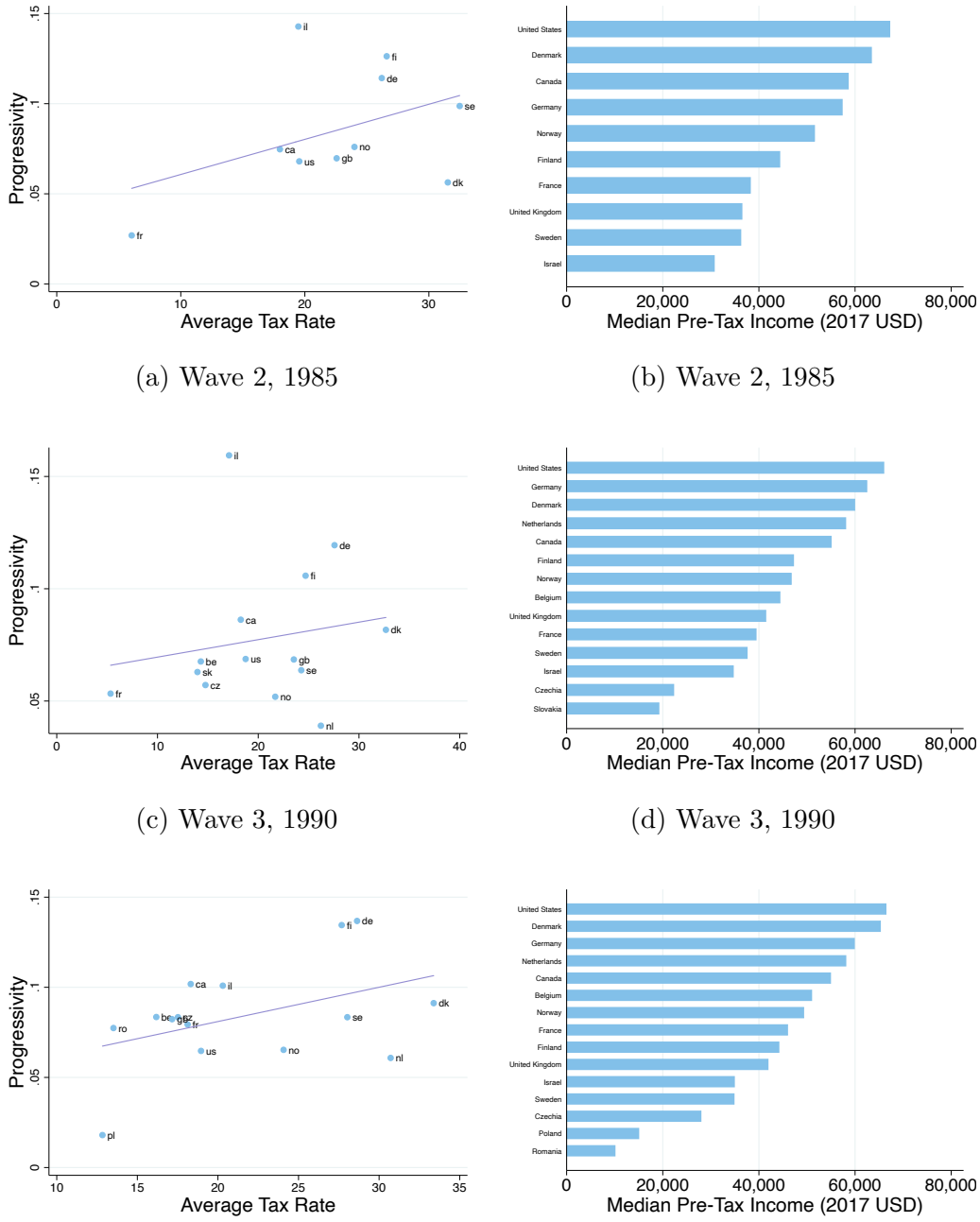


Figure A-3: Distribution of the R^2 from year-by-year and country-by-country regressions of log post-tax income on log pre-tax income when we exclude imputed values

Country	**Wave 1** 1980	**Wave 2** 1985	**Wave 3** 1990	**Wave 4** 1995	**Wave 5** 2000	**Wave 6** 2004	**Wave 7** 2007	**Wave 8** 2010	**Wave 9** 2013	**Wave 10** 2016	**Wave 11** 2018
Australia						yes	yes	yes	yes	yes	yes
Austria						no	no	no	no	no	no
Belgium			yes	yes		yes	yes	yes	yes	yes	
Brazil							yes	yes	yes	yes	
Canada		no	no	no	no	no	no	no	no	no	no
China					no						
Colombia					yes	yes	yes	yes	yes	yes	yes
Czechia			no	no	yes	no	no	no	yes	yes	
Denmark		no	no	no	no	no	no	no	no	no	
Dominican Republic							no				
Estonia					no	yes	yes	yes	yes	yes	
Finland		no	no	no	no	no	no	no	no	no	
France	no	no	yes	no	no	no	no	no	no	no	no
Germany	no	no	yes	yes	yes	yes	yes	yes	yes	yes	yes
Greece							yes	yes	yes	yes	
Guatemala							no	yes	yes		
Iceland						no	no	no			
Ireland					no	no	no	no	no	no	no
Israel		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Italy						yes	yes	yes	yes	yes	
Japan							yes	yes	yes		
Lithuania								no	no	no	no
Luxembourg						no	no	no	no		
Netherlands			yes	no	no	no	no	no	no	no	no
Norway		no	no	no	no	no	no	no	no	no	no
Panama							yes	yes	yes	yes	
Peru						no	no	no	no	no	
Poland				no							
Republic of Korea							no	no	no	no	
Romania				no							
Russian Federation								yes	yes	yes	yes
Slovakia			no			no	no	no	yes	yes	yes
Spain							no	no	no	no	
Sweden	no	no	no	no	no	no					
United Kingdom	no	no	no	no	no	no	no	no	no	no	no
United States	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Percent Imp.	20	20	43	27	35	35	40	45	53	52	47

Table A-2: This table shows which country-wave pair has an imputed measure of income taxes. "yes" means taxes are imputed, while "no" means taxes are directly observed. In the last row, we compute the percentage of countries with imputed income taxes in each wave.

II Effective Taxes Across Countries



(a) Wave 2, 1985

(b) Wave 2, 1985

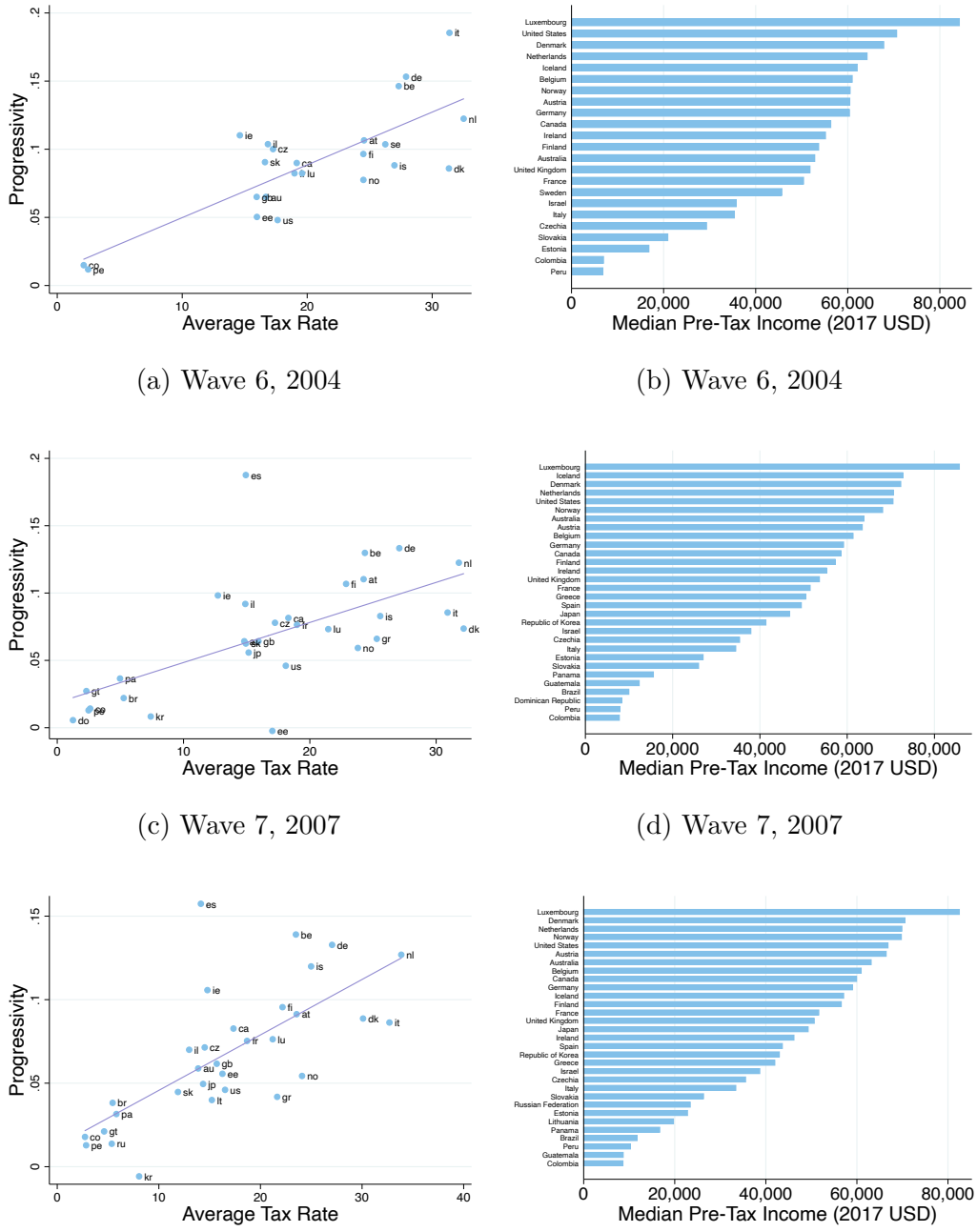
(c) Wave 3, 1990

(d) Wave 3, 1990

(e) Wave 4, 1995

(f) Wave 4, 1995

Figure A-4: Tax Parameters Across Countries. Panels on the left: progressivity as a function of the average tax rate in a given wave. The average tax rate is evaluated at the median income of each country. The solid lavender line is the OLS fitted line. Panels on the right: pre-tax median income measured in 2017 USD PPP.



(a) Wave 6, 2004

(b) Wave 6, 2004

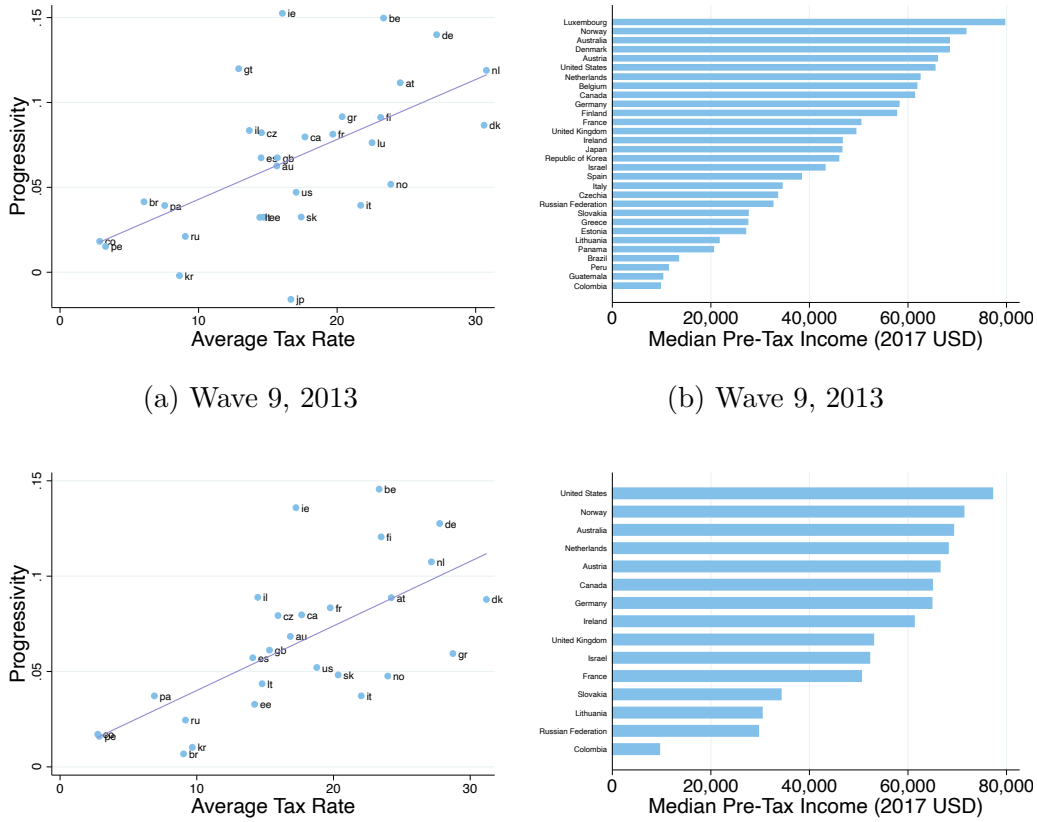
(c) Wave 7, 2007

(d) Wave 7, 2007

(e) Wave 8, 2010

(f) Wave 8, 2010

Figure A-5: Tax Parameters Across Countries. Panels on the left: progressivity as a function of the average tax rate in a given wave. The average tax rate is evaluated at the median income of each country. The solid lavender line is the OLS fitted line. Panels on the right: pre-tax median income measured in 2017 USD PPP.



(a) Wave 9, 2013

(b) Wave 9, 2013

(c) Wave 10, 2016

(d) Wave 10, 2016

Figure A-6: Tax Parameters Across Countries. Panels on the left: progressivity as a function of the average tax rate in a given wave. The average tax rate is evaluated at the median income of each country. The solid lavender line is the OLS fitted line. Panels on the right: pre-tax median income measured in 2017 USD PPP.

Country	Wave										
	1 1980	2 1985	3 1990	4 1995	5 2000	6 2004	7 2007	8 2010	9 2013	10 2016	11 2019
Australia						16.70	14.81	13.87	15.65	16.85	17.31
Austria						24.55	24.26	23.56	24.56	24.23	24.43
Belgium			14.30	16.18		27.32	24.36	23.49	23.35	23.34	
Brazil							5.26	5.45	6.06	9.03	
Canada		17.99	18.27	18.31	20.04	19.17	18.30	17.34	17.68	17.67	17.74
China					3.59						
Colombia					2.21	2.12	2.61	2.73	2.86	2.76	2.70
Czechia			14.76	17.52	16.01	17.27	17.24	14.51	14.54	15.94	
Denmark		31.53	32.68	33.39	33.13	31.34	32.18	30.10	30.61	31.19	
Dominican Republic							1.25				
Estonia					12.74	15.98	17.03	16.26	14.69	14.23	
Finland		26.60	24.70	27.68	26.58	24.50	22.87	22.17	23.14	23.49	
France	5.98	6.04	5.34	18.12	18.96	18.99	18.98	18.69	19.69	19.76	19.42
Germany	21.30	26.20	27.58	28.63	29.39	27.91	27.08	27.05	27.18	27.77	28.11
Greece							25.30	21.65	20.37	28.74	
Guatemala							2.31	4.62	12.89		
Iceland						26.98	25.57	24.99			
Ireland					9.40	14.61	12.72	14.78	16.05	17.25	19.44
Israel		19.48	17.11	20.30	19.84	16.86	14.89	12.99	13.66	14.46	14.83
Italy						31.39	30.91	32.70	21.70	22.03	
Japan							15.15	14.36	16.67		
Lithuania								15.22	14.42	14.78	14.78
Luxembourg						19.60	21.46	21.21	22.52		
Netherlands			26.22	30.72	25.65	32.52	31.80	33.86	30.78	27.16	27.69
Norway		24.00	21.69	24.07	24.57	24.50	23.80	24.10	23.88	23.97	23.84
Panama							4.97	5.82	7.56	6.90	
Peru						2.47	2.48	2.84	3.28	2.88	
Poland				12.84							
Republic of Korea							7.40	8.06	8.62	9.67	
Romania				13.52							
Russian Federation								5.36	9.04	9.17	9.13
Slovakia			13.97			16.62	14.93	11.88	17.41	20.34	23.66
Spain							14.93	14.14	14.51	14.09	
Sweden	30.45	32.48	24.28	28.03	29.16	26.25					
United Kingdom	20.12	22.57	23.54	17.16	16.10	15.96	15.93	15.70	15.68	15.32	15.72
United States	19.33	19.55	18.75	18.95	19.63	17.64	18.10	16.52	17.04	18.78	16.98

Table A-3: Average tax rate across countries and waves. The average tax rate is evaluated at the median income of each country in each wave.

Country	Wave										
	1	2	3	4	5	6	7	8	9	10	11
	1980	1985	1990	1995	2000	2004	2007	2010	2013	2016	2019
Australia						0.07	0.06	0.06	0.06	0.07	0.07
Austria						0.11	0.11	0.09	0.11	0.09	0.10
Belgium			0.07	0.08		0.15	0.13	0.14	0.15	0.15	
Brazil							0.02	0.04	0.04	0.01	
Canada		0.07	0.09	0.10	0.10	0.09	0.08	0.08	0.08	0.08	0.08
China					0.01						
Colombia					0.01	0.01	0.01	0.02	0.02	0.02	0.02
Czechia			0.06	0.08	0.10	0.10	0.08	0.07	0.08	0.08	
Denmark		0.06	0.08	0.09	0.10	0.09	0.07	0.09	0.09	0.09	
Dominican Republic							0.01				
Estonia					0.04	0.05	0.00	0.06	0.03	0.03	
Finland		0.13	0.11	0.13	0.12	0.10	0.11	0.10	0.09	0.12	
France	0.04	0.03	0.05	0.08	0.09	0.08	0.08	0.08	0.08	0.08	0.08
Germany	0.08	0.11	0.12	0.14	0.15	0.15	0.13	0.13	0.14	0.13	0.12
Greece							0.07	0.04	0.09	0.06	
Guatemala							0.03	0.02	0.12		
Iceland						0.09	0.08	0.12			
Ireland					0.07	0.11	0.10	0.11	0.15	0.14	0.18
Israel		0.14	0.16	0.10	0.13	0.10	0.09	0.07	0.08	0.09	0.14
Italy						0.19	0.09	0.09	0.04	0.04	
Japan							0.06	0.05	-0.02		
Lithuania								0.04	0.03	0.04	0.04
Luxembourg						0.08	0.07	0.08	0.08		
Netherlands			0.04	0.06	0.08	0.12	0.12	0.13	0.12	0.11	0.12
Norway		0.08	0.05	0.07	0.07	0.08	0.06	0.05	0.05	0.05	0.04
Panama							0.04	0.03	0.04	0.04	
Peru						0.01	0.01	0.01	0.02	0.02	
Poland				0.02							
Republic of Korea							0.01	-0.01	0.00	0.01	
Romania				0.08							
Russian Federation								0.01	0.02	0.02	0.03
Slovakia			0.06			0.09	0.06	0.04	0.03	0.05	0.06
Spain							0.19	0.16	0.07	0.06	
Sweden	0.07	0.10	0.06	0.08	0.10	0.10					
United Kingdom	0.06	0.07	0.07	0.08	0.07	0.07	0.06	0.06	0.07	0.06	0.06
United States	0.07	0.07	0.07	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.04

Table A-4: Progressivity across countries and waves. Progressivity is measured by the tax function parameter τ.

Country	Wave										
	1	2	3	4	5	6	7	8	9	10	11
	1980	1985	1990	1995	2000	2004	2007	2010	2013	2016	2019
Australia						52833	63831	63139	68425	69480	69272
Austria						60440	63462	66436	65999	65605	66523
Belgium			44374	50970		60974	61359	60949	61815	62912	
Brazil							9969	11746	13448	11854	
Canada		58589	55039	54902	55426	56308	58583	59940	61359	63538	64952
China					5109						
Colombia					6616	6959	7789	8629	9775	9922	9605
Czechia			22270	27937	26609	29337	35355	35568	33554	38820	
Denmark		63405	59922	65271	67819	67826	72294	70573	68398	70679	
Dominican Republic							8306				
Estonia					11176	16813	26981	22813	27065	33955	
Finland		44338	47202	44161	48436	53686	57240	56579	57699	58501	
France	37972	38219	39411	45959	49001	50408	51524	51642	50463	50681	50574
Germany	66165	57331	62449	59856	61642	60379	59184	59042	58203	62162	64867
Greece							50483	41991	27502	32657	
Guatemala							12341	8688	10248		
Iceland						62056	72758	57102			
Ireland					48835	55166	55271	46189	46681	55166	61292
Israel		30709	34669	34899	36593	35778	37934	38685	43192	48460	52240
Italy						35380	34472	33416	34468	34166	
Japan							46789	49301	46602		
Lithuania								19730	21703	27463	30415
Luxembourg						84238	85716	82504	79650		
Netherlands			58052	58081	59433	64196	70566	69892	62474	66463	68186
Norway		51565	46728	49306	56444	60518	68145	69766	71783	70277	71361
Panama							15592	16714	20548	23875	
Peru						6816	7928	10290	11406	11555	
Poland				15000							
Republic of Korea							41378	42980	45973	49326	
Romania				10061							
Russian Federation								23421	32611	29446	29679
Slovakia			19193			20915	25949	26334	27601	30098	34269
Spain							49504	43639	38369	41130	
Sweden	33117	36228	37553	34829	42925	45702					
United Kingdom	35398	36468	41427	41894	47094	51803	53648	50650	49439	50443	53035
United States	68412	67225	65980	66430	71503	70622	70509	66836	65500	71532	77188

Table A-5: Pre-tax median income measured in 2017 USD PPP across countries and waves.

III Effective Taxes Over Time

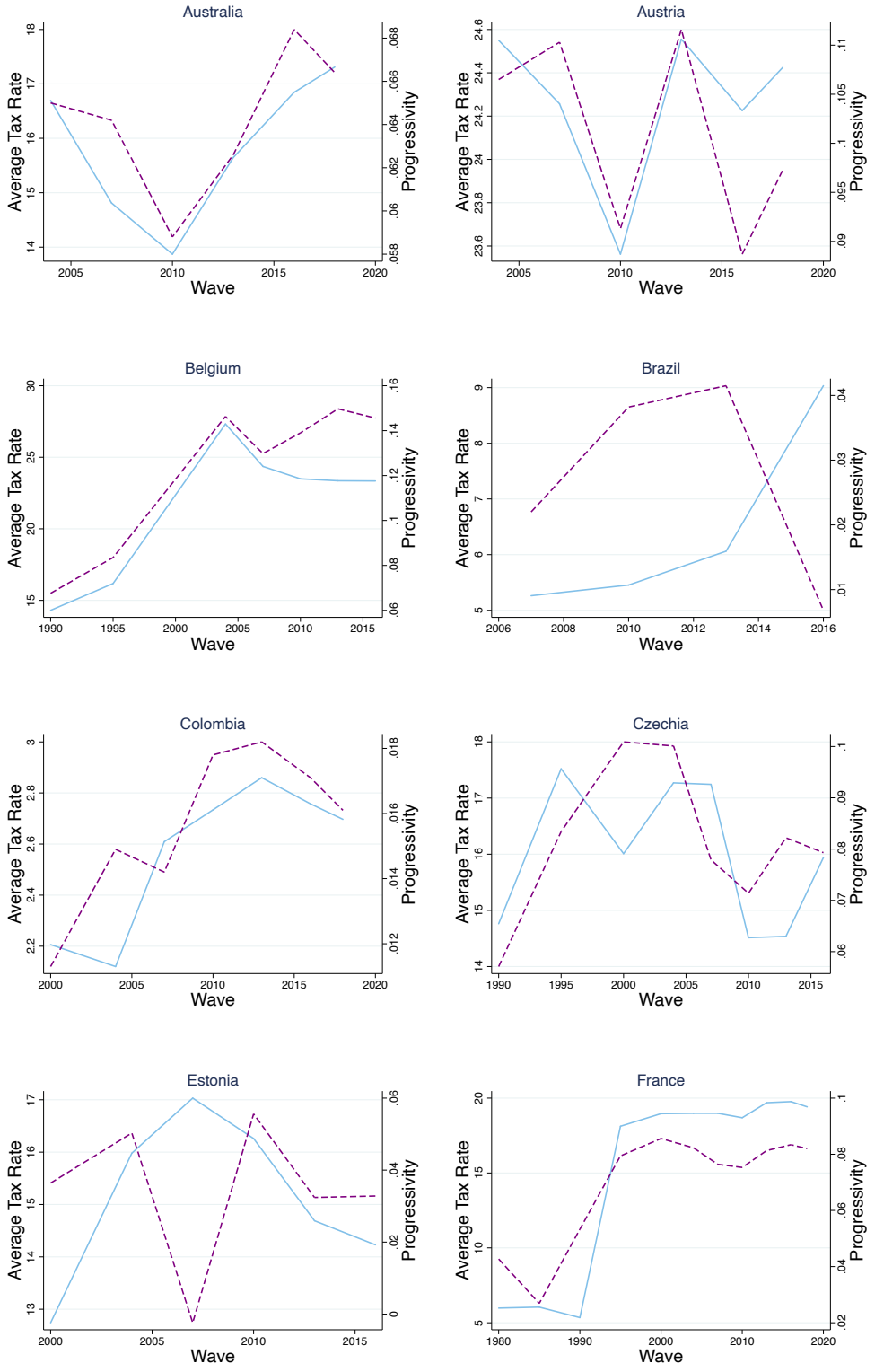


Figure A-7: Average tax rate and progressivity over time. The solid blue line is the average tax rate for the median household. The dashed purple line is the progressivity parameter τ.

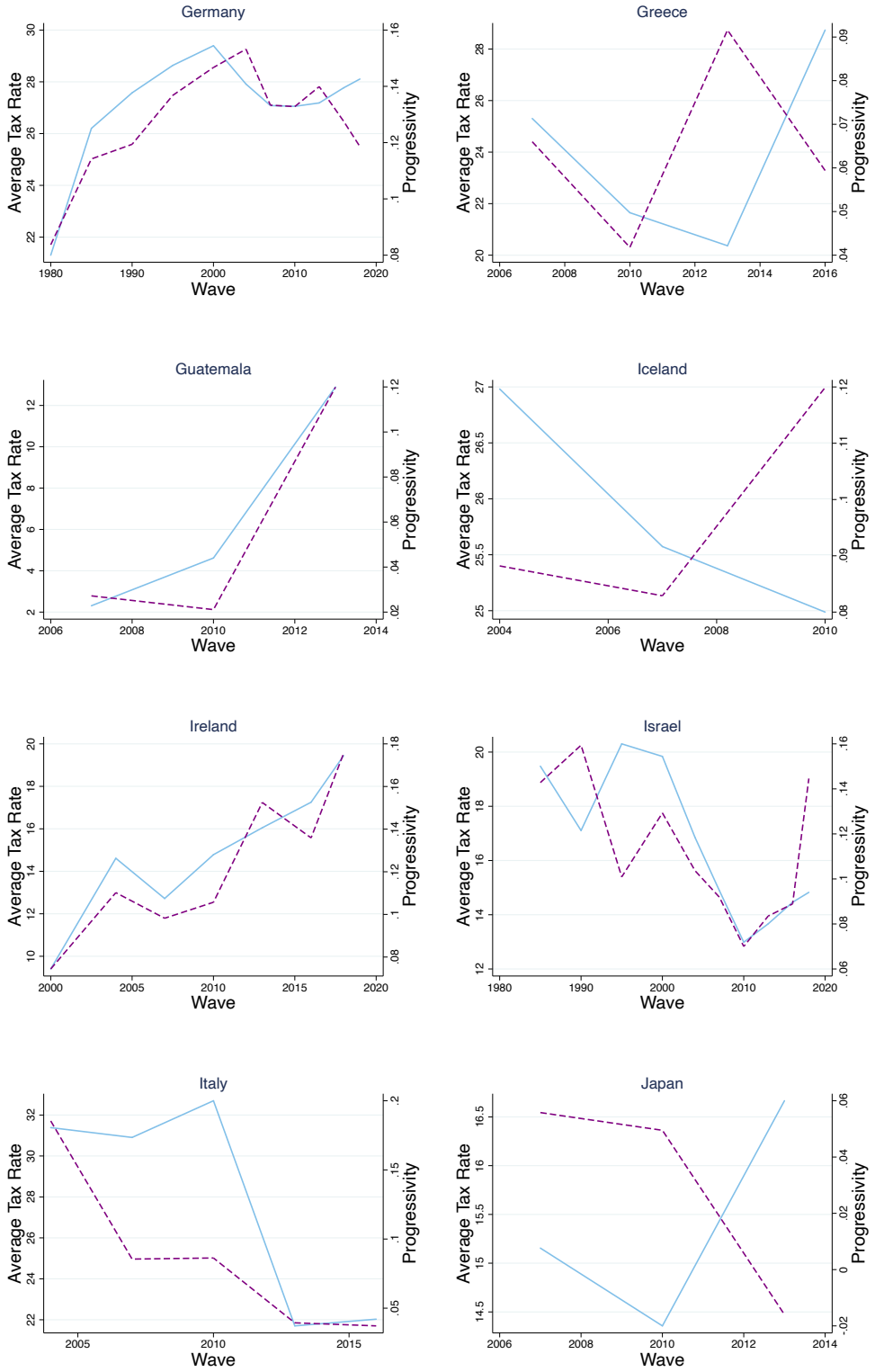


Figure A-8: Average tax rate and progressivity over time. The solid blue line is the average tax rate for the median household. The dashed purple line is the progressivity parameter τ.

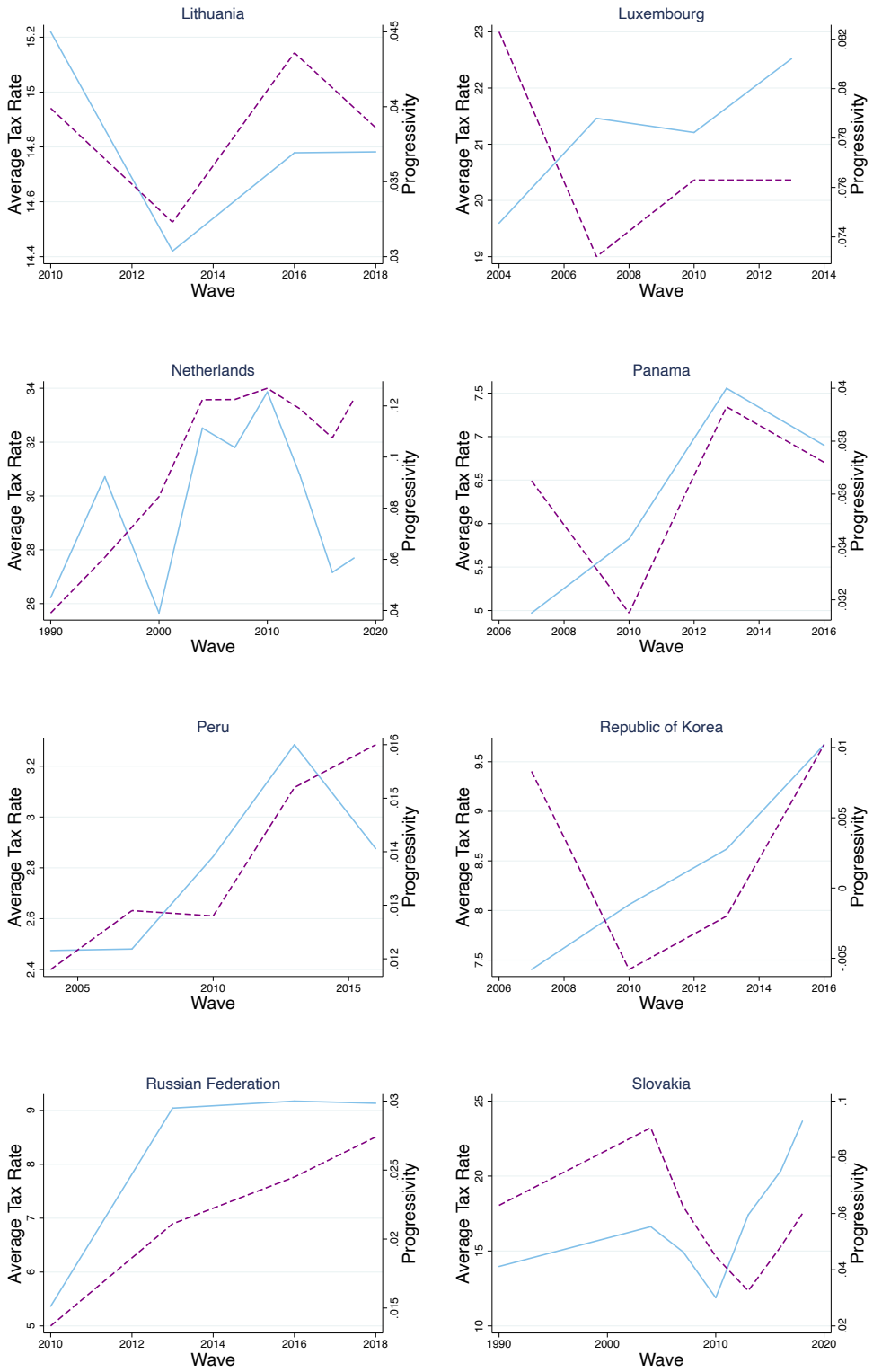


Figure A-9: Average tax rate and progressivity over time. The solid blue line is the average tax rate for the median household. The dashed purple line is the progressivity parameter τ.

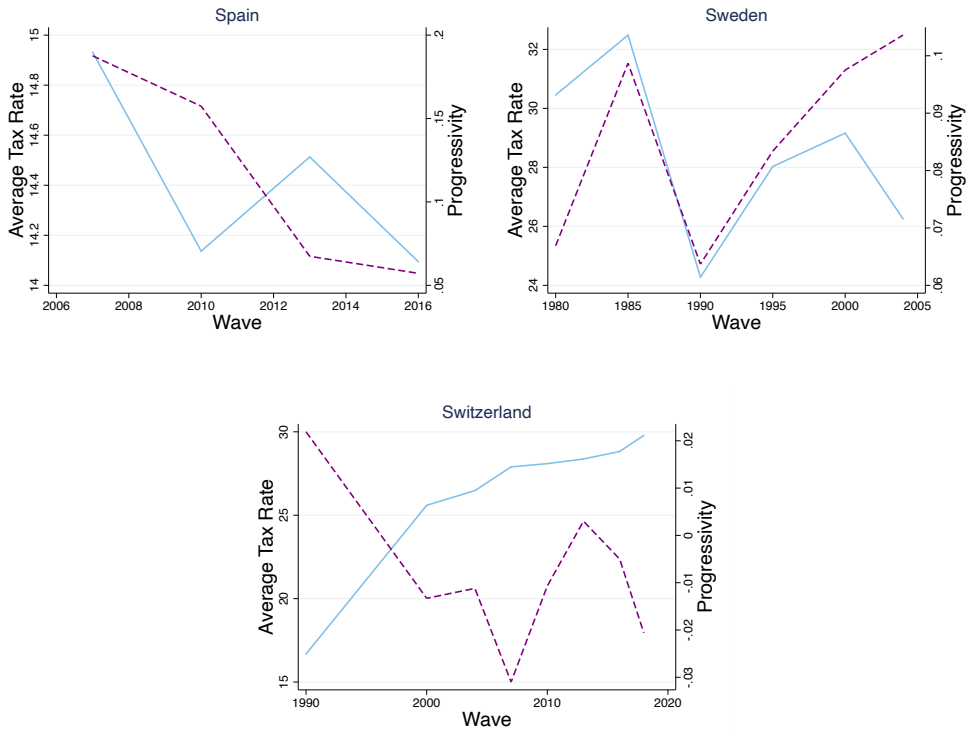


Figure A-10: Average tax rate and progressivity over time. The solid blue line is the average tax rate for the median household. The dashed purple line is the progressivity parameter τ.

IV Progressivity and Development

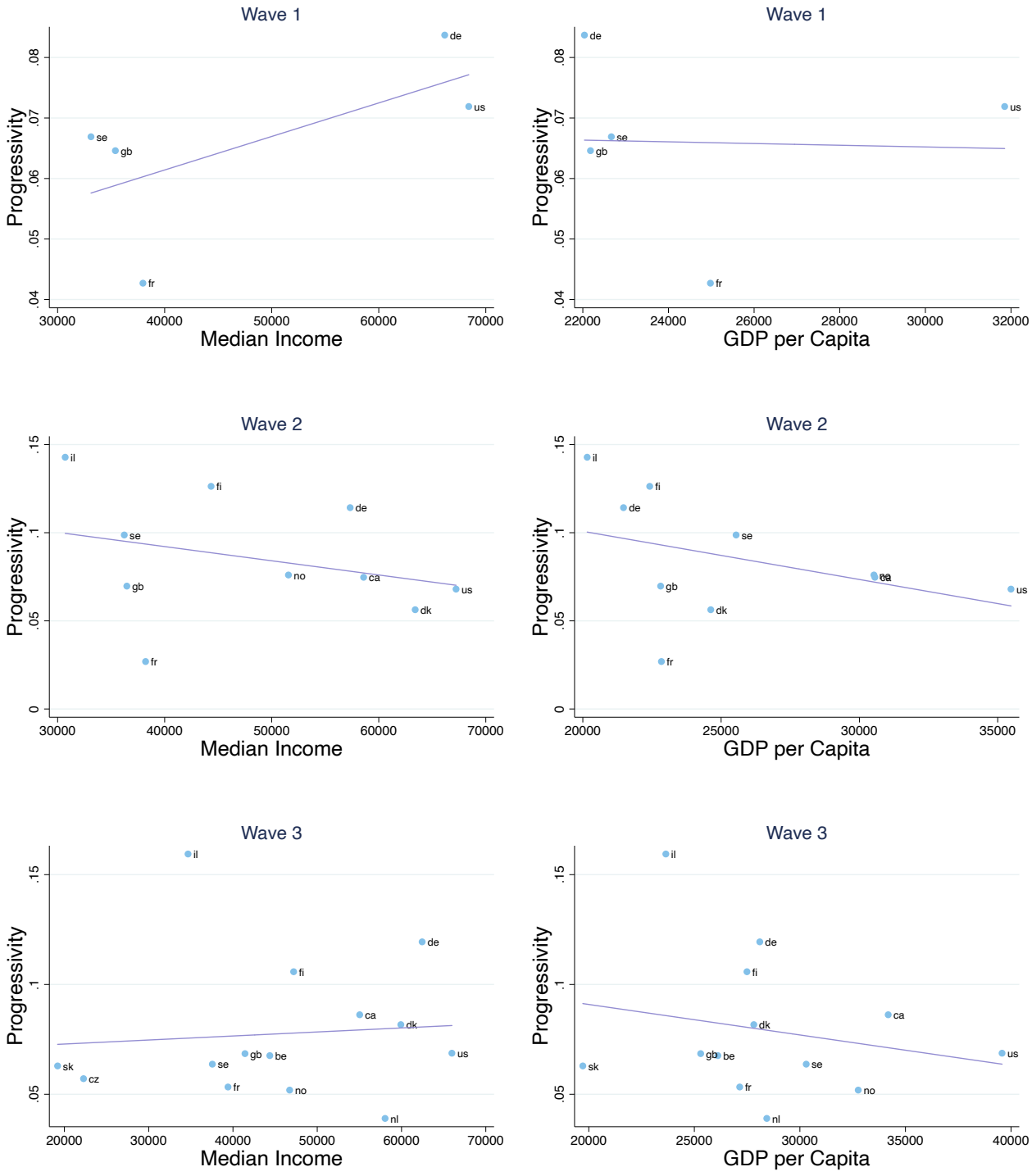


Figure A-11: Progressivity as a function of median income and GDP per capita. Left panels: progressivity as a function of median income. Right panels: progressivity as a function of GDP per capita. Progressivity is measured by the parameter τ. GDP per capita comes from the Penn World Tables and is measured at chained PPP and in 2017 US dollars.

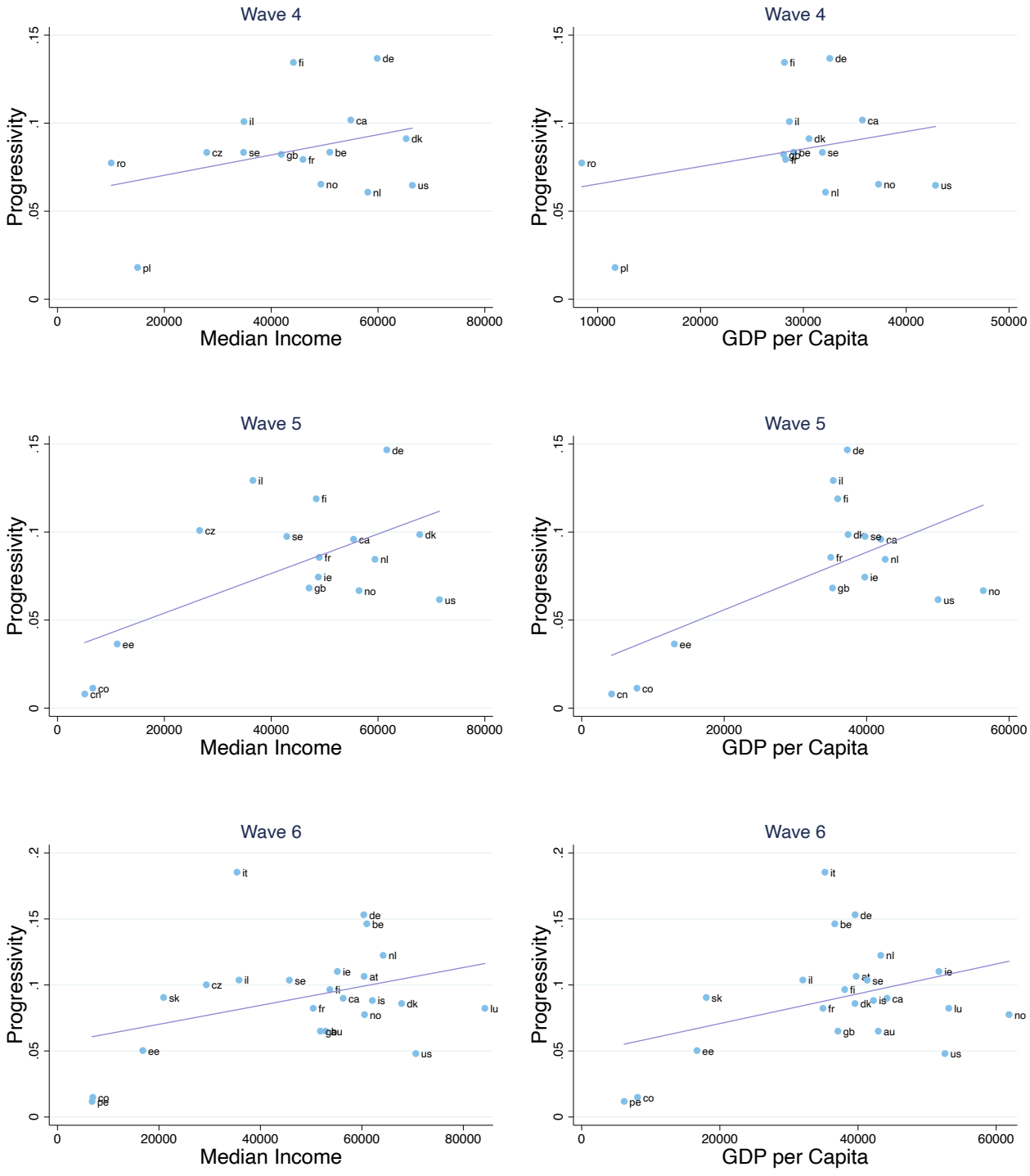


Figure A-12: Progressivity as a function of median income and GDP per capita. Left panels: progressivity as a function of median income. Right panels: progressivity as a function of GDP per capita. Progressivity is measured by the parameter τ. GDP per capita comes from the Penn World Tables and is measured at chained PPP and in 2017 US dollars.

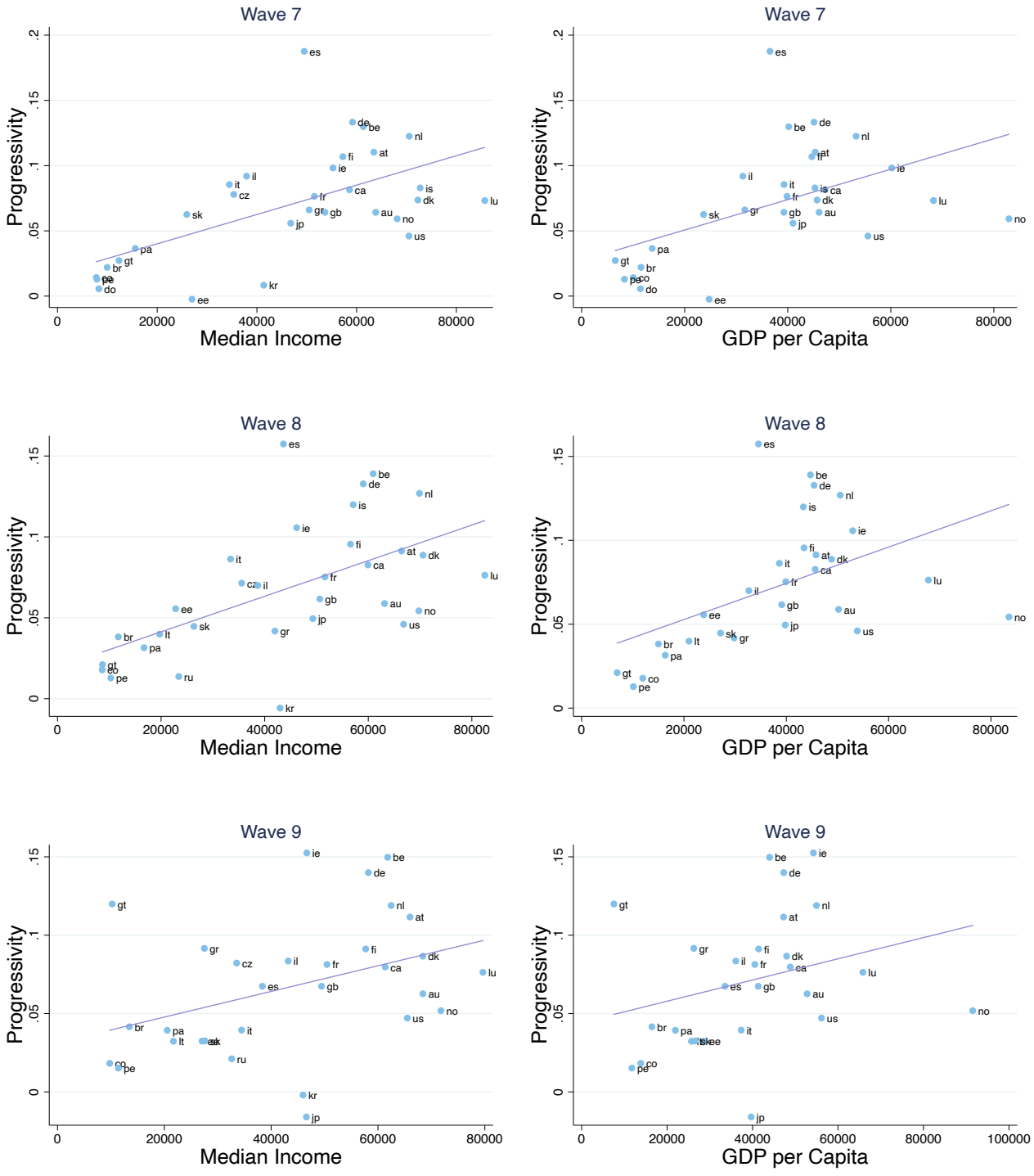


Figure A-13: Progressivity as a function of median income and GDP per capita. Left panels: progressivity as a function of median income. Right panels: progressivity as a function of GDP per capita. Progressivity is measured by the parameter τ. GDP per capita comes from the Penn World Tables and is measured at chained PPP and in 2017 US dollars.

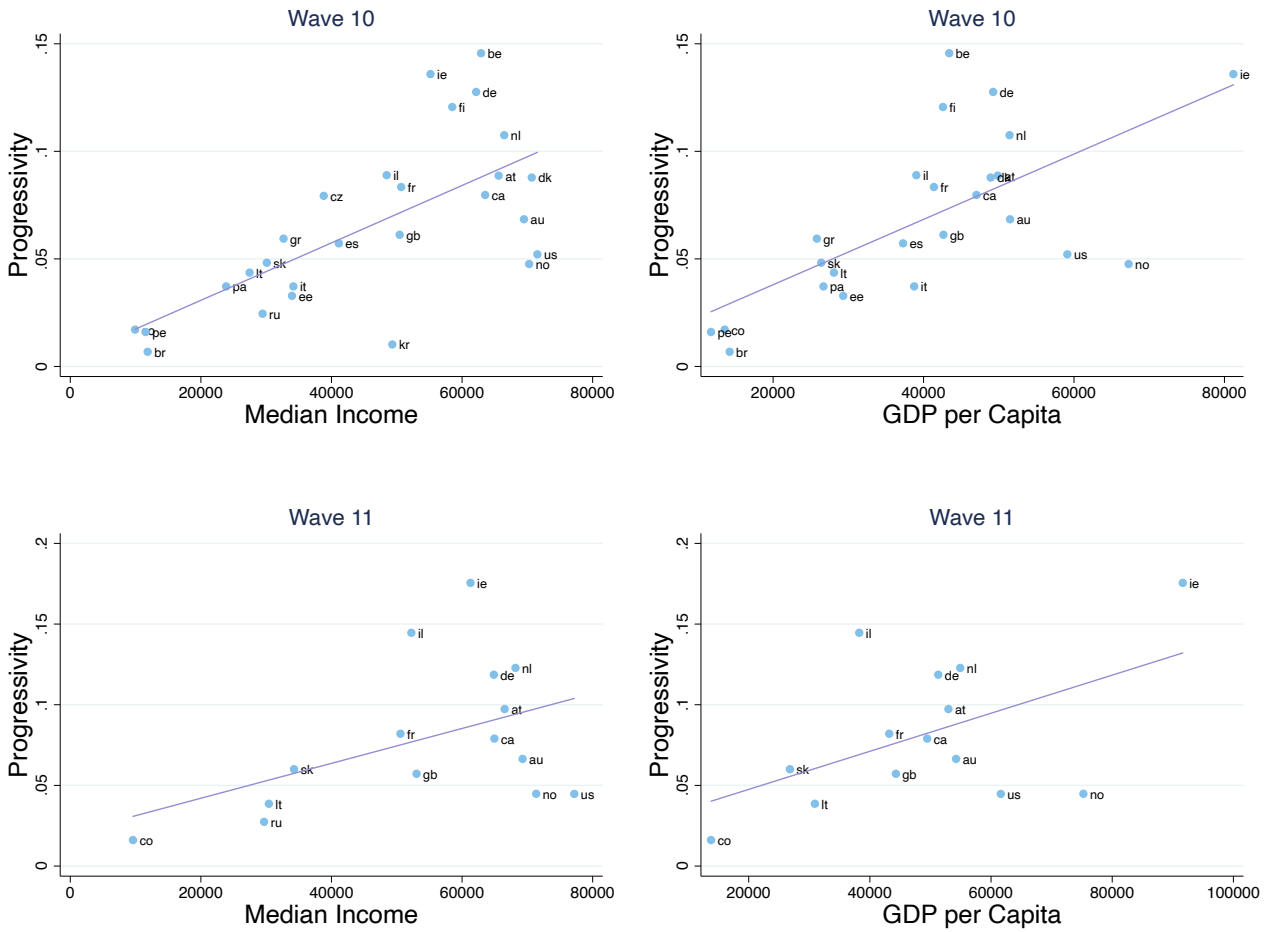


Figure A-14: Progressivity as a function of median income and GDP per capita. Left panels: progressivity as a function of median income. Right panels: progressivity as a function of GDP per capita. Progressivity is measured by the parameter τ. GDP per capita comes from the Penn World Tables and is measured at chained PPP and in 2017 US dollars.

V Evolution of Household Composition

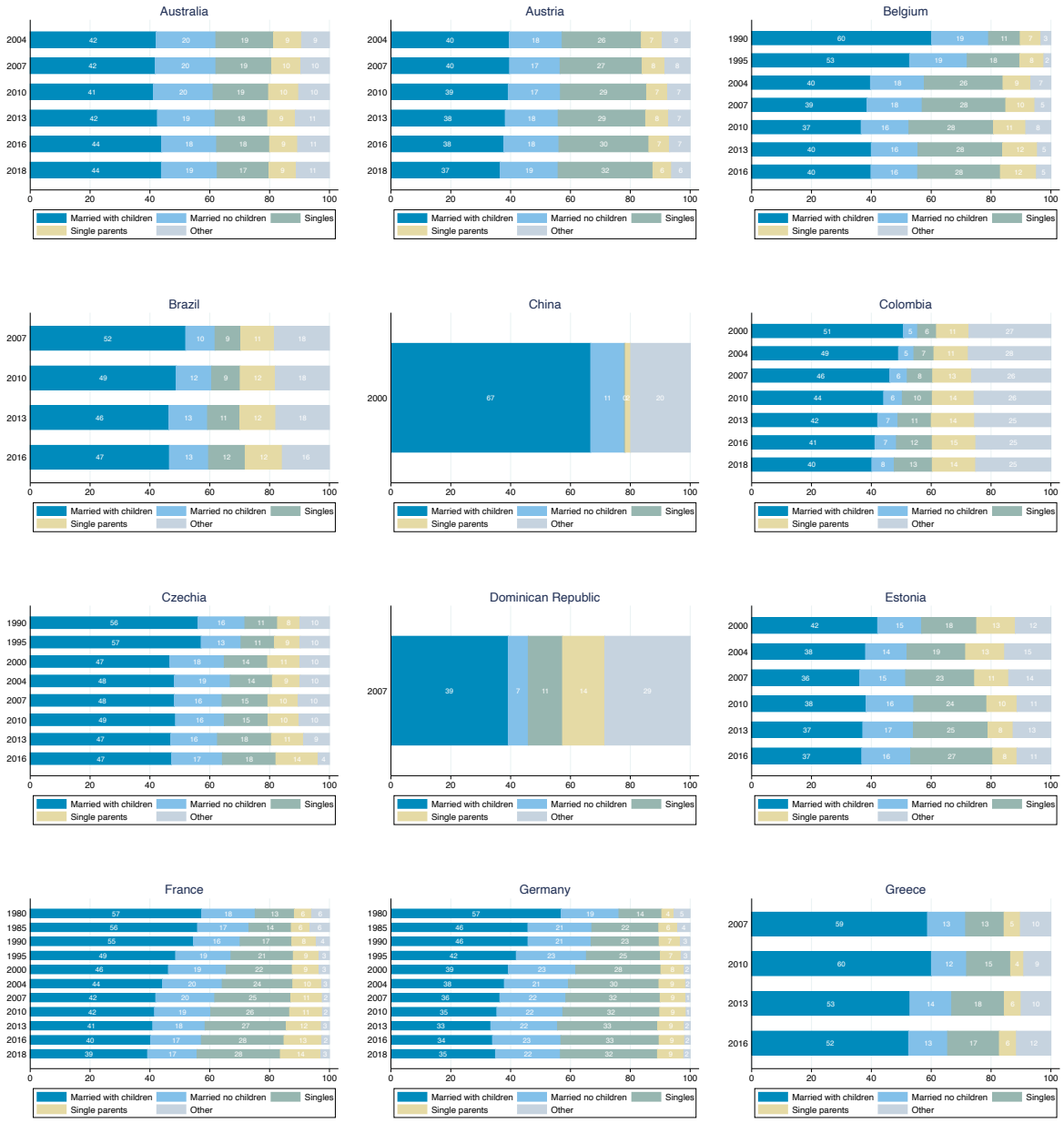


Figure A-15: Household composition by wave for selected countries in our sample. Each share is computed by dividing the number of households with the corresponding family structure by the number of total households in the given country and year.

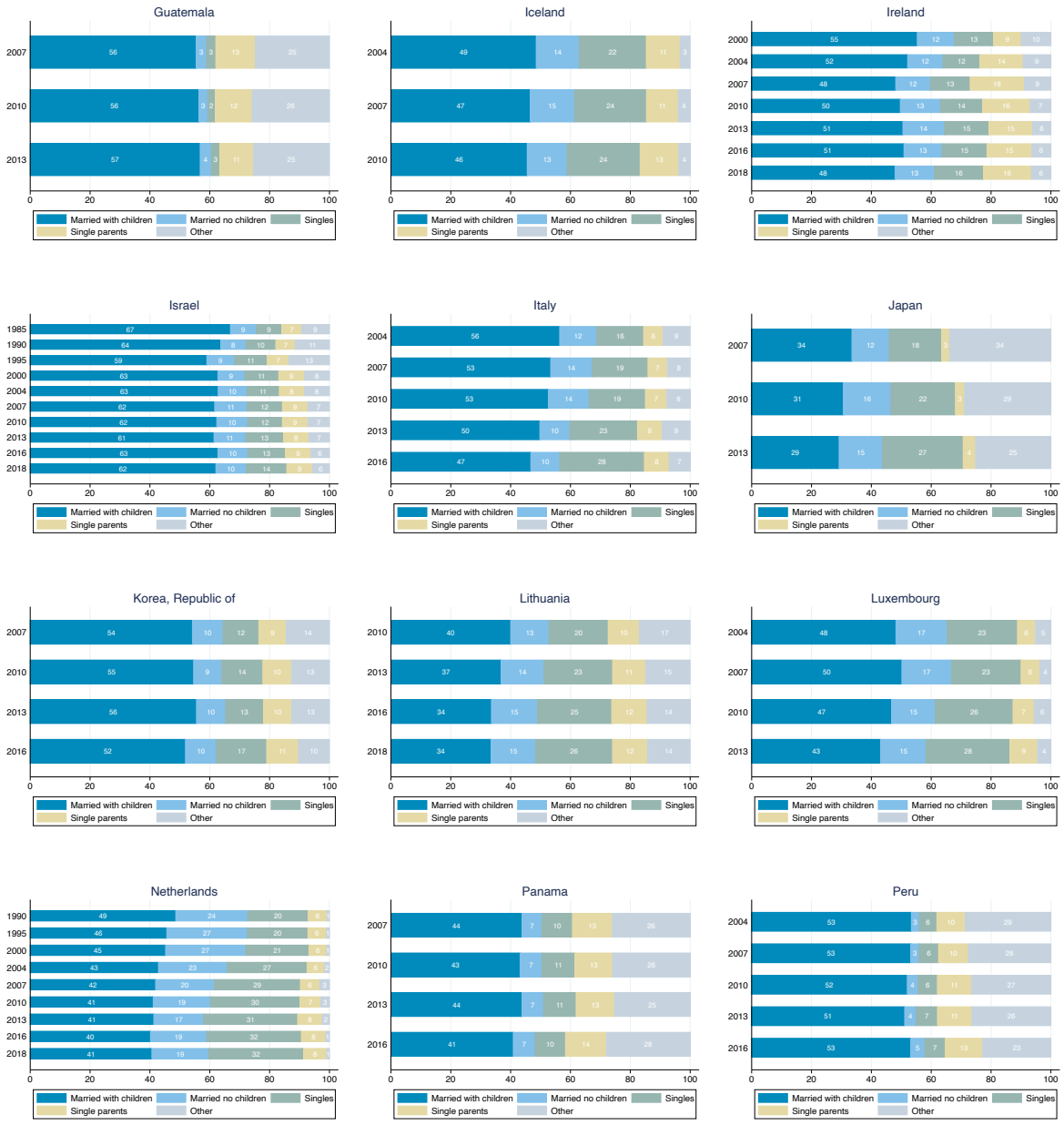


Figure A-16: Household composition by wave for selected countries in our sample. Each share is computed by dividing the number of households with the corresponding family structure by the number of total households in the given country and year.

Figure A-17: Household composition by wave for selected countries in our sample. Each share is computed by dividing the number of households with the corresponding family structure by the number of total households in the given country and year.

VI Progressivity by Household Type in the Cross-Section

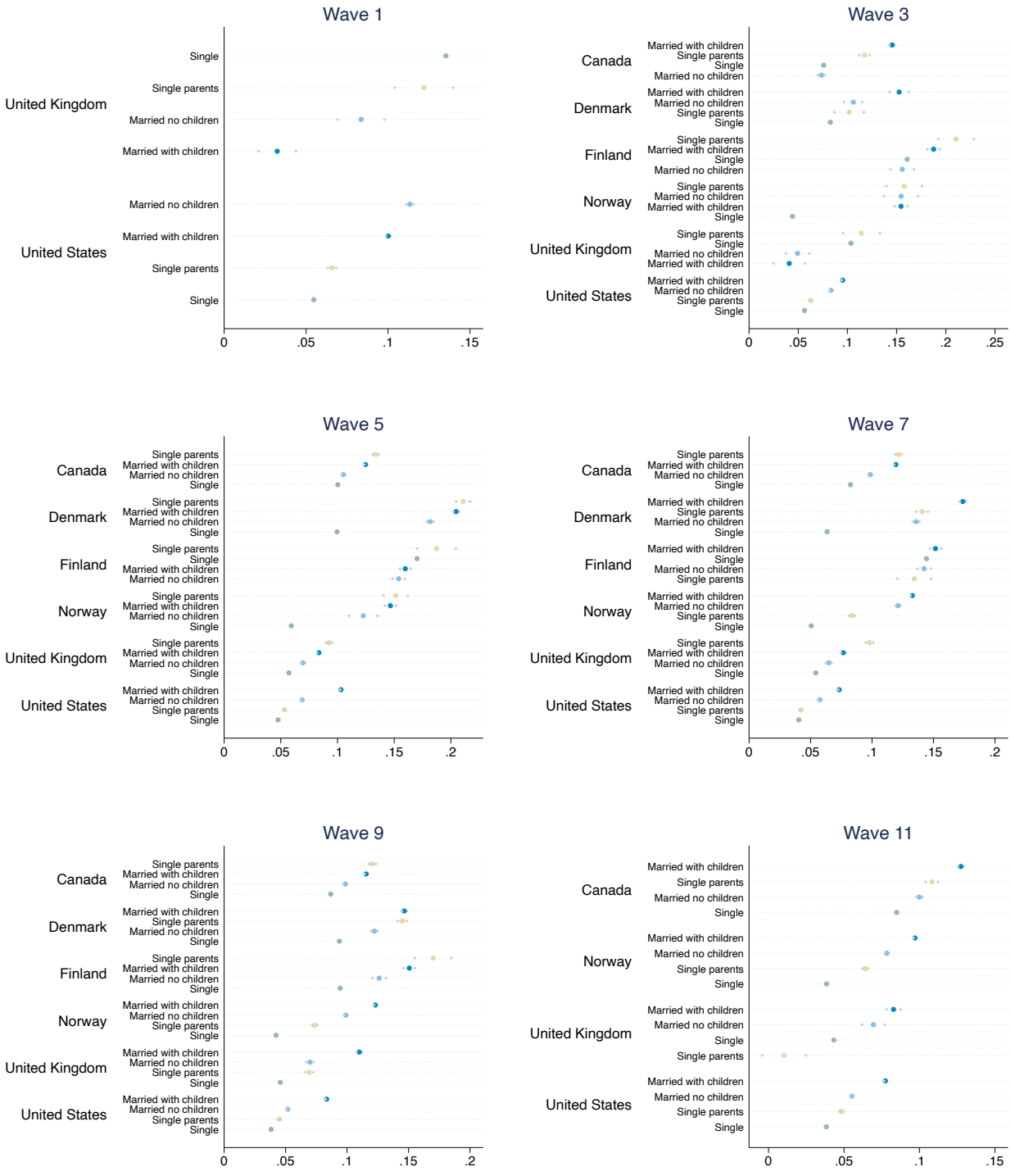


Figure A-18: Gross income tax progressivity by household type in six countries. Blue dots are the point estimate for the progressivity parameter τ, and gray diamonds mark the 95% confidence interval.

Country	Family Structure	Wave 1 1980	Wave 2 1985	Wave 3 1990	Wave 4 1995	Wave 5 2000	Wave 6 2004	Wave 7 2007	Wave 8 2010	Wave 9 2013	Wave 10 2016	Wave 11 2018
Australia	Married, no children	.	.	.	.	.	0.087	0.069	0.065	0.069	0.100	0.072
	Married with children	.	.	.	.	.	0.111	0.111	0.084	0.086	0.112	0.104
	Singles	.	.	.	.	.	0.053	0.053	0.047	0.047	0.046	0.048
	Single parents	.	.	.	.	.	0.064	0.073	0.064	0.063	0.090	0.072
Austria	Married, no children	.	.	.	.	.	0.097	0.122	0.120	0.131	0.161	0.150
	Married with children	.	.	.	.	.	0.124	0.138	0.119	0.143	0.115	0.130
	Singles	.	.	.	.	.	0.149	0.131	0.100	0.123	0.088	0.108
	Single parents	.	.	.	.	.	0.136	0.163	0.088	0.162	0.083	0.086
Belgium	Married, no children	.	.	0.049	0.093	.	0.163	0.179	0.139	0.172	0.151	.
	Married with children	.	.	0.152	0.220	.	0.192	0.162	0.209	0.221	0.215	.
	Singles	.	.	0.054	0.050	.	0.158	0.140	0.147	0.164	0.155	.
	Single parents	.	.	0.061	0.137	.	0.230	0.198	0.214	0.220	0.282	.
Brazil	Married, no children	.	.	.	.	.	.	0.024	0.041	0.046	0.007	.
	Married with children	.	.	.	.	.	.	0.027	0.041	0.047	0.004	.
	Singles	.	.	.	.	.	.	0.015	0.038	0.038	0.008	.
	Single parents	.	.	.	.	.	.	0.016	0.032	0.035	0.011	.
Canada	Married, no children	.	0.125	0.074	0.092	0.105	0.103	0.098	0.096	0.098	0.101	0.100
	Married with children	.	0.115	0.145	0.115	0.125	0.116	0.119	0.123	0.116	0.122	0.127
	Singles	.	0.054	0.076	0.135	0.100	0.096	0.083	0.089	0.087	0.086	0.085
	Single parents	.	0.083	0.117	0.119	0.134	0.125	0.122	0.114	0.121	0.109	0.108
China	Married, no children	.	.	.	.	0.005	.	.	.	.	.	.
	Married with children	.	.	.	.	0.009	.	.	.	.	.	.
	Singles	.	.	.	.	0.006	.	.	.	.	.	.
	Single parents	.	.	.	.	0.014	.	.	.	.	.	.
Colombia	Married, no children	.	.	.	.	0.014	0.018	0.017	0.023	0.023	0.021	0.019
	Married with children	.	.	.	.	0.013	0.017	0.016	0.021	0.023	0.021	0.021
	Singles	.	.	.	.	0.009	0.012	0.013	0.015	0.015	0.014	0.013
	Single parents	.	.	.	.	0.009	0.011	0.010	0.012	0.013	0.012	0.011
Czechia	Married, no children	.	.	0.132	0.137	0.132	0.131	0.140	0.105	0.120	0.113	.
	Married with children	.	.	0.077	0.112	0.122	0.114	0.121	0.101	0.103	0.098	.
	Singles	.	.	0.155	0.097	0.139	0.138	0.062	0.072	0.127	0.120	.
	Single parents	.	.	0.084	0.090	0.124	0.117	0.109	0.093	0.111	0.105	.
Denmark	Married, no children	.	0.071	0.106	0.178	0.182	0.163	0.136	0.133	0.122	0.122	.
	Married with children	.	0.146	0.153	0.193	0.205	0.177	0.174	0.152	0.147	0.150	.
	Singles	.	0.053	0.083	0.095	0.100	0.080	0.064	0.098	0.094	0.093	.
	Single parents	.	0.044	0.102	0.151	0.211	0.178	0.141	0.152	0.145	0.156	.
Dominican Republic	Married, no children	.	.	.	.	.	.	0.008	.	.	.	.
	Married with children	.	.	.	.	.	.	0.006	.	.	.	.
	Singles	.	.	.	.	.	.	0.003	.	.	.	.
	Single parents	.	.	.	.	.	.	0.005	.	.	.	.
Estonia	Married, no children	.	.	.	.	0.022	0.048	0.083	0.052	0.039	0.040	.
	Married with children	.	.	.	.	0.046	0.051	0.052	0.064	0.043	0.063	.
	Singles	.	.	.	.	0.040	0.064	-0.026	0.071	0.029	0.031	.
	Single parents	.	.	.	.	0.045	0.050	0.004	0.088	0.043	0.071	.
Finland	Married, no children	.	0.213	0.156	0.198	0.154	0.134	0.142	0.139	0.126	0.161	.
	Married with children	.	0.197	0.188	0.201	0.160	0.150	0.152	0.142	0.151	0.166	.
	Singles	.	0.210	0.161	0.198	0.170	0.110	0.144	0.106	0.094	0.161	.
	Single parents	.	0.196	0.211	0.218	0.187	0.173	0.134	0.156	0.170	0.180	.
France	Married, no children	0.053	0.050	0.081	0.089	0.098	0.099	0.093	0.091	0.098	0.107	0.097
	Married with children	0.072	0.060	0.088	0.099	0.105	0.094	0.088	0.084	0.100	0.109	0.101
	Singles	0.035	0.019	0.049	0.102	0.120	0.115	0.103	0.103	0.108	0.104	0.108
	Single parents	0.042	0.031	0.054	0.108	0.115	0.114	0.113	0.110	0.120	0.125	0.122
Germany	Married, no children	0.124	0.170	0.163	0.212	0.231	0.185	0.182	0.173	0.153	0.166	0.169
	Married with children	0.067	0.128	0.140	0.172	0.196	0.193	0.129	0.168	0.169	0.149	0.164
	Singles	0.148	0.138	0.155	0.153	0.169	0.193	0.168	0.162	0.188	0.152	0.133
	Single parents	0.116	0.144	0.149	0.175	0.196	0.210	0.209	0.202	0.192	0.178	0.179
Greece	Married, no children	.	.	.	.	.	.	0.097	0.041	0.089	0.056	.
	Married with children	.	.	.	.	.	.	0.066	0.033	0.094	0.063	.
	Singles	.	.	.	.	.	.	0.057	0.056	0.100	0.055	.
	Single parents	.	.	.	.	.	.	0.051	0.050	0.087	0.087	.
Guatemala	Married, no children	.	.	.	.	.	.	0.041	0.017	0.120	.	.
	Married with children	.	.	.	.	.	.	0.031	0.023	0.123	.	.
	Singles	.	.	.	.	.	.	0.016	0.019	0.138	.	.
	Single parents	.	.	.	.	.	.	0.016	0.017	0.111	.	.
Iceland	Married, no children	.	.	.	.	.	0.118	0.088	0.144	.	.	.
	Married with children	.	.	.	.	.	0.111	0.119	0.168	.	.	.
	Singles	.	.	.	.	.	0.156	0.121	0.136	.	.	.
	Single parents	.	.	.	.	.	0.160	0.131	0.192	.	.	.
Ireland	Married, no children	.	.	.	.	0.108	0.128	0.109	0.100	0.155	0.212	0.221
	Married with children	.	.	.	.	0.111	0.138	0.152	0.183	0.202	0.223	0.227
	Singles	.	.	.	.	0.054	0.107	0.079	0.073	0.169	0.098	0.241
	Single parents	.	.	.	.	0.058	0.105	0.073	0.105	0.091	0.113	0.157

Table A-6: Progressivity by household type.

Country	Family Structure	Wave 1 1980	Wave 2 1985	Wave 3 1990	Wave 4 1995	Wave 5 2000	Wave 6 2004	Wave 7 2007	Wave 8 2010	Wave 9 2013	Wave 10 2016	Wave 11 2018
Israel	Married, no children	.	0.177	0.163	-0.062	0.153	0.131	0.115	0.103	0.105	0.132	0.130
	Married with children	.	0.199	0.184	0.138	0.153	0.109	0.106	0.074	0.098	0.105	0.116
	Singles	.	0.091	0.154	0.161	0.095	0.097	0.077	0.071	0.079	0.077	0.343
	Single parents	.	-0.111	0.116	0.075	0.081	0.069	0.043	0.047	0.044	0.056	0.086
Italy	Married, no children	.	.	.	.	.	0.257	0.164	0.069	0.054	0.041	.
	Married with children	.	.	.	.	.	0.226	0.087	0.101	0.048	0.038	.
	Singles	.	.	.	.	.	0.214	0.097	0.088	0.038	0.039	.
	Single parents	.	.	.	.	.	0.107	0.052	0.072	0.025	0.029	.
Japan	Married, no children	.	.	.	.	.	.	0.074	0.064	0.081	.	.
	Married with children	.	.	.	.	.	.	0.058	0.075	0.061	.	.
	Singles	.	.	.	.	.	.	0.084	0.059	-0.092	.	.
	Single parents	.	.	.	.	.	.	0.060	0.087	0.057	.	.
Lithuania	Married, no children	.	.	.	.	.	.	.	0.048	0.052	0.055	0.064
	Married with children	.	.	.	.	.	.	.	0.048	0.046	0.042	0.041
	Singles	.	.	.	.	.	.	.	0.036	0.030	0.034	0.028
	Single parents	.	.	.	.	.	.	.	0.041	0.043	0.124	0.110
Luxembourg	Married, no children	.	.	.	.	.	0.097	0.121	0.137	0.116	.	.
	Married with children	.	.	.	.	.	0.107	0.120	0.106	0.121	.	.
	Singles	.	.	.	.	.	0.132	0.089	0.114	0.104	.	.
	Single parents	.	.	.	.	.	0.112	0.054	0.108	0.146	.	.
Netherlands	Married, no children	.	.	0.032	0.044	0.118	0.124	0.145	0.162	0.137	0.156	0.162
	Married with children	.	.	0.039	0.122	0.159	0.168	0.160	0.172	0.179	0.148	0.162
	Singles	.	.	0.041	0.062	0.067	0.155	0.187	0.187	0.148	0.142	0.180
	Single parents	.	.	0.077	0.046	0.124	0.123	0.183	0.136	0.099	0.166	0.192
Norway	Married, no children	.	0.147	0.155	0.069	0.123	0.093	0.121	0.099	0.099	0.089	0.078
	Married with children	.	0.137	0.154	0.144	0.147	0.126	0.133	0.125	0.123	0.100	0.097
	Singles	.	0.079	0.044	0.058	0.059	0.086	0.051	0.045	0.042	0.040	0.038
	Single parents	.	0.157	0.158	0.134	0.151	0.074	0.084	0.079	0.074	0.068	0.064
Panama	Married, no children	.	.	.	.	.	.	0.041	0.035	0.047	0.043	.
	Married with children	.	.	.	.	.	.	0.041	0.038	0.049	0.043	.
	Singles	.	.	.	.	.	.	0.032	0.022	0.029	0.025	.
	Single parents	.	.	.	.	.	.	0.030	0.030	0.035	0.036	.
Peru	Married, no children	.	.	.	.	.	0.017	0.011	0.017	0.019	0.022	.
	Married with children	.	.	.	.	.	0.013	0.016	0.016	0.019	0.019	.
	Singles	.	.	.	.	.	0.010	0.009	0.008	0.010	0.010	.
	Single parents	.	.	.	.	.	0.009	0.008	0.010	0.012	0.015	.
Poland	Married, no children	.	.	.	0.019	.	.	.	.	.	.	.
	Married with children	.	.	.	0.021	.	.	.	.	.	.	.
	Singles	.	.	.	0.030	.	.	.	.	.	.	.
	Single parents	.	.	.	0.023	.	.	.	.	.	.	.
Republic of Korea	Married, no children	.	.	.	.	.	.	0.001	-0.037	-0.013	0.004	.
	Married with children	.	.	.	.	.	.	0.009	0.004	0.005	0.015	.
	Singles	.	.	.	.	.	.	0.001	-0.022	-0.017	0.005	.
	Single parents	.	.	.	.	.	.	-0.006	0.000	-0.039	-0.039	.
Romania	Married, no children	.	.	.	0.091	.	.	.	.	.	.	.
	Married with children	.	.	.	0.074	.	.	.	.	.	.	.
	Singles	.	.	.	0.097	.	.	.	.	.	.	.
	Single parents	.	.	.	0.079	.	.	.	.	.	.	.
Russian Federation	Married, no children	.	.	.	.	.	.	.	0.017	0.027	0.034	0.034
	Married with children	.	.	.	.	.	.	.	0.017	0.017	0.021	0.026
	Singles	.	.	.	.	.	.	.	0.016	0.029	0.033	0.036
	Single parents	.	.	.	.	.	.	.	0.009	0.026	0.026	0.027
Slovakia	Married, no children	.	.	0.145	.	.	0.115	0.106	0.082	0.060	0.059	0.091
	Married with children	.	.	0.101	.	.	0.097	0.074	0.053	0.015	0.061	0.052
	Singles	.	.	0.112	.	.	0.158	0.102	0.051	0.036	0.051	0.086
	Single parents	.	.	0.075	.	.	0.084	0.061	0.057	0.058	0.079	0.075
Spain	Married, no children	.	.	.	.	.	.	0.177	0.092	0.045	0.064	.
	Married with children	.	.	.	.	.	.	0.234	0.226	0.068	0.079	.
	Singles	.	.	.	.	.	.	0.171	0.111	0.091	0.032	.
	Single parents	.	.	.	.	.	.	0.097	0.224	0.030	0.131	.
Sweden	Married, no children	0.110	0.111	0.104	0.116	0.102	0.137	.	.	.	.	.
	Married with children	0.140	0.157	0.144	0.163	0.135	0.153	.	.	.	.	.
	Singles	0.064	0.174	0.074	0.099	0.152	0.153	.	.	.	.	.
	Single parents	0.147	0.177	0.155	0.117	0.181	0.158	.	.	.	.	.
United Kingdom	Married, no children	0.084	0.091	0.049	0.085	0.069	0.070	0.065	0.064	0.070	0.074	0.069
	Married with children	0.032	0.018	0.041	0.091	0.083	0.087	0.077	0.092	0.110	0.098	0.083
	Singles	0.135	0.134	0.104	0.073	0.057	0.053	0.054	0.041	0.046	0.039	0.043
	Single parents	0.122	0.114	0.114	0.124	0.093	0.079	0.098	0.105	0.069	0.078	0.010
United States	Married, no children	0.113	0.085	0.083	0.072	0.069	0.052	0.058	0.054	0.052	0.054	0.055
	Married with children	0.100	0.103	0.095	0.098	0.103	0.082	0.073	0.082	0.083	0.092	0.077
	Singles	0.055	0.053	0.056	0.051	0.048	0.041	0.041	0.040	0.038	0.041	0.038
	Single parents	0.066	0.072	0.063	0.057	0.053	0.046	0.042	0.041	0.045	0.057	0.048

Table A-7: Progressivity by household type.

VII Progressivity by Household Type over Time

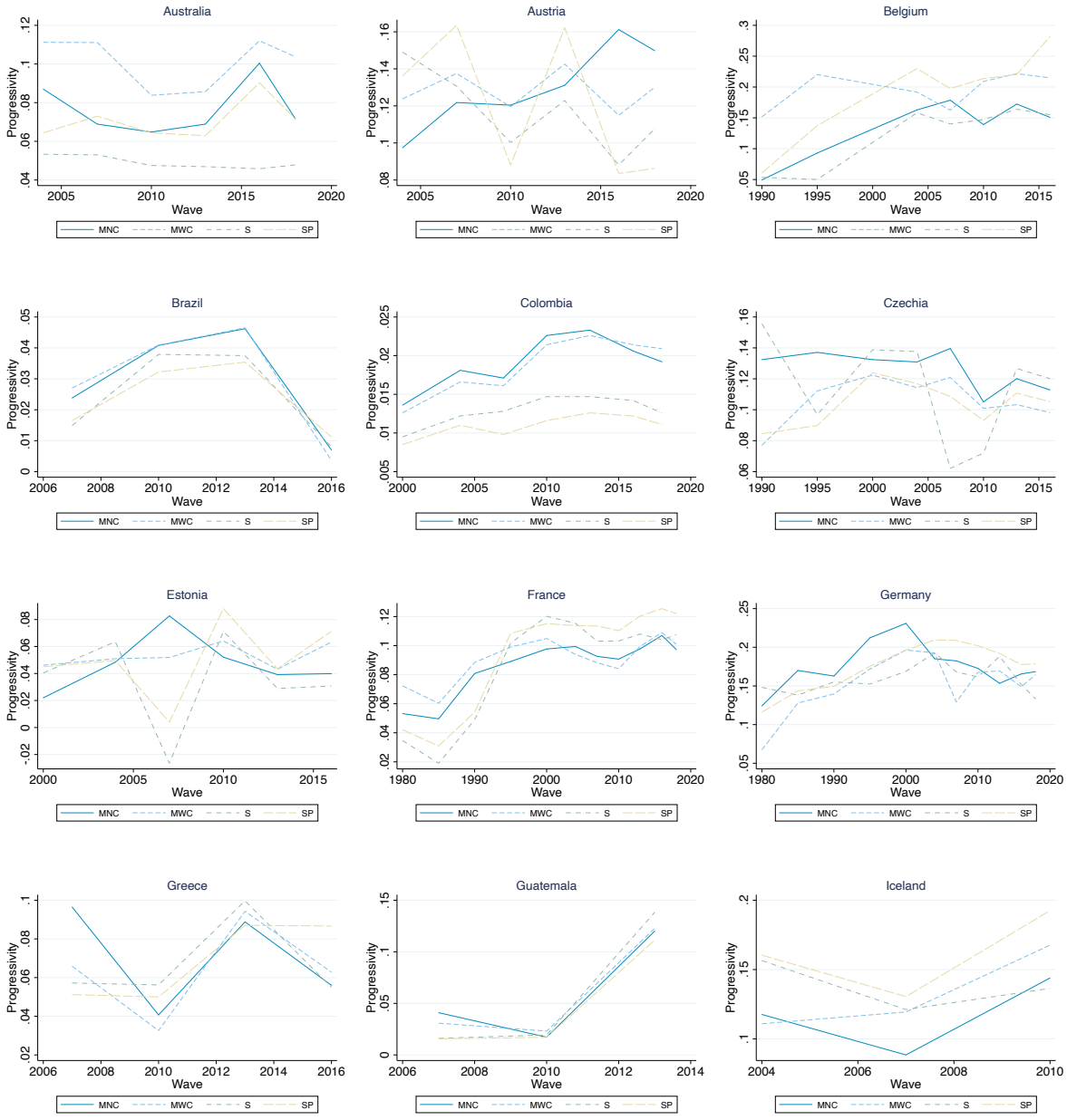


Figure A-19: Income tax progressivity by household type over time. MNC denotes married couples without children, MWC married couples with children, S singles without children, and SP single parents.

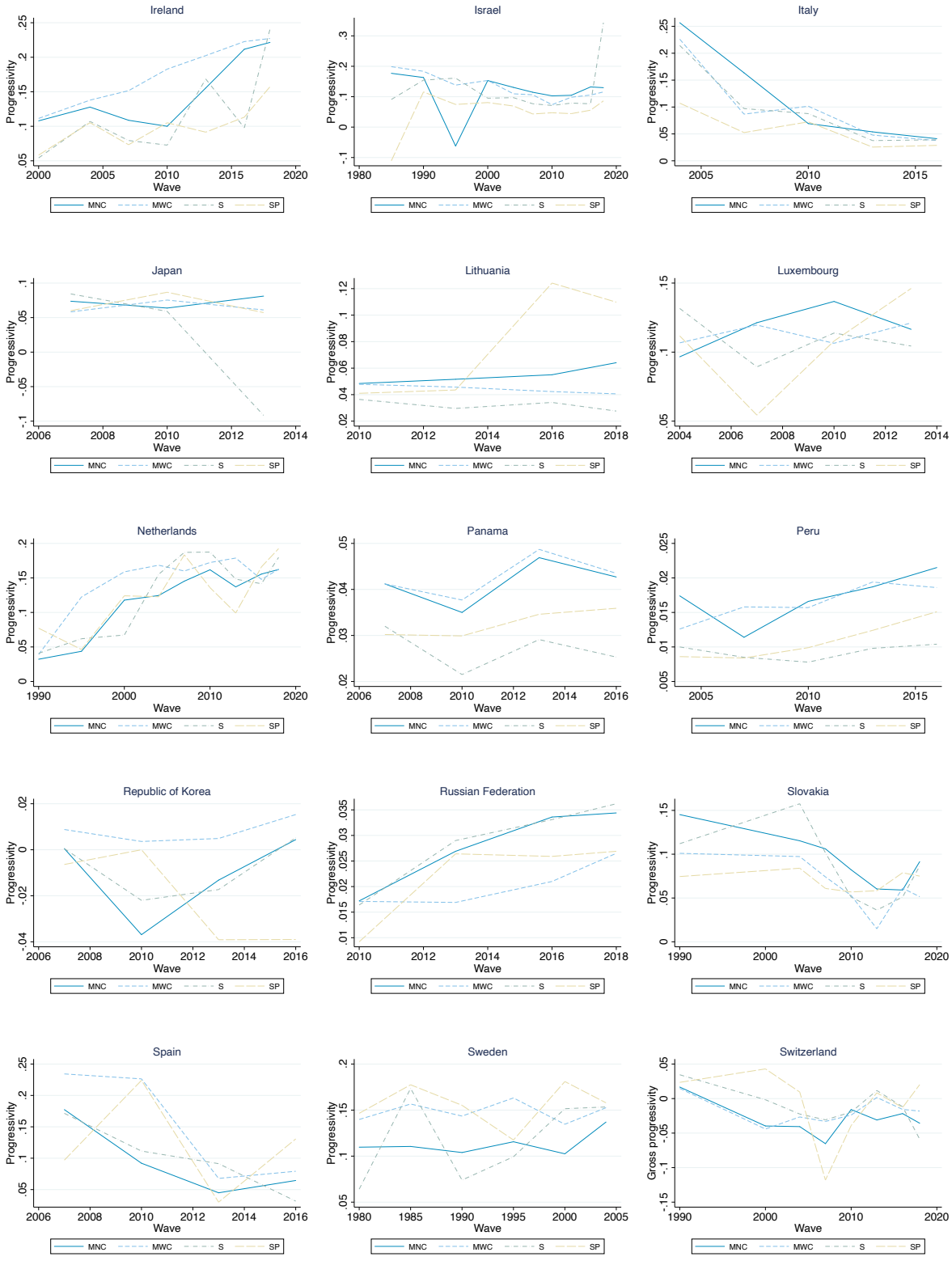


Figure A-20: Income tax progressivity by household type over time. MNC denotes married couples without children, MWC married couples with children, S singles without children, and SP single parents.

VIII The Role of Transfers for Progressivity

So far, we have treated public social benefits in the same way as the income earned in private markets. However, public transfers play a crucial role in redistribution policies. To study the effect of transfers on income tax progressivity, we define a tax-and-transfer function in which we include public social benefits in the post-tax income (rather than in the pre-tax one) to highlight that they come from the government. Using the tax-and-transfer function, we compute the progressivity net of government transfers. We then compare it to the progressivity gross of government transfers which we have computed in Section 5.

Figure A-21 compares gross and net progressivity. In this figure, we plot the point estimates for each measure of progressivity and the 95% confidence intervals. The confidence intervals show that progressivity is tightly estimated and that there are significant differences between gross and net progressivity. This figure shows that net progressivity is much higher than its gross counterpart in every country and wave. In our sample, net progressivity is, on average, seven times larger than its gross counterpart. Therefore, public transfers have a large and significant effect on redistribution in every country we study. This Figure also shows that including transfers preserves the ranking of countries at the extremes of the progressivity distribution. Thus, countries with high gross progressivity tend to have high net progressivity. For example, in wave 9, Ireland has the highest gross and net progressivity, while in wave 2, France has the lowest values in both measures.

The significant differences between gross and net progressivity highlight the importance of the choice of tax function when studying (and modeling) income tax systems. From an empirical point of view, using a gross or a net measure leads to significantly different assessments of the degree of progressivity in a specific country. As policymakers may want to act to increase (or decrease) income tax progressivity, its correct measurement is vital to guide income tax policy. From an economic modeling perspective, the choice of which tax function to use is critical for the magnitude of the after-tax income that enters the household's budget constraint.

In Figure A-22, we show net progressivity by household types. Studying net progressivity is particularly meaningful when we distinguish by household types, especially when looking at the role of children. Governments around the world use transfers to redistribute resources to families with children. For example, the Temporary Assistance for Needy Families (TANF) provides cash transfers to low-income families with children in the United States. In the United Kingdom, the Child Benefit provides financial support to parents with children younger than 16.

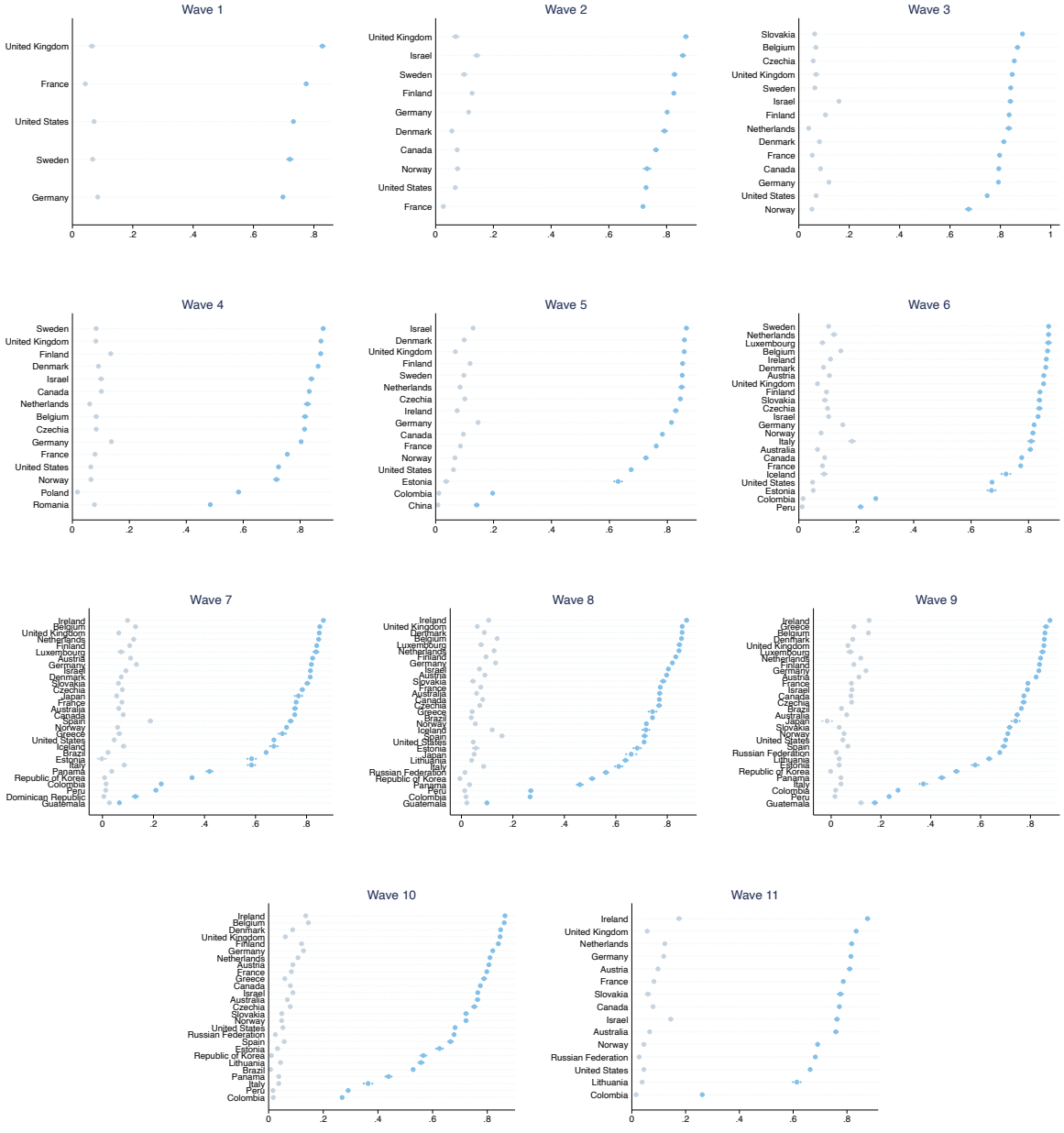


Figure A-21: Comparison of progressivity gross and net of government transfers. The gray dots mark gross progressivity. The blue ones denote net progressivity. Gray and blue diamonds mark the 95% confidence interval for the corresponding progressivity.

Several interesting facts emerge from Figure A-22. First, as we observed above, net progressivity is much higher than gross progressivity in each country and wave. For example, in wave 10, in the United States, net progressivity is more than five times as large as the gross one.

Second, marriage and the presence of children generate significant differences in net progressivity. For example, childless couples face lower net progressivity than singles in the United States in wave 10. In turn, married couples without children enjoy higher net progressivity than couples with children in Canada in wave 10.

Third, married couples with children face the lowest net progressivity in almost every country and wave. This is the opposite of what we observed for gross progressivity. Notably, in the United States, couples with children face the lowest net progressivity in every wave. At the same time, they enjoy the highest gross progressivity in each wave. In turn, single parents have the highest net progressivity in almost every country and wave. For example, in Canada and the United States, single parents face the highest net progressivity in each wave. These dynamics could be due to single parents having lower incomes and receiving more child-related government transfers than married couples with children.

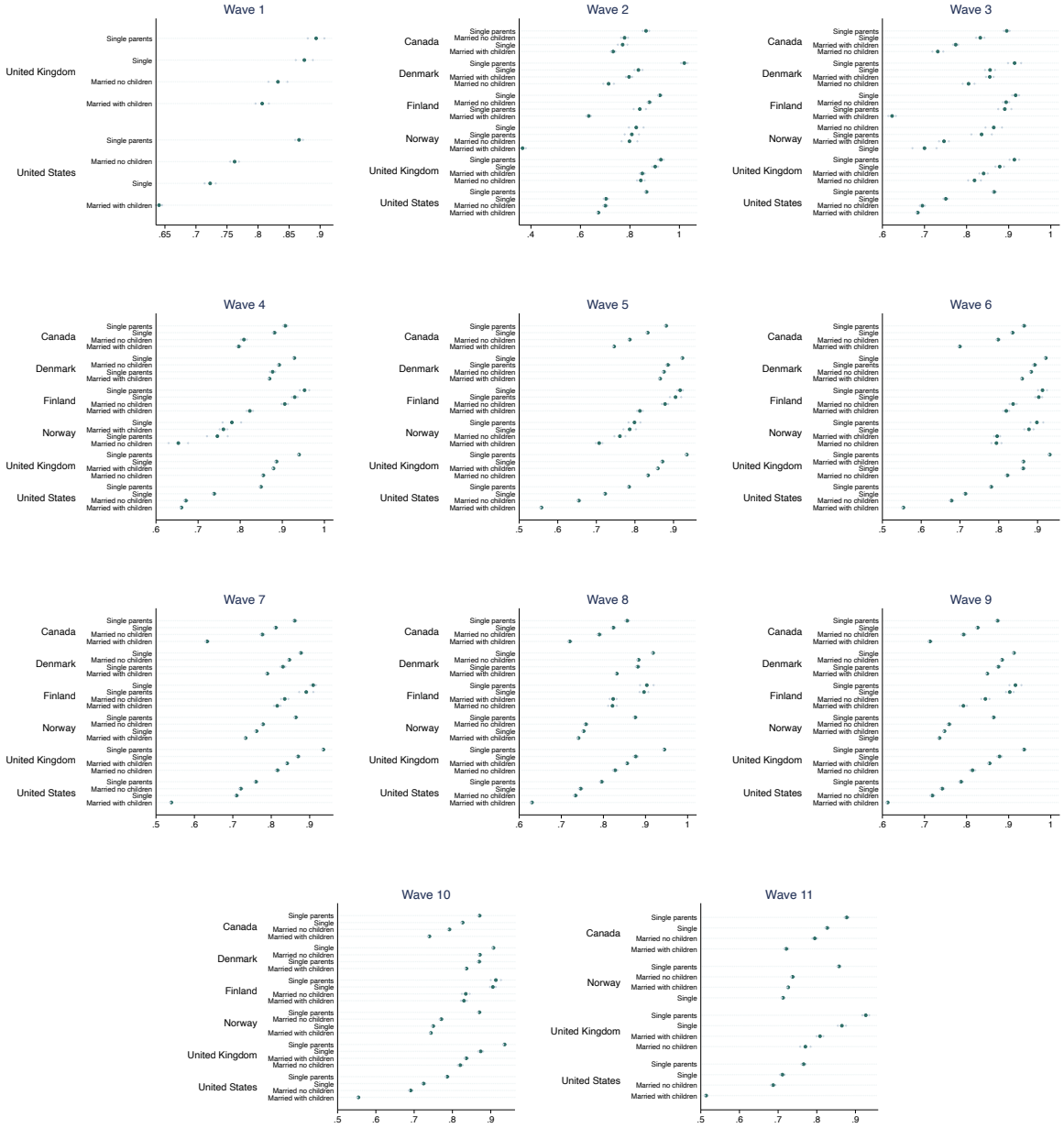


Figure A-22: Net income tax progressivity by household type. Green dots are the point estimate for the progressivity parameter τ, and gray diamonds mark the 95% confidence interval.