Income Tax Progressivity: A Cross-Country Comparison*

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Abstract

This paper studies income taxes across the world using detailed micro-data from the Luxembourg Income Study. We first show that income tax systems worldwide are approximated remarkably well by a two-parameter effective tax function. Then, we estimate country-year specific tax functions to compare the level of average taxation and income tax progressivity across countries and over time. We also examine the effects of economic development and family structure on income tax progressivity. We find that a higher level of taxation is associated with a higher degree of progressivity. We also find that progressivity has undergone significant changes over the last forty years. We show a positive association between economic development: countries with a higher median income also display higher income tax progressivity. We also demonstrate that income tax progressivity varies significantly across family structures: married couples with children face the highest degree of progressivity worldwide, while childless singles the lowest.

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1 Introduction

Income tax systems are complicated by nature. In a single country, numerous factors must be accounted for: deductions, credits, and tax rates that depend on how taxpayers file their returns. Across countries, more complications arise. Comparing tax systems in different countries requires comparing fundamentally different institutions and policies. For these reasons, the literature on income taxes has mainly focused on one country in isolation or compared countries in pairs. In this paper, we build on this literature and compare the income tax systems of thirty-seven countries. Our paper has two goals. First, we systematically describe the effective income taxes paid by families in different countries. Second, we provide estimates of effective tax functions for many countries, years, and family types, which researchers can use for numerous projects.

We estimate effective income tax functions for over thirty countries over the last forty years. Effective income tax functions characterize the empirical relationship between taxes paid and pre-tax income and summarize the numerous details of income tax systems using a parsimonious functional form. We use the estimated effective tax functions to study how average income taxation and progressivity vary by country, year, and household type.

Assessing the level of average income taxation and progressivity is crucial for both policymakers and macroeconomists. On the one hand, policymakers need an accurate assessment of the progressivity of the tax system to guide redistribution and social insurance policies. On the other hand, numerous questions in macroeconomics require characterizing the features of income tax systems. Guner, Kaygusuz, and Ventura (2012) study whether couples and singles are – and should be – taxed differently. One could ask whether families with and without children are taxed differently. Heathcote, Storesletten, and Violante (2020) evaluate how the U.S. income tax policy has responded to the rise in wage inequality over the last forty years. A related question could be how different governments worldwide have adjusted their income tax policy to respond to changes in inequality. Macroeconomists may also need effective income tax functions to compute after-tax income in their models. We systematically describe the features of income tax systems across countries, years, and household types. We also provide estimated effective tax functions that researchers can use in structural models of the economy.

We use household microdata from the Luxembourg Income Study (LIS) Database. LIS has many advantages which make it the ideal dataset for our analysis. First, it covers a large number of countries, and it spans a long time. Second, it harmonizes data across countries, which

allows us to compare variables across countries and survey waves. Third, it has a very large sample size: our final sample consists of almost eight million household-wave observations. Finally, it contains much information: we have data on labor and capital income, public social benefits, taxes, contributions, demography, employment, and consumption.

Using a detailed and large sample of working-age households from LIS, we estimate log-linear effective tax functions. This functional form has been used extensively in the literature on earnings dynamics. Our tax function is easy to estimate and allows us to characterize income tax systems parsimoniously. In particular, we compare inherently complicated tax systems by comparing two parameters: the average level of taxation and tax progressivity.

Our findings are as follows. First, we demonstrate that our log-linear tax function is a remarkably accurate approximation of income tax systems worldwide. We show that our tax function can almost entirely explain the variation of post-tax income in all countries and waves in our sample. Due to the high approximation quality, our estimates can be used for many projects and datasets beyond our own. Any structural model of the economy which require the computation of post-tax income can incorporate our tax functions. Then, our estimates can supplement datasets lacking specific measures of income. For example, the public data from the Survey on Household Income and Wealth (SHIW), conducted by the Bank of Italy, only contains information on post-tax income for Italian households. Researchers can use our estimated tax functions for Italy based on the confidential SHIW data to construct an accurate measure of pre-tax income for public SHIW data.

Second, we document a positive association between income tax progressivity and the average level of taxation. Across all years in our sample, countries with a higher average tax rate on households with the median income in that country and year also provide a higher level of progressivity. We also show that, over the last forty years, the average level of taxation for median households has remained relatively stable, while income tax progressivity has undergone significant changes in many countries across the world.

Third, in light of its considerable changes, we focus on income tax progressivity and study some of its determinants. We find evidence of a positive association between income tax progressivity and economic development. We proxy economic development by median pre-tax income and show that, in every year in our sample, wealthier countries are associated with a higher degree of income tax progressivity. Then, we show that tax progressivity varies significantly across family structures. We study the effects of marriage and children and find that they significantly affect progressivity. Across countries and time, effective income taxes are more progressive for

couples with children and less for childless singles.

The rest of the paper is organized as follows. Section 2 highlights our contributions in the context of the related literature. Section 3 defines our tax function and estimation strategy. Section 4 describes the LIS Database, our sample selection, and the income definitions for our tax functions. Section 5 presents evidence on the fit of our tax function and discusses the evolution of the average level of taxation and progressivity across countries and time. Section 6 analyzes the relationship between progressivity and economic development. Section 7 presents effective tax functions by family structure. Section 8 concludes.

2 Related Literature

First, our paper 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 made popular by Heathcote, Storesletten, and Violante (2017). While there are various approaches to modeling the income tax and transfer system, these papers argue in favor of the log-linear specification due to both its simplicity, as it requires 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. Guner, Kaygusuz, and Ventura (2014) use IRS data for the year 2000 and investigate how effective taxes change with family status and composition. They estimate several effective tax functions, including a log-linear one, and conclude that the log-linear tax function fits the data well. Heathcote, Storesletten, and Violante (2020) use data from the Congressional Budget Office to study tax progressivity between the end of the 1970s and 2016. They find that the level of progressivity is the same in 2012-2016 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, Russo, and Yang (2022) use PSID data

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

to study the evolution of effective tax rates between the end of the 1960s and 2016. They compile a history of income tax reforms over that period and compare the evolution of progressivity and average tax rates with the desired outcomes of the reforms.

A few recent papers have used the log-linear tax function for 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 quite well. Kaas, Kocharkov, Preugschat, and Siassi (2020) study homeownership in Germany and use the log-linear tax function in the context of a rich structural model. They show that it approximates the income tax and transfer system quite well. Finally, De Magalhaes, Martorell, and Santaeulalia-Llopis (2019) plan to use microdata to estimate and compare tax progressivity across over 20 countries. To our knowledge, they have not yet provided estimated tax functions.

Second, our paper connects to the literature on cross-country comparisons of tax progressivity. Holter, Krueger, and Stepanchuk (2019) study the role of tax progressivity to assess how much additional tax revenue governments can generate by increasing 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 being in Denmark and the least progressive in Japan. Ayaz, Fricke, Fuest, and Sachs (2021) study how optimal income taxes should respond to an increase in public debt in five European countries. They find that, for all countries, income taxes should be less progressive as a response to an increase in fiscal pressure.

3 The Tax Function

We use a two-parameter log-linear effective tax function, which can be estimated by ordinary least squares (OLS).

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

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

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

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 of income 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, as the elasticity of post-tax income with respect to pre-tax income, $\partial \log(Y - T(Y))/\partial \log(Y)$, is equal to $1-\tau$. In particular, 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) delivers:

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

Equation (4) makes it clear why it is called a log-linear tax function: log after-tax income is a linear function of log pre-tax income.

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 weight to obtain results representative of the whole population of each country in each wave. The OLS estimates are denoted $\hat{\alpha}_{c,t}$ 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. Comparing the regression equation (5) with the log-linear tax function (4) reveals 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] Section 5.1 shows that this tax function fits the data remarkably well.

4 Data

This section describes our data, sample selection, and income definitions.

4.1 Luxembourg Income Study (LIS)

We use microdata from the Luxembourg Income Study (LIS) Database. LIS contains harmonized microdata from about 50 countries for over 50 years. 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 and its evolution over time and discusses some data limitations. Numerous papers have used this dataset. Among others, De Nardi, Ren, and Wei (2000) used it to study income redistribution policies and the trade-off between redistribution and inefficiency. Chiuri and Jappelli (2010) used LIS data to analyze the patterns of homeownership for the elderly across OECD countries. Laun and Wallenius (2016) used LIS to assess the role of social insurance for the cross-country differences in the labor supply of older workers.

[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.

4.2 Sample Selection

We conduct household-level analysis and focus on working-age households whose head is between 25 and 60 years old. We restrict our analysis to working-age households to facilitate the comparison across countries.

There are 11 available LIS waves spanning from the early 1970s to 2020. We use all waves and countries for which we have data on gross household income, income taxes, and government transfers. We operate at the wave level rather than the annual level to ensure a consistent and comparable time unit across countries. 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. 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 is very large and consists of 7,625,531 household-wave observations for 37 countries, observed over different waves. The large sample size is an advantage of the LIS dataset and allows us to estimate our tax function parameters tightly.

In a first step, we restrict our attention to "standard" households, defined as the following four types of households: (1) one-person household; (2) couple without children; (3) couple with children; or (4) one parent with children. 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. Our household selection is similar to the one of Heathcote, Storesletten, and Violante (2020), who, given their focus on the working age, only select households with children and non-elderly childless households. 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. Sections 5 and III presents results for standard households.

After estimating tax functions for standard households, to study the role of family composition for progressivity, we estimate effective tax functions separately for each of the four household types that make up our notion of a standard household. We present descriptive statistics on household composition and the estimated tax functions in Section 7.2.

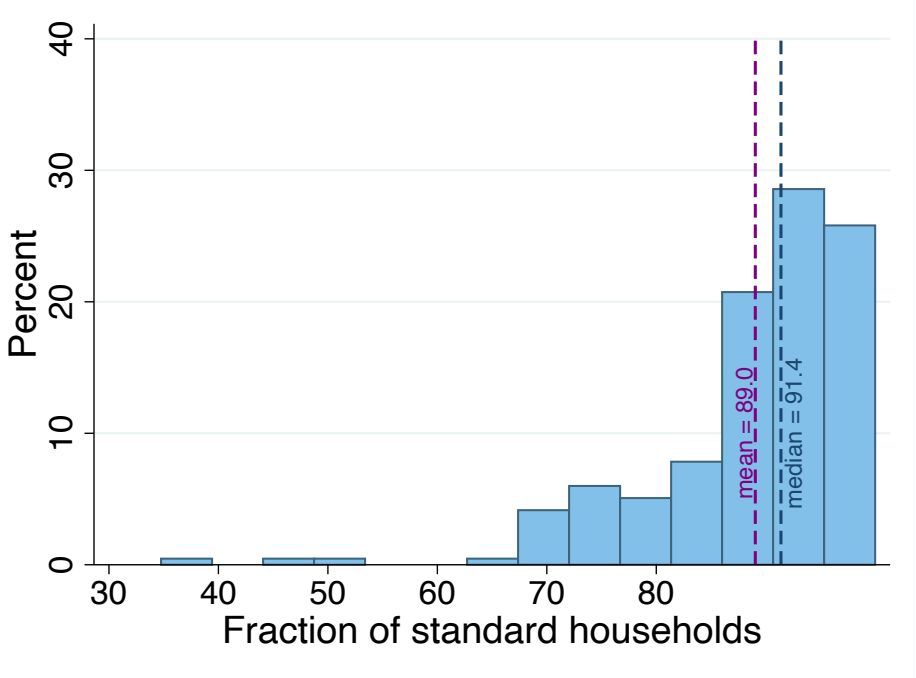


Figure 1: Share of households with heads between 25 and 60 that qualify as "Standard" Households. Results for all countries and all waves in our sample.

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.[4,5] Public social benefits capture transfers from government insurance and assistance programs. Appendix I.2 describes the income components in detail. Using the tax function allows us to interpret the parameter λ from Equation (1) as the average tax rate and τ as a measure of progressivity of the income tax system. A tax function defined this way can be used in structural models which model government transfers explicitly, as it only captures income taxes. Section 5 reports the results for our tax function.

The monetary quantities that make up our income definitions need to be adjusted to be comparable across country and time. First, we need Consumer Price Indices (CPIs) to compare real

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

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

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 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

In this section, we first show that our tax function is a good approximation of the income tax systems of all countries in our sample. Then, we describe the average level of taxation and progressivity in the cross-section and over time.

5.1 Fit of the Tax Function

As Heathcote, Storesletten, and Violante (2017) show, 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.[6] We plot the logarithm of post-tax income as a function of the logarithm of pre-tax income for six countries in wave 10, corresponding to 2015-2017. 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.

[6] Due to space limitation, we show 6 countries in the main text. We show Canada, Denmark, Finland, Norway, the United Kingdom, and the United States. We choose these countries because they appear in our sample in almost every wave. See Online Appendix for the remaining countries. Figure 3 corroborates the remarkable fit of the estimated tax functions across all countries in our sample.

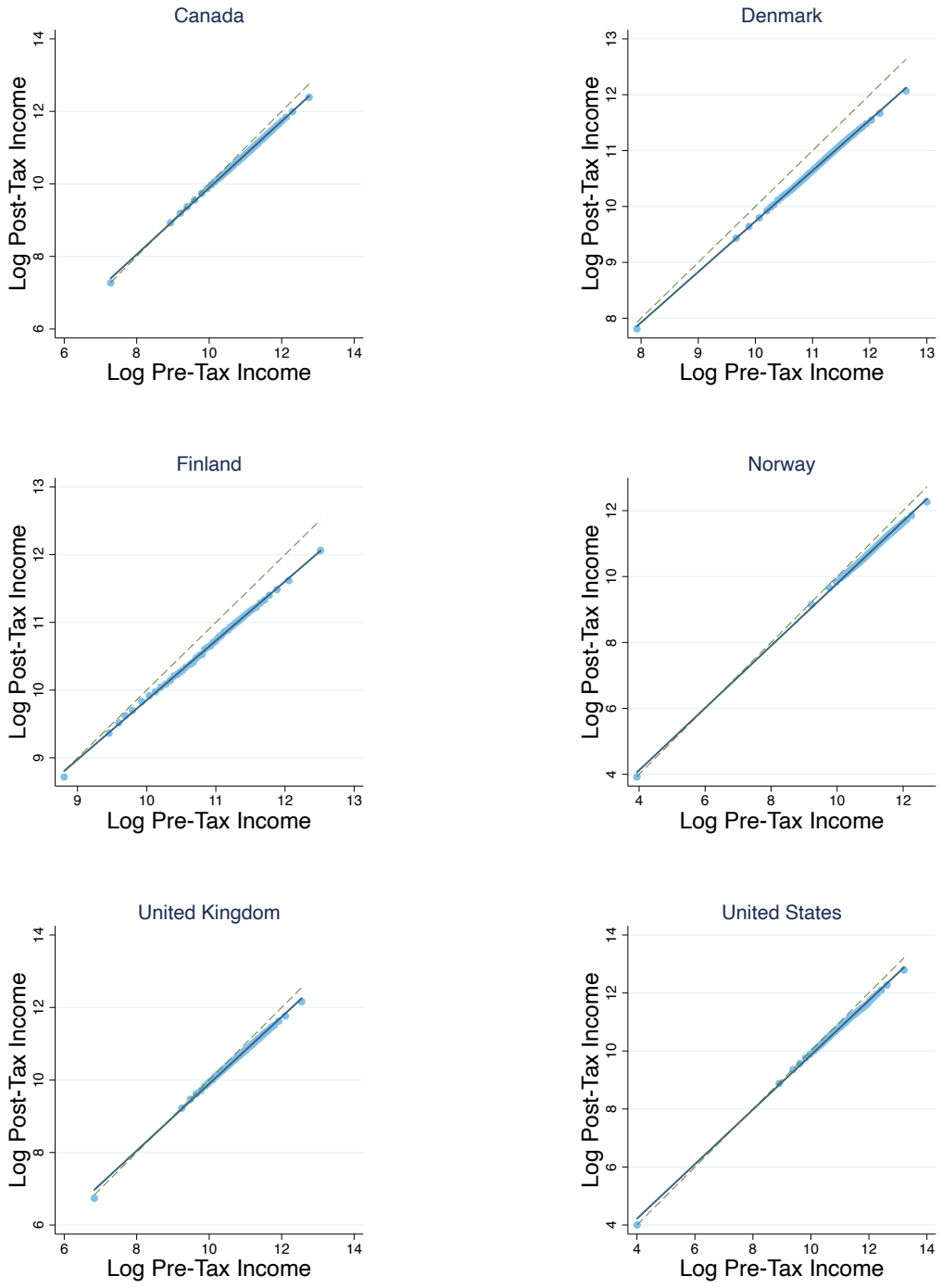


Figure 2: Log post-tax income as a function of log pre-tax income, Wave 10. Post-tax income is defined as pre-tax income minus income taxes. Each dot is a percentile of the log pre-tax income distribution. The dashed line is the 45 degree line. The solid line is the OLS fitted line.

Second, in Figure 3 we show that the R^2 from the regressions we use to estimate our tax functions is very high. We run the regression in Equation (4) wave-by-wave and country-by-country and we and report the distribution of the R^2 from these regressions in Figure 3. 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 well approximates the income tax systems of the countries in our sample.

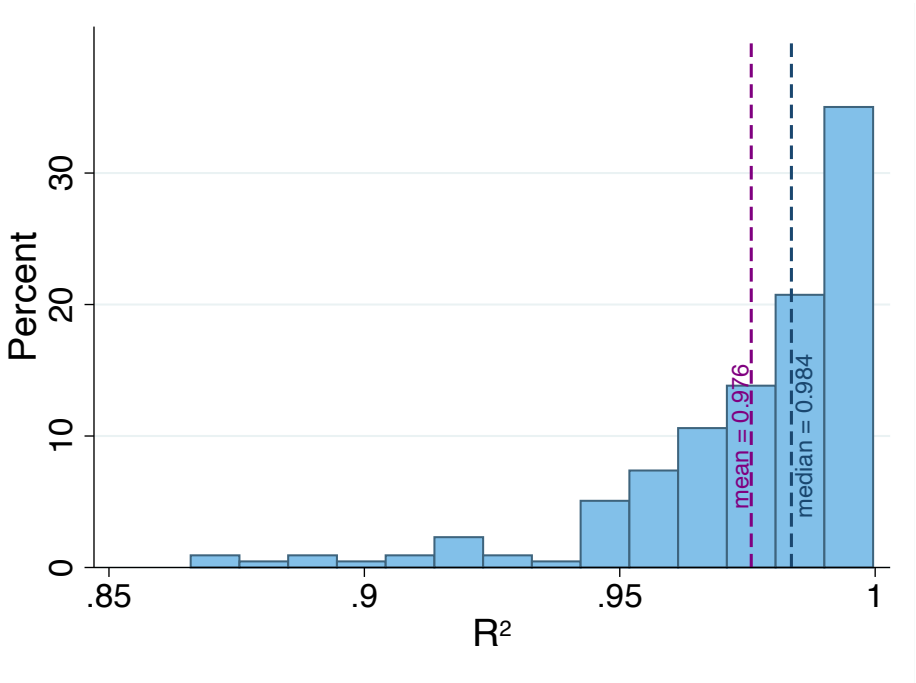


Figure 3: Distribution of the R^2 from year-by-year and country-by-country regressions of log post-tax income on log pre-tax income.

The validity of our results on the goodness-of-fit of our tax function is not challenged by the imputation and simulation procedures used by LIS and the country-specific datasets that LIS utilizes. 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 in Appendix I.1 shows whether taxes and contributions are imputed or not in each country and in each 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-1 in Appendix II confirms that our results are not affected by imputation. 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 both the mean and the median of the distribution of R^2 are untouched when we exclude imputed values.

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 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 3, 7, and 10. In particular, in the left panels, 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. The right panels of Figure 4 show pre-tax median income in each country in each of the waves we consider. Monetary values are reported in 2017 dollars, as described in Section 4.3. Looking at these two figures together, we see that, for example, in wave 10 – corresponding to 2016 – the average tax rate in the USA is about 19%, corresponding to a median pre-tax income of about $ 72,000.

Figure 4 displays several interesting facts. First, a higher degree of progressivity is associated with a higher average tax rate for the median household. The positive association is confirmed by the positively-sloped fitted line and is consistent across all waves we show in Figure 4 and all the remaining ones.

Second, northern-European countries such as Denmark (DK) and the Netherlands (NL) are among the richest in terms of median income and display the highest progressivity and average tax rate. For example, in wave 7, corresponding to 2007, the median income in Denmark and the

Netherlands was 72,000 and 70,000 dollars, respectively, and the average tax rate for the median household in each country was 32 percent. The high level of average taxation and progressivity in northern-European countries is consistent with the high degree of social protection present in these countries.[7]

Third, there is significant variation in the tax structure of rich countries with similar median incomes. For example, while the United States and Denmark have very similar median incomes in each wave, they display vastly different levels of average taxation and progressivity. For example, in wave 10 – corresponding to 2016 – the median income for both countries was about 71,000 dollars, but the average tax rate in Denmark was 31 percent, and the one in the United States was 19 percent. Similarly, the level of progressivity in Denmark was almost twice the one in the United States. Section 6 investigates the relationship between progressivity and median income further.

Fourth, countries with lower median incomes tend to have similar income tax structures. We can observe this across all waves and, in particular, Panels (c) and (e) of Figure 4 show this is the case for south-American countries such as Brazil (BR), Colombia (CO), and Peru (PE) in waves 7 and 10.

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

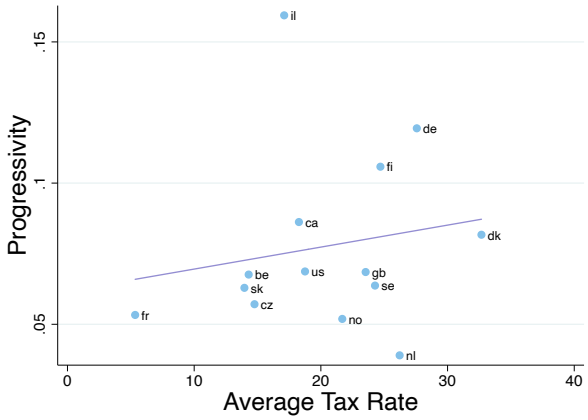
5.3 Effective Income Taxes Over Time

To complete our description income tax systems, we present the evolution of the average tax rate for the median household and income tax progressivity over time. We compute the average tax rate for the median household by applying Equation (2) to the median pre-tax income of each country in each wave. Figure A-2 in Appendix II shows the evolution of median pre-tax income for the countries in Figure 5. We measure progressivity by the parameter τ in our tax function.

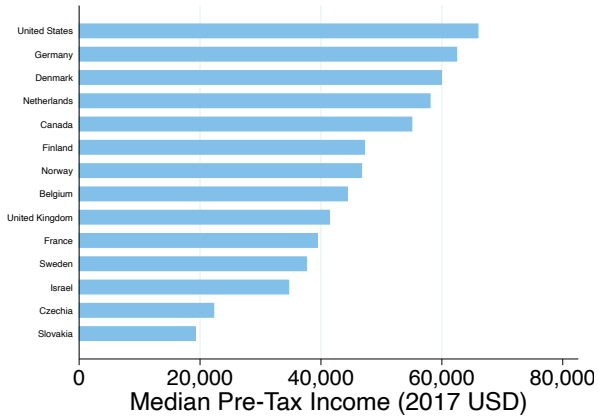
Changes in effective taxation over time are due to numerous factors. First, tax laws determine the levels of statutory taxation and translate into changes in effective taxation.[8] Second, taxpayers' behavior influences effective taxation, as people can change their labor choices based on the incentives or disincentives provided by the tax laws. Finally, the business cycle affects tax laws

[7] See Alesina and Glaeser (2006) for a discussion of the differences between the American and the European welfare state and for a summary of the European approaches to social insurance.

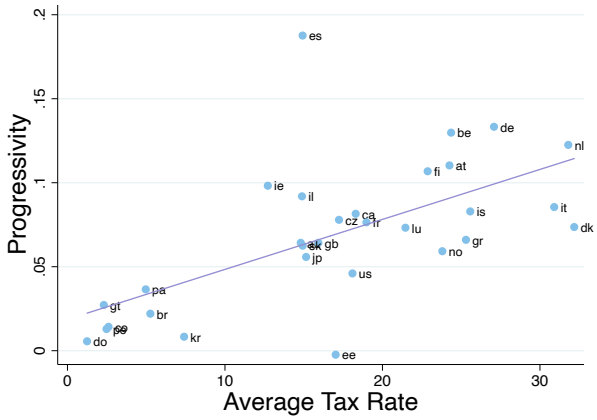
[8] Borella, De Nardi, Pak, Russo, and Yang (2022) focus on the United States and compare the history of income tax reforms with changes in the effective tax burden.



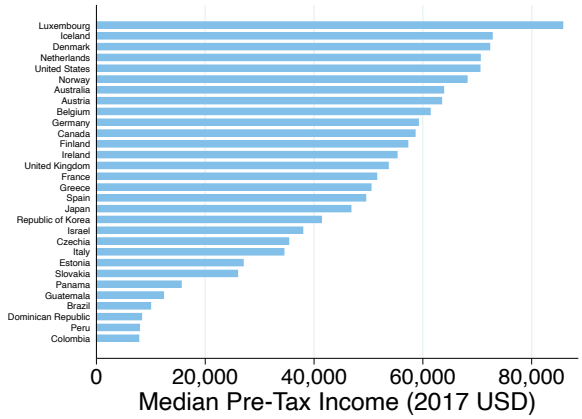
(a) Wave 3, 1990



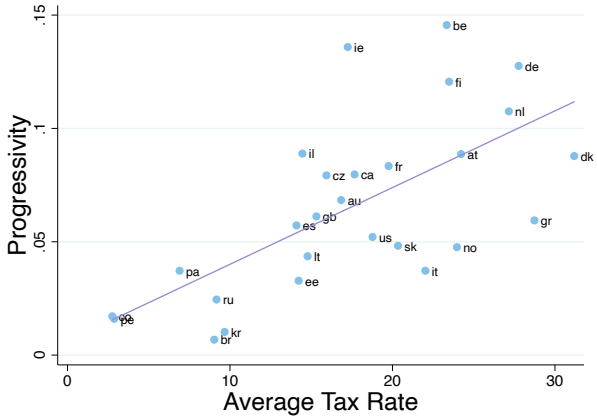
(b) Wave 3, 1990



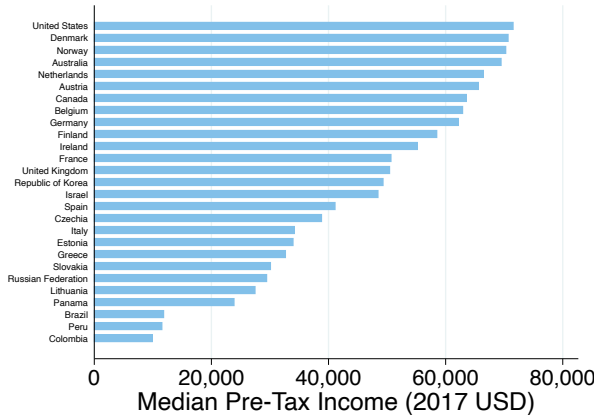
(c) Wave 7, 2007



(d) Wave 7, 2007



(e) Wave 10, 2016



(f) Wave 10, 2016

Figure 4: The panels on the left plot 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. Progressivity is measured by the parameter τ. The solid lavender line is the OLS fitted line. The panels on the right provide a ranking of countries by pre-tax median income. Income is measured in 2017 USD PPP. LIS, waves 4, 8, and 10.

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 the United States, Canada, Denmark, Norway, and Finland, the average tax rate has remained relatively stable over the past 40 years, despite a general increase in median income. For example, the average tax rate in Canada was 18 percent in 1985 (corresponding to a median income of 58,000 dollars) and 18 percent in 2018 (for a median income of 65,000 dollars). In the United States, the most significant drop in the average tax rate for the median household occurred between 2000 and 2010. This decline is due to the reduction in median income over those years and the 2003 and 2006 income tax reforms 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 increased 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 decreased markedly between 1990 and 1995 and remained stable ever since. We also observe remarkable differences in average taxation across countries, even for similar income levels. For example, in 1985 median income in the United States was 67,000 dollars, while in Denmark, it was 63,000 dollars. The corresponding average tax rate in the United States was 19 percent, while the one in Denmark was 32 percent.

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 saw a general decrease in progressivity over the last 40 years. Progressivity in 2018 was about 40 percent lower than in 1980. The United Kingdom and Canada showed a similar evolution: progressivity increased between 1985 and 1995 and then declined. Compared to its 1995 level, progressivity in 2018 was a third lower in the United Kingdom and a quarter lower in Canada. The Scandinavian countries saw an increase in progressivity between 1990 and 1995 but then showed different dynamics. In Denmark, progressivity grew until 2000, decreased markedly between 2000 and 2006, rebounded, and stabilized after 2010. In Norway, it grew until 2004 but declined after then and in 2018 was about half the size of 2004. Finally, progressivity declined between 1995 and 2013 but rebounded to its 2000 level in 2018.

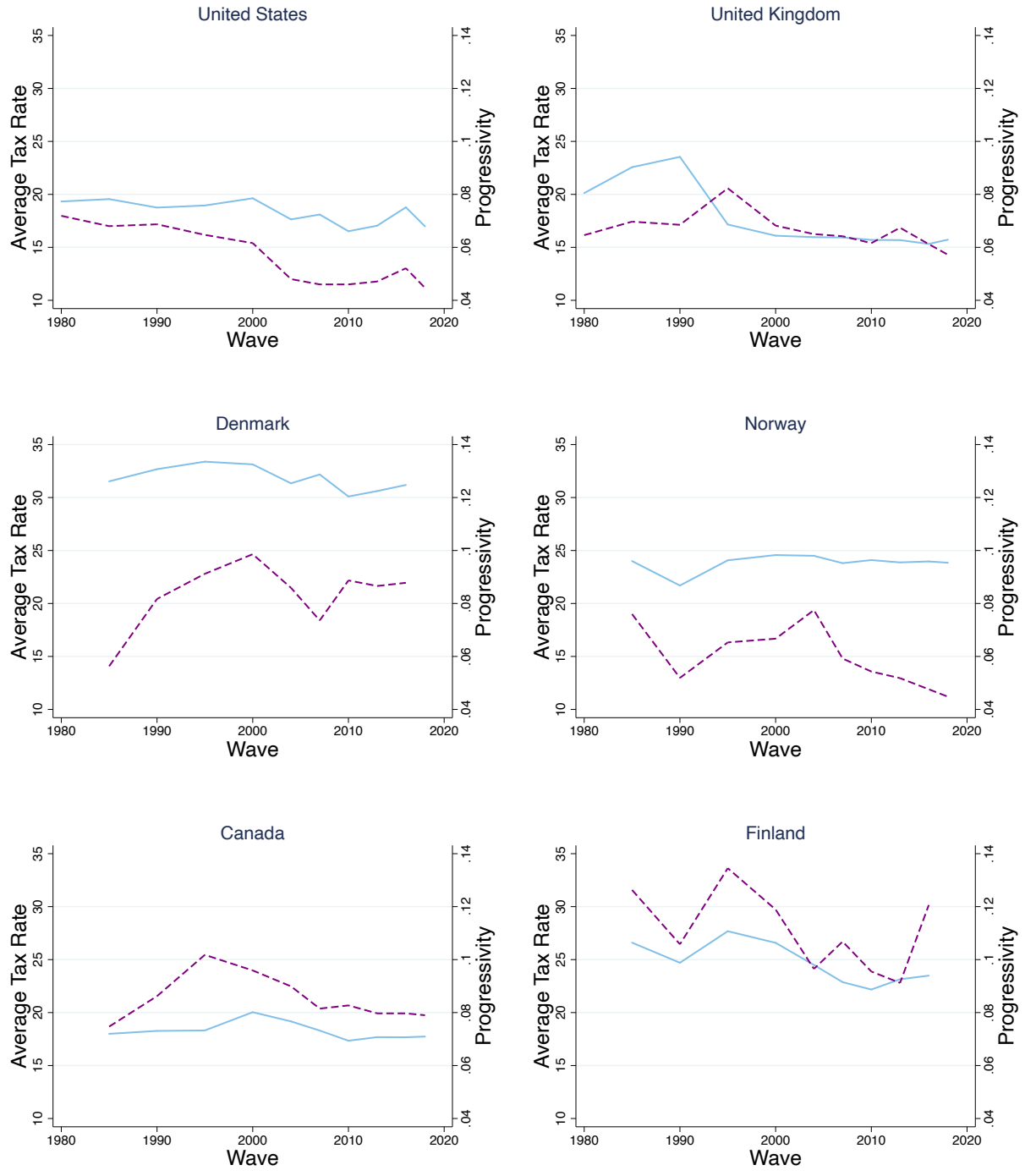


Figure 5: Average tax rate and progressivity over time for selected countries. The solid blue line is the average tax rate for the median household in each year. The dashed purple line is progressivity, measured by the parameter τ.

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. We proxy economic development by median pre-tax income and plot its relationship with income tax progressivity in Figure 6.[9]

Figure 6 offers several interesting insights. First, richer countries are associated with 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. Countries such as Belgium, Germany, and the Netherlands consistently rank among the wealthiest countries and display the highest degree of income tax progressivity.

Second, there are large differences in progressivity across countries with similar median income levels. For example, in Wave 9, many countries have a median income between 60,000 and 70,000 dollars but display vastly different progressivity levels. Belgium (BE) is slightly less wealthy than the USA (US), but its income tax progressivity is three times as large.

Finally, 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 much as Czechia's.

[9] Using median pre-tax income as a proxy for economic development is similar, in spirit, to using GDP per capita, as, among others, Lagakos, Moll, Porzio, Qian, and Schoellman (2018) do.

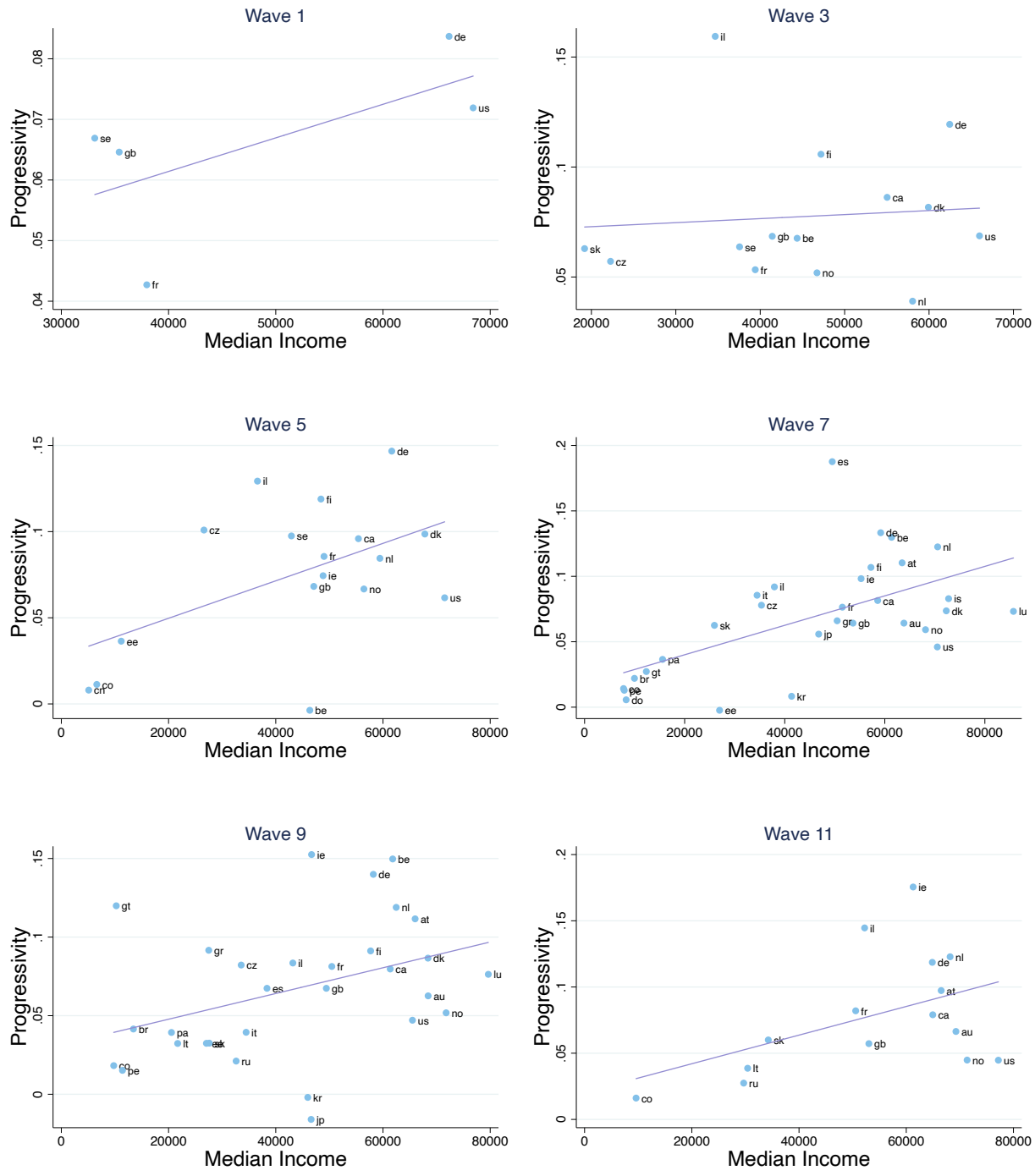


Figure 6: Progressivity as a function of median income. Progressivity is measured by the parameter τ. Income is measured in 2017 USD PPP. The solid lavender line is the OLS fitted line.

7 The Role of Family Structure on Progressivity

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 household type to assess whether it differs for different family structures. We first present descriptive statistics about household composition in our sample, then we estimate income tax progressivity separately by household type.

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.

Figure 7 displays the dynamics of household composition for six countries in our sample and highlights 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 example, half of the Norwegian households in 1985 were married with children, while only 11 percent were married without children. By 2018, the fraction of couples with children declined to 35 percent, while the fraction of married couples without children increased to 15 percent. Second, the share of singles without children has increased in most countries, while the fraction of single parents is relatively stable. For example, the share of singles in the United States increased by half between 1980 and 2018, while the fraction of single parents remained constant.

Figure 7 shows the shift from being married and having children to either not having children or, in large part, being single. These trends are consistent with the decline in marriage and fertility rates experienced by numerous countries worldwide.[10]

7.2 Progressivity by Household Type in the Cross-Section

In light of the demographic changes described in the previous section, we now turn to estimate progressivity separately by household type. Figure 8 shows several interesting facts. First, we observe significant differences in almost every country and wave. The number of children being

[10] 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 over the last few decades.

Figure 7: 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.

equal, progressivity varies by marital status. For example, in Norway, in wave 10, progressivity for married couples with children is significantly higher than the one for single parents. The presence of children causes further differences in progressivity, marital status being the same. For instance, in the United States, in wave 10, the progressivity for married couples with children is almost twice as large as for couples without children. These differences are due to income tax systems generally distinguishing between married and single taxpayers and applying different statutory tax rates to each. Moreover, families with children may enjoy additional deductions and transfers when paying their income taxes.

Second, while the nature of these differences varies by country and wave, we observe similar trends. Starting in wave 4 for all countries except Canada, childless singles face the lowest progressivity. On the other hand, families with children tend to enjoy the highest progressivity in almost all countries and waves. For example, married couples with children have enjoyed the highest progressivity in every wave in the United States.

Finally, Finland is the only country in Figure 8 where the differences in progressivity are small and rarely significant.

7.3 Progressivity by Household Type over Time

In this section, we study the evolution of progressivity over time. Figure 9 plots the dynamics of progressivity in Canada, Denmark, Finland, Norway, the United Kingdom, and the United States.

We observe several facts. First, the presence of children in the family is associated with the highest level of progressivity. In Canada, Denmark, Norway, and the USA, married couples with children enjoy the highest progressivity. In turn, single parents face the highest progressivity in Finland and the United Kingdom.

Second, childless singles face the lowest level of progressivity in each country. In Denmark, Norway, and the United States, singles consistently rank last in every wave. Canada, Finland, and the United Kingdom experience more fluctuations, but progressivity for childless singles has declined since the early Nineties.

Finally, progressivity is more volatile in European than North-American countries. While progressivity for all household types is relatively stable in Canada and the United States, it exhibits large fluctuations in European countries, especially Denmark and Norway.

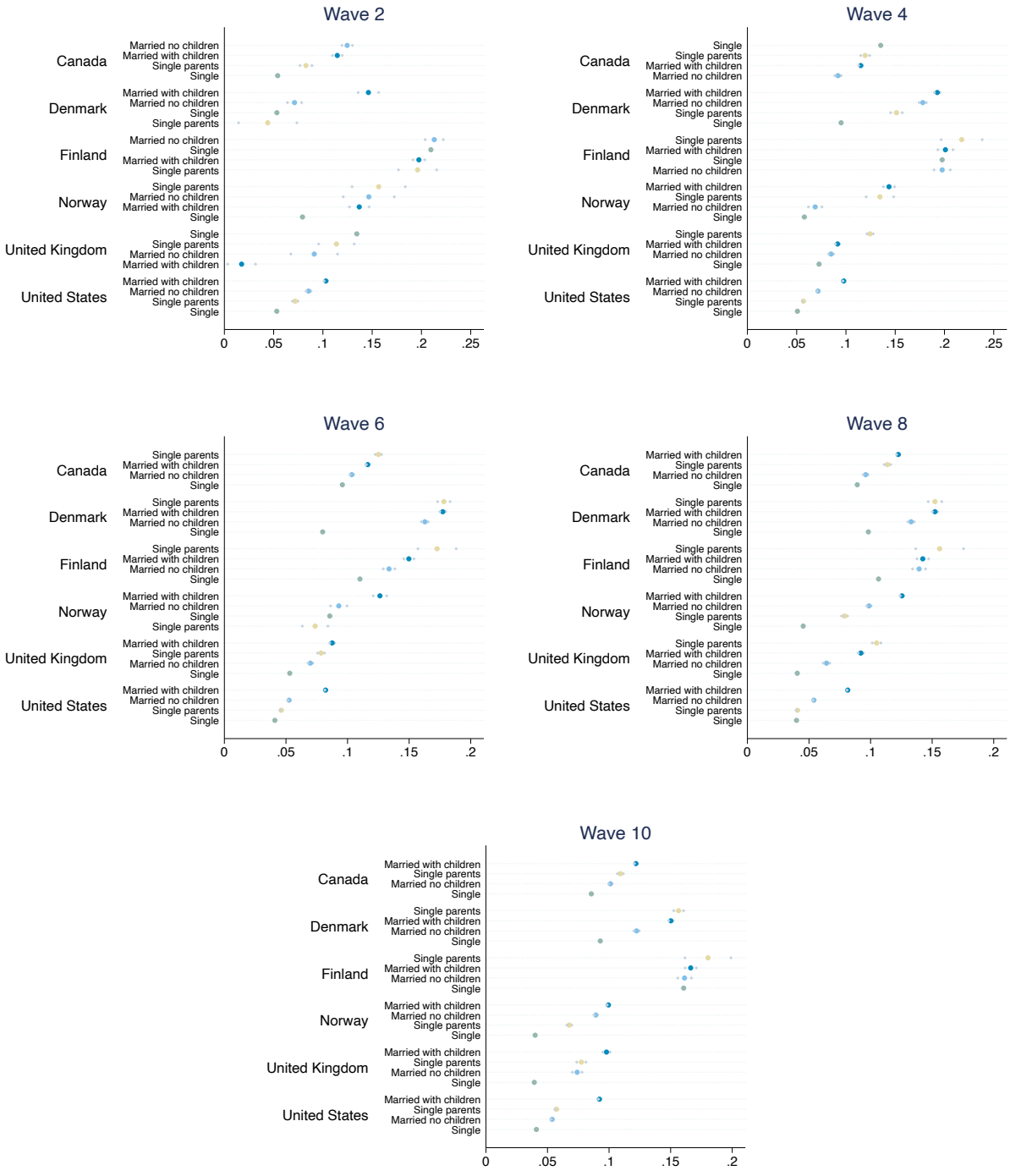


Figure 8: Gross income tax progressivity by household type in six countries. Blue dots are the point estimate for the progressivity parameter τ, and gray diamonds mark the 95% confidence interval.

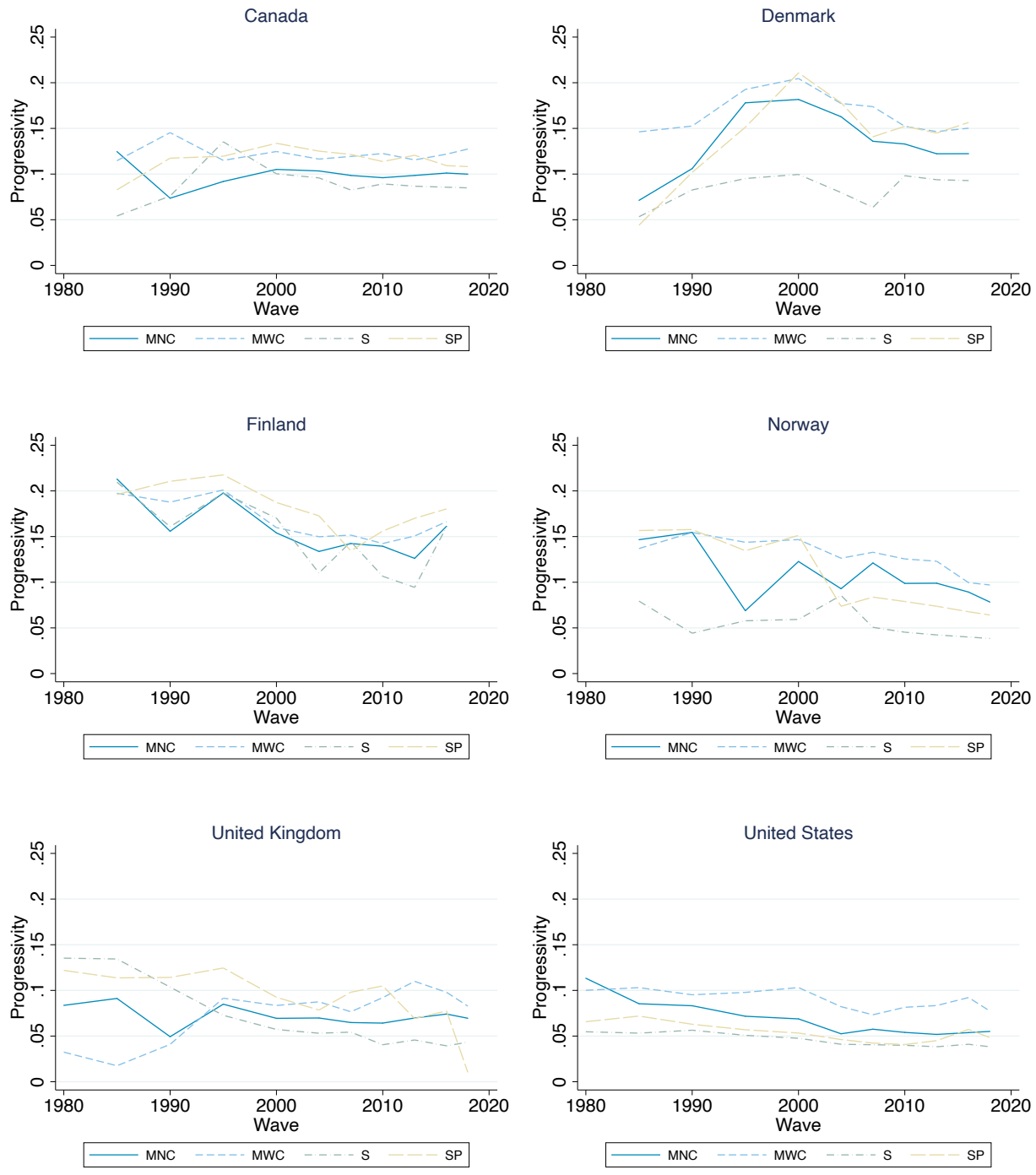


Figure 9: Income tax progressivity by household type over time. MNC denotes married couples without children, MWC married couples with children, S singles without children, and SP single parents.

7.4 The Role of Family Structure for Effective Taxes

So far, we have studied the effect of family structure on income tax progressivity. Now, we summarize the role of family structure for effective incomes taxes through 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 country c at wave t,) β_h captures the household-type fixed effects, and $\gamma_{c,t}$ captures the country-wave fixed effects. We are interested in the household-type fixed effects β_h, whereas the country-wave fixed effects are nuisance parameters absorbed in the regression. We restrict attention to standard households and set childless singles as the base group. The levels of the country-wave fixed effects are normalized such that the constant term represents the average level of the base group.

Table 1 reports the regression results. Columns (1) and (2) report the results for $\lambda_{h,c,t}$ and $\tau_{h,c,t}$. We also consider the average and marginal tax rates facing a household with a median income in each country-wave-household-type group. These additional results are reported in Column (3) and (4) of Table 1.

Column (1) of Table (1) shows that the tax function parameter λ – which captures the average level of taxation – tends to be largest for singles, is smaller for couples without children, is even smaller for single parents, and is the smallest for couples with children. As discussed before, conditional on thhousehold income level income, a higher λ captures a heavier tax burden, *ceteris paribus*. This suggests that single households pay the most taxes, whereas couples with children pay the least for the same pre-tax income. In fact, both the presence of children and marriage are associated with a decline in λ.

However, it may not be realistic to compare a couple with children with a single household that earns the same amount of pre-tax income. Thus, 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) of Table (1). The average and marginal tax rates are calculated according to Equation (2) and (3), respectively. Couples with children have a much lower λ than single households. However, the median couple with children pays a similar average tax rate as the median single household, as indicated by the statistically and economically insignificant coefficient for couples with children in Column (3).

Averaging across all countries and all waves in the sample, a median single household is subject to an average tax rate of 18.2%, and a median couple with children 18.6%, net of country and wave components. Single parents are subject to the lowest average tax rate, which is 5.4 percentage points lower than the one for singles. Couples without children pay the highest average tax rate, which is 1.8 percentage points higher than the one for singles. Both comparisons refer to median-income households in their household type groups. We note that the R-squared of the regression has a very high value of 0.86, indicating a very good fit of this simple regression model to the data.

Results for the marginal tax rate – i.e., the fraction of an additional dollar earned that needs to be taxed – for the median-income households are reported in Column (4). The estimates tell a similar story as in Column (3). Consider a median household in each household type. Single parents pay the lowest marginal tax rate, whereas couples without children pay the highest. Note that a median one-person household is subject to a marginal tax rate of 24.7%, higher than the average tax rate of 18.2%, suggesting some extent of progressivity, which we now turn to.

Column (2) reports the regression results for the progressivity parameter τ. There is some level of progressivity for all types of households. The tax system is the most progressive for couples with children.

8 Conclusions

This paper compares the income tax system of over thirty countries worldwide by estimating country-and-year-specific effective tax functions. We first discuss the fit of a log-linear effective tax function. Then, we study effective income taxes across countries and years. Finally, we analyze the effect of economic development and family structure on income tax progressivity.

We find that a log-linear tax function provides an excellent approximation of income tax systems across the world. Estimating such a tax function requires estimating only two parameters and allows to compare inherently complicated income tax systems by comparing their average level of taxation and progressivity.

We also find that a higher income tax progressivity is associated with a higher average level of taxation. While there is significant variation across countries, this trend has been consistent across the last four decades. We also show that progressivity has significantly changed since the Eighties. In contrast, the average tax rate for a household with median income in each country and wave has been relatively stable.

Table 1: The Role of Family Structure in Tax

	(1) λ	(2) τ	(3) Average	(4) Marginal
One person household (base)	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Couple without children	-0.327**	0.012***	0.018***	0.025***
	(0.130)	(0.003)	(0.002)	(0.003)
Couple with children	-0.779***	0.021***	0.004**	0.021***
	(0.130)	(0.003)	(0.002)	(0.003)
One parent with children	-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

Notes: This table reports the regression estimates of the role of family structure in tax. 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 one-person households as the base group.

We show a positive association between economic development and income tax progressivity. In all the years in our sample, a higher median pre-tax income corresponds to a higher level of income tax progressivity. We also study the impact of family structure on progressivity and show that marriage and children generate significant differences. While married couples with children enjoy the highest progressivity, childless single parents face the lowest.

Our paper provides several contributions. First, it provides evidence in favor of approximating income tax systems across the world through a log-linear effective tax function. Second, it systematically describes the relationship between progressivity and average taxation across countries and years. Third, it studies the effect of economic development and family structure on progressivity. Finally, it provides effective tax functions for numerous countries, years, and household

types that researchers can easily incorporate into their projects.

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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	1,355	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.[11]

Labor income. Total income from 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. 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), 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. Expenditure on income taxes are defined here as compulsory payments to the Government based on 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

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

wage and salary workers for first and second pillars of social insurance: social security, health plans, unemployment insurance, etc.

I.3 Details on Imputation

Country	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Wave 7	Wave 8	Wave 9	Wave 10	Wave 11
Australia						yes	yes	yes	yes	yes	yes
Austria						no	no	no	no	no	no
Belgium			yes	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 Additional Figures

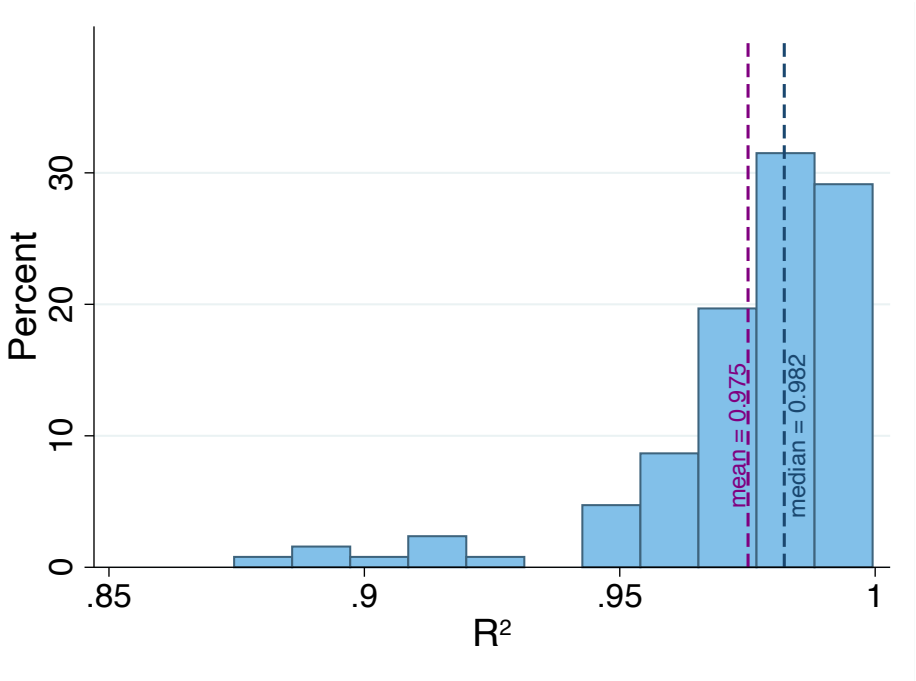

Figure A-1: Distribution of the R^2 from year-by-year and country-by-country regressions of log post-tax income on log pre-tax income when we exclude imputed values

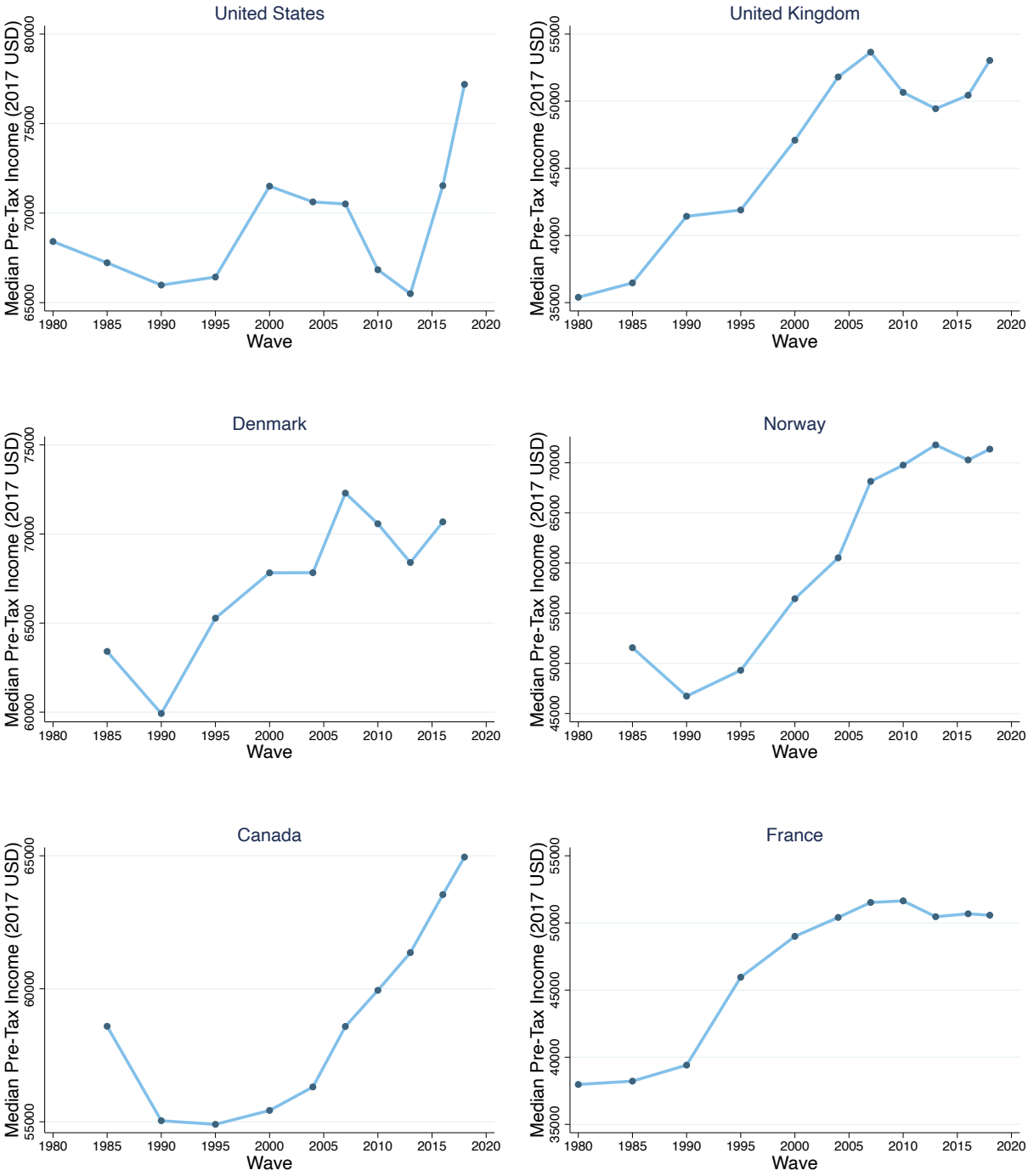

Figure A-2: Median pre-tax household income for standard households in 2017 USD PPP.

III The Role of Transfers for Progressivity

This section analyzes the effects of government transfers on the progressivity of the income tax system. We do so by estimating a tax and transfer function, in which public social benefits enter the post-tax income, not the pre-tax one.

So far, we have ignored the role of transfers for redistribution, as 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-3 compares gross and net progressivity in six waves of LIS. 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.

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.

Then, 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 the 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-4 we show net progressivity by household types. Studying net progressivity is par-

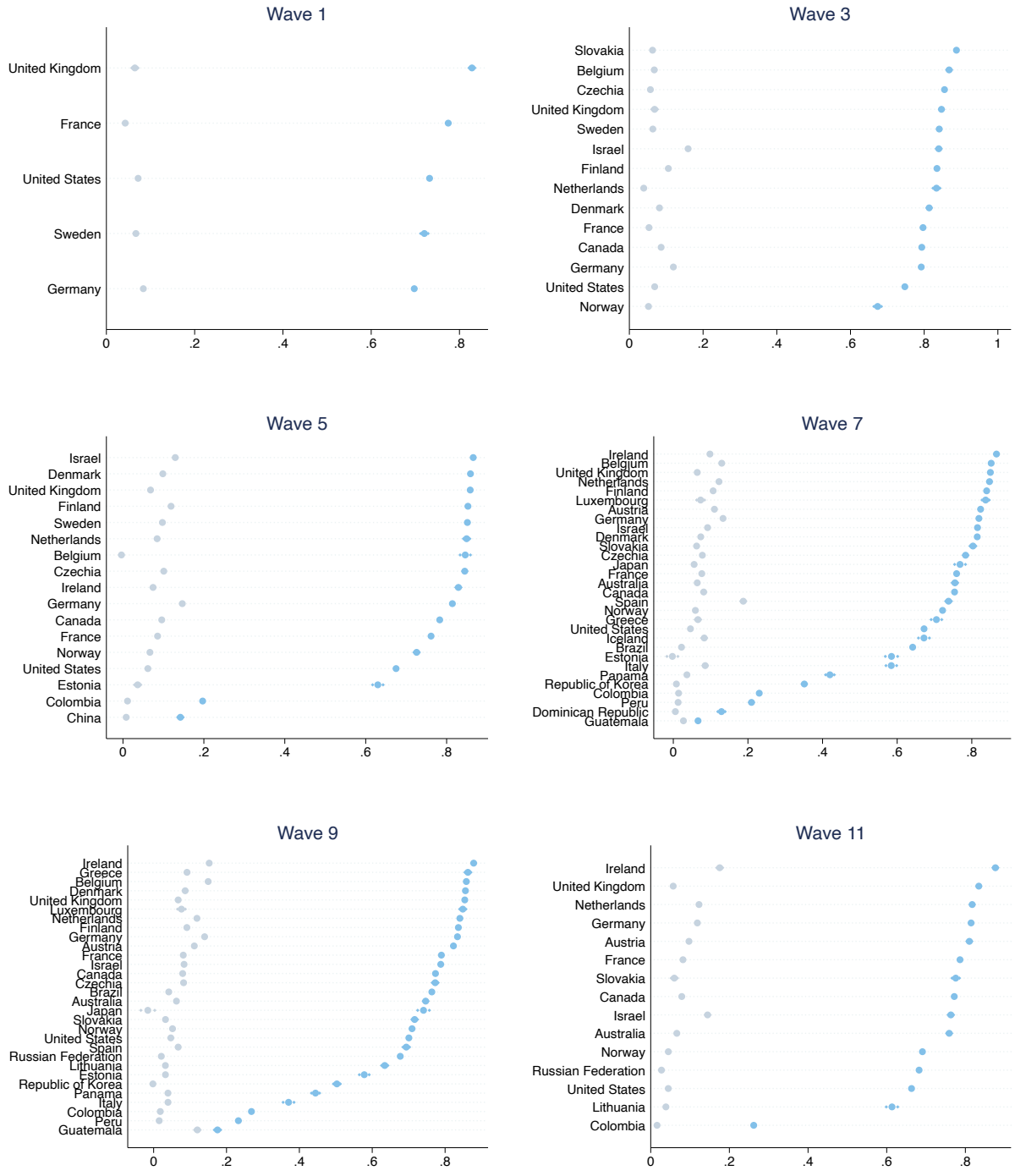

Figure A-3: Comparison of progressivity gross and net of government transfers. The gray dots mark gross progressivity. The blue ones denote net progressivity. Gray and blue diamonds mark the 95% confidence interval for the corresponding progressivity.

ticularly meaningful when we discriminate 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.

Several interesting facts emerge from Figure A-4. 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.

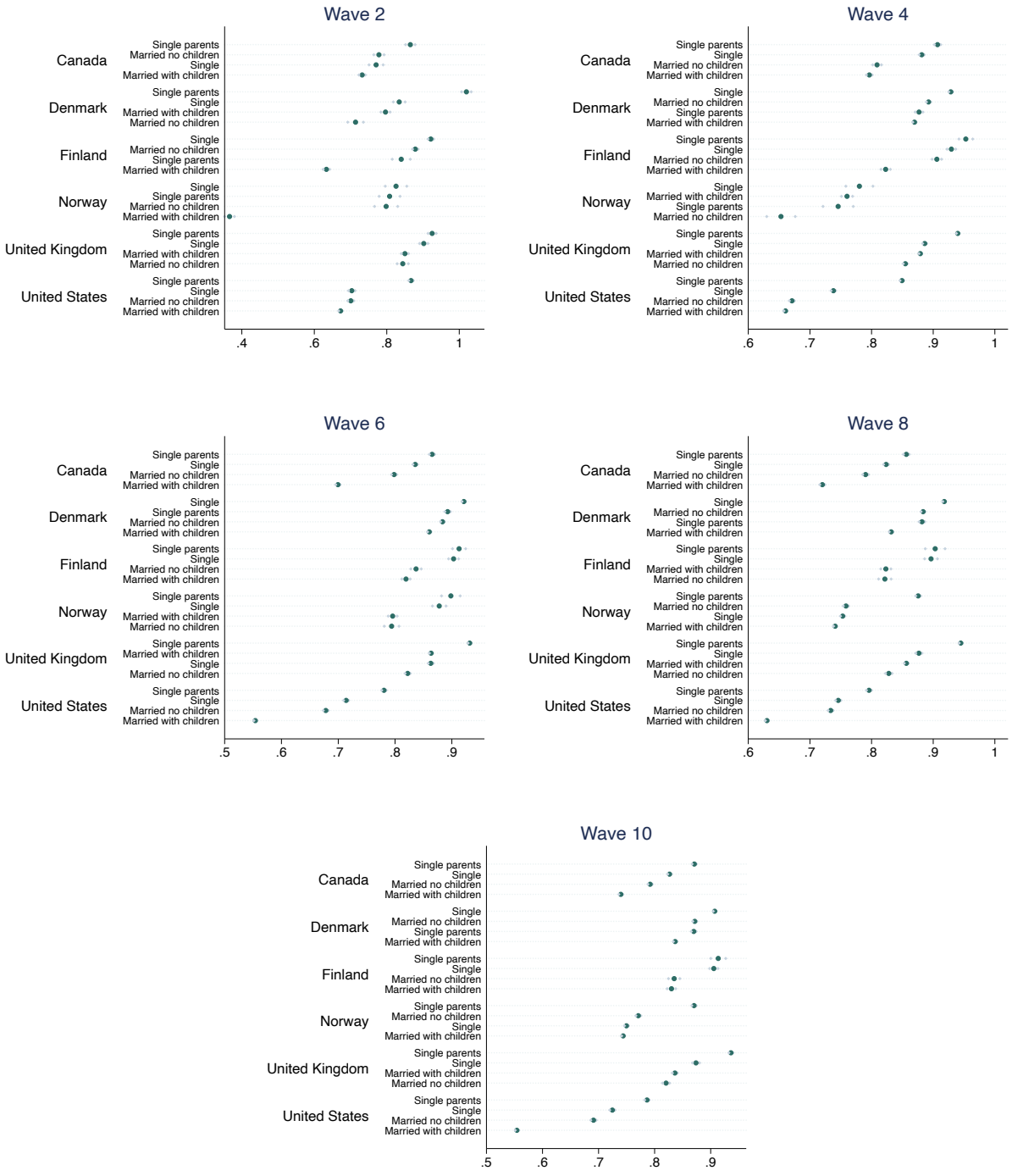

Figure A-4: Net income tax progressivity by household type. Green dots are the point estimate for the progressivity parameter τ, and gray diamonds mark the 95% confidence interval.