

**A Cross-Country Examination of Tax Systems Changes:  
New Evidence from a Novel Database**

**Laura Kawano  
Office of Tax Policy Research  
University of Michigan**

**Joel Slemrod  
Department of Economics and Ross School of Business  
University of Michigan**

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## 1. Introduction and Motivation

The likely consequences of changes in tax systems—rates, bases, and enforcement—for key aspects of economic performance—e.g., income levels and growth rates, investment, and wage rates—play a major role in policy debates about tax reform throughout the world. The debate leading up to the US Tax Cuts and Jobs Act enacted in 2017 is a good example, as supporters and opponents publicized estimates of its impact on these outcomes, and disputed the accuracy of the other side’s estimates, revealing sharp divisions among academics as to the proper direction of policy, as well as controversy as to what the empirical record shows.

The reliability of empirical analyses of the consequences of tax system changes depends in part on the accuracy of the quantitative measurement of the tax systems. Because of the stupefying complexity of modern tax systems, by necessity measurement can strive only to capture the key elements that affect economic outcomes. At a minimum the description should cover not only statutory rates applied to tax bases, but also the elements of the base itself, as well as the enforcement of the tax laws. In an earlier paper (Kawano and Slemrod, 2016), we constructed a dataset that described changes in 12 aspects of corporate tax systems in 30 countries between 1980 and 2004, and related those changes to changes in corporate tax rates and revenues. In that paper, we emphasize that statistical analysis that captures only a subset of the aspects of tax systems might generate biased estimates of those aspects that are included, as the excluded aspects might be consequential and correlated with the included aspects. In addition, having measures of tax bases allows one to pursue to what extent the tax rate elasticity of a given tax depends on the composition of the base, as developed in Slemrod and Kopczuk (2002) and Kopczuk (2005).

In this paper, we revisit these issues in two ways. First, we take advantage of data newly assembled by the IMF and augmented by us to construct a data set that describes changes in the top rate and aspects of the tax base for the corporate income tax (CIT) but also the personal income tax (PIT) and value added tax (VAT) of 23 countries over 34 years; in addition, we have a more limited set of variables that covers 144 countries for the years 1981 through 2015. With these data we calculate the correlation between rate and base changes within each of the three taxes and across the taxes.

## 2. A Brief Gallop through Past Literature

Economists have analyzed many different kinds of data to learn about the consequences of taxation. This paper lies within one strand of that literature: the use of cross-country panel data. The presence of multiple years of data on any given country allows analysis to avoid the problem caused by the presence of unobserved, time-invariant aspects of countries biasing estimates of tax systems, as discussed by, for example, Slemrod (1995). Analysis of time-series data for single countries also avoids this problem, but is often plagued by limited periods of data and even more limited episodes of tax system changes. This is not to say that cross-country panel data analysis is without its challenges; for example, this research design usually requires assumptions that certain transmission mechanisms are the same across countries.

In what follows we offer a highly selected overview of this literature, focusing on how tax systems are characterized and the implications of the measurement choices for the analyses.

### *Quantifying Tax Systems*

In part because of the potential bias from omitting as explanatory variables in a regression analysis important non-rate aspects of the corporate tax system, Kawano and Slemrod (2016) examine to what extent corporate tax bases tend to change when corporate tax rates change. They create a dataset that records when each of 12 aspects of corporate tax bases change in OECD countries from 1980 to 2004. They find, for the OECD countries between 1980 and 2004, that of 171 country-year tax rate changes, 90 (52.6%) were accompanied by base changes. This is a high enough percentage to be concerned about the potential bias from ignoring the base changes. However, one should also note that, of the 485 country-years without rate changes, 219, or 45.2%, featured base changes. Thus, although base changes are more likely in a year when the rate changes, they are not substantially more likely. A linear probability analysis reveals that, on average, tax-base-broadening measures are 26% more likely to occur when the corporate tax rate decreases and 20% more likely to occur when is unchanged, both compared to a corporate tax rate increase. On average, there is a tendency for base changes to offset, rather than reinforce, the revenue effects of tax rate changes; for example, a crackdown on evasion was eight times more likely to occur when the corporate rate fell compared to when it rose. The linear probability analysis reveals that base-narrowing changes are 16% more likely to occur when the corporate tax rate decreases compared to when it increases. All of these differences are statistically significant. These results suggest that the potential problem of bias cannot be dismissed, because the changes in base measures usually excluded from analyses are indeed correlated with statutory rate changes.

With the new data described below, we can extend this exercise to see the co-movement of rate and base changes for the PIT and VAT. In addition, we can determine whether rate changes and base changes among the three taxes tend to happen at the same time. According to the same logic discussed above, if there is such co-movement and either the PIT or VAT affect the outcomes of interest here, omitting these changes in a regression analysis of the effects of the CIT could bias the estimated results.

### *Corporate Tax Revenues*

Several papers have analyzed cross-country panel data to estimate the elasticity of corporate tax revenues—and, by implication, the elasticity of the corporate tax base—with respect to the statutory rate. Under some assumptions, this reveals the marginal efficiency cost of raising that rate; in addition, a large enough elasticity suggests that the rate is beyond the revenue-maximizing rate, although the assumptions needed for these conclusions are quite strong, including that there are no spillover effects to other tax bases.

These cross-country panel studies focus on developed countries and generally feature a regression of corporate tax revenues as a fraction of GDP on the corporate tax rate, the corporate tax rate

squared and year fixed effects to allow for worldwide macroeconomic conditions that affect all countries' corporate tax system outcomes. Clausing (2007) uses data on 29 OECD countries from 1979 to 2002 and finds in her baseline model a substantial negative response of the corporate tax base to corporate tax rate changes. The baseline estimate implies a revenue-maximizing corporate tax rate is 33%, although the estimates are quite sensitive to the set of included controls. Brill and Hassett (2007) estimate a related model, but without year fixed effects, using data on 29 OECD countries between 1980 and 2005 and find similar results. Devereux (2007) uses data for 20 OECD countries from 1986 to 2004 and obtains similar results when estimating a model similar to Clausing (2007).

Despite using panel data, notably all of these studies omit country-specific fixed effects, so they do not control for omitted time-invariant aspects of countries, including non-rate aspects of the corporate tax system, which may differ substantially across countries. This is important because such unobserved heterogeneity may impart bias to the previous analyses. There are several potential sources of heterogeneity. For example, a reduction in the corporate tax rate may induce a larger behavioral response by corporations in a country where the detection of tax avoidance is relatively sophisticated than a similar reduction in a country where firms are able to employ tax avoidance schemes with relative ease. Other examples include the willingness to rely on corporations for tax revenues, the effectiveness of tax collection agencies and differences in data collection systems. Some of these omitted variables likely affect both corporate tax revenues and corporate tax rates, rendering the previous estimates biased and inconsistent. While acknowledging this issue, both Clausing (2007) and Devereux (2007) argue that when country-specific fixed effects are included, insufficient within-country variation remains to identify tax rate effects. Notably, Gravelle and Hungerford (2007) find that when they add country-specific fixed effects to this type of specification, corporate tax rates are no longer statistically significant predictors of corporate tax revenues. This finding confirms that unobserved heterogeneity is indeed quite important when considering the impacts of the corporate tax rate on corporate tax revenues using a cross-country analysis. Moreover, and quite strikingly, their results suggest that we cannot reject the null hypothesis that changes in corporate tax rates have no effect on changes in corporate tax revenues.

Even controlling for time-invariant unobserved heterogeneity, omitted-variable bias will remain if non-rate, but revenue-relevant aspects, of the corporate tax system that are not included as explanatory variables vary over time. To address the issue of non-rate aspects of the corporate tax system being left out and biasing estimates of the effect of the corporate tax rate, some of the previous studies include proxies for the tax base, using the size and profit rate of the corporate sector in the case of Clausing (2007), and a measure of depreciation allowances in the case of Devereux (2007). Kawano and Slemrod (2016) control for changes to the measurement and enforcement of the corporate tax base directly using their newly developed measures. They find in that context, however, that the inclusion of the tax base measures does not materially impact the relationship between corporate tax rates and revenues. In future versions of this paper, we will re-estimate the models in Kawano and Slemrod (2016) using a longer time period and the new IMF

database that we describe below. It is possible that the relationship between corporate tax revenues and aspects of the tax system have changed following the global financial crisis in 2008 or with increased globalization, for example.

Serrato-Suarez and Zidar (2018) find that the relationship between corporate tax revenues and corporate tax rates depends on the breadth of the corporate tax base when examining U.S. state policies. In future versions of this paper, we will attempt to construct a composite measure of the breadth of the corporate tax base by summing over changes that are documented in the IMF database described below, and use this information to test whether there are similar differences in these relationships when looking across countries.

### *GDP per capita*

Barro (1991) initiated the modern empirical analysis of GDP growth, although his government-related explanatory variables are all ratios of various government expenditures to GDP and are therefore only implicitly related to the level of taxes, and not at all to the details of tax systems. Moving to the more recent literature focusing on taxes, Arnold et al (2011) analyze data from 21 OECD countries over the time period 1971 to 2004, and find a negative and significant effect of a revenue-neutral shift of revenue sources to corporate income taxation. Subsequent research has failed to replicate this result. For example, Xing (2012) examines the robustness of the Arnold et al. (2011) results to different assumptions about the long-run and short-run parameters, studying 17 OECD countries for the period 1970-2004, and finds “no clear evidence that corporate income taxes are ‘worse’ than personal income taxes” (p. 381). Baiardi et al. (2017) also fail to completely replicate this result, finding a positive but insignificant coefficient on corporate income taxes, holding constant property and consumption taxes. Moreover, when Baiardi et al. (2017) extend the data to 34 OECD countries (and due to data limitations restrict the time period to 1995-2014), they find that a revenue-neutral shift to corporate taxation is significantly *positively* related to GDP per capita in the long run.

Acosta-Ormaechea et al. (2018) examine 70 countries over the period 1970 through 2009. They find a negative relationship between long-term GDP growth and a shift in revenue sources towards income taxes and away from consumption and property taxes. The relationship between long-term growth and the corporate tax share of revenues is sensitive to model specification. They argue that when the model includes sufficient lags to account for lags in revenues collection, then there is a negative and statistically significant relationship between growth and the corporate income tax share of revenues, and this relationship is more negative for more open economies.

These recent studies share a tax system measurement feature that is, in our view, problematic. The tax measures used as independent variables are revenues in different categories, as a ratio to total revenues. Revenue measures are, loosely speaking, the product of tax rates and tax bases. To the extent that the bases are affected by the rates, they are endogenous. In the extreme, imagine that a base has an elasticity of -1 with respect to the rate. In this case, a change in the rate would not affect

revenues, even though the changed rate almost certainly had economic impact (as indicated by the base changing).

### *Wages*

Hassett and Mathur (2015) explore the effect of corporate tax rates on manufacturing wages, studying a panel of 66 countries over 1981-2005. They divide their 25 years of data into five five-year periods, and regress the 5-year log average of the nominal US\$ manufacturing wage rate against the statutory corporate tax rate in the first year of the five-year period; they explore alternative measures of the effective corporate tax rate that take account of tax depreciation schedules (but use the same inflation rate for each country, which is far from the truth.) All specifications have country fixed effects and (5-year period) time effects. Across these various specifications, the headline partial association between the statutory corporate tax rate and the subsequent five-year average wage is large and statistically significant. They highlight the estimated coefficient of -0.78: a one-percent increase in the corporate tax rate is associated with a 0.78% decrease in hourly wages.

Two aspects of the Hassett-Mathur (2015) study are worthy of note. First, it investigates the effect of the statutory corporate tax rate on wages that are on average two and a half years later (averaging 0, 1, 2, 3, and 4), and does not investigate whether these effects persist. The relatively short time frame seems inconsistent with their assertion that the corporate tax rate affects wages through its impact on capital-labor ratios, which certainly take time to change even if the tax rate affects the flow of investment adding to the stock. Second, their measure of wage rates is adjusted, using purchasing power parity exchange rates, to US dollars. This means that wage rate measures change abruptly during periods of volatile exchange rates. For example, there are numerous instances when the measured wage rate changes by 30 percent or more from one year to the next.<sup>1</sup> The regression equations are thus straining to fit huge changes in wage rate measures that are not conceivably related to short-run changes in capital intensity.

## **3. A New Data Set**

We first describe the new IMF-constructed dataset, and then relate how we have augmented that data.

### **3.1 A New IMF Data Set**

The new IMF data set covers 23 advanced and emerging market economies<sup>2</sup> over the period 1970-2014. In the spirit of Kawano and Slemrod (2016), it reports the direction of change in the base or rate of six tax types: personal income tax (PIT), corporate income tax (CIT), value-added tax (VAT), excise, social security contributions, and property taxes. In this paper we focus on the first three of these taxes. Constructing this database entailed processing information from more than 900 OECD country reports and 37,000 International Bureau of Fiscal Documentation news clips using text

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<sup>1</sup> The 95<sup>th</sup> percentile of the wage rate change distribution is 37%.

<sup>2</sup> The 23 countries are Australia, Austria, Brazil, Canada, China, the Czech Republic, Denmark, France, Greece, Germany, India, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Poland, Portugal, Spain, Turkey, the United Kingdom, and the United States.

mining techniques to extract textual information that potentially describes tax policies, and identified which proposed policies were actually implemented.

For the CIT, the base measures recorded refer to R&D promotion (e.g., tax credits), investment promotion (e.g., depreciation rules), loss-carry rules, thin capitalization, capital gains, and all other changes to the CIT base. For the PIT, the base measures recorded refer to standard relief (e.g., single or family deductions, tax credits), child relief, capital gains, interest relief, relief for SSC, insurance premiums, and private pensions, and all other changes to the PIT base. Changes to the VAT base are recorded as either exemptions on food items, exemptions on medical supplies, exemptions on education, and all other VAT base changes. Moreover, for most specific measures it documents the announcement and implementation dates (e.g., day or month and year). For each measure, there is a variable that indicates whether the change entails an increase or a decrease in the breadth of the tax base. A measure is coded to increase (decrease) the tax base if it will contemporaneously increase (decrease) tax revenues holding constant other aspects of the tax system and behavioral responses. There are also indicator variables that denote whether the measure represents a “major” base change, whether it was taken as part of a package, and whether it is multi-year in nature.

Each observation in the IMF tax measures database provides information on a specific type of tax rate or base change. If there are several tax policy changes that occur in the same calendar year or tax reform packages that affect several aspects of the tax system, each measure will be documented separately. We collapse these observations at the country-year level to construct a panel dataset. For each tax base measure, we tabulate the number of times that there was an “increase” or “decrease” in that tax base measure. We use the implementation year to collapse the data.

The measures that capture CIT base changes in the IMF database differ somewhat from those that are contained in Kawano and Slemrod (2016). Table A1 in the Data Appendix provides a mapping between the base measures found between the two databases. There are several notable differences between the variables in the Kawano and Slemrod series and the IMF database. First, the pro-investment measure in the IMF database combine the investment tax credit and accelerated depreciation measures that are separately coded in Kawano and Slemrod. Second, Kawano and Slemrod separately identify changes to loss carryforward and loss carryback rules, whereas they are combined in the IMF database. Third, several of the measures from Kawano and Slemrod are incorporated in the “other base change” category in the IMF database: controlled foreign corporation legislation, the treatment of foreign corporations, and the foreign tax credit. Finally, and perhaps most importantly, the Kawano and Slemrod database includes an indicator for any year that mentioned measures that are meant to curb tax evasion or avoidance, but the IMF database does not include such a measure. The tax avoidance measures in Kawano and Slemrod account for roughly one-third of the changes to the CIT base.

### **3.2 Augmented Data**

We add data from several data sources, described in detail in the Data Appendix. We obtain top statutory CIT and PIT tax rates and VAT rates for 34 OECD countries from 1981 through 2015

from the OECD Tax Database. We supplement these data with information on statutory tax schedules from the American Enterprise Institute (AEI) International Tax Database. This database covers 159 countries from 1981 through 2011. We identify the top statutory corporate and personal income tax rates, and the value-added tax and sales tax rates for each country in each year. The corporate tax rate refers to the rate that applies generally in cases where there are multiple tax rates for different sectors, and to the rate that applies to publicly traded companies if a different rate applies to privately-held businesses.

One of our outcomes of interest is GDP per capita. These data come from the World Development Indicators (WDI), assembled by the World Bank. This measure is available both in constant U.S. dollars and in constant PPP (measured in 2011 international dollars).

A second outcome we examine is the ratio of tax revenues to GDP. For OECD countries, we collect these data for total taxes, CIT and PIT from the OECD's Tax Revenue Statistics Database.<sup>3</sup> The database includes 34 countries spanning 1965 through 2015. We construct these series for both the consolidated government and central/federal government levels. We supplement these series with data from Acosta-Ormaechea and Yoo (2012). The authors compile data from 69 countries spanning 1970 through 2009 from several data sources. These statistics are reported at the consolidated central and local government level for the 28 most developed countries, but are reported at the consolidated central government level for the other countries due to data availability.<sup>4</sup> For our baseline analysis, we use the consolidated government revenues series when available.

We collect several additional macroeconomic variables from the WDI database. These variables are: GDP, GDP growth rate, population growth rate, unemployment rate, urban share of population, gross fixed capital formation as a percentage of GDP, and household final consumption expenditure (PPP, in constant international dollars).

Because coverage over years and countries varies across databases, we construct two analysis samples. The first sample contains observations with information on tax rates and tax bases. This sample covers the 23 countries included in the IMF database between 1981 and 2015.<sup>5</sup> We refer to this sample as the "IMF sample." The second sample considers macroeconomic variables as the outcome of interest. We include all country-years that contain both GDP-per-capita and tax rate data. This sample includes 144 countries and covers years 1981 through 2015. We refer to this sample as the "full sample."<sup>6</sup>

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<sup>3</sup> These data are available at [http://www.oecd-ilibrary.org/taxation/data/oecd-tax-statistics\\_tax-data-en](http://www.oecd-ilibrary.org/taxation/data/oecd-tax-statistics_tax-data-en).

<sup>4</sup> The 28 countries are Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Greece, Ireland, Italy, Japan, Mexico, the Netherlands, Norway, New Zealand, Portugal, Slovak Republic, South Korea, Spain, Sweden, Switzerland, Turkey, West Germany (until 1990), the United Kingdom, and the United States.

<sup>5</sup> We do not have information on tax revenues for China, so are unable to include it in this sample.

<sup>6</sup> A third potential analysis sample includes country-years with data on tax revenues and on tax rates. This sample includes 59 countries between 1981 and 2009. In this version of the paper, we do not make use of this sample but plan to do so in future iterations of the paper.



Tables A2 and A3 in the Data Appendix reports countries that appear in the IMF and full samples, respectively. Summary statistics for the small analysis samples are provided in Table 1, and summary statistics for the full sample are provided in Table 2. In Table 3, we provide tabulations of the top statutory tax rate and tax base changes, by source and direction of change. By definition, this table provides information for the IMF sample only, restricted to the country-years observations that also have information on tax rate changes. The table includes 740 country-year observations when considering the corporate and personal income tax, and 579 country-year observations when considering the VAT.<sup>7</sup> We compute rate changes using our top statutory tax rate measures. Although the IMF database records instances of rate changes, this includes aspects of the tax rate structure other than the top statutory rate (e.g., capital gains, or rates affecting lower incomes). In a small number of instances, there are both changes that broaden and narrow a particular tax base measure in the same year. This phenomenon is most common for the “other base broadener” categories. In such cases, both types of changes are included because, without measures that capture the relative impacts of these changes, we are unable to determine the net effect of these changes on the tax base. The table includes information about the number of country-years where there is *any* change in a tax base definition. In 280 country-years, there is some change to the definition of the corporate tax base. There can be several policies that change aspects of a particular tax base in a given year. In the case of the corporate tax base, for example, Table 3 shows that within these 280 country-years with any change to the corporate tax base, these comprise 524 changes documented in the IMF database. We describe these patterns in the next section.

Table 1: Summary Statistics for the IMF Sample

| Variable   | N. Obs. | Mean   | Std. Dev. | Min    | Max     |
|--|---------|--------|-----------|--------|---------|
| GDP per capita (constant 2010 US\$)                  | 787     | 28,399 | 19,886    | 361    | 111,968 |
| GDP per capita, PPP (constant 2011 international \$) | 598     | 29,938 | 16,527    | 1,526  | 97,864  |
| Corporate tax revenues/GDP                           | 692     | 2.74   | 1.29      | 0.57   | 7.68    |
| Personal tax revenues/GDP                            | 692     | 7.86   | 4.96      | 0.13   | 26.28   |
| Corporate tax rate                                   | 765     | 36.68  | 9.78      | 12.50  | 65.00   |
| Personal tax rate                                    | 764     | 43.88  | 11.60     | 15.00  | 84.40   |
| VAT rate   | 598     | 16.30  | 5.74      | 0.00   | 35.00   |
| Sales rate   | 42      | 16.59  | 6.80      | 3.30   | 28.80   |
| GDP growth   | 805     | 0.36   | 0.48      | 0.00   | 1.00    |
| Population (thousands)                               | 805     | 0.39   | 0.49      | 0.00   | 1.00    |
| Unemployment rate                                    | 805     | 0.09   | 0.29      | 0.00   | 1.00    |
| Urban population (%)                                 | 785     | 3.19   | 3.49      | -11.61 | 25.56   |
| Population growth                                    | 737     | 7.57   | 4.36      | 0.70   | 27.50   |
| Physical capital investment                          | 805     | 69.90  | 15.16     | 20.12  | 93.50   |
| PPP (billions, constant 2011 international \$)       | 805     | 0.77   | 0.68      | -1.85  | 2.89    |
| Wage rate  | 194     | 15.27  | 5.95      | 0.00   | 27.24   |

The table presents sample means, standard deviations, minimum values and maximum values for the sample that is included in the IMF database. The second column presents the number of observations with non-missing information for each variable.

<sup>7</sup> There are fewer observations with a tax rate change because we require two consecutive years of data to compute the change. We additionally lose the first year of data for each country.

Table 2: Summary Statistics for the Full Sample

|  |      |        |        |        |         |
|--|------|--------|--------|--------|---------|
| GDP per capita (constant 2010 US\$)                  | 4626 | 14,027 | 18,382 | 116    | 141,165 |
| GDP per capita, PPP (constant 2011 international \$) | 3582 | 18,174 | 19,260 | 247    | 129,350 |
| Corporate tax revenues/GDP                           | 1797 | 2.84   | 1.92   | 0.01   | 15.59   |
| Personal tax revenues/GDP                            | 1721 | 6.31   | 5.12   | 0.01   | 26.28   |
| Corporate tax rate                                   | 3284 | 32.41  | 12.54  | 0.00   | 75.00   |
| Personal tax rate                                    | 3244 | 35.61  | 17.55  | 0.00   | 95.00   |
| VAT rate   | 1024 | 17.58  | 5.63   | 0.00   | 35.00   |
| Sales rate   | 184  | 13.80  | 6.80   | 3.00   | 28.80   |
| GDP growth   | 805  | 0.36   | 0.48   | 0.00   | 1.00    |
| Population (thousands)                               | 805  | 0.39   | 0.49   | 0.00   | 1.00    |
| Unemployment rate                                    | 805  | 0.09   | 0.29   | 0.00   | 1.00    |
| Urban population (%)                                 | 4644 | 3.44   | 5.61   | -62.08 | 106.28  |
| Population growth                                    | 3103 | 8.41   | 5.80   | 0.00   | 38.80   |
| Physical capital investment                          | 5031 | 55.91  | 23.82  | 4.79   | 100.00  |
| PPP (billions, constant 2011 international \$)       | 5025 | 1.45   | 1.52   | -6.18  | 16.33   |
| Wage rate  | 1998 | 14.69  | 6.53   | -0.20  | 54.07   |

The table presents sample means, standard deviations, minimum values and maximum values for the sample that is included in the full sample. The second column presents the number of observations with non-missing information for each variable.

Table 3: Frequency of tax system changes (country-years), 1982-2015

|  | Increase | Decrease | Total Changes |
|--|----------|----------|---------------|
| <b>Tax Rate Changes</b>                                  |          |          |               |
| CIT rate   | 74       | 204      | 278           |
| PIT rate   | 42       | 128      | 170           |
| VAT rate   | 53       | 17       | 70            |
| <b>Corporate Tax Base Changes</b>                        |          |          |               |
| Changes focusing on capital gains                        | 16       | 27       | 43            |
| R&D promotion  | 5        | 31       | 36            |
| Investment promotion                                     | 36       | 80       | 116           |
| Loss carry rules   | 6        | 8        | 14            |
| Thin Capitalization                                      | 6        | 8        | 14            |
| Other CIT base change                                    | 121      | 180      | 301           |
| Any base change  | 133      | 204      | 280           |
| Total base change measures                               | 190      | 334      | 524           |
| <b>Personal Tax Base Changes</b>                         |          |          |               |
| Relief for SSC, insurance premiums, and private pensions | 11       | 16       | 27            |
| Child relief   | 8        | 46       | 54            |
| Interest relief  | 17       | 19       | 36            |
| Relief on capital gains                                  | 18       | 18       | 36            |
| Standard relief  | 61       | 150      | 211           |
| Other PIT base changes                                   | 111      | 174      | 285           |
| Any base change  | 148      | 235      | 304           |
| Total base change measures                               | 226      | 423      | 649           |
| <b>VAT Base Changes</b>                                  |          |          |               |
| Food items   | 2        | 3        | 5             |
| Medical supplies   | 0        | 0        | 0             |
| Other  | 28       | 16       | 44            |
| Any base change  | 26       | 19       | 39            |
| Total base change measures                               | 30       | 19       | 49            |

The table presents tabulations of extensive margin changes to corporate, personal, and value-added tax rates and bases. Some country-years have both base broadeners and base narrowers, so the number of country-years with any base change is less than the number of country-years with any base broadeners plus the number of country years with any base narrower.

## 4. Tax Policy Patterns

### 4.1 CIT

Figure 1 demonstrates the downward time trend of CIT rates, as noted by Clausing (2007) and Becker and Fuest (2011), among others. This pattern holds true across all samples that we consider. In the full sample, the GDP-weighted average CIT rate is 49.1 percent in 1981 and falls to 31.0 percent by 2011, the last year of the AEI International Tax Database. In the IMF sample, the GDP-weighted average CIT rate is 50 percent in 1981 and falls to 32.8 percent by 2015.

Although the trend toward lower statutory corporate tax rate is well-known, until now there has been no hard evidence about the trend in the broadness of the corporate tax base. In Figure 2, we plot the number of tax base increasing and tax base decreasing measures that are implemented in each year across the 23 countries in the small sample. Overall, tax base narrowing measures outnumber tax-base-broadening measures. The years fall roughly into three eras. Until 1984, base narrowing greatly exceeds base broadening. This is followed by the period 1985-1991, when there are almost as many base broadeners as base narrowers (61 broadeners and 60 narrowers); this is of course when the rate-cutting, base-broadening U.S. Tax Reform Act of 1986 occurred, as well as similar measures in the U.K. and Canada. Then, from 1991 to 2015, tax base narrowers greatly exceed broadeners, with the exception of a brief interlude from 1996 to 1998 and from 2007 to 2010.

Figure 1: Average Top Corporate Tax Rate, GDP-Weighted

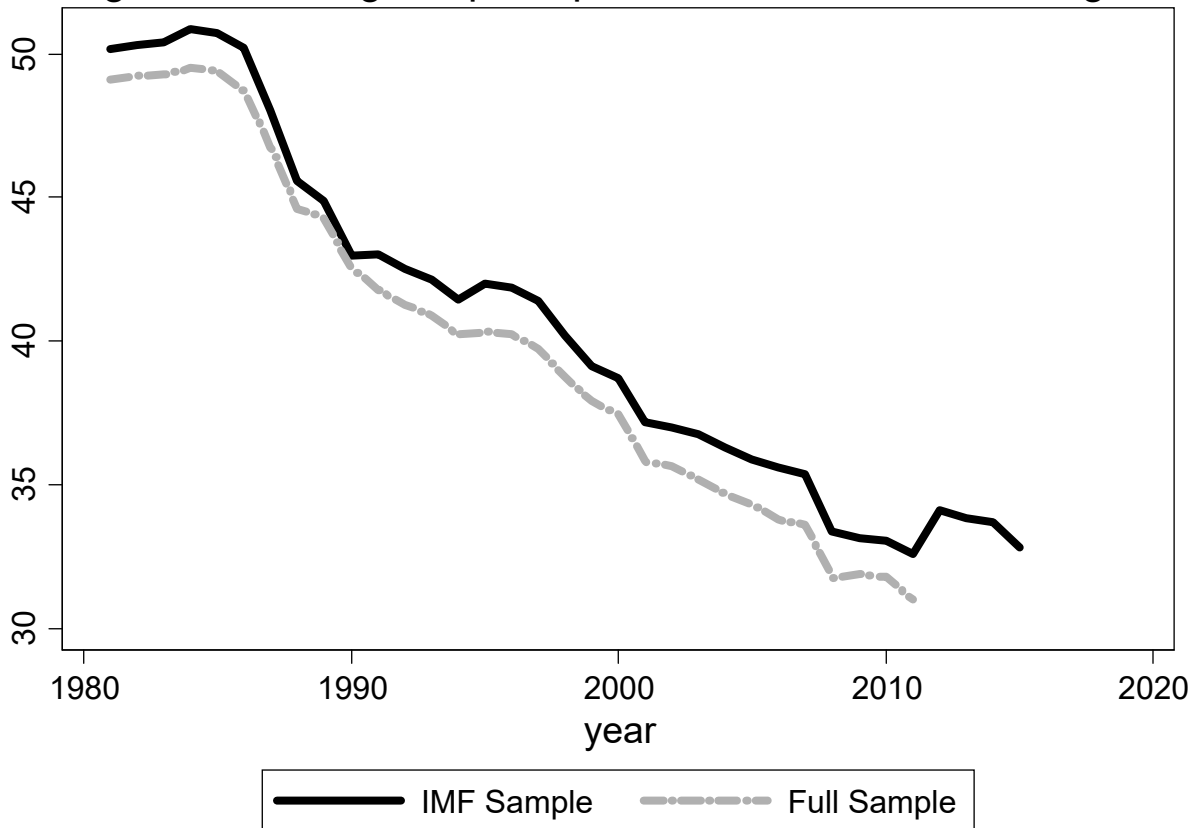
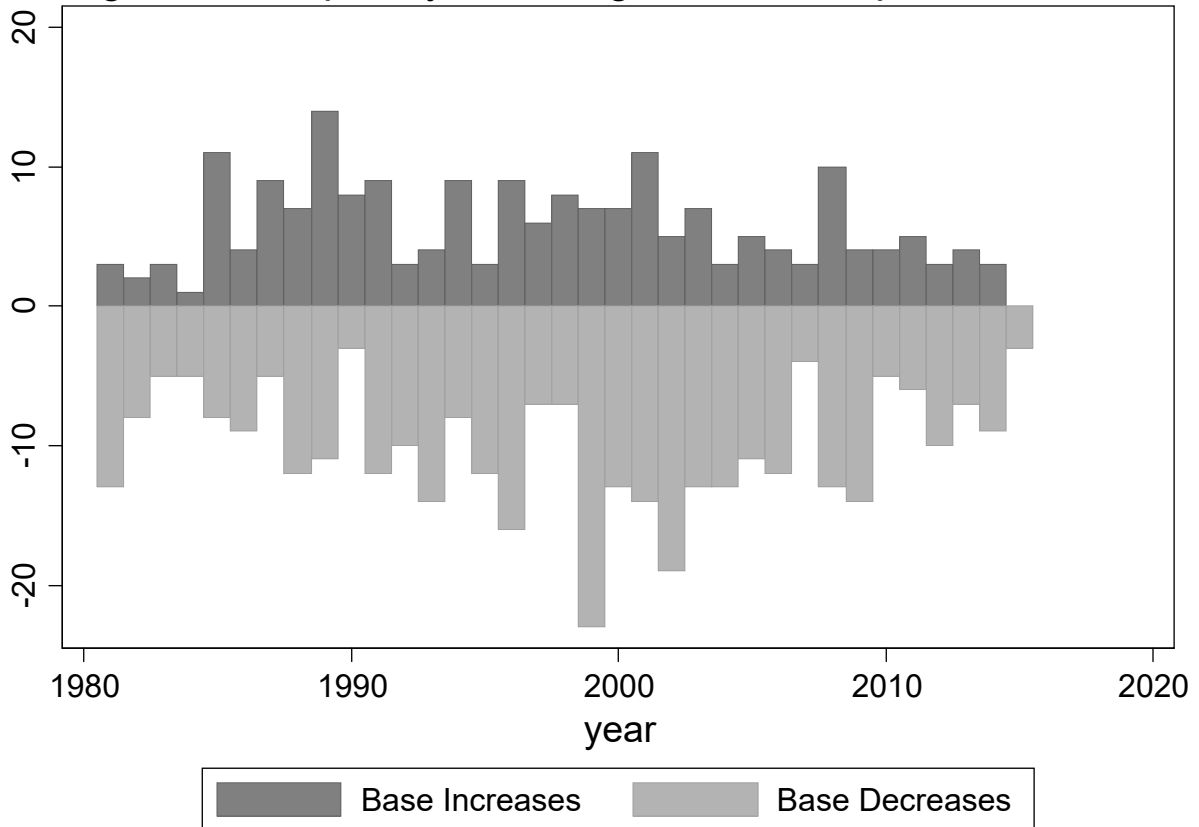


Figure 2: Frequency of Changes to the Corporate Tax Base



Within the IMF data, in 278 out of 740 country-years, the CIT rate changed. As suggested by the data just mentioned, tax rate declines dominated tax rate increases, comprising 73.4% (204/278) of the changes. Of the 805 country-years covered in the IMF data, there was at least one change to the CIT base in 292 country-years, or 36.3% of the time. Consistent with Figure 2, CIT base narrowing measures were more prevalent than base broadening measures. Of the 552 tax base changes, 64% are measures that narrow the CIT base.

Within the IMF data, we can explore the correlation between CIT rate and base changes, as done by Kawano and Slemrod (2016). This is not precisely a replication, in that the range of base changes considered is different (and narrower) in the IMF data. These tabulations are presented in Table 4, focusing on the 740 country-years with both information on the change in tax rates (which requires two consecutive years of data) and changes to the CIT base. In 38% (280 out of 740) country-years, there was at least one CIT base change, and in 37.6% of country-years (278 out of 740) the rate changed. But base changes were more likely in years when the CIT rate also changed, 43.9% (122/278) versus 34.2% (158/462). This is not particularly surprising, given that both the CIT rate and base might change as part of a broader tax reform package.

In over half of the country-years in the IMF data, there is a change to some aspect of the CIT system (436 of 740 country-years, or 59%). The majority of CIT system changes consisted of a

change to the rate or the base but not both: there were 158 country-years that consisted of a change to the base with no rate change, and 156 country-years that consisted of a change to the rate with no change to the base. Of the 122 changes that involved both rate and base changes, the most common combination is to lower the rate, narrow the base (44), followed by lower the rate, broaden the base (25), raise the rate, narrow the base (16), and raise the rate, broaden the base (9). In 28 country-years when there is a rate change, there are both measures that broaden the base and measures that narrow the base. Given the coarseness of our data, we are unable to determine the net effect on the breadth of the CIT base in these years.

The frequency of CIT base changes is similar our earlier evidence, occurring in 44% of country-years in the Kawano and Slemrod (2016) database. However, our earlier analyses showed that CIT base broadeners were more common than base narrowers (56.9% versus 43.1%). This difference is driven, at least in part, by the IMF database excluding measures to curb tax evasion and avoidance. This difference generates a different pattern in the types of CIT system changes that we observe. In contrast to Kawano and Slemrod (2016), base broadening measures are slightly less likely to accompany rate decreases relative to rate increases. Of the base changes that accompany a tax rate decrease, 50% (44/88) are broaden the tax base, while 53% (18/34) of the base changes that accompany a tax rate increase do so. In the earlier data, the most prevalent tax policy change was those that lower the rate and broaden the base. However, the other combinations of rate and base changes were also observed.

Table 4: Frequency of CIT base changes accompanying CIT rate changes (country-years)

| <b>Tax Base</b>            | <b>Tax rate</b> |                  |                 | <b>Total</b> |
|----------------------------|-----------------|------------------|-----------------|--------------|
|                            | <b>Decrease</b> | <b>No change</b> | <b>Increase</b> |              |
| Only Decrease              | 44              | 87               | 16              | 147          |
| Only Increase              | 25              | 42               | 9               | 76           |
| Both Increase and Decrease | 19              | 29               | 9               | 57           |
| Some Base Change           | 88              | 158              | 34              | 280          |
| No Change                  | 116             | 304              | 40              | 460          |
| <b>Total</b>               | <b>204</b>      | <b>462</b>       | <b>74</b>       | <b>740</b>   |

The table provides tabulations of the coincidence of changes to the corporate tax rate and changes to the corporate tax base.

Of interest is the question about whether CIT changes are predictable.<sup>8</sup> To begin to answer this question, we estimate linear probability models of an indicator variable for there being any change in the top statutory CIT rate on lagged values of log GDP per capita, the GDP growth rate, the unemployment rate, and the proportion of the population living in urban areas. We also include year fixed effects to control for global economic conditions. In results not shown, we find that an increase in GDP per capita is positively correlated with CIT rate changes in the following year, and

<sup>8</sup> We leave for future work the question of whether tax *base* changes are predictable.

that this effect is primarily driven by CIT rate decreases. When we include country-specific fixed effects, however, this relationship becomes statistically insignificant. None of the other included macroeconomic factors appears to have any predictive power over CIT rate changes.

## 4.2 PIT

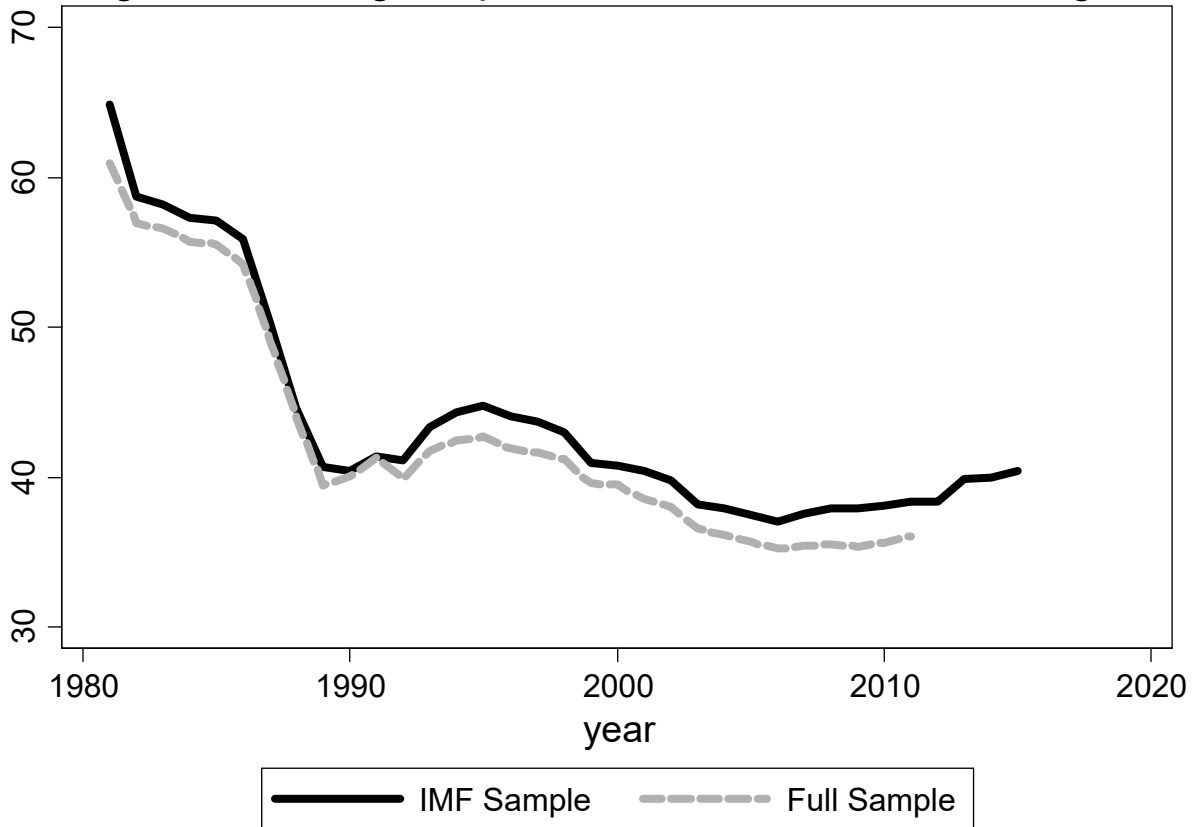
Table 5 presents information on changes to the PIT tax system in the IMF sample. In 23% (170/740) of country-years, the top PIT rate changes. Rate decreases predominated, comprising 75.3% (128/170) of the instances. The GDP-weighted average of the top PIT rate over time is depicted in Figure 2. This rate was 64.8 percent in 1981 for the IMF sample, and fell to 40.4 percent by 2015. This is comparable to the trend noted in OECD (2012).

Table 5: Frequency of PIT base changes accompanying PIT rate changes (country-years)

| <b>Tax Base</b>            | <b>Tax rate</b> |                  |                 | <b>Total</b> |
|----------------------------|-----------------|------------------|-----------------|--------------|
|                            | <b>Decrease</b> | <b>No change</b> | <b>Increase</b> |              |
| Only Decrease              | 24              | 126              | 6               | 156          |
| Only Increase              | 11              | 52               | 6               | 69           |
| Both Increase and Decrease | 29              | 44               | 6               | 79           |
| Some Base Change           | 64              | 222              | 18              | 304          |
| No Change                  | 64              | 348              | 24              | 436          |
| <b>Total</b>               | <b>128</b>      | <b>570</b>       | <b>42</b>       | <b>740</b>   |

The table provides tabulations of the coincidence of changes to the personal tax rate and changes to the personal tax base.

Figure 3: Average Top Personal Tax Rate, GDP-Weighted



In 41.1% (304 out of 740) country-years, there was at least one PIT base change. The time series of PIT base changes, depicted in Figure 4, has broadly the same pattern as the CIT base changes. Base decreases predominate overall, except for a surge in base increases in the late 1980's. Base narrowing measures peaked in the late 1990s and early 2000s, and then has on average tailed off.



Figure 4: Frequency of Changes to the Personal Tax Base

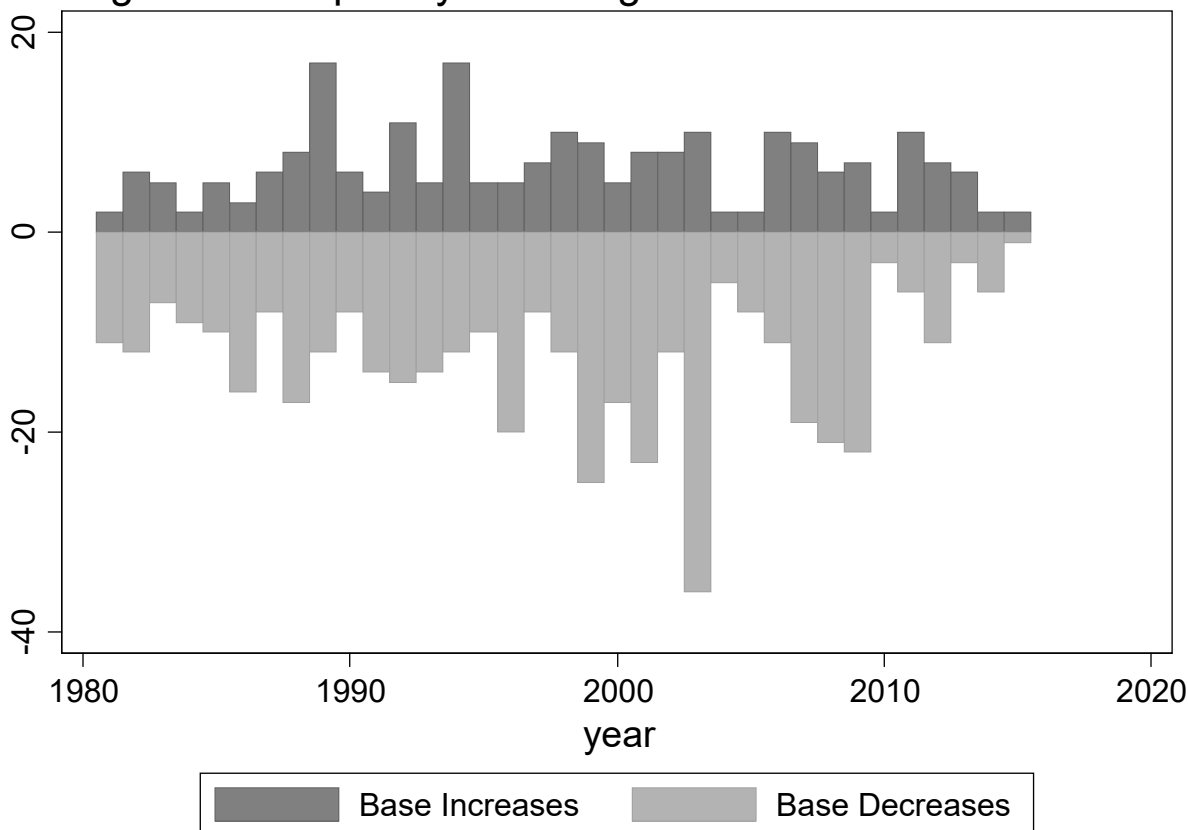


Table 5 also explores the correlation between PIT rate and base changes. Like the CIT system, the majority of PIT system changes consist of a change to the rate or base, but not both: there were 250 country-years with this pattern. In contrast to the CIT, base changes were less likely in years when the PIT rate also changed: 48.2% (82/170) versus 63.8% (222/348). Of the 80 changes that involved both rate and base changes, the most common combination is to lower the rate, narrow the base (24), followed by lower the rate, broaden the base (11), raise the rate, narrow the base (6), and raise the rate, broaden the base (6). In 35 country-years, there are both measures that broaden the base and measures that narrow the base that occur when there is a rate change. As with the CIT, though, base-broadening measures were less likely to accompany rate decreases relative to rate increases. Of the base changes that accompany a PIT rate decrease, 37.5% (24/64) broaden the tax base, while 33% (6/18) of the base changes that accompany a tax rate increase do so; the latter is a small enough sample to suggest caution in drawing confident conclusions.

Are PIT changes predictable? We run linear probability models similar to those used to examine the predictability of changes to the CIT rate. In these regressions (results not shown), we find that none of the macroeconomic variables is statistically significantly related to future changes in the top PIT tax rate. This result holds regardless of whether we include country-specific fixed effects.

### 4.3 VAT

So far, we have seen that, with just a few exceptions, the changes since 1980 in the CIT and PIT have followed similar patterns. The similarity does not carry over to the VAT. As Table 6 shows, in 12.1% (70/579) of country-years, the VAT rate changed; this is a much lower fraction than either the CIT or PIT. In clear contrast to both the CIT and PIT, rate increases predominated in VATs, comprising 75.7% (53/70) of the tax rate change episodes. The trend in weighted-average VAT rates, shown in Figure 5, is consistent with this set of facts, as it exhibits a continual upward trend.

That VAT rates have been rising will not come as a surprise to any even casual observer of trends in worldwide taxation. But we now can say more. In particular, we can examine the trends in VAT base changes as well as the correlation between VAT rate and base changes. These issues are explored in Figure 6 and Table 6. The figure shows that VAT base changes were overall much less likely than base changes in either the CIT or PIT, and were more prevalent before 2000 compared to after. In only 6.7% (39 out of 579) of country-years was there at least one VAT base change. Base changes were also noticeably less likely in years when the VAT rate also changed, 1.0% (7/70) versus just 6.3% (32/509). There is no clear difference in the nature of the base changes that accompany a tax rate increase versus a tax rate decrease.

Figure 5: Average VAT Rate, GDP-Weighted

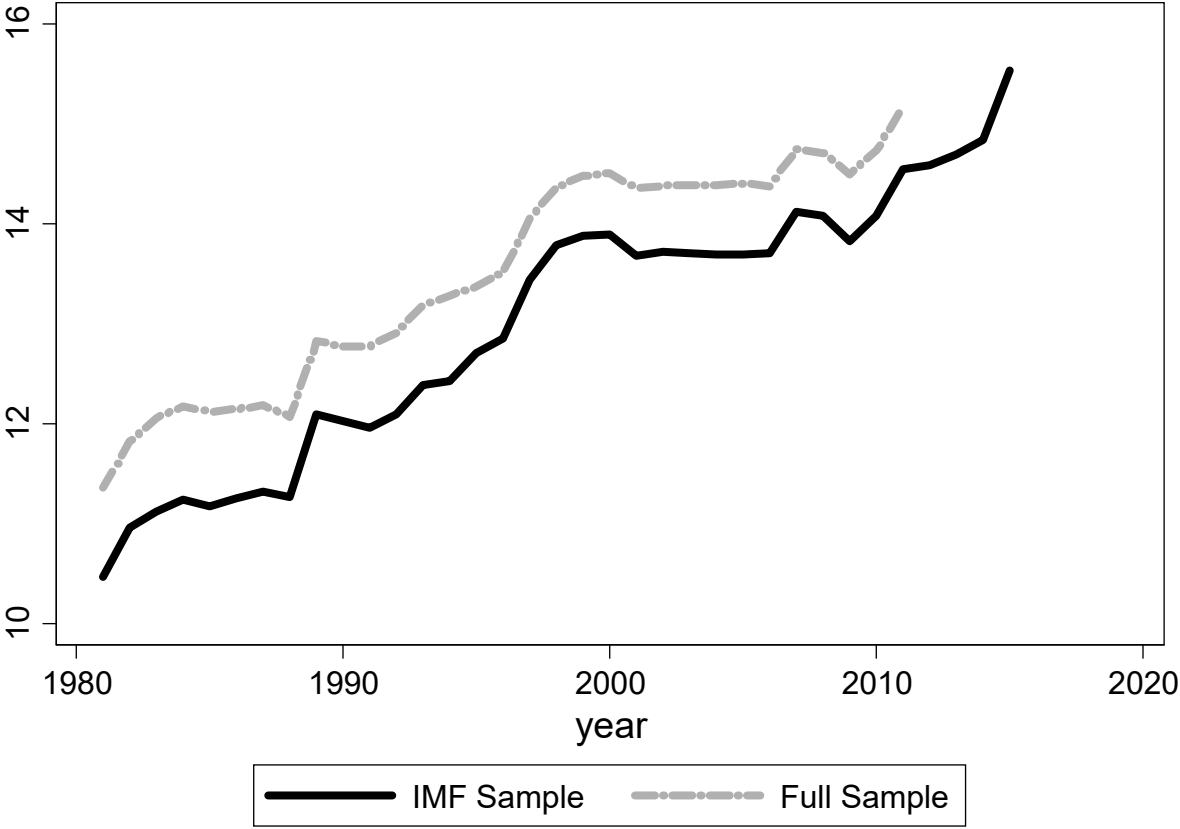


Figure 6: Frequency of Changes to the VAT Base

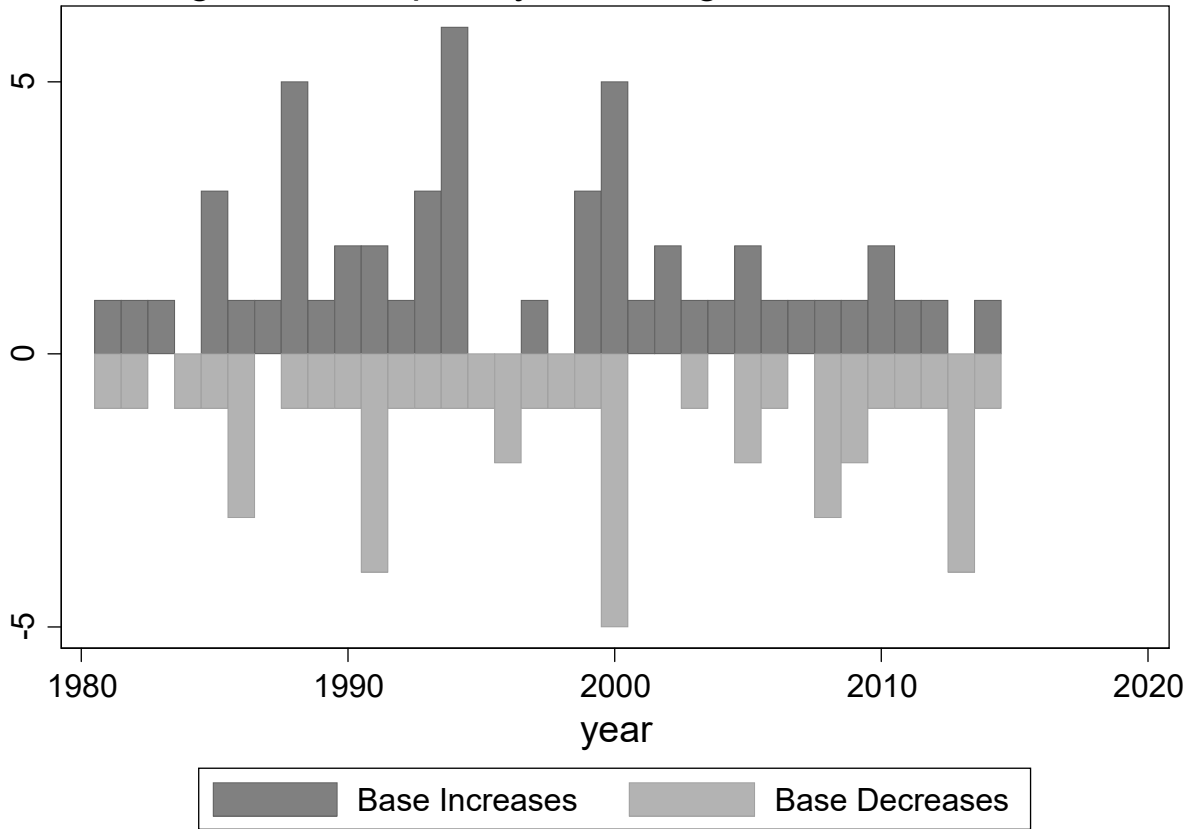


Table 6: Frequency of VAT base changes accompanying VAT rate changes (country-years)

| Tax Base                   | Tax rate |           |          | Total |
|----------------------------|----------|-----------|----------|-------|
|                            | Decrease | No change | Increase |       |
| Only Decrease              | 0        | 13        | 0        | 13    |
| Only Increase              | 2        | 13        | 5        | 20    |
| Both Increase and Decrease | 0        | 6         | 0        | 6     |
| Some Base Change           | 2        | 32        | 5        | 39    |
| No Change                  | 15       | 477       | 48       | 540   |
| Total                      | 17       | 509       | 53       | 579   |

The table provides tabulations of the coincidence of changes to the VAT rate and changes to the VAT base.

As with the other tax bases that we consider, once we control for underlying, time-invariant differences across countries by including country-specific fixed effects, none of the macroeconomic variables are predictive of future VAT rate changes.

#### 4.4 Correlation across CIT, PIT and VAT Rates

The correlation across taxes of changes matters for a few reasons. One is if revenue-neutral changes have different effects than non-revenue-neutral changes. Another is if the choice of legal form

depends on, say, the relative rate of CIT versus pass-through entities, perhaps proxied by the top PIT rate. Finally, in the same spirit as the importance of controlling for both base and rate changes for a given tax, if PIT or VAT matters for our outcome variables, and changes in either their rates or bases are correlated with CIT base or rate changes, then leaving them out of regression analyses could bias the findings.

Table 7: Association between CIT and PIT rate changes

| CIT change | PIT change   |              |              |            | Total         |
|------------|--------------|--------------|--------------|------------|---------------|
|            | No change    | Any change   | Decrease     | Increase   |               |
| No change  | 377<br>51.4% | 80<br>10.9%  | 54<br>7.4%   | 26<br>3.5% | 457<br>62.3%  |
| Any change | 189<br>25.8% | 87<br>11.9%  | 73<br>10.0%  | 14<br>1.9% | 276<br>37.7%  |
| Decrease   | 132<br>18.0% | 70<br>9.5%   | 63<br>8.6%   | 7<br>1.0%  | 202<br>27.6%  |
| Increase   | 57<br>7.8%   | 17<br>2.3%   | 10<br>1.4%   | 7<br>1.0%  | 74<br>10.1%   |
| Total      | 566<br>77.2% | 167<br>22.8% | 127<br>17.3% | 40<br>5.5% | 733<br>100.0% |

Table 7 shows the association between CIT and PIT rate changes. In 51.4% of country-years, neither rate changed. In 25.8% of cases, just the CIT rate changed and in 10.9% of cases, just the PIT rate changed, while in 11.9% both changed. There is a strong positive association in the likelihood of changing. In 31.5% of the country-years that the CIT rate changed, so did the PIT rate, but in only 17.5% of the years that the CIT rate did not change did the PIT rate change. Reversing the story, in 52.1% of the country-years that the PIT rate changed, so did the CIT rate, but in only 33.4% of the years that the PIT rate did not change did the CIT rate change. There is also a strong positive association between the direction of CIT and PIT rate changes. In 80.5% of cases when both the CIT and PIT rate change, they move in the same direction. This is almost entirely driven by instances of both rates decreasing (3 of 70 cases, or 90%). When the CIT and PIT rate change in opposite directions, it is slightly more likely that the PIT rate falls while the CIT rate increases. Thus, when both rates change, on average, they move in the same direction rather than in offsetting directions.

Table 8: Association between CIT and VAT rate changes

| CIT change | VAT change   |             |            |            | Total         |
|------------|--------------|-------------|------------|------------|---------------|
|            | No change    | Any change  | Decrease   | Increase   |               |
| No change  | 329<br>57.3% | 40<br>7.0%  | 7<br>1.2%  | 33<br>5.7% | 369<br>64.3%  |
| Any change | 175<br>30.5% | 30<br>5.2%  | 10<br>1.7% | 20<br>3.5% | 205<br>35.7%  |
| Decrease   | 136<br>23.7% | 22<br>3.8%  | 8<br>1.4%  | 14<br>2.4% | 158<br>27.5%  |
| Increase   | 39<br>6.8%   | 8<br>1.4%   | 2<br>0.3%  | 6<br>1.0%  | 47<br>8.2%    |
| Total      | 504<br>87.8% | 70<br>12.2% | 17<br>3.0% | 53<br>9.2% | 574<br>100.0% |

Tables 8 and 9 present the association between CIT and VAT changes and the association between PIT and VAT changes, respectively. There are several key differences between the relationships depicted in these two tables, and those in Table 7. First, VAT changes are much less likely to occur than CIT or PIT changes: the frequency of VAT changes amount to roughly 20% of the number CIT changes and 38.3% of PIT changes. As we have already noted, the rate changes of these three taxes tend to move in opposite directions, on average. While only 18.5% of CIT changes and 22.4% of PIT changes are increases, 75.7% of VAT changes are increases. In 57.3% of country-years, neither the CIT nor VAT rate changed. In 30.5% of cases, just the CIT rate changed, and in 7.0% of cases just the VAT rate changed, while in 5.2% both changed. A similar pattern emerges when comparing PIT and VAT rate changes. In 68.2% of country-years, neither the PIT nor VAT rate changed. In 19.6% of cases, just the PIT rate changed, and in 8.4% of cases just the VAT rate changed, while in 3.8% both changed.

There is a weak positive association in the likelihood of changing depicted in these two tables. VAT rate changes are accompanied by a CIT rate change 42.9% of the time and accompanied by a PIT rate change 45.8% of the time. In years that the VAT did not change, there was a CIT rate change 34.7% of the time and a PIT rate change 22.3% of the time. Both CIT and PIT rate changes are about equally likely depending on whether the VAT changes. In 10.2% of the country-years that the CIT rate change, so did the VAT rate, and in 16% of the country-years that the PIT rate changed did the VAT rate change. Reversing the story, in 10.8% of the years that the CIT rate did not change and in 11.8% of the years that the PIT rate did not change did the VAT rate change.

There does not appear to be a strong relationship between the direction of CIT and VAT rate changes. When both rates change, they move in the same direction 46.7% of the time, and in opposite directions 53.3% of the time. The most frequent combination is that CIT rate decreases are accompanied by a VAT rate increase. In contrast, when both the VAT and PIT rates change, they

tend move in the same, rather than offsetting, direction. When both rates move, they move in the same direction 63.5% of the time.

Table 9: Association between PIT and VAT rate changes

| PIT change | VAT change   |             |            |            | Total         |
|------------|--------------|-------------|------------|------------|---------------|
|            | No change    | Any change  | Decrease   | Increase   |               |
| No change  | 390<br>68.2% | 48<br>8.4%  | 11<br>1.9% | 37<br>6.5% | 408<br>71.3%  |
| Any change | 112<br>19.6% | 22<br>3.8%  | 6<br>1.0%  | 16<br>2.8% | 134<br>23.4%  |
| Decrease   | 90<br>15.7%  | 14<br>2.4%  | 6<br>1.0%  | 8<br>1.4%  | 104<br>18.2%  |
| Increase   | 22<br>3.8%   | 8<br>1.4%   | 0<br>0.0%  | 8<br>1.4%  | 30<br>5.2%    |
| Total      | 502<br>87.8% | 70<br>12.2% | 17<br>3.0% | 53<br>9.3% | 572<br>100.0% |

#### 4.5 Correlation across CIT, PIT, and VAT Bases

Tables 10, 11, and 12 document the association between base changes of the three taxes we are studying. Table 10 shows that in country-years when the CIT base changes, a PIT base change also happens 62.7% (183/292) of the time, but when no CIT base change happens, the PIT base changes only 26.1% (134/513) of the time. A similar, but less striking, coincidence of base changes obtains between the CIT and VAT; when the CIT base changes, the VAT base also changes in 15.3% (44/288) of the time, but the VAT base changes in only 6.4% of the country-years when the CIT base does not change. Not surprisingly given the previous two findings, the same phenomenon obtains when comparing the incidence of PIT and VAT base changes: when the PIT base changes, the VAT base changes in 14.1% (43/304) of the country-years, but the VAT base changes in only 6.9% of the country-years (32/466) when the PIT base does not change.

When the breadth of both the CIT and PIT bases changes, the most frequent combination is that both bases are narrowed (33%, or 61 of 183 country-years). It is equally likely that both bases are broadened and that the bases are strictly moving in opposing directions (12-13% each). When the CIT base is broadened, it is more likely to be accompanied by some change in the PIT base (56 versus 23 country-years). In years where the CIT base is broadened, the PIT base is more likely to also be broadened, rather than narrowed. This pattern is consistent with tax reform packages that broaden both bases as part of a comprehensive tax reform. However, this is not the only pattern observed.

Table 10: Frequency of CIT base changes accompanying PIT base changes (country-years)

| <b>CIT Base</b>            | <b>PIT Base</b> |               |                            |                  |            | <b>Total</b> |
|----------------------------|-----------------|---------------|----------------------------|------------------|------------|--------------|
|                            | Only Decrease   | Only Increase | Both Increase and Decrease | Some Base Change | No Change  |              |
| Only Decrease              | 61              | 9             | 16                         | 86               | 67         | 153          |
| Only Increase              | 13              | 23            | 20                         | 56               | 23         | 79           |
| Both Increase and Decrease | 17              | 4             | 20                         | 41               | 19         | 60           |
| Some Base Change           | 91              | 36            | 56                         | 183              | 109        | 292          |
| No Change                  | 75              | 34            | 25                         | 134              | 379        | 513          |
| <b>Total</b>               | <b>166</b>      | <b>70</b>     | <b>81</b>                  | <b>317</b>       | <b>488</b> | <b>805</b>   |

The table provides tabulations of the coincidence of changes to the corporate tax base and changes to the personal tax base.

Table 11: Frequency of CIT base changes accompanying VAT base changes (country-years)

| <b>CIT Base</b>            | <b>VAT Base</b> |               |                            |                  |            | <b>Total</b> |
|----------------------------|-----------------|---------------|----------------------------|------------------|------------|--------------|
|                            | Only Decrease   | Only Increase | Both Increase and Decrease | Some Base Change | No Change  |              |
| Only Decrease              | 10              | 7             | 4                          | 21               | 127        | 148          |
| Only Increase              | 2               | 8             | 2                          | 12               | 65         | 77           |
| Both Increase and Decrease | 5               | 5             | 1                          | 11               | 46         | 57           |
| Some Base Change           | 17              | 20            | 7                          | 44               | 238        | 282          |
| No Change                  | 10              | 15            | 6                          | 31               | 457        | 488          |
| <b>Total</b>               | <b>27</b>       | <b>35</b>     | <b>13</b>                  | <b>75</b>        | <b>695</b> | <b>770</b>   |

The table provides tabulations of the coincidence of changes to the person tax base and changes to the VAT base.

Table 12: Frequency of PIT base changes accompanying VAT base changes (country-years)

| <b>PIT Base</b>            | <b>VAT Base</b> |               |                            |                  |            | <b>Total</b> |
|----------------------------|-----------------|---------------|----------------------------|------------------|------------|--------------|
|                            | Only Decrease   | Only Increase | Both Increase and Decrease | Some Base Change | No Change  |              |
| Only Decrease              | 9               | 7             | 6                          | 22               | 138        | 160          |
| Only Increase              | 2               | 8             | 1                          | 11               | 56         | 67           |
| Both Increase and Decrease | 5               | 5             | 0                          | 10               | 67         | 77           |
| Some Base Change           | 16              | 20            | 7                          | 43               | 261        | 304          |
| No Change                  | 11              | 15            | 6                          | 32               | 434        | 466          |
| <b>Total</b>               | <b>27</b>       | <b>35</b>     | <b>13</b>                  | <b>75</b>        | <b>695</b> | <b>770</b>   |

The table provides tabulations of the coincidence of changes to the personal tax base and changes to the VAT base.

## 5. Conclusions

In this paper we report on the compilation of a new database that tracks not only the statutory tax rates of the CIT, PIT and VAT, but also changes in several aspects of the base of these taxes. We corroborate the well-known facts that on average the top rates of the first two taxes have been declining since 1980 and the average rate of the VAT has been increasing. But we can now say much more.

In almost 60% of the country-years considered, there was some documented change to the CIT system. While the majority of these involved changes to only either the tax rate or the measurement of the tax base, there were still a significant number of instances when both aspects to the CIT system changed. Although frequency of CIT base changes is similar to that found in Kawano and Slemrod (2016), the new IMF data reveal that policies that lower-the-rate, narrow-the-base were 76% more common than the lower-the-rate, broaden-the-base policies, in contrast to our earlier observations. In any event, the coincidence of tax rate and tax base definition changes casts doubt on analyses that estimates the impacts of tax rates without accounting for changes to other aspects of the tax system.

Patterns for the PIT base are quite similar to those found with the CIT base. The majority of policy changes involved a change to the rate or the measures of the base, but not both. In addition, when both aspects of the PIT system changed, it was most often the case that the policies lower the rate and narrow the base. In contrast to the CIT and PIT, changes to the VAT base definition have been quite uncommon, occurring in only 6.7% of country-years.

A unique feature of our augmented database is that we can consider the correlation of changes between aspects of the tax system *across* these three tax bases. The coincidence of such changes can inform whether other tax base systems are another potential source of bias in the previous literatures that we have reviewed. This might occur, for example, if a tax reform package contains measures that affect both the CIT and PIT systems. We find that the CIT and PIT base definitions are more likely to occur in concert, rather than alone, suggesting another potentially important source of bias in previous estimates of the effect of CIT rates on economic activity.

The next step, which we are currently pursuing, is to make use of these data to clarify the relationship between tax systems and economic outcomes of interest such as real GDP per capita and wage rates. With these data available, such analyses will be less subject to estimation biases due to the exclusion of consequential tax system variables.



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## Appendix A1: Appendix Tables and Figures

**Table A1: Mapping of CIT Base Categories between IMF Database and Kawano-Slemrod (2016)**

| IMF Database  | Kawano & Slemrod (2016)   |
|---------------|---|
| CIT_pro_RD    | R&D credit  |
| CIT_pro_inv   | Investment tax credit<br>Accelerated depreciation                                     |
| CIT_loss_rule | Loss carry forward<br>Loss carry back   |
| CIT_cap_gain  | Changes to other tax rates  |
| CIT_thin_cap  | Thin capitalization   |
| CIT_other     | Other base broadeners<br>CFC<br>Treatment of foreign businesses<br>Foreign tax credit |
| Not Included  | Measures to curb evasion  |

**Table A2: Countries in the IMF Sample**

| <u>Country</u>       |
|----------------------|
| Australia            |
| Austria              |
| Brazil               |
| Canada               |
| China                |
| Czech Republic       |
| Denmark              |
| France               |
| Germany              |
| Greece               |
| India                |
| Ireland              |
| Italy                |
| Japan                |
| Luxembourg           |
| Mexico               |
| Poland               |
| Portugal             |
| South Korea          |
| Spain                |
| Turkey               |
| United Kingdom       |
| <u>United States</u> |

**Table A3: Countries in the Full Sample**

| Country                       | Country         | Country                        | Country              |
|-------------------------------|-----------------|--------------------------------|----------------------|
| Albania                       | Georgia         | Morocco                        | Thailand             |
| Angola                        | Germany         | Mozambique                     | Trinidad and Tobago  |
| Antigua and Barbuda           | Ghana           | Myanmar                        | Turkey               |
| Argentina                     | Greece          | Namibia                        | Uganda               |
| Aruba                         | Grenada         | Netherlands                    | Ukraine              |
| Australia                     | Guatemala       | New Zealand                    | United Arab Emirates |
| Austria                       | Guyana          | Nicaragua                      | United Kingdom       |
| Azerbaijan                    | Honduras        | Nigeria                        | United States        |
| Bahamas                       | Hong Kong       | Norway                         | Uruguay              |
| Bahrain                       | Hungary         | Oman                           | Uzbekistan           |
| Bangladesh                    | Iceland         | Pakistan                       | Vanuatu              |
| Barbados                      | India           | Panama                         | Venezuela            |
| Belgium                       | Indonesia       | Papua New Guinea               | Vietnam              |
| Belize                        | Iran            | Paraguay                       | Zambia               |
| Bermuda                       | Ireland         | Peru                           | Zimbabwe             |
| Bolivia                       | Isle of Man     | Philippines                    |                      |
| Bosnia and Herzegovina        | Israel          | Poland                         |                      |
| Botswana                      | Italy           | Portugal                       |                      |
| Brazil                        | Jamaica         | Puerto Rico                    |                      |
| Brunei Darussalam             | Japan           | Qatar                          |                      |
| Bulgaria                      | Jordan          | Romania                        |                      |
| Cambodia                      | Kazakhstan      | Russia                         |                      |
| Canada                        | Kenya           | Rwanda                         |                      |
| Chile                         | Kuwait          | Samoa                          |                      |
| China                         | Kyrgyz Republic | Saudi Arabia                   |                      |
| Colombia                      | Laos            | Senegal                        |                      |
| Congo, Democratic Republic of | Latvia          | Serbia                         |                      |
| Costa Rica                    | Lebanon         | Singapore                      |                      |
| Cote d'Ivoire                 | Liberia         | Slovak Republic                |                      |
| Croatia                       | Libya           | Slovenia                       |                      |
| Cyprus                        | Liechtenstein   | Solomon Islands                |                      |
| Czech Republic                | Lithuania       | South Africa                   |                      |
| Denmark                       | Luxembourg      | South Korea                    |                      |
| Dominica                      | Macedonia       | Spain                          |                      |
| Dominican Republic            | Madagascar      | Sri Lanka                      |                      |
| Ecuador                       | Malawi          | St. Kitts and Nevis            |                      |
| Egypt                         | Malaysia        | St. Lucia                      |                      |
| El Salvador                   | Malta           | St. Vincent and the Grenadines |                      |
| Estonia                       | Mauritius       | Sudan                          |                      |
| Fiji                          | Mexico          | Swaziland                      |                      |
| Finland                       | Moldova         | Sweden                         |                      |
| France                        | Mongolia        | Switzerland                    |                      |
| Gabon                         | Montenegro      | Tanzania                       |                      |

## Appendix 2: Description of the Construction of the Tax Rates, Tax Revenues, and Wages Data Series

Our tax rates and tax revenues data come from two different sources. In this Data Appendix, we first document how we have reconciled discrepancies between the two data sources. We then describe our difficulties in attempting to recreate the Hassett and Mathur (2015) wage data series.

### 1. *Tax Rates*

We construct our top statutory CIT and PIT rates and VAT rates series using the OECD Tax Database and the American Enterprise Institute's (AEI) International Tax Database.<sup>9</sup>

#### A. *Corporate Tax Rates*

Table II.1 of the OECD Tax Database provides the central government and combined (central plus sub-central government) top statutory corporate income tax (CIT) rates.<sup>10</sup> This table provides CIT rates for 34 countries between 2000 and 2017.<sup>11</sup> Historical data are available for 1981—1999, but the OECD notes that these data have not been verified in recent years. Nevertheless, we use these data when available.

The AEI's International Tax Database contain CIT schedules at the central government and the local government level. These data are available for 153 countries between 1981 and 2011. The database references several underlying source materials: (1) PriceWaterhouseCooper's *Corporate Taxes -Worldwide Summaries*; (2) Coopers and Lybrand's *International Tax Summaries*; (3) Earnest and Young's *Worldwide Corporate Tax Guide 2001*; (4) the International Bureau of Fiscal Documentation Loose-leaf Service; (5) Embassies and ministries of taxation in individual countries; (6) and KPMG's *Worldwide Corporate Tax Tables*.

Figure A1 depicts the central government CIT rate series for the 34 countries that appear in both the OECD and AEI databases. These two data sources agree in a majority of country-year observations. The non-trivial differences occur for the following countries: Estonia, Italy, Norway, and Portugal. We turn to external data sources to reconcile these differences.

- Estonia: Data from the Republic of Estonia Tax and Customs Board match the OECD data. Data available at: <https://www.emta.ee/eng/business-client/income-expenses-supply-profits/tax-rates>.
- Italy: Table 1 in Caiumi and Di Biaggio (2015) provides information on changes to the general corporate income tax rate (initially called IRPEG, and then renamed to IRES in

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<sup>9</sup> We thank Aparna Mathur for sharing this database with us.

<sup>10</sup> These data are available at [http://www.oecd.org/tax/tax-policy/tax-database.htm#C\\_CorporateCapital](http://www.oecd.org/tax/tax-policy/tax-database.htm#C_CorporateCapital).

<sup>11</sup> These countries are Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States.

2004). These rates are consistent with the AEI tax rate series. In addition, the data in the University of Michigan's World Tax Database (WTD), when available, is consistent with the AEI series.

- Norway: The WTD data are consistent with the AEI data. We were unable to locate a primary data source from the Norwegian government.
- Portugal: The WTD data are consistent with the AEI series between 1982 and 1999. Two other sources provide evidence that the AEI series contains the central government rate. First, an *International Tax Review* article reports that for 2015, there was a reduction in the standard corporate income tax rate from 23% to 21% (Article available at: <http://www.internationaltaxreview.com/Article/3421912/Portugal-Portuguese-corporate-tax-changes-for-2015.html>). Second, Figure 1 (page 10) of Bessa (2016) shows that the central government tax rate (taxa nominal) was 25%, 23%, and 21% in 2013, 2014, and 2015, respectively. These figures match the AEI data. The rates that add in state and municipal tax rates appear to match the OECD data.

We construct our top statutory CIT rate series using the OECD Tax Database as our primary source, and supplementing with the AEI International Tax Database, except where indicated above.

#### B. Personal Income Tax Rates

We construct a series of the top statutory central government PIT tax rate. Table I.1 of the OECD Tax Database includes the central government rates and thresholds for the PIT schedule.<sup>12</sup> As with the CIT series, the OECD database contains data for 34 countries between 2000-2017, with historical data available from 1981-1999.

From the AEI International Tax Database, we use a spreadsheet of central government rates and thresholds for the PIT schedule. The database contains data for 150 countries between 1981 and 2012. The underlying sources for the AEI database are the same as for CIT rates, with the exception of the PriceWaterhouseCooper's *Individual Taxes -Worldwide Summaries*.

Figure A2 depicts the central government PIT rate series for the 34 countries that appear in both the OECD and AEI databases. These two data sources agree in a majority of country-year observations. The non-trivial differences occur for the following countries: Canada, France, Germany, Israel, Norway, Spain, and Sweden. We turn to external data sources to reconcile these differences.

- Canada: The Canadian Government's website provides historical information on General Income Tax and Benefit Packages in each year from 1985 through 2017. These documents include Schedule 1, which shows rates and income thresholds for the federal income tax schedule. We compile the top statutory PIT rate for 1985 through 2000. These data are consistent with the OECD series. Data available at: <https://www.canada.ca/en/revenue-agency/services/forms-publications/tax-packages-years.html>.

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<sup>12</sup> Tables I.2 and I.3 provide subcentral personal income tax rates for non-progressive systems and progressive systems, respectively.



- France: The Institut des Politiques Publiques (2014) study, “1914-2014: One Hundred Years of Income Tax in France,” provides information on the French PIT schedule in 1983, 1988, 1994, 2006, 2007, and 2014. The top statutory rate reported in these years match the OECD data. In addition, the publication provides a supplementary table of rates between 1981-2013, which match the OECD series.
- Germany: The WTD data, available through 1999, are consistent with the OECD numbers. The Tax Policy Center (TPC) provides tables of top marginal PIT rates in OECD countries. This series is also consistent with the OECD series through 1999. Beginning in 2000, the TPC series is consistent with the AEI series but this is the same year in which the TPC changes its data source. In 2000, the TPC begins to use OECD Table I.7, “Top statutory personal income tax rate and top marginal tax rates for employees,” which combines central government and sub-central government rates. To maintain a consistent definition throughout the panel, we use the OECD data.
- Israel: When available, the WTD and TPC series are consistent with the OECD data, so we use that series throughout.
- Norway: The WTD data are closest to the OECD countries in 1984 – 1996, when it becomes closer to the AEI series. The WTD data are well above both series in 1981 and 1982 (data missing in 1983). We use the OECD data.
- Poland: The observations in 1988 and 1989 appear to be outliers in the series, and are notably unavailable in the OECD Database. The PIT rate reported for these years might be the CIT rate, as the source notes in the AEI International Tax Database reference an “equalization tax.” Mieszkowski, Bolkowski, Lubick and Sochaka-Krysiak (1993) report that 1988 and 1989 were years of massive tax reform with many different rates depending on a number of factors, such as whether the employer was socialized or non-socialized, industry, etc. Beginning in 1990, a 40% top rate was uniformly applied. To maintain a consistent definition, we begin the Poland series in 1990.
- Spain: The two series diverge in 2008 and 2009. We use the OECD data in these years.
- Sweden: Figure 2 in Stenkula, Johansson and Rietz (2013) depicts the central government PIT rate (called the state rate, as opposed to municipalities). These data are consistent with the AEI series prior to 1991.

### C. Value-Added Tax Rates

The OECD Tax Database contains data on 34 countries in 1985, 1990, 1995, 2000, and each year between 2005 and 2015. The AEI International Tax Database contains data on 147 countries between 1981 and 2008, and then in 2011. Figure A3 depicts the central government VAT rate series

for the 34 countries that appear in both the OECD and AEI databases. These two data sources agree in a majority of country-year observations, and there were no changes to the data made.

Figure A4 demonstrates the impact of the unbalanced nature of the VAT data series. The impact of having the over 100 non-OECD countries exiting the sample in 2009, re-appearing in 2011, and then leaving again is immediately apparent. To mitigate this effect, we use the OECD data as our primary source and fill in the missing years of data using the AEI International Tax Database for these countries only. Figure X of the main text depicts the VAT rate series in the resulting VAT rate series.

## 2. *Corporate Tax Revenues as a Share of GDP*

We have two data sources for the ratio of CIT revenues to GDP. The OECD Tax Revenues Statistics Database covers 34 countries between 1981 through 2015. We also have the dataset that underlies the analysis in Acosta-Ormaechea and Yoo (2012).<sup>13</sup> These data cover 66 countries between 1981 and 2009.

Figure A3 depicts the CIT revenues to GDP series for the 34 countries that appear in both the OECD and AEI databases. The series move together rather well and have a correlation coefficient of 0.97. We use the OECD data as our primary source, supplemented with data from Acosta-Ormaechea and Yoo (2012).

## 3. *Wages*

Hassett and Mathur (2015) construct a dataset of the average hourly wage earned in manufacturing, measured in US dollars.<sup>14</sup> Their data cover 70 countries between 1981 and 2005. We attempt to recreate the wage series so that we can extend the data series further. However, we encountered difficulty reconciling both the earnings data and the data on hours worked.

The data appendix of Hassett and Mathur (2015) references the following methodology for computing these series: (1) collect the wage and earnings data from the International Labour Organization, measured in local currency; (2) convert wage and earnings data to USD using the Penn World Tables (available at <https://www.rug.nl/ggdc/productivity/pwt/>); and (3) compute average wages by dividing the result of (2) by total hours worked.

Regarding the earnings data, there were several potential issues preventing complete replication: (1) industry classifications have changed over time, resulting in some cases in retroactive reclassification of firms into or out of the manufacturing sector, and thus revisions to earnings estimates for past years; (2) within each country, different sources are available with estimates for certain years (e.g., establishment surveys and insurance records) and changes in availability or retroactive additions may have also resulted in revisions to past earnings estimates; and (3) for some countries, data for certain years are missing in the ILO database but included in the database used by Hassett and Mathur – it is not clear how they fill in these missing observations.

Regarding the estimates for hours worked, there is similar variety in data availability and consistency. In particular, for some countries there are published statistics on average hours worked in the

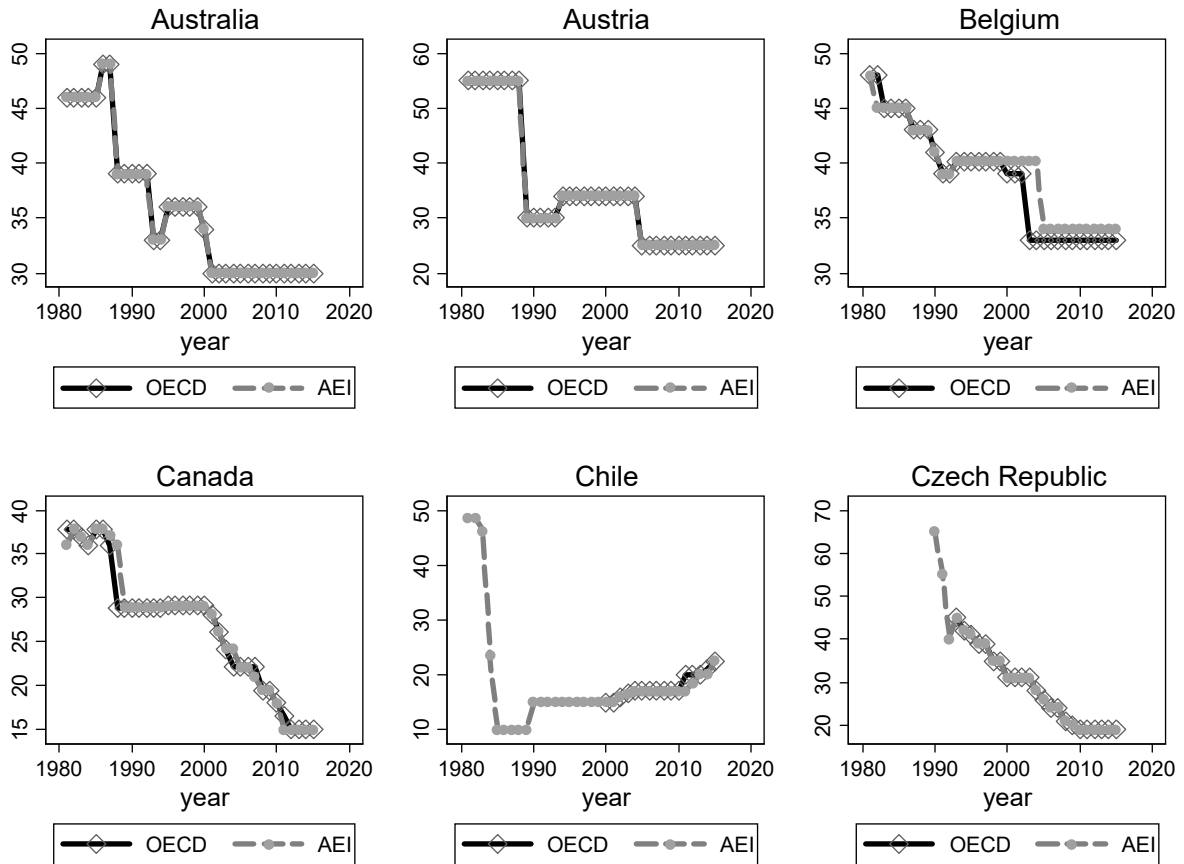
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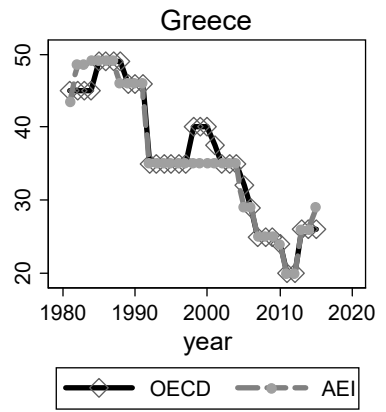
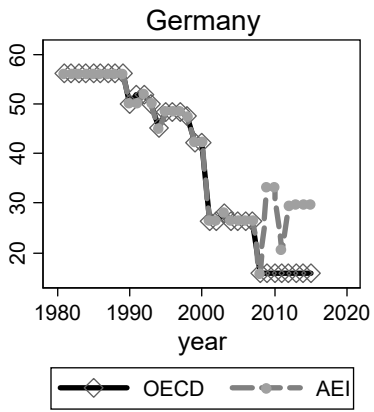
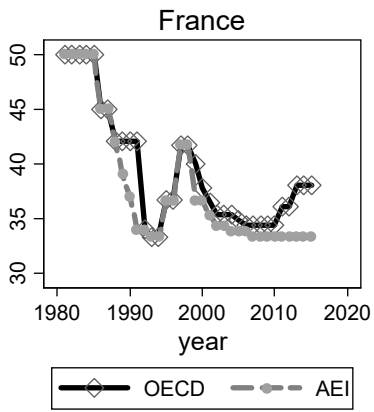
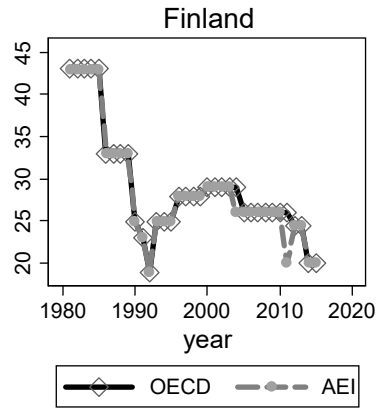
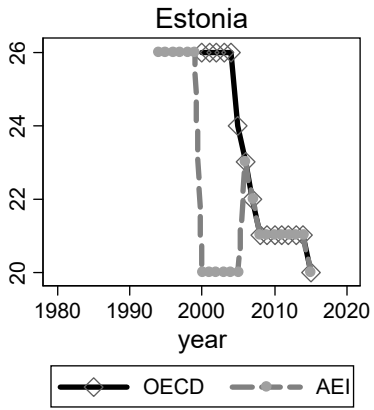
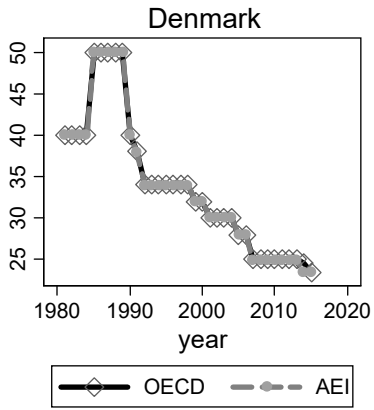
<sup>13</sup> We thank Santiago Acosta-Ormaechea for providing us the dataset used in this paper.

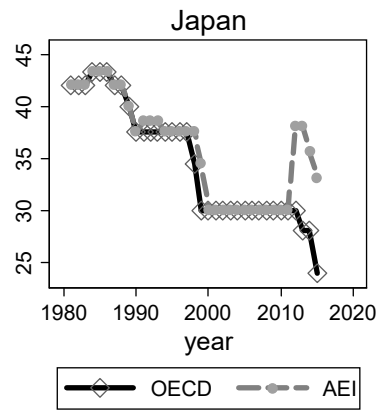
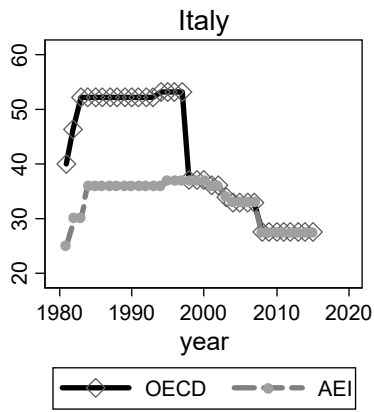
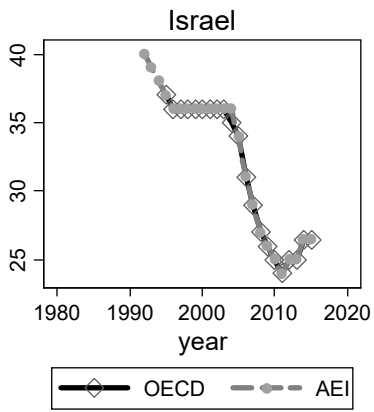
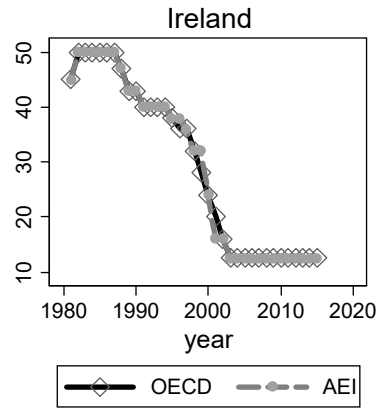
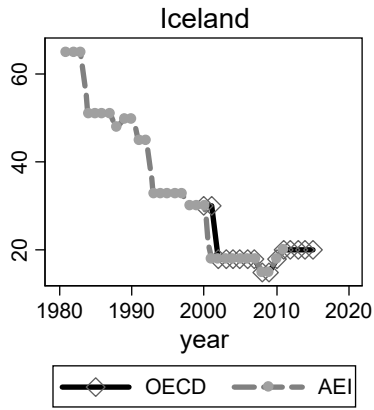
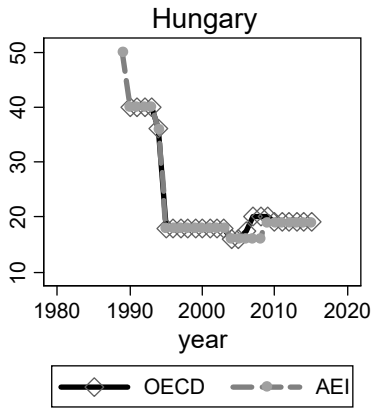
<sup>14</sup> We thank Aparna Mathur for providing us the dataset used in this paper.

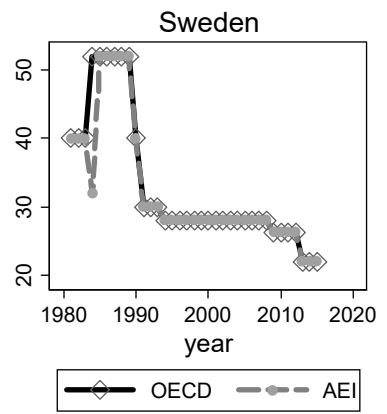
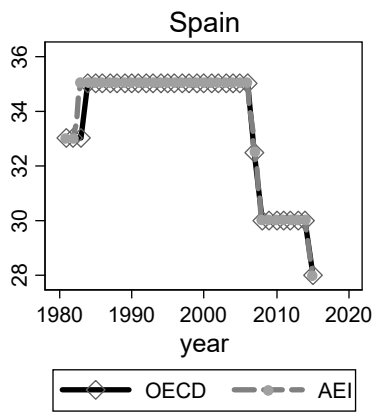
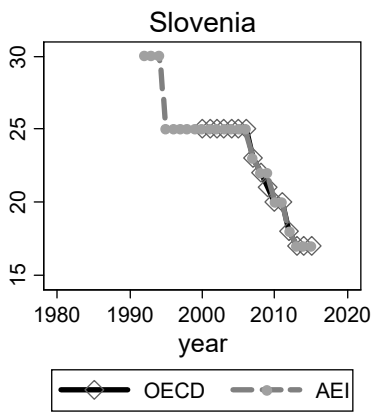
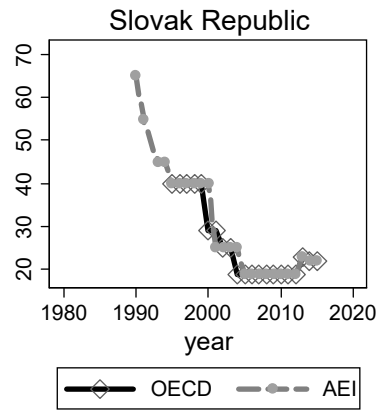
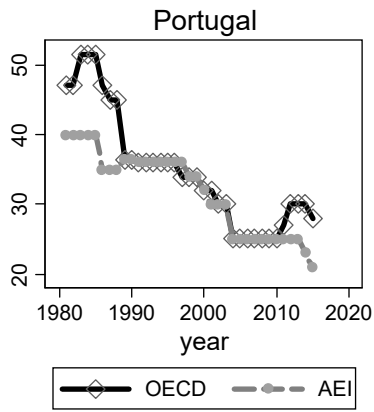
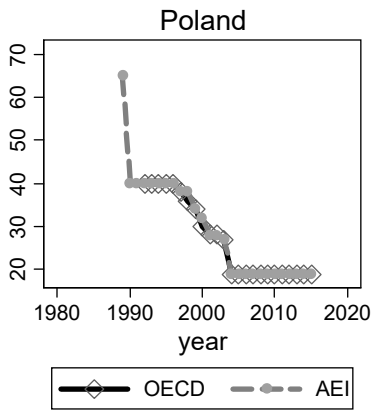
manufacturing sector, and it appears these data were used in the calculation of average hourly wages. For other countries without published statistics, it appears that different assumptions were made regarding the hours worked.

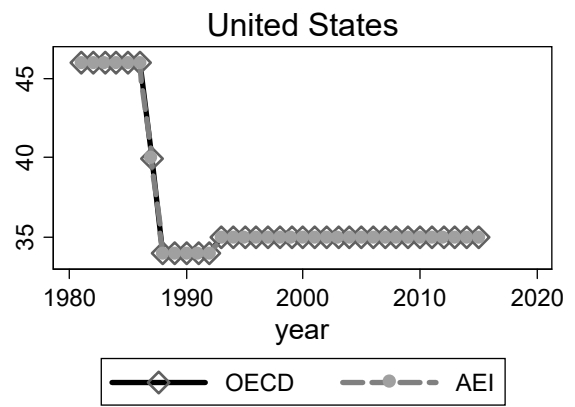
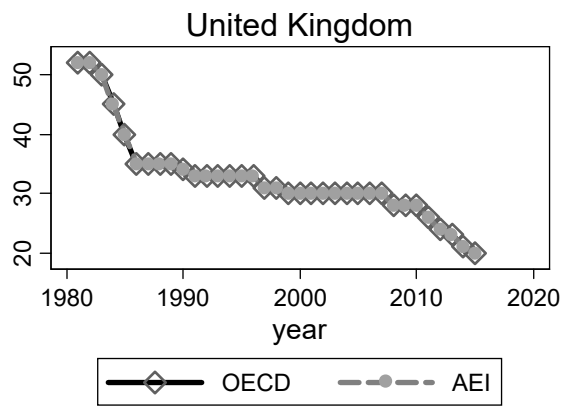
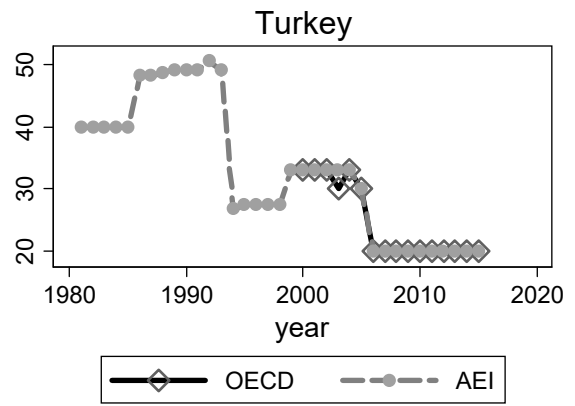
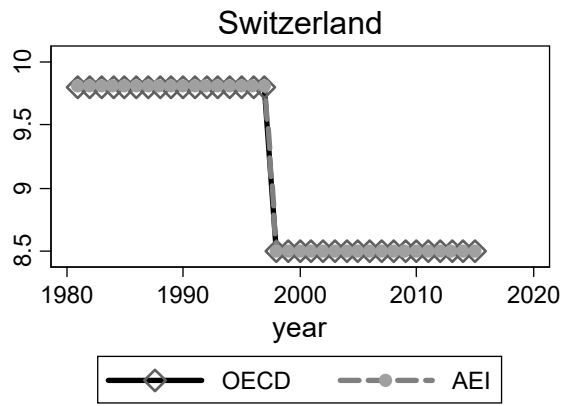
**Figure A2.1: Comparison of Corporate Income Tax Rates from the OECD Tax Database and the AEI International Tax Database**

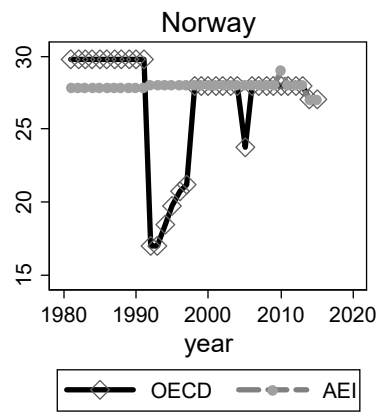
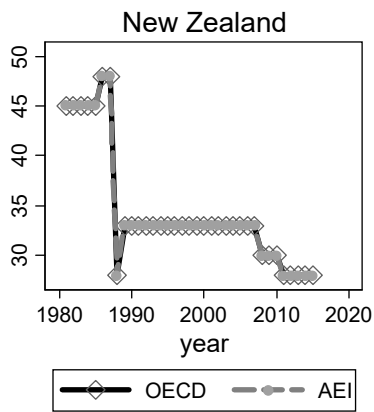
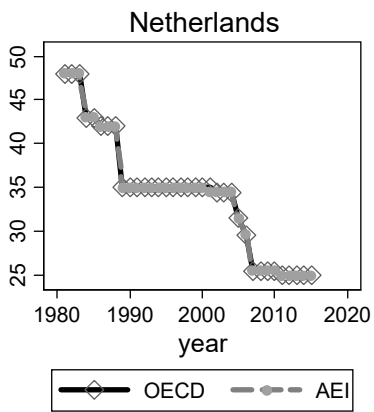
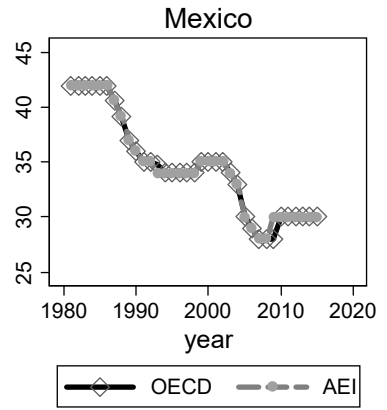
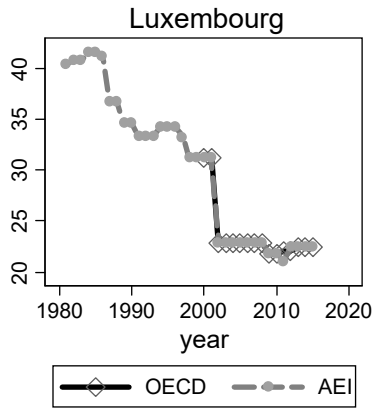
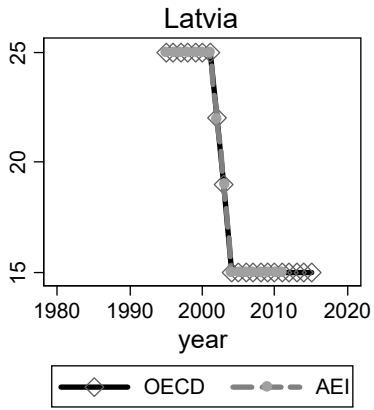






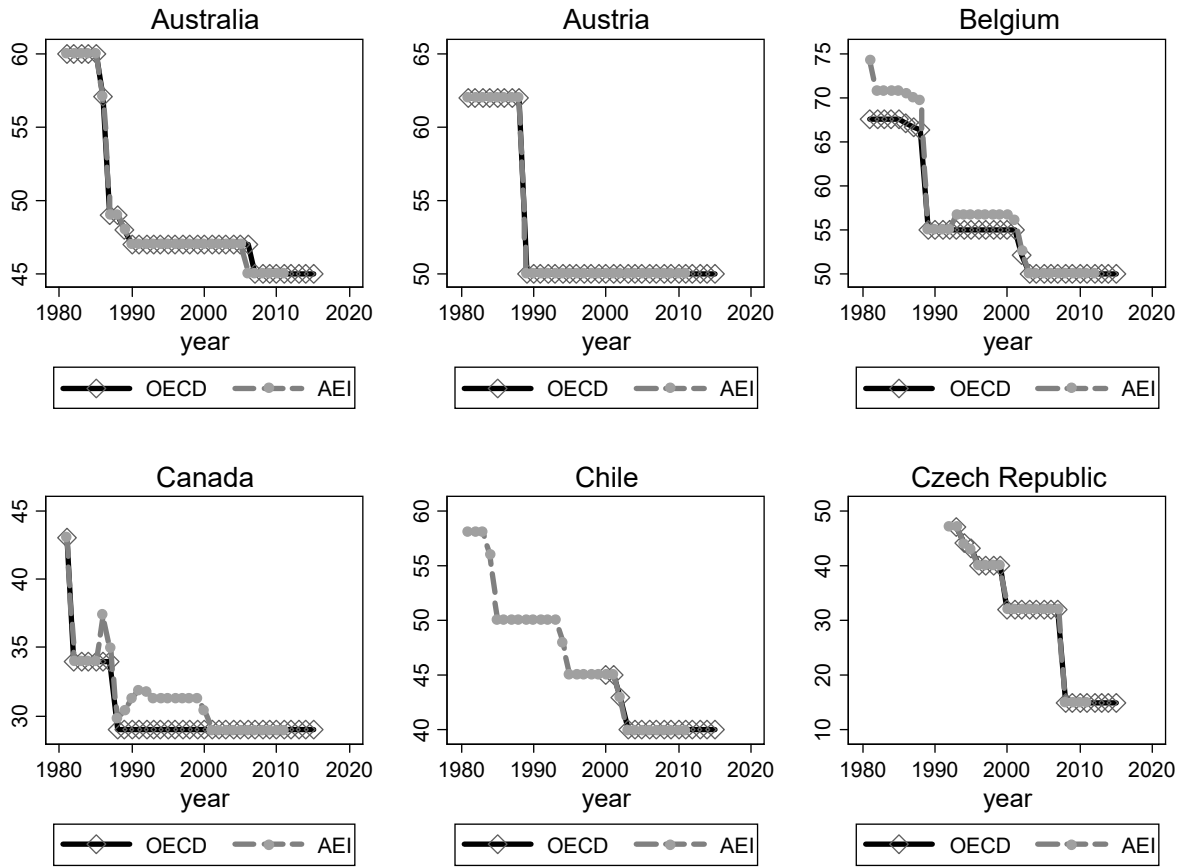


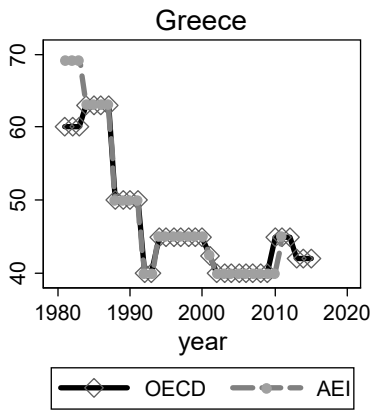
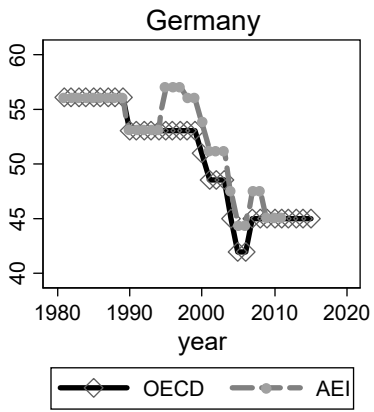
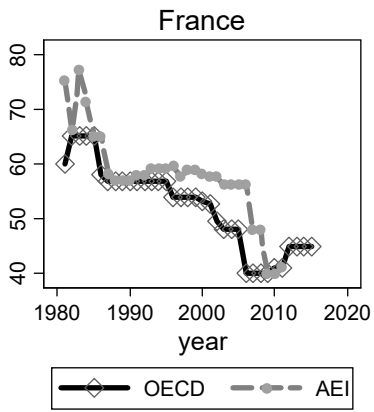
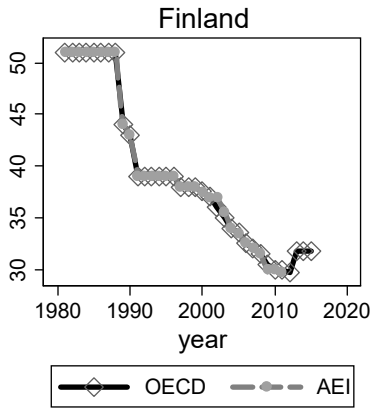
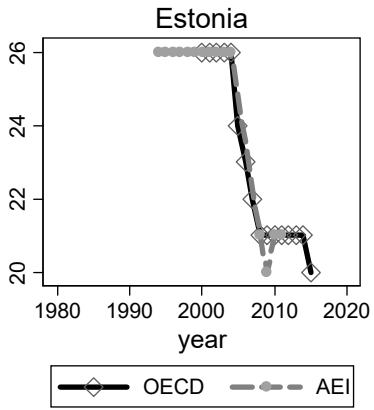
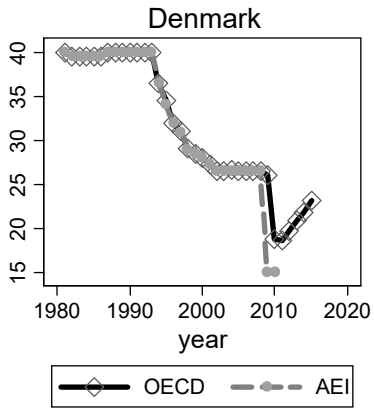


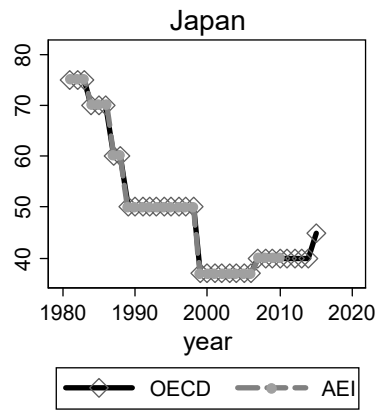
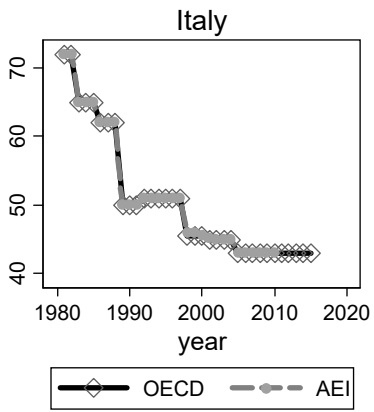
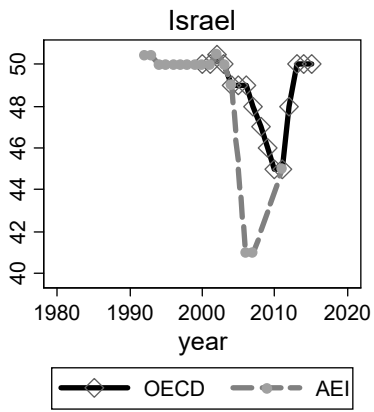
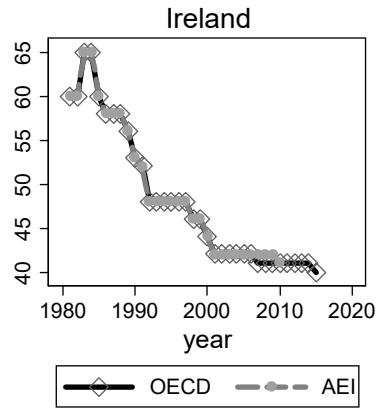
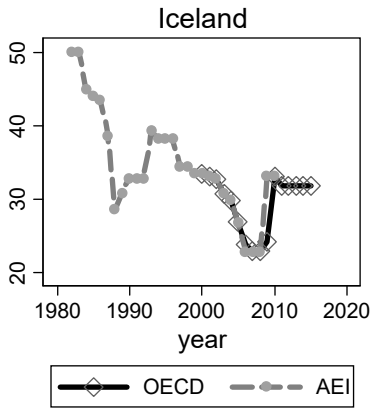
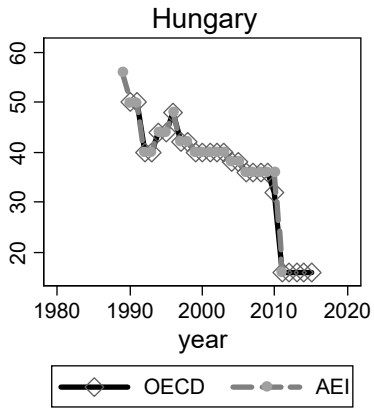


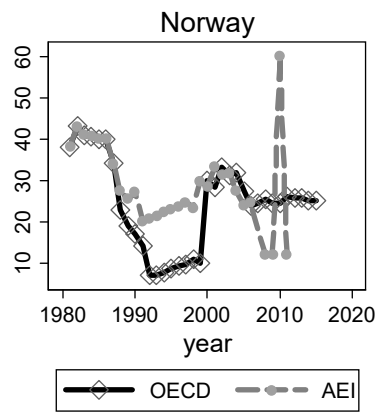
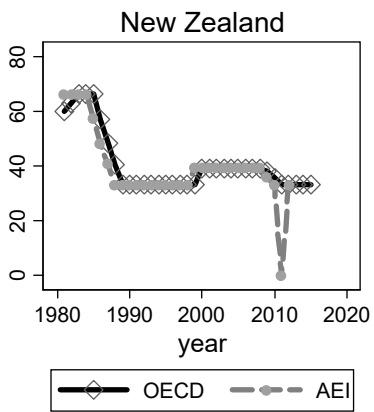
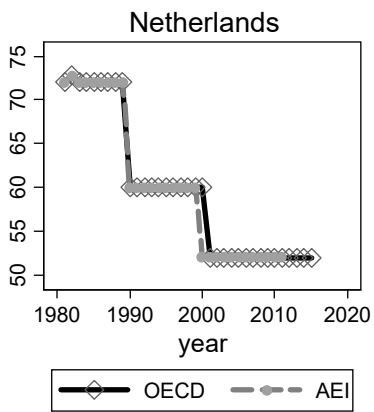
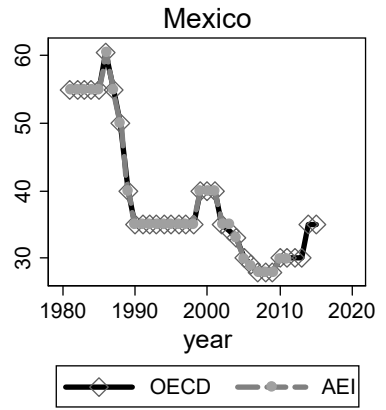
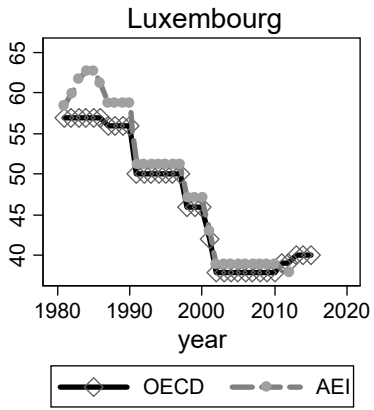
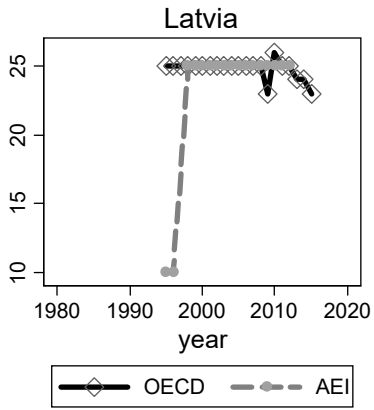


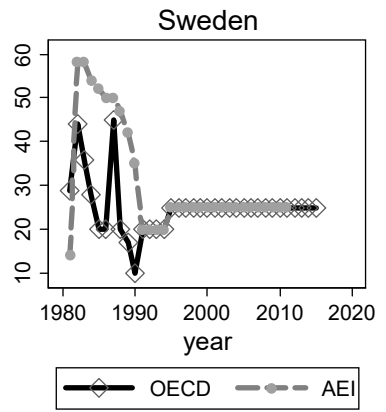
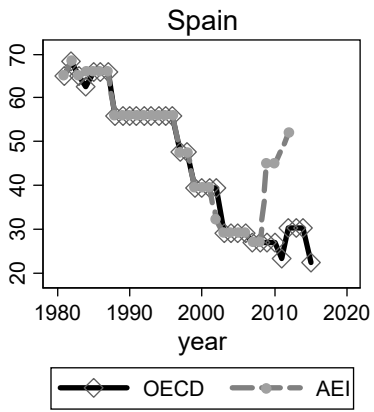
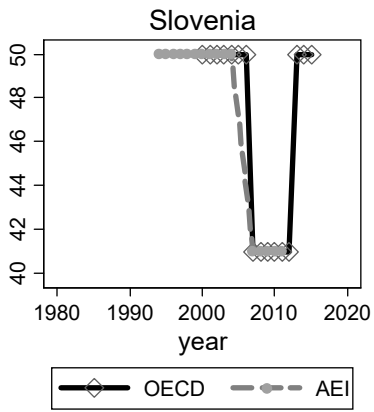
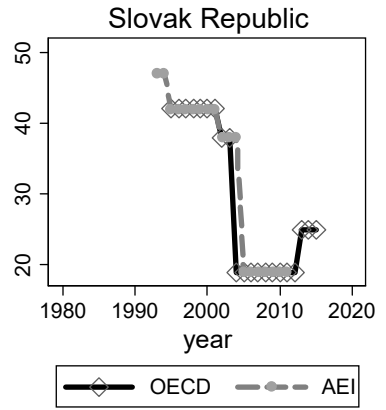
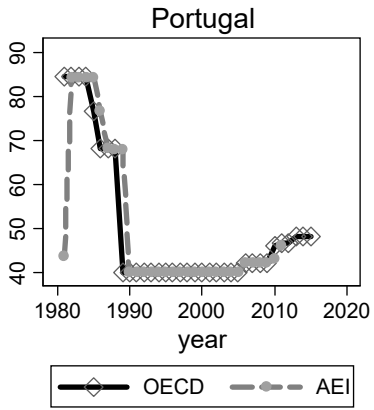
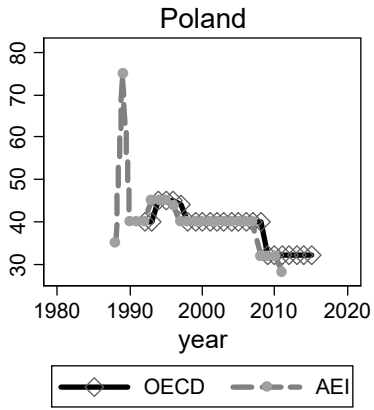
**Figure A2.2: Comparison of Personal Income Tax Rates from the OECD Tax Database and the AEI International Tax Database**











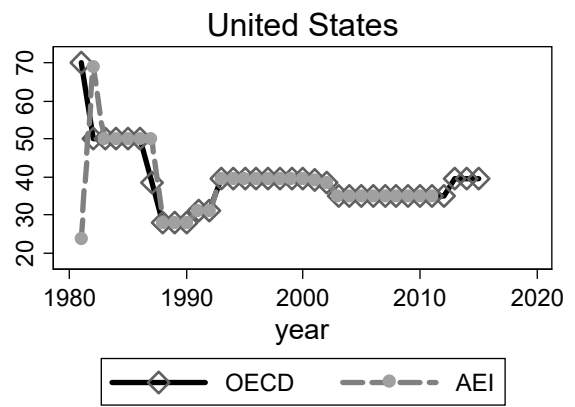
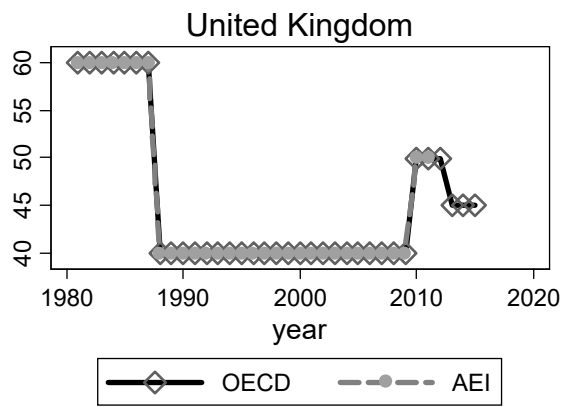
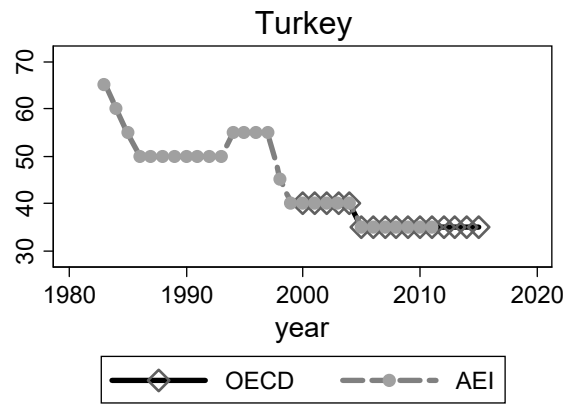
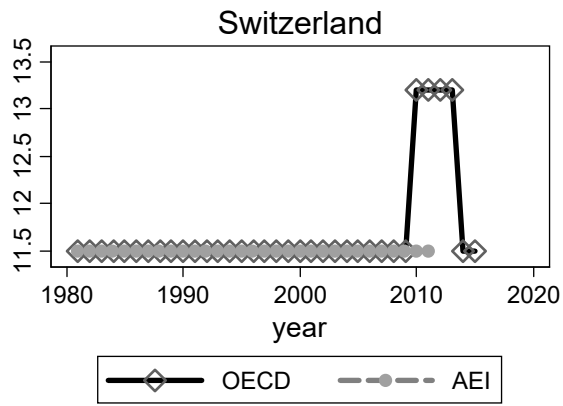
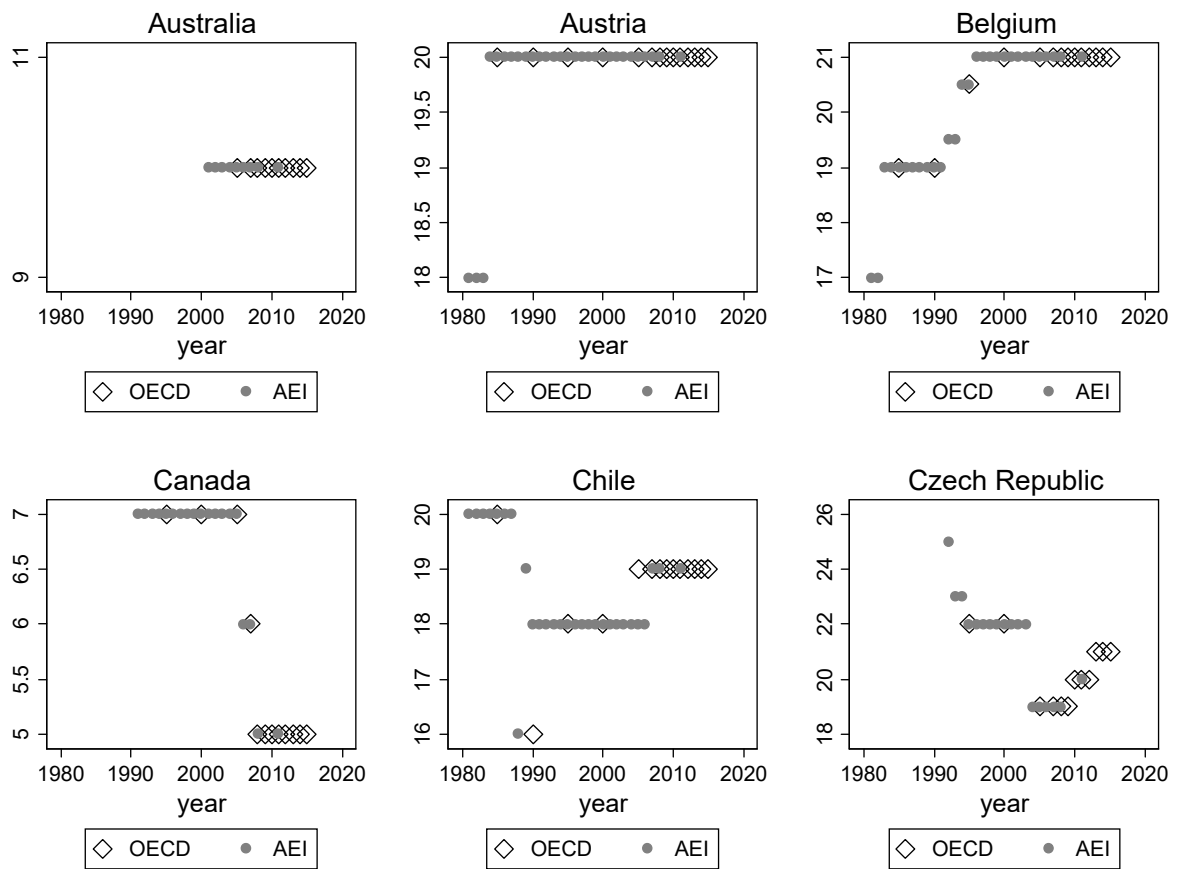
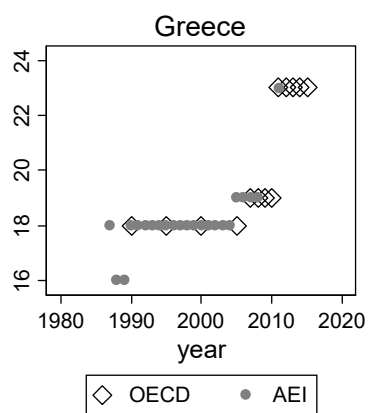
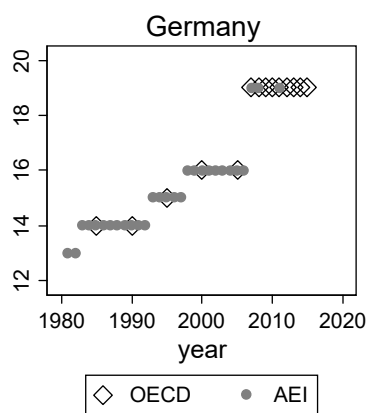
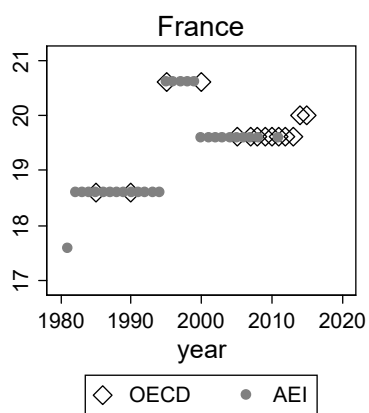
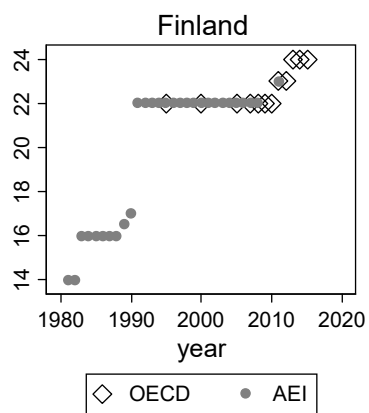
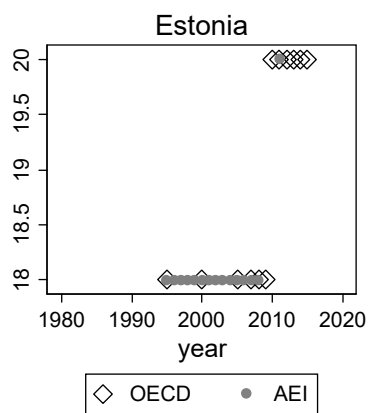
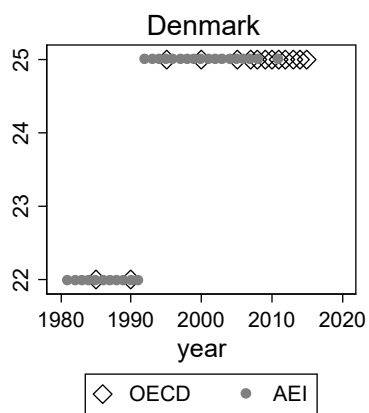
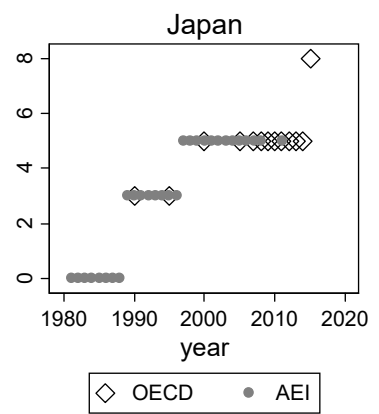
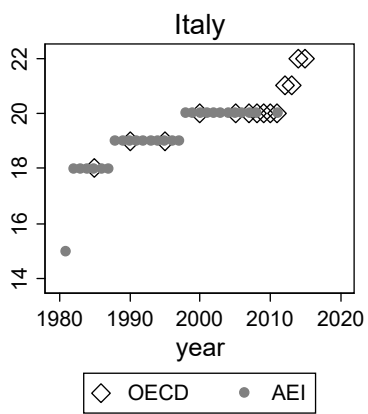
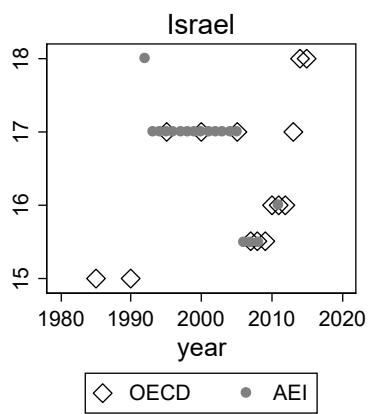
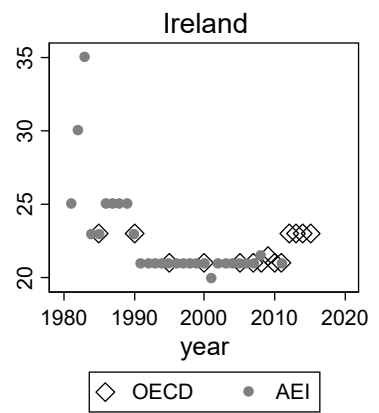
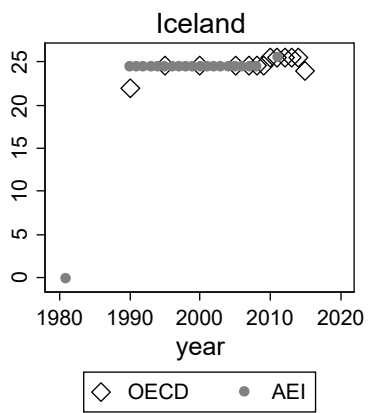
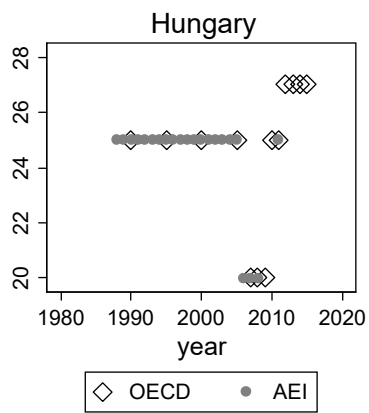


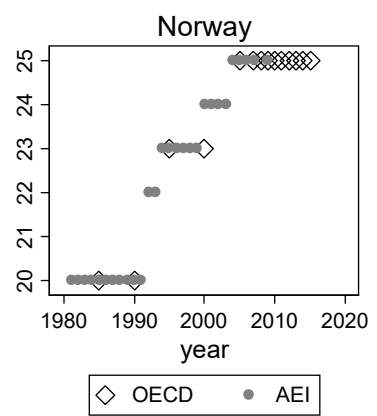
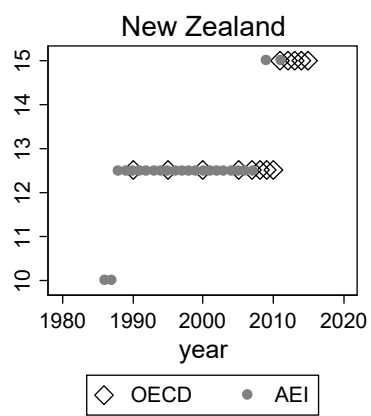
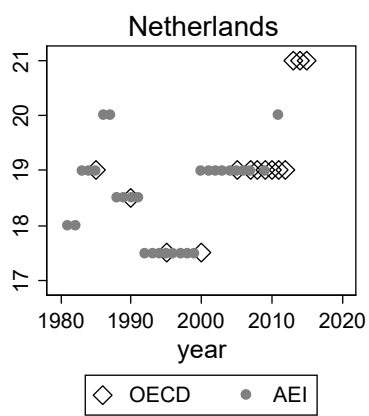
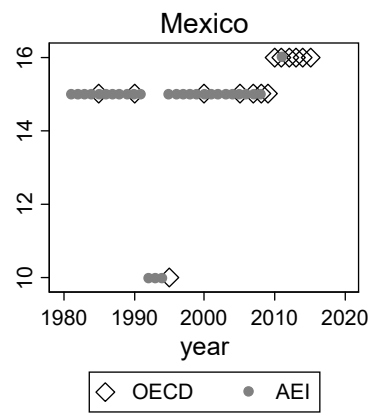
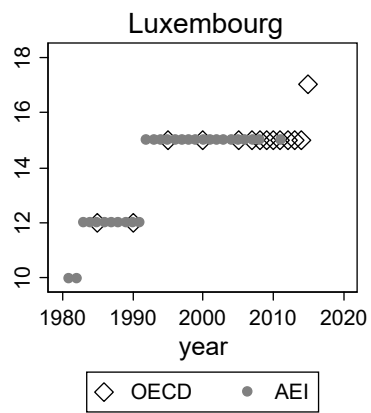
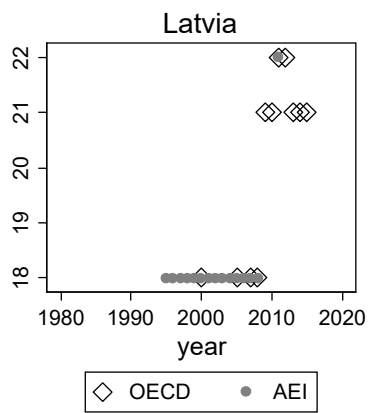
Figure A2.3: Comparison of Value-Added Tax Rates from the OECD Tax Database and the AEI International Tax Database

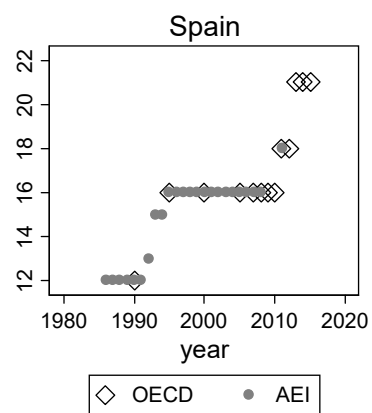
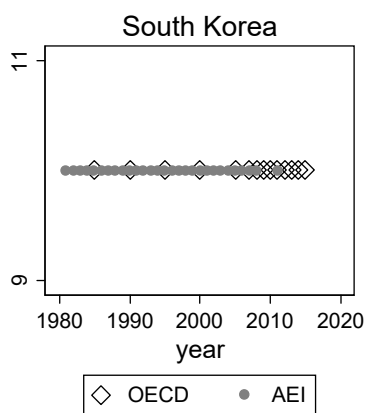
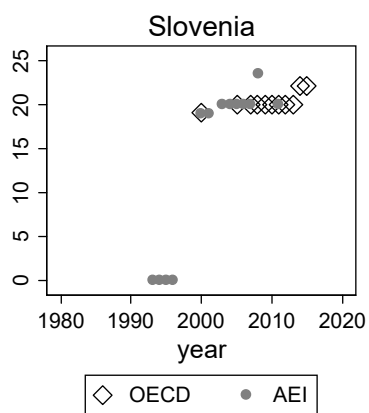
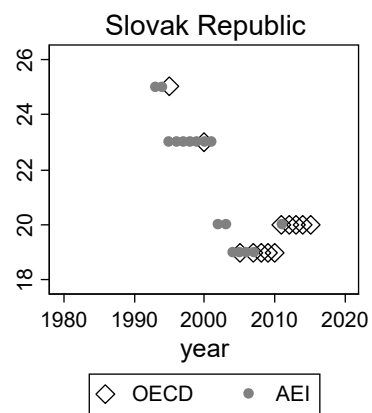
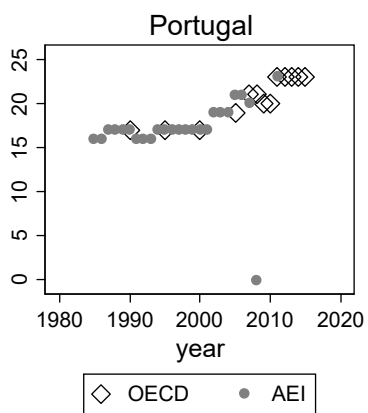
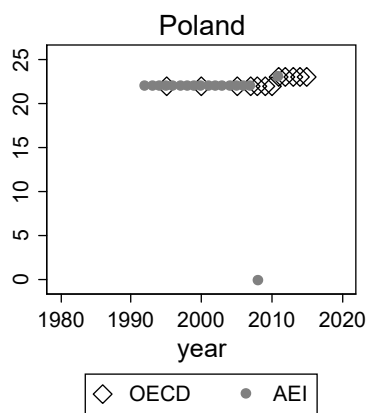


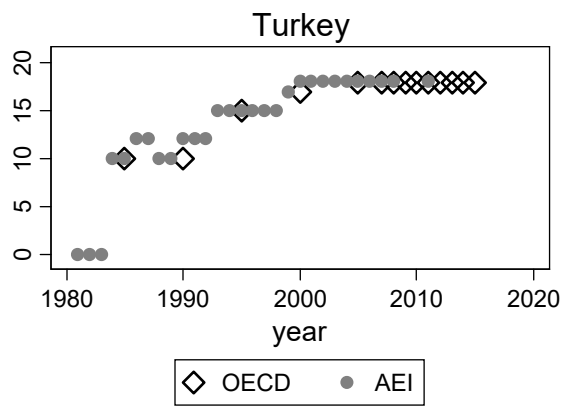
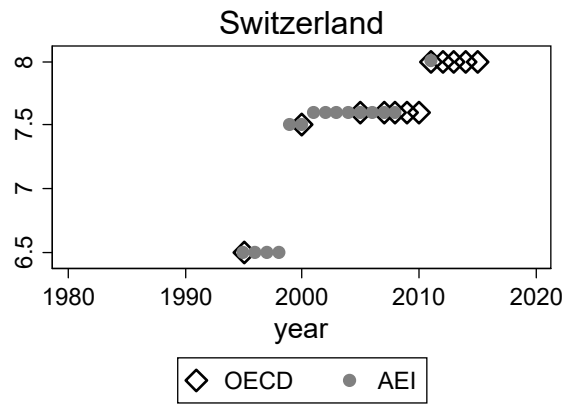
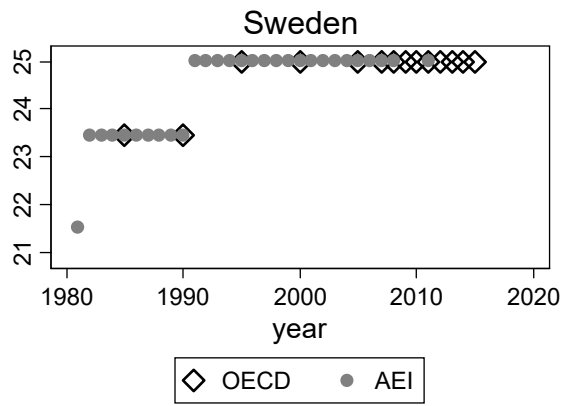












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