State Tax Competition in the United States

José Caso*, Salomón García†

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Abstract

We construct a panel database for all states in the U.S. from 1980 to 2016, and document that the average corporate income tax rate has declined by approximately 40%. At the same time, we observe that most states have gradually shifted towards imposing a sales-only apportionment weight on multi-state firms. We ask whether these patterns are consistent with states competing in setting their corporate tax policy. Empirically, we find evidence of strategic interaction in setting tax policies between neighboring states. Theoretically, we show that moving towards a sales-only apportionment scheme is consistent with the prediction of a dynamic general equilibrium model of tax competition that incorporates the Formula Apportionment rule.

*Ph.D. candidate, University of Minnesota, email: casco008@umn.edu
†Ph.D. candidate, University of Minnesota, email: garci795@umn.edu

1 Introduction

This paper studies the decline in the average corporate tax rate during the last 40 years at the state level in the United States.[1] The prevailing narrative across the literature is that states engage in corporate tax competition to attract investment, mainly from firms that operate in multiple states, known as multi-state corporations. Such competition has led States to offer a variety of tax credit incentives and to modify their schemes of Formula Apportionment, effectively reducing the taxable base to multi-state corporations. The Formula Apportionment rule is a system that all States have adopted to determined the taxable income earned from multi-state corporations within each state. It was initially introduced as a weighted average of a corporation's sales, payroll, and assets in the State it operates.[2] However, most States have gradually shifted towards imposing a sales-only apportionment scheme to reduce a corporation's incentives to move assets and employment to other States. This behavior has raised concerns among policymakers, who see States engaging in a harmful competition that leads to inefficiently low corporate tax rates, and consequently lower provision of public goods, and lower welfare.[3]

We challenge this view and propose to study corporate taxation using the Ramsey Approach to optimal taxation. This approach takes a complete view of the tax system and considers the most efficient tax policy to finance an exogenously given sequence of public goods. We ask specifically whether the theory can account for the observations discussed above, and whether States have moved toward less distortive tax systems? The US represents an interesting environment to address this question, mainly because of the high degree of capital mobility and the relative homogeneity of tax rules across States.

First, using a panel database for all States from 1980 to 2016, we document cross-sectional and time-series patterns for a set of tax variables that provide a more general view of the evolution of state's tax systems. We find that the average corporate income tax rate across States has declined by approximately 40% during the period of our analysis; this is robust to several measures. On the other hand, the statutory marginal tax rates for labor and corporate income have remained roughly constant, and sales tax rates have steadily increased across all States. In terms of share of total revenue, labor income tax revenues have become predominantly important for States' coffers, increasing from 27.2% in 1980 to 34% in 2016. Sales tax revenue share has stabilized at 50%, and corporate income tax revenue shares had steadily decreased from 9.4% in 1980 to 5.9% in 2016. These three

[1] Currently, 46 of the 50 states levy a corporate income tax rate.

[2] The Multistate Tax Compact was established in 1967. Under the Formula Apportionment rule in the U.S., a multi-state corporation is subject to the corporate income tax in every State where it has sufficient economic activity (nexus) for the State to tax its income.

[3] Nerich (2007), and Stark and Wilson (2006) documents several petitions to the Supreme court to legislate "harmful" competitive practice among States to attract multi-state corporations. Wilson and Chirinko (2017) report that in recent years, the U.S. Congress has considered several bills that would alter States' capacity to set their capital tax policy independently.

sources of tax revenue have consistently represented 90% of state receipts throughout and across the majority of States.

Second, we show that the move towards a sales-only apportionment scheme adopted by most States is consistent with the prediction of a dynamic, neoclassical general equilibrium model of tax competition that incorporates the Formula Apportionment rule. Moreover, it can bee seen as a reduction of distortions in the allocation of production inputs within and between States across time. This implication is in contrast with theoretical implications from the Formula Apportionment literature. Two assumptions are key; first, we allow the tax authority to have access to a rich set of tax instruments, as it is the case in practice. Second, we assume that the distribution of a corporation's sales might differ from the distribution of output across States. Moreover, we identify that the distribution of sales of multi-state corporations is the key object of study to understand whether the adopted sales-only apportionment scheme is related to the decline in the average tax rate. Moving from an equally weighted scheme to a sales-only scheme does not directly imply a lower average corporate tax rate.

Third, under the Ramsey approach to taxation, a lower corporate tax rate reduces distortions on production margins, which put it differently can lead to gains in factors' allocative efficiency. If States have access to a rich set of tax instruments, they can maintain fiscal solvency and the provision of public goods by increasing less distortive taxes. We argue that this is the case for US States, which have gradually move from less reliance on corporate taxes towards more sales and labor income taxes.

The paper is structured as follows: , Section 2 briefs on related literature review, Section 3 documents the empirical findings, Section 4 presents the model and Tax Competition Framework, Section 5 presents the theoretical analysis, and Section 66concludes.

2 Literature Review

The adoption of Formula Apportionment to allocate a corporation's income among states was established by the Multistate Tax Compact in 1967. It aimed at increasing uniformity across estates by apportioning among the states the business income from multi-states companies on the basis of an equally weighted, three-factor formula, of the company's sales, payroll, and property in each state. This scheme prevailed from 1965 until 1978, year in which the Supreme Court[4] clarified that state have the right to deviate from the equally weighted three-factor formula to any scheme as long as when one or more factors are dropped, weight is reallocated to the remaining factor/s. Since then, X% of the states that levy a corporate tax income have deviated from the equally weighted formula to a

[4]The Supreme Court upheld the right of state to deviate in *Moorman Manufacturing Company v. Bair,* 437 U.S. 267 (1978), known as the 1978 Moorman decision.

double-weighted sales scheme, or to a only-sales weighting scheme. Interestingly, no state have moved in the opposite direction, i.e towards weighting more labor and property and less sales.

The literature on formula apportionment have progressively grown during recent years due to intention of the European Commission (2001, 2007a,b) to implement it within the European Union. This system has also been adopted in Canada, Germany and Switzerland. The debate in the literature centers around the optimal choice of apportionment weights, and whether such choice should be left to the states in a decentralized manner, or whether it should be centralized. Most of this analysis concludes that if the choice of apportionment weights is left to the states, tax competition leads to inefficiently low tax rates and could be detrimental for welfare (see, Gordon and Wilson 1986; Eggert and Schjelderup 2003; Eichner and Runkel 2011). Runkel and Schjelderup (2011), evaluate the choice of apportionment weight in a two-factors formula and conclude that weights on production inputs, capital and labor, should be positive regardless of whether the formula is determined decentralized (set by states) or set by a central authority. This results is at odds with the empirical evidence of apportionment weights for the US. This body of literature assumes that the tax authority have access only to a restricted set of tax instruments–usually only the tax on corporate income–and on the simplifying assumption that sales and output in each state are the same object.

[Empirical Literature:] In an effort to understand why state have move towards apportionment schemes with higher weights on sales, B. and Sansing (2000) develop a partial equilibrium model of location choice and find that importing states have incentives to increase the weight on sales, vice versa for exporting states. They also, find that aggregate welfare is maximized when states coordinate to use the same weighting scheme, although it is not an equilibrium in their model since there are incentives to deviate. Goolsbee and Maydew (2000) provide empirical support to state switching to higher weights on sales finding that such states have experienced faster employment growth compared to those who have remained under the equally weighted scheme.

Our approach falls within the literature that takes a comprehensive approach to study tax systems and fiscal policy (see Chari and Kehoe 1999a; Atkeson et al. 1999; Mendoza and Tesar 2005). We apply the insights of this literature on optimal taxation to jointly study the empirical observations in corporate taxation, and in the rest of tax variables of US states. Our dynamic, Neoclassical general equilibrium growth model is a simplified version of the standard two country model used in the trade literature (see Backus et al. 1994; Ljungqvist and Sargent 2012; Chari et al. 2019). Our exercise follows closely Mendoza and Tesar (2005) who shows that the behavior of tax competition among European countries after markets integrated in the early 80's does not necessarily leads to a "race to the bottom", and is consistent with the quantitative predictions of a growth model of tax

competition.

3 Overview of States Tax System

Changes in tax revenue can impact policymakers' best efforts to balance state budgets. Over the past three decades, there has been several changes in the tax revenue system of many states, caused by tax policy changes. The flow of tax revenues that a state government collects to sustain a balanced budget can be influenced by changes in the structure of the state's tax rates system as well as the state's tax base. Many studies have examined the behavior of state's corporate tax structure as well as tax competition among states by evaluating just one of the tax components and assessing the reaction of one state to changes in a particular policy in other states, without taking into consideration the complete tax system (see for instance, Zodrow and Mieszkowski 1986; Gordon and Wilson 1986; Eggert and Schjelderup 2003; Eichner and Runkel 2011; Runkel and Schjelderup 2011; Chirinko and Wilson 2017). The present study diverts from that perspective and analyze distortive effects of corporate tax competition under formula apportionment taking into consideration a comprehensive set of tax policies available for state policy makers.

In the public finance literature, there is an important discussion about the driver factors that influence changes in state's corporate tax policy, putting special attention on the competition among states. Tax policy structure among U.S. states allow us to examine this important issue, since individual states are able to set their own tax policies as well as tax base structures within a similar institutional framework. In this context, this study starts by examining the observed changes in the main elements that affect states' tax policy system. To document the evolution over time of important tax policy components, we build a panel database from 1954 to 2016 for states' tax variables within Unites States. This structure allows us to recognize cross-sectional and time series patterns of statutory tax rates for capital income, consumption and labor income, behavior of apportionment factors and tax credits and the evolution of tax revenue shares and public debt.

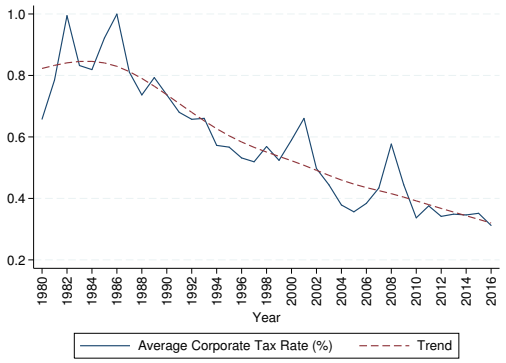
In the data we observe that state corporate taxation has changed in the last decades, moving towards a structure that is more hospitable to corporations. One possible reason for this pattern could be a strategic behavior in a tax competition environment tended to convert a state more attractive to corporations in relation to competitor states. From a theoretical perspective, tax competition could be seen–in a simplistic framework–as incentives to corporations' capital mobility among states. Since in the present study we are interested in examining distortive effects of corporate tax competition among neighboring jurisdictions, it is necessary to start the analysis by inspecting the behavior over time of the effective tax rate for corporations. However, we are unable to observe this variable at a macro level. Therefore, we have examined the average corporate tax

rate—which is a related measure of the effective tax rate burden by corporations—by constructing two proxy measures: the ratio of state's corporate tax revenues to state's corporate income (measured via sate's gross operating surplus) and the ratio of the sum of states corporate tax revenues to U.S. corporate profits.

Figure 1: Average Corporate Tax Rate

(a) Corporate Tax Revenue / Gross Operating Surplus

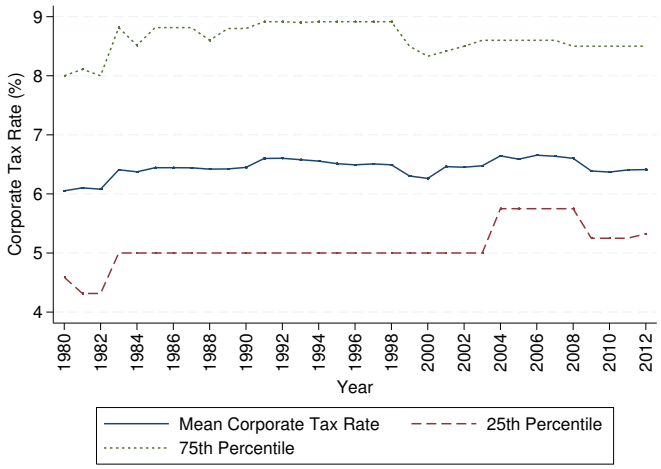
(b) Corporate Tax Revenue / U.S. Corporate Profits



Note: The weighted average is calculated over the 48 contiguous states for the period 1980 to 2012, using as weights the states GDP (we excluded District of Columbia, Hawaii and Alaska). The average corporate tax rate variable is the ratio of state tax revenues from corporate taxes plus corporation license fees divided by total state business income measured via state's gross operating surplus. The trend was obtained by applying the Hodrick–Prescott high-pass filter.
Source: Bureau of Economic Analysis (Regional Accounts), Annual Survey of State Government Tax Collections (STC)–U.S. Census Bureau.

In Figure 1, we show these two measures over a 32 years period. In Panel (a) the average corporate tax rate is computed using a weighted average over the 48 contiguous states for the period 1980 to 2012. We observe that since 1980, the weighted average corporate tax rate has gradually declined more than 1 percentage point. The trend also portrays these fact showing a consistent downward slope for this period. Similarly, in Panel (b) the other proxy measure of average corporate tax rate, as well as its trend, show a steady descending pattern in the last three decades. Figure 1 suggest that state capital taxation has experienced important changes. This variation could be due to competition among states that lead to changes in statutory tax rates or changes in components that determine the taxation base or both. We observe in the data that changes in statutory corporate tax rates have not experienced a dramatic change in the last 30 years. From Figure 2 we observe that statutory corporate tax rates have remained relatively flat over the last decades, which suggest that this component might not be a substantial driver of the observed decline in average corporate tax rate.

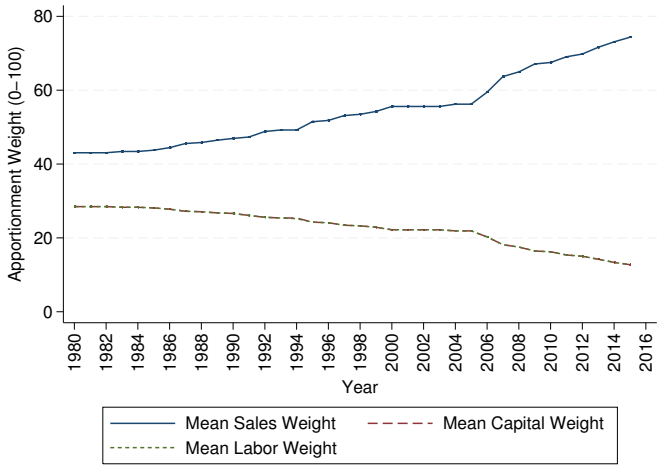
Figure 2: Statutory Corporate Tax Rate Across U.S. States



Note: The figures present the evolution over time of the state corporate tax rate as well as the 25th and 75th percentiles. We excluded District of Columbia, Hawaii and Alaska in the computation.
Source: The University of Michigan Tax Database. The Tax Foundation. National Bureau of Economic Research (TAXSIM).

Another possible explanation for the decline in the average corporate tax rates is related to changes in components that affect the tax base e.g. formula apportionments or tax credits, as states could also use this tax policy tools to provide a friendly taxation environment for business operations. In this context, a very important instrument, in terms of corporate taxation, is the apportionment factors.

Figure 3: Apportionment Weights Across U.S. States



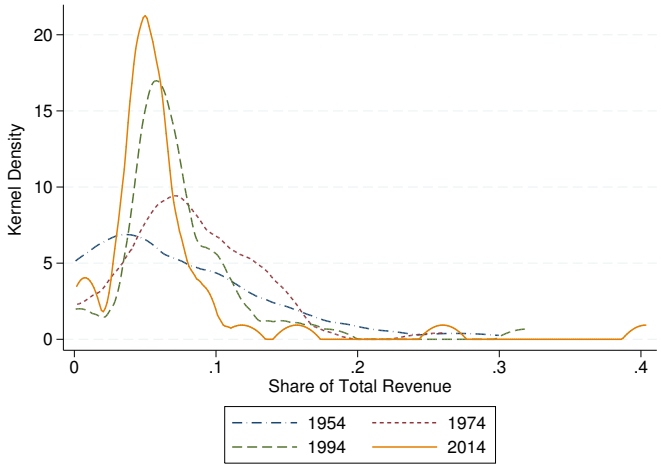
Note: The figure present the evolution over time of the states sales, capital and payroll apportionment weights as well as the 25th and 75th percentiles. We excluded District of Columbia, Hawaii and Alaska in the computation.
Source: Commerce Clearing House's State Tax Handbooks.

Under the formula apportionment structure, the tax bases of multistate corporation's subsidiaries are first consolidated and then apportioned to the states according to a for-

mula that takes into consideration the capital share, sales share and payroll share of the multistate corporation in each of the states in which it has a nexus. In Figure 3 we observe that states have increased the apportionment weight on sales, and decreased the weights on property and payroll over time. This reveals a clear pattern of the sates towards relying more on the sales apportionment weight, which has important implications for the corporate tax faced by multistate corporations. This, data also suggests that apportionment factors have been constantly changing over time and therefore are important and actively used tax policy tools.

Variation in the tax structure (tax rates and base) could lead to changes in the revenues received by state governments from the different taxation sources. In the data, we observe that corporate tax revenue share[5] has changed over time. In Figure 4, we show that over the past sixty years, corporate tax share has been declining.

Figure 4: Corporate Tax Revenue as a Share of Total Revenue



Note: These are kernel density function for the states corporate revenue as a share of total state tax revenue, analyzed by two decades time spams. We excluded District of Columbia, Hawaii and Alaska in the computation.
Source: Annual Survey of State Government Tax Collections (STC)–U.S. Census Bureau.

We observe that corporate tax share was 6.95% of total revenues in 1954 increased significantly to 8.14% in 1974 and then has declined to 6.56% in 2014. This situation has generated preoccupation among academic and policymakers. Previous studies have tried to understand if a tax competition environment could drive states to charge inefficiently low tax rates, leading to less tax collections that could end up affecting the provision of public goods and lowering welfare (see for instance Besley and Case 1995, Figlio, Kolpink,

[5] This was measured as a proportion that measures the importance of the corporate tax revenue in the total state revenue.

and Reid 1999, Saavedra 2000, Rork 2003, Egger, Pfaffermayr, and Winner 2005, Devereux, Lockwood, and Redoano 2007 and Wilson and Chirinko 2017).

We don't think that this is necessarily true in a dynamic framework that analyze corporate taxation taking into consideration the complete tax system. We will show the mechanism behind this idea in our theoretical model in where we study corporate taxation using the Ramsey approach to optimal taxation. We will show that our observation in the data that many states over the years have moved towards a system that relies more on the sales apportionment factor is consistent with the prediction of a dynamic, neoclassical general equilibrium model of tax competition that incorporates the Formula Apportionment rule. Moreover, this pattern improves aggregate welfare by reducing distortions in the allocation of production inputs within and between states.

Since we are taking into consideration the complete tax systems, it is also important to examine the behavior of the other components of available for policymakers. It is important to note that different statutory corporate tax rates among states suggest that apportionment factors will play an important role in terms of average corporate tax rate faced by multistate enterprises. Changes in apportionment factors, however, will not necessarily imply a lower average corporate tax rate and they become relevant contingent on the location of sales and production of the multistate corporation. We will show this in mechanism in the next section. In tax competition framework, all these factors affect all states simultaneously, however their importance may be heterogeneous depending on the state. Therefore, it is important to document the behavior of these components over the last decades and across states.

State's statutory tax rates have displayed a dissimilar behavior over the period of analysis. Overall, we observe that over the last 30 years, there are very modest increases in the averaged corporate and labor tax rates across states, and an important increase in the averaged sales (consumption) tax rate. Figure 5 shows the gradual development over time of the corporate, labor and sales tax rates.[6] In Panel (a), corporate tax rate across states displays a roughly constant behavior over time, oscillating in-between 6% and 7%. Similarly, Panel (b) and Panel (c) show the evolution over time of labor income tax rate and sales tax rate averaged over states. Labor income tax exhibit a nearly constant behavior fluctuating around 5.2%, while sales tax rate have almost double during the last few decades. By looking at the dispersion of tax rates, the interquartile range shows that the majority of states have corporate tax rates between 5% and 8.5%, however, since 2002 this measure has slightly narrowed. The same measure shows that labor income tax rates fluctuate between 5% and 8.5% prior 1988, but it has narrowed in the subsequent years, fluctuating around 4% and 7%. Consumption tax rates, on the other hand, have and interquartile range that rises consistently with the rise in the average sales tax rate.

[6] All the remaining figures are placed in the appendix due to space considerations.

Since 1986 we observe that sales tax rate dispersion have been mainly between 4% and 6%, and since 2008 it has been between 4.5% and slight below 6.5%.

Table 1 provides a clearer picture of this situation. We observe that mean statutory corporate income tax rate has not changed significantly in the last 30 years, with a positive variation of only 0.32 percentage points. A different pattern is observed when we use the weighted mean[7], as we see a slightly negative change of 0.23 percentage points. The variability, expressed by the standard deviation displays a stable patter around 2.9%. The behavior of labor income tax rate also shows a stability in the last decades. The mean has increased 0.14 percentage points while the weighted mean indicates an increase of 0.18 percentage points. Conversely, the mean over statutory sales tax rates among states has notoriously changed in the last 30 years, with a positive variation of 1.57 percentage points. We notice a similar pattern by using the weighted mean, however the change is a bit higher with 1.76 percentage points.

Analyzing state's statutory tax rates by region[8], we found observable differences. In Figure 6, Panel (a) shows a clear difference between the Northeast region and all the other three regions. States in the Northeast region have consistently set a higher corporate tax rate that oscillates between 8% and 9%. On the other hand, the West region has gradually decrease the corporate tax rate and in the last years has wavered around 5.5%. Panel (b) display the statutory labor tax rates across regions, which provides evidence of higher volatility. A salient feature, however, is that states in the South region have steadily set lower labor tax rates which oscillate just below 5%. Now, by observing Panel (c), it is noticeable the consistent increasing pattern across states of the statutory sales tax rate, with states in the Midwest region setting higher sales tax rates since 1994. In contrast, the states on the West region have the lower sales tax rates in relation to the other three regions.

The declining behavior of average corporate tax rate could also respond to the increase of pass-through businesses which have increased in the last years and which are not subject to corporate income tax and instead, the shareholders are taxed upon their allocated share of the income. We acknowledge the fact that this corporate structures may play a role in the decline of average corporate tax rate, however, we think the main driver of this decline are changes in the corporate tax system applied to large corporations as response to external corporate tax policy. To examine the importance of multistate

[7]In the construction of the weighted mean we have used state GDP from the Bureau of Economic Analysis (BEA) regional accounts as weights.

[8]For our analysis we have selected four different regions that cluster several states: West={Arizona, Colorado, California, Idaho, Oregon, Montana, New Mexico, Utah, Washington, Nevada, Wyoming,}, Midwest={North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Michigan, Ohio}, Northeast{Pennsylvania, New York, New Jersey, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermount, Maine} and South{Oklahoma, Texas, Arkansas, Louisiana, Alabama, Mississippi, Tennessee, Kentucky, West Virginia, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida}.

corporations, in Figure 7, we compare C-corporations and S-corporations share of returns and share of receipts. By looking at Panel (a), the share of tax returns of S-corporations show a pronounced upward drift since 1984 , surpassing C-corporation share of returns by 1996 and then experiencing a diminishing patter after 2008. Currently, from each 100 returns received from corporations, S-corporations are responsible of 72 returns while C-corporations are responsible of 27 returns. In Panel (b), however, we observe that despite the increase in the share of receipt from S-corporations over time, C-corporations remain as the most important corporate contributors. Currently, from each dollar received from corporations, S-corporations are responsible of 23 cents while C-corporations are responsible of 75 cents. This suggest that even though pass-through businesses have increased in number, C-corporations are still the main tax contributors.

Recalling that different statutory corporate tax rates among states suggest that apportionment factors will play an important role in terms of average corporate tax rate faced by multistate enterprises, it is necessary to further analyze the behavior of these important taxation instruments to better understand its evolution across states and see if these have been used actively used as a tax policy tool in the last decades.

Table 2 provide us with a perspective of the heterogeneity among states in setting the apportionment factors and how this heterogeneity has changed over time. In this table we observe that states have moved from an equally weighted structure to a configuration that relies more heavily on the sales apportionment factor. In 1980, from the 48 states analyzed, the majority of states placed less than 50% of the apportionment weight on sales. We observe that 38 states had three factors equally weighted structure, 4 states had three-factor double-weighted sales and 6 states had sales single factor structure. This initial situation has change in last 30 years, with a gradual increase in the share of states that placed 50% or more of the apportionment weight on sales. We observe that in 2010, 10 states were using three factors equally weighted structure, 16 states were employing three-factor double-weighted sales and 17 states were using sales a single factor structure. Overall, this table clearly shows the patter of changes among states towards relying more on the sales apportionment weight, which has important implications for the corporate tax faced by multistate corporations. This, table also suggests that apportionment factors are an important and actively used tax policy tool.

In Figure 8, from Panels (a), (b) and (c) we can appreciate the distribution across states and the evolution over certain points in time of the different apportionment factors. The distributions tell us that over the years, higher capital and labor apportionment weights have become less likely among states, while higher sales apportionment weigh has become more likely. This situation can also be observe in Table 3. Mean property and payroll apportionment factors have tended towards a lower weight. We observe a reduction of 12.22 percentage points in the mean weights associated with property and

payroll. A more pronounced decline is observed when we employ a weighted mean, with a reduction of 14.24 percentage points in the magnitude of these weights. On the other hand, we observe that mean sales apportionment factor has increase its importance with a positive variation of 24.45 percentage points in the last 30 years. A more noticeable rise is observed when we employ a weighted mean, with an upsurge of 28.49 percentage points in the last three decades. In terms of the dispersion we observe that the standard deviation of all three apportionment factors has slightly increased over the last years, which implies slightly increase in the diversity in terms of apportionment weight policy across states.

This heterogeneity can be better observed if we analyze the behavior of apportionment weights disaggregated by regions. In Figure 9, we see that regions are distinct in setting their sales apportionment weights, they are different in the changing patterns over time and also there is important variation within some of the regions. Nevertheless, a salient feature is that over the period of analysis we witness a clear upward trend of the sales apportionment factor in all four regions. A symmetric opposite behavior is observed for capital apportionment weights[9] across regions. In Figure 10, we observe the dissimilar patterns of regions in their capital apportionment weights, as well as the dispersion within the regions. In contrast, to the sales apportionment factors observed in the previous figure, for capital and payroll weight we observe that over the period of analysis there is a declining trend in all four regions, however the declining slopes are different across regions. However, we observe that all regions have slightly declined the participation of corporate tax revenues in the last 34 years.

By looking at the states' structure of the corporate tax system, we observe a stable behavior of the statutory corporate tax rate and important variations in the apportionment weights over time. We also observe heterogeneity across states in both policy instruments. If we expand the analysis to other tax instruments, we observe that labor income tax rate also shows a stable pattern in the last decades, while statutory sales tax rates among states has notoriously increased in the last 30 years. Change in tax rates as well as rules that affect the tax base could lead to changes in the revenues received by state governments from the different taxation sources. In the data, we observe that the structure of tax revenue shares has changed across states and over time. In Figure 11, we observe the evolution over time of the distribution of corporate, labor and sales tax revenue shares (The revenue share is a proportion that measures the importance of the different taxes in the total state revenue.) This shows that over the past sixty years, there was considerable changes in the shares of total state revenue from these different

[9] We have just reported capital apportionment weights since payroll apportionment weights follow a similar pattern.

tax components. Corporate tax share has been slightly declining over the last decades, while sales tax share experienced a more pronounced drop. On the other hand, labor tax share has been significantly increasing in these years.

Table 4, provides a clearer picture of this situation.[10] We observe that corporate tax share has experienced a reduction of 36.8% and 22.6% measures by the weighted and unweighted averages, respectively. It is important to note that the variability of this component has increased, as we observe that in 2012 the standard deviation was 5.41% while in 1982 it was 4.78%. Labor income tax share, has consistently increased its participation in total revenues with a rise of 25.25% of the weighted mean and 25.18% in the unweighted mean over the past thirty years. This was accompanied with a slightly increase in variability in the magnitude of 1.04% over the same period. This indicates that over the years, states are relying more on labor income taxation rather than on corporate taxation. On the other hand, sales tax share has evolved in relatively stable pattern with small decline in that last three decades and with a constant variability that oscillates around 15%.

If we analyze the composition of tax revenues by region, we found some level of heterogeneity among states and regions. In Figure 12, we show the tax revenue share decomposed by regions, and it is observable from Panel (a) that in the last years, Northeast region has consistently experienced a higher participation of corporate tax revenues compared to states in the other regions. However, we observe that all regions have declined the participation of corporate tax revenues from 1980 to 2012. In panel (b), labor tax revenue shares show consistent growth among all regions, although, it is visible that Northeast region have a higher participation of labor tax in their revenue structure compared to the other regions and South region has considerably lower participation of corporate tax revenues compared to states in the other regions. In panel (c) we observe a different situation as states within the South region have steadily relied in sales tax revenue as their main source of state revenue. On the other hand the Northeast region is the geographic cluster that has relied less in sales tax revenue. This changes in shares are consistent with our theoretical model in where changes in corporate tax rate or corporate apportionment factor could lead to reduction in tax collections from this source of revenue; however policymakers have other—less distortive—taxes to balance state's budget and maintain the provision of public goods. In the next section we develop a theoretical model that debunk the decline in the average corporate tax rate using a Ramsey approach to taxation and show that lower corporate tax rate might not be detrimental to welfare, on the contrary it may actually improve welfare through a less distortive taxation structure.

[10] We have also calculated in this table the weighted average, which takes into consideration the relative importance of the states' economy in the computation of the average.

4 The model

This model is a simplified version, with only one tradable commodity, of a standard two country model used in the trade literature, see Backus et al. (1994), Ljungqvist and Sargent (2012), and Chari et al. (2017).

4.1 Environment

Time is discrete and infinite. There is no uncertainty and decision makers have perfect foresight. The economy is comprised of two countries, indexed by $i = a, b$. In each country there is a representative household, a government authority, and a subsidiary firm that is part of a parent firm who owns the two subsidiaries.

The representative household in each country has the same preferences over consumption c_{it}, and leisure $1 - n_{it}$,

$$U^i = \sum_{t=0}^{\infty} \beta^t u^i(c_{it}, 1 - n_{it}), \qquad \beta \in (0, 1) \tag{1}$$

where $u^i(\cdot)$ is strictly increasing in c_{it} and $1 - n_t$, twice continuously differentiable, and strictly concave[11].

The technology of each subsidiary firm is the same in both countries, $i = a, b$, given by

$$y_{it} = F(k_{it}, n_{it}) \tag{2}$$

where y_{it} denotes the quantity of the commodity good produced by country i, and $F(\cdot)$ is a constant returns to scale function with positive and decreasing marginal products of capital and labor.

The total production of the commodity good across countries can be used for private consumption c_{it}, public consumption g_{it}, and investment, x_{it}. The resource constraint of the economy is

$$c_{at} + c_{bt} + x_{at} + x_{bt} + g_{at} + g_{bt} \leq y_{at} + y_{bt} \tag{3}$$

the law of motion of capital is

$$x_{it} = k_{it+1} - (1 - \delta)k_{it} \qquad \forall i = a, b \tag{4}$$

where $\delta \in (0, 1)$ represents the depreciation rate.

[11] We also require that $c_{it} \geq 0$, and $n_{it} \in [0, 1]$. These are the standard assumptions on preferences, see Ljungqvist and Sargent (2012)

4.2 Parent-Firm

The parent firm owns the aggregate capital in the economy, and centrally decides on investment and labor for each subsidiary. Let V_0 denote the value of the firm in period zero after the dividend payout in that period, d_0. Then the parent firm maximizes the value of its after tax dividends,

$$V_0 + d_0 = \sum_{t=0}^{\infty} Q_t d_t \tag{5}$$

where Q_t is the intertemporal price of the common numeraire at time t in units of the numeraire at zero ($Q_0 = 1$), and dividends are defined as [12]:

$$\begin{aligned} d_t &= \Pi_t(1-\bar{\tau}_t) - (x_{at} - \delta k_{at}) - (x_{bt} - \delta k_{bt}) \\ \Pi_t &= [y_{at} - w_{at} n_{at} - \delta k_{at}] + [y_{bt} - w_{bt} n_{bt} - \delta k_{bt}] \end{aligned} \tag{6}$$

The parent firm first consolidates its taxable base across countries, Π_t. Consolidated profits are taxed at rate $\bar{\tau}_t$, which is a weighted averaged of each individual country corporate income tax rate, $\{\tau_a, \tau_b\}$, that we assume time-invariant. We assume that the weighting scheme is determined according to the Formula Apportionment rule[13]. This rule specifies a vector of weights $\overrightarrow{\alpha}_i$ on the firm's shares of production inputs and sales in each country according to the formula in eq(7).

$$\begin{aligned} \bar{\tau}_t &= \tau_a \left(\alpha_a^K \frac{k_{at}}{k_{at}+k_{bt}} + \alpha_a^L \frac{n_{at}}{n_{at}+n_{bt}} + \alpha_a^S \frac{s_{at}}{s_{at}+s_{bt}} \right) \\ &+ \tau_b \left(\alpha_b^K \frac{k_{bt}}{k_{at}+k_{bt}} + \alpha_b^L \frac{n_{bt}}{n_{at}+n_{bt}} + \alpha_b^S \frac{s_{bt}}{s_{at}+s_{bt}} \right) \end{aligned} \tag{7}$$

$$\begin{aligned} \alpha_i^K + \alpha_i^L + \alpha_i^S &= 1 \qquad \alpha_i \in [0,1],\ i = a, b \\ s_{at} + s_{bt} &= y_{at} + y_{bt} \qquad \forall t \\ k_0 &= k_{a0} + k_{b0} > 0 \end{aligned} \tag{8}$$

The problem of the parent firm is to choose allocations $\{x_{it}, n_{it}\}$ to maximize (5) subject to (2), (4), (7) given initial conditions (8).

[12] For convenience, we assume that a deduction allowance equal to the value of the depreciated capital in each country, δk_{it}. A more general deduction schemes could be easily implemented by allowing to deduct ρx_{it} instead of δk_{it}, where $\rho \in [0,1]$ represents the fraction of investment expenditures allowed to be deducted. This framework is more general and encompasses the above by setting $\rho x_{it} = \delta k_{it}$ in each country.

[13] Notice that under Formula Apportionment the tax bases of the firm's subsidiaries are first consolidated and then apportioned to countries. We consider a formula with three factors: capital, labor and sales which is the formula used across US states.

4.3 Households

Households in each country i, save or borrow using two type of assets: equity shares, e_{it}, from the parent firm that we assume is internationally traded, and a domestic government bond, b_{it}, traded locally. The flow of funds constraint in period t for the household in country i in units of the numeraire is,

$$(1+\tau_i^c)c_{it} + V_t e_{it+1} + b_{it+1} \quad = \quad (1-\tau_i^n)w_{it}n_{it} + (V_t + d_t)e_{it} + \frac{q_{it-1}}{q_{it}}b_{it} \tag{9}$$

Household face country specific consumption taxes,τ_i^c, and labor income taxes, τ_i^n[14]. Notice that returns on domestic debt, $\frac{q_{it-1}}{q_{it}}$, are country specific because countries can have different tax systems[15].

The problem of the representative household in each country i is to choose allocations $\{c_{it}, n_{it}, b_{it+1}, e_{it+1}\}$ to maximize (1) subject to (9), and a non-Ponzi scheme condition on domestic debt $\lim_{T\to\infty} Q_T b_{iT} \geq 0$, given initial conditions e_{i0} for each $i = a, b$.

4.4 Government

The fiscal policy in each country i consist of an exogenous sequence of public consumption g_{it}, that government finances by raising revenues through its time-invariant tax policy sequence $\pi_i = \{\tau_i, \tau_i^c, \tau_i^n, \overrightarrow{\alpha}_i\}$, and by choosing a sequence of public bonds b_{it}. The flow of funds of the government in each country i is given by

$$\tau_i^c c_{it} + \tau_i^n w_{it} n_{it} + \hat{\tau}_{it}\Pi_t \quad - g_{it} = \quad b_{it} \qquad \forall t,\ \forall i = a, b \tag{10}$$

where $\hat{\tau}_{it}$ is the effective tax rate of state i over the parent firm's consolidated taxable income according to the Formula Apportionment Rule:

$$\hat{\tau}_{it} = \tau_i \left(\alpha_i^K \frac{k_{it}}{k_{at} + k_{bt}} + \alpha_i^L \frac{n_{it}}{n_{at} + n_{bt}} + \alpha_i^S \frac{s_{it}}{y_{at} + y_{bt}} \right)$$

where time dependence of the allocation of production inputs and sales induces a effective time varying corporate income tax rate.

The flow of funds (10) expressed in present value, together with the No-Ponzi condition

[14] Taxes on dividends and capital gains are ignored in this version. However, it is straightforward to add them.

[15] Government from each country might adjust debt differently, according to its tax revenues and public consumption expenditures.

for government debt $\lim_{T\to\infty} Q_T b_{iT} \geq 0$ yields the government budget constraint,

$$\sum_{t=0}^{\infty} Q_t \left[\tau_i^c c_{it} + \tau_i^n w_{it} n_{it} + \hat{\tau}_{it}\Pi_t - g_{it}\right] = Q_{-1} b_{i0} \tag{11}$$

4.5 Optimality Conditions

Taking F.O.Cs with respect $\{c_{it}, n_{it}, e_{it+1}, b_{it+1}\}$ for the household's problem rearranging we obtain the intra-temporal and inter-temporal conditions, and the non-arbitrage condition for assets:

$$\begin{aligned}
\frac{u^i_{ct}(1-\tau_i^n)}{u^i_{nt}(1+\tau_i^c)} &= \frac{1}{w_{it}} \\
\frac{u^i_{ct}}{(1+\tau^c_{it})} &= \frac{V_{t+1}+d_{t+1}}{V_t}\frac{\beta u^i_{ct+1}}{(1+\tau^c_{it+1})} \\
\frac{q_{it-1}}{q_{it}} &= \frac{V_{t+1}+d_{t+1}}{V_t}
\end{aligned}$$

We define the change in equity value in units of the numeraire between period t and period $t+1$ to be:

$$\frac{Q_t}{Q_{t+1}} = \frac{V_{t+1}+d_{t+1}}{V_t} \tag{12}$$

The parent firm's problem can be re-written as choosing allocations $\{k_{it+1}, n_{it}\}_{i=a,b}$ subject to the structure of the average tax rate (7)

$$\begin{aligned}
\max_{\{k_{it+1},n_{it}\}_{i=a,b}} \quad & \sum_{t=0}^{\infty} Q_t\big(\left[F(k_{at},n_{at}) - w_{at}n_{at} - \delta k_{at}\right](1-\bar{\tau}_t) - \left[k_{at+1}-k_{at}\right] \\
& + \left[F(k_{bt},n_{bt}) - w_{bt}n_{bt} - \delta k_{bt}\right](1-\bar{\tau}_t) - \left[k_{bt+1}-k_{bt}\right] \big)
\end{aligned}$$

The F.O.C for the parent firm are:

$$F^i_{nt} = w_{it} + \frac{\Pi_t}{1-\bar{\tau}_t}\frac{\partial \bar{\tau}_t}{\partial n_{it}} \qquad i=a,b \tag{13}$$

$$\frac{Q_t}{Q_{t+1}} = 1 + (1-\bar{\tau}_{t+1})(F^i_{kt+1} - \delta) - \Pi_{t+1}\frac{\partial \bar{\tau}_{t+1}}{\partial k_{it+1}} \; i=a,b \tag{14}$$

If we ignore the the terms containing the derivative respect to $\bar{\tau}_t$ in equations (13) and (14), we obtain the standard expressions of the problem of a firm, that equates marginal product of inputs to its net prices. The average tax rate doesn't distort the firm's labor decision, whereas the capital decision is distorted because the firm cannot fully deduce its capital investment cost. Hence, the net return of capital is affected by the tax rate. The terms containing the derivative respect to $\bar{\tau}_t$ show how the firm's choice of inputs affects

the average tax rate it faces, the firm internalizes the fact that it choice of production inputs can affect the weighting scheme of formula apportionment.

Note that eq(14) indicates that the net marginal return of capital in each country must equate the ratio of inter-temporal prices of the numeraire, from this equation we can obtain the capital allocation Production Efficiency:

$$(1-\bar{\tau}_{t+1})(F^a_{kt+1}-\delta)-\Pi_{t+1}\frac{\partial\bar{\tau}_{t+1}}{\partial k_{at+1}}=(1-\bar{\tau}_{t+1})(F^b_{kt+1}-\delta)-\Pi_{t+1}\frac{\partial\bar{\tau}_{t+1}}{\partial k_{bt+1}} \tag{15}$$

this equation indicates that the parent firm will allocation capital in each country so that the marginal return of the last unit of capital in across countries is equated.

Combining the FOCs from the firm and households we obtain, the Intra-temporal Euler equation:

$$\frac{u^i_{ct}(1-\tau^n_i)}{u^i_{nt}(1+\tau^c_i)} = \frac{1}{F^i_{nt}-\frac{\Pi_t}{1-\bar{\tau}_t}\frac{\partial\bar{\tau}_t}{\partial n_{it}}} \qquad \forall i=a,b \tag{16}$$

and the Inter-temporal Euler equation:

$$\frac{u^i_{ct}}{\beta u^i_{ct+1}}\frac{(1+\tau^c_i)}{(1+\tau^c_i)} = 1+(1-\bar{\tau}_{t+1})(F^i_{kt+1}-\delta)-\Pi_t\frac{\partial\bar{\tau}_{t+1}}{\partial k_{it+1}} \qquad \forall i=a,b \tag{17}$$

4.6 Equilibrium

A competitive equilibrium for this two-country economy consist of a set of allocations $\{c_{it}, n_{it}, e_{it}, k_{it+1}, x_{it}, b_{it}\}$, prices $\{Q_t, w_{it}, V_0, q_{it}\}$, and policies $\{\tau^c_i, \tau^n_i, \tau_i, \overrightarrow{\alpha^i_i}\}$, given $\{k_0, e_{i0}, Q_{-1}b_{i0}\}$such that households maximize solve their problem, firms maximize value, government budget constraint holds (10), and markets clear meaning (3), (4), together with the condition for the parent firm's equity,

$$e_{at}+e_{bt} = 1$$

The system of equations that characterizes the equilibrium in this economy are given by (16), (17), (15) , (12), (11), (9), (4), and (3).

4.7 Tax Competition Framework

We follow the approach of Mendoza and Tesar (2005) in modeling tax competition as governments from each country meeting once to play a game in which they choose a particular scheme for the Formula Apportionment (FA) weights in (7) that define the average corporate income tax rate. The payoffs of the game are the welfare gains or

losses that each country incurs at the competitive equilibrium supported by the choice of FA factors and the endogenous consumption taxes needed to satisfy the intertemporal government budget constraints. Specifically, payoffs are computed as the percentage change between the present value of lifetime utility under the initial conditions and the lifetime utility under the competitive equilibrium under the new tax system.

Our strategy to keep labor and corporate income tax rates fixed is motivated by the observations in Section 3. There, we documented that the statutory tax rates on capital and labor income have remained roughly constant, whereas the sales statutory tax rates have significantly increased since the 1980, these are common patterns across all states in the US. Consequently, we allow the tax authority in each country to adjust the consumption tax rate in order to maintain fiscal solvency through out time.

In a competitive equilibrium the restriction that endogenous tax adjustments -in response to the other country's tax policy- must respect the government budget constraint to preserve fiscal solvency can be expressed as:

$$\begin{aligned} Q_{-1}b_{i0} &= \sum_{t=0}^{\infty} Q_t(\pi_i,\pi_j)[\tau_i^c c_{it}(\pi_i,\pi_j) \\ &\quad +\tau_i^n w_{it}(\pi_i,\pi_j)n_{it}(\pi_i,\pi_j) + \hat{\tau}_{it}\Pi_t(\pi_i,\pi_j) - g_{it}] \end{aligned} \tag{18}$$

Here, we have made explicit the dependence of the intertemporal price $Q_t(\pi_i,\pi_j)$ of the numeraire on the vector of tax policy (π_i,π_j). The left-hand side of (18) is the present value of government deficits- surpluses which must equate its initial asset position, $Q_{-1}b_{i0}$. Also, equilibrium factor prices w_{it}, and allocations $(c_{it}, n_{it}, x_{it}, k_{it})$ depend on the vector tax policy since those determine government's tax revenues.

A strategic decision rule for each country's choice of FA weights given the other country's choice of factors consist of each government in each country choosing its FA weights in order to maximize the payoff to the residents on its country subject to:

1. The implied allocations and prices for a global tax structure $\pi_a = (\tau_a, \tau_a^c, \tau_a^n, \overrightarrow{\alpha}_a)$, and $\pi_b = (\tau_b, \tau_b^c, \tau_b^n, \overrightarrow{\alpha}_b)$ constitute a competitive equilibrium.

2. Governments in each country adjust consumption taxes in order to keep their intertemporal budget constraints balanced.

Let $V(\overrightarrow{\alpha}_i|\overrightarrow{\alpha}_j)$ be *the payoff function* for country i strategic choice of FA weights given country's j scheme of FA weights, for $i \neq j$. Then, country i reaction curve $\overrightarrow{\boldsymbol{\alpha}}_{\boldsymbol{i}}(\overrightarrow{\alpha}_j)$ is given by

$$\overrightarrow{\boldsymbol{\alpha}}_{\boldsymbol{i}} = \arg\max_{\overrightarrow{\alpha}_i \in \mathcal{A}_i} V(\overrightarrow{\alpha}_i|\overrightarrow{\alpha}_j) \qquad i = a, b,\ i \neq j$$

where $\mathcal{A}_i$ is the space of admissible schemes for FA weights.

A *Nash Equilibrium* for the Formula Apportionment competition game is defined by a pair of FA weight vectors $(\overrightarrow{\alpha}_a, \overrightarrow{\alpha}_b)$ and the associated payoffs $V(\overrightarrow{\alpha}_a|\overrightarrow{\alpha}_b)$, and $V(\overrightarrow{\alpha}_b|\overrightarrow{\alpha}_a)$ such that:

1. $\overrightarrow{\alpha}_a$ maximizes $V(\overrightarrow{\alpha}_a|\overrightarrow{\alpha}_b)$ given $\overrightarrow{\alpha}_b$,
2. $\overrightarrow{\alpha}_b$ maximizes $V(\overrightarrow{\alpha}_b|\overrightarrow{\alpha}_a)$ given $\overrightarrow{\alpha}_a$,
3. the payoff functions are consistent with the competitive equilibrium prices and allocations corresponding to $(\overrightarrow{\alpha}_a, \overrightarrow{\alpha}_b)$,
4. the fiscal solvency rules of both $i = a, b$ countries are satisfied.

Then the Nash equilibrium satisfies:

$$\overrightarrow{\alpha}_a^N = \overrightarrow{\boldsymbol{\alpha}}_{\boldsymbol{a}}(\overrightarrow{\alpha}_b^N) \tag{19}$$

$$\overrightarrow{\alpha}_b^N = \overrightarrow{\boldsymbol{\alpha}}_{\boldsymbol{b}}(\overrightarrow{\alpha}_a^N) \tag{20}$$

meaning that the Nash equilibrium is at intersection of the reaction curves, (19) and (20).

5 Theoretical Analysis

5.1 Formula Apportionment Analysis

The Formula Apportionment method for defining the taxable base in each country makes the tax rate faced by the parent firm a weighted average of individual state tax rates. Weights are function of the countries apportionment weights ($\alpha_i's$), and of fraction of the firm's capital, and labor allocations, and sales used or consumed in each country.

We assume that sales are not under the control of the parent firm, or either of the subsidiaries, but sales get determined according to the demand for consumption in both countries. This is an important assumption, our approach treat sales and output as different objects motivated by the empirical observation that corporations operating in different countries distribute their production operations and sales differently across such countries. This implies that firm's output and firm's sales are different objects and can have different distributions across the countries the firm operates[16].

We repeat eq(7) here,

[16]Notice that total sales must add up to total output across countries, $s_{at} + s_{bt} = y_{at} + y_{bt}$ $\forall$t. However, there is no presumption that sales in each country must coincide with output in that country. For a different analysis in which sales and output are the same object see Eichner and Runkel (2011)

$$\begin{aligned}\bar{\tau}_t &= \tau_a\left(\alpha_a^K\frac{k_{at}}{k_{at}+k_{bt}}+\alpha_a^L\frac{n_{at}}{n_{at}+n_{bt}}+\alpha_a^S\frac{s_{at}}{s_{at}+s_{bt}}\right)\\ &\quad+\tau_b\left(\alpha_b^K\frac{k_{bt}}{k_{at}+k_{bt}}+\alpha_b^L\frac{n_{bt}}{n_{at}+n_{bt}}+\alpha_b^S\frac{s_{bt}}{s_{at}+s_{bt}}\right)\end{aligned}$$

The formula apportionment structure has an impact on the firm's average tax rate as long as the firm operate in countries that levy different corporate income tax rates $\tau_a \neq \tau_b$. If a firm has only subsidiaries in countries with the same tax rate, then formula apportionment is irrelevant as the average tax rate for a firm will be exactly the same as the countries' tax rate on capital, $\bar{\tau} = \tau_a = \tau_b$. This can be easily seen in the equation above as weights across countries add up to one.

The interesting case for analysis is when corporate income tax rates differ across countries. In this case, a parent firm has incentives to reallocate production input in order to modify the weights on its favor. Equations (22) and (21) show how the choice of capital and labor allocations in the firm's problem (5) affects the average tax rate the firm faces,

$$\frac{\partial\bar{\tau}_t}{\partial n_{it}} = \frac{n_{jt}(\tau_i\alpha_i^L-\tau_j\alpha_j^L)}{(n_{at}+n_{bt})^2}-F_{nt}^i\frac{\sum\tau_{it}\alpha_{it}^S s_{it}}{(y_{at}+y_{bt})^2} \qquad i=a,b \tag{21}$$

$$\frac{\partial\bar{\tau}_{t+1}}{\partial k_{it+1}} = \frac{k_{jt+1}(\tau_i\alpha_i^K-\tau_j\alpha_j^K)}{(k_{at+1}+k_{bt+1})^2}-F_{kt+1}^i\frac{\sum\tau_{it+1}\alpha_{it+1}^S s_{it+1}}{(y_{at+1}+y_{bt+1})^2} \qquad i=a,b \tag{22}$$

For expositional purposes suppose, $\forall t: \ \tau_a > \tau_b$, $\alpha_a^L > \alpha_b^L$, and $\alpha_a^K > \alpha_b^K$. Then, the effective tax burden of country a is greater than country b, $\tau_b\alpha_b^K < \tau_a\alpha_a^K$, and $\frac{\partial\bar{\tau}_{t+1}}{\partial k_{bt+1}} < 0 < \frac{\partial\bar{\tau}_{t+1}}{\partial k_{at+1}}$ which implies that allocating one unit of capital to the subsidiary in country b will reduce the average tax rate the firm faces. From the production efficiency condition, eq (29), we see that the return of investing in country b would be higher than investing in country a. Hence, the parent firm will invest more on country b in order to reduce its average tax rate $\bar{\tau}$, which will increase its production activity in country b. A similar interpretation holds with respect to labor.

5.2 Efficiency of setting production inputs weights to zero

As documented in Section 3 we see that in practice most states in the US have move towards setting weights on capital and labor equal or close to zero. We argue that this behavior can be explained by strategic competition between states that compete to attract capital investments from multi-state corporations. Although the idea that competition among states will direct state's choice of apportionment factors towards lower weights on capital has some support by researchers in the field, see B. and Sansing

(2000); Eggert and Schjelderup (2003), there is no consensus on the whether this is an efficient outcome or not. Furthermore, the leading theoretical work in this field see this outcome as an inefficient result of tax competition, see Gordon and Wilson (1986); Eggert and Schjelderup (2003); Runkel and Schjelderup (2011) to name a few.

We argue that setting production inputs weights to zero in the formula apportionment is an efficient outcome from the perspective of the primal approach to taxation, also known as the Ramsey approach. To see why, consider the case in which $\alpha_i^K = \alpha_i^L = 0$ for both $i = a, b$, in this case the formula apportionment structure depends only on firm's distribution of sales across countries as $\alpha_i^S = 1$ for both $i = a, b$. Then, eq(7) becomes:

$$\bar{\tau}_t = \tau_a \left(\frac{s_{at}}{s_{at} + s_{bt}} \right) + \tau_b \left(\frac{s_{bt}}{s_{at} + s_{bt}} \right) \tag{23}$$

which is independent of firm's allocation of inputs but still induces time dependence on the average corporate income tax rate faced by the firm according to the demand of the composite good in each country. In this case the derivatives with respect to $\bar{\tau}_t$ in the firm's F.O.C. will disappear obtaining,

$$F_{nt}^i = w_{it} + \frac{\Pi_t}{1 - \bar{\tau}_t} \frac{\partial \bar{\tau}_t}{\partial n_{it}} \qquad i = a, b \tag{24}$$

$$\frac{Q_t}{Q_{t+1}} = 1 + (1 - \bar{\tau}_{t+1})(F_{kt+1}^i - \delta) - \Pi_{t+1} \frac{\partial \bar{\tau}_{t+1}}{\partial k_{it+1}} \; i = a, b \tag{25}$$

$$F_{kt+1}^a = F_{kt+1}^b \tag{26}$$

which means that there are no distortions to the intra-temporal conditions, and the only distortion in the inter-temporal conditions is the wedge introduced by the average tax rate. Consequently, there are no distortions in the production efficiency condition across countries, eq (26). Thus, the parent firm allocates capital and labor between subsidiaries according to their marginal returns, and there are no additional wedges derived from the effect of the allocation choice in the average tax rates.

Notice that this result pertains completely to the efficient allocation of inputs across countries and does not imply that the average tax rate faced by the firm will change in any particular direction. The distortion imposed by the average tax rate depends exclusively on the distribution of sales across both countries. Hence, our result does not imply neither higher nor lower tax revenue collection by the tax authority. Our result is in contrast with current results in the literature of taxation under Formula Apportionment. This is because the primal approach to taxation that we follow does not focus on revenue maximization, but on avoiding distortions to production margins. It assumes the tax authority has access to a rich set of tax instruments, as it is in practice, instead of relying only on a restricted set of instruments to raise revenue.

6 Conclusion

In this paper we have documentd that the average corporate income tax rate has declined by approximately 40% from 1980 to 2016. During the same period, we observe that states have gradually shifted towards imposing a sales-only apportionment weight on multi-state firms. We ask whether these patterns are consistent with states' competing in setting corporate tax policy. Empirically, we find evidence of strategic interaction in setting tax policies between neighboring states. Theoretically, we have shown that moving towards a sales-only apportionment scheme, adopted by most states, is consistent with the prediction of a dynamic general equilibrium model of tax competition that incorporates the Formula Apportionment rule.

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Part I

Appendix: Benchmark Planner's Problem

If lump sum taxes and transfers across countries are available to a planner[17], the problem it solves is the following:

$$\max_{\{c_{it},k_{it+1},n_{it}\}} \quad \theta_a U^a + \theta_b U^b$$

subject to the aggregate resource constraint (3) and the law of motion of capital (**??**). The F.O.C. are

$$\begin{aligned} c_{it}: \quad \theta_i \beta^t u^i_{ct} &= \lambda_t \qquad \forall i = a, b \\ n_{it}: \quad -\theta_i \beta^t u^i_{nt} &= \lambda_t F^i_{nt} \qquad \forall i = a, b \\ \lambda_{t+1}[F^i_{kt+1} + 1 - \delta] &= \lambda_t \qquad \forall i = a, b \end{aligned}$$

re-ordering we obtain the intratemporal condition:

$$-\frac{u^i_{ct}}{u^i_{nt}} = \frac{1}{F^i_{nt}} \qquad \forall i = a, b \tag{27}$$

the inter-temporal condition

$$\frac{u^i_{ct}}{\beta u^i_{ct+1}} = F^i_{kt+1} + 1 - \delta \qquad i = a, b \tag{28}$$

and the production efficiency condition

$$F^a_{kt+1} = F^b_{kt+1} \tag{29}$$

Every allocation $\{c_{it}, n_{it}, k_{it+1}\}_{i=a,b}$that satisfies equations (3), (4), (27), (28), and (29) is on the Pareto efficient frontier of this economy. Notice that when a planner is unconstrained on the set of instrument it can choose, then there are not intra-temporal wedges and there are not inter-temporal wedges. This allocation can also be achieved in a decentralized economy where governments can use lump-sum taxes and transfers across countries.

The following section analyses the case in which a government cannot use lump-sum taxes

[17] This is the case in which the planner is unconstrained in the set of tax instruments it can use.

and must raise revenue using distorting taxes on consumption and labor. This setting is also isomorphic to using distorting taxes on consumption and capital, or distorting taxes on labor and capital. The main point of this section is that the most efficient tax system in an environment in which government must use distorting taxes, is one in which there are production efficiency wedges. It is preferable to distort the intra-temporal condition in order to keep the inter-temporal condition undistorted.

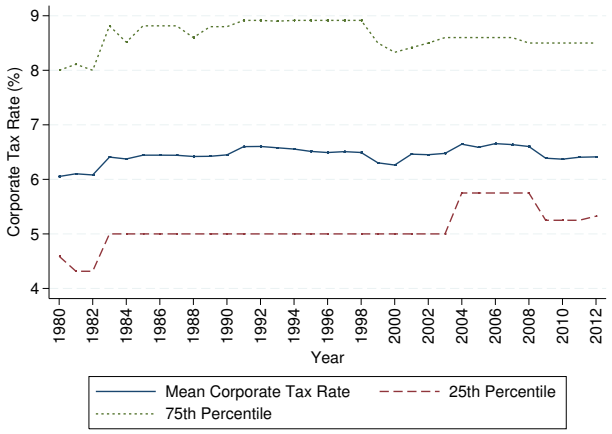
The above result is key for as our analysis of choice of apportionment factor driven by competition among states points towards a reduction of the wedges in the intertemporal condition, and the production efficiency condition, which brings the economy closer to more efficient tax system in general.

Part II

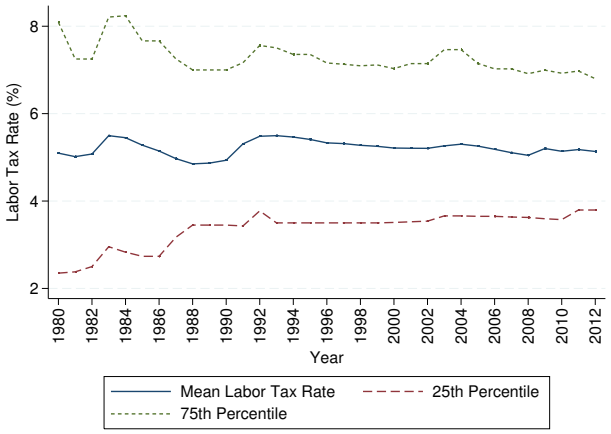
Figures and Tables

Figure 5: Tax Rates Across U.S. States

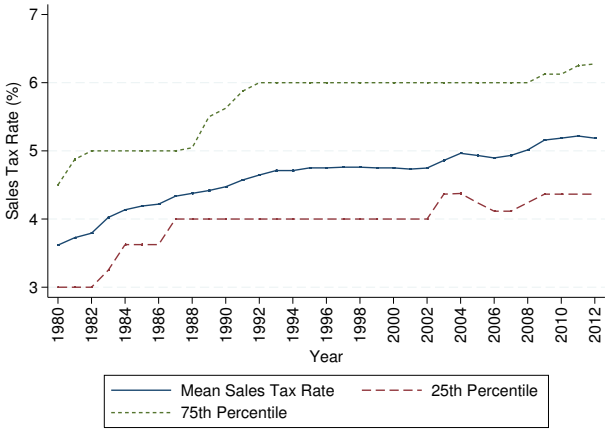
(a) Corporate Tax Rate



(b) Labor Tax Rate



(c) Sales Tax Rate



Note: These figures present the evolution over time of the state corporate, labor and sales tax rates as well as the 25th and 75th percentiles. We excluded District of Columbia, Hawaii and Alaska in the computation.
Source: The University of Michigan Tax Database. The Tax Foundation. National Bureau of Economic Research (TAXSIM).

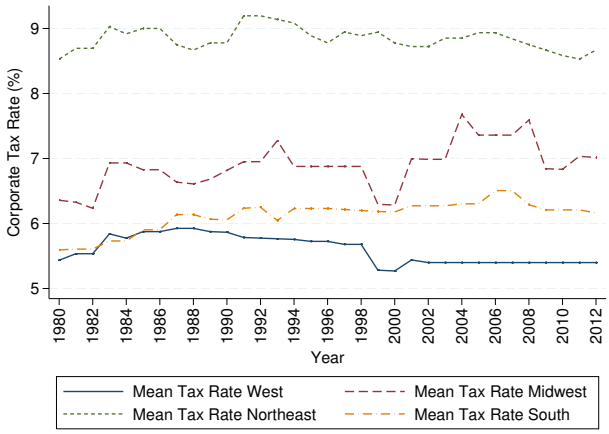
Table 1: Tax Rates

Year	Corporate Tax			Labor Tax			Sales Tax		
	W. Mean	Mean	S.D.	W. Mean	Mean	S.D.	W. Mean	Mean	S.D.
1980	6.51	6.05	2.95	5.21	5.10	3.83	4.07	3.62	1.47
1990	6.67	6.45	2.90	5.06	4.93	2.90	4.93	4.47	1.69
2000	6.28	6.26	2.90	5.23	5.21	2.88	5.22	4.75	1.72
2010	6.28	6.37	2.87	5.42	5.14	2.87	5.83	5.19	1.89

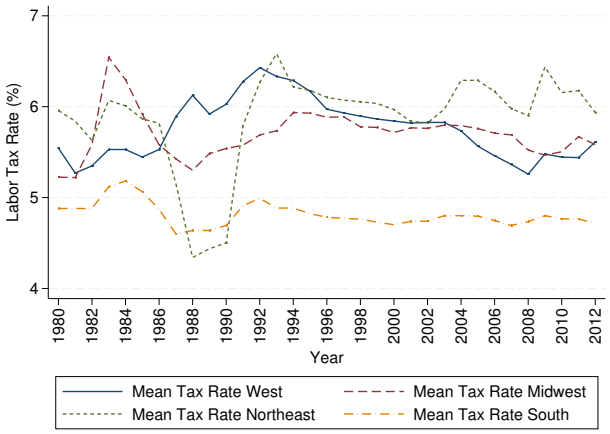
Note: The table report weighted mean, mean and standard deviation of the different state tax rates, analyzed by decade and using as weights the states GDP . We excluded District of Columbia, Hawaii and Alaska in the computation.
Source: The University of Michigan Tax Database. The Tax Foundation. National Bureau of Economic Research (TAXSIM).

Figure 6: Tax Rates by Region

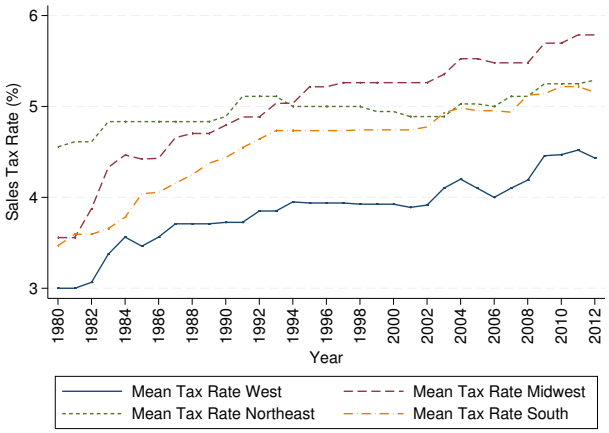
(a) Corporate Tax Rate



(b) Labor Tax Rate



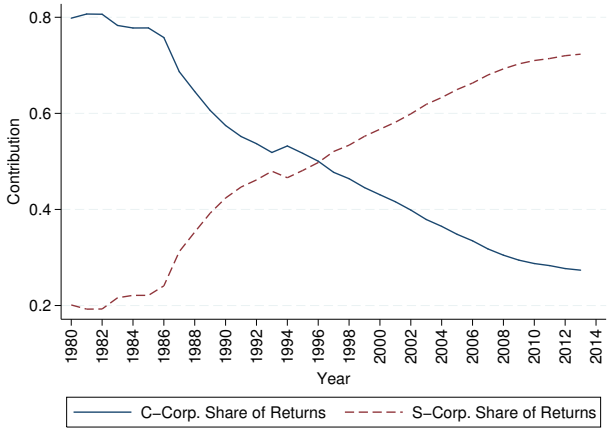
(c) Sales Tax Rate



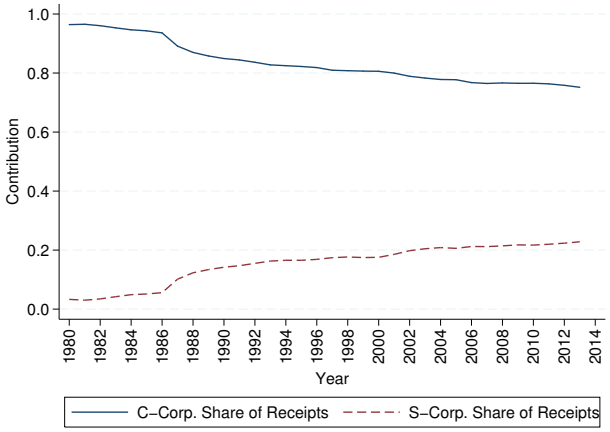
Note: These figures present the evolution over time of the state corporate, labor and sales tax rates by region. We excluded District of Columbia, Hawaii, Alaska because these are not-continental states. Washington, Wyoming, Nevada and South Dakota in the computation because they do not have a corporate income tax rate.
Source: The University of Michigan Tax Database. The Tax Foundation. National Bureau of Economic Research (TAXSIM).

Figure 7: Comparison of C-Corporations and S-Corporations

(a) Filed Corporate Tax Returns



(b) Tax Receipts



Note: Tax returns refer to the number of filed forms IRS received from each type of corporation and tax receipts refer to the amount of income IRS received from each type of corporation.
Source: Statistics of Income (SOI)–IRS.

Table 2: Apportionment Weights Structure Across States

Apportionment Structure	1980	1985	1990	1995	2000	2005	2010	2015
33.33	38	36	30	18	13	13	10	7
50	4	6	10	22	23	22	16	13
(50,100)	0	0	2	1	4	5	5	1
100	6	6	6	7	8	8	17	23
Number of States	48	48	48	48	48	48	48	44

(a) Sales Apportionment Weights Structure

Apportionment Structure	1980	1985	1990	1995	2000	2005	2010	2015
0	6	6	6	7	8	8	17	23
(0, 25)	0	0	2	1	4	5	5	1
25	4	6	10	22	23	22	16	13
33.33	38	36	30	18	13	13	10	7
Number of States	48	48	48	48	48	48	48	44

(b) Payroll Apportionment Weights Structure

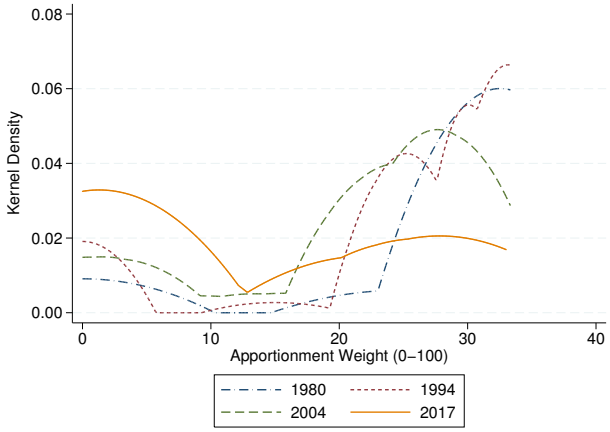
Apportionment Structure	1980	1985	1990	1995	2000	2005	2010	2015
0	6	6	6	7	8	8	17	23
(0, 25)	0	0	2	1	4	5	5	1
25	4	6	10	22	23	22	16	13
33.33	38	36	30	18	13	13	10	7
Number of States	48	48	48	48	48	48	48	44

(c) Capital Apportionment Weights Structure

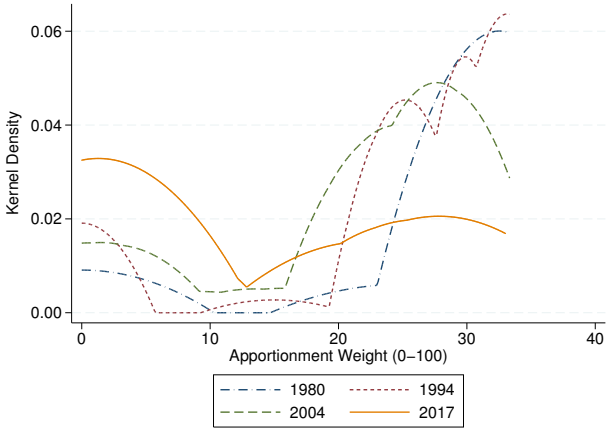
Note: The table report the number of states that used property, payroll and sales apportionment factors, analyzed by five year spams . We excluded District of Columbia, Hawaii and Alaska in the computation.
Source: Commerce Clearing House's State Tax Handbooks.

Figure 8: Apportionment Weights Across U.S. States

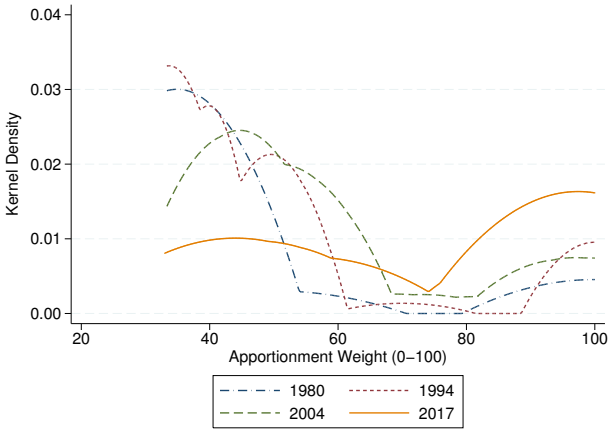
(a) Capital Apportionment Weight



(b) Labor Apportionment Weight



(c) Sales Apportionment Weight



Note: These figures present the evolution over time of the state sales, capital and payroll apportionment weights as well as the 25th and 75th percentiles. We excluded District of Columbia, Hawaii and Alaska in the computation.
Source: Commerce Clearing House's State Tax Handbooks.

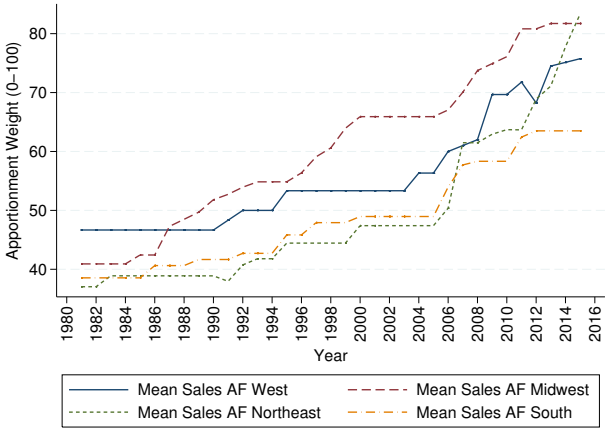
Table 3: Apportionment Weights

Year	Property Apportionment Factor			Payroll Apportionment Factor			Sales Apportionment Factor		
	W. Mean	Mean	S.D.	W. Mean	Mean	S.D.	W. Mean	Mean	S.D.
1980	27.91	28.47	11.12	27.91	28.47	11.12	44.17	43.06	22.23
1990	26.43	26.63	11.24	26.43	26.63	11.24	47.19	46.94	22.78
2000	20.15	22.20	11.42	20.15	22.20	11.42	59.70	55.59	22.85
2010	13.67	16.15	13.86	13.67	16.25	13.86	72.66	67.51	27.73

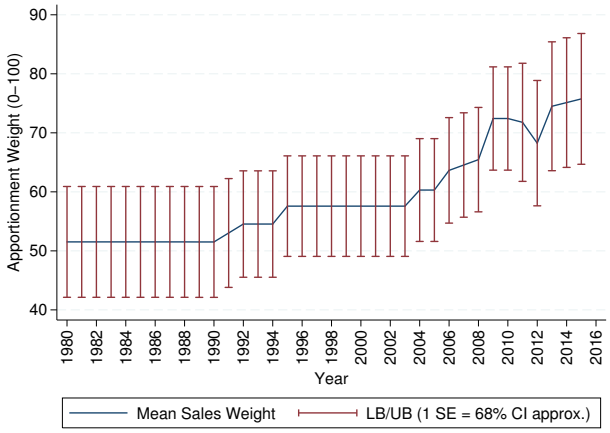
Note: The table report weighted mean, mean and standard deviation of the states property, payroll and sales apportionment factors, analyzed by decade and using as weights the states GDP . We excluded District of Columbia, Hawaii and Alaska in the computation.
Source: Commerce Clearing House's State Tax Handbooks.

Figure 9: Sales Apportionment Weight by Region

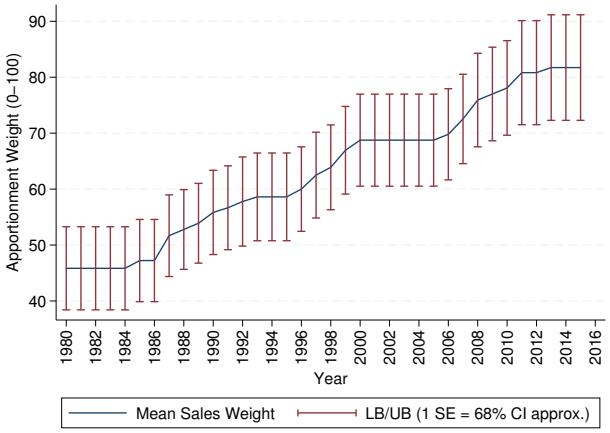
(a) Sales Apportionment



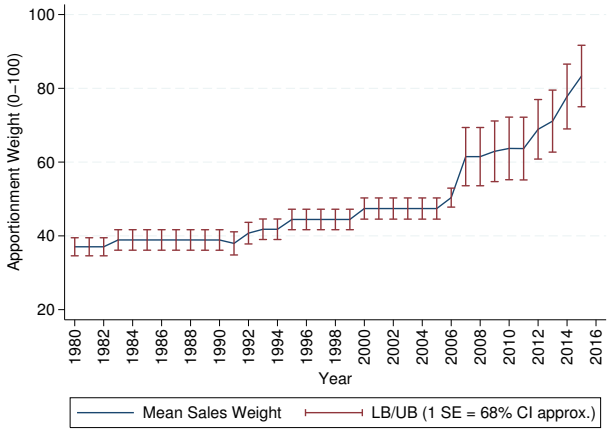
(b) West



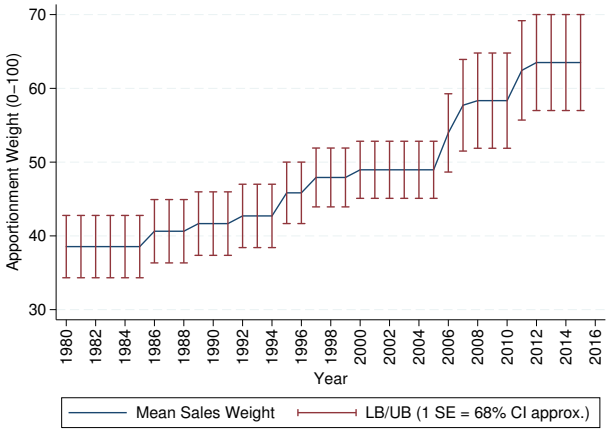
(c) Midwest



(d) Northeast



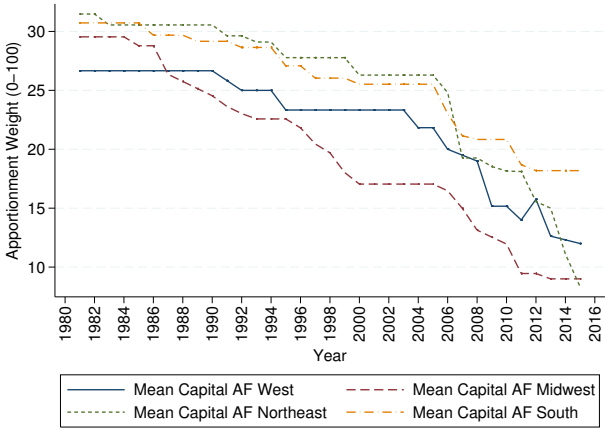
(e) South



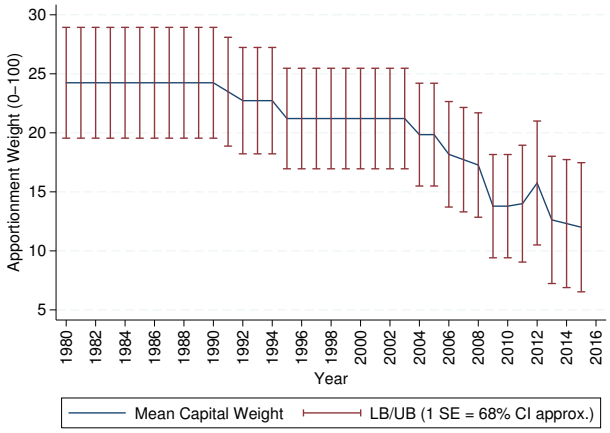
Note: These figures present the evolution over time of the state sales apportionment factor by region. We excluded District of Columbia, Hawaii, Alaska, Nevada and South Dakota in the computation to make the regions more regionally homogeneous.
Source: Commerce Clearing House's State Tax Handbooks.

Figure 10: Capital Apportionment Weight by Region

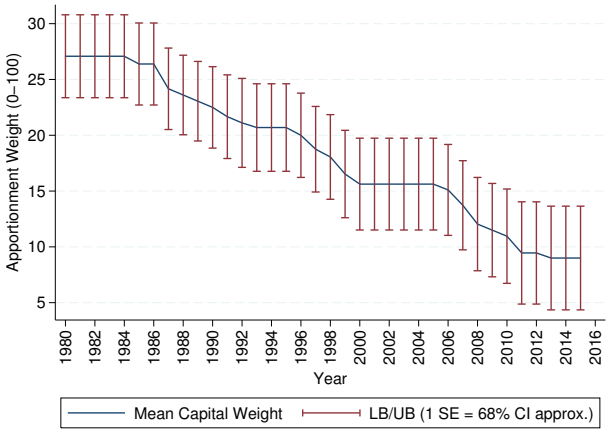
(a) Capital Apportionment



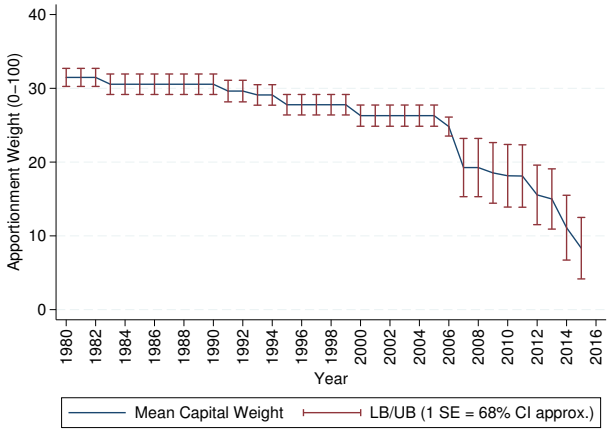
(b) West



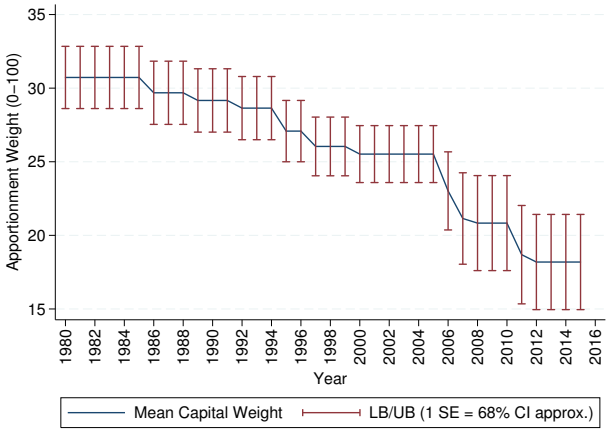
(c) Midwest



(d) Northeast



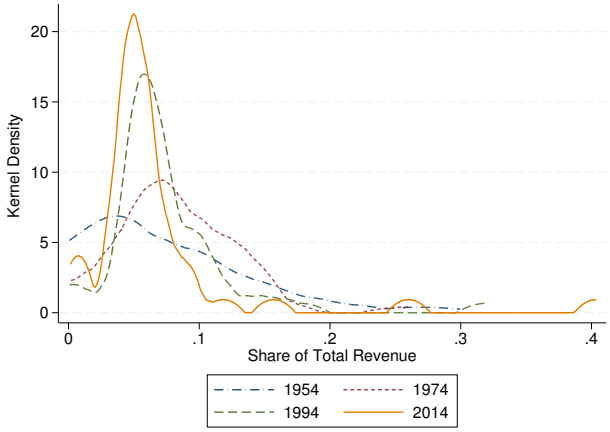
(e) South



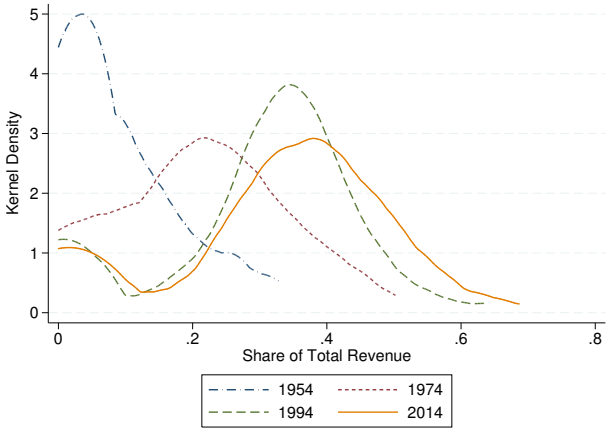
Note: These figures present the evolution over time of the state capital apportionment factor by region. We excluded District of Columbia, Hawaii, Alaska, Nevada and South Dakota in the computation to make the regions more regionally homogeneous.
Source: Commerce Clearing House's State Tax Handbooks.

Figure 11: Share of Total Revenue

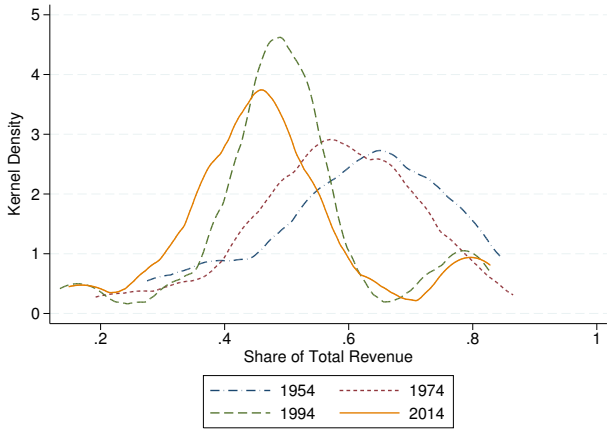
(a) Corporate Tax Share of Total Revenue



(b) Labor Tax Share of Total Revenue



(c) Sales Tax Share of Total Revenue



Note: These are kernel density functions for the state share of total state tax revenue by the main components: corporate, labor and sales tax revenues, analyzed by two decades time spams. We excluded District of Columbia, Hawaii and Alaska in the computation.
Source: Annual Survey of State Government Tax Collections (STC)–U.S. Census Bureau.

Table 4: Tax Revenue Share

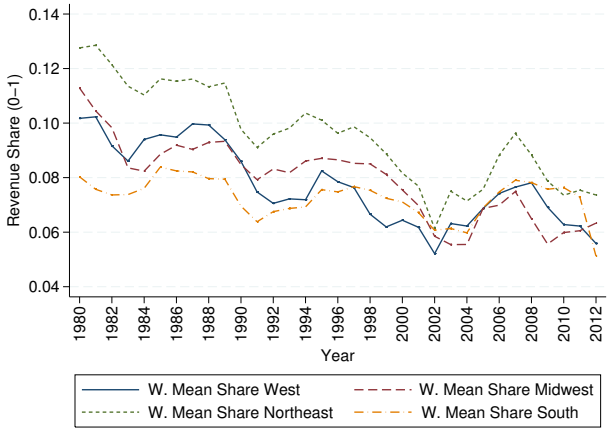
Year	Corporate Tax (%)			Labor Tax (%)			Sales Tax (%)		
	W. Mean	Mean	S.D.	W. Mean	Mean	S.D.	W. Mean	Mean	S.D.
1982	9.35	8.27	4.78	27.17	25.26	16.11	49.95	50.67	15.69
1992	7.79	6.96	4.84	31.09	29.64	15.75	50.57	50.48	15.30
2002	5.80	5.58	5.50	34.00	31.72	16.91	49.90	49.69	15.37
2012	5.91	6.40	5.41	34.03	31.62	17.15	49.93	48.25	15.50

Year	Property Tax (%)			Other Tax (%)		
	W. Mean	Mean	S.D.	W. Mean	Mean	S.D.
1982	1.76	1.76	2.99	11.76	14.04	11.93
1992	2.07	2.02	3.98	8.48	10.91	7.38
2002	1.65	2.92	5.96	8.64	10.09	6.04
2012	1.48	2.95	6.16	8.65	10.78	9.16

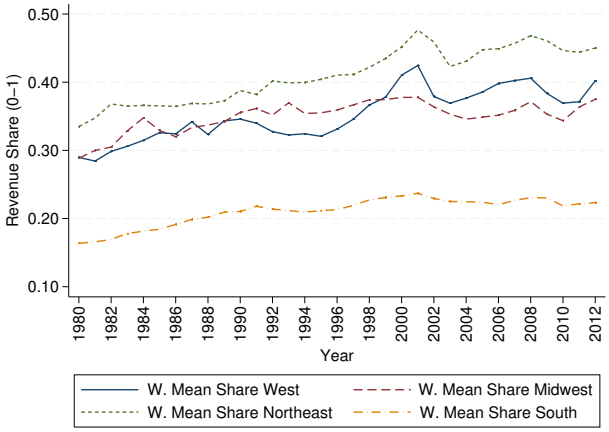
Note: The table report weighted mean, mean and standard deviation of the state share of total state tax revenue (expressed in percentages) by its components, analyzed by decade and using as weights the states GDP. We excluded District of Columbia, Hawaii and Alaska in the computation.
Source: Annual Survey of State Government Tax Collections (STC)–U.S. Census Bureau.

Figure 12: Weighted Tax Revenue Share by Region

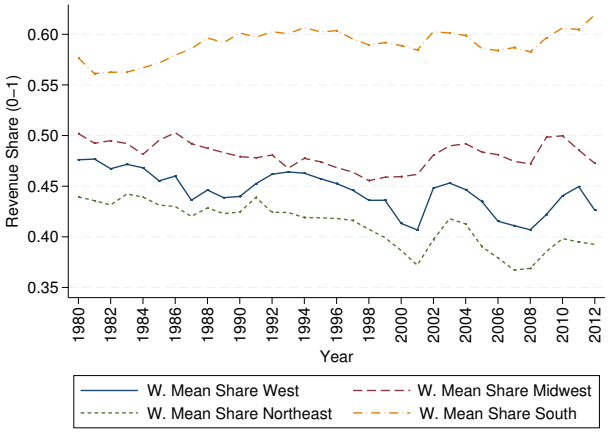
(a) Corporate Tax Revenue Share



(b) Labor Tax Revenue Share



(c) Sales Tax Revenue Share



Note: These figures present the evolution over time of the share of total state tax revenue of each tax component by region. We excluded District of Columbia, Hawaii, Alaska, Nevada and South Dakota in the computation to make the regions more regionally homogeneous. We have used GDP as weights.
Source: Annual Survey of State Government Tax Collections (STC)–U.S. Census Bureau.