Factor Apportionment and Price Distortions

Nathan Lazarus and Ian Sapollnik

September 9, 2023

Abstract

We study the extent to which firms adjust prices and wages in response to incentives created by corporate tax apportionment formulas. When jurisdictions use formulary apportionment and have heterogeneous tax rates, this creates an incentive for firms to distort the prices of the factors used in the apportionment formulas. In the case of sales factor apportionment, this entails charging higher prices and selling lower quantities in high tax jurisdictions, increasing the share of sales revenue in low tax jurisdictions. A similar incentive exists for wages in the case of payroll factors in apportionment formulas if labour supply to the firm is not perfectly inelastic. We propose empirical designs to estimate how fully firms respond to this incentive. Then we outline a structural model that we will use to study optimal apportionment formulas and compare the welfare implications of shifting international corporate taxes from a system of separate accounting to formulary apportionment.

1 Background

When firms produce and operate in multiple jurisdictions, governments must determine how to tax overall profits while avoiding double taxation. A fundamental problem in doing so is that while revenue can easily be observed at a regional level in a firm's books, profits generally can not. Under the current international corporate tax regime of separate accounting in which firms report value added by location, firms have been able to avoid massive tax liabilities by offshoring profits to "tax havens", countries with no corporate tax rate. Recently, there has been increased focus on this issue in the context of international taxation, with the OECD developing an Inclusive Framework on Base Erosion Profit Shifting (BEPS), focused around two pillars. The first is a shift away from separate accounting and towards sales factor apportionment, in which the share of sales occurring in a jurisdiction determine the share of world profits the firm is liable to pay.

In the United States, state corporate taxes have been assessed using apportionment formulae for some time. Most states utilized factor apportionment formulas that rely on the location of payroll, property and sales to determine a multi-state firm's liabilities in their state, though in recent years there has been a large shift to only apportioning based on the sales factor. As of 2022, 32 states rely solely on sales in apportioning corporate income tax liabilities. A further 9 states place more than a 50% weight on sales in their apportionment formulas, while just 6 states continue to use three factor formulas.[1]

This note presents a simple fact about factor apportionment rules: when there is regional heterogeneity in tax rates and firms have monopoly power, it is optimal for firms to raise prices in high-tax regions. This will push prices above the monopolist's optimal price in the absence of apportionment. While these elevated prices lower demand and thus revenue in the high-tax region, this loss can be more than offset by the gains

[1] Four states have no corporate income taxation. The District of Columbia is counted as a state.

from paying fewer taxes on the inframarginal units that are still sold. Similarly, as has been previously documented, payroll factor apportionment rules have the tendency to reduce employment in higher tax regions. We further show that when firms have monopsony power, the margin of adjustment can be the wages paid to employees rather than employment. In particular, higher tax states see lower wages when taxes are apportioned via payroll factors.

2 Related Work

The most related paper to this project is Fajgelbaum, Morales, Suárez Serrato and Zidar (2019), who study the overall spatial misallocation induced by heterogeneity in state tax rates and rules. While not central to their results, these authors make a similar theoretical point, namely that monopolistic firms will distort prices to be higher in higher-tax jurisdictions. Beyond this, there is a large literature examining the structural impacts of apportionment rules in the United States on a wide range of economic outcomes. Gordon and Wilson (1986) were the first to examine the incentive structures created by three factor apportionment, arguing that many perverse incentives induced by apportionment can be eliminated with separate accounting. They focus primarily on payroll and property; they mention in passing a similar price effect, but focus their discussion of sales factor apportionment on "cross-hauling".[2] McLure (1981) suggests that the corporate tax is essentially a tax on the underlying factors used in apportionment formulas. He further makes the point that the incidence of such taxes rests primarily on residents of the taxing state, a position which we somewhat contradict by pointing out that a change in tax rates or formulas in one state can alter wages and prices in another. Goolsbee and Maydew (2000) document that the inclusion of payroll in apportionment formulae lead to large changes in employment across states, but have a zero net effect on aggregate employment. Suárez Serrato and Zidar (2016) use variation in apportionment rules to identify the incidence of corporate tax cuts across firms, workers and landowners. Giroud and Rauh (2019) study how businesses reallocate activity with changes in tax rates, using similar variation in apportionment rules.

There is also a large theoretical literature focused on tax competition in formulary apportionment and separate accounting systems. Riedel and Runkel (2007) construct such a game where some countries choose separate accounting and others formulary apportionment. The biggest downside of separate accounting is the phenomenon of transfer pricing, in which firms manipulate input costs to gain tax advantages.[3] The challenge in this literature is to get interior solutions with separate accounting, where firms engage in some tax avoidance but do not report that 100% of their profits are earned in Bermuda. Riedel and Runkel, and other papers in this literature, use a convex cost of concealment of the true location of profits to generate interior solutions for evasion, which is what we propose to do as well in our structural model.

[2] Cross-hauling is an effect where, in a three factor system, a firm that is located in a high tax jurisdiction is more averse to selling in a high tax jurisdiction because taxes there have a larger effect on retained profits, $1-\tau$, because τ is larger. It seems like in practice this would be very small in magnitude.

[3] Separate accounting can also lead to some inefficient trade. Suppose a firm produces in a high cost, high price, high tax jurisdiction and a low cost, low price, low tax jurisdiction. Under separate accounting, it's optimal to sell the goods produced in the high tax jurisdiction in the low tax jurisdiction, so that the subsidiary in the high tax jurisdiction has low or no profits, while all the profits are earned by the subsidiary in the low tax jurisdiction. This can lead to wasteful trade in the presence of trade costs.

3 Basic Framework

A monopolistic firm operates in two locations, $i = 1, 2$. In each region, there is isoelastic demand for the good $D_i(p_i) = \kappa_i p_i^{-\varepsilon_i}$. The good is produced using the production technology $q = \ell_1^\alpha + \ell_2^\alpha$. That is, the good is produced only with labour from both regions with identical production technologies in all regions. The firm faces no transport costs between the two regions. By market clearing, $D_1(p_1) + D_2(p_2) = \ell_1^\alpha + \ell_2^\alpha$. The firm pays wage w_i per unit of labour, determined exogenously, so that total pre-tax profits are $\pi = p_1 q_1 + p_2 q_2 - w_1 \ell_1 - w_2 \ell_2$. The firm chooses prices and labour to maximize post-tax profits.

We first consider the case of separate accounting, which is how international corporate taxes are implemented. The firm's problem is then:

$$\max_{p_1, p_2} (1 - \tau_1)\pi_1 + (1 - \tau_2)\pi_2$$

Then we explore four possible apportionment rules, where the firm faces corporate tax rates $\tau_i(p_i, \ell_i, t_i) = s(p_i, \ell_i) \times t_i$ in each region i. The rate τ_i is applied to the firm's total profits in all regions. $s(p_i, \ell_i)$ determines the share of total profits apportioned to region i, and t_i is the local tax rate set by policymakers. The firm maximizes post-tax profits

$$\max_{p_1, p_2} (1 - \tau_1 - \tau_2)\pi$$

We consider a 100% sales factor apportionment rule, $\tau_i(p_i, \ell_i, t_i) = \frac{p_i q_i}{p_i q_i + p_{-i} q_{-i}} t_i$, which is the system that currently exists in most U.S. states. We also look at a 100% payroll factor apportionment rule, $\tau_i(p_i, \ell_i, t_i) = \frac{w_i \ell_i}{w_i \ell_i + w_{-i} \ell_{-i}} t_i$ with an exogenous wage and no monopsony power, and a 50/50 sales and payroll apportionment rule, $\tau_i(p_i, \ell_i, t_i) = \frac{1}{2}\left(\frac{p_i q_i}{p_i q_i + p_{-i} q_{-i}} + \frac{w_i \ell_i}{w_i \ell_i + w_{-i} \ell_{-i}}\right) t_i$. Finally, we also examine the full payroll apportionment rule in the presence of monopsony power. Each of the subsections below outlines a preliminary analysis of the firm's problem.

We present a simple case with two regions. Throughout, we set $t_2 = 0.2$, $\kappa_1 = \kappa_2 = 1$, $w_1 = w_2 = 1$ and $\varepsilon_1 = \varepsilon_2 = 6$. The objective is to examine what happens to relative prices, labour demand and quantities, when the tax in region 1 moves from zero to 0.4, while holding the tax in region 2, t_2, fixed at 0.2.

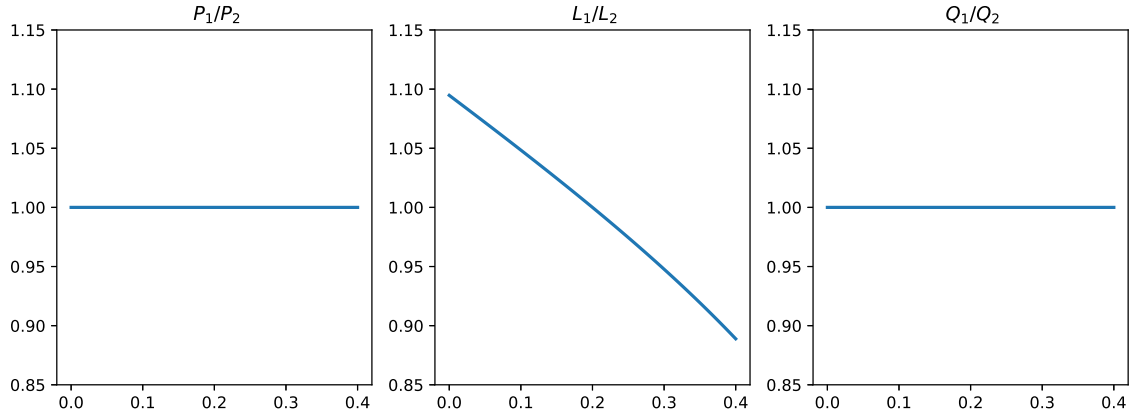
3.1 Separate Accounting

Under separate accounting, the firm is taxed on in profits derived from each region. The firm can choose whether to sell goods produced in region j in any region of its choice i; the cost of transporting a good produced in j to i, an iceberg trade cost, is assumed to be 0. The firm solves the problem

$$\max_{p_1, p_2, \ell_1, \ell_2, q_i^j} (1 - t_1)\left(p_1 q_1^1 + p_2 q_2^1 - \ell_1 w_1\right) + (1 - t_2)\left(p_1 q_1^2 + p_2 q_2^2 - \ell_2 w_2\right)$$

subject to $q_1^1 + q_2^1 = \ell_1^\alpha$, $q_1^2 + q_2^2 = \ell_2^\alpha$, $q_1^1 + q_1^2 = \kappa_1 p_1^{-\varepsilon_1}$, $q_2^1 + q_2^2 = \kappa_2 p_2^{-\varepsilon_2}$ and $q_i^j \geq 0$. Figure 1 shows that under separate accounting, firms keep a constant price and output as tax rates vary; however, they allocate more labour demand to the region with lower taxes.

Figure 1: Separate Accounting



3.2 Sales Factor Apportionment

The optimization condition of the firm can be re-expressed as

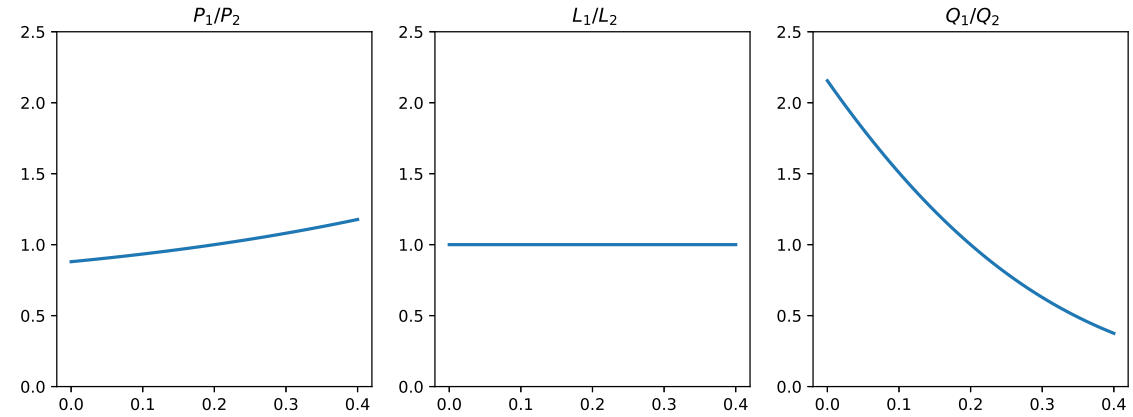
$$\max_{p_1,p_2,l_1,l_2} \left(1 - \frac{\kappa_1 p_1^{1-\varepsilon_1}}{\kappa_1 p_1^{1-\varepsilon_1} + \kappa_2 p_2^{1-\varepsilon_2}} t_1 - \frac{\kappa_2 p_2^{1-\varepsilon_2}}{\kappa_1 p_1^{1-\varepsilon_1} + \kappa_2 p_2^{1-\varepsilon_2}} t_2\right) \left(\kappa_1 p_1^{1-\varepsilon_1} - w_1 \ell_1 + \kappa_2 p_2^{1-\varepsilon_2} - w_2 \ell_2\right)$$

subject to

$$\kappa_1 p_1^{-\varepsilon_1} + \kappa_2 p_2^{-\varepsilon_2} = \ell_1^{\alpha} + \ell_2^{\alpha}$$

Figure 2 shows that as region 1 increases its tax rate, relative prices rise in region 1, with relative sales falling drastically.

Figure 2: Sales Factor Apportionment



3.3 Payroll Apportionment (fixed wage)

Under 100% payroll apportionment of corporate taxes, the optimization condition of the firm can be re-expressed as

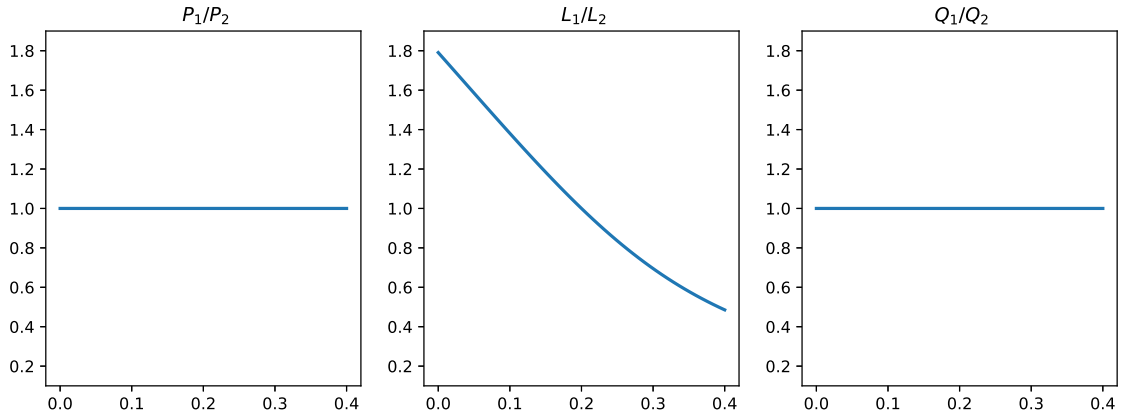
$$\max_{p_1,p_2,l_1,l_2} \left(1 - \frac{w_1\ell_1}{w_1\ell_1 + w_2\ell_2}t_1 - \frac{w_2\ell_2}{w_1\ell_1 + w_2\ell_2}t_2\right)\left(\kappa_1 p_1^{1-\varepsilon_1} - w_1\ell_1 + \kappa_2 p_2^{1-\varepsilon_2} - w_2\ell_2\right)$$

subject to

$$\kappa_1 p_1^{-\varepsilon_1} + \kappa_2 p_2^{-\varepsilon_2} = \ell_1^{\alpha} + \ell_2^{\alpha}$$

We solve numerically as above. As can be seen in 3, prices and quantities remain constant as under separate accounting, while labour is shifted to the low-tax region.

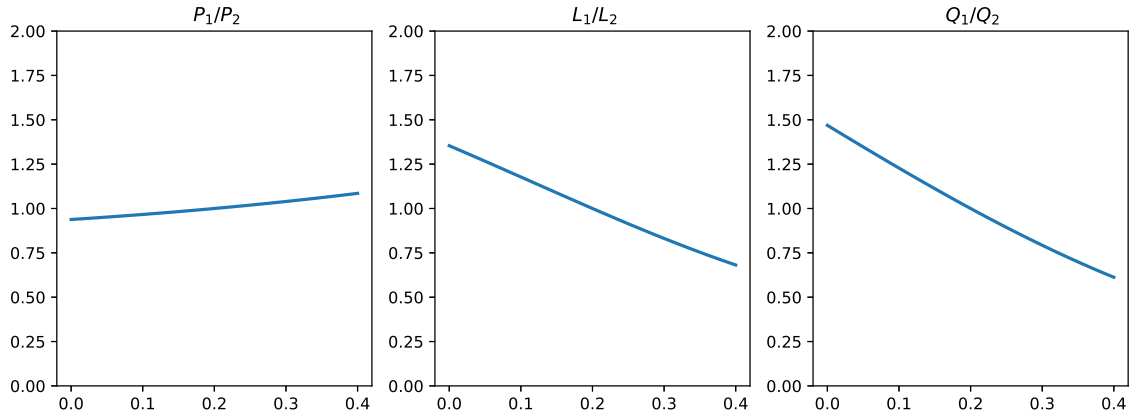
Figure 3: Payroll Apportionment



3.4 50/50 Sales and Payroll

Consider a two factor apportionment system with fixed wages. The firm solves the same problem as above, with $\tau_i\left(p_i, \ell_i, t_i\right) = \frac{1}{2}\left(\frac{p_i q_i}{p_i q_i + p_{-i} q_{-i}} + \frac{w_i \ell_i}{w_i \ell_i + w_{-i} \ell_{-i}}\right) t_i$. 4, prices and quantities remain constant as under separate accounting, while labour is shifted to the low-tax region.

Figure 4: 50/50 Payroll and Sales Apportionment



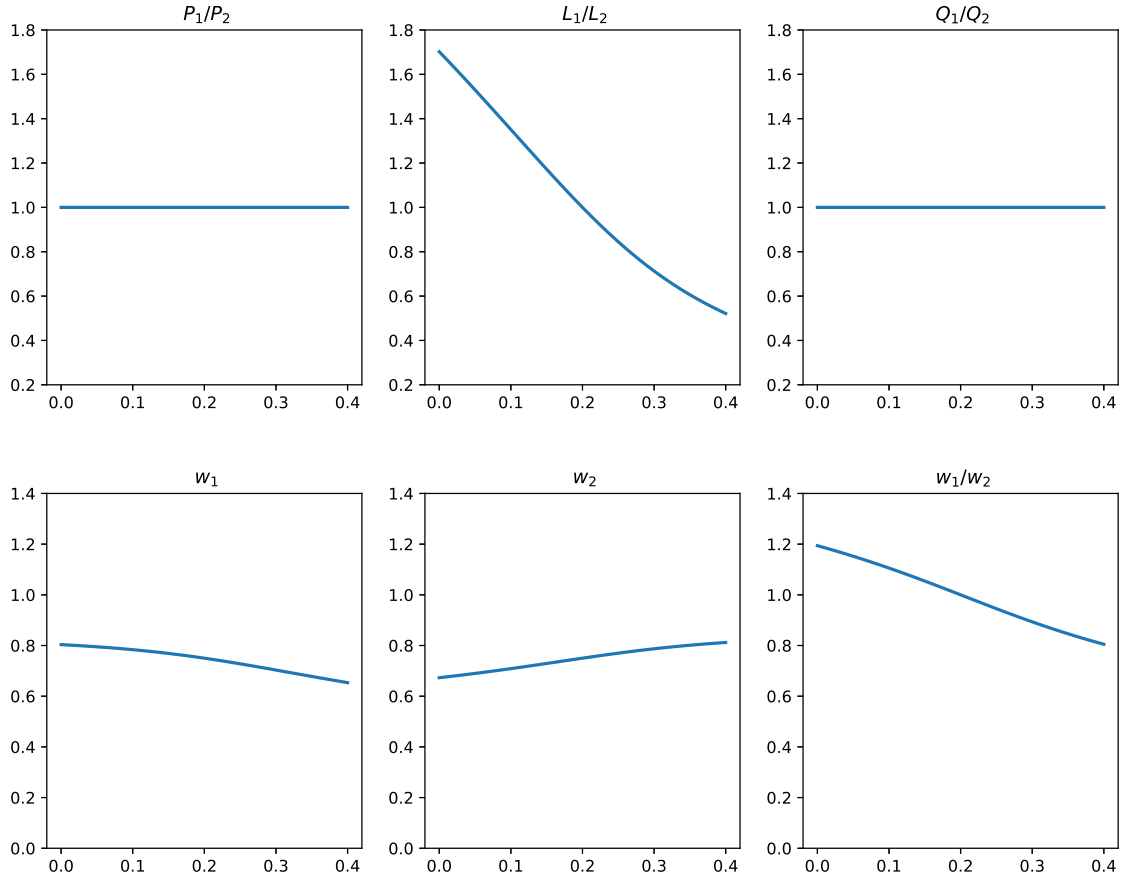
3.5 Payroll Apportionment (monoposony)

Suppose that instead of a fixed wage w_i in each region, the firm chooses the wage and faces a labour supply curve of the form $\ell_i(w_i) = cw_i^{\rho}$. It then solves the problem

$$\max_{p_1,p_2,w_1,w_2} \left(1 - \frac{w_1\ell_1}{w_1\ell_1 + w_2\ell_2}t_1 - \frac{w_2\ell_2}{w_1\ell_1 + w_2\ell_2}t_2\right)\left(\kappa_1 p_1^{1-\varepsilon_1} - w_1\ell_1 + \kappa_2 p_2^{1-\varepsilon_2} - w_2\ell_2\right)$$

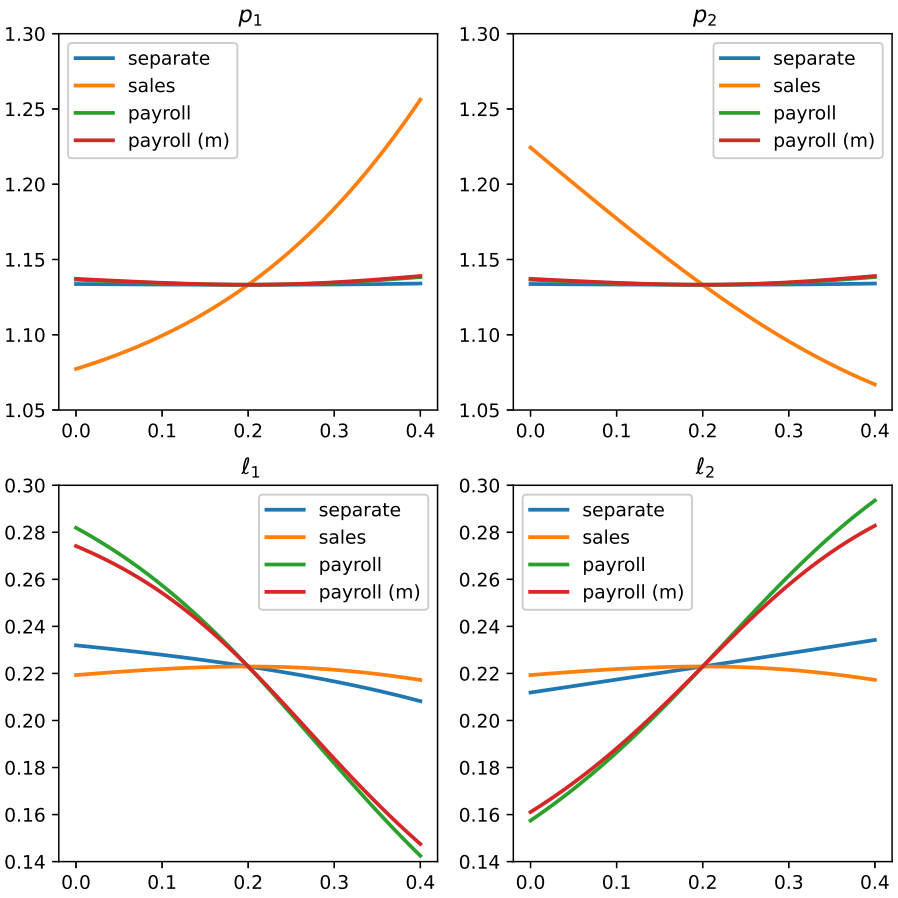
subject to $\kappa_1 p_1^{-\varepsilon_1} + \kappa_2 p_2^{-\varepsilon_2} = \ell_1^{\alpha} + \ell_2^{\alpha}$ and $\ell_i(w_i) = cw_i^{\rho} \iff \left(\frac{\ell_i}{c}\right)^{\frac{1}{\rho}} = w_i$. We set labour supply elasticity, $\rho = 3$, and calibrate c so that price levels are equal to those under separate accounting when $t_1 = t_2 = 0.2$. Similarly to when wages were fixed, relative prices and quantities are equal across regions, with labour decreasing as tax rates increase. However, we can also see that wages fall in region 1 and rise in region 2 as the tax rate is enlargened.

Figure 5: Payroll Apportionment under monopsony



Looking more broadly, Figure 6 shows the price and labour levels in each region under each tax system. We can see that sales factor apportionment induces large price distortions relative to the other systems. Employment levels similarly fall rapidly under payroll apportionment, regardless of monopsony power.

Figure 6: Comparison of systems



4 Empirical Approach

Our goal is to develop a more fully fledged model of this phenomenon and take the model to the data to determine whether firms vary prices and wages in response to the incentives we document from these apportionment rules. We will exploit variation in apportionment rules and tax rates as in Suárez Serrato and Zidar (2016) and Giroud and Rauh (2019). We require data on prices set by firms that operate in multiple states and have at least some amount of market power, and the ability to easily change their prices. In particular, it is essential that the firm does not use uniform pricing across the country (as Gentzkow and DellaVigna (2019) document for retail firms). Some preliminary idea for data sources are:

- gas stations
- fast food chain restaurants
- personal income tax preparation services

- supermarkets, using Nielsen scanner data (worried about uniform price setting)

For wages, we have looked at data from Burning Glass and Glassdoor; which are posted wages in job ads and worker reports of wages, respectively. But it is difficult to identify multi-state employers in this data, especially given franchising. The LEHD data uses state unemployment insurance accounts to identify firms, and so, while it is a multi-state panel, it is not possible to link firms across states. Social Security Administration data would be ideal. Focusing on price distortions from sales factor apportionment, the ideal dataset would be a panel of firms in a common industry, with each observation being a unique firm in a location in a given year. The panel would need to be complete, meaning that we require data from all locations in which a firm is operating. Data going as far back as 1980 would be ideal, as there was larger variation in US states' corporate tax rules in the 1980s.

4.1 Identification

We plan to do an event study around the change in apportionment rules to see if prices adjust. An important challenge is that the extent of price and wage adjustment that is optimal is determined by the elasticity of demand (or elasticity of labor supply, in the case of wages). If demand is perfectly elastic, there's no scope for price adjustment (the case of perfect competition), whereas if demand is very inelastic prices can move a lot to game the tax rules. We could take an elasticity of demand from the IO literature, but if that is an underestimate we might say that firms are not shifting prices by as much as is optimal, when in fact demand is just more elastic. So really we can test joint hypothesis about demand and the price adjustment response.

The naive event study specification is to focus on firms that operate within a state that changed its tax rate or apportionment formula, and to, for instance, examine whether prices in a state rise in response to tax rate increases. But there's another, potentially cleaner source of variation we can use: consider a firm that operates in Massachusetts and Vermont, and another firm that operates in Massachusetts and New Hampshire. If all states use sales factor apportionment, in response to a decrease in the tax rate in New Hampshire, the Massachusetts establishments of the firm that operates in New Hampshire should raise prices while the Massachusetts establishments of the firm that doesn't operate in New Hampshire should keep prices constant.

4.2 Sketch of Structural Estimation

We can also structurally estimate the model described above if we add in a parameter describing whether firms are naive or sophisticated about the incentives created by apportionment formulas. After a tax change, firms' perceived tax rates are $\hat{\tau}_{i,t+1}\left(p_{i,t+1}, \ell_{i,t+1}, t_{i,t+1}, p_{i,t}, \ell_{i,t}, t_{i,t}\right) = \left[\gamma s\left(p_{i,t+1}, \ell_{i,t+1}\right) + (1-\gamma)\, s\left(p_{i,t}, \ell_{i,t}\right)\right] \times t_i$, where if $\gamma = 1$, the firm is sophisticated about apportionment rules, but if $\gamma = 0$, the firm assumes that the apportionment factors will be held constant at their previous levels no matter its actions. Then, given a fixed elasticity of demand, we can simply choose the value for γ that minimizes the squared deviations between predicted and actual price changes. The issue with such an approach is that limited price adjustment is also a prediction of menu cost models; high menu costs would make it seem as though firms are naive, $\gamma = 0$. We hope to in the future write down a more full structural model that attempts to predict prices in levels instead of just predicting changes, has menu costs, and uses demand instruments instead of an exogenous elasticity.

4.3 Welfare Calculations and Optimal Apportionment Formulas

Then we want to take use estimate of pricing and wage responses to do welfare calculations, accounting for the distortions involved in various potential systems of international corporate taxation. To do these welfare calculations, we will also lean heavily on the existing estimates of corporate tax incidence from Suárez Serrato and Zidar, but augment them with the distortions we measure and outline. It seems like the reasons U.S. states use formulary apportionment while international corporate taxes use separate accounting is that it is harder to determine the location of costs and easier to manipulate transfer prices within U.S. states than internationally. So we will follow the literature in using a convex cost of transfer price manipulation to pin down the extent of evasion under separate accounting and also account for the inefficient trade occurring under separate accounting discussed in Section 2. But we are also interested in testing the widespread intuition that sales factor apportionment is more efficient and less distortionary than payroll apportionment, and considering whether payroll apportionment should play a role in international corporate taxation.