as given in Table 3, there exists a unique set of α and β that exactly replicates these ratios under any set of assumptions regarding elasticities and wage and rental rates.[9]

Table 4A reports these values for different assumptions regarding the elasticity of substitution between capital and non-farm land. To illustrate how the calibrated vales for α and β are generally related to underlying economic variables for the different states, Table 4B complements Table 4A by reporting some simple linear regressions that relate the calibrated values for α and β to various state characteristics. The structural parameter α is generally higher the greater the fraction of income within a state is derived from capital, and lower the greater the fraction of income is derived from labor. The factors influencing the structural parameter β are not as easily pinned down as the relationship with underlying variables seems to be more non-linear.

IV. Tax Reform in a "Typical" U.S. State

It is apparent from Tables 1 through 4 that U.S. states—their economies and their tax structures—vary substantially. For example, labor income as a fraction of total state income is as low as 0.66 in Florida and as high as 0.80 in Alaska; capital income as a fraction of total income ranges between 0.17 (Alaska, Georgia, Utah) and 0.28 (Florida), and land income as a fraction of total state income is estimated to range between 0.026 and 0.106. Similarly, per capita tax amounts paid for the different types of taxes vary widely, with per capita property tax payments varying between $251 (Alaska) and $1,472 (New Jersey), per capita sales taxes varying between $213 (Oregon) and $1,640 (Hawaii), per capita personal income taxes varying between $0 (Alaska, Florida, Nevada, Texas, Washington, Wyoming) and $1,109 (New York), and per capita corporate income tax payments varying between $0 (Nevada, Texas, Washington, Wyoming) and $308 (New York). These per capita tax payment differences translate into substantially different tax rates on capital, labor and land (see Table 3), and the differences in state economies are reflected in the very different values for α and β in Table 4A.

Nevertheless, we will devote this section to an analysis of a "typical" or "average" state, where an average state is simply defined as a state with the average (population weighted) characteristics of the fifty states.[10] This permits an in-depth analysis of various tax reform scenarios under different assumptions regarding some of the crucial parameters, and thus serves as both a useful empirical exercise while at the same time providing intuition for factors necessary to make such reforms a success.

[9] The world rate of return on capital is set to 0.06 throughout. The world wage rate is normalized to 1 throughout.

[10] In all state tables, the average state characteristics are given in the last line.

4.1. Reducing Taxes on Capital and Labor in the Typical State

We begin our analysis of the typical or average state by considering the impact of reducing taxes on capital or labor while raising the tax on land rents in a way that leaves overall state revenues constant. Since almost every real world tax is borne not just by one factor of production, this analysis is largely illustrative—i.e. it would be difficult for policy makers to actually design tax reforms that literally just cut taxes on a single factor while raising taxes on land rents. We therefore then proceed to considering tax reforms involving specific real world taxes—such as sales, personal and corporate income as well as property taxes. Reductions in these taxes entail implicit reductions in tax rates on labor and capital in ways linked to the incidence assumption discussed above. The results we focus on initially assume that the state is a small open economy with respect to capital (i.e. the elasticity of supply of capital is infinite). As argued above, it seems implausible that such an assumption would hold with respect to labor. We therefore begin our analysis with a state elasticity of supply of labor of 1—which seems conservative given that it falls within the range of empirical estimates of labor supply elasticities when mobility of labor is *not* considered. Finally, our initial simulations will take the elasticity of substitution of capital for land to be 0.75 and the elasticity of substitution of capital/land for labor as 0.5. As argued above, these estimates are toward the middle to conservative end of the range of empirical estimates in the literature.

Table 5 reports simulation results for various levels of these types of tax reforms in a typical state economy with these elasticities. Specifically, for reductions of taxes ranging from 20% to 100%, the table focuses on the percentage changes in the level of capital investment, state income and labor force use, as well as on the impact of the reforms on the average price of land in the state and the percentage change in the tax on land rents required to insure revenue neutrality. Since taxation of land rents is always economically efficient, and since—under plausible elasticity assumptions—taxation of other factors is always economically inefficient, such tax reforms must always yield increases in state capital, income, and labor use. The interesting aspect of these simulations on these three variables is therefore not so much the direction of the change (which is theoretically unambiguous) but rather the magnitude of the change. With regard to the change in average land prices and tax rates on land rents, on the other hand, theory by itself does not offer an unambiguous prediction regarding the sign of the change—thus making both the direction and the magnitude of interest.

The first sixth of the table focuses on the hypothetical reduction in taxes on capital, while the second sixth reports results for the hypothetical reduction in taxation of labor. From Table 3 it is quickly seen that state and local tax rates on labor are substantially lower than they are for capital, but at the same time, total state and local revenues from taxation of labor are substantially higher than total state and local revenues from capital taxation (Table 2). Reducing state and local taxes on labor by 20% therefore imposes a substantially larger drop in revenue than imposing a similar rate cut on taxes of capital—thus, all else being equal, requiring a much larger increase in taxes on land rents to compensate for this loss in revenues. Furthermore, the simulations assume a higher elasticity of supply for capital than for labor, as well as a greater implicit elasticity of substitution with land. Thus, the elasticity assumptions implicit in the analysis (and based

at least broadly on empirical realities) would suggest that a cut in capital taxation is less painful than a cut in labor taxation for state and local treasuries because of the relatively larger inflow of capital resulting from such lower taxes.

It is then not surprising to see in Table 5 that revenue neutral reforms that raise taxes on land rents and lower taxes on capital are more feasible than similar reforms that lower taxes on labor. A 20 percent reduction in taxes on capital, for instance, results in much larger increases in capital and labor use than does a 20 percent reduction in taxes on labor. In fact, this increase in economic activity for a cut in taxes on capital is so large that state and local revenues barely decline—which then necessitates a trivial 1.81% increase in the tax on land rents. A similar reduction of tax rates on labor, on the other hand, requires a nearly 43% increase in taxes on land rents. Furthermore, land owners—who presumably care about the price of land—actually benefit slightly from the 20% cut in taxes on capital despite the fact that their land rents are being taxed at higher rates, while their land loses nearly 21% in value under a similarly sized cut in taxes on labor income.

Looking closely on the $\% \Delta p$ column in Table 5 in fact provides a good gauge of the feasibility of different types of revenue neutral reforms. While there is no theoretical impediment to policies that decrease the average price of land by any amount—even by more than 100%, and while the gains from such reforms are always sufficient in principle to compensate land owners for their losses, there are clear political and equity arguments against reforms that impose undue burdens on one narrowly defined segment of the population. Revenue neutral policies that raise the price of land would therefore encounter very few obstacles as it becomes difficult to find anyone who loses from such policies.[11] Policies that result in relatively small decreases in land prices, while more controversial, could still be politically feasible. However, once the expected declines in average land prices become large, it is difficult to imagine such policies making it through a political process that tends to weigh concentrated benefits/losses more heavily than diffuse ones.

Using this standard, the difference between hypothetical cuts in taxes on capital and labor income become rather dramatic. Even the complete elimination of state and local taxation of capital results in a predicted decline in land values of only slightly greater magnitude than what is predicted from a mere 20% reduction in the taxation of labor income. Substantial reductions in taxation of capital income to be replaced by higher taxes on land rents therefore seem feasible, while similar reductions in taxes on labor income seem out of reach unless elasticity assumptions in reality are substantially more favorable than what is assumed in Table 5. We will return to this issue shortly but for now merely note that an elimination of state taxation of labor would in fact require such massive increases

[11] As demonstrated in Nechyba (1998), this statement is strictly true only if land is relatively homogeneous. If land is very heterogeneous, then it is possible for some land owners to experience declines in land value even as the average land owner experiences increases in the value of his land. This point is discussed in some more detail in Section 7.

in taxes on land rents as to drive land prices into negative territory under the current elasticity assumptions.

4.2. Reductions in Real World Taxes in the Typical State

Having explored the different issues raised by hypothetical reductions in taxes on capital and labor income, we now turn to an analysis of actual taxes used by state and local governments. In particular, the remainder of Table 5 reports results from revenue neutral tax reforms that lower either sales, personal income, corporate income or property taxes, where we note again that reductions in these taxes imply reductions in taxes on capital and labor through the incidence assumptions made earlier in the paper. Specifically, sales taxes are assumed to be borne proportionately by capital, labor and land as are personal income taxes, while corporate income taxes are assumed borne by capital and property taxes by capital and land. Furthermore, it should be emphasized that we are simulating reductions in *state and local* taxes, thus leaving federal taxes entirely in place even when state and local taxes are eliminated.

Looking first at the $\% \Delta p$ column, it seems that—at least in principle—most of the simulated tax reforms are feasible. The largest reduction in average land prices occur for reforms involving sales taxes, while the smallest such reductions occur for reductions in corporate income and in property taxes. Note how this arises straightforwardly from the lessons learned regarding hypothetical reductions in taxes on labor and capital in the previous section: given that reductions in taxes on capital result in more favorable outcomes than reductions in taxes on labor, we would expect real world tax reforms that disproportionately impact the implicit tax on capital to result in more favorable outcomes than those that impact the implicit taxes on labor. The incidence assumptions that we have made imply that reductions in sales as well as personal income taxes translate into reductions in the implicit tax on capital, labor and land, while reductions in corporate and property taxes translate primarily into reductions in the implicit tax on capital.[12]

Compare, for instance, the impact of reducing the property tax to the impact of reducing the sales tax. The per capita revenue raised from these taxes before any reform is of roughly similar magnitude ($749 for the property tax and $850 for the sales tax (Table 2)), which implies that—all else equal—a certain percentage cut in one tax would have roughly the same revenue implication as the same percentage reduction in the other. All else, however, is not equal because of the different incidence assumptions: a cut in the sales tax is a cut in the implicit tax on capital, labor and land, while a cut in the property tax is a cut in the implicit tax on capital and land. Since capital is assumed to be more responsive to tax changes (due to the elasticity assumptions), cuts in property taxes then

[12] This is entirely correct for corporate income taxes that are assumed to be taxes on capital, while it is essentially true in our context for property taxes despite the fact that these taxes are assumed to be borne by both capital and land. In particular, while it is true that a reduction in property taxes in the model is equivalent to a reduction in the tax on capital and land, our simulated reforms simultaneously raise the taxes on land rents to insure revenue neutrality – thus causing a decrease in the property tax to essentially be a decrease in the tax on capital income.

result in larger increases in economic activity and less of a need to raise the tax on land rents to insure revenue neutrality. A 20 percent cut in the sales tax, for instance, requires a nearly 24% increase in the tax on land rents, while a similar cut in property taxes requires virtually no change (0.2%) in the tax on land rents. Even a complete elimination of the state and local property tax calls for only a 23% increase in the tax on land rents, while an elimination of the sales tax would require a whopping 131% increase in the tax on land rents. With regard to comparing the political feasibility of the reforms, land owners are deeply and adversely impacted by reforms that focus on cutting the sales tax (losing up to two thirds of their wealth under a complete elimination of the sales tax), while they would barely feel the impact of most reforms focused on the property tax (with at most a 7% decline in their wealth under the complete elimination of the property tax and with an actual increase in their wealth for less dramatic property tax reforms.)

A similar comparison can be made for reductions in the personal and corporate income tax rates, although this comparison is clouded by the fact that revenues from the state and local personal income tax are roughly five times as high as revenues from the state and local corporate income tax ($489 as compared to $107 on a per capita bases (Table 2)). Our incidence assumptions imply that reductions in taxes on personal income translate into implicit reductions in the tax rates on capital, labor and land, while reductions in the corporate income tax translate directly into reductions in the tax rate on capital income. Given that state and local corporate income taxes represent an overall small portion of the tax on capital incurred in the state (with sales, personal income and property taxes representing the bulk of the tax on capital income), even the elimination of the corporate income tax in the typical state results in a relatively modest reduction of the overall state and local tax rate on capital income (less than 10%). In the previous section we found that even a 20% reduction in the tax on capital results in virtually no change in the tax on land rents to insure revenue neutrality, which makes it not too surprising that even the elimination of the corporate income tax does not require an increase in the tax on land rents. More modest reforms involving the corporate income tax in fact require a simultaneous *reduction* in the tax on land rents, accompanied by an *increase* in the average price of land. This is decidedly not the case for reforms involving the personal income tax. Because this tax yields roughly five times the revenue of the corporate income tax, a 20 percent reduction is—all else being equal—roughly equivalent to an elimination of the corporate income tax in terms of its revenue implications. Yet, because all else is not equal in that the different taxes impact capital and labor differently, this 20% reduction in personal income taxes requires a 14% increase in the tax on unimproved land rents accompanied by a 6.3% decline in land prices, while an elimination of the state and local corporate income tax requires no change in the tax on land rents and yields a slight (1.22%) increase in land prices.

4.3. Sensitivity of Results for the Typical State to Elasticity Assumptions

All of the results analyzed thus far are predicated on a specific set of elasticity assumption as indicated at the top of Table 5. So much of the story of tax reform, however, revolves around these assumptions, and while we have endeavored to start with assumptions we feel are conservative but still realistic, it is important to investigate how

results change as the assumptions change. We therefore devote this section to a thorough sensitivity analysis by reporting simulation results for similar tax reforms under a variety of different combinations of elasticity assumptions. The one elasticity we hold constant throughout is the elasticity of substitution between capital/land and labor which has been set at a very realistic and conservative level of 0.5 and which—when altered around a small neighborhood of that value—does not impact results profoundly. The remaining elasticities—the elasticity of substitution between capital and land as well as the supply elasticities for capital and labor—are the main focus of this section.

To begin with, we note that the exercise of investigating the sensitivity of results of elasticity assumptions is not as straightforward as may be apparent at first. In particular, it would not be valid to take the same production function values (α and β) as have been used for results reported in Table 5 and simply change the elasticity parameters. This is because a change in the elasticity parameters results in a different benchmark (pre-tax reform) equilibrium with different levels of capital, land and labor inputs that no longer correspond to those in the data. Thus, for each set of elasticity parameters, the entire model has to be re-calibrated to produce the values of α and β that accurately (in combination with elasticity parameters) yield the actual pre-reform ratios of capital to land and capital to labor ratios that all simulations are calibrated to replicate.

Table 6 reports the results from these re-calibrations. It provides the calibrated values for α and β for 24 different combinations of elasticity values. More precisely, the elasticity of substitution ($\boldsymbol{\sigma_{kl}}$) is varied between the very low value of 0.25 and the value of 0.75 used in Table 5, while the elasticity of supply for capital is varied between 0 and infinity and the elasticity of supply for labor is varied between 0 and the (unrealistically) high value of 5. The values used to arrive at estimates for the simulations discussed in the last two sections and reported in Table 5 are highlighted in bold. Tables 7A through 7F then report the impact of the elimination of different hypothetical and real world taxes on the five variables reported in Table 5 (the percentage change in capital, income, labor, the price of land and the required change in the tax on land rents) under each of these 24 sets of elasticity assumption. The set of elasticity assumptions corresponding to those underlying results in Table 5 are again highlighted in bold.

As before, we begin with the hypothetical elimination of implicit state and local taxes on capital and labor (Tables 7A and 7B). The most striking and most immediate aspect of these tables is the large variance in predictions as elasticities vary. This variance highlights the importance of using realistic elasticity values in simulating the predicted impact of state tax reforms involving a greater emphasis on taxation of land rents. At the same time, we do not want to convey the impression that all the elasticity values simulated in Tables 7A through 7F are anywhere close to realistic. Nevertheless, much can be learned from understanding how elasticities are the key to understanding tax reform involving taxation of land rents.

Take, for instance, Table 7A which simulates the impact of the elimination of implicit state and local taxes on capital. So long as the elasticity of supply of capital (ε_k) is zero, tax reforms focused on lowering taxes on capital income in favor of increased taxes on land rents have no impact whatsoever—both taxes are fully efficient, and the tax reform

simply involves lump sum transfers from land owners to capital owners.[13] A similar phenomenon is true in Table 7B where the impact of eliminating implicit state and local taxes on labor is simulated—so long as the elasticity of labor supply is set to zero which then simply involves lump sumtransfers from land owners to workers.[14] Tax rate increases on land rents required to eliminate either capital or labor taxes under zero elasticity assumptions are huge, as are accompanying declines in land prices.[15] However, with elasticity assumptions at the other extreme, we obtain the highly implausible result that taxes on labor or capital can be entirely eliminated while simultaneously overturning the tax on land rents into a subsidy on land rents. (For the elimination of capital taxation, land rent taxation could be reduced by over 500% under the most extreme elasticity assumptions—with an accompanying increase in land prices of almost 500%. An only slightly less extreme result arises for the elimination of labor taxation under these assumptions.) Since these extreme elasticity assumptions do not fall within the range of empirical estimates, and since it is safe to assume that any political system would recognize the potential for such windfall gains, it is safe to assume that these predictions are of little more than theoretical curiosity. Our focus should therefore clearly be on the sets of elasticity assumptions that fall in between these extremes.

The small open economy assumptions in regard to capital, for instance, may strike some as overly optimistic—at least in the short run. We would argue that a strong case in favor of the assumption can be made in the long run, but a lower elasticity seems appropriate for more short run analysis. By looking up from the bold sections of Tables 7A and 7B, we can get a sense of the likely short run impact of eliminating taxes on capital and labor in favor of higher taxes on land rents. As is expected, such tax reforms lose some of their luster in the short run. For instance, while the elimination of state and local capital taxes seems eminently plausible under the long run assumption of an infinite capital supply

---

[13] However, a relatively large caveat needs to me made to this statement. In particular, the capital supply elasticity emerges in part from the choice households make regarding savings versus consumption. As is well known, the theoretical impact of distorting the after tax interest rate is ambiguous due to the likely offsetting impact of an income and a substitution effect. The income effect by itself does not cause efficiency losses, but the substitution effect does. Since these are offsetting, a zero capital supply elasticity may be masking a substitution effect offset by an income effect. If this is true, there are efficiency gains from reducing taxes on capital *even if there is no impact on capital use, output, or labor supply.* To appropriately measure true dead weight losses, one would therefore need to know compensated rather than uncompensated elasticities.

[14] This statement is subject to the same caveat as was raised in the previous footnote. The labor supply elasticity arises in part from the labor/leisure decision of households – and this decision also typically involves opposing income and substitution effects when the after tax wage is altered through tax policy. Again, the substitution effect – if present – would cause efficiency gains from lower taxation of labor income *even if there is no change in labor supply, capital use or output*.

[15] It may initially seem odd that the required land rent tax increases in the first row of simulations in Table 7A declines even though none of the simulations entail any change in economic behavior. The explanation, however, is simple and mechanical. Wage levels are impacted (see equation 5) by different labor supply elasticity assumptions – thus yielding different tax base sizes on which tax reforms are based.

elasticity, this same policy would require substantially higher taxes on land rents in the short run—roughly twice as high for a short run elasticity of 5 and over 4 times as high for a short run elasticity of 1.[16] Since capital supply responses do not play as large a role in tax reforms focused on reducing taxes on labor, the difference between short run and long run estimates using different values of capital supply elasticities is not as great in Table 7B. Thus, while revenue neutral reforms focused on reducing state and local taxation of labor is not as promising as similar reforms focused on reducing state and local taxation of capital in the long run, the policy appeal of the former increases the shorter the time-span of concern.

For completeness, Tables 7C through 7F report similar results for the elimination of state and local sales, personal income, corporate income and property taxes for each of the 24 sets of elasticity parameters. As in Tables 7A and 7B, these elasticity assumptions are shown to matter a lot and in ways similar to those illustrated above.

4.4. Conclusions Reached from the "Typical State" Analysis

Several broad lessons emerge from the analysis of a typical state. First, elasticity assumptions are crucial to the exercise of predicting the likely impact of tax reforms because embedded in the elasticity assumptions are the magnitudes of behavioral responses as well as the level of initial distortions in the economy. Second, under elasticity assumptions we find both plausible and relatively conservative, our model then predicts that some types of tax reforms are more likely to succeed than others. In particular, tax reforms that are more focused on reducing taxation of capital in favor of land taxation will have more positive general welfare implications while at the same time minimizing the losses to landowners. As such, they are more feasible in a technical sense as well as politically. This would tend to lead policy makers to want to consider reforming corporate income and property taxes rather than sales and personal income taxes. Third, since elasticities tend to be lower in the short run, it is likely that some of the positive gains of tax reforms that reduce distortionary taxes in favor of land rent taxes will emerge only with time.

V. Differences Across States

As noted at the beginning of the previous section and as expressed in Tables 1 through 4, there are indeed substantial differences in both the nature of the states' economies as well as the way they currently fund their government expenditures. Thus far, we have investigated the consequences of revenue neutral tax reforms for an "average" or "typical" state that essentially reflects the average of state characteristics. In this section we turn to considering the 50 states explicitly in order to detect how differences in their

[16] It is less straightforward to use estimates of the impact on land prices given that land markets might indeed be more forward looking toward the long run. Nevertheless, it is safe to say that land prices would likely fall more in the short run than the long run simulations indicate.