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(UNCONTROLLED) AGGREGATE SHOCKS OR VERTICAL TAX INTERDEPENDENCE? EVIDENCE FROM GASOLINE AND CIGARETTES [*]

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ABSTRACT: Besley and Rosen (1998) were the first authors to empirically estimate the presence of vertical tax externalities. They tested it on gasoline and tobacco unitary taxes. However, they did not take into account the difference in cost of living across states: high cost areas pay less in real terms than low cost areas, since the nominal unit tax on cigarettes and gasoline does not differ according to the state in which it is applied. Consequently, we propose that vertical tax competition can be estimated by deflating all financial variables using the House Price Index (HPI), which is disaggregated by states. This produces a federal tax variable that is expressed in real terms and shows cross-sectional variation. This empirical strategy enabled us to disentangle the vertical interdependence between state and federal tax rates from aggregate shocks over time, using US data from 1975 to 2006 on gasoline and tobacco. We found significant horizontal tax competition, which was higher for cigarettes, but no vertical tax reaction. The results were robust to the period analyzed.

JEL Codes: H3, H21, H77

Keywords: vertical externality, aggregate shock, tax rate, deflator

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1. Introduction

The co-occupation of the same tax bases between layers of government might make taxes inefficiently high from a social perspective, if taxes are distortionary (Keen, 1998). Co-occupation creates a common pool problem. Each sub-central government sets taxes without taking into account the erosion of federal revenues, and so underestimates the reduction in the level of federal public good provision in its own jurisdiction.

In the literature, the presence of vertical tax externalities has been tested by estimating the reaction of sub-central government to variations in the federal tax rate. This is an indirect test of vertical externality. It implies that the interdependence one might find between the state and the federal tax is due to the strategic behavior of the state, which reacts to the negative fiscal externality that it is bearing due to a federal tax decision that erodes state-tax revenues.[1] The empirical results in the literature are somewhat mixed: sub-central governments react by increasing or decreasing tax rates, which is coherent, to a certain extent, with the ambiguous results obtained in the theoretical literature (Keen, 1998; Devereux *et al.*, 2007).

Besley and Rosen (1998) were the first authors to attempt to test for the presence of vertical tax externalities in unitary taxes. They tested cigarettes and gasoline and obtained a positive reaction in both cases (that was greater for gasoline). Regarding cigarettes, Devereux *et al.* (2007) used a different time period, and in some cases estimated different equations (*e.g.*, the lagged endogenous variable and/or taking into consideration horizontal tax competition), but did not find a statistically significant response, while Fredriksson and Mamun (2008) found a negative response. The results for gasoline are not so contradictory: Devereux *et al.* (2007) found a positive or no reaction. In this paper, we will reconsider these estimations, and will thus try to reconcile the somewhat contradictory results, which were all obtained for the US case.

In all the studies cited above, the federal unitary tax rate did not show cross-sectional variation, as it was transformed into real terms by a national consumer price index

[1] Direct tests could also be performed to check for vertical externality by estimating the determinants of the tax base. For example Brett and Pinkse (1997, 2000) calculated horizontal externalities using data from municipalities in British Columbia (Canada).

(CPI). The deflation of a federal tax with a national deflator can give a misleading idea of the real tax burden imposed at state level: cost differentials impact the value of a federal dollar differently among states. In a federal country like the USA, economic and quality-of-life conditions may vary widely according to the area considered. Recent discussions in the USA have focused on the fact that high cost areas pay more in real terms of income tax for the transfers and federal public goods and services they receive. This is because federal income tax is based on nominal income, but its real value varies among geographical areas due to differences in the cost of living. In contrast, federal transfers and public goods and services are normally indexed using the federal CPI, rather than a state cost of living. This asymmetry has generated political attention, as well as recent academic interest (Albouy, 2008; Gyourko, Mayer and Sinai, 2006; Shapiro, 2006; Glaeser, 1998).

Differences in prices among states can be explained by the general equilibrium trade theory (Rosen, 1979; Roback 1982, 1988): the difference in quality of life and in labor productivity generates labor migration, and therefore creates gaps in price levels across states. Some authors argue that federal taxation should take into account this peculiarity through indexation to the cost of living, which is disaggregated by states (Albouy, 2008). US congressmen from high cost areas have also repeatedly supported proposals to index taxes and transfers to regional cost of living (the Tax Equity Act; the Poverty Data Correction Act; the COLA Fairness Act), but none of these acts have been passed. Similar legislation is proposed every Congress. The most recent proposal was the Tax Equity Act of 2005.

Almost all of the political and academic debate has focused on the unfairness of not indexing the federal income tax. However, a similar problem could arise with a federal unit tax, such as that on gasoline or cigarettes. In this case, given that the nominal unit tax on cigarettes and gasoline does not differ among states, high cost areas pay less in real terms than low cost areas. Consequently, this bias should be internalized (*i.e.*, an absence of regional cost of living indexation for federal taxation) in the different states' expenditure and tax decisions. Namely, states should set their taxes and level of expenditure by evaluating the corresponding financial determinants (*e.g.*, the federal tax rate), according to the local cost of living.

Unfortunately, there is no US general state-price index available. Therefore, we use the House Price Index (HPI) to deflate the federal unitary tax rate. The HPI is a broad measure of the movement of single-family house prices. It is computed by the Office of Federal Housing Enterprise Oversight[2] (OFHEO), and is a weighted, repeat-sales index, which measures average price changes in repeat sales or refinancing on the same properties.[3]

A national deflator might also be used to obtain real federal taxes. However, this creates a potential identification problem between the variation in the federal tax rate and common shocks. This econometric problem was recognized in previous studies of vertical tax competition applied to unitary taxes (Devereux *et al.*, 2007). In particular, the impossibility of including time effects potentially creates a specification bias, as the estimate of the federal variable might pick up the impact of aggregate shocks. This problem disappears if we use the HPI deflator—a price index that shows cross-sectional variation—as it allows for the inclusion of time effects to control for shocks.

When we used the HPI, we did not find any vertical response for cigarette taxation or gasoline taxation. As shown in Section 2, some of the results of studies that used the CPI deflator are dependent on the time period considered. In contrast, once we had controlled for common annual shocks, our results did not depend on the time period considered. Regarding horizontal tax competition, we found a strong reaction for cigarette and gasoline taxes. In particular, in the long term, a 1 cent increase in the neighboring states' tax rates provokes a 0.57 cent increase in the corresponding state's tax rate for gasoline. This reaction was even stronger for cigarettes (a 0.87 cent increase). According to Proposition 1 in Devereux *et al.* (2007), if demand is price-inelastic, we should expect no vertical reaction and a horizontal reaction of 0.5. Our empirical results were consistent with this proposition, as there was no vertical response. However, the estimate of 0.5 for horizontal tax competition only applied to gasoline. In the case of cigarettes, the well-documented presence of interstate cross-border shopping and smuggling (Fleenor, 1998; or Farrelly *et al.*, 2003) and the fact that this good is easily storable, which implies scale economies in shopping (Scharf, 1999),

[2] http://www.ofheo.gov.

[3] This information is obtained by reviewing repeat mortgage transactions on single-family properties whose mortgages have been purchased or securitized by Fannie Mae or Freddie Mac since January 1975. For more detailed technical information, see Calhoun (1996).

might make the horizontal reaction stronger.[4] This positive reaction was also obtained by Rork (2003).

The structure of the rest of the paper is as follows. In Section 2 we review the results obtained in the previous literature, which all apply to unitary taxes and to the USA; in Section 3 we develop our empirical framework and present the data, and in Section 4 we present our results. Finally, a conclusion is given in Section 5.

2. Previous literature

Table 1 summarizes the main results in the literature on testing the presence of vertical interactions for unitary taxes in the USA. Besley and Rosen (1998) obtained a positive reaction (row 1, Table 1). Their results were checked by Devereux *et al.* (2007) and Fredriksson and Mamun (2008) (rows 2 and 3, respectively). We can see that the results are highly dependent on the time span: there was a positive result for the 1977-1997 period and no reaction for the 1975-2001 period. It is also essential to take into account horizontal tax competition and the inertia of state tax rates by including the lagged endogenous variable. Then, for the 1977-1997 period, the estimated reaction is no longer statistically significant (row 4 and 5). Fredriksson and Mamun (2008) excluded the 1975-1981 period, because no nominal tax changes occurred during this time. As a result, they found that a negative reaction, regardless of further assumptions about the estimated equation (row 6 and 7). Consequently, these authors state "the time period studied does appear crucial for states' responses to federal taxes" (p. 43).

This instability of the estimated sign of the state reaction over time might be due to the impact of annual common shocks, which are not properly controlled for in the aforementioned studies. This was explicitly recognized by Devereux *et al.* (2007), in which they stated that "the presence of federal variables, which vary only over time, preclude the use of time dummies which might otherwise capture aggregate shocks which create a common effect across states on cigarette tax rates" (p. 466). This creates a potential identification problem, in the sense that the key variable in the empirical specification (the federal tax rate) might be confused with a linear combination of year

[4] For example, when transportation costs are not linear and the price elasticity is still null, the horizontal reaction can be higher than 0.5 (Rizzo, 2008).

common shocks. In Section 3, we will explain how we try to overcome this identification problem.

Table 1. Review of the empirical literature on vertical tax externalities and unitary taxes applied to the USA: the case of cigarette taxes

	Period	Time dummies	Endogenous lagged	Horizontal tax competition (*neighbors*)	Sign reaction
Besley & Rosen (1998); Table 3, 1st column	1975-1989	NO	NO	NO	+ (significant)
Devereux *et al.* (2007); Table 1, 1st column	1977-1997	NO	NO	NO	+ (significant)
Fredriksson & Mamun (2008); Table 5, Model III	1975-2001	NO	NO	NO	+ (not significant)*
Devereux *et al.* (2007); Table 1, 2nd column	1977-1997	NO	YES	NO	+ (not significant)
Devereux *et al.* (2007); Table 1, 4th column	1977-1997	NO	YES	YES	+ (not significant)
F & M (2008); Table 3, Model I	1983-2001	NO	NO	NO	- (significant)*
F & M (2008); Table 3, Model VIII	1983-2001	NO	NO	YES	- (significant)*

Notes: In all cases, the federal tax is instrumented; (*): not fully comparable, as they include additional control variables.

With respect to gasoline, the results obtained in the literature are not as contradictory, but indicate a positive or no reaction. Table 2 shows these results. Again, Besley and Rosen (1998) obtained a positive reaction (row 1, Table 2), which was not robust (row 2) to expanding the period to 1997 (Devereux *et al.*, 2007). Therefore, the time span was again of key importance. This result does not change if we take into account the horizontal tax competition and inertia of taxes (row 3 and 4) (Devereux *et al.*, 2007).

Given the ambiguous results obtained in the literature for the same taxes and country, a more robust empirical approach is clearly needed to tackle the identification problem, which is namely to disentangle the impact of aggregate shocks on the state tax rate from variations in the federal tax rate.

Table 2. Review of the empirical literature on vertical tax externalities and unitary taxes applied to the USA: the case of gasoline taxes

	Period	Time dummies	Endogenous lagged	Horizontal tax competition (*neighbors*)	Sign reaction
Besley & Rosen (1998); Table 3, 2nd column	1975-1989	NO	NO	NO	+ (significant)
Devereux *et al.* (2007); Table 4, 1st column	1977-1997	NO	NO	NO	+ (not significant)
Devereux *et al.* (2007); Table 4, 2nd column	1977-1997	NO	YES	NO	+ (not significant)
Devereux *et al.* (2007); Table 4, 4th column	1977-1997	NO	YES	YES	+ (not significant)*

(*): However, if the relative horizontal interdependence is based both on neighboring states and on the population density at the border, the estimate becomes positive and statistically significant.

3. Empirical analysis

3.1. Empirical framework

To test for the presence of vertical tax externalities in the USA, we estimate the tax-reaction function by relating one state tax to the federal tax for the period 1975-2006. We repeat this procedure for gasoline and cigarette taxes. Given that we are dealing with unitary taxes, both taxes have to be transformed into real terms.

We then estimate the following equation:

$$t_{jst} = \alpha_s + \phi_t + \varphi \sum_{i \neq s} w_{si} t_{jst} + \gamma T_{jst} + X_{jst}\beta + \mu t_{jst-1} + \varepsilon_{jst} \qquad [1]$$

where t_{jst} is the real tax rate on commodity j for state s and year t; α_s is a state fixed effect; ϕ_t is a year effect; $\sum_{i \neq s} w_{si} t_{jst}$ is the average real tax rate for commodity j of the neighboring states of state s in year t, where w_{si} are identical exogenous weights, normalized such that $\sum_{i \neq s} \omega_{si} = 1$, which account for the relative interdependence relation between s and the rest i-states; T_{sjt} is the real federal tax rate for commodity j in year t

(without the sub-index *s* as long as we deflate by CPI); X_{jst} is a vector of state-specific time-varying regressors; while ε_{jst} is a mean zero, normally distributed random error. As long as the estimate of γ is different from zero, we can confirm the relevance of a vertical tax externality.

In order to isolate the independent impact of the federal tax rate on the tax rate of the states, we include other variables that might affect the state tax rate and that must be taken into account. These variables are included in the vector X_{jst}. In particular, state taxation may be influenced by the economic and demographic environment. As usual in the literature, this is controlled for by the following variables: population (and its square), per-capita income (and its square), unemployment rate, proportion of population over 65 and proportion of population between 5 and 17. We also take federal fiscal instruments into account, as these may differ from state to state and might condition the setting of state tax rates. Thus, we include federal grants-in-aid in relation to total population and the federal income tax collected in each state, normalized by the adjusted gross income. As we work with real tax rates and nominal tax rates change infrequently, we control for inflation. The political affiliation of the state government may also affect the tax-rate level. Thus, we divide the US party system into two main groups: Republicans and Democrats. We also build dummies for the governors' membership in each of the two political groups and variables to account for the percentage in the House and Senate of the two groups.

Certain unchanging characteristics of a state are likely to affect its tax system, such as climate or geography, among others. We can take these characteristics into account by including a dichotomous variable for each state. Changes in the macroeconomic situation may also affect states' fiscal policies. To account for this, we include a set of time dummies, unlike previous studies on vertical tax externalities. This is of key importance to our paper. As we explain in Section 3.2.2, this is possible as we use a state price index to deflate our federal unitary tax. This ensures that the federal tax rate has time and cross-sectional variation. Thus, time effects can be included in Equation [1]. To date, common shocks in the literature have been controlled by the inclusion of federal GDP and federal unemployment, which are only a specific two-linear combination of common annual shocks.

3. 2. Data

3.2.1 Nominal tax rates

We use annual data on US states from 1975 to 2006. From 1975 to 1983, the federal gasoline tax was four cents per gallon. In 1983, the gasoline tax increased to 9 cents, of which 8 financed the Highway Trust Fund and 1 funded the Mass Transit Fund. From 1987, the rate increased by 0.1 to finance the Underground Storage Tank Leakage Fund. On 1 December 1990, the tax rate jumped to 14.1, which generated an increase in resources for Transportation grants, but also for the specific purpose "deficit reduction". On 1 October 1993, there was a further increase to 18.4, which was only due to an increase in the provision of resources to reduce the deficit. The destination of the revenue changed from October 1, 1995, as 2.5 cents were redirected to Transportation grants and the rate did not change. More funds were provided for Transportation from October 1, 1997, since the deficit reduction fund was canceled and the tax rate remained unchanged. Therefore, there have been several important statutory tax changes since 1983, while for the case of cigarettes, no nominal changes occurred prior to this date. From 1975 to 1983, the federal cigarette tax rate was eight cents per pack of 20 cigarettes; from 1983 it was 16 cents per pack. The rate then increased to 20 cents per pack in 1991, and 24 cents in 1993. In 2000 it increased by 10 cents and has been 39 cents per pack since 2002.

Taxes on gasoline and cigarettes vary considerably across states. In 1990, for example, the tax per pack on cigarettes ranged from 2 cents in North Carolina to 40 cents in Connecticut. In the same year, the tax per gallon of gasoline ranged from 7.5 cents in Georgia to 22 cents in Connecticut and Washington. Thus, there is significant cross-sectional variation.

Taxes on cigarettes vary differently with time according to the state. For example, the tax in North Carolina varied from 2 to 5 cents in 1992 and then reached 30 cents in 2005 and at 35 in 2006. Connecticut shows more variation, as it had a tax of 21 cents until 1983, a change to 26 in 1984, then an increase to 40 in 1989, 45 in 1992, 47 in 1994, 50 in 1995, 111 in 2002 and finally 151 in 2003. Taxes on gasoline also vary differently over time according to the state. Georgia, for example, maintained the same

tax (7.5) throughout the time period under consideration. In contrast, Connecticut and Washington had a major variation over time. Connecticut increased the tax from 10 to 11 cents per gallon in 1976, from 14 in 1983 to 38 in 1997; followed by a decrease to 36 in 1998, 32 in 1999 and, finally, to 25 in 2002. Washington levied 9 cents till 1976, which rose gradually to 18 in 1984, 22 in 1990 and 23 in 1991. The tax was then increased to 28 in 2004, 31 in 2005 and, finally, 34 in 2006.

3.2.2 Real tax rates: CPI *vs.* HPI

In the previous literature, nominal unitary taxes were divided by CPI to adjust for inflation. However, the use of the CPI does not enable us to identify vertical externality. This is because it precludes the real federal tax rate from showing cross sectional variation, which prevents us from controlling for macroeconomic shocks by using year effects. The federal tax could be a particular linear combination of year effects.

However, it is reasonable to consider that prices vary widely across US states and have a real impact on federal taxes (see, for example, Albouy, 2008). The increase in the federal nominal gasoline tax in 1990 from 9 cents to 14.1 cents did not have the same impact in Wyoming as in California. It had a more negative effect on the former than the latter, as the price level is higher in California than in Wyoming. Thus, if we use the same deflator in both states, the impact of the federal tax rate on the tax decision of California may be overestimated with respect to Wyoming.

To resolve this problem, we use the HPI to deflate financial variables. Shapiro (2006) showed that house price differentials among states are the prime determinant of cost-of-living differences. He found that a 10% increase in the implicit price of land increases the price of the market basket of goods and services used to compute the CPI by about 3.2%, with a lower bound of 2.2%. Moreover, Albouy (2008) used a geographical partition, as defined by the Metropolitan Statistical Area (MSA) and found that in 2000 "wage and housing prices exhibit a strong positive correlation, with a regression line, weighted by employment, having a positive slope near one-half." (p. 24). Therefore, the HPI seems a reasonable proxy for a general state price index.

Figure 1, in which we report the HP indices normalized by their corresponding value in

1975, clearly shows that the type of price index affects the real value of the monetary variables that determine state-tax choices. However, in some states, the HPI increases on average much more than the CPI, particularly after the 1990s. Most of these are coastal states (Figure 1). Hence, some caution should be taken in interpreting our results, since the volatility of house prices is significantly different in the coastal states (Figure 2) from the rest of the US states (Abraham and Hendershott, 1996; Davis and Palumbo, 2006; Glaeser *et al.*, 2008). In our empirical analysis, we perform a robustness check to test the sensitivity of our results to the exceptional performance of house prices in coastal states.

[FIGURE 1]

[FIGURE 2]

3.2.3 The other variables

The rest of the right-hand-side variables of [1], with their definitions, meanings and standard deviations are also reported in Table 3. In the following sections, we use data that is both normalized by the CPI and by the HPI. In the former case, as previously shown in the empirical literature, we control for macroeconomic shocks using the national unemployment rate, *FEDUNEMP*, and the real federal GDP. In contrast, when we use the HPI we include year effects.

[TABLE 3]

Next, we include a set of time-varying variables that characterize the state's economic and demographic situation: the state population (*POP*), per capita state income (*INC*), the state unemployment rate (*UNEMP*), the proportion of individuals in the state who are aged between 5 and 17 (*CHILD*), and the proportion who are over 65 (*AGED*). The state's political environment can also affect fiscal outcomes. Therefore, we use a dummy variable that equals one if the governor is a Democrat, otherwise we use zero (*DEMGOV*). We also account for the proportions of Democrats in the state Senate and House of Representatives (*DEMSEN* and *DEMHOU*, respectively). The cigarette and gasoline industries can affect the state tax rate by lobbying for the rates of their respective commodities (Dixit, 1996). Therefore, we use a measure of importance to the

state economy, as in Besley and Rosen (1998), by including *TOBINC* (tobacco production per dollar of state income) and *GASINC* (gasoline production per dollar of state income). The federal fiscal policy, other than commodity tax rates, may also affect state commodity tax rates. Thus, we control for per capita federal grants to the states (*GRANTS*), and the average federal income in the state *(INCTAX)*, defined as the ratio of the state's federal income tax liability to its adjusted gross income. Inflation (INFLATION) is computed as the annual growth rate in the corresponding price index. Finally, we account for state unchanging characteristics by using state fixed effects.

3.3 Empirical strategy

The mean US neighboring tax rate, $\sum_{i \neq s} w_{si} t_{jst}$, is endogenous, because it can be simultaneously influenced by the tax rate that we are estimating. Then, if this was a structural model, a simple OLS estimation of [1] would suffer from endogeneity bias: the error term ε_{jst} would be correlated with the error terms of the other simultaneous equations in the system. In order to overcome the simultaneity bias, we use the two-stage least squares method: first, we estimate the reduced forms of the endogenous variables, and then we substitute their fitted values into [1]. The residuals of this last equation are corrected using the actual values of the endogenous variables. We instrument the mean US neighboring tax rate with the US neighboring variables POP_{st}, $CHILD_{st}$, $AGED_{st}$, $UNEMP_{st}$, $DEMSEN_{st}$, $DEMHOU_{st}$.

With respect to the federal tax rate, we could also consider that the federal layer and state governments set their tax rates simultaneously, which is the case in Devereux *et al.* (2007). In contrast, Besley and Rosen (1998) assume that the federal government is a Stackelberg leader and therefore the federal tax rate is exogenous. We take a conservative approach and instrument the federal tax rate by using the federal deficit over the federal GDP, as Besley and Rosen (1998) did in a robustness check. However, when we use the HPI to deflate the federal tax rate and control for year effects, we have no federal instrument, and so cannot instrument the federal variable. Consequently, we have 7 instruments in total. Hence Equation [1], which has one or two endogenous

variables (depending on the deflator we use), is identified.[5]

4. Results

We started by using the dataset that had been deflated with CPI. The results are shown in Table 4. In column (1), we obtained a positive reaction of states to federal tax increases. A $1 increase in the federal gasoline tax provoked a $0.37 increase in the state tax rate (5% statistically significant). However, this basic result might be biased, as we did not control for horizontal tax competition or for the possibility of inertia in the setting of state tax rates. Once we had included spatial lag in the basic model, in column (2) the reaction due to the vertical tax externality was no longer significant, while a strong horizontal reaction emerged (0.95; 1% significant). Finally, in column (3), we simultaneously took into account both factors (horizontal tax competition and inertia). In this case, vertical tax externality was still not an issue, while the horizontal tax reaction strongly diminished (0.24; 1% significant), but was still significant. We obtained significant inertia (today's taxes are almost 80% of yesterday's taxes). The presence of inertia enabled us to differentiate between a short-term reaction in terms of horizontal tax competition (0.24), and a long-term reaction (0.24/(1-0.78)=1.09; which we cannot reject as equal to 1).

[TABLE 4]

Nonetheless, the above results might be conditioned by the impossibility of fully controlling for macroeconomic shocks. As we argued before, the use of a state price index enabled us to enrich the previous empirical specification and include a set of time effects. This is shown in columns (4) to (6) of Table 4. The previous results were basically unchanged. That is, there was no vertical reaction (either in the short-term or the long-term), there was a significant degree of inertia (0.79 in column 6; 1% significant), and we still detected horizontal interaction, although to a lesser extent (0.12 in column 6; 1% significant). In this case, the long-term reaction due to horizontal tax competition was 0.57 (1% significant).

[5] The lag of the dependent variable biases all the estimated coefficients of the regression for finite-*T* samples. However, in our case, the Nickell (1981) bias should not be a significant problem, due to the fact that our panel runs over 32 years. Therefore, we do not instrument the lagged endogenous variable.

If we compare the statistical tests of column (3) and column (6), we can see that the model that includes time effects has greater explanatory power and the test of over-identifying restrictions performs better. In addition, the long-term reaction for horizontal competition seems more reasonable (*i.e.*, the long-term estimate is below 1) when we use the HPI. In fact, if we use the HPI, the results obtained are fully consistent with Proposition 1 of Devereux *et al.* (2007): if demand is price-inelastic, the theoretical prediction is that there should be no vertical reaction and the reaction due to horizontal tax competition should be 0.5, which coincides with our long-term estimate (we cannot reject at 1% that the estimate is equal to 0.5). Finally, in both sets of regressions, the estimate of inflation was negative. That is, regardless of how inflation was measured (national *vs.* state), states seemed to be reluctant to vary their nominal tax rates in the presence of inflation, which is coherent with casual observation and with previous literature (Bowmann and Mikesell, 1983; Ang-Olson *et al.*, 1999).

In Table 5, we present the same set of results, but for cigarette taxation. The main difference can be seen in the horizontal tax competition, which is stronger in this case. This result is qualitatively coherent with that of Devereux *et al.* (2007). When we used the CPI, we obtained a short-term reaction equal to 0.35 (1% significant) and a long-term reaction equal to 1.54 (1% significant) (column 3). When we used the HPI, we obtained 0.22 (1% significant) and 0.87 (1% significant) (column 6), respectively. Moreover, when inflation was measured by the CPI, it did not have a significant effect on state taxes, that is, the states maintained the level of real tax rates, according to the inflation index. However, this result might be misleading, as the CPI-based inflation rate does not show cross-sectional variation, and so might mimic other uncontrolled factors that also only show time variation. In contrast, an increase in the state price index decreases the level of real state taxes, which means that states do not take into account variations in the HPI when they set their tax rates, or that states are generally reluctant to update their statutory tax rates according to the inflation rate.

Overall, for the period 1975-2006, the main difference between using the CPI and the HPI is that the latter index gives a lower estimate of horizontal tax competition. Most importantly, its long-term value is below one, which guarantees the existence of a Nash Equilibrium in the tax-setting.

[TABLE 5]

In the literature review of Section 2, we showed that the time period was of key importance for the empirical results, in terms of the vertical tax reaction. We will now check whether this is also the case for our empirical approach. To test this approach, in Table 6 we compared our results with those obtained by Fredriksson and Mamun (2008). As we already know from Section 2, these authors obtained a negative reaction for cigarette taxation in terms of vertical externality, once they had restricted the period to 1983 onwards. In other words, they excluded the late 1970s, in which neither the state nor the federal government carried out statutory tax changes. In Table 6, we have replicated the regressions for the period 1983-01, with the only difference that we included the inflation rate and the lagged endogenous variable. We obtained the same result: a $1 increase in the federal cigarette tax provoked a $0.48 (5% significant) decrease in state taxes. This result was replicated when the inflation rate and the lagged endogenous variable were excluded. However, we did not find this result when we included a set of time effects. In this case, just as for the whole period, states did not react to federal taxes. In Table 6, we also estimated a tax reaction function for gasoline. The estimate of the vertical tax externality using CPI was also negative (-0.22, 10% significant) and positive but statistically insignificant when we used the HPI. Therefore, the negative reaction obtained by Fredriksson and Mamun (2008) is not exclusive to cigarette taxation, but disappears when we control for aggregate shocks.

[TABLE 6]

According to the results in Section 3.2.2, the time series performance of house prices was not equal across states. In particular, in the case of East (Maryland, Delaware, Pennsylvania, New Jersey, New York and the states belonging to New England) and West (California, Oregon and Washington) coastal states, house prices have suffered an exponential increase since the mid-1990s. For example, according to Davis and Palumbo (2006), from 1999 till 2004, house prices increased by about 25% in the large cities of the Midwest and the Southwest, while in coastal states, they increased by around 80%. The trend of house prices in those states is compatible with a generalized price increase in all states from 1996 until 2006 (Glaeser *et al.*, 2008). This peculiar price behavior in the housing market might make the HPI less reliable as a proxy of a

general state price index.

Therefore, in Table 7 we performed a robustness check to test whether our results are dependent on that expansionary path of house prices. In columns (1) and (2) we show the results excluding the coastal states for gasoline and cigarettes, respectively; while in columns (3) and (4) we show results excluding the years from 1996 onwards, again for gasoline and cigarettes, respectively. There were no changes in terms of vertical tax externality: state tax rates did not respond to changes in the federal tax rate for gasoline or for cigarettes. With respect to horizontal tax competition, we still found this to be an issue in the US tax setting.

[TABLE 7]

5. Conclusions

We tested the impact of an increase in federal tax on state tax in the USA, and provide evidence that an increase in the federal tax does not affect state tax rates in the case of gasoline and cigarettes. Our results differ from those of previous papers, in which mixed results were obtained.

The novelty of our empirical approach is that we can identify the impact of the federal tax rate on the state tax rate by using a state-specific deflator, the HPI, which differs from the usual CPI as it presents cross-sectional variations. This approach allows us to test the impact of the federal tax rate on the state tax rate by controlling for macroeconomic shocks, proxied by year effects. This is not possible when the CPI is used as a deflator, in which the real federal tax rate is perfectly collinear with a particular linear combination of year effects. We developed a test using a data set for the USA running from 1975 to 2006 for cigarette and gasoline taxes.

6. References

Abraham, J. M., P. H. Hendershott (1996): "Bubbles in Metropolitan Housing Markets", *Journal of Housing Research*, 7, 191-208.

Albouy, D. Y. (2008): "The Unequal Geographic Burden of Federal Taxation", *Journal of Political Economy*, forthcoming.

Ang-Olson, J., M. Wachs, B. D. Taylor (1999): "Variable-Rate State Gasoline Taxes", Working Paper #3, Institute of Transportation Studies, University of California at Berkeley.

Besley, T., Rosen, H. (1998): "Vertical externalities in tax setting: Evidence from gasoline and cigarettes", *Journal of Public Economics*, 70, 383-398.

Bowman, J.H., J. L. Mikesell (1983): "Recent Changes in State Gasoline Taxation: An Analysis of Structures and Rates, *National Tax Journal*, 26.

Brett, C., J. Pinkse (1997): "Those taxes are all over the map: a test for spatial dependence of municipal tax rates in British Columbia", *Canadian Journal of Economics*, 33, 695-714.

Brett, C., J. Pinkse (2000): "Strategic Interactions among governments: an overview of empirical studies", *International Regional Science Review*, 33, 695-714.

Calhoun, C. A. (1996): "OFHEO House Price Indexes: HPI Technical Description", Office of Federal Housing Enterprise Oversight, mimeo Washington, http://www.ofheo.gov/Media/Archive/house/hpi_tech.pdf.

Davis, M.A., M.G. Palumbo (2006): "The Price of Residential Land in Large US Cities", Finance and Economics Discussion Series No. 25, Divisions of Research & Statistics and Monetary Affairs, Federal Reserve Board, Washington, D.C.

Devereux, M.P., B. Lockwood, M. Reodano (2007): "Horizontal and vertical indirect tax competition: Theory and some evidence from the USA", *Journal of Public Economics*, 91, 451-479.

Dixit, A., (1996): "Special-interest lobbying and endogenous commodity taxation", *Eastern Economic Journal*, 22, 375–388.

Farrelly, M.C., Ch. T. Nimsch, J. James (2003): "State Cigarette Excise Taxes: Implication for Revenue and Tax Evasion", prepared for *Tobacco Technical Assistance Consortium*, Emory University.

Fleenor, P. (1998): "How excise tax differentials affect interstate smuggling and cross-border sales of cigarettes in the United States", Tax Foundation Background Paper, No. 26.

Fredriksson, P.G., K. A. Mamun (2008): "Vertical externalities in cigarette taxation: Do tax revenues go up in smoke?", *Journal of Urban Economics*, 64, 35-48.

Glaeser, E. (1998): "Should Transfer Payments be Indexed to Local Price Levels?", *Regional Science and Urban Economics*, 28, 1-20.

Glaeser, E., J. Gyourko, A. Saiz (2008): "Housing Supply and Housing Bubbles", NBER Working paper N. 14193, Cambridge, MA.

Gyourko, J., C. Mayer, T. Sinai (2006): "Superstar Cities." NBER Working paper N.

12355, Cambridge, MA.

Kaplow, L. (1995): "Regional Cost–of–living adjustments in tax–transfer schemes" NBER Working paper N. 5008, Cambridge, MA.

Keen, M.J. (1998): "Vertical tax externalities in the theory of fiscal federalism", *IMF Staff Papers*, 45, 454-485.

Nickell, S. (1981): "Biases in dynamic models with fixed effects" *Econometrica* 49, 1417-1426.

Rizzo, L. (2008): "Local Government Responsiveness to Federal Transfers: Theory and Evidence", *International Tax and Public Finance*, 15, 316-337.

Roback, J. (1982): "Wages, Rents and Quality of Life" *Journal of Political Economy*, 90, 1257-1278.

Roback, J. (1988): "Wages, Rents and Amenities: Differences among Workers and Regions" *Economic Inquiry*, 26, 23-41.

Rork, J.C. (2003): "Coveting Thy Neighbors' Taxation", *National Tax Journal*, 56, 777-787.

Rosen, H. (1979): "Housing Decision and the US Income Tax: An Econometric Analysis" *Journal of Public Economics*, 11, 1-23.

Scharf, K. (1999): "Scale Economies in Cross-Border Shopping and Commodity Taxation", *International Tax and Public Finance*, 6, 89-99.

Shapiro, J. M. (2006): "Smart Cities: Quality of Life, Productivity, and the Growth Effects of Human Capital", *The Review of Economics and Statistics,* 88, 324-335.

Data Appendix

- t_{st} US cigarette tax rate for state s in year t, divided by the CPI or the HPI. These rates are taken from www.OTPR.org: cigarette tax rates are expressed in US dollars per pack of 20 cigarettes and gasoline tax rates are expressed in US dollars per gallon of gasoline.

Endogenous variables

- T_t is the federal US cigarette tax rate. This data is taken from www.OTPR.org.
- $\sum_{i \neq s} w_{si} t_{st}$ is the mean of the states tax rates, divided by the CPI or HPI, of the states bordering state s in year t.

Demographic and economic variables

- POP_{st} is the number of persons in state s in year t. This figure is taken from www.census.gov.
- $CHILD_{st}$ is the ratio of individuals aged 5-17 years to the total population of state s in year t, taken from www.census.gov for the USA.
- $AGED_{st}$ is the ratio of individuals of over 65 years of age to the total population of state s in year t, taken from www.census.gov for the USA.
- $UNEMP_{st}$ is the unemployment rate for state s in year t, taken from www.stats.bls.gov.
- INC_{st} is the per-capita income for state s in year t divided by the CPI or HPI. Income data were taken from http://www.bea.doc.gov.
- $GRANT_{st}$ is the per-capita federal grant-in-aid for state s in year t. It is obtained from "Federal Expenditures by State" which is part of the Consolidated Federal Funds Reports program from US Census Bureau.
- $DEMGOV_{st}$ dummy=1 if the governor of the state is a Democratic, taken from the Statistical Abstracts of the United States.
- $DEMSEN_{st}$ proportion of state Senate that is Democratic, taken from the Statistical Abstracts of the United States.
- $DEMHOU_{st}$ proportion of state House that is Democratic, taken from the Statistical Abstracts of the United States.
- GDP_t is the federal GDP for year t divided by the CPI or HPI, taken the Statistical Abstracts of the United States.
- $FED\ UNEMP_t$ is the federal unemployment for year t, taken from the Statistical Abstracts of the United States.
- CPI_t (Consumer Price Index) was taken from the Statistical Abstracts of the United States (2000).
- HPI_{st} (House Price Index) was taken from http://www.ofheo.gov, the website of the Office of Federal Housing Enterprise Oversight in the USA.
- $TOBINC_{st}$ annual tobacco production (thousand of pounds); from http://www.nass.usda.gov, the website of the National Agricultural Statistics Service in the USA.
- $GASINC_{st}$ is the daily gasoline production (thousand barrels per day) per dollar of state income in real terms with CPI or HPI; from http://www.eia.doe.gov, the website of the Energy Information Administration in the USA.
- $INCTAX_{st}$ federal income tax divided by adjusted gross income. Federal income tax and adjusted gross income are from the http://www.irs.gov, the website of the Internal Revenue Service, a Department of the Treasury in the USA.

Table 3: 'Summary statistics*

Variable	Obs	Mean	Stand. Dev.	Min	Max
tg*10 (state unit gasoline tax, cents in real terms with CPI)	1504	121.487	27.700	37.202	236.760
Tg*10 (federal unit gasoline tax cents in real terms with CPI)	1504	89.653	23.241	41.451	127.336
tc*10 (state unit cigarette tax, cents in real terms with CPI)	1504	216.776	164.998	13.587	1302.276
Tc*10 (federal unita cigarette tax cents in real terms with CPI)	1504	151.423	33.508	82.902	216.787
tg*10 (state unit gasoline tax, cents in real terms with HPI)	1504	97.673	31.177	18.201	201.350
Tg*10 (federal unit gasoline tax cents in real terms with HPI)	1504	74.898	25.379	31.025	147.409
tc*10 (state unit cigarette tax, cents in real terms with HPI)	1504	160.183	89.162	7.990	649.710
Tc*10 (federal unita cigarette tax cents in real terms with HPI)	1504	119.973	33.349	50.480	235.863
GDP (real national gross domestic product , billion of dolllars in real terms with CPI)	1504	45.662	10.138	30.452	65.707
GDP (real national gross domestic product , billion of dolllars in real terms with HPI)	1504	36.121	9.925	15.484	66.492
FED UNEMP (federal unemployment rate)	1504	6.284	1.410	4	9.7
DEF (federal deficit over national gross domestic product)	1504	0.026	0.020	-0.027	0.059
POP(state population*10^{-6})	1504	5.314	5.577	0.382	36.250
INC (state income per capita*10-3 in real terms with CPI)	1504	140.754	28.405	78.134	251.798
INC (state income per capita*10-3 in real terms with HPI)	1504	110.134	22.616	58.685	197.910
UNEMP (state unemployment rate)	1504	5.984	2.018	2.3	17.4
CHILD (proportion of population between 5 and 17)	1504	0.196	0.021	0.155	0.268
AGED (proportion of population over 65)	1504	0.122	0.019	0.073	0.185
TOBINC (tobacco production per dollar of state income in real terms with CPI)	1504	257.890	925.431	0	10225.09
TOBINC (tobacco production per dollar of state income in real terms with HPI)	1504	323.134	1155.657	0	13393.34
GASINC (daily gasoline production per dollar of state income in real terms with CPI)	1504	0.818	2.703	0.000	31.343
GASINC (daily gasoline production per dollar of state income in real terms with HPI)	1504	0.950	3.211	0.000	35.934
GRANTS (federal grants per capita in dollars*10-8 in real terms with CPI)	1504	$563*10^{-8}$	$226*10^{-8}$	$231*10^{-8}$	$2740*10^{-8}$
GRANTS (federal grants per capita in dollars*10-8 in real terms with HPI)	1504	$444*10^{-8}$	$199*10^{-8}$	$151*10^{-8}$	$2210*10^{-8}$
INCTAX (federal income tax divided by adjusted gross income)	1504	0.137	0.016	0.092	0.193
DEMGOV (=1 if the governor is a Democrat)	1504	0.537	0.499	0	1
DEMSEN (proportion of state Senate that is Democratic)	1504	0.577	0.186	0.086	1
DEMHOU (proportion of state House that is Democratic)	1504	0.574	0.179	0.129	1

*Figures are based on annual data for continental US states for the year 1975 to 2006, inclusive. All the monetary variables are espressed in real terms, divideded by the Consumer Price Index (CPI) 1982-84 taken from the Statistical Abstract of the United States or the Housing Price Index (HPI) 1980 taken from the Office of Federal Housing Enterprise Oversight (http://www.ofheo.gov). We do not include non continental states (Hawaii, District of Columbia and Alaska) and Nebraska, whose Legislature is unicameral and non-partisan.

Table 4: Gasoline tax rates (1975-2006), using the CPI and HPI deflator

	(1)	(2)	(3)	(4)	(5)	(6)
		CPI			HPI	
fedgastax	0.3703	-0.0563	-0.0968	1.1214	0.7761	0.0875
	(2.03)**	(0.40)	(1.21)	(5.87)***	(4.21)***	(0.88)
L1stgastax	-.-	-.-	0.7820	-.-	-.-	0.7934
			(33.76)***			(37.23)***
Wstgastax	-.-	0.9554	0.2439	-.-	0.5157	0.1170
		(6.76)***	(3.06)***		(8.40)***	(2.92)***
inflation	-45.0680	-31.3973	-103.3521	-6.0178	-6.6109	-75.1240
	(0.58)	(0.65)	(3.54)***	(0.66)	(0.75)	(13.07)***
population	-4.6474	-2.2657	0.5248	-5.5966	-5.0914	-0.1793
	(3.12)***	(1.44)	(0.70)	(4.37)***	(4.30)***	(0.30)
popsq	0.0928	0.0364	0.0006	0.1307	0.1117	0.0143
	(3.96)***	(1.26)	(0.05)	(6.29)***	(5.13)***	(1.36)
fedgdp	-1.2077	-0.1833	-0.2360	-.-	-.-	-.-
	(5.31)***	(0.69)	(1.79)*			
fedunemp	-5.6786	-0.8830	-0.8038	-.-	-.-	-.-
	(7.76)***	(0.86)	(1.48)			
stinc	-0.6079	0.2225	0.0453	1.0672	0.6245	0.0523
	(1.22)	(0.49)	(0.20)	(4.30)***	(2.45)**	(0.48)
stincsq	0.0017	-0.0007	-0.0002	-0.0034	-0.0016	-0.0001
	(1.35)	(0.65)	(0.30)	(3.53)***	(1.53)	(0.26)
stunemp	1.7188	0.2678	0.6687	1.6911	1.1060	0.6162
	(3.57)***	(0.48)	(1.95)*	(3.80)***	(2.44)**	(2.04)**
child	219.7473	9.3785	-183.9985	366.3174	103.1825	-1.0938
	(2.32)**	(0.13)	(4.83)***	(5.17)***	(1.34)	(0.02)
aged	360.6784	138.8985	31.4811	561.0173	514.2720	120.3130
	(1.57)	(1.02)	(0.42)	(5.67)***	(5.32)***	(2.44)**
tobinc	-0.0006	-0.0025	-0.0013	0.0009	-0.0001	-0.0003
	(0.41)	(1.90)*	(1.61)	(1.16)	(0.13)	(0.75)
gasinc	-2.1049	-2.0416	-0.2214	-1.8781	-1.6290	-0.2121
	(4.63)***	(4.98)***	(1.37)	(6.34)***	(5.49)***	(1.60)
grants*10^{-7}	0.0217	0.0212	-0.0179	-0.2102	-0.2175	-0.0340
	(0.58)	(0.49)	(1.05)	(3.51)***	(3.52)***	(1.39)
fedinctax	-434.8958	-74.6963	-28.4610	-136.5768	-97.2346	-66.3272
	(6.53)***	(0.84)	(0.62)	(1.29)	(0.96)	(1.17)
demgov	-0.3233	0.6197	-0.0328	0.6649	0.3383	-0.0490
	(0.35)	(0.65)	(0.06)	(0.84)	(0.44)	(0.10)
demsen	-10.6060	3.4049	2.4677	-11.2628	1.8557	1.4519
	(1.65)*	(0.56)	(0.61)	(2.19)**	(0.36)	(0.41)
demhou	28.5083	3.6513	4.3493	22.5508	11.0005	1.9467
	(3.27)***	(0.46)	(0.90)	(3.45)***	(1.72)*	(0.50)
Constant	177.5466	13.8365	50.4767	-217.3821	-146.9240	-13.9351
	(2.53)**	(0.22)	(1.54)	(8.15)***	(5.17)***	(0.79)
Observations	1457	1457	1457	1457	1457	1457
r-squared	0.6674	0.6482	0.8909	0.8297	0.8264	0.9428
J-statistics (p-value)	-.-	0.1977	0.5709	-.-	0.0901	0.9584
Fixed effects	YES	YES	YES	YES	YES	YES
Years effects	NO	NO	NO	YES	YES	YES

Robust z statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Two stage least squares regressions where the average of the taxes of the neighbors (Wstgastax) are instrumented by using the average of the neighbors of AGED, CHILD, STUNEMP, DEMSEN, DEMHOU while in columns 1-3 FEDGASTAX are also instrumented by means of FED DEF. We use the Hansen-Sargan test to test for overidentifying restrictions. The J-statistic is consistent in the presence of heteroskedasticity; Sargan's statistic is not. Since we use the command "robust" and therefore assume the presence of heteroskedasticity, which is quite common in a panel for a federal nation such as US, we use, as STATA does, Hansen's J-statistic, which allows observations to be correlated within groups.

Table 5: Cigarette tax rates (1975-2006), using the CPI and HPI deflator

	(1)	(2)	(3)	(4)	(5)	(6)
	CPI			HPI		
fedcigtax	10.7467	-2.0222	-0.8002	-0.0322	0.1580	-0.0777
	(2.68)***	(1.80)*	(1.13)	(0.09)	(0.44)	(0.29)
L1stcigtax	-.-	-.-	0.7805	-.-	-.-	0.7484
			(15.04)***			(22.19)***
Wstcigtax	-.-	1.1248	0.3461	-.-	0.8380	0.2192
		(7.42)***	(2.76)***		(8.79)***	(2.95)***
Inflation	5,324.8541	-1,122.2133	-498.2441	-62.7194	-50.3215	-139.9674
	(2.88)***	(1.86)*	(1.36)	(2.27)**	(1.88)*	(7.49)***
population	-44.6609	46.7264	22.4808	-7.4145	6.2988	4.2950
	(1.89)*	(3.14)***	(2.55)**	(1.07)	(0.91)	(0.83)
popsq	0.7951	-0.8584	-0.4151	0.1308	-0.1803	-0.0842
	(1.84)*	(2.94)***	(2.59)***	(0.97)	(1.33)	(0.90)
fedgdp	-8.9289	4.9995	1.4392	-.-	-.-	-.-
	(0.84)	(2.38)**	(1.16)			
fedunemp	-24.6514	5.9440	6.6098	-.-	-.-	-.-
	(1.12)	(1.20)	(2.42)**			
stinc	-8.0413	-2.2188	0.5332	1.1221	0.2137	0.4060
	(1.96)**	(0.97)	(0.44)	(1.52)	(0.28)	(0.72)
stincsq	0.0267	0.0042	-0.0014	-0.0018	-0.0001	-0.0006
	(2.60)***	(0.63)	(0.39)	(0.74)	(0.02)	(0.34)
stunemp	9.5487	-4.1719	-0.7096	2.4382	0.2739	-0.0517
	(1.19)	(1.49)	(0.47)	(1.67)*	(0.19)	(0.06)
child	-514.0419	-238.2661	-183.3021	1,770.8212	657.3963	7.9823
	(0.63)	(0.61)	(0.87)	(6.50)***	(2.07)**	(0.04)
aged	3,902.0920	-2,188.9863	-564.1070	1,844.6291	663.3671	417.4967
	(1.50)	(2.71)***	(1.07)	(4.31)***	(1.50)	(1.41)
tobinc	0.0442	-0.0092	-0.0002	0.0072	-0.0005	0.0023
	(1.93)*	(1.36)	(0.04)	(2.12)**	(0.20)	(1.13)
gasinc	-4.3098	0.7157	-0.3734	-3.2934	-2.7680	-1.4349
	(0.83)	(0.31)	(0.23)	(3.08)***	(2.73)***	(1.73)*
grants*10^{-7}	-3.0262	0.6006	0.3377	-0.7449	-0.3638	-0.1472
	(2.28)**	(1.19)	(1.20)	(3.98)***	(1.46)	(0.94)
fedinctax	4,002.3267	-326.3991	-496.3470	481.7771	245.3470	239.0337
	(2.39)**	(0.64)	(1.68)*	(1.19)	(0.61)	(0.82)
demgov	6.3217	18.1995	6.0954	15.1482	11.8395	3.9283
	(0.51)	(2.90)***	(1.64)	(4.55)***	(3.57)***	(1.74)*
demsen	75.7224	60.3804	22.1756	22.2099	29.4601	9.5122
	(0.97)	(1.77)*	(1.11)	(1.10)	(1.38)	(0.70)
demhou	94.7299	67.9774	38.5570	127.3979	29.7572	19.2426
	(1.00)	(1.26)	(1.34)	(4.62)***	(0.94)	(0.89)
Constant	-1,345.1463	341.4636	-7.2574	-673.5114	-320.1579	-144.3115
	(1.86)*	(1.27)	(0.05)	(6.73)***	(3.00)***	(1.95)*
Observations	1457	1457	1457	1457	1457	1457
r-squared	0.2717	0.6575	0.8770	0.6636	0.6495	0.8337
'J-statistics (p-value)	-.-	0.1449	0.4895	-.-	0.0000	0.2330
Fixed effects	YES	YES	YES	YES	YES	YES
Years effects	NO	NO	NO	YES	YES	YES

Robust z statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: See Table 4.

Table 6: Gasoline and cigarette tax rates (1983-2001), using the CPI and HPI deflator.

	(1)	(2)	(3)	(4)
	83-01 CPI		83-01 HPI	
	stgastax	stcigtax	stcigtax	stgastax
fedtax	-0.2224	-0.4842	0.2695	0.1756
	(1.91)*	(2.01)**	(1.16)	(0.96)
L1sttax	0.6354	0.7052	0.7013	0.6447
	(17.97)***	(12.91)***	(15.47)***	(18.22)***
Wsttax	0.4235	0.4163	0.3099	0.1689
	(3.46)***	(2.71)***	(3.07)***	(2.07)**
inflation	-16.5453	-117.4722	-119.3227	-71.5054
	(0.33)	(0.55)	(5.23)***	(7.04)***
population	-2.2327	20.9977	10.4939	-3.2568
	(1.20)	(2.71)***	(2.08)**	(2.11)**
popsq	0.0644	-0.1972	-0.1074	0.0756
	(1.77)*	(1.15)	(0.94)	(2.91)***
fedgdp	0.1160	0.2462	-.-	-.-
	(0.31)	(0.12)		
fedunemp	1.6601	2.7140	-.-	-.-
	(1.19)	(0.76)		
stinc	0.6595	-1.5851	-0.0333	0.3483
	(1.73)*	(1.12)	(0.07)	(1.60)
stincsq	-0.0017	0.0035	-0.0015	-0.0008
	(1.65)*	(0.97)	(0.82)	(0.98)
stunemp	0.6617	-1.0418	0.1751	0.5968
	(1.17)	(0.82)	(0.22)	(1.21)
child	-42.0604	-461.6379	133.5096	-1.7427
	(0.51)	(1.71)*	(0.63)	(0.02)
aged	122.8587	-540.7688	356.1837	178.7325
	(1.05)	(1.34)	(1.53)	(1.75)*
tobinc	-0.0024	-0.0029	-0.0013	-0.0025
	(1.46)	(1.05)	(0.77)	(1.85)*
gasinc	0.1001	1.7110	-0.6128	-0.4505
	(0.11)	(1.12)	(0.66)	(0.70)
grants*10^{-7}	-0.0050	0.5298	0.2487	-0.0524
	(0.09)	(2.02)**	(1.37)	(0.67)
fedinctax	80.1320	196.0545	350.6625	90.8697
	(0.82)	(0.56)	(1.24)	(1.12)
demgov	0.2847	0.3088	0.1076	0.7354
	(0.31)	(0.12)	(0.06)	(0.96)
demsen	-6.0503	9.7931	-7.2009	-3.4406
	(1.06)	(0.53)	(0.48)	(0.63)
demhou	3.5102	-8.5052	1.0711	0.2833
	(0.56)	(0.35)	(0.06)	(0.05)
Constant	-59.1895	197.8748	-183.9587	-34.5520
	(0.91)	(1.64)	(2.50)**	(1.33)
Observations	893	893	893	893
r-squared	0.8908	0.8961	0.8982	0.9415
'J-statistics (p-value)	0.3591	0.4071	0.3450	0.3334
Fixed effects	YES	YES	YES	YES
Years effects	NO	NO	YES	YES

Robust z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Notes: See Table 4.

Table 7: Robustness check: regressions without coastal states and for the period 1975-1995, using the HPI deflator.

	(1)	(2)	(3)	(4)
	Without East and West coastal states		Period: 1975-1995	
	stcigtax	stgastax	stcigtax	stgastax
fedtax	0.2319	0.1608	0.0155	0.2533
	(0.65)	(1.18)	(0.06)	(1.27)
L1sttax	0.7269	0.7800	0.7551	0.7523
	(14.87)***	(30.36)***	(24.85)***	(26.75)***
Wsttax	0.3502	0.1423	0.0949	0.0701
	(2.65)***	(2.07)**	(2.00)**	(1.73)*
inflation	-149.8047	-75.3660	-115.8719	-77.2606
	(6.22)***	(9.47)***	(8.23)***	(11.37)***
population	-0.5298	0.3994	3.9908	-2.5119
	(0.04)	(0.40)	(0.58)	(2.17)**
popsq	0.1388	0.0109	-0.0306	0.0553
	(0.25)	(0.31)	(0.23)	(2.22)**
stinc	0.2477	0.1244	-0.1085	0.2863
	(0.37)	(0.91)	(0.28)	(1.75)*
stincsq	-0.0009	-0.0005	0.0013	-0.0010
	(0.45)	(1.11)	(1.32)	(1.91)*
stunemp	-0.6926	0.6556	0.6014	0.5104
	(0.58)	(1.81)*	(0.76)	(1.43)
child	53.0420	-12.5046	134.6258	-4.5262
	(0.23)	(0.23)	(0.89)	(0.06)
aged	615.0438	72.4076	399.3648	260.9417
	(1.59)	(1.21)	(1.88)*	(2.76)***
tobinc	-0.0004	-0.0004	0.0011	-0.0001
	(0.21)	(0.86)	(1.18)	(0.19)
gasinc	-0.7588	-0.1154	-0.5124	-0.8348
	(0.94)	(0.64)	(0.86)	(3.29)***
grants*10^{-7}	-0.2018	-0.0113	-0.2187	-0.1494
	(1.12)	(0.45)	(1.45)	(1.99)**
fedinctax	306.7781	-75.0355	-130.5880	-153.8064
	(0.80)	(0.98)	(0.67)	(1.59)
demgov	3.8180	-0.1186	-2.7824	-0.1893
	(1.28)	(0.19)	(1.71)*	(0.25)
demsen	-0.0745	-1.1276	1.7605	-1.6200
	(0.00)	(0.24)	(0.16)	(0.35)
demhou	6.2807	2.9448	20.8194	5.7902
	(0.20)	(0.59)	(1.29)	(1.01)
Constant	-150.7825	-7.6221	-68.9462	-30.5209
	(2.04)**	(0.42)	(1.12)	(1.15)
Observations	1054	1054	940	940
r-squared	0.8229	0.9364	0.8975	0.9214
'J-statistics (p-value)	0.3188	0.4464	0.9199	0.1708
Fixed effects	YES	YES	YES	YES
Years effects	YES	YES	YES	YES

Robust z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Notes: See Table 4.

Figure 1: Time evolution of CPI vs. HPI (1975-2006)

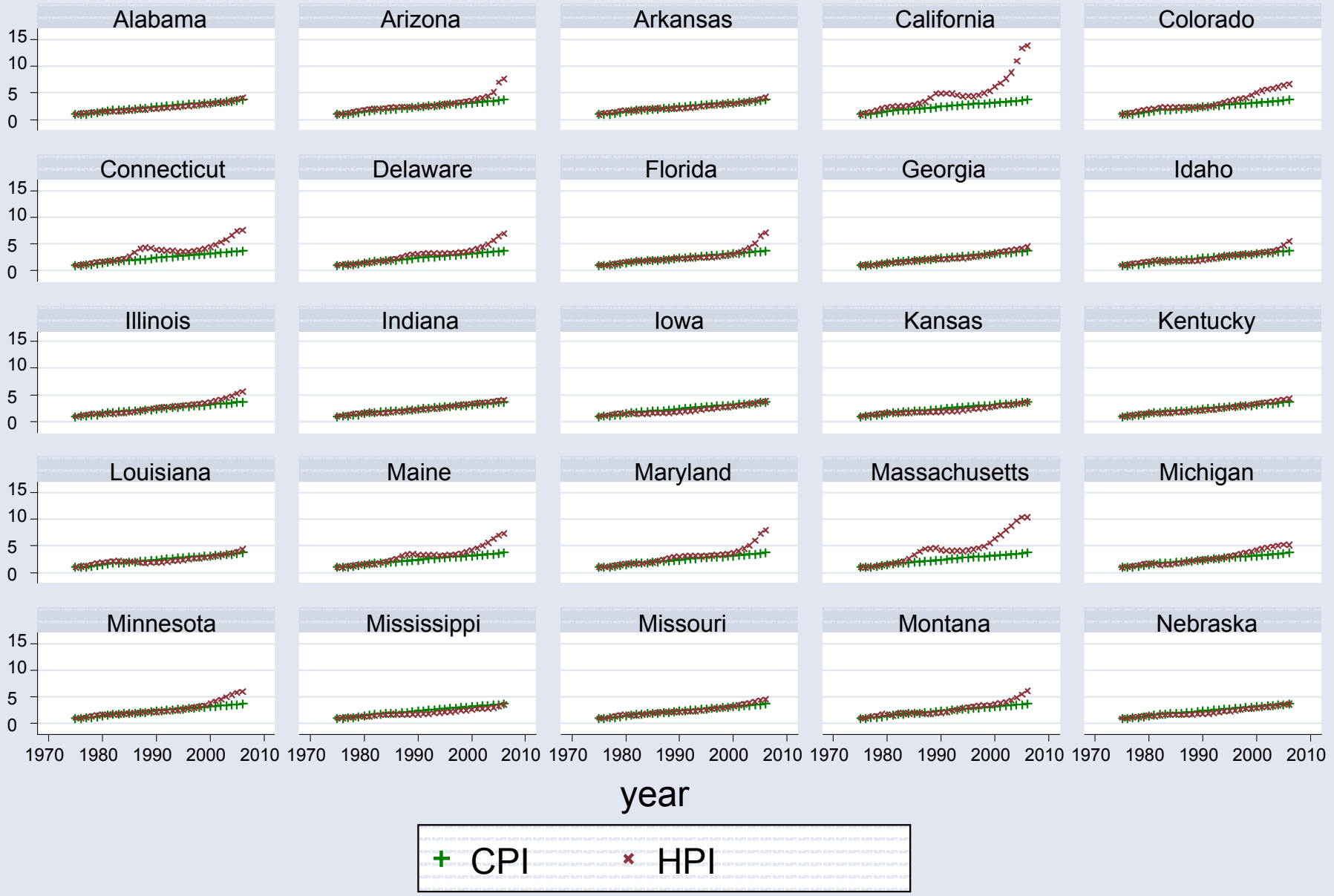


Figure 1 (cont.): Time evolution of CPI vs. HPI (1975-2006)

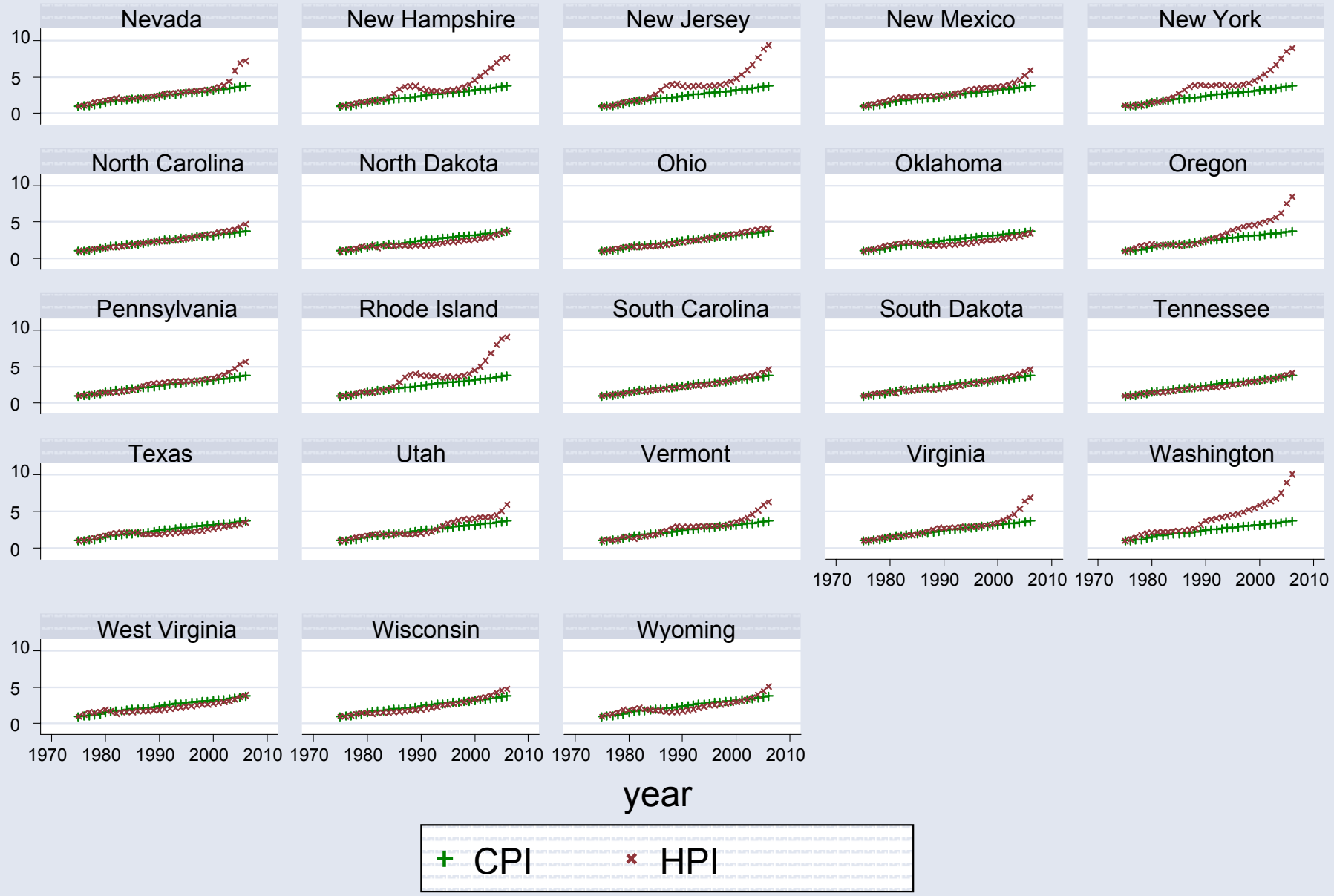
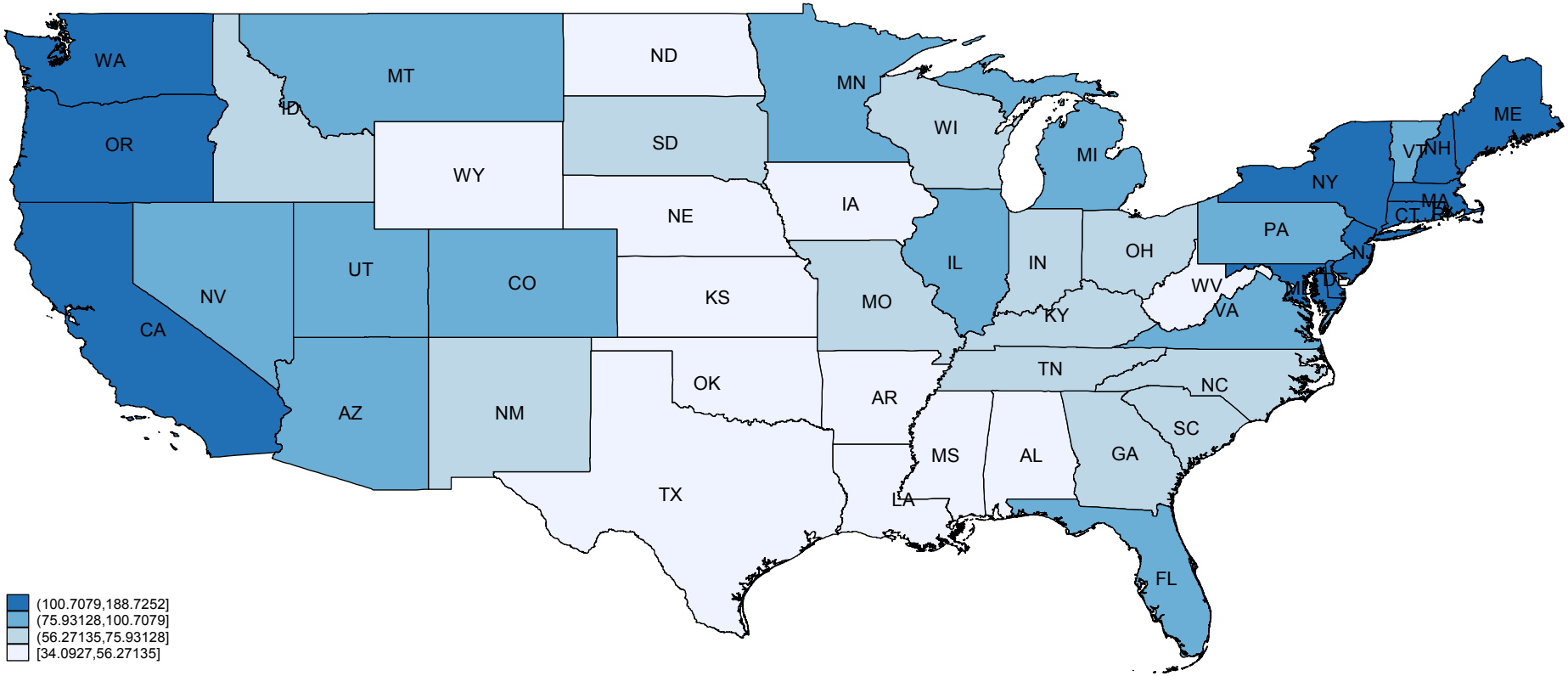


Figure 2: Standard deviation of HPI (1975-2006)



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