IDENTIFICATION OF VERTICAL TAX EXTERNALITIES IN CONSUMPTION: AN APPLICATION TO THE US CASE

Alejandro Esteller Moré
(aesteller@ub.edu)
Universitat de Barcelona & IEB

Leonzio Rizzo
(leonzio.rizzo@unife.it)
Università di Ferrara

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Abstract: Besley and Rosen (1998) was one of the first papers that empirically estimated the presence of vertical tax externalities. This was applied to excise taxes: gasoline and tobacco. However, such analysis might suffer from a potential identification problem. Given that the (statutory) federal tax rate does not show cross-section variation, it might mimic federal shocks common to all states along time. We thus propose redefining the unitary federal tax taking into account the differential price level among states. Thereby, we get a federal tax variable expressed in real terms, showing cross-section variation. This empirical strategy let us identify vertical interdependence between the state tax rates and the federal tax rate, by using US data from 1975 to 2006 on gasoline and tobacco.

JEL Codes: H3, H21, H77

1. Introduction

As it is well-known, the co-occupation of tax bases between layers of government and the myopic behavior of sub-central governments make taxes to be inefficiently high from a social point of view as long as taxes are distortionary (Keen, 1998). The literature has tested the presence of vertical tax externalities by means of estimating the reaction of sub-central governments in front of variations in the federal tax rate. The results obtained are mixed: depending on the tax, on the country, or on the time period, sub-central governments react increasing or decreasing tax rates. In part, this is coherent with the ambiguous results obtained by the theoretical literature (Keen, 1998; or Devereux *et al.*, 2007).

Besley and Rosen (1998) was the first paper that attempted to test the presence of vertical tax externalities, applied to unitary taxes. They did it both for cigarettes and gasoline, and obtained a positive reaction in both cases (higher for gasoline). However, regarding cigarettes, using different time periods and in some cases estimating different equations (*e.g.*, including the lagged endogenous variable and/or taken into consideration horizontal tax competition), Devereux *et al.* (2007) do not find a statistically significant response, while Fredriksson and Mamun (2008) find a negative response. Regarding gasoline, the results are not so contradictory, since Devereux *et al.* (2007) point out to a positive or to an absence of reaction. In this paper, we will reconsider these estimations, and so will try to reconcile these contradictory results.

In all the studies cited above, the federal tax rate does not show cross-section variation as it is transformed into real terms by means of employing a national consumer price index (CPI). This creates a potential identification problem between the variation in the federal tax rate and common shocks. That is why, we propose deflating the federal unitary tax rate by means of a price index that shows cross-section variation, and so we aim at disentangling the impact of the federal tax rate from common shocks. For this purpose we use the HPI (House Price Index), which is a broad measure of the movement of single-family house prices. The House Price Index computed by the OFHEO[1] (Office of Federal Housing Enterprise Oversight) is a weighted, repeat-sales index, meaning that it measures average price changes in repeat sales or refinancing on

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

the same properties.[2] We think that this index, which shows a cross section variation, can reasonably be used to substitute the CPI. The HPI is in fact based on housing price differentials among States, which have been shown to be the prime determinants of cost-of-living differences (Shapiro, 2006)[3].

Once we do that, we do not find any response in the cigarette tax case and a negative one with respect to the gasoline case. As we will see, the results obtained by the literature - all deflating by the CPI - are very dependent on the considered time period, contrary to the case when we deflate for the price index showing cross section variation. In this latter case, the results obtained do not depend on the time period considered.

The structure of the rest of the paper is as follows. In section 2 we review the results obtained by the previous literature, applied to unitary taxes and to the US case; in section 3 we develop our empirical framework and present the data, while in section 4 we present our results. Finally, section 5 concludes.

2. Relation with the previous literature

Table 1 provides a summary of the main results obtained by the literature regarding the testing of the presence of vertical interaction for unitary taxes, all of them having been applied to the US case. Besley and Rosen (1998) obtained a positive reaction, being their seminal result checked by Devereux *et al.* (2007). From this latter work, we can conclude that extending the period of analysis beyond 1989 and till 1997 does not change the basic result, while it is key taking into account horizontal tax competition and the inertia of state tax rates by means of including the lagged endogenous variable. Then, the estimated reaction is not statistically significant. Expanding the period of analysis even beyond, in particular till 2001, makes the estimation of the reaction to become insignificant, although the sign is still positive (Fredriksson and Mamun, 2008). Nonetheless, when these authors exclude the period 1975-1981, when no nominal tax changes occurred, a negative reaction arises independently of further assumptions

[2] 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 refers to Calhoun (1996).

[3] Shapiro (2006) shows that 10% increase in the implicit price of land increases the price of the market basket of goods and services used to compute the CPI (Consumer Price Index) of about 3.2% with a lower bound of 2.2%.

regarding the equation estimated. That is why, the authors state "the time period studied does appear crucial for states' responses to federal taxes" (p. 43), although they also include additional control variables (basically based on political economics arguments), which makes a little bit difficult the comparison with previous works.

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

	Period	Time dummies	Endogenous lagged	Horizontal tax competition (*neighbors*)	Sign reaction
Besley & Rosen (1998)	1975-1989	NO	NO	NO	+ (significant)
Devereux *et al.* (2007); Table 1, 1st column	1977-1997	NO	NO	NO	+ (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)
Fredriksson & Mamun (2008); Table 5, Model III	1975-2001	NO	NO	NO	+ (not significant)*
F & M (2008); Table 5, Model IV	1982-2001	NO	NO	NO	- (significant)*
F & M (2008); Table 5, Model IX	1982-2001	NO	YES	NO	- (significant)*
F & M (2008); Table 5, Model VIII	1982-2001	NO	NO	YES	- (significant)*
Esteller & Rizzo (2009); w/ CPI; Table 4, col. 7-8	1975-2006	NO	YES	YES	+ (not significant)
Esteller & Rizzo (2009); w/ State price index; Table 4, col. 7-8	1975-2006	YES	YES	YES	- (not significant)
Esteller & Rizzo (2009); w/ State price index; Table 4a, col. 7-8	1982-2006	YES	YES	YES	- (not significant)
Esteller & Rizzo (2009); w/ CPI; Table 4a, col.5	1982-2006	NO	NO	NO	- (significant)

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

However, in all these studies – and this also applies to the case of gasoline taxes, as we will see later – "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" (Devereux *et al.*, 2007, p. 466). This creates a potential identification problem, which we try to overcome as we explain in section 3. In any case, first, if we do not deal with this issue, and simply expand the time period analyzed till 2006 (*i.e.*, 1975-2006), but also take into account horizontal tax competition and inertia of state tax rates, obtain the same result than Devereux *et al.*

(2007): no reaction. Second, if we deflate for the state index and include time dummies and so solve the identification problem, the same result holds, although the sign of the estimate is now negative. Therefore, the result for the longest possible span of time is quite robust: states have not reacted to changes in the federal tax rate. When we shorten the time period to 1982-2006 and tackle the identification problem we still get no reaction contrary to Fredriksson & Mamun (2008). Therefore, our result is robust along the longest time-span we are considering. Finally, note that if we use the CPI deflator for period 1982-2006, we are able to replicate Fredriksson and Mamun's result showing a negative relation for cigarette taxes.

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

	Period	Time dummies	Endogenous lagged	Horizontal tax competition (*neighbours*)	Sign reaction
Besley & Rosen (1998)	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)*
Esteller & Rizzo (2009); w/ CPI; Table 4, col. 3-4.	1975-2006	NO	YES	YES	- (not significant)
Esteller & Rizzo (2009); w/ State price index; Table 5, col. 3-4	1975-2006	YES	YES	YES	- (significant)

(*): However, if the relative horizontal interdependence is not exclusively based on neighboring but also on density (*i.e.*, population density in the border), the estimate becomes positive and statistically significant. Thus, although in that case their estimate is substantially lower, they are able to confirm Besley and Rosen's (1998) original result.

With respect to gasoline, the previous results obtained by the literature are not so contradictory, but point out to a positive or to an absence of reaction. In Table 2, we show the results obtained in the literature. Again, Besley and Rosen (1998) obtained a positive reaction, which in this case is not robust to expanding the period analyzed till 1997 (Devereux *et al.*, 2007). Taking into account horizontal tax competition and inertia of taxes do not change this latter result (Devereux *et al.*, 2007, and our own results). However, once we tackle the identification problem, we obtain a statistically significant

negative reaction.

On the whole, our empirical approach permits identifying the consequences of a vertical tax externality in unitary consumption taxes. The reaction of States is different according to the tax under analysis: negative in the case of gasoline taxes, and no-reaction in the case of cigarette taxes. Both results are robust to the time period considered. Note also these results are fully consistent with theory. On the one hand, according to their theoretical model, Devereux *et al.* (2007) hypothesize that in the case of cigarettes, the reaction should be close to zero (p. 462). That is what they obtained and what we have confirmed by means of our new approach to the empirical estimation, while it is in clear contrast with the recent result obtained by Fredriksson and Mamun (2008). On the other hand, still following Devereux *et al.*'s theoretical model, in the case of gasoline – which demand is relatively more elastic – the sign of the reaction is harder to predict, but in any case a negative reaction is fully compatible with their theoretical development. Thus, in this latter case, we obtain a different result from theirs (negative reaction *vs.* no-reaction), which at the same time is compatible with their theoretical framework again.

In the next section, we set up the empirical model that permits obtaining the results advanced in this section.

3. Empirical Analysis

3.1. Empirical framework

To test for the presence of vertical tax externalities in the US case, we estimate for the period 1975-2006 the tax-reaction function relating one states' tax to the federal tax. We do it for gasoline and cigarette taxes, which are the taxes extensively analyzed in the literature as we have shown in the previous section. In particular, we are interested in identifying the sign of the reaction of the state tax in front of changes in the federal tax rate. Given we are dealing with unitary taxes, it is key both variables are expressed in real terms.

We then estimate the following equation:

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

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 on commodity j of the neighbor states of state s in year t, where w_{si} are exogenous weights, normalized such that $\sum_{i \neq s} \omega_{si} = 1$, and 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; s_{st} is what we call the inflation surprise in year t for state s (to be defined next); while ε_{jst} is a mean zero, normally distributed random error. As long as the estimate of γ is different from zero, we would have confirmed the relevance of a vertical tax externality. However, we are also interested in estimating its sign. In order to obtain sensitive conclusions about it (presence and sign of the reaction), though, we have to be sure that we are controlling for other variables that could bias that estimate.

That is why, to isolate the independent impact of the federal tax rate on the tax rate of the states, other variables that might affect the state tax rate must be taken into account. Those 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 by using the following variables: population, per-capita income, unemployment rate, proportion of population over 65 and proportion of population between 5 and 17. Account is also taken of the federal fiscal instruments, which may differ from state to state and might condition the setting of state tax rates, by using federal grants-in-aid in relation to total population and the federal income tax, collected in each state, normalized by the adjusted gross income. The political affiliation of the state government may also affect the tax-rate level: we divide the US party system in two main groups: Republicans and Democrats. We then build dummies for the governors' membership in each of the two political groups and variables accounting for the percentage in the House and Senate of the two groups.

There are certain unchanging characteristics of a state that are likely to affect its tax system, such as climate and geography. We take these characteristics into account by including a dichotomous variable for each state. Changes in the macroeconomic situation may also affect the fiscal policies of states. To account for this, we include a set of time dummies in contrast with previous literature. This is possible as long as our federal unitary tax is deflated by a state-price-index. Otherwise, using the CPI deflator, common shocks are controlled by means of including the federal GDP and federal unemployment.

Finally, unexpected inflation might also cause real tax changes (see Appendix). We cope with this by building an unexpected inflation variable regressing the deflator IND_t on the *IND* lags at *t*-1, *t*-2 an *t*-3, and then using the fitted values to proxy the unexpected inflation. We then define the following "surprise" variable as follows:

$$s_t = \frac{IND_{st} - \hat{IND}_{st}}{IND_{st}} \qquad [2]$$

where $\hat{IND}_t$ is the fitted value from the following time-series regression for each state:

$$IND_{st} = \phi + \theta_1 IND_{st-1} + \theta_2 IND_{st-2} + \theta_3 IND_{st-3} + \psi_{st}\,.$$

being ψ_{st} the random error term.

3. 2. Data

3.2.1 Tax rates

We use annual data on US states from 1975 to 2006, excluding Hawaii, District of Columbia and Alaska. From 1975 to 1983, the federal gasoline tax was four cents per gallon. From 1983, the gasoline tax increased to 9 cents, of which 8 finance the Highway Trust Fund and 1 the Mass Transit Fund. From 1987 the rate increased by 0.1 to finance the Underground Storage tank Leakage Fund. In December 1, 1990, the tax rate jumped to 14.1 generating an increase in resources for Transportation grants, but also for the specific purpose "deficit reduction"; in October 1, 1993, there was a farther increase to 18.4, due only to an increase in the provision of resources to reduce the deficit; the destination of the revenue changed from October 1, 1995, since 2.5 cents of

it were redirected to Transportation grants and the rate did not change. More expenditure to Transportation was given from October 1, 1997, since the deficit reduction fund was canceled and the tax rate remained unchanged. Therefore, from 1983, there have been several important statutory tax changes, while – as advanced in section 2 also for the case of cigarettes – no nominal changes occurred prior to that 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 increased to 20 cents per pack in 1991, becoming 24 in 1993. In 2000 it increased 10 cents and it has been 39 cents per pack from 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 on gasoline ranged from 7.5 cents in Georgia to 22 cents in Connecticut and Washington. Thus, there is an important cross-section variation.

Taxes on cigarettes vary as well, across time, differently according to states; in fact North Carolina varied its tax from 2 to 5 cents in 1992 and then it arrived at 30 in 2005 and at 35 in 2006; Connecticut showed more variation, presenting a tax of 21 cents until 1983, a change to 26 in 1984, then it went to 40 in 1989, 45 in 1992, 47 in 1994, 50 in 1995, 111 in 2002 and finally 151 from 2003. Taxes on gasoline also vary very differently across time according to states; Georgia, for example, maintained the same tax (7.5) during all the time period we consider. Nevertheless, Connecticut and Washington present a good variation across time; Connecticut increased tax from 10 to 11 cents per gallon in 1976, the tax went gradually from 14 in 1983 to 38 in 1997; it started decreasing to 36 in 1998, then it passed to 32 in 1999 and finally to 25 in 2002. Washington levied 9 cents till 1976, then it shrank gradually to 18 in 1984, which changed to 22 in 1990 and to 23 in 1991, until the change to 28 in 2004, passing to 31 in 2005 and finally to 34 in 2006.

3.2.2 CPI and state-specific deflator

In the previous literature, nominal unitary taxes are divided by CPI to adjust for

inflation. However, the use of CPI does not allow identifying the vertical externality, namely exploring the potential relation between federal tax and state tax. In fact, in that case the federal tax rate does not show cross section variation preventing the possibility to control for macroeconomic shocks by using year effects: the federal tax would be a particular linear combination of year effects.

Nonetheless it is reasonable to think of prices to be very different across US states and to have a real impact on federal taxes (see, for example, Albouy, 2008). The increase of the federal gasoline tax in 1990 from 9 cents to 14.1 cents has not the same impact in Wyoming and California. It hurts more the former than the latter. The mechanism, all other things being equal, should imply a different tax response from Wyoming and California to a change in federal tax. This happens because each state faces a state and federal tax deflated by its own state-specific inflation.

The example cited above seems particularly true if we look at Figure 1 where we report the indices normalized using their corresponding value in 1975. It is interesting noting that there are some states, especially after the nineties, for which the HPI increases more than the CPI. These are California, Colorado, Connecticut, Massachusetts, New Jersey, New York, Oregon, Rhode Island, and Washington. On the other hand, the HPI trend seems to be well fitted by the CPI trend for other states.[4] Therefore, using one or another price index has statistical consequences, and in any case according to economic theory the state-index is the one that makes more sense, that is, the one that each state-representative-citizen should take into account when adopting economic decisions.

[FIGURE 1]

3.2.3 The rest of variables

The right-hand-side variables of [1], with their definitions, means, and standard deviations, are also reported in Table 3. In the following sections we use data both normalized by the CPI and the HPI. In the former case we control for macroeconomic

[4] Looking at figure 1, this seems true for the following states: Wyoming, West Virginia, Wisconsin, Tennessee, South Dakota, South Carolina, Ohio, Oklahoma, Nebraska, North Dakota, North Carolina, Mississippi, Nebraska, Montana, Louisiana, Kentucky, Kansas, Indiana, Iowa, Georgia, Arizona, and Alabama.

shocks by using the national unemployment rate, *FEDUNEMP*, and real federal GDP which are included in the *X* vector of [1], in the latter case (*i.e.*, when we use the HPI) we use year effects.

[TABLE 3]

Next are a set of time-varying variables characterizing the state's economic and demographic situation: state population (*POP*), per capita state income (*INC*), state unemployment rate (*UNEMP*), the proportion of individuals in the state who are between 5 and 17 (*CHILD*), and the proportion who are over 65 (*AGED*). The state's political environment can also affect fiscal outcomes and therefore we use a dummy variable that equals one if the governor is a Democrat and zero otherwise; (*DEMGOV*), and the proportions of Democrats in the state Senate and House of Representatives (*DEMSEN* and *DEMHOU*, respectively). The industries of cigarettes and gasoline can also affect through lobbying process the state government the tax rate on their respective commodities (Dixit, 1996); we use a measure of the 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 affect state commodity tax rates, therefore 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. Finally, we account for state unchanging characteristics by using state fixed effects.

3.3 Empirical strategy

The mean US neighbouring tax rate is endogenous, because it can also be influenced by the tax rate that we are estimating. Then, if this is a structural model, a simple OLS estimate of [1] would suffer from endogeneity bias: the error term ε_{jst} would be correlated with the error terms of the other simultaneous equations of the system. The endogeneity bias arises from the fact that we are dealing with simultaneous equations. We use the two-stage least squares method: first, we estimate the reduced forms of the endogenous variables and then substitute their fitted values into [1]. The residuals of this last equation are corrected using the actual values of the endogenous variables.

We instrumented the mean US neighbouring tax rate $\sum_{i \neq s} w_{si} t_{jst}$ with the neighbouring US variables $AGED_{st}$, $UNEMP_{st}$, $DEMGOV_{st}$, and the federal tax with the federal GDP_t. We have 3 instruments, and hence Eq. [1], which has two endogenous variables, is identified.[5]

In the first case we estimate a Stackelberg model where the federal government moves first and the states follow, which implies an exogenous federal tax; in the second case the federal government moves simultaneously with the provincial governments and therefore the federal tax is endogenous.[6]

4. Results

We start by using the dataset deflated with CPI. We regress the own tax rate in each state on the federal US tax rate for gasoline. The own tax rate is strongly correlated with the federal US tax rate. The coefficient is 0.41 and more than 1% significant.[7]

[TABLE 4]

In column 1 of Table 4 we add the variable accounting for the average state tax of the neighbours, whose coefficient, 0.81, is significant at 1% and makes the federal tax not significant; we further insert the lag of the dependent variable, whose coefficient (0.76) is very significant, leaving the federal tax coefficient not significant; we then control for the unexpected inflation surprise, resulting in a 5% significant coefficient (-80.3), but still with the federal tax coefficient not significant. We finally instrument the federal tax, but nothing changes.

We carry out the same regressions for cigarettes. The own tax rate is not correlated with the federal US tax rate: the coefficient is -0.18 and not significant[8] and so it remains for

[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 along 32 years. That is why, we do not instrument the lagged endogenous variable.
[6] Keen and Kotsogiannis (2002) explore differences in statics-comparative results between the two models.
[7] This basic regression does not appear in the tables but is available from the authors upon request.
[8] As for gasoline, this basic regression does not appear in the tables but is available from the authors upon request.

all the other specifications we consider. In column 5 of Table 4 we add the variable accounting for the average state tax of the neighbours, whose coefficient is unexpectedly high (1.65) and significant at 10%. The coefficient becomes not significant when we add the lag of the dependent variable, which, on the contrary, is 1% significant and says that a 10% increase in previous year tax determines more than 6% increase in current year tax. When in the forth column we add the surprise variable nothing changes, as well as if we instrument, except that the lag of the coefficient variable increases.

These results on gasoline and cigarettes are coherent with Devereux *et al.* (2007): when they control for the average tax rate of the neighbours and the lag of the dependent variable, the federal tax is not significant.

[TABLE 5]

We then deflated all our monetary variables by using the state index. We start with gasoline tax. In column 1 of Table 5, the coefficient of average state tax of the neighbours is 0.42 and significant at 1% and the federal tax coefficient is 1.01 and 1% significant; controlling for the lag of the dependent variable is very important because it makes the federal tax not significant; however once we control for the unexpected inflation surprise, which is 1% significant and negatively affects the state tax, the negative federal tax coefficient increases in absolute value (-0.25), saying that a 10% increase in federal tax determines a 2.5% decrease in the state tax. Moreover the overidentification test (Hansen J) jumps from 0.35 in the specification without the unexpected surprise term to 0.85, when we include it, confirming that the surprise variable was really affecting the residuals of the regression. When we instrument the federal tax nothing changes and moreover the federal tax coefficient increases (up to -0.42) and becomes 5% significant, with an overidentification test sill acceptable (0.76).
As with the CPI deflator, we did the same regressions for cigarettes using the state price index: the coefficient of the federal tax is not significant in all the specifications. In column 5 of Table 5 the coefficient of the variable for the average state tax of the neighbours is 0.61 and 1% significant. The coefficient is still significant but at 5% when we add the lag of the dependent variable (column 6 of Table 5), which is 1% significant and says that a 10% increase in previous year tax determines more than 7.2% increase in

current year tax. In column 7 the coefficient of the surprise variable is negative and 5% significant and moreover symmetrically to the gasoline regression increases the absolute value of the federal tax coefficient even if it remains not significant. When we instrument the federal tax (column 8) nothing changes.

[TABLE 4a]

[TABLE 5a]

Notice that this result is robust to different time-spans of the dataset. We tried a regression for the period 1982-2001: with the HPI nothing changes (Table 5a, col. 1 and 3), but with CPI we get a negative coefficient (Table 4a, col. 1 and 3), exactly as Fredriksson and Mamun (2008) get. Notice that this last result disappears not only using the dataset from 1975, as Fredriksson and Mamun (2008) argue, but also updating the data set 1982-2001 till 2006 (Table 4a, col. 5 and 7): from 2001 to 2006 some US states registered a very strong increase in prices which justifies their nominal increase in taxes. Using our state index (HPI) the federal tax coefficient is not significant not depending on the time period we consider (Table 5a, col. 1, 3, 5, 7).

5. Conclusions

We have tested the impact of an increase in federal tax on state tax in US, providing evidence that an increase in federal tax affects state tax in the gasoline case and not in the cigarette case. Moreover in the gasoline case the sign is opposite to what the literature has found till now: an increase in federal tax on gasoline induces a decrease in state gasoline tax.

The novelty of our approach is that we are able to identify the impact of the federal tax rate on the state tax rate by using a state-specific deflator, the HPI (Housing Price Index) which differently from the usual CPI (Consumer Price Index) presents cross-section variations. This approach allows testing the impact of the federal tax rate on the state tax rate, by controlling for macroeconomic shocks, proxied by year effects. This would not have been possible using the CPI as deflator whereby the introduction of year effects prevents from checking the impact of the real federal tax rate, which is perfectly collinear with a particular linear combination of year effects. The paper developed a test

using a data set for US running from 1975 to 2006 for specific cigarette and gasoline taxes.

We also cast light on the role on unexpected inflation in determining the link between the federal and state tax in the gasoline case. Only when the unexpected inflation term is introduced a fiscal negative relation emerges.

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Appendix: Unitary taxes, vertical tax externalities and the role of inflation

We consider a model with excise taxes, where both the federal government and state governments co-occupy the same tax base. Tax rates are unitary, such that the consumer price including taxes is $q_t \equiv p_t + \tau_t + T_t$, where p_t is the (exogenously given) producer price, τ_t is the state tax, and T_t is the federal tax, all of them at time *t*. We analyze the decision problem of a representative state government regarding its choice of τ_t, as usual taking as given the decision problem of the federal government.

Given we are dealing with unitary taxes, the consideration of inflation is not a trivial issue, in particular, the consideration of unexpected inflation. In order to show this, let suppose the federal government, first, chooses its (expected) real tax, that is, its nominal tax rate given the expected inflation rate, and next, each state government acts in the same way. As long as inflation is not perfectly foreseen *ex ante*, this will create surprises that *ex post* might be neutralized by governments by means of modifying their corresponding nominal tax rates. Hence, governments should not react to expected inflation, but to unexpected inflation.

In order to take inflation into account, we will suppose nominal tax rates (at stage 1 for the federal government; and at stage 2 for each state government) are set given an expected inflation rate π_t^E (with respect to a base year). Thus, (expected) real revenue at time *t*, R_t^E, for a representative state government is:

$$R_t^E(\alpha = 0) \equiv \frac{\tau_t^N}{\left(1+\pi_t^E\right)(1+\alpha)} . X\left(\frac{q_t^N}{\left(1+\pi_t^E\right)(1+\alpha)}\right) \qquad [A1]$$

where *X(.)* is the consumption of the taxed good, which we assume only depends on its (real) price; super-index *N* reflects nominal values; and α is the potential surprise (positive or negative) on expected inflation. At time *t*, we suppose α=0.

If there is a positive (negative) surprise at *t*+1 (*i.e.*, at stage 3 for all governments), the real tax rate decreases (increases), and so the demand of the taxed good increases (decreases). As long as (reasonably) the price elasticity in absolute value, ε, is less than one, real revenues decrease, and so nominal tax rates should increase. Analytically,

$$\left.\frac{d\tau_t^N}{d\alpha}\right|_{\alpha=0} = \frac{\tau_t^N(1-\varepsilon)}{1-\left(\tau_t^N/q_t^N\right)\varepsilon} \geq 0 \qquad [A2]$$

The real tax rate might also change due to the fact that the tax is distortionary. The real tax rate at *t*+1 is:

$$\tau_{t+1}^R(\alpha > 0) \equiv \frac{\tau_t^N + \left\{\dfrac{\tau_t^N(1-\varepsilon)}{1-\left(\tau_t^N/q_t^N\right)\varepsilon}\right\} d\alpha}{\left(1+\pi_t^E\right)(1+\alpha)}$$

where $d\alpha = \alpha$ (or $d\alpha = -\alpha$ if true inflation is lower than expected, that is, if there is a

"negative surprise"), since at t $\alpha = 0$. It is very easy to verify that $\tau_t^R = \tau_{t+1}^R$ as long as $\varepsilon = 0$, which obviously does not make sense within our framework of vertical tax externalities. Otherwise, if there is a negative (positive) surprise, the real tax should go up (down). Therefore, $d\tau_t^R / d\alpha \leq 0$. Obviously, there will not be any effect neither on the nominal nor on the real tax rate as long as governments perfectly foresee the inflation rate.

Table 3

Summary statistics*

Variable	Obs	Mean	Stand. Dev.	Min	Max
tg*10 (state unit gasoline tax, cents in real terms with cpi)	1536	122.133	27.840	37.202	236.760
'wtg*10 (avarage of neighbors state unit gasoline tax, cents in real terms with cpi)	1536	121.395	17.445	63.244	171.004
Tg*10 (federal unit gasoline tax cents in real terms with cpi)	1536	89.653	23.241	41.451	127.336
tc*10 (state unit gasoline tax, cents in real terms with cpi)	1536	216.764	163.423	13.587	1302.276
wtc*10 (average of neighbors state unit cigarette tax, cents in real terms with cpi)	1536	210.095	125.615	46.196	965.237
Tc*10 (federal unita gasoline tax cents in real terms with cpi)	1536	151.423	33.508	82.902	216.787
tg*10 (state unit gasoline tax, cents in real terms with state index)	1536	98.451	31.504	18.201	201.350
'wtg*10 (avarage of neighbors state unit gasoline tax, cents in real terms with state index)	1536	97.573	23.476	35.106	163.209
Tg*10 (federal unit gasoline tax cents in real terms with state index)	1536	75.021	25.378	31.025	147.409
tc*10 (state unit gasoline tax, cents in real terms with state index)	1536	160.780	88.496	7.990	649.710
wtc*10 (average of neighbors state unit cigarette tax, cents in real terms with state index)	1536	155.534	59.483	30.729	469.234
Tc*10 (federal unita gasoline tax cents in real terms with state index)	1536	120.238	33.300	50.480	235.863
surprise*100 with cpi	1392	0.025	0.978	-2.033	2.440
surprise*100 with state index	1392	0.088	4.437	-20.588	26.505
GDP (real national gross domestic product , billion of dolllars in real terms with cpi)	1536	45.662	10.137	30.452	65.707
GDP (real national gross domestic product , billion of dolllars in real terms with state index)	1536	36.204	9.919	15.484	66.492
FED UNEMP (federal unemployment rate)	1536	6.284	1.410	4	9.7
POP(state population*10^{-6})	1536	5.237	5.544	0.382	36.250
POP2 (square of state population*10^{-6})	1536	58.142	146.125	0.146	1314.053
INC (state income per capita*10^{-3} in real terms with cpi)	1536	140.725	28.242	78.134	251.798
INC (state income per capita*10^{-3} in real terms with state index)	1536	110.393	22.615	58.685	197.910
INC2 (square of state income per capita*10^{-3} in real terms with cpi)	1536	20600.720	8563.152	6104.852	63402.160
INC2 (square of state income per capita*10^{-3} in real terms with state index)	1536	12697.670	5242.610	3443.895	39168.270
UNEMP (state unemployment rate)	1536	5.933	2.032	2.3	17.4
WUNEMP (average of neighbors state unemployment rate)	1536	5.910	1.685	2.3	13.2
CHILD (proportion of population between 5 and 17)	1536	0.196	0.021	0.155	0.268
AGED (proportion of population over 65)	1536	637034	665592	33695	3923749
WAGED (average of neighbors proportion of population over 65)	1536	642107	331658	68072	1508692
TOBINC (tobacco production per dollar of state income in real terms with cpi)	1536	252.517	916.475	0	10225.090
TOBINC (tobacco production per dollar of state income in real terms with state index)	1536	316.402	1144.480	0	13393.340
GASINC (daily gasoline production per dollar of state income in real terms with cpi)	1536	0.803	2.677	0	31.343
GASINC (daily gasoline production per dollar of state income in real terms with state index)	1536	0.933	3.180	0	35.934
GRANTS (federal grants per capita in dollars*10^{-8} in real terms with cpi)	1536	562*10^{-8}	225*10^{-8}	231*10^{-8}	2740*10^{-8}
GRANTS (federal grants per capita in dollars*10^{-8} in real terms with state index)	1536	444*10^{-8}	197*10^{-8}	151*10^{-8}	2210*10^{-8}
INCTAX (federal income tax divided by adjusted gross income)	1536	0.136	0.016	0.092	0.193
DEMGOV (=1 if the governor is a Democrat)	1536	0.536	0.499	0	1
WDEMGOV (=1 if the governor is a Democrat)	1536	0.538	0.292	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 ona 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).

Table 4: regressions with real state tax rates (gasoline and cigarettes) as dependent variable (1975-2006), using the cpi deflator.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	stgastax	stgastax	stgastax	stgastax	stcigtax	stcigtax	stcigtax	stcigtax
Wstgastax	0.8171	0.2858	0.2514	0.2799				
	(4.90)***	(2.53)**	(2.32)**	(2.42)**				
fedgastax	0.0566	0.0036	0.0180	-0.0972				
	(0.70)	(0.08)	(0.45)	(1.12)				
stgastaxL1		0.7631	0.7394	0.7594				
		(28.69)***	(26.42)***	(24.75)***				
surprise1			-80.3195	-91.9723			-407.0184	-68.2947
			(2.48)**	(2.78)***			(0.93)	(0.11)
Wstcigtax					1.6534	0.8827	1.2321	0.2781
					(1.89)*	(1.12)	(1.06)	(0.64)
fedcigtax					0.2005	0.2500	0.3386	0.0501
					(0.56)	(1.20)	(1.21)	(0.04)
stcigtaxL1						0.6497	0.5612	0.8062
						(3.05)***	(1.84)*	(5.76)***
population	-5.5534	-1.2200	-0.7810	-2.8294	25.0487	13.3485	22.2870	12.3173
	(2.49)**	(1.02)	(0.54)	(1.55)	(1.73)*	(1.16)	(1.16)	(0.71)
fedunemp	-1.3098	0.0186	-0.6174	-0.2545	-11.0963	-5.1162	-10.2770	5.1487
	(1.24)	(0.03)	(0.94)	(0.34)	(0.60)	(0.41)	(0.56)	(1.39)
fedgdp	-0.1645	-0.1786	-0.2210	-0.0555	-7.3801	-6.3489	-10.9199	-0.3878
	(0.64)	(1.29)	(1.60)	(0.31)	(0.61)	(0.79)	(0.88)	(0.33)
pop2	0.0589	0.0124	0.0135	0.0192	-0.9171	-0.5949	-0.9304	-0.3330
	(2.16)**	(0.88)	(0.88)	(1.21)	(1.99)**	(1.43)	(1.23)	(0.94)
stinc	-0.0238	0.1418	-0.0483	0.2976	6.6620	6.6987	10.5569	1.4529
	(0.07)	(0.76)	(0.24)	(0.99)	(0.60)	(0.91)	(0.95)	(0.30)
stinc2	-0.0001	-0.0003	0.0001	-0.0008	-0.0211	-0.0195	-0.0307	-0.0030
	(0.09)	(0.67)	(0.29)	(0.98)	(0.62)	(0.86)	(0.91)	(0.22)
stunemp	0.4734	0.7499	0.7812	0.8797	2.8100	3.3558	3.7080	0.6498
	(0.88)	(2.11)**	(2.05)**	(2.24)**	(0.47)	(0.94)	(0.86)	(0.44)
child	27.2148	-167.1237	-214.2477	-205.6499	-463.5745	-427.2962	-268.7521	67.7085
	(0.43)	(4.63)***	(5.20)***	(4.85)***	(0.47)	(0.85)	(0.41)	(0.25)
aged	0.0000	0.0000	0.0000	0.0000	0.0002	0.0001	0.0002	0.0000
	(1.37)	(1.44)	(0.86)	(1.85)*	(1.04)	(1.08)	(1.05)	(0.72)
tobinc	-0.0022	-0.0015	-0.0017	-0.0015	-0.0017	0.0025	-0.0000	0.0042
	(1.85)*	(1.79)*	(1.77)*	(1.62)	(0.39)	(0.68)	(0.00)	(0.56)
gasinc	-2.0667	-0.3229	-0.2981	-0.5114	-4.5327	-4.4954	-8.2067	-1.5990
	(4.95)***	(1.79)*	(1.11)	(1.74)*	(0.83)	(0.99)	(0.98)	(0.61)
grants	-47,890.4394	-386018.8973	-238220.6769	-569401.0682	-3.2517e+06	-2.1529e+06	-2.6235e+06	1023120.2489
	(0.12)	(2.04)**	(1.25)	(2.12)**	(0.68)	(0.58)	(0.54)	(0.62)
fedinctax	-149.9509	-68.9501	-68.2278	-17.1810	1,206.5333	531.5916	702.9126	-352.5855
	(1.72)*	(1.58)	(1.68)*	(0.33)	(0.92)	(0.56)	(0.54)	(1.13)
demgov	0.2763	-0.0956	0.1744	0.1273	10.6229	3.2331	3.0887	5.0409
	(0.30)	(0.17)	(0.30)	(0.22)	(1.14)	(0.71)	(0.53)	(1.33)
demsen	2.3027	3.3138	4.5280	4.8699	11.5165	-3.8069	-21.7078	20.8603
	(0.38)	(0.79)	(1.06)	(1.10)	(0.15)	(0.09)	(0.34)	(0.73)
demhou	3.9717	2.0877	2.8168	4.7479	-42.2002	-39.2588	-75.3822	37.0158
	(0.50)	(0.39)	(0.52)	(0.85)	(0.28)	(0.41)	(0.56)	(1.17)
Constant	66.3833	27.9210	60.5851	20.1218	-440.0487	-389.9402	-570.3783	-258.2793
	(1.37)	(1.04)	(2.06)**	(0.51)	(1.51)	(1.55)	(1.44)	(0.95)
Overid (Hansen Test)	0.14011	0.05921	0.01887	0.05671	0.89905	0.86603	0.94262	0.51074
Observations	1504	1457	1363	1363	1504	1457	1363	1363

Robust z statistics in parentheses

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

Notes: Columns 1-3 and 5-7 are two stage least squares regressions where the average of the taxes of the neighbors (Wstgastax and Wstcigtax) are instrumented by using the average of the neighbors of AGED, STUNEMP e DEMGOV. Columns 4 and 8 present two stage least squares regressions where besides the average of the taxes of the neighbors also the federal tax (FEDGASTAX, FEDCIGTAX) is instrumented by using FED DEF. All regressions include state fixed effects.

Table 4a: regressions with real state tax rates (cigarettes) as dependent variable, using the cpi deflator.

	1982-2001				1982-2006			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	stcigtax	stcigtax	stcigtax	stcigtax	stcigtax	stcigtax	stcigtax	stcigtax
fedcigtax	-0.1634	-0.1139	-0.0939	-0.0076	-0.4873	0.4450	0.3854	1.1741
	(1.81)*	(1.30)	(1.68)*	(0.09)	(3.07)***	(0.87)	(1.22)	(0.59)
Wstcigtax		0.3762	0.1809	0.2011		2.3524	1.3813	-0.0517
		(1.86)*	(1.30)	(1.44)		(1.76)*	(1.12)	(0.08)
surprise1		75.8902	-81.1731	-71.7779		-732.2491	-468.1369	379.7669
		(0.43)	(0.76)	(0.66)		(0.98)	(0.89)	(0.47)
L1stcigtax			0.7371	0.7348			0.5442	0.8938
			(16.69)***	(16.52)***			(1.90)*	(4.79)***
population	-4.3027	12.7221	1.4285	0.5405	15.6070	102.9690	61.1148	-11.1702
	(0.28)	(0.77)	(0.14)	(0.05)	(0.72)	(1.84)*	(1.17)	(0.20)
fedunemp	-3.6754	-4.1889	-1.9103	-2.3055	22.0088	-30.5644	-17.0852	2.2079
	(1.36)	(1.66)*	(1.24)	(1.46)	(5.37)***	(1.03)	(0.74)	(0.51)
fedgdp	4.4923	1.2941	-0.0568	-0.5932	20.2490	-26.0026	-17.6817	-0.0398
	(3.59)***	(0.61)	(0.04)	(0.44)	(8.86)***	(1.02)	(0.97)	(0.01)
popsq	0.4317	0.1467	0.0392	0.0413	-0.0796	-2.3325	-1.4758	-0.0372
	(1.90)*	(0.57)	(0.22)	(0.23)	(0.28)	(1.76)*	(1.27)	(0.05)
stinc	-3.1495	-2.0234	-0.5556	-0.2984	-18.0695	21.9798	15.8920	-1.8026
	(2.00)**	(1.21)	(0.53)	(0.30)	(7.58)***	(0.98)	(1.02)	(0.25)
stincsq	0.0105	0.0072	0.0017	0.0012	0.0496	-0.0621	-0.0439	0.0066
	(2.41)**	(1.52)	(0.60)	(0.43)	(8.26)***	(0.98)	(0.99)	(0.31)
stunemp	3.0180	1.6110	1.2768	1.2286	-0.9881	-0.7874	0.3018	1.5150
	(1.63)	(0.83)	(1.13)	(1.08)	(0.32)	(0.18)	(0.11)	(0.59)
child	807.7895	567.1100	-141.7241	-86.3590	-1,133.8404	1,997.5677	1,415.9753	13.1364
	(2.11)**	(1.52)	(0.69)	(0.41)	(1.68)*	(1.12)	(1.09)	(0.02)
aged	0.0000	0.0000	0.0000	0.0001	-0.0000	0.0002	0.0002	0.0001
	(0.47)	(0.33)	(1.26)	(1.42)	(0.56)	(1.15)	(1.17)	(1.07)
tobinc	0.0165	0.0117	0.0010	0.0016	0.0302	-0.0051	-0.0045	0.0137
	(3.00)***	(2.26)**	(0.52)	(0.81)	(2.77)***	(0.24)	(0.35)	(0.82)
gasinc	6.4055	4.7790	1.7732	1.5407	9.3220	-13.1751	-10.0187	-1.6851
	(2.42)**	(1.91)*	(1.29)	(1.16)	(1.89)*	(0.90)	(0.97)	(0.37)
grants	4793815.162	5996454.8265	2496185.7651	2288653.9899	2058607.7443	3318306.7517	2401554.0837	-848452.9377
	(1.67)*	(2.11)**	(1.38)	(1.29)	(0.56)	(0.62)	(0.66)	(0.15)
fedinctax	1,264.5731	827.2868	298.5460	252.0547	-312.6043	585.1677	-12.3082	-468.6234
	(3.78)***	(2.00)**	(1.14)	(0.97)	(0.71)	(0.64)	(0.02)	(1.34)
demgov	5.1106	2.8020	0.6177	0.2424	24.9239	16.5470	8.7766	5.0462
	(1.43)	(0.77)	(0.25)	(0.10)	(3.50)***	(1.48)	(1.29)	(0.79)
demsen	42.9712	41.3316	15.0076	14.6513	199.0616	-24.8332	-28.3358	46.7343
	(1.62)	(1.70)*	(0.88)	(0.85)	(4.06)***	(0.17)	(0.35)	(1.19)
demhou	88.0181	45.0955	14.8156	9.1047	236.4136	-146.3765	-93.0909	44.0079
	(2.98)***	(1.36)	(0.63)	(0.39)	(4.24)***	(0.66)	(0.62)	(1.09)
Constant	-280.5821	-191.1154	-11.7689	-20.5483	433.3568	-1,400.1694	-1,011.7961	-75.7502
	(1.92)*	(1.32)	(0.14)	(0.25)	(1.81)*	(1.35)	(1.30)	(0.15)
Observations	940	940	940	940	1175	1175	1175	1175

Robust z statistics in parentheses

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

Notes: Columns 1 and 5 are OLS. Column 2-3 and 6-7 are two stage least squares regressions where the average of the taxes of the neighbors (Wstcigtax) is instrumented by using the average of the neighbors of AGED, STUNEMP e DEMGOV. Columns 4 and 8 present two stage least squares regressions where besides the average of the taxes of the neighbors also the federal tax (FEDCIGTAX) is instrumented by using DEF.

Table 5: regressions with real state tax rates (gasoline and cigarettes) as dependent variable (1975-2006), using the hpi deflator

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	stgastax	stgastax	stgastax	stgastax	stcigtax	stcigtax	stcigtax	stcigtax
Wstgastax	0.4247	0.3578	0.5014	0.5014				
	(3.78)***	(3.91)***	(3.96)***	(3.96)***				
fedgastax	1.0108	-0.0104	-0.2569	-0.4254				
	(5.16)***	(0.08)	(1.90)*	(2.41)**				
stgastaxL1		0.7015	0.6907	0.6968				
		(27.83)***	(23.62)***	(23.70)***				
surprise1			-51.2054	-52.3901			-76.3934	-76.7782
			(7.34)**	(7.47)***			(3.35)**	(3.25)***
Wstcigtax					0.6119	0.3195	0.4046	0.4332
					(3.04)***	(2.06)**	(1.69)*	(1.81)*
fedcigtax					0.3003	-0.0347	-0.1120	-0.1410
					(0.87)	(0.12)	(0.37)	(0.37)
stcigtaxL1						0.7244	0.7118	0.7084
						(18.96)***	(15.78)***	(15.62)***
population	-8.3025	-2.0682	-3.2487	-3.1940	-12.2191	-0.9271	-2.3725	-1.7834
	(4.79)***	(1.91)*	(2.42)**	(2.38)**	(1.32)	(0.12)	(0.23)	(0.17)
pop2	0.1365	0.0316	0.0364	0.0371	-0.0142	-0.0803	-0.1124	-0.1244
	(6.51)***	(2.37)**	(2.20)**	(2.24)**	(0.10)	(0.70)	(0.72)	(0.81)
stinc	0.5126	0.1340	-0.1445	-0.0842	0.1058	0.6235	0.5173	0.5276
	(2.09)**	(0.95)	(0.86)	(0.47)	(0.16)	(1.14)	(0.78)	(0.94)
stinc2	-0.0013	-0.0001	0.0014	0.0014	0.0005	-0.0014	-0.0008	-0.0007
	(1.28)	(0.15)	(1.97)**	(2.07)**	(0.22)	(0.88)	(0.40)	(0.40)
stunemp	1.0946	1.7777	1.3380	1.3340	1.2460	2.5485	2.0766	2.0121
	(2.64)***	(5.88)***	(4.12)***	(4.11)***	(0.97)	(2.57)**	(1.81)*	(1.68)*
child	65.0410	-170.3701	-214.8013	-187.8826	826.5709	-260.7527	-349.6796	-368.3082
	(0.74)	(2.68)***	(2.78)***	(2.35)**	(2.22)**	(0.99)	(1.04)	(1.15)
aged	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0001
	(1.35)	(1.66)*	(2.18)**	(2.08)**	(2.15)**	(1.46)	(1.77)*	(1.79)*
tobinc	-0.0002	-0.0003	-0.0013	-0.0013	-0.0004	0.0022	0.0008	0.0006
	(0.29)	(0.62)	(2.03)**	(2.01)**	(0.17)	(0.99)	(0.25)	(0.19)
gasinc	-1.5185	-0.1596	-0.2252	-0.2217	-2.6252	-1.3081	-1.9195	-1.9076
	(5.06)***	(0.98)	(1.18)	(1.15)	(3.04)***	(1.74)*	(2.09)**	(2.10)**
grants	-2.1321e+06	-740825.1226	-636314.8951	-594561.4722	-4.6911e+06	-1.6255e+06	-1.2725e+06	-1.1457e+06
	(3.72)***	(2.68)***	(2.05)**	(1.94)*	(2.05)**	(0.94)	(0.65)	(0.52)
fedinctax	-91.6160	-169.6388	-135.7970	-185.0549	262.7710	42.5049	121.4652	90.5178
	(0.92)	(2.50)**	(1.97)**	(2.39)**	(0.69)	(0.14)	(0.36)	(0.21)
demgov	0.3538	-0.3388	-0.2825	-0.3915	12.4302	3.4363	3.3790	3.2951
	(0.47)	(0.64)	(0.50)	(0.68)	(3.95)***	(1.50)	(1.38)	(1.32)
demsen	0.5751	6.6612	12.1740	12.5222	30.2595	12.3950	13.8655	14.2043
	(0.10)	(1.54)	(2.45)**	(2.52)**	(1.52)	(0.87)	(0.87)	(0.88)
demhou	10.1910	-0.1501	-5.1266	-5.6376	56.2708	12.4143	2.9897	-0.3453
	(1.56)	(0.03)	(1.02)	(1.12)	(1.75)*	(0.54)	(0.10)	(0.01)
Constant	-8.4677	28.5872	66.5161	52.9552	-248.4736	-57.7889	-35.3691	-28.0225
	(0.43)	(1.57)	(3.04)***	(2.91)***	(3.09)***	(1.00)	(0.44)	(0.34)
Overid (Hansen Test)	0.00925	0.35397	0.84796	0.76186	0.67256	0.87215	0.74982	0.76375
Observations	1504	1457	1363	1363	1504	1457	1363	1363

Robust z statistics in parentheses

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

Notes: Columns 1-3 and 5-7 are two stage least squares regressions where the average of the taxes of the neighbors (Wstgastax and Wstcigtax) are instrumented by using the average of the neighbors of AGED, STUNEMP e DEMGOV. Columns 4 and 8 present two stage least squares regressions where besides the average of the taxes of the neighbors also the federal tax (FEDGASTAX, FEDCIGTAX) is instrumented by using FED GDP. All regressions include state fixed effects and year effects controls.

Table 5a: regressions with real state tax rates (cigarettes) as dependent variable, using the hpi deflator.

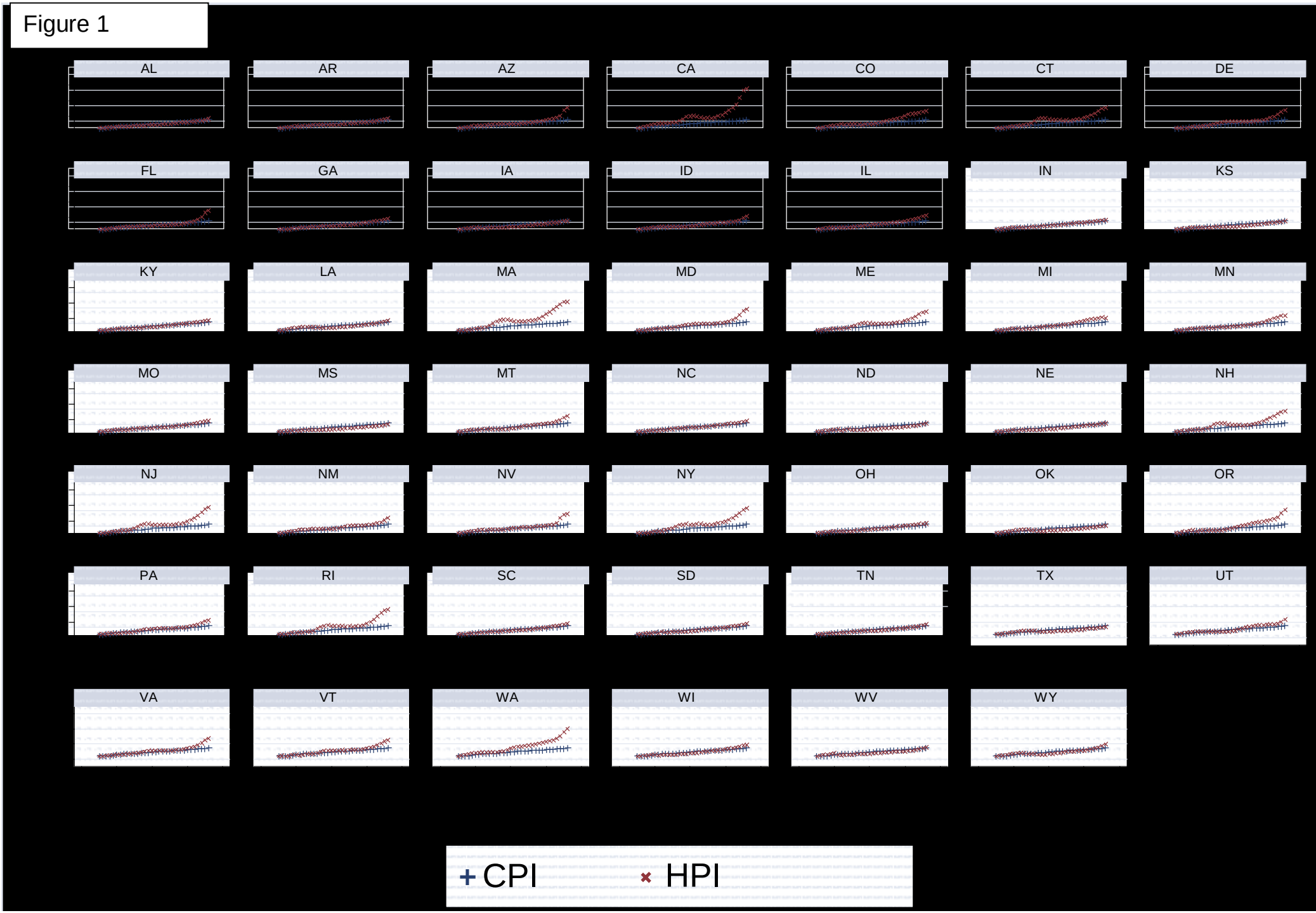
	1982-2001				1982-2006			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	stcigtax	stcigtax	stcigtax	stcigtax	stcigtax	stcigtax	stcigtax	stcigtax
fedcigtax	0.3025	0.2594	0.1024	-0.0113	-0.3742	-0.0311	-0.0102	-0.0137
	(0.91)	(0.82)	(0.46)	(0.04)	(0.82)	(0.06)	(0.03)	(0.02)
Wstcigtax		0.2820	0.2262	0.2301		0.7287	0.4704	0.5520
		(1.44)	(1.64)	(1.65)*		(1.73)*	(1.43)	(1.56)
surprise1		1.9903	-64.3098	-64.5057		-14.9283	-97.3997	-100.2055
		(0.07)	(2.90)***	(2.93)***		(0.34)	(2.80)***	(2.69)***
L1stcigtax			0.6963	0.6962			0.6853	0.6777
			(16.63)***	(16.60)***			(14.00)***	(13.23)***
population	-10.6201	-3.8712	-2.5713	-2.3955	-40.3325	-17.3384	0.0848	2.4278
	(0.94)	(0.33)	(0.33)	(0.31)	(2.78)***	(0.90)	(0.01)	(0.14)
popsq	0.2557	0.1089	-0.0027	-0.0040	0.2254	-0.1688	-0.2047	-0.2470
	(1.59)	(0.57)	(0.02)	(0.03)	(1.33)	(0.59)	(0.91)	(1.04)
stinc	2.0702	1.4531	0.6099	0.7211	2.3307	0.8156	0.8750	0.7579
	(3.42)***	(2.00)**	(1.26)	(1.44)	(2.40)**	(0.61)	(0.81)	(0.89)
stincsq	-0.0091	-0.0068	-0.0030	-0.0030	-0.0051	-0.0014	-0.0023	-0.0019
	(4.20)***	(2.70)***	(1.60)	(1.63)	(1.55)	(0.35)	(0.75)	(0.65)
stunemp	4.3591	3.7562	3.5553	3.5111	4.2420	2.2542	1.9946	1.7484
	(3.78)***	(3.12)***	(4.61)***	(4.44)***	(2.71)***	(1.12)	(1.26)	(0.94)
child	1,872.1767	1,520.4175	0.5379	15.9217	1,136.6814	428.1066	-427.9523	-487.0045
	(5.95)***	(4.01)***	(0.00)	(0.07)	(3.38)***	(0.80)	(1.14)	(1.32)
aged	0.0000	0.0000	0.0001	0.0001	0.0002	0.0002	0.0001	0.0001
	(0.74)	(1.09)	(1.85)*	(1.85)*	(2.92)***	(3.11)***	(1.82)*	(1.83)*
tobinc	0.0053	0.0034	-0.0016	-0.0015	0.0169	0.0077	0.0011	0.0002
	(1.65)*	(1.09)	(1.11)	(1.01)	(3.28)***	(1.08)	(0.19)	(0.03)
gasinc	-5.1302	-4.6884	-0.6090	-0.6463	-9.0354	-6.8468	-2.0924	-1.9270
	(3.67)***	(3.43)***	(0.77)	(0.82)	(4.36)***	(3.13)***	(1.12)	(1.06)
grants	4891177.3150	5315440.2053	2360891.5341	2634873.1377	-5.8225e+06	-3.6835e+06	-1.3100e+06	-1.0736e+06
	(1.73)*	(1.92)*	(1.41)	(1.61)	(2.43)**	(1.14)	(0.57)	(0.41)
fedinctax	1,338.7049	1,106.8510	300.8922	244.7493	1,041.6325	446.8199	7.7762	-74.4741
	(3.66)***	(2.91)***	(1.06)	(0.78)	(2.10)**	(0.77)	(0.02)	(0.10)
demgov	3.5367	2.3789	-0.1598	-0.2197	14.7786	13.4399	5.0661	4.9939
	(1.38)	(0.93)	(0.09)	(0.12)	(3.83)***	(3.51)***	(1.79)*	(1.72)*
demsen	-4.3734	-2.2880	4.7779	5.4470	64.3254	54.6908	23.6197	23.2531
	(0.20)	(0.12)	(0.32)	(0.36)	(2.49)**	(2.16)**	(1.20)	(1.14)
demhou	61.7618	39.9146	7.3144	6.2085	127.3849	45.7787	-2.4209	-11.0878
	(2.71)***	(1.65)*	(0.39)	(0.32)	(3.95)***	(0.84)	(0.06)	(0.25)
Constant	-639.7616	-549.8834	-142.5578	-140.0413	-552.9404	-272.8280	-83.8644	-63.5747
	(7.87)***	(6.21)***	(2.19)**	(2.11)**	(5.88)***	(2.02)**	(0.84)	(0.47)
Observations	940	940	940	940	1175	1175	1175	1175

Robust z statistics in parentheses

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

Notes: Columns 1 and 5 are OLS. Columns 2-3 and 5-7 are two stage least squares regressions where the average of the taxes of the neighbors (Wstcigtax) is instrumented by using the average of the neighbors of AGED, STUNEMP e DEMGOV. Columns 4 and 8 present two stage least squares regressions where besides the average of the taxes of the neighbors also the federal tax (FEDCIGTAX) is instrumented by using FED GDP.

Figure 1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