American Enterprise Institute for Public Policy Research

Predicting Tax Reform

Kevin A. Hassett
American Enterprise Institute

and

Aparna Mathur
American Enterprise Institute

AEI WORKING PAPER #138, AUGUST 1, 2007
www.aei.org/workingpapers
http://www.aei.org/publication26587
22038

Predicting Tax Reform

By

Kevin A. Hassett[1]

and

Aparna Mathur[2]

Abstract

Despite the frequency of tax changes and their potential importance to investors, there has been relatively little modeling of anticipated tax changes. Yet whether future tax reforms are predictable or not will have an enormous effect on estimates of the impact of current tax policies. This paper develops a probit model for predicting tax reforms. We find that the likelihood that a country will lower its corporate tax rate in the future is significantly affected by what we describe as "learning" and "strategic" factors. The learning comes from a country's own experience with tax rate reductions. Hence a country is more likely to lower rates if it has lowered rates in the past and seen an economic benefit from such actions. At the same time, countries respond strategically to tax rates in competing countries. They are more likely to lower rates if their rates are higher than the average for their neighbor countries. Hence countries do appear to engage in tax competition. Our model performs well, with an in-sample and out-of-sample accuracy of close to 85 percent. We conclude that empirical investment research should account for the fact that future tax changes are highly predictable.

Keywords: Tax Competition, Corporate Tax Reform, Predicted Probability, Probit Model

JEL Classification: H2, C33, F21

[1] Director of Economic Policy Studies, American Enterprise Institute. *Email*: khassett@aei.org
[2] Research Fellow, American Enterprise Institute. *Email*: amathur@aei.org

1. Introduction

When business investors make decisions about either the level or the location of their corporate investment, they face a tremendous amount of uncertainty. Apart from other factors, the rate at which governments tax new investments is likely to have substantial consequences for investor incentives. In a dynamic setting, investors need to make long-term decisions about their investment since the bulk of an investor's return comes in years subsequent to the year in which new plant and equipment is put in place. Tax reforms affect these returns not only by changing the amount of money owed to the government, but also by encouraging or discouraging competing future investment and thereby changing levels of before-tax future earnings. For example, the knowledge that the government plans to introduce a large investment tax credit in two years would depress investment this year and the next, since the investment wave two years hence will be expected to drive down the return to any capital already in place when it starts.[3]

Despite the frequency of tax changes and their potential importance to investors, there has been relatively little modeling of anticipated tax changes and their impact on investment.[4] Much of the literature assumes that investors never anticipate any tax changes (Dale Jorgenson (1963), Auerbach (1983) and King and Fullerton (1984)). Some exceptions are Auerbach and Hines (1988), Auerbach (1989) and Auerbach and Hassett (1992). Auerbach and Hines (1988) and Auerbach (1989) were among the first papers to explicitly account for the impact of current and expected future tax changes on investment levels in a model of dynamic firm behavior. In such a model, the user cost of capital differs from the standard specification by an additional term incorporating the

[3] Auerbach and Hines, 1988

[4] For instance, in the U.S. itself, Congress changed investment incentives with new tax legislation in 1981, 1982, 1984 and 1985, and over the period 1953-1985 made such changes in 16 different years.

probability that investors place on the passage of a tax reform. For the U.S., they then derive a table of effective tax rates on corporate investment for the years 1953-1986. They show that the frequency of reforms in the 1970s and early 1980s convinced investors that a major tax reform was impending which would rob the tax system of many of its investment incentives. Hence contemporaneous investment incentives looked extremely attractive by comparison.

The paper by Auerbach and Hassett (1992) derives and estimates a similar model of business fixed investment in which current and future tax conditions directly affect the incentive to invest. In the Auerbach-Hassett model, value maximizing firms are motivated by adjustment cost considerations to smooth their capital expenditures over time. Firms are forward looking in their investment behavior basing investment decisions on expected changes in the tax system. Hence the investment equation is a function of the future cost of capital as well as expected future tax rates, both of which are deviations from the standard user cost of capital familiar in the investment literature. As examples they cite that in the U.S., frequent manipulation of tax policy such as the introduction of accelerated depreciation in 1954, the introduction of the investment tax credit in 1962, the sharp increase in depreciation benefits provided by the Accelerated Cost Recovery System in 1981, and the reduction in the statutory tax rate under the Tax Reform Act of 1986, have played a significant role in affecting the level and pattern of investment. If investors can anticipate at least some of these changes, the instability and uncertainty that they face in making investment decisions, would be reduced. In addition, to the extent that investors accurate expect future changes, but econometricians ignore them, then estimates of the impact of tax policy will be biased.

These considerations are likely to be magnified in a global setting where investors need to anticipate tax changes, not just in one country, but in all countries that are potential recipients of their capital flows. The empirical international tax literature however, has not yet moved in the direction of trying to predict when countries are most likely to lower rates or undertake some measure of tax reform.[5] While it is now widely accepted that countries lower rates in order to stay competitive with other countries, there has been no effort at modeling and forecasting the likelihood that a country will lower rates, conditional on other countries' tax rates and a country's own experience with lowering rates. The purpose of this paper is to build such a model and use it to forecast the likelihood that a country will undertake some level of corporate tax reform in the near future. In future work, we will use the model to explore the relationship between tax policy and investment behavior.

Historical trends suggest that countries do not set their tax rates independently. The top statutory corporate tax rate has declined significantly for most OECD and non-OECD countries since the early 1980s (see Table 1A). Within the OECD economies, the United Kingdom lowered its statutory rate from 52 percent to 35 percent between 1982 and 1986. This prompted other countries to lower their rates as well. The U.S. corporate tax rate was reduced substantially by the Tax Reform Act of 1986 and then increased by

[5] The international tax literature has devoted a tremendous amount of attention to the issue of international variations in corporate tax rates and their impact on capital mobility. It is often argued that countries compete in setting tax rates on capital to divert investment away from other areas towards themselves. Hence, in open economies, tax rates set by other countries may influence domestic tax rates. The theoretical literature on tax competition includes papers by Zodrow and Mieszkowski (1986), Wilson (1986), Kanbur and Keen (1993) and is recently surveyed in Wilson (1999). Empirical research (for example, Grubert and Mutti (2000); and Devereux and Griffith (1998) among others) finds that freely mobile capital moves fluidly from high tax to low tax jurisdictions. The location of investment among competing locations is often driven by the search for the lowest (effective) tax rates, which has also fed fears of 'harmful tax competition' or a 'race to the bottom' especially among European economies (Mendoza and Tesar,2003).

1 percentage point in 1993. Thus, the median tax rate among the OECD economies declined from about 50 percent in 1982 to 34 percent by 2003.[6]

At the same time, our own analysis suggests that countries that have lowered their rates once are significantly more likely to lower rates again. For instance, countries such as Iceland, Malaysia, Mexico etc have consistently reduced rates every few years. While a part of this may be driven by international tax competition, it could also partially be attributed to their potential realization that lower tax rates have resulted in higher levels of investment, higher wages and employment for their labor force and higher GDP growth.

Our results suggest the presence of both 'strategic' factors i.e. lowering tax rates in response to other countries and 'learning' factors i.e. a country's realization from its own experience that lower corporate taxes are beneficial for investment, wages and economic growth.

Section 2 reviews some of the literature on strategic behavior by countries in choosing their corporate tax rates. Section 3 discusses the data and the empirical estimation. Section 4 presents the results. Section 5 concludes.

2. Literature Review

The empirical literature on corporate taxation has focused on the effect of corporate taxes on investment. See Gordon and Hines (2002) for a review of the literature. For instance, Grubert and Mutti (2000) and Hines and Rice (1994) estimate the effect of national tax rates on the cross-sectional distribution of aggregate American-owned property, plant and equipment (PPE) in 1982. Grubert and Mutti report an

[6]CBO, 2005

elasticity of -0.1 with respect to local tax rates. Hines and Rice report a much larger elasticity of -1. Devereux and Griffith (1998) find that effective average corporate tax rates influence the location of U.S. investment within Europe.

While no paper has yet developed a model to predict tax reform, several papers have studied how a country's choice of corporate tax rate is likely to be influenced by other countries' rates. For instance, Altshuler and Goodspeed (2003) estimate a tax reaction function for European countries for a pure Nash model as well as a Stackelberg model in which the U.S. acts as a Stackelberg leader while the European countries compete with each other in a Nash way. They conclude that after the U.S. Tax Reform Act of 1986, the European countries fit the Stackelberg model better, becoming more intensely competitive with the U.S. and less competitive among themselves. They estimate a regression with a country's own corporate tax rate as the dependent variable, and the U.S. tax rate as well as other regional neighbors tax rates as explanatory variables (among others). They find positive and significant effects of U.S. and neighbor rates on a country's tax rate.

Devereux, Lockwood and Redoano (2003) find that strategic interaction between countries is intensified when countries have fewer exchange controls, especially on the capital account. Liberalization of exchange controls in other countries also affects a countries corporate tax rate. Their analysis is focused on the OECD countries. In the political science literature Hays (2003) and Basinger and Hallerberg (2004) also demonstrate interdependence in tax setting among countries.

Slemrod (2001) provides a useful starting point for our paper, since it suggests which variables, at the domestic and international level, may be important in setting

corporate tax rates. The paper does not model strategic interactions and is based on cross-sectional data for the years 1975 and 1995. Slemrod experiments with variables such as the expenditure to GDP ratio for a country, the top personal income tax rate, various openness measures, the extent of electrification, etc.

3. Data and Empirical Analysis

3.A. Empirical Model

Our data on corporate tax rates are taken from the AEI International Tax Database. From this we chose a sample of 68 countries based on data availability for the period 1981-2005. We estimate a probit model to study the likelihood that a country will lower its corporate tax rate in the next three years. Underlying the probit specification is the assumption that a certain observed action has a net benefit or utility associated with it which is unobserved. In our case, it could be the perceived benefits or costs that countries associate with lowering corporate tax rates, which we do not observe. However, we do observe the action that they take, which is either lowering rates, raising them or leaving them unchanged. Accordingly we specify our probit model as follows;

$$L^{*}_{i(t+1,t+3)} = const + \tau_t + LowerRates_t + NbrLowerRates_t + GDPGrowth_{t-1,t} + Openness_t + \alpha_{it}$$

$$L_{it} = 1 \; if \; L^{*}_{it} > 0$$

$$L_{it} = 0 \; if \; L^{*}_{it} \leq 0$$

$$\alpha_{it} = u_i + \varepsilon_{it} \quad \text{where} \quad i=1,..,68 \; and \; t=1,....,25$$

L^{*}_{it} is the unobserved latent variable while L_{it} is the observed variable equal to 1 if country *i* lowered rates in the three year period between *t+1* and *t+3* and zero otherwise. The explanatory variables include a country's current (period t) corporate tax

rate, τ, whether it had lowered rates between t-1 and t, whether it's "neighbor" or competitor countries lowered rates between t-1 and t, and also various factors that may be important at the domestic level, such as the country's GDP growth rates, it's level of openness as captured by the ratio of trade to GDP and the level of capital mobility. We experiment with different combinations of these factors and different timing of the explanatory variables to obtain the best fit of the model.

Data on GDP growth rates and trade openness were obtained from the World Bank's World Development Indicators Database and also from the IMF's International Financial Statistics Database. Data on Capital Mobility were obtained from the Fraser Institute's Economic Freedom of the World Index. Data on all tax rates were obtained from AEI's International Tax Database.

We estimate two kinds of probit models. The first is a random effects probit and the second is a probit model which allows for robust standard errors and clustering across countries. The random effects model allows for country specific unobservables that don't vary over time. The cluster command adjusts the standard errors for within group correlation. In practice the two methods yield similar results, but the predicted probabilities with the two models differed marginally, so we present results with both.

3.B. Discussion of Data

The purpose of the paper is to try and explain what might drive countries to change or lower their corporate tax rates. Formally, we can think of the decision making process as a Markov process, where countries display different probabilities of switching their rates depending on their initial situation or state. Markov chains are defined by a

triple of objects, namely, an n-dimensional vector $\bar{x}$ that records the possible values of the state of the system; an n x n transition matrix P which records the probability of moving from one value of the state to another in one period and an nx1 vector π_0 recording the probabilities of being in each state i at time 0. The matrix P has the interpretation

$$P_{ij} = \Pr ob(x_{t+1} = \bar{x}_j \mid x_t = \bar{x}_i)$$

Further, for $i=1,\ldots,n$, the matrix P satisfies

$$\sum_{j=1}^{n} P_{ij} = 1$$

In our context, we can model a country's decision to lower it's corporate tax rate as a Markov chain, characterized by a vector $\bar{x}$, with the three states being (1) whether the country had lowered rates in period t (2) whether it raised rates (3) whether it made no change to the tax rate. The transition matrix P can then be calculated as the probability of switching to a different state, conditional on being in a certain state at the beginning of the period. These transition probabilities are displayed in Figure 1.

As is clear from the graphs, in any given year, starting from any state, the probability that a country will *lower* rates is much higher than the probability that a country will raise rates. These probabilities are calculated as the averages for all countries conditional on those countries being in a similar state at the beginning of the period. The probability of lowering rates is much higher when countries start from an initial state of having lowered rates. Thus this suggests the possibility of a learning mechanism wherein countries with prior experience of having lowered rates are significantly more likely to do so today. Further, having started from a state of having raised rates earlier, the possibility

that a country will raise rates again is very low. Thus countries display an asymmetric response to their previous actions. There appear to be larger benefits associated with lowering rates that induces a higher probability of doing so again in the future, as compared to raising rates. This is particularly true in the period starting from the mid-1980s where as we mentioned earlier, tax reforms by the UK and the U.S. prompted similar responses by other, especially OECD, countries.

Table 1B shows the average change in corporate tax rates after 1 year and after 3 years, given a country's initial tax rate. As is evident from the table, countries with relatively low rates are likely to experience fewer changes and smaller magnitude changes as compared to countries with tax rates in the range of 40-50 percent.

To explore whether some tax cuts or tax reforms are driven by strategic behavior on the part of a country in response to competing countries, we present Figures 2A and 2B. Competing countries can be defined in two ways. Either they could be regional neighbors, so that countries may respond more strongly to other countries within the same geographic area or they could be income neighbors, i.e. countries at the same level of economic development, though not necessarily in the same region. For instance, countries in South America such as Argentina, Brazil, Mexico etc may compete with countries such as Malaysia, India or Thailand for capital, because in the minds of the investors they offer the same set of investment conditions and are at similar levels of development. At the same time, many European economies may react more to U.S. tax rates, than to their smaller geographic neighbors.

Figure 2A shows when countries undertook tax cuts and whether this could be seen as a response to their income neighbors cutting rates. Note that this is not the full set

of countries used in our sample. We present these graphs for illustrative purposes. The blue lines represent the country's own response, which equals 1 if it lowered rates, while the red lines represent the proportion of income neighbors who cut rates each year. The graphs show no clear pattern. Some countries such as Belgium, Iceland, France, UK, Canada and the U.S. seem to be 'leaders' in the sense that they cut their rates before major tax reductions by other countries had taken place, at least in our sample period. Other countries seem to have responded with a lag. For example, Denmark cut rates only in the 1990s after several years of rate cutting by its income neighbors. Similarly Philippines had no major tax reform till the late 1990s, even though Malaysia and Singapore had been aggressively cutting rates throughout the 1980s and 1990s.

Turning to the impact of regional neighbors, in some countries we see a greater level of response. For instance, for the U.S. and France, it is clear that two episodes of rate cutting by their regional neighbors may have driven them to lower rates. Belgium, UK and Canada still appear to be leaders in these graphs, since they cut rates before any of their neighbors did. Mexico, too, saw major cuts in the 1990s which could at least partially be ascribed as a response to its regional neighbors, since the first cuts came in 1989, just after nearly 40 percent of its neighbors cut rates.

Hence these graphs suggest that tax competition may be driving some part of the reduction in tax rates undertaken by countries in the 1980s and 1990s, but not all. Our Markov transition matrices suggest a role for 'learning' as well i.e a country's own experience with lowering rates may be a big part of the picture. Even from these graphs, it is clear that countries that had lowered rates previously are much more likely to undertake subsequent tax reductions, irrespective of how the neighbors respond.

Countries such as Japan, Singapore, Malaysia, Brazil have undertaken tax reforms even when less than 20 percent of their neighbors have cut rates. For most countries, the average number of regional neighbors is 4 or 5, hence only 1 or 2 countries would have lowered rates.

Keeping these trends in mind, we turn next to our regression model.

4. Empirical Results

4.A. Modeling Tax Competition

Before we specify the model that we will use to forecast corporate tax rate reductions, we test to see if our data are able to reproduce results from the earlier literature relating to tax competition. For instance, using a specification similar to, though not exactly like that of Altshuler and Goodspeed (2002), Hays (2003), Basinger and Hallerberg (2004) etc, are we able to show that countries respond strategically to tax setting by other countries? This will form the baseline for our forecasting model. Table 2 presents results with the corporate tax rate as the dependent variable and income weighted averages of corporate tax rates in other countries as one of the main explanatory variables. We estimate a random effects GLS model.

Using this model, our data are able to replicate results for spatial tax competition that other authors have obtained. For instance, the coefficient on the neighbor's corporate tax is positive and significant at 1 percent confidence level. Neighbors in this particular formulation have been defined as countries that belong to the same income group, using a measure of GDP per capita. A different set of neighbors will be considered in the specifications we discuss in the forecasting model. The coefficient on this variable

suggests that a 10 percent decrease in the neighbor's corporate tax rate leads to a 4.6 percent decrease in a country's corporate tax rate. This is similar in magnitude to results in Altshuler and Goodspeed (2002).

We further control for domestic variables such as a country's economic growth rate and their level of openness, measured by a capital mobility index and the ratio of trade to GDP. Higher values of the capital mobility index imply more open economies. Our results suggest that more open economies are less likely to raise rates, or more likely to have lower rates. This is in line with current thinking in the international tax literature that more open economies should tax capital less, since the mobility of capital ensures that taxes are more likely to be shifted to less-mobile factors such as labor. Razin and Sadka (1989) show that investors will simply transfer funds abroad to avoid taxation in high-tax countries.

In Specification 2 in Table 2 we introduce some additional variables, such as whether a country had lowered its rates previously and whether it experienced positive economic growth since the experience of lowering rates. These variables also yield the predicted sign. Countries with some experience of lowering rates, especially those that experienced economic growth subsequent to the tax reform are significantly less likely to have high rates of corporate taxes.

Other authors have also experimented with additional variables such as the tax rate on personal income, the ratio of government expenditure to GDP and the ratio of corporate revenue to GDP. We can include these additional variables in our specification, without affecting the basic results. However, we do not include these in the forecasting model described later, since we do not have data for the personal tax rate for recent years,

and the data on revenues and expenditures are extremely limited for our sample, which includes both OECD and non-OECD economies as well.

Since our data are able to reproduce earlier results on tax competition, we are able to move ahead with some degree of confidence to develop a model for forecasting tax reform.

4.B. Forecasting Model

To move from the basic regression model employed in the literature to ours, we change the specification of the dependent variable. Our dependent variable in each of these models is a dummy variable equal to 1 if the country lowered its rates at any point in the three year period beyond the current period t. We use this specification since we are interested in obtaining forecasts for three year periods, rather than just a 1 or 2 year period. This will enable us to predict whether tax rates will be lowered in the period 2006-2008 given that data are available up until 2005.

Table 3 presents results with our two regression specifications. Specification 1 is estimated using a random effects probit model, and specification 2 using a probit model which allows for clustering or intra-group correlation. The sample size is 1190 observations and approximately 68 countries are part of the sample. The sample period is 1981-2005.

The first explanatory variable we include is a country's current corporate tax rate. As we may expect, the coefficient on this variable is positive and significant at 1 percent. This implies that the higher the current rate, the more likely a country is to lower rates in the next three years. To further capture the effect of 'learning', we included two

additional variables. The first is a dummy equal to 1 if the country had currently experienced a lowering of rates. This goes back to our Markov model, where depending on the initial state (in this case, a country's current experience with lowering rates), a country is more likely to take a certain action. It can be argued that the most recent experience of lowering rates carries with it all the information that a country needs in deciding whether to lower rates in the future. This variable is positive and significant, suggesting what we had previously discussed. At the same time, we can also allow for the effect that a previous lowering of rates had by interacting that variable with the GDP growth rates. To do this, we defined a dummy variable that takes on the value 1 if a country had lowered rates in period t-1. We then interacted this variable with the GDP growth rate for the country between t-1 and t. The coefficient is positive and significant, suggesting that high GDP growth in countries that lowered rates makes them more likely to lower rates in the future.

Apart from the own country learning effects, we further allow for the possibility that actions taken by other countries may have an influence on tax setting by the domestic economy. Again, we do this through two kinds of variables. We first constructed a spatial variable that defines weighted average taxes in neighboring countries based on two classifications of neighbors-an income classification and a regional classification. The weighting scheme that we used was income weights i.e. each country was weighted by it's GDP per capita. So, for example, countries in the high income group included Australia, UK, USA, Germany etc. These countries would act as neighbors to each other with the average tax rate for this group defined as the tax rate for each country weighted by it's GDP per capita. Similarly countries were classified into upper middle income,

lower middle income and low income. The tax rate of the country itself would not be included in calculating the average tax rate in the neighboring countries i.e. no country could be a neighbor to itself and the weighting matrix would assign a zero weight to the country.

Similarly, region-wise, countries were classified as belonging to 14 groups, such as East Europe, South Africa etc. These countries were then weighted using their GDP per capita.

We then defined a dummy variable equal to 1 if the corporate tax rate in the country was higher than the income-weighted corporate tax rate of the income neighbors. This variable also takes on the predicted value and sign. Countries with tax rates higher than their competing income countries are significantly more likely to lower rates than those with lower rates than their income neighbors. This works as well when we use the income weighted regional neighbors. The coefficient on the dummy variable is marginally lower at 0.126, but is still positive and significant. Note that if we include the weighted average tax rate of the neighbors as an additional explanatory variable, this does not affect any of the other results. The coefficient on this variable is not significant, since all of the information is being captured by the dummy variable which has the relative rates.

Next we included an additional variable that is a weighted average of whether the (income) neighbors lowered rates in the current period. The coefficient on this variable is positive as we may expect, but is not significant. It is possible that once we control for the relative position of the country in terms of its tax rates, the fact that other countries lowered rates is not that important. For instance, if a country had a relatively lower rate

than it's neighbors, it would not be much more likely to cut rates if other countries did so as well. Hence the fact that we are controlling for the relative tax rates via the dummy variable may be clouding out the effect of this variable. In fact, if we do exclude the dummy variable from our specification, we get this variable to be significant at 10 percent.

Hence results from these spatial variables suggest that countries do respond strategically to tax rates and actions taken by competitor countries.

Finally, we also control for the level of a country's GDP growth rate which reflects their level of economic development. The coefficient on this variable is not significant. Apart from this, we control for various measures of openness as suggested by the literature. These variables also yield the predicted result. Greater levels of openness as captured by higher trade to GDP ratios and more capital mobility imply that countries are more likely to lower rates. This is especially true when capital is freely mobile since the mobility of capital leads to greater competition among countries. Capital flows from high tax to low tax jurisdictions.

This is the basic model that we use to derive our predictions. Apart from the variables considered here, we also experimented with others such as the country's personal income tax rate, lagged values of the right-hand side variables, un-weighted averages of neighbor country tax rates etc. However, none of these were significant and did not alter our results.

In Specification 2, we estimated exactly the same model, but used a probit model with clustering and robust standard errors. This allows for intra-group correlation. The

results are pretty similar to those in specification 1, except that the magnitude of the coefficients is marginally different, which may affect the probability forecasts.

4. C. Predicted Probabilities

In this section, we use the probit models from the previous section to do three-year-ahead forecasts of which countries are most likely to lower rates. Figures 3A and 3B present graphs showing the predicted probabilities from the two probit models for the years 2004 and 2005. Since these are three year forecasts, the probabilities for 2004 show the probability of lowering rates between 2005-2007 and the probabilities for 2005 show the probability of lowering rates between 2006-2008. The two models yield fairly similar results though some countries rank higher in Model 1 compared to Model 2. For instance, comparing forecasts for the period 2005-2007 in Models 1 and 2, while Belgium is the highest ranked country in Model 1, Mexico is the highest ranked country in Model 2. Both Belgium and Mexico have probabilities greater than 0.65 in the two models. Other countries that are ranked highly in the two models include Singapore, Turkey, Costa Rica, Czech Republic.

This is interesting since Singapore recently declared that it would cut its corporate tax rate by 2 percentage points.[7] Mexico and Germany are other examples that fit the predictions well. [8,9]

Turning to the predictions for 2006-2008 the mix of countries at the top of the probability distribution is slightly different. This fits in with the intuition that countries

[7] http://www.iesingapore.gov.sg/wps/portal/!ut/p/kcxml/04_Sj9SPykssy0xPLMnMz0vM0Y_QjzKLN4g38nAHSYGYjvqRMJEgfW99X4_83FT9AP2C3IhyR0dFRQBOc5AF/delta/base64xml/L3dJdyEvd0ZNQUFzQUMvNElVRS82XzlfMUZC

[8] http://www.heritage.org/research/features/index/country.cfm?id=Mexico

[9] http://www.iht.com/articles/2006/11/02/business/tax.php

that lowered rates just the year before are less likely to do so very quickly. Countries at the top now include Azerbaijan, Belgium, Czech Republic, Malaysia, Denmark, Colombia and Mexico again.

Malaysia recently announced that it would cut its corporate tax rate by 1 percentage point a year to a lower rate of 26 percent by 2008.[10] Similarly, Colombia plans to cut its corporate tax rate to 34 percent in 2007 and 33 percent in 2008 from its current level of 38.5 percent.[11]

We turn more formally to model evaluation in the next section.

4.D. Accuracy of Model

To check the in-sample and out-of-sample accuracy of our model, we re-estimated the regressions shown in Specifications 1 and 2 of Table 3, but for different time periods stopping before the actual sample years ended in 2005. For instance, we estimated Specification 1 for the period 1981-1995 and 1981-2001. We then calculated in-sample and out-of sample predicted probabilities. To see if the model accurately predicted a tax reform, we defined the predicted value as being equal to 1 if the probability of lowering rates was higher than or equal to a certain value. For instance, we can set the value equal to 1 if the predicted probability were higher than or equal to 0.4 or 0.5 or 0.6 etc. Results of this test of the model are presented in Table 4.

Model 1 for the sample years 1981-2001 is based on Specification 1 in Table 3. The in-sample size is 1008 observations, while the out-of-sample size is 182. The number under "Percentage" shows the percentage of correctly predicted 1's as a fraction of the

[10] http://www.iht.com/articles/ap/2006/09/01/business/AS_FIN_ECO_Malaysia_Budget.php
[11] http://www.tmcnet.com/usubmit/2007/02/09/2328252.htm

total predicted 1's. So for instance, if we set the predicted value equal to 1 when the predicted probability is greater than or equal to 0.4, the model predicts a 1 accurately 57 percent of the time. As we set the cut off criteria higher, for instance to 0.6 or 0.7, the accuracy of the model naturally improves. In the highest cutoff category, the model has an in-sample accuracy of 76 percent. If we look at the out-of-sample period i.e., between 2002-2005, the accuracy is fairly high at about 85 percent when probability is greater than or equal to 0.4.

Changing the sample period to 1981-1995, the in-sample accuracy in the highest cutoff category is higher, at 79 percent. The out-of-sample forecasts are better with the model accurately predicting all the 1s correctly in the highest cutoff category of 0.7.

Model 2, where we allow for robust standard errors and clustering does even better. In the sample using the years 1981-2005, the in-sample accuracy is 83 percent while the out-of-sample accuracy is 100 percent. This is also true if we consider the sample period 1981-1995. Hence overall this model performs much better than the random effects model. This is probably because the error terms are highly correlated for countries over time, and the model accounts for that correlation much better than the random effects model.

Hence our model performs quite well in terms of the accuracy of its in-sample and out-of-sample predictions.

4.E. Testing Predictions with Historical Data

Apart from the most recent years, 2004 and 2005, which give us forecasts for the period 2005-2007 and 2006-2008, we can also check if the model accurately predicted

historical tax changes for previous years. Figure 4A and 4B present charts showing the predicted probabilities for certain other years, such as 1989 and 1995. These probabilities are derived from a probit model with robust standard errors and clustering, and are based on in-sample and out-of-sample predictions for these years.

How well does the model predict tax changes for these years? The countries that are highest on the list for the year 1989 in the in-sample forecasts are Malaysia, Denmark, Trinidad and Tobago, France, Belgium, Pakistan and Panama. Did these countries undertake tax reform in the subsequent three year period, 1990-1992? Starting in 1990, Malaysia lowered its corporate tax rate from 39 percent to 38 percent in 1991 and 37 percent in 1992. Similarly Denmark undertook major tax rate reductions in this period lowering its rate from 50 percent in 1989 to 40 percent in 1990, 38 in 1991 and 34 in 1992. The overall decrease was nearly 16 percentage points. Other successful predictions include Trinidad and Tobago, France, Belgium, Pakistan and Panama.

Since these results are based on in-sample estimates, the model is likely to do much better perhaps than if we treated these years as out of sample. To explore the out-of-sample accuracy of the model for these years, we re-estimated the probit regression for the sample years 1981-1988, thus treating the predictions for the year 1989 as out-of-sample. Given the extremely small sample size of 287 observations associated with this regression, it is surprising but encouraging that the predictions are fairly similar to those obtained with the in-sample forecasts. The same set of countries is still found at the top, though the probability numbers change marginally.

Turning to the second period 1995, countries listed as most likely to lower rates include Czech Republic, Slovakia, Pakistan, Malaysia and Israel. Among these countries,

our data show that Czech Republic lowered rates between 1995 and 1996 and also between 1997 and 1998. Israel, Pakistan and Malaysia also undertook some reforms in this period. Slovakia, however, is a failure. There was no change in the tax rate in the period 1995-1998. However, the country did successively lower rates by nearly 15 percentage points over the period 1990-1995, which may explain why our model places a high probability on the event.

These predictions hold for the out-of-sample forecast based on a regression using 597 observations. In fact, the difference between the in-sample and out-of-sample forecasts is much lower for this period as compared to those for the year 1989.This is probably due to the much larger sample size for the year 1995, yielding more information for the predictions.

4.F. Other Specifications

While we do not have recent data or complete data for certain additional variables that have been employed in tax competition regressions in the literature, in this section we experiment with adding these additional variables to our baseline specifications to see whether it affects our predicted probabilities.

Some additional variables that we employ are the personal income tax rate, a democracy index and the ratio of government expenditure to GDP. Data on personal income taxes are available from AEI's International Tax Database, however, they are not available as yet uptil 2005. Instead of using the top personal income tax rate, which is likely to be highly correlated with the top corporate tax rate, we use the average of personal tax rates as an explanatory variable. Data on the democracy index are available

from Freedom House's Freedom in the World Country ratings. This index is constructed from two separate indices on political rights and civil liberties. Higher values of the index represent more democratic countries. The reason we include this variable here is that in the political science literature (such as Hays, 2003) the type of democracy has been shown to have an impact on capital taxation. Finally, data on government expenditure to GDP are compiled from several sources such as the World Development Indicators and the International Financial Statistics.

Adding each of these variables separately to our probit regression model (Specification 2 in Table 3) did not yield a significant coefficient on any of them. The sample size went down, but the sign and significance of our main explanatory variables did not change. Hence it is not surprising that the predicted probabilities do not look very different from those we had obtained earlier for the year 1995. These are shown in Figure 5. The chart at the top shows results with the democracy variable and average personal taxes. These are shown separately since there is relatively more data available for these variables for each country, as compared to the government expenditure data. The chart at the bottom shows the probabilities with all three variables included.

Hence it appears that adding additional variables does not significantly change our results. Our fairly simple model has enough information to reasonably accurately predict tax reform.

5. Conclusion

The purpose of this study has been to develop a model to predict the likelihood that a country will undertake a tax reform effort. No such study has been undertaken till date.

The model that we develop is a probit model that takes account not only of strategic interactions between countries, which have been widely discussed in the literature, but also a country's own experience with lowering rates. We are able to show that countries that have lowered rates in the past are significantly more likely to do so in the future. At the same time, countries also respond to corporate tax reductions undertaken by competitor countries, and are more likely to lower rates when their rates are out of line compared with those of their competing countries.

The model does well in terms of the accuracy of its in-sample and out-of-sample forecasts. We conclude that efforts to study the impact of tax policy on investment in an international setting must account for the fact that future tax policy changes appear to be highly predictable.

References

Altshuler, Rosanne and Goodspeed, Timothy (2002), "Follow the Leader: Evidence on European and U.S. Tax Competition," Rutgers University, Department of Economics Working Papers No. 200226

Auerbach, Alan (1983), "Corporate Taxation in the United States," *Brookings Papers on Economic Activity*, 2, pp.451-505

Auerbach, Alan (1989), "Tax Reform and Adjustment Costs: The Impact on Investment and Market Value," *International Economic Review*, Vol. 30, No.4

Auerbach, Alan and Hassett, Kevin (1992), "Tax Policy and Business Fixed Investment in the United States," *Journal of Public Economics*, Vol. 44, pp.141-170

Auerbach, Alan and Hines, James R. (1988), "Investment Tax Incentives and Frequent Tax Reforms," *American Economic Review*, Vol. 78, No.2

International Tax Database, American Enterprise Institute

Basinger, Scott and Hallerberg, Mark (2004), "Remodeling the Competition for Capital: How Domestic Politics Erases the Race to the Bottom," *American Political Science Review*, Vol. 98, No.2., May

"Corporate Income Tax Rates: International Comparisons", Congressional Budget Office (CBO), November 2005

Devereux, Michael and Griffith, Rachel (1998), "Taxes and the Location of Production: Evidence from a Panel of U.S. Multinationals," *Journal of Public Economics*, 68, pp. 335-367

Deveruex, Michael, Lockwood, Ben and Redoano, Michela (2003), "Capital Account Liberalization and Corporate Taxes," University of Warwick Working Paper

Freedom in the World Database, Freedom House

Gordon, Roger and Hines, James (2002), "International Taxation," *Handbook of Public Economics*, Edition 1, Vol. 4, Chapter 28, pp.1935-1995

Grubert, H. and J. Mutti (2000), "Do Taxes Influence Where U.S. Corporations Invest?," *National Tax Journal* 53, pp. 825-839

Hassett, Kevin and Mathur, Aparna (2006), "Taxes and Wages", American Enterprise Institute Papers and Studies
http://www.aei.org/publications/filter.all,pubID.24629/pub_detail.asp

Hays, Jude (2003), "Globalization and Capital Taxation in Consensus and Majoritarian Democracies," *World Politics* 56, October, pp.79-113

Hines, J.R. and E.M. Rice (1994), "Fiscal Paradise: Foreign Tax Havens and American Business," *Quarterly Journal of Economics* 109, Vol.1.

International Financial Statistics, IMF

Jorgenson, Dale W. (1963), "Capital Theory and Investment Behavior," *American Economic Review Proceedings*, 53, pp. 247-259

Kanbur, Ravi and Keen, Michael (1993), "Jeux Sans Frontieres: Tax Competition and Tax Coordination when Countries Differ in Size," *American Economic Review*, September, pp.877-892

King, Mervyn A. and Fullerton, Don, *The Taxation of Income from Capital*, Chicago: University of Chicago Press, 1984

Ljungqvist, Lars and Sargent, Thomas (2000), *Recursive Macroeconomic Theory*

Mendoza, Enrique and Tesar, Linda (2005), "Why Hasn't Tax Competition Triggered a Race to the Bottom?," *Journal of Monetary Economics*, v.52, pp. 163-204

Razin, Assaf and Sadka, Efraim (1989), "International Tax Competition and Gains from Tax Harmonization," NBER Working paper No.3152

Slemrod, Joel (2001), "Are Corporate Tax Rates or Countries Converging?," University of Michigan Working Paper

Wildasin, David (1988), "Nash Equilibria in Models of Fiscal Competition," *Journal of Public Economics* 35, pp. 229-240

Wilson, John (1986), "A Theory of Interregional Tax Competition," *Journal of Urban Economics*, 19(3), pp. 296-315

World Development Indicators, World Bank Database

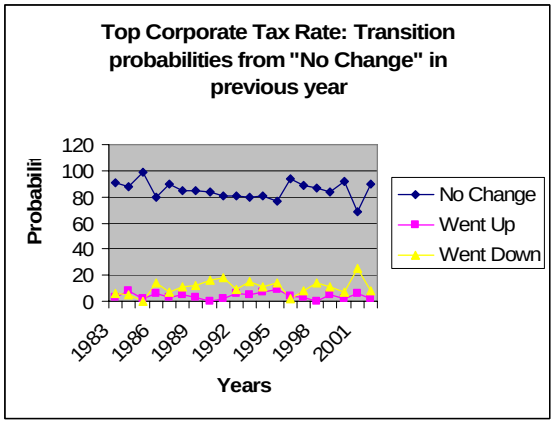
Zodrow, George and Mieszkowski, Peter (1986), "Pigou, Tiebout, Property Taxation and the Under-provision of Public Goods," *Journal of Urban Economics*, 19, pp.356-370

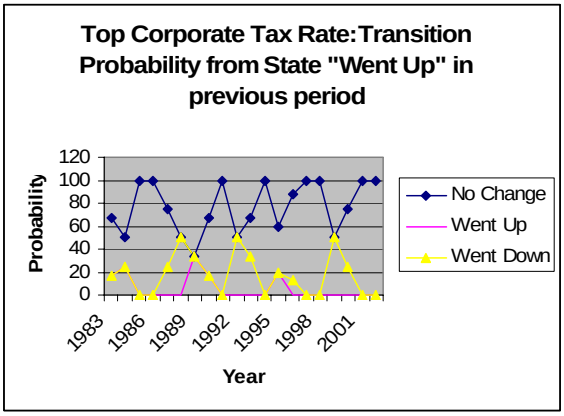
Table 1A: Historical Trends in Corporate Tax Rates For a sub-set of Sampled Countries

1982-1985	1986-1990	1991-1995	1996-2000
1982 Italy+5 (30%)	1986 Aus +3(49%) Bel -2(43%) Fra-5(45%) Malaysia-2(48%) Singapore-7(33%) Turkey-8(48%) US-3(46%) UK-5(35)	1991 Bel-2(39%) Can-1(23%) UK-1(33%) Korea-3.5(34%)	1996 Zimbabwe-2(39%)
1983 Can-1 (31%) Chile-2 (46%) UK-2 (50%) S.Korea-4(37.5%)	1987 Can-3(29%) Col-10(30%) US-4(40%)	1992 Pakistan-5(44%)	1997 UK-2(31%) France-5(41%)
1984 Chile-23(23.5%) CostaRica-8(57.5%) UK-5(45%) Iceland-15(51%) Italy+6(36%) US+3(49%)	1988 Aus -10(39%) Can-3(26%) Fra-3(42%) Iceland-3(48%) Malaysia-3(45%) US-5(35%)	1993 Aus-6(33%) Bel+1(40%) Col+7(37.5%) Iceland-12(33%) Mexico-1(34%) Singapore-3(27%)	1998 Switzerland-1(8%)
1985 Can+1(32%) Chile-13(10.5%) UK-5(40%) Malaysia-2(50%)	1989 Aut -25(30%) Malaysia-6(39%) Can-1(25%) Mexico-5(37%) US+4(39%)	1994 Aut +4(34%) Pakistan-3(39%) Hun-4(36%)	1999 Zimbabwe-4(35%) UK-1(30%) France-5(36%)
	1990 Bel-2(41%) UK-1(34%) Can-1(24%) Denmark-10(40%) Finland-8(25%) Mexico-1(36%)	1995 Aus +3(36%) Hun-18(18%) Col-2(35%) Fra+3(36%) Kor-2(32%) Malaysia-2(30%) Pakistan-3(36%) US-4(35%)	2000 Brazil -1(34) Estonia -26(0)[12] Finland +1(29) Japan -4.5(30) Philippines -1(32) Poland -2(32) Portugal -2(32)

[12] Estonia imposes a zero rate on re-invested profits, but distributed profits are taxed.

Figure 1. Transition Graphs based on Markov Switching Probabilities





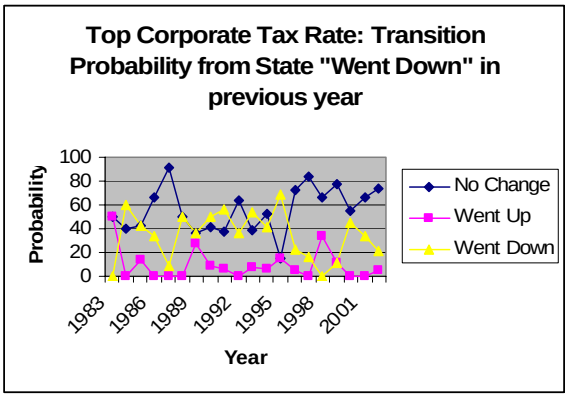
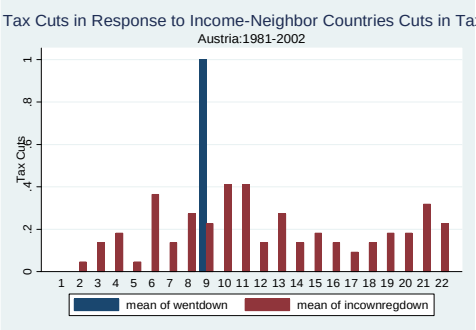


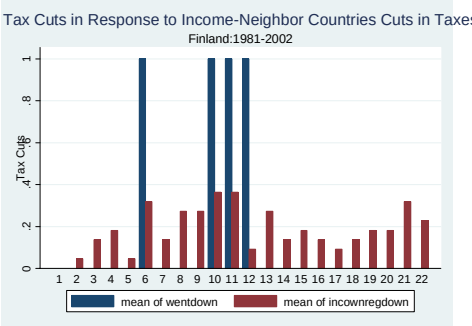
Table 1B: Average Change in Corporate Tax Rates given an Initial Value

Tax Rate (t)	Δ (t+1) *Average Change after 1 year*	Δ(t+3) *Average Change after 3 years*
10	5	8
11	-5	-5
13	0	-6
15	0	0
16	0	1
18	0	-1
19	-2	6
20	0	0
22	0	0
23	-6	-4
24	-2	-5
25	-1	-3
26	-1	-3
27	2	1
28	-1	0
29	-1	-4
30	0	-1
31	0	-1
32	0	-2
33	-2	2
34	-1	-2
35	-1	-1
36	-1	1
37	0	-1
38	-1	-3
39	-1	-4
40	-1	-2
41	0	0
42	-4	-8
43	-1	-4
44	-2	-8
45	-3	-7
46	0	0
47	-4	-16
48	-1	-4
49	-2	-12
50	-2	-7
51	-1	-9
52	0	-4
53	-2	-7
54	1	-3
55	-1	-6
>55	-5	-7

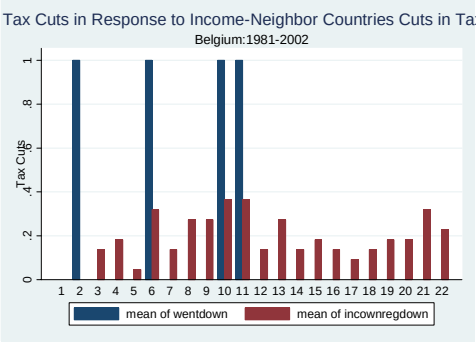
Figure 2A. Reactions to Own Income Group Neighbors



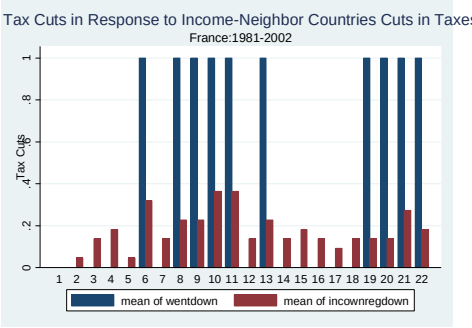
Austria



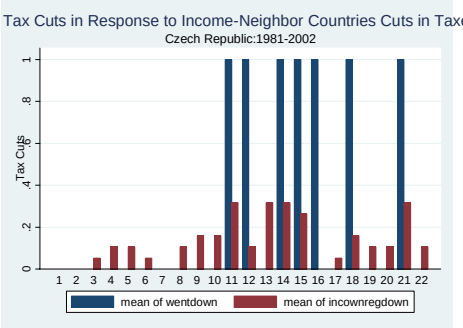
Finland



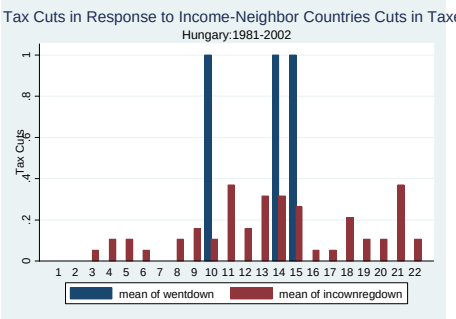
Belgium



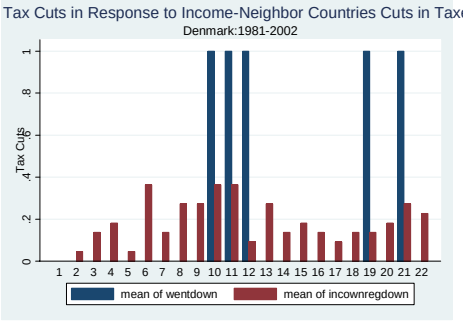
France



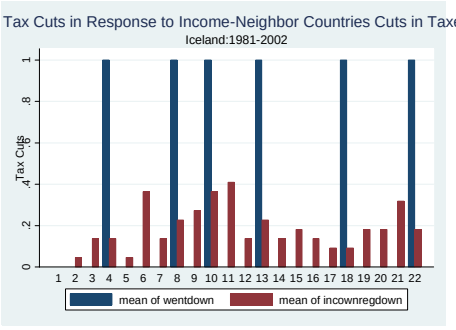
Czech Republic



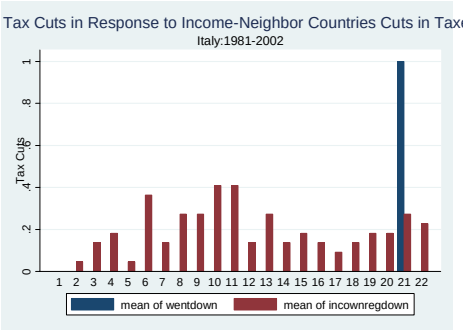
Hungary



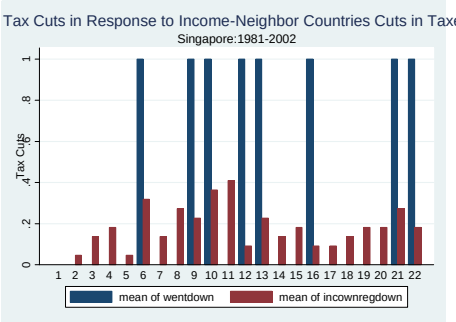
Denmark



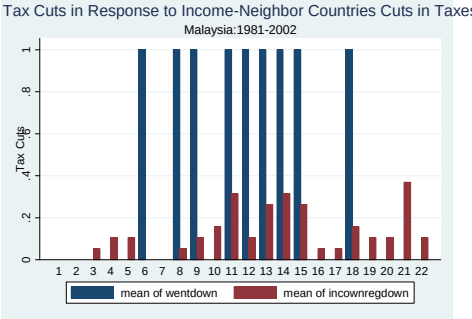
Iceland



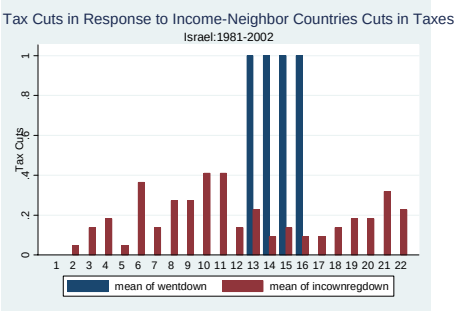
Italy



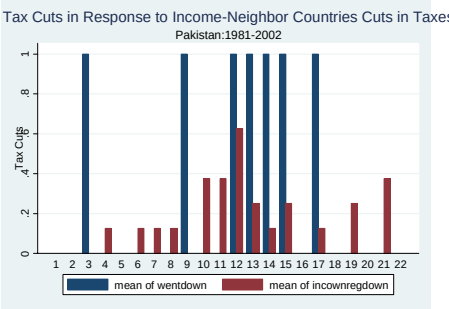
Singapore



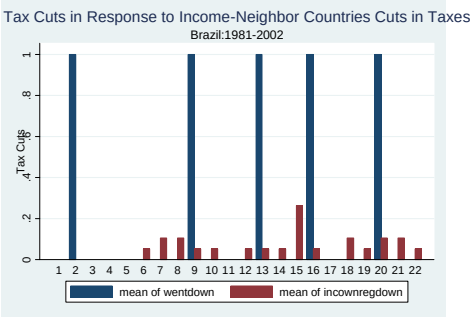
Malaysia



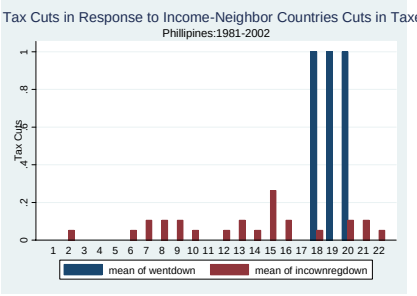
Israel



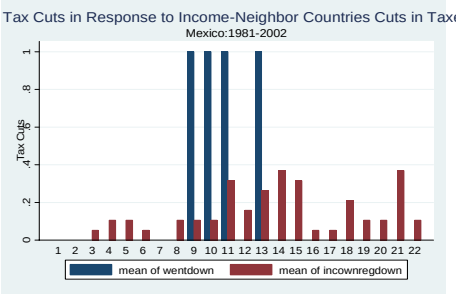
Pakistan



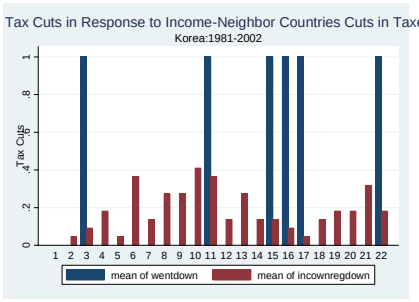
Brazil



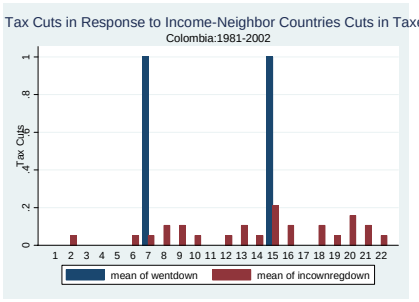
Philippines



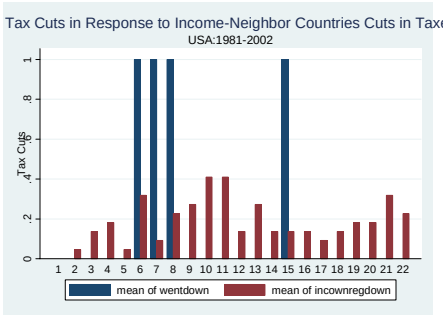
Mexico



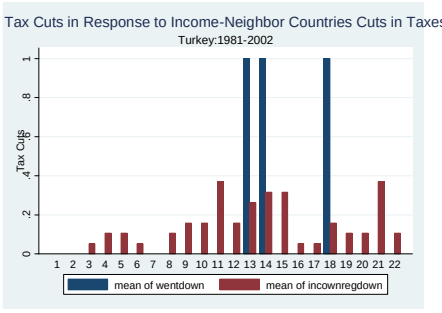
Korea



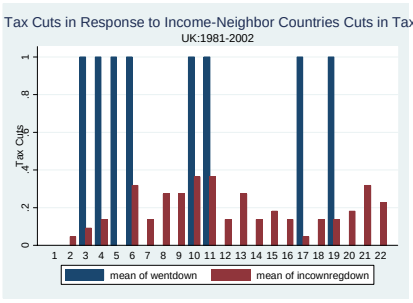
Colombia



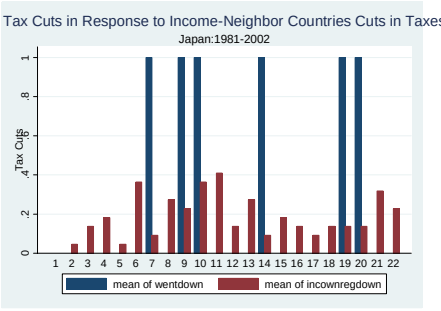
USA



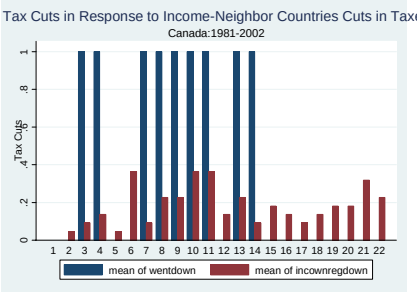
Turkey



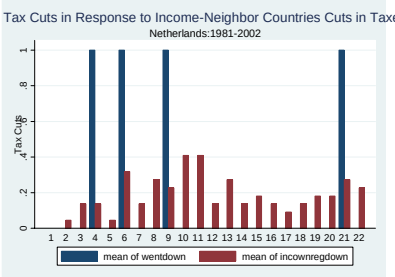
UK



Japan

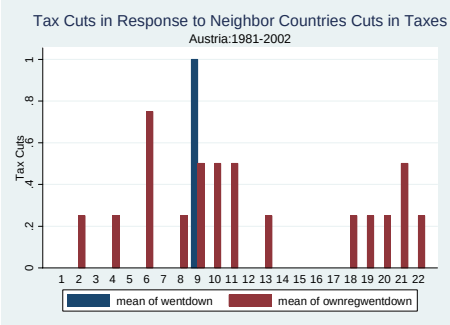


Canada

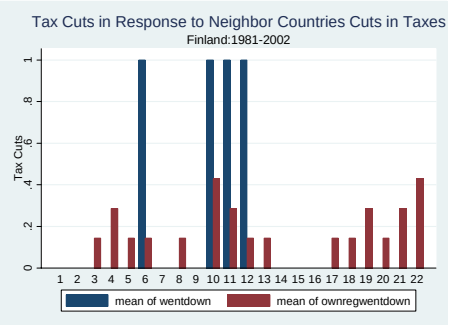


Netherlands

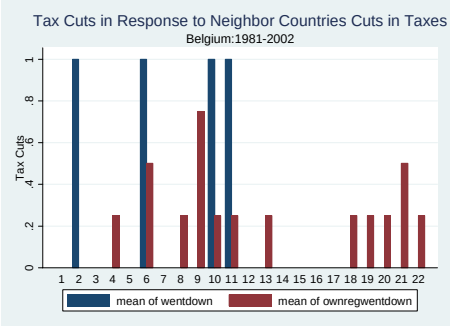
Figure 2B. Reactions to Own Region Neighbors



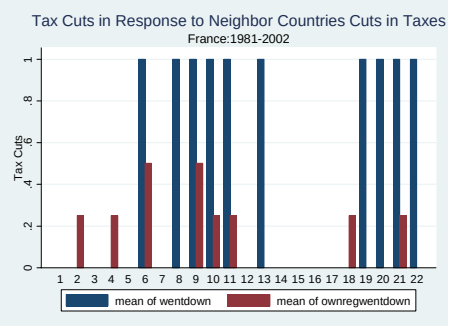
Austria



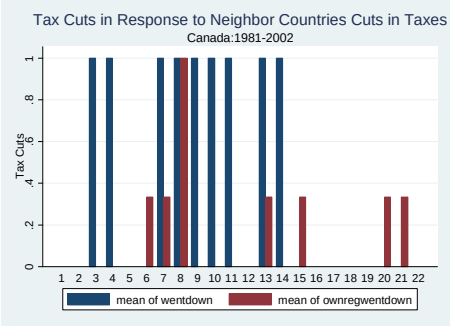
Finland



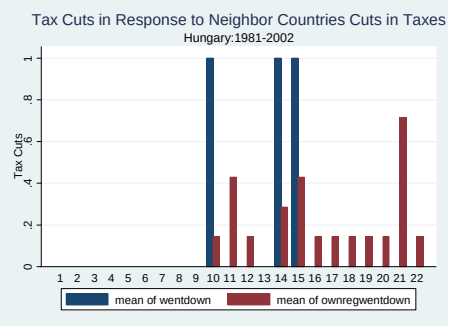
Belgium



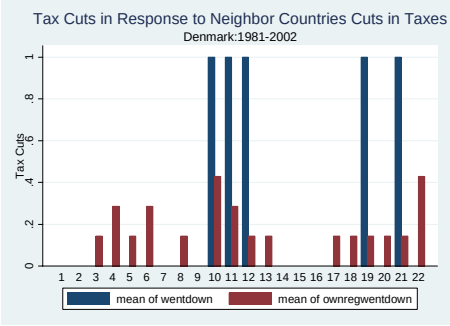
France



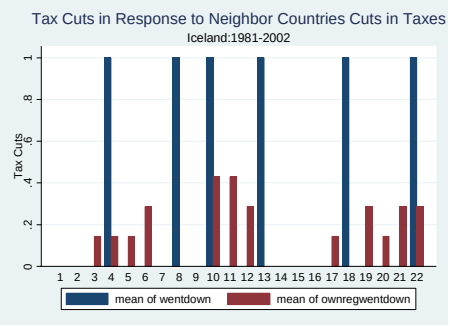
Canada



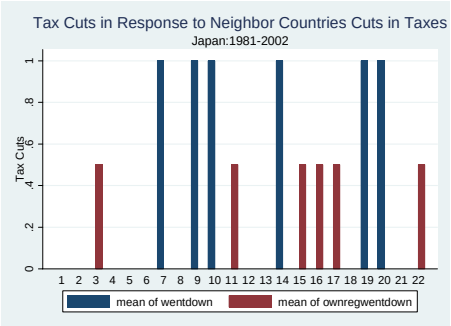
Hungary



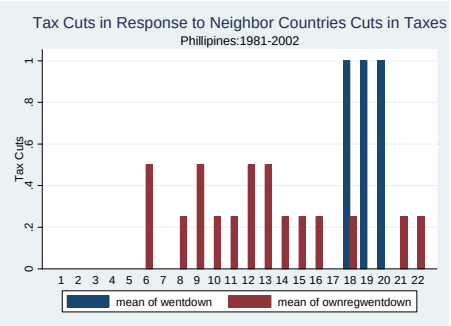
Denmark



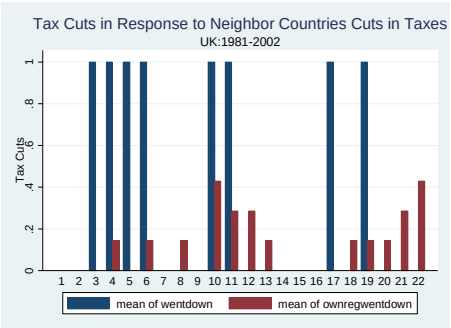
Iceland



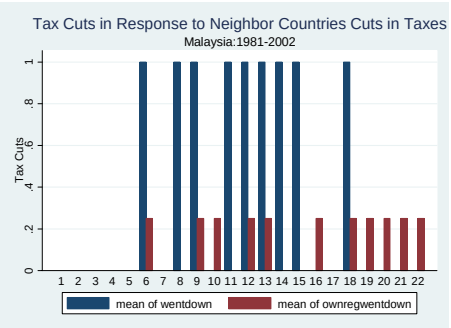
Japan



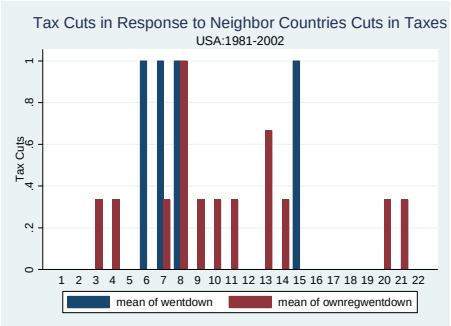
Phillipines



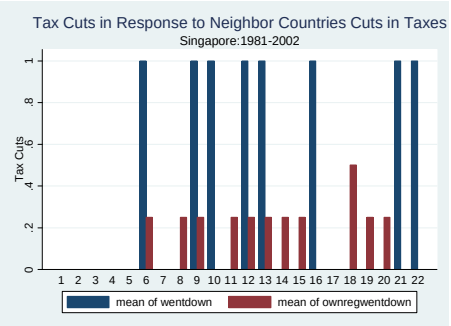
UK



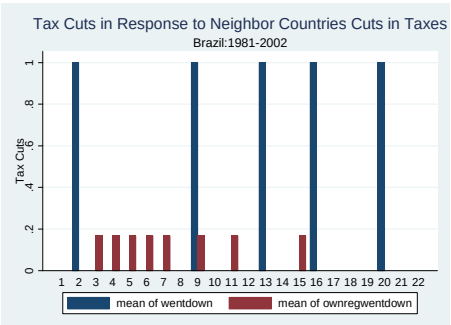
Malaysia



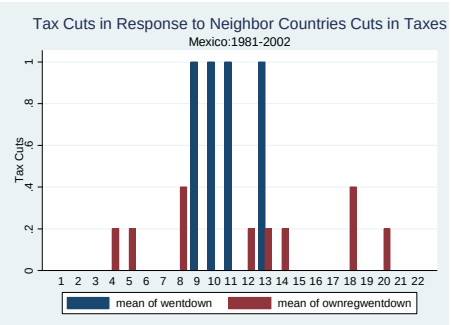
USA



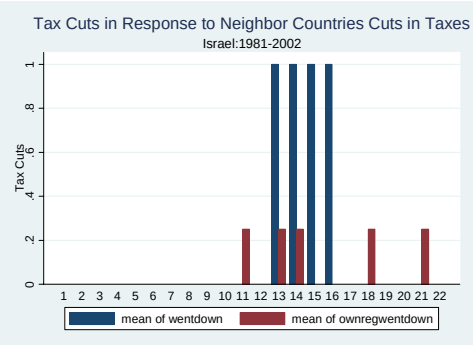
Singapore



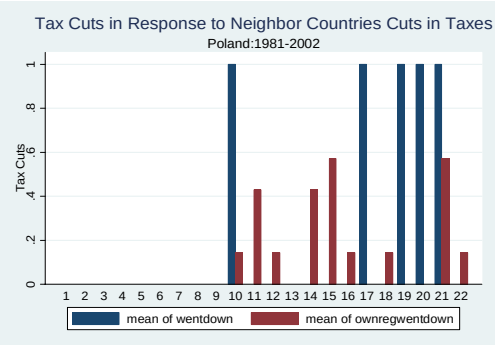
Brazil



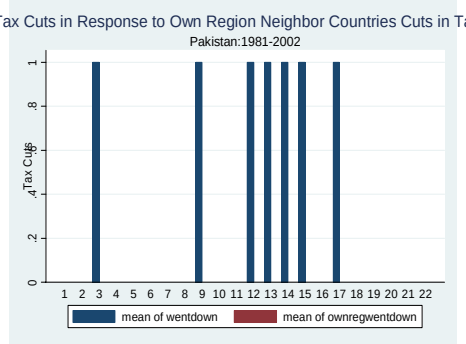
Mexico



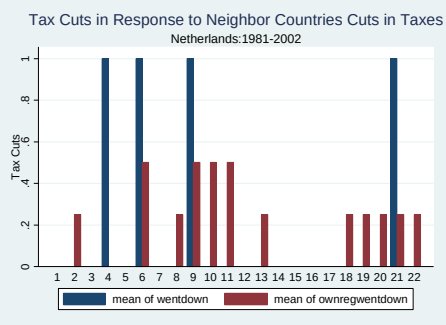
Israel



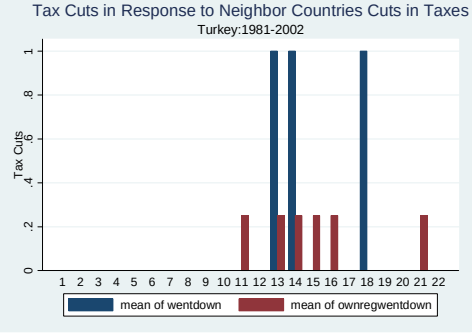
Poland



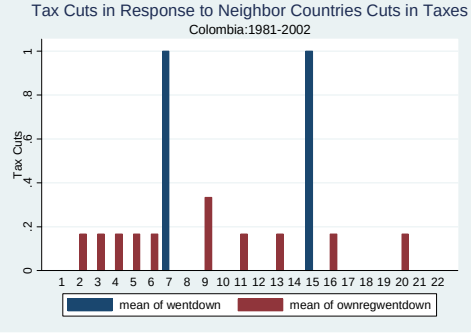
Pakistan



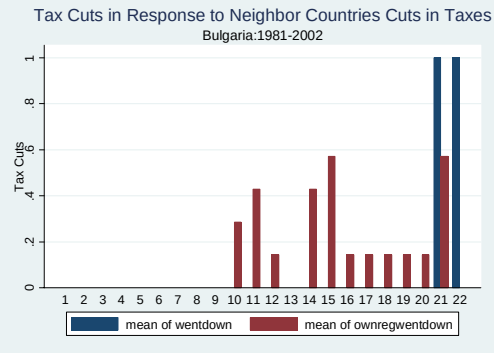
Netherlands



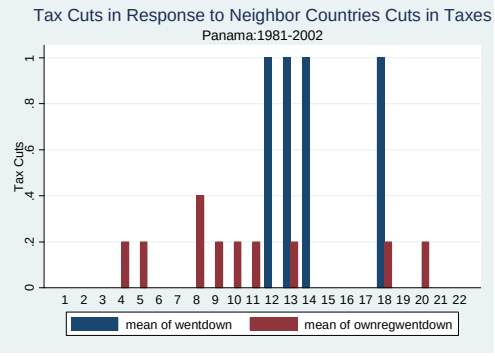
Turkey



Colombia



Bulgaria



Panama

Table 2: Modeling Tax Competition

Dependent Variable Corporate Tax Rate	(1)	(2)
Average Neighbors Tax Rates	0.465*** (.038)	0.456*** (.038)
Lowered Rates(t)		-0.025*** (.004)
Lowered Rates(t-1)*GDPGrowth(t-1,t)		-0.002*** (.001)
GDP Growth	-0.001*** (.0001)	-0.001 (.001)
Capital Mobility	-0.006*** (.001)	-0.005*** (.001)
Log(Trade/GDP)	-0.041*** (.007)	-0.046** (.008)
Observations	1254	1254
Number of countries	68	68

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

Note:
(1) Both models are estimated using a random effects specification. The results hold even for a fixed effects specification. All regressions allow for a constant and time dummies.

Table 3: Probit Coefficients

Dependent Variable *(Dummy=1 if Lowered Rates in the next 3 years)*	(1)	(2)
Log(TopNatCorpTax)	1.812*** (.291)	1.048*** (.329)
Lowered Rates(t)	0.346** (.112)	0.603*** (.123)
Lowered Rates(t-1)*GDP Growth(t-1,t)	0.054** (0.023)	0.081*** (.020)
Dummy=1 if Own Tax Rate is Higher Than Neighbors	0.507*** (.157)	0.382** (.152)
Income Weighted Neighbors Lowered Rates	0.566 (.430)	0.621 (.469)
GDP Growth	-0.003 (.014)	-0.017 (.016)
Capital Mobility	0.066*** (.024)	0.006 (.022)
Log(Trade/GDP)	0.582*** (.181)	0.275** (.138)
Observations	1190	1190
Number of countries	68	68

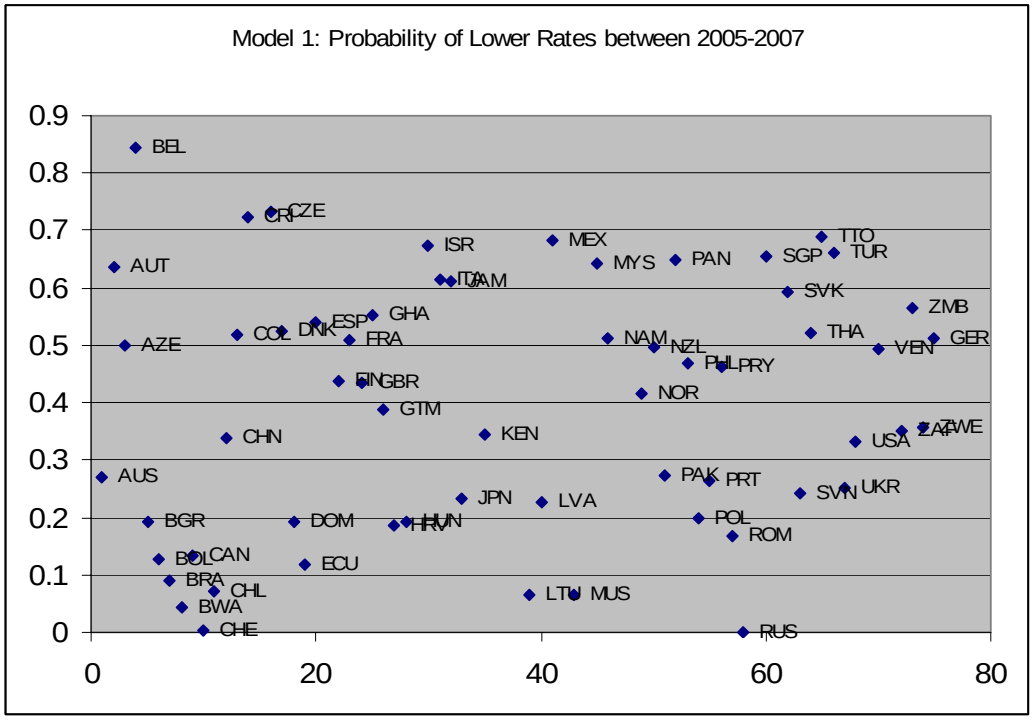
***significant at 1%; **significant at 5%* significant at 10%

Note:
(1) Specification 1 is estimated using a random effects probit model. Specification 2 is estimated using a probit model with robust standard errors and clustering. All regressions allow for a constant and time dummies.

Table 4: Accuracy of Model Prediction

	Predicted Value=1(Lowered Tax Rates) if			
	prob>=0.4	prob>=0.5	prob>=0.6	prob>=0.7
Model 1:Random Effects Probit Model				
Sample Years: 1981-2001	Percentage	Percentage	Percentage	Percentage
In sample(1008)	57	64	72	76
Including out of sample(1190)	59	64	72	76
Out of sample(182)	85	82	75	0
Year 2004(60)	77	75	0	0
Sample Years: 1981-1995	Percentage	Percentage	Percentage	Percentage
In sample: (Size:656)	60	65	72	79
Including out of sample(Size:1190)	62	65	71	80
Out of sample(Size:534)	68	64	65	100
Year 2004(Size:60)	89	75	100	0
Model 2: Probit Model with Clustering and Robust Standard Errors				
Sample Years: 1981-2001	Percentage	Percentage	Percentage	Percentage
In sample: (Size:1008)	58	67	74	83
Including out of sample(Size:1190)	59	67	74	83
Out of sample(Size:182)	75	74	57	0
Year 2004(Size:60)	60	56	60	0
Sample Years: 1981-1995				
In sample: (Size:656)	60	67	78	85
Including out of sample(Size:1190)	61	68	76	84
Out of sample(Size:534)	65	69	69	75
Year 2004(Size:60)	56	56	50	100

Figure 3A
Model 1: Probability Forecasts from a RE Probit Model



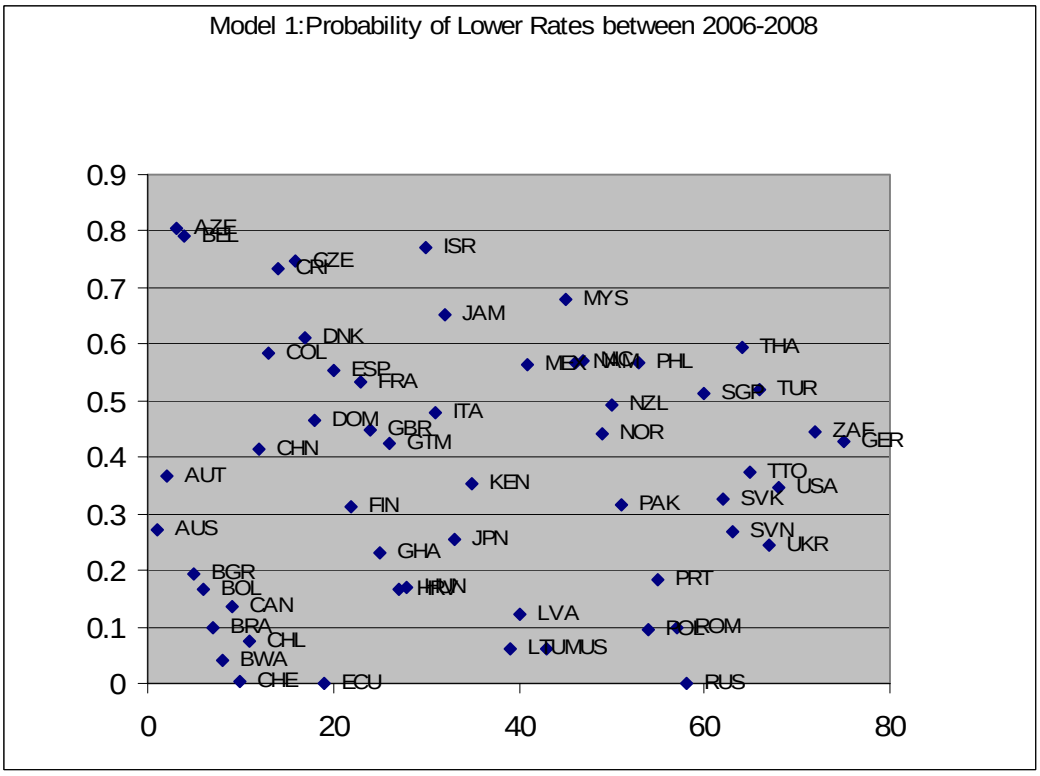
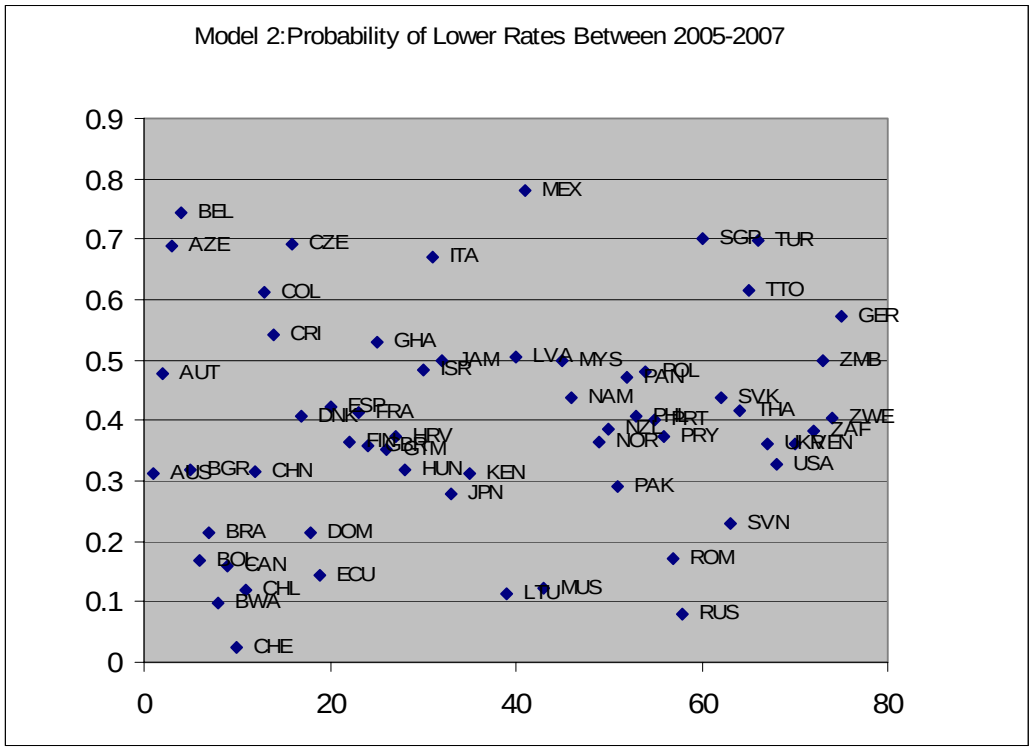


Figure 3B
Model 2: Probability Forecasts from a Probit Model with Clustering



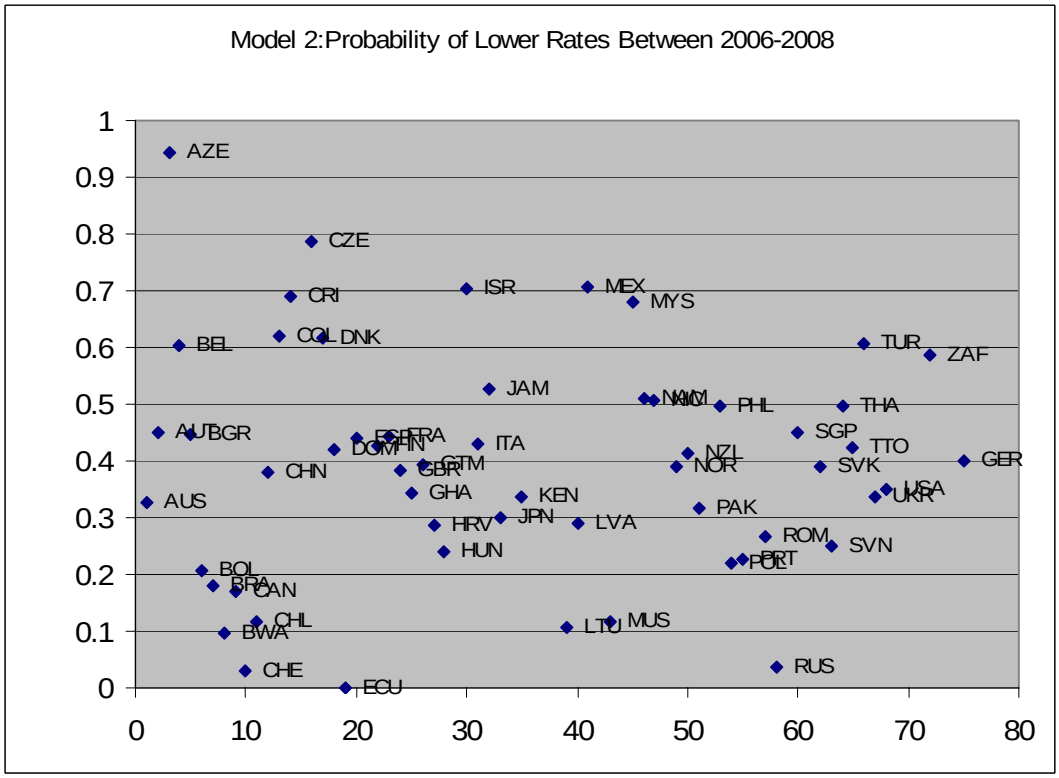
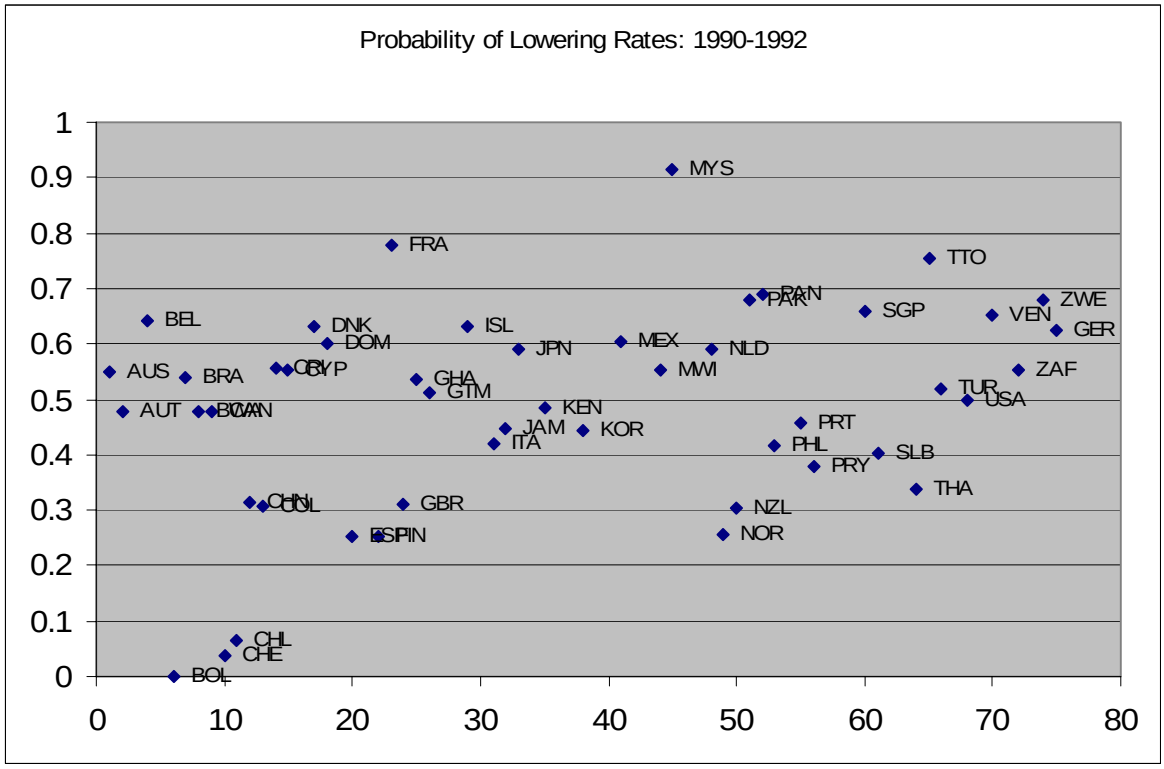
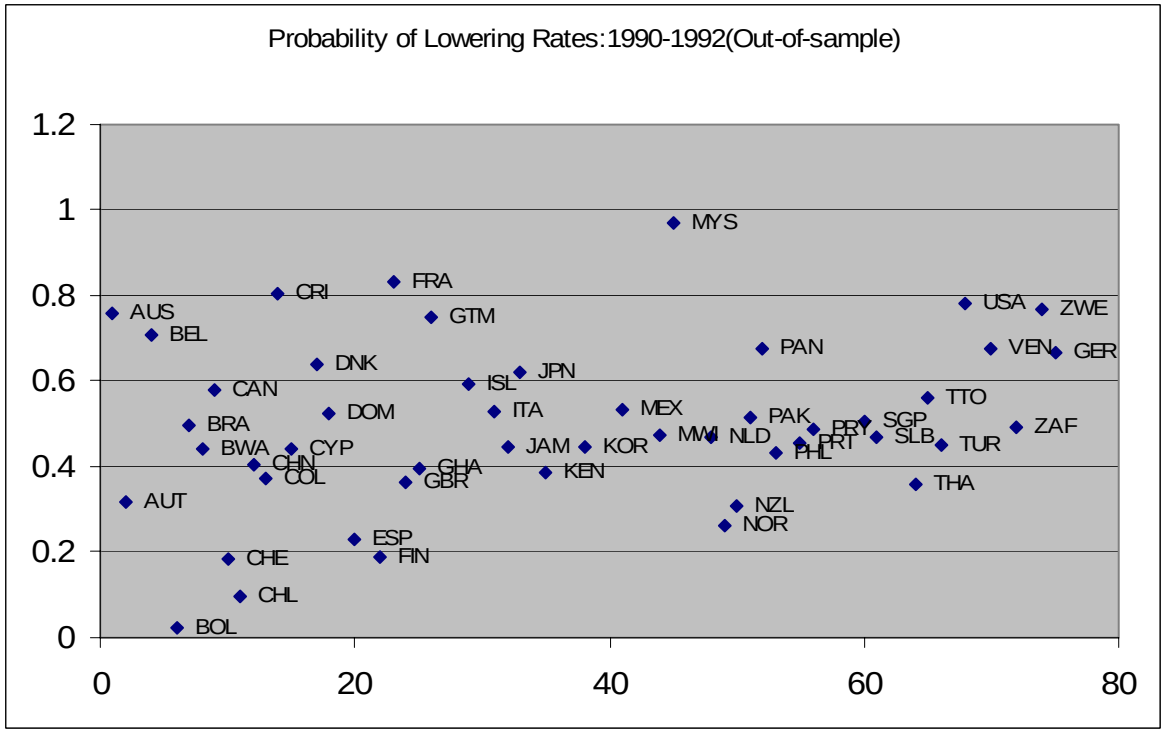


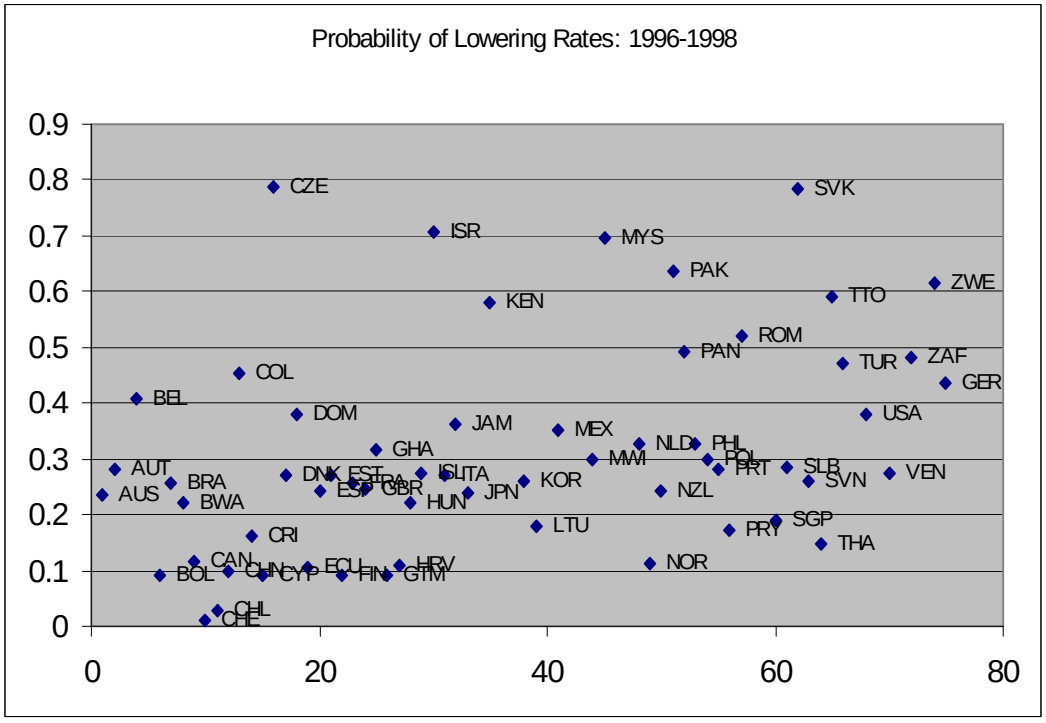
Figure 4A: Alternative Years:1989

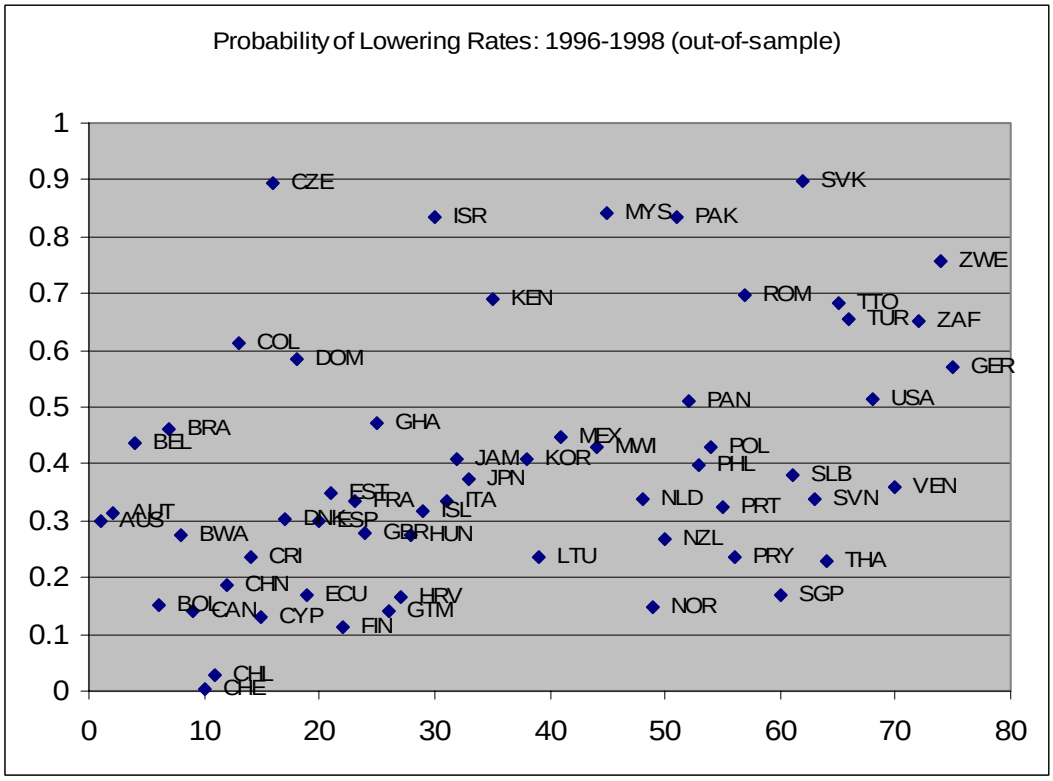




Note: These probabilities are calculated using a probit model with robust standard errors and clustering

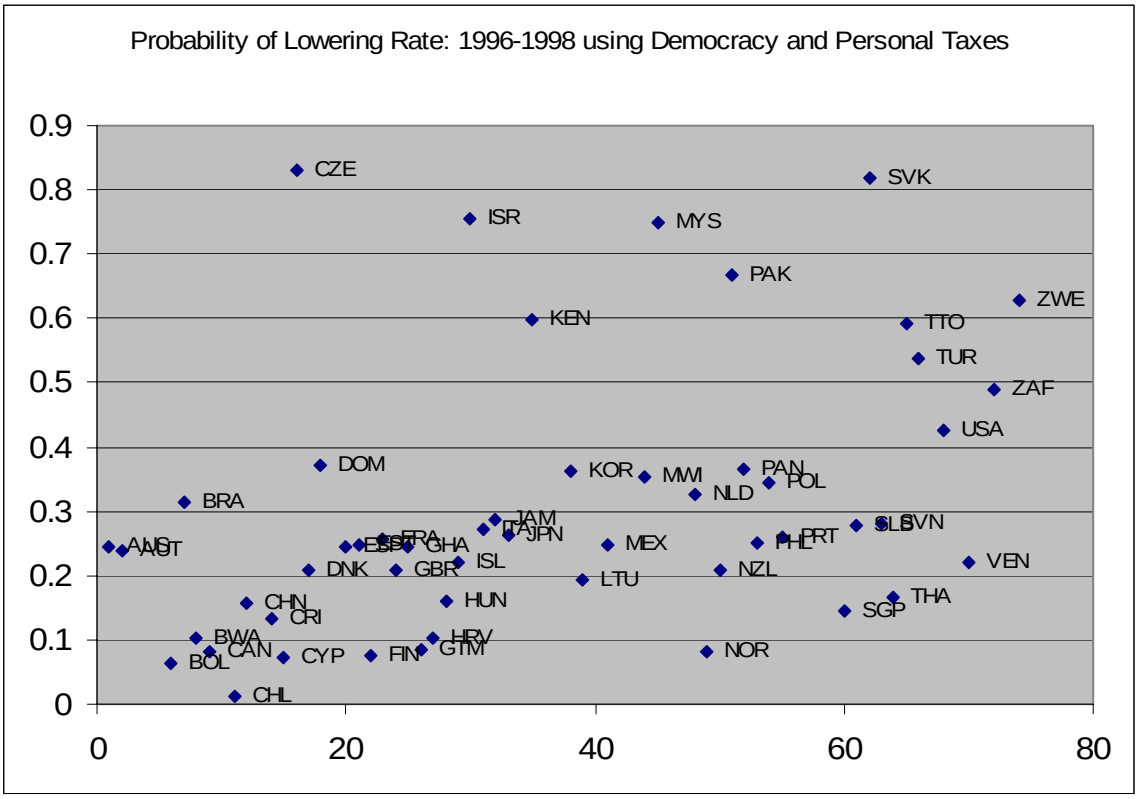
Figure 4B: Alternative Years:1995

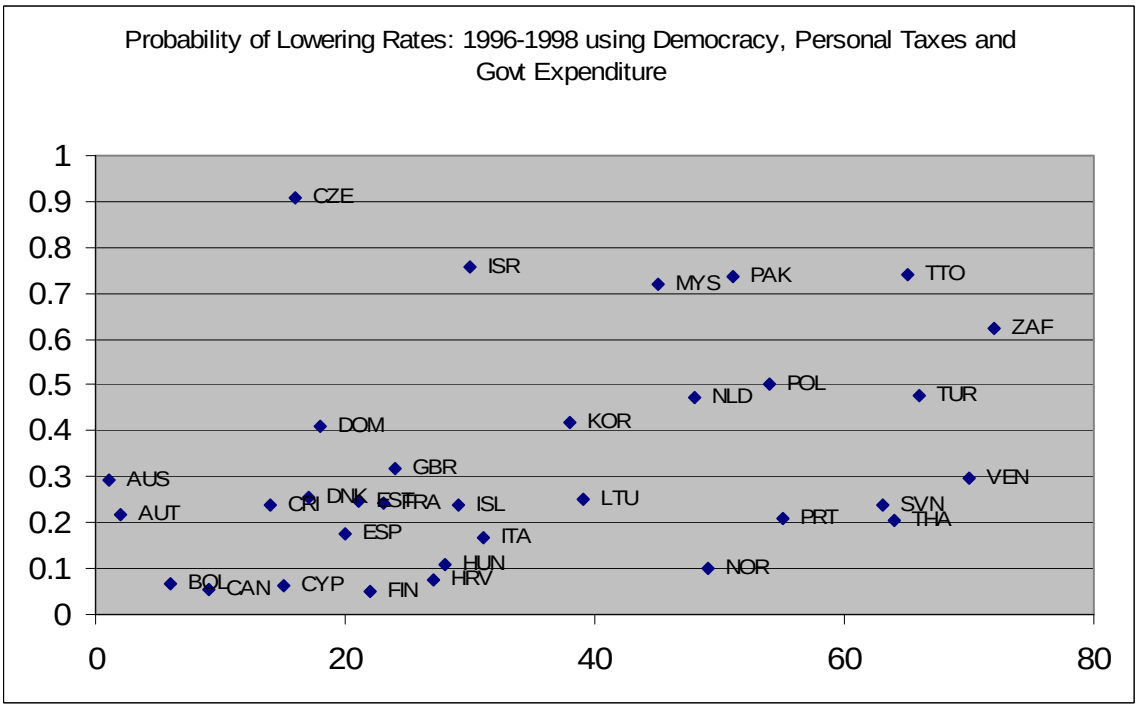




Note: These probabilities are calculated using a probit model with robust standard errors and clustering

Figure 5: Alternative Specifications for Year 1995





Note: These probabilities are calculated using a probit model with robust standard errors and clustering