International Corporate Tax Rate Competition

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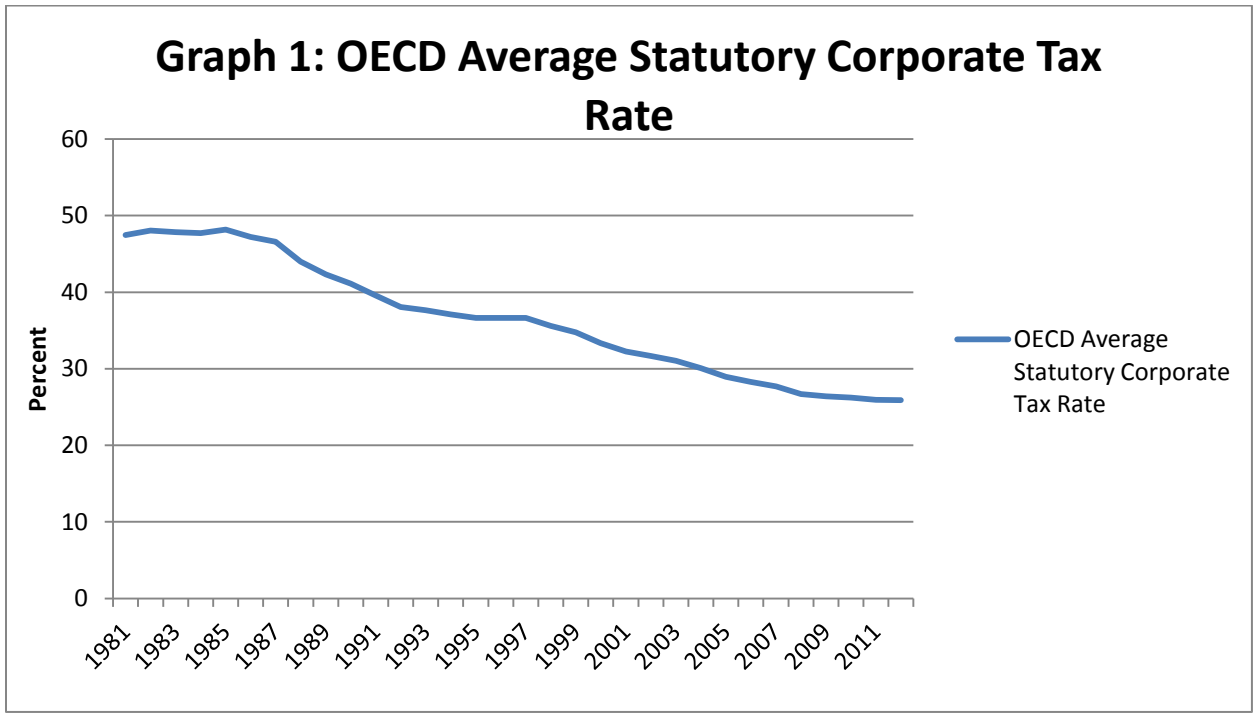
1.0 Introduction

Statutory corporate tax rates have been steadily declining around the world since the start of the 1980's. For example, the statutory corporate tax rate in Canada has declined from 51% in 1981 to 26% in 2012 (Source: OECD Tax Database). Other developed countries have experienced similar trends in their statutory corporate tax rates. Across the OECD, corporate tax rates have declined by nearly 50% since the early 1980s (see Graph 1). The decline in statutory corporate tax rates has been studied by economists, social scientists and political scientists alike. One of the common findings in the majority of the existing literature is that competition amongst governments for the right to tax corporate profits has been a driving force behind the decline. The purpose of this paper is to build on the existing theoretical and empirical research in this field and further explore the reasons for this decline.



Source: OECD Tax Database (http://www.oecd.org/tax/taxpolicyanalysis/oecdtaxdatabase.htm)

This paper will explore the statistical relationship between statutory corporate tax rates and the different variables that influence corporate tax rate policy. These variables include both external factors, such as a weighted average of other countries' statutory corporate tax rates and internal factors that influence a countries need for revenue. This paper makes the following contributions to the literature. Firstly, it is one of the most comprehensive papers, to my knowledge, in terms of data, spanning 29 countries and 30 years. Secondly, it introduces a new country specific variable, the unemployment rate, that to my knowledge, has not been explored by other authors and that adds to the explanatory power to the model. Thirdly, this paper explores whether there is any evidence of a delay in the reaction of governments to changes in other countries statutory corporate tax rates or to its own domestic factors that shape tax policy. Finally, this paper explores the possibility of a structural change in the way corporate tax rate policy has progressed. This is done by exploring the relationships between statutory corporate tax rates and their influencing factors over two consecutive 15-year periods.

This paper will unfold as follows: first, it will look at the existing models and empirical research on the topic, second, it will propose some amendments to the existing empirical research and discuss the reasons for these proposed changes, thirdly, it will discuss the data sources and empirical methods. Finally, it will discuss the results of the empirical work and draw some conclusions.

2.0 Review of existing literature

In a world where firms are unable to shift revenues between countries to maximize their after-tax profits, governments would have a great deal of discretion in choosing their tax policy. However, in the real world firms are, for the most part, able to shift revenues and expenses between countries in order to minimize the tax that they pay. As such, governments have a clear incentive to lower corporate tax rates both to attract revenues and to maintain their existing tax bases. If governments were able to collude, they could keep tax rates at a level sufficient to maximize social welfare, however, the incentive to cheat and lower corporate taxes to steal the tax base away from other countries is too strong for the average politician to ignore. And so, with the exception of some transfer pricing agreements between certain countries, governments seem to compete fiercely to broaden their tax bases. And indeed, the empirical research supports this theory. Slemrod (2004), Devereaux et al (2008), Overesch and Rincke (2009), Fuest and Weichenrieder (2002), Bretschger and Hettich (2000), Redoano (2007), and Altshuler and Goodspeed (2002) all find strong evidence to suggest that governments do indeed compete over statutory corporate tax rates. There are also several authors that expect that globalisation or the openness of countries should be contributing factors to the decline in corporate tax rates. Bretschger and Hettich (2000) have found a statistically significant link between the degree of openness and the rate of decline in statutory corporate tax rates in a sample of 14 OECD countries between 1967 and 1996. However, few other authors have found evidence to support this conclusion. Perhaps this is due to the lack of a clear statistic to determine how globalised or open a country is.

The first widely accepted models in the literature were developed by Zodrow and Miezkowski and by Wilson in 1986. The basic model with welfare-maximising governments,

assumes that if capital cannot be moved between various regions, tax policies would be efficient assuming that the total capital stock is fixed. The majority of the existing literature in the field has been built up from this model by relaxing some of its unrealistic assumptions. For example, Devereaux et al (2008) point out a major weakness in the Zodrow-Miezkoski-Wilson model, that is, that it only assumes one tax instrument is available to governments to tax corporations. However, in the real world, governments can compete on both the statutory tax rate – the tax rate on rent, and on the effective marginal tax rate (EMTR)—the statutory rate adjusted for allowances for depreciation and cost of capital. Devereaux et al. present a model "which combines mobile capital with profit-sharing via transfer pricing, and [they] study competition in corporate tax systems in this model." (p. 1212) The model presented by Devereaux et al. is a two country model, in which firms are able to shift profits between the two countries. The authors note that the same model could be extended to a multiple country case with the same results. Their model consists of firms that have both a home base and foreign subsidiary and each firm can shift profits between its home country and the foreign country subject to some degree of transfer pricing rules, a realistic extension of the existing literature. The authors "explicitly characterize both the Nash equilibrium in the two taxes, *and* the slopes of the reaction functions in the neighborhood of the Nash equilibrium, in order to obtain testable predictions." (p. 1212) Their model shows that countries do, in theory, compete in statutory corporate tax rates to attract firms profits and that the EMTR will be positive in equilibrium (as opposed to the unrealistic value of zero in the Zodrow-Miezkowski-Wilson Model).

Devereux et. al also test their model empirically by regressing statutory corporate tax rates on the average of other countries statutory corporate tax rates and several other control variables such as the income tax rate, country size, openness, public consumption and percentage

of the population that is dependant. They find strong evidence that countries do compete over statutory corporate tax rates. They find that a reduction in the average world corporate tax rate of 1% will lead to a nearly 0.7% decrease in the home countries statutory corporate tax rate (when uniform weights are used in determining the average world tax rates). The authors were unable to find strong evidence that countries compete over EMTRs. They also showed that there is no competition between the two tax instruments, i.e. a change in EMTRs does not lead to a change in the statutory corporate tax rate. The authors were not able to find a statistically significant link between openness and the decline in statutory corporate tax rates.

Other authors have also concluded that the decline in corporate tax rates has been a result of international competition. Joel Slemrod (2004) arrives at this conclusion using a slightly different methodology. Slemrod regresses a countries statutory corporate tax rates on several domestic factors that would be expected to influence corporate tax policy using panel data for several countries between 1980 and 1995. He finds little to no evidence that any of the domestic factors that should affect the need for corporate tax revenues have any effect on the corporate tax policies of those countries. He finds that "the corporate tax rate is insulated from a country's revenue needs." (p. 1183) However, Slemrod also finds that openness does not explain the decline in corporate tax rates.

Overesch and Rincke (2009), perform an empirical study to determine the drivers of corporate tax rate policy. Their study is perhaps the most comprehensive in terms of data as it covers 32 countries between the years of 1983 and 2006 (where data is available). They come to similar conclusions to Devereux et. al, in that they "find strong support for direct tax competition effects among countries with respect to statutory tax rates...[and] only weak evidence for competition over effective average tax rate and no evidence for interdependence of effective

marginal tax rates." (p. 32) However, the estimated effect found by Overesch and Rincke is much lower as they take into account several time and country specific effects that were left out of Devereux et al. (2008). When taking into account these effects, the authors find little evidence to suggest that economic or financial openness can explain the decline in corporate tax rates.

Bretschger and Hettich (2000) do find evidence that openness matters when it comes to corporate tax competition. Using panel data between 1967 and 1996 for 14 countries across the OECD, they find strong evidence to suggest that the decline in corporate tax rates over the period is a result of the degree to which a country is open. However, they leave other countries corporate tax rates out of their study, a variable that other research has found to be statistically important. The same results may not be obtained if this variable were to be included.

Altshuler and Goodspeed (2002) also find empirical evidence of corporate tax rate competition amongst countries. Their research, however, differs from much of the existing literature. The majority of the literature assumes that countries compete at a Nash equilibrium. While Altshuler and Goodspeed find this to be true for European countries, they also find evidence that after 1986, the Unites States "acts as a Stackelberg leader while the other countries follow the leader and compete among themselves in a Nash way" (p. 22)

3.0 Empirical methods and Data

There is a great deal of evidence suggesting that countries do indeed compete over statutory corporate tax rates. However, the degree to which a country's reduction in its statutory corporate tax rates is a function of its competitor nations' corporate tax policy is debated. The estimated effect of a 1% decrease in the average statutory corporate tax rate on a specific country's statutory corporate tax rate varies widely from a decrease of nearly 0.7% (Devereux et al.) to as

little as a decrease of 0.155% (Overesch and Rinke). The purpose of this paper is to investigate empirically the degree to which the decline in statutory corporate tax rates around the world is a direct result of competition between countries and, if there are other reasons (domestic or foreign) that can help to explain the phenomenon. This will be done using an unbalanced panel of 29 countries between the years 1981 and 2010 (when data is available). There are several variables that have already been investigated by other authors. This paper will draw on the experience of these other authors when deciding what variables to include and exclude from the analysis.

This paper will build upon the following equation estimated by Devereux et al (2008) :

(1)

where is the statutory corporate tax rate in country i and year t;

is the weighted average tax rate of all countries excluding country i;

is a matrix of country specific variables for country i;

are the country specific fixed effects; and

are the country specific time trends

This paper will explore both the above model and several alternative specifications of the model using two-stage least squares IV regression with fixed effects for each country. First, it will explore three different weighting schemes for . These weighting schemes are discussed below. Second, it will look at how immediately governments react to changes in the variables that drive corporate tax policy. This will be done by lagging the independent variables (where

appropriate) by one year, two years, three years, and finally as an average of the most recent year and the two preceding years. Looking at averaged variables could explain whether governments react more to temporary shocks or more to permanent or semi-permanent shocks. Finally, it will explore the possibility that there have been structural changes that have fundamentally changed the way in which governments set their corporate tax policy. This will be done by looking at two separate 15 year periods, the first between 1981 and 1995, and the second between 1996 and 2010.

3.1 Variables and Data Sources

The Statutory Corporate Tax Rate ( )

The statutory corporate tax rate is the headline rate that corporations pay on their profits. It can differ somewhat from the EMTR which takes account of deductions for interest and depreciation, investment tax credit, taxes on capital and sales taxes on capital purchases. While one would expect countries to compete over EMTRs, most authors have found little to no evidence of such competition. This is perhaps due to the fact that there is no simple, straight forward way of calculating the EMTR. As Slemrod points out, "even in its most worked-out form the procedure relies on a set of fairly arbitrary assumptions and does not account for certain features of some countries tax systems." (p. 1177) As such, this paper will not explore the EMTR any further. In fact, even just finding statutory corporate tax rates that are perfectly comparable is not entirely possible, as in addition to national corporate tax rates, there are sub-national corporate tax rates that can vary greatly across jurisdictions. The statutory corporate tax rates used for this study are found in the OECD Tax Database. They are a combination of the national and average sub-national statutory corporate tax rates. This study uses data from 30 OECD countries between the

years of 1981 and 2010 where data are available. Table 1, below, shows what countries are included in the study and for what years statutory corporate tax rates were available.

Table 1: Statutory Corporate Tax Rates (%)				
Country	Years Data Available	Min	Max	Mean
Australia	1981-2010	30	49	37
Austria	1981-2010	25	55	37
Belgium	1981-2010	34	48	40
Canada	1981-2010	29	51	41
Czech Republic	1993-2010	19	45	31
Denmark	1981-2010	25	50	36
Finland	1981-2010	25	62	38
France	1981-2010	33	50	40
Germany	1981-2010	30	60	50
Greece	1981-2010	24	49	38
Hungary	1991-2010	16	40	22
Ireland	1981-2010	13	50	32
Israel	2000-2010	25	36	32
Italy	1981-2010	28	53	42
Japan	1990-2010	40	50	44
Korea	2000-2010	24	31	28
Mexico	1981-2010	28	42	35
Netherlands	1981-2010	26	48	36
New Zealand	1981-2010	28	48	36
Norway	1981-2010	28	51	36
Poland	1992-2010	19	40	29
Portugal	1981-2010	27	55	37
Slovak Republic	1993-2010	19	45	29
Slovenia	2000-2010	20	25	24
Spain	1981-2010	30	35	34
Sweden	1981-2010	26	60	38
Switzerland	1981-2010	21	33	27
Turkey	2000-2010	20	33	27
United Kingdom	1981-2010	28	52	34
United States	1981-2010	39	50	42

Source: OECD Tax Database

$\bar{\tau}_{-i}$, Weighted Average Statutory Corporate Tax Rates

Debate remains on whether current or lagged values of other countries corporate tax rates should be used. Devreux et al. (2008) use the current values, whereas Overesch and Rincke (2009) and Altshuler and Goodspeed (2002) look at lagged values. There are convincing arguments for both cases. A case can be made for using current values as governments can predict how other governments around will set their corporate tax policy and can react accordingly. Furthermore, as Devereux et al. point out, this is consistent with game theory as "at Nash equilibrium, every country correctly predicts the current tax rates of the other countries." (p. 1220) However, from a practical standpoint, this may not be terribly realistic. While governments can try to predict other counties corporate tax policies, they will typically set their own policy well into the future, and most governments cannot always react quickly to changes in other countries tax policies. For example, a minority government could be blocked by the opposition when introducing changes to its tax policy. Therefore, it may be unrealistic to assume that corporate taxes are always set at a level consistent with a Nash equilibrium. Due to the theoretical advantage of using current values and the practical realities of the lagged values, this paper will look at both and see which model the data fits best.

There are several approaches that have been used to weight other countries' corporate tax rates. Most authors have experimented with different weighting schemes with an emphasis on uniform weights (Devereux et al. 2008, Redoano, 2007). Devereux et al. also look at weights based on country size using GDP and openness using FDI. They obtain statistically significant results for all measures although they obtain the strongest results with uniform weights. Overesch and Rincke explore spatial weights that are also a function of size. Their weights are a function of both population and distance between countries. This paper will make use of uniform weights

but will also look at weights using size and openness measures. Size weights will be determined using the same method as Devereux et al (2008), that is, GDP divided by US GDP. Openness weights will be determined as the sum of exports and imports divided by GDP which differs from the weights used by Devereux et al. Devereux et al use openness weights based on the sum of inward and outward FDI as a percentage of GDP, however, they do not obtain good statistical results with these weights.

Country Specific Variables ( )

This paper will be looking at several different country specific variables. These country specific variables act as control variables. They are variables that would logically cause fluctuations in corporate tax rates. Essentially, if we were to exclude these variables from the regression, we would be picking up the effect of these variables through either other variables in the regression that are correlated to these variables or through the error term, giving us inaccurate estimates of the effects of the other variables on statutory corporate tax rates. Table 2, below, summarizes the country specific variables.

Table 2: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Source
Top Personal Income Tax Rate	741	0.464	0.130	0.115	0.850	1981-1999: Tax Policy Centre 2000-2010: OECD Tax Database
Unemployment Rate	708	0.075	0.037	0.002	0.213	OECD Stat Extracts
Percentage of Dependent Population	749	0.334	0.026	0.268	0.484	OECD Stat Extracts
Openness	749	0.723	0.351	0.159	1.831	OECD Stat Extracts
Size	629	0.200	0.059	0.017	0.357	OECD Stat Extracts
Public Social Expenditure	749	0.105	0.198	0.004	1.000	OECD Stat Extracts

The first, and perhaps most important of these variables is the top statutory personal income tax rate. Corporate tax is thought to be a backstop for the income tax. As Slemrod points out, "the statutory corporate tax rate will be higher in countries in which the top individual tax rate is high." (p. 1171) This happens because of the incentive to shift profits between personal and

corporate tax rates. Fuest and Weichenrieder (2002) point out that if a country were to increase its personal tax rate, managers would find ways to shift labour income to capital income and pay less personal tax and more corporate tax (at a lower rate). Therefor, there is expected to be a great deal of correlation between the two rates within a country.

Another important variable is the dependency ratio, that is, the percentage of the population that is dependent on government services. An increase in this ratio would lead to an increased need for revenue, assuming there are not cuts to government services. As such, a prori, we would expect a rise in the dependency rate to lead to a rise in the tax rate. This is measured by Devereux et al. and by Overesch and Renke as the percentage of the population that is old and the percentage of the population that is young. This paper will be using the same measure. However, unlike previous authors, I will be looking at the percentage of old and young as a single variable instead of separately.

Size matters; the bigger a country is the larger the administrative burden of running the country will be. It is generally supported in the theoretical literature that residents of larger countries will need to pay higher taxes to achieve the same level of utility from public goods than a smaller country. This occurs, as Bucovetsky (1991) points out, because the larger country imposes a positive externality on the smaller country. For example, the United States spends more on its military then Canada, however, Canada benefits from having a powerful ally as its neighbour without imposing the same costs for national defence. Therefore, it would be expected that increases in size would lead to increases in the tax rate. Like Devereux et al (2008), I will be accounting for size using GDP of country i divided by US GDP.

Public consumption should also be an important determinant of the governments need for tax revenue, as public consumption rises, the need for government revenue also rises. Devereux et. al did not find a relationship between corporate tax rates and public consumption/GDP. This could perhaps be due to the ability of governments to run deficits and issue debt to provide public goods. Governments can either raise money through taxes to fund a public good, or they can provide the public good and worry about paying for it at a later date. Regardless, I will be including a variable for public consumption as a percent of GDP in my regression.

Authors such as Bretschger and Hettich (2000) have suggested that globalisation is an important factor in explaining the decline in corporate tax rates. In their panel of 14 OECD countries, they find statistically significant results for the openness variable. For their measure of openness they start from the same measure used by other authors, that is, the sum of exports and imports divided by GDP. However, they find that this measure is biased since smaller countries will have a higher trade to GDP ratio than a large country. Therefore, they correct for this bias by "performing a panel regression with *openness1* [sum of exports plus imports divided by gdp] as exdogenous variable and *size* as exogenous variable. Only the residuals from the average trend out of this regression are then regarded as indicators of real openness of an economy." (p. 10) This method seems to be one of the few that has produced statistically significant results for openness. Other authors, such as Overesch and Rincke have used the sum of exports and imports as a percentage of GDP and were unable to find a statistically significant relationship. Devereux et al tried the sum of inward and outward foreign direct investment divided by GDP and also found stastisically insignificant results. This paper will be using the sum of exports and imports divided by GDP.

Dummy Variables

Some dummy variables will also be included in the analysis. Dummy variables that take on a value of 1 if true and 0 if false will be used for the following scenarios:

1) The country is a member of the EU in year *i*; and,
2) The country is a member of NAFTA in year *i*

Country Fixed Effects

Using country fixed effects allows for a different intercept for each country. Other authors have used this technique as it produces better results. This paper will also be using fixed effects regressions.

3.2 Econometric issues

One of the major econometric issues is endogeneity. The model implies that endogeniety will be present since the hypothesis is that a country's statutory corporate tax rate depends on the statutory corporate tax rate of other countries but that other countries statutory corporate tax rates also depend on that countries corporate tax rate. The most common approach used to deal with this issue in the literature is to create an instrument for the weighted average of other countries corporate tax rates. That instrument is typically a weighted average of other countries' country specific dependent variables. Like other authors, the appropriateness of these instruments is tested using the J-Test for overidentifying restrictions.

A second issue identified by other authors such as Devereux et al (2008) is that of serial correlation in the tax rates. The tax rate in any given year will always be a function of what the tax rate was in the previous year. Firms' business models are built around the expected tax rate

and abrupt changes in this rate would be difficult to deal with. Therefore, this paper will look at t-statistics based on country specific robust standard errors.

Finally, time series data presents the issue of a time trend. Ideally we would like to remove the decreases in the corporate tax rate resulting from changes in time, however, it is not possible to separate the effect of time from the average of other countries statutory corporate tax rates. Other authors such as Devereux et al. (2008) have used country specific time trends. This paper uses the same approach.

4.0 Results

4.1 Benchmark Model: Current Values, Different Weights

The results from this regression can be found in Table 3 (below). The case for size weights fails the test for overidentification with a p-value of 0.0012. Therefore, there is no point in interpreting the results for this case as the instrument is not valid. Both the uniform weights and openness weights cases pass the test for overidentification with p-values of 0.1645 and 0.2433 respectively. The two weighting schemes also produce similar results in terms of goodness of fit. The R-squared in the model with uniform weights is 0.629, while the R-squared in the model with openness weights is 0.625. Both cases easily pass the F-test with F-statistics above 90.

Table 3: Results Benchmark Case	(1)	(2)	(3)
VARIABLES	y1	y1	y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	0.962***		
	(3.478)		
Top Personal Income Tax Rate	0.101***	0.118***	0.103***
	(3.705)	(4.365)	(3.794)
Unemployment Rate	-0.217	-0.220*	-0.210
	(-1.614)	(-1.654)	(-1.563)
Percentage of Dependent Population	0.0654	-0.0269	0.124
	(0.209)	(-0.0847)	(0.395)
Openness	-0.165***	-0.154***	-0.161***
	(-5.146)	(-4.832)	(-5.076)
Public Social Expenditure	-0.417***	-0.477***	-0.417***
	(-2.776)	(-3.260)	(-2.741)
Size	0.0610	-0.186	0.0872
	(0.239)	(-0.732)	(0.345)
NAFTA Dummy	0.0471***	0.0455***	0.0468***
	(5.524)	(5.255)	(5.386)
EU Membership Dummy	-0.0315**	-0.0279**	-0.0320**
	(-2.472)	(-2.230)	(-2.501)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		0.161	
		(0.629)	
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights			0.991***
			(3.605)
Observations	598	598	598
R-squared	0.629	0.644	0.625
Number of country	29	29	29
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	93.46	96.98	91.44
p	0	0	0
j	7.853	20.19	6.708

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The weighted average of other countries' statutory corporate tax rates :

The estimates of range in value from 0.962, in the case of uniform weights to 0.991 in the case of openness weights. is highly statistically significant (using robust standard errors) in

both cases at the $p<0.01$ level. In the case of uniform weights, a one percent change in the average of other countries average statutory corporate tax rates will lead to a 0.962% change in country i's statutory corporate tax rate, *ceterus paribus*. This lies within expectations, however, it is slightly higher than other authors estimate of this variable. Devereux et al, for example estimate the coeffecient to be 0.678. The estimate for is most significant in the model with openness weights with a robust t-statistic of 3.605.

Top Marginal Income Tax Rate ( )

The estimate of is fairly consistent across weighting schemes. It ranges from 0.101 in the uniform-weighted model to 0.103 in the openness-weighted model. The coefficient also carries the anticipated sign. If corporate tax acts as a backstop for income tax then the two tax policies must be coordinated. The estimates are also statistically significant at the $p<0.001$ level in all cases.

Unemployment ( )

The unemployment rate fails to explain. An increase in unemployment will create a need for revenue to deal with the newly unemployed, however, economic theory suggests that loosening fiscal policy can help to stimulate economic activity and hence employment. Therefore, one would expect increases in unemployment lead to decreases in statutory corporate tax rates. As the unemployment rate increases, governments lower corporate tax rates to get corporations hiring again. While the estimates of do carry the anticipated sign, they fall just short of statistical significance at the $p<0.1$ level with a t-stat of 1.614 (in the case of uniform weights).

Percentage of Population that is Dependent ( ):

While our estimates of make sense intuitively, they are not statistically significant at any reasonable level. This is likely due to the fact that governments have many tools to raise the revenues they require to finance public spending and the statutory corporate tax rate is just one of those tools. The government can easily borrow money and pay for an increased need for revenue in the future, therefore it is not surprising that is not statistically significant. Other authors have found mixed results on the statistical significance of this variable. Devereux et al find no evidence to suggest that it is statistically significant. Redoano (2007) finds the variable to be statistically significant in some models and not statistically significant in others, while Overesch and Rincke (2010) find it to be highly statistically significant in some cases.

Openness ( ):

In the literature, authors have found mixed results on the effect of openness on the statutory corporate tax rate, perhaps due to the different metrics used to measure openness. However, my model suggests that openness matters. Authors that have found openness to be statistically significant have used a similar metric to measure openness. This result, along with results from other authors that have found this variable statistically significant suggest that globalization, or openness should be measure using a trade based measure and not a financial measure. In both the uniform and openness weighted cases, it is statistically significant at the $p<0.01$ level in all models. The estimates of range from -0.165 in the case of the uniform weights to -0.161 in the case of the openness weights. This fits in with my a priori expectations. The expectation was that as a country becomes more open, its statutory corporate tax rate will decrease. The estimates

suggest that a 1% increase in openness will lead to approximately a 0.1% reduction in statutory corporate tax rates.

Public Social Expenditure ( ):

Increases in public social expenditure create a clear need for government revenue. Therefore, one would expect increases in public social expenditure to lead to increases in the statutory corporate tax rate. However, the empirical model suggests the opposite. This is a rather puzzling result. The model estimates the value of to be -0.417 in both the uniform and openness weighted cases. Furthermore, the estimate is statistically significant at the $p<0.01$ level. While Devereux et al. also found this variable to be negative, there estimates were not statistically significant. Perhaps, increases in government spending have stimulated economic activity, increasing the tax base and allowing governments to collect more revenue at a lower tax rate.

Size ( ):

The estimates of size are not statistically significant, however their signs do fit in with a priori expectations. The estimates are both small and positive, which is what we would expect from a theoretical perspective. However, given that we cannot reject the null hypothesis that the true value of this estimate is zero, we cannot say with any reasonable level of confidence that the estimates are reasonably accurate. Devereux et al (2008) find size to be a statistically significant variable when using uniform weights, however, they do not find it to be statistically significant when using size or openness weights. Most authors do not find the statistical relationship that is generally theoretically accepted in the literature between size and corporate tax rates.

NAFTA Dummy ( ):

The estimates for are not in line with a priori expectations. One would expect that the extra level of openness that would have occurred as a result of the free trade agreement would have put downward pressure on the statutory corporate tax rate. However the results from the model suggest the opposite. The model suggests that being part of NAFTA has caused statutory corporate tax rates to increase within those countries, albeit at a very low rate. Using uniform weights, being part of NAFTA leads to an annual increase in statutory corporate tax rates of 0.049%. The estimates of the NAFTA dummy are also highly statistically significant at the $p<0.01$ level.

EU Dummy ( ):

Dummy variable were included for whether or not a country was a member of the EU. Estimates of the impact of this variable range in value from -0.0315 in the case of uniform weights to -0.0320 in the case of openness weights. This suggests that being a member of the EU puts pressure on a country to lower its statutory corporate tax rates. This makes sense given that it is relatively easy for firms to shift profits within EU countries and so, the competition for firms' profits within the EU is strong. This suggests that competition from within the EU to lower corporate tax rates is higher than competition from outside the EU.

4.2: Adjustment delays in tax policy

4.2.1 Single Year Lag

Lagging the independent variables one year produces statistically significant results for most variables that were found to be statistically significant in the case of current year variables (see Table 4). Again, the instrument variable for other countries' corporate tax rates fails the test for overidentification with a J-stat of 20.09. Both the uniform weight and openness weight regressions produce reliable IVs for other countries' corporate tax rates with p-values from the J-

test of 0.28 and 0.22 respectively. In the case of uniform weights, the R-squared is 0.001 lower when lagged independent variables are used than when current values are used. With openness weights the R-squared values are identical. While the F-stat is slightly lower with lagged values, it is still well above the critical value that would cause us to be unable to reject the joint null hypothesis that the independent variables do not explain the dependent variable. While the estimates for some of the variables differ slightly from the case of current values, they all carry the same signs. Again, neither the unemployment rate nor the size of a country seem to have any impact on statutory corporate tax rates.

Table 4: Results using single year lag	(1)	(2)	(3)
VARIABLES	y1	y1	y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	1.422***		
	(4.993)		
Top Personal Income Tax Rate lagged one year	0.0718**	0.109***	0.0738***
	(2.569)	(3.947)	(2.638)
Unemployment Rate lagged one year	-0.211	-0.201	-0.196
	(-1.635)	(-1.599)	(-1.519)
Percentage of Dependent Population lagged one year	0.232	0.130	0.304
	(0.805)	(0.447)	(1.054)
Openness lagged one year	-0.214***	-0.188***	-0.212***
	(-6.650)	(-6.045)	(-6.509)
Public Social Expenditure lagged one year	-0.529***	-0.587***	-0.543***
	(-3.502)	(-3.842)	(-3.541)
Size lagged one year	0.333	0.0562	0.334
	(1.443)	(0.249)	(1.478)
NAFTA Dummy lagged one year	0.0510***	0.0520***	0.0519***
	(5.459)	(5.556)	(5.467)
EU Membership Dummy lagged one year	-0.0152	-0.0119	-0.0162
	(-1.229)	(-1.013)	(-1.311)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		0.574*	
		(1.927)	
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights			1.388***
			(4.451)
Observations	599	599	599
R-squared	0.628	0.649	0.625
Number of country	29	29	29
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	83.15	87.86	81.82
p	0	0	0
j	6.312	20.09	7.042

Robust t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.2.2 Two Year Lag

In order to determine how quickly governments react to changes in the variables that are believed to shape corporate tax policy, we try running the same regressions with the independent variables lagged two years. Table 5, below, summarizes the results from this regression.

For the most part, the lagged independent variables produce similar results in terms of the signs of the variables and the statistical significance. Again, only the instrument variable for the uniform weight and openness weight cases is valid. We lose only a small amount of explanatory power in terms of the R-squared. When two year lags are used, the impact of a change in other countries weighted average statutory corporate tax rates is much higher than when current values are considered. For example, in the case of uniform weights, a 1% decline in other countries corporate tax rates will lead to a 1.715% decrease in country i's corporate tax rate 2 years later (1.620% when openness weights are applied). When the top marginal income tax rate is lagged two years, it is no longer statistically significant. This makes sense. Because the corporate tax is a backstop for the income tax, it makes sense that a shock to the income tax rate would move quickly to the corporate tax rate. Also of note, the size variable is statistically significant at the $p<0.1$ level when lagged two years in both the uniform and openness weighted cases. It also carries the anticipated positive sign. Theory suggests that this should be the case. This raises the question of why the size effect is only felt when lagged. Perhaps, as countries' economies grow, their governments take time to adjust to their new responsibilities. The EU dummy is also no longer significant when lagged. Perhaps, the competition from within the EU transitions to the corporate tax rate quickly.

Table 5: Results using two year lag	(1)	(2)	(3)
VARIABLES	y1	y1	y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	1.715***		
	(6.137)		
Top Personal Income Tax Rate lagged two years	0.0448	0.0959***	0.0483
	(1.489)	(3.326)	(1.565)
Unemployment Rate lagged two years	-0.169	-0.142	-0.156
	(-1.395)	(-1.221)	(-1.284)
Percentage of Dependent Population lagged two years	0.296	0.302	0.393
	(1.104)	(1.143)	(1.469)
Openness lagged two years	-0.253***	-0.192***	-0.248***
	(-8.402)	(-6.786)	(-8.193)
Public Social Expenditure lagged two years	-0.613***	-0.588***	-0.623***
	(-4.095)	(-3.837)	(-4.075)
Size lagged two years	0.371*	0.208	0.360*
	(1.686)	(0.967)	(1.681)
NAFTA Dummy lagged two years	0.0525***	0.0587***	0.0534***
	(5.429)	(6.276)	(5.473)
EU Membership Dummy lagged two years	0.000203	0.000402	-0.00165
	(0.0170)	(0.0363)	(-0.139)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		0.610**	
		(2.230)	
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights			1.620***
			(5.355)
Observations	599	599	599
R-squared	0.624	0.643	0.622
Number of country	29	29	29
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	77.89	82.01	78.61
p	0	0	0
j	3.369	25.80	5.694

Robust t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.2.3 Three Year Lag

When the independent variables are lagged three years, they produce similar results to when they are lagged 2 years. Table 6, below, summarizes the results from this regression. Again, we see that the size weighted regression fails to produce a valid instrument for other countries' statutory corporate tax rates.

The effect of the other countries statutory corporate tax rates is comparable to that of the same variable lagged 2 years. The top personal income tax rate, which was not statistically significant when lagged two years, becomes statistically significant, at the $p<0.1$ level, when three year lags are considered. The size variable, which was statistically significant when lagged two years falls just shy of being statistically significant when lagged 3 years with a robust t-stat of 1.528 and 1.592 for the uniform and openness weight cases respectively.

Table 6: Results using three year lag	(1)	(2)	(3)
VARIABLES	y1	y1	y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	1.635***		
	(5.683)		
Top Personal Income Tax Rate lagged three years	0.0534*	0.0940***	0.0554*
	(1.866)	(3.514)	(1.917)
Unemployment Rate lagged three years	-0.104	-0.0755	-0.0880
	(-0.916)	(-0.672)	(-0.773)
Percentage of Dependent Population lagged three years	0.313	0.452*	0.400
	(1.215)	(1.833)	(1.568)
Openness lagged three years	-0.259***	-0.181***	-0.258***
	(-9.299)	(-6.745)	(-9.107)
Public Social Expenditure lagged three years	-0.607***	-0.501***	-0.611***
	(-4.114)	(-3.380)	(-4.106)
Size lagged three years	0.348	0.388*	0.351
	(1.528)	(1.772)	(1.592)
NAFTA Dummy lagged three years	0.0529***	0.0588***	0.0535***
	(5.637)	(6.532)	(5.645)
EU Membership Dummy lagged three years	0.0110	0.00736	0.00993
	(1.000)	(0.705)	(0.899)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		0.307	
		(1.122)	
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights			1.537***
			(5.068)
Observations	599	599	599
R-squared	0.623	0.636	0.622
Number of country	29	29	29
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	74.40	78.13	75.69
p	0	0	0
j	3.943	24.88	4.034

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.2.4 Three-Year Averages

It is quite possible that some of the independent variables influence corporate tax policy when looked at over a longer time period. Therefore, I regress statutory corporate tax rates on three year averages of the independent variables. The results from this regression are summarized in Table 7, below.

Firstly, the size weighted regression again fails to produce a valid instrument. Both the even weight and openness weight regressions produce valid instruments. The averaged independent variables do a slightly better job of explaining variations in statutory corporate tax rates. The R-squared is 0.65 and 0.646 in the uniform and openness weighted cases respectively, which is about 3% better when compared to the best single-year cases.

Table 7: Results using three year averages	(1)	(2)	(3)
VARIABLES	y1	y1	y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	1.377***		
	(5.381)		
Top Personal Income Tax Rate_three year average	0.0790***	0.130***	0.0825***
	(2.708)	(4.729)	(2.811)
Unemployment Rate three year average	-0.295**	-0.337***	-0.282**
	(-2.252)	(-2.710)	(-2.163)
Percentage of Dependent Population three year average	0.396	0.353	0.460*
	(1.560)	(1.385)	(1.795)
Openness three year average	-0.207***	-0.180***	-0.203***
	(-6.392)	(-5.743)	(-6.266)
Public Social Expenditure three year average	-0.433***	-0.477***	-0.439***
	(-2.899)	(-3.207)	(-2.908)
Size lagged three year average	0.452**	0.218	0.442**
	(2.064)	(1.006)	(2.075)
NAFTA Dummy three year average	0.0607***	0.0599***	0.0616***
	(6.148)	(6.062)	(6.119)
EU Membership Dummy three year average	-0.0118	-0.00643	-0.0125
	(-0.927)	(-0.529)	(-0.975)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		0.612**	
		(2.300)	
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights			1.318***
			(5.144)
Observations	623	623	623
R-squared	0.650	0.667	0.646
Number of country	30	30	30
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	91.27	97.13	90.66
p	0	0	0
j	4.567	20.34	7.768

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Using three year averages greatly increases the statistical significance of two key variables. Firstly, the unemployment rate, which was not statistically significant in any of the single year cases is statistically significant at the $p<0.05$ level in both the uniform and openness weighted cases. It also carries the anticipated sign. This makes sense. Governments are much less interested in temporary shocks to the unemployment rate. A temporary rise in unemployment does not call for economic stimulus. However, a lasting shock is a different story. When a recession hits and unemployment starts rising, governments will be pressured to provide some type of economic stimulus. This is what the results suggest. In the case of even weights, an average rise of one percent per year in the unemployment rate will lead to a 0.295 percent reduction in the statutory corporate tax rate.

The second variable that shows much improved results when averaged over three years is size. The size variable is statistically significant at the $p<0.05$ level. For the most part, size did not seem to matter in the single year regressions. In the case of uniform weights, the coefficient for size is 0.452 and in the case of openness weights, it is 0.442. They carry the theoretically anticipated sign and seem reasonable. Again, for this variable, it makes sense that the three year average variables matter and the single year variables do not. Governments will want to ensure that the changes in their size (or economic clout) are lasting and part of a trend before they open the purse strings.

4.2.5 Combination of Benchmark and Adjustment Delay Models

Finally, I perform one last regression. We have seen from the previous regressions that some variables perform well at explaining fluctuations in the statutory corporate tax rates but only

under certain circumstances. Therefore, the following regression takes either single year or averaged variables for the dependent variables, where appropriate. It also only looks at the cases of uniform and openness weights. In the previous tests, these weighting schemes have consistently performed better than those that were weighted by size. The results from this regression can be found in Table 8, below.

Table 8: Results using single year and averaged variables	(1)	(2)
VARIABLES	y1	y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	1.267***	
	(4.771)	
Top Personal Income Tax Rate	0.103***	0.106***
	(3.457)	(3.602)
Unemployment Rate lagged three years	-0.253*	-0.250*
	(-1.839)	(-1.810)
Percentage of Dependent Population lagged three years	0.181	0.262
	(0.628)	(0.895)
Openness lagged three years	-0.225***	-0.219***
	(-6.579)	(-6.436)
Public Social Expenditure lagged three years	-0.592***	-0.599***
	(-3.893)	(-3.877)
Size lagged three years	0.279	0.283
	(1.189)	(1.232)
NAFTA Dummy	0.0528***	0.0524***
	(5.723)	(5.540)
EU Membership Dummy	-0.0280**	-0.0282**
	(-2.161)	(-2.177)
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights		1.239***
		(4.873)
Observations	563	563
R-squared	0.648	0.643
Number of country	29	29
Country FE	YES	YES
Country Time Trend	YES	YES
F	88.01	87.48
p	0	0
j	5.077	7.274

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Both uniform and openness weights produce valid instruments. They both pass the F-test and have a relatively high R-squared. First off, other countries' weighted average statutory corporate tax rates are highly statistically significant and carry the expected signs. The estimate suggests

that a 1% decrease in other countries corporate tax rates will lead to a 1.239%-1.267% decrease in country i's statutory corporate tax rate. The top personal tax rate is also highly statistically significant and carries the expected sign. The unemployment rate is statistically significant at the $p<0.1$ level and carries the anticipated sign. In this case, the percentage of the dependent population does not seem to add much to the model as it is not statistically significant. Openness is highly statistically significant and carries the anticipated sign. Public social expenditure is highly statistically significant although it carries a negative sign. This suggests that increases in public expenditure (i.e. fiscal stimulus) are often accompanied by reductions in corporate tax rates. The size variable does not seem to matter in this case as it is not statistically significant. Both the EU and Nafta dummies are statistically significant, however, the NAFTA dummy carries the opposite sign of what is expected.

4.3 Sub-Period Analysis

4.3.1 Sub-Period One 1981-1995

This sub-section explores the relationship between the dependent and independent variables using only the years 1981-1995 for the benchmark case. The results from this regression can be found in Table 9, below.

Table 9: First Sub-Period: 1981-1995	(1)	(2)	(3)
VARIABLES	y1	y1	y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	0.328		
	(1.399)		
Top Personal Income Tax Rate	0.145***	0.143***	0.144***
	(3.249)	(3.091)	(3.241)
Unemployment Rate	-0.218	-0.248	-0.225
	(-1.076)	(-1.201)	(-1.104)
Percentage of Dependent Population	1.883***	1.987***	1.863***
	(-4.045)	(-4.283)	(-4.012)
Openness	-0.106	-0.125*	-0.101
	(-1.648)	(-1.889)	(-1.587)
Public Social Expenditure	0.860***	0.888***	0.852***
	(-3.776)	(-3.945)	(-3.717)
Size	2.750***	2.970***	2.675***
	(-2.885)	(-3.176)	(-2.789)
EU Membership Dummy	-0.00185	0.000931	-0.00239
	(-0.0892)	(0.0449)	(-0.115)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		0.266	
		(1.224)	
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights			0.357
			(1.574)
Observations	275	275	275
R-squared	0.612	0.618	0.610
Number of country	24	24	24
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	41.81	42.37	41.69
p	0	0	0
j	4.665	3.377	3.874

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Between 1981 and 1995, all three weighting schemes produce instruments that pass the J-test for overidentification. When current independent variables are used, competition amongst different

nations seems to matter less. The variable for other countries statutory corporate tax rates does not produce statistically significant results in any of the three regressions. The income tax rate was highly statistically significant (at the $p<0.01$ level) and carried the expected sign using all weighting schemes.

The unemployment rate and EU membership did not matter as neither variable was statistically significant. Openness only mattered with size weights, and only at the $p<0.1$ level.

The percentage of the population that is dependent, public social expenditure and size are all very important variables in this regression. They are all statistically significant at the $p<0.01$ level. The magnitude of the impact of these variables is also significantly higher than it is when the entire 30 years of data are analysed. It appears as though domestic factors played a greater role in shaping corporate tax policy in this earlier period.

4.3.2 Adjustment Delays in Sub-Period One

Regressions for this sub-period were also performed for each of the adjustment delay cases explored in Section 4.2. When the independent variables are lagged one year, the results change slightly. Table A.1 (see appendix) summarizes the results from this regression. All three weighting schemes do produce valid instruments. However, the R-squared drops from above 60%, by about 5%. The other countries' statutory corporate tax rate variable is statistically significant using all weighting schemes. It also carries the anticipated sign. The top income tax rate is also significant at the $p<0.1$ level for the uniform and openness weighted cases.

Lagging the independent variables by two years changes the results slightly. The results from this regression can be found in Table A.2 (see Appendix A). All three weighting schemes produce valid instruments. However, introducing a longer lag decreases the overall explanatory power of the model. The degree of the impact of the other countries' statutory corporate tax rates variable is very different with the different models. It's coefficient ranges from 1.484 when using uniform weights to 0.777 when using size weights. Although the estimate with uniform weights is statistically significant at the $p<0.01$ level, while the estimate with size weights only produces results that are statistically significant at the $p<0.05$ level. The lagged personal income tax rate variable is not statistically significant when any of the weighting schemes are employed. Neither are the unemployment rate or openness variables. The percentage of the population that is dependent is significant in the cases of uniform and openness weights, however, they carry the opposite of the anticipated sign. Public social expenditure and EU membership are both statistically significant in all three cases at the $p<0.01$ level.

Lagging the independent variables by three years produces similar results as can be seen in Appendix A.3. All three weighting schemes again produce instruments that pass the J-Test for overidentification. The R-square from this regression are higher than the regression that was lagged 2 years. The different weighting schemes produce very different results for the main independent variable, that is, other countries' corporate tax rates. The estimates range in value from 1.696, in the case of uniform weights to 0.776 in the case of size weights. This is a very wide range which casts some doubt over the validity of these results. The top income tax rate, the unemployment rate and openness are all not statistically significant. The percentage of the population that is dependent is again statistically significant, however it carries the opposite sign of what would be expected. Size is statistically significant in all cases, however, it too carries the

opposite sign of what theory tells us we should expect. There are signficantly fewer observations when three year lags are introduced (since data are not available for any country before 1981) and this may be contributing to the somewhat surprising results for many of the variables in this regression.

Finally, I look at three year averages for this period where possible. For example, for any variable, the first year for which data is available is a single year variable, the second year is a two-year average and all subsequent years are three year averages. All three weighting schemes produce instruments that pass the test for overidentification. The results from this regression can be found in Appendix A.4.

The variable for other countries' statutory corporate tax rates is only statistically significant in the case of uniform and size weights. In the case of openness weights, the variable is not statistically significant. The estimates are fairly similar in the cases of both uniform weights and size weights. The top personal tax rate is highly statistically significant and carries the anticipated sign in all cases. The unemployment rate and EU membership are the only variables that are not statistically significant in any case. Both the size and the percentage of the population that is dependent variables are statistically significant but carry the opposite sign of what would be expected.

4.3.3 Sub-Period Two: 1996-2010

This sub-section explores the relationship between the dependent and independent variables for the benchmark case over the period 1996-2010. It produces results that are different from both the full 30-year period and the former 15-year period. The results from this regression are displayed below in Table 10. All three weighting schemes produce instruments for other

countries statutory corporate tax rates that are statistically significant. They all pass the F-test and perform reasonable well in terms of explanatory power.

Table 10: Sub-Period Two: 1996-2010 VARIABLES	(1) y1	(2) y1	(3) y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	1.719*		
	(1.928)		
Top Personal Income Tax Rate	0.142***	0.121***	0.143***
	(4.285)	(4.034)	(4.272)
Unemployment Rate	-0.0801	-0.0796	-0.0538
	(-0.468)	(-0.501)	(-0.313)
Percentage of Dependent Population	1.574***	1.469***	1.628***
	(3.232)	(3.179)	(3.291)
Openness	-0.0772**	-0.0819***	-0.0834***
	(-2.378)	(-2.666)	(-2.602)
Public Social Expenditure	-0.374	-0.396*	-0.373*
	(-1.645)	(-1.855)	(-1.650)
Size	1.987***	1.845***	1.952***
	(4.340)	(4.328)	(4.357)
EU Membership Dummy	-0.00725	-0.00827	-0.00551
	(-0.637)	(-0.753)	(-0.485)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		0.214	
		(0.674)	
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights			1.325**
			(2.083)
Observations	322	322	322
R-squared	0.548	0.591	0.558
Number of country	29	29	29
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	32.84	36.61	34.32
p	0	0	0
j	4.954	14.56	5.973

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The main independent variable, other countries statutory corporate tax rate is statsitically significant at the $p<0.1$ level when uniform weights are applied, at the $p<0.05$ level when openness weights are applies, and not at all when size weights are applied. While they do carry the anticipated sign, the range in values is higher that over the full 30 year period. The estimates range from 1.325 to 1.719 for the 15 year period. This suggests that the intensity of competition amongst governments for corporate tax profits has increased over the 30 year period studied here. The top personal income tax rate is highly statistically significant, carries the anticipated sign and the estimates are comparable to both the 30 year and earlier 15 year period. The percentage of the population that is dependent is highly statistically significant and carries the anticipated sign. The estimates for Openness also fit in with the theory. They are statistically significant in all cases and carry the anticipated negative sign. Public social expenditure is weakly statistically significant in the cases of size and openness weights. It carries a negative sign, a result that was found over the full 30 year period. The size variable was found to be highly statistically significant and carries the theoretically anticipated positive sign. The EU dummy, which was found to be statistically significant over the 30 year period, was not statistically significant in this case. The NAFTA dummy was dropped from the regression due to coliniarity.

4.3.4 Adjustment Delays in Sub-Period Two

Regressions for this sub-period were also performed for each of the adjustment delay cases explored in Section 4.2. One year lags produce results that are fairly similar to when current values are used. The results from this regression are displayed in the Appendix in table A.5. All weighting schemes pass the F-test and have reasonably strong explanatory power. However, the instrument in the case of the size weighted regression has a p-value of 0.017 and therefore, we

cannot reject the null hypothesis that the matrix is overidentified. While the magnitude of the impact of other countries' corporate tax rates changes, for the most part, we obtain results that are very similar to the case of current values. When one-year lags are used, the estimate of other countries' corporate tax rates is between 1.362 (size weighted) and 2.074 (uniformly weighted).

In the case of independent variables lagged two years, only openness weights produce a valid instrument. The results from this regression are displayed below in the Appendix in Table A.6. The openness case passes the F test and is able to explain 63.7% of the fluctuations in statutory corporate tax rates.

The estimate for other countries' statutory corporate tax rates produces a statistically significant estimate that is much lower than that produced by the full 30 years of data. The other variables in this regression produce estimates that are fairly similar to the case of single year lags with the exception of the EU membership dummy variable which produces a statistically significant result. However, at 0.0187, it is not far from zero and carries the opposite of the expected sign.

In the case of three-year lags, none of the weighting schemes were able to produce valid instruments. We were unable to reject the null-hypothesis that the instruments are overidentified at any reasonable level of confidence. The P-values from the J-Test are reported in the Appendix A in Table A.7.

In the case of three-year averages, only the test with openness weights produces a valid instrument. The results from this regression can be found below in Appendix A in Table A.8. The openness case also passes the F-test and explains 60.4% of the fluctuations in the dependent variable.

4.3.5 General Comments Regarding the Two Sub-Periods

In general, most of the statistical relationships that we find in the period between 1981 and 2010 are not the same as those that we find in the first sub-period, between 1981 and 1995. For the most part, it appears as though the degree of tax competition between governments is less intense than it is over the entire 30 year period. It also appears that domestic factors were more important during this period. These results may in part be due to the limited data available during the earlier time period. The panel of data is very unbalanced during this time period. In addition to having only a few years of data for some of the countries, other countries have no data available during that time period. The following section will look at the latter half of the 30 year period. This panel is much more balanced in terms of data availability than the panel between 1981 and 1995.

The results from the second sub-period, between 1996 and 2010 differ from both the first sub-period and the whole 30-year period. Firstly, this period exhibits a greater intensity of tax competition between governments. Secondly, some of the domestic factors that were more important in the first sub-period, seem to have less of an impact on statutory corporate tax rates in the second sub-period.

Another interesting result appears regarding the percentage of the population that is dependent variable. A priori, it was expected that the coefficients for the percentage of the dependent population variable should be positive. i.e. increases in the dependent population should require more revenue and hence lead to increases in the need for revenue, causing statutory corporate tax rates to increase. In previous regressions this coefficient was negative. However, here we find it to be positive.

Conclusion

The paper set out to achieve four goals. This first of these goals was to see how existing models stand up to larger data sets covering longer time periods, using an unbalanced panel covering 29 OECD countries and 30 years. The second goal was to determine if there are other variables that the previous authors have neglected to include in their existing models. The third goal was to see if there is a delay in governments' reaction to either tax competition from other countries or from its own domestic determinants. The fourth goal was to see if the intensity of corporate tax rate competition has changed over time. This paper does confirm many of the conclusions reached by previous authors. First and foremost, there is clear evidence that countries compete over statutory corporate tax rates. The results from this study suggest, however, that the degree to which countries react to a reduction in other countries corporate tax rates is slightly higher than other authors have determined. Secondly, this paper has demonstrated that the degree of openness of an economy is a significant factor in the reduction in statutory corporate tax rates around the world. This is one variable that has been debated in the literature and this study gives weight to the idea that globalization has been a major contributing factor to the reduction in statutory corporate tax rates. Thirdly, this paper has shown that the need for a government to raise revenue has played virtually no role in the OECD governments' decisions to lower corporate tax rates. This is likely due to the fact that there are many tools available to governments to raise revenues and the statutory corporate tax rate is just one of those tools. The statistical relationship between a government's need for revenue and the statutory corporate tax rate is further muddied by the fact that governments can borrow money to cover revenue shortfalls and pay for these shortfalls at a later date. Therefore, finding a statistical relationship between the two variables is extremely difficult due to this timing issue.

Fourthly, this paper explored different weighting schemes for other countries' statutory corporate tax rates. Like other authors, this study has found that uniform weights produce statistically significant results. This is a result that has been found by the majority of authors that have researched the subject. This paper also explored the use of weights based on size and openness. Using weights based on size caused problems with the instrument variable for other countries statutory corporate tax rates. However, using openness weights did produce strong statistical results. This is an area where other authors such as Devereux et al. have ran into overidentification problems with the IV approach. Given that both the even weights and openness weights produced logical, statistically significant results, it is not possible to conclude that one is better than the other.

Fifthly, this paper explored how the timing of the independent variables affect statutory corporate tax rates. This was done by looking at one year, two year and three year lags as well as at three year averages of the independent variables. There are good arguments to support the different approaches and so this paper explored whether one approach yielded stronger statistical results than the other. This was not typically the case. All methods produced results that were both intuitive and statistically significant. However, for some variables, certain methods produced better results. For instance, some of the variables such as the unemployment rate are only significant when averaged over three years. This is likely because governments may not react to temporary shocks in the same way that they react to lasting shocks. However, for many variables, it is not possible to conclude on the basis of statistical strength that one method is better than the other.

This paper also explored whether or not countries react the same way to changes in its key statutory corporate tax rate variables today as they did several years ago. This was done by

performing the same regressions over two separate periods, one between 1981 and 1995 and the other between 1996 and 2010. It appears as though there has been a structural shift in many of the variables, as the statistical relationships are very different. The empirical analysis suggests that the degree of tax competition has increased over time. In the first sub-period analysed, it appeared as though domestic determinants played a more important role in forming corporate tax policy, whereas in the second sub-period analysed, other countries corporate tax rates played a much more important role. As such, the model that looks at the more recent time period may have better predictive powers than when the full 30 year period is considered.

Finally, this paper has introduced one new variable into the model that has a statistically significant and logical impact on the level of statutory corporate tax rates: the unemployment rate. The statutory corporate tax rate is also an important fiscal tool. It can be used to stimulate the labour market when the unemployment rate rises and indeed, the statistical relationship between the unemployment rate and the statutory corporate tax rate suggest that this is the case. This is, to my knowledge, the first paper that has explored the relationship between these two variables.

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Appendix A

Table A.1: 1981-1995, One Year Lag	(1)	(2)	(3)
VARIABLES	y1	y1	y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	0.756**		
	(2.289)		
Top Personal Income Tax Rate lagged one year	0.0782*	0.0827	0.0759*
	(1.677)	(1.644)	(1.662)
Unemployment Rate lagged one year	-0.0131	0.0399	-0.0313
	(-0.0567)	(0.180)	(-0.132)
Percentage of Dependent Population lagged one year	-1.274**	-1.506***	-1.244**
	(-2.538)	(-3.196)	(-2.468)
Openness lagged one year	-0.0549	-0.112	-0.0445
	(-0.725)	(-1.402)	(-0.590)
Public Social Expenditure lagged one year	-1.156***	-1.237***	-1.160***
	(-4.414)	(-4.859)	(-4.380)
Size lagged one year	-1.767*	-2.486***	-1.633*
	(-1.857)	(-2.745)	(-1.693)
EU Membership Dummy lagged one year	0.0386	0.0449*	0.0371
	(1.621)	(1.899)	(1.549)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		0.623*	
		(1.928)	
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights			0.779**
			(2.327)
Observations	252	252	252
R-squared	0.570	0.591	0.566
Number of country	24	24	24
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	31.89	34.85	31.50
p	0	0	0
j	8.941	5.904	7.495

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.2: 1981-1995, Two Year Lag	(1)	(2)	(3)
VARIABLES	y1	y1	y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	1.484***		
	(3.235)		
Top Personal Income Tax Rate lagged two years	-0.00822	0.00657	-0.00777
	(-0.152)	(0.120)	(-0.143)
Unemployment Rate lagged two years	0.0345	0.221	0.0104
	(0.142)	(1.001)	(0.0417)
Percentage of Dependent Population lagged two years	-1.009*	-1.446***	-0.922
	(-1.811)	(-2.727)	(-1.640)
Openness lagged two years	-0.000545	-0.0309	0.0244
	(-0.00622)	(-0.343)	(0.281)
Public Social Expenditure lagged two years	-1.305***	-1.228***	-1.302***
	(-4.549)	(-4.425)	(-4.519)
Size lagged two years	-1.671	-2.627**	-1.669
	(-1.632)	(-2.348)	(-1.622)
EU Membership Dummy lagged two years	0.0607***	0.0516***	0.0579***
	(2.802)	(2.799)	(2.672)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		0.777**	
		(2.240)	
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights			1.340***
			(3.332)
Observations	225	225	225
R-squared	0.513	0.551	0.513
Number of country	21	21	21
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	26.56	30.32	26.37
p	0	0	0
j	7.992	11.22	5.766

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.3: 1981-1995, Three Year Lag	(1)	(2)	(3)
VARIABLES	y1	y1	y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	1.696***		
	(3.205)		
Top Personal Income Tax Rate lagged three years	-0.0388	-0.0367	-0.0363
	(-0.688)	(-0.711)	(-0.671)
Unemployment Rate lagged three years	0.125	0.347	0.208
	(0.484)	(1.520)	(0.779)
Percentage of Dependent Population lagged three years	-1.445**	-1.796**	-1.250*
	(-2.105)	(-2.603)	(-1.813)
Openness lagged three years	0.0816	0.141	0.0889
	(0.839)	(1.553)	(0.921)
Public Social Expenditure lagged three years	-1.306***	-1.084***	-1.237***
	(-4.548)	(-4.119)	(-4.435)
Size lagged three years	-2.731**	-2.823**	-1.988*
	(-2.413)	(-2.356)	(-1.815)
EU Membership Dummy lagged three years	0.0539**	0.0317*	0.0481**
	(2.442)	(1.654)	(2.320)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		0.776**	
		(2.452)	
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights			0.969**
			(2.298)
Observations	204	204	204
R-squared	0.484	0.534	0.509
Number of country	21	21	21
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	22.75	27.18	22.24
p	0	0	0
j	6.644	12.27	7.639

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.4: 1981-1995, Three Year Averages VARIABLES	(1) y1	(2) y1	(3) y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	0.735*		
	(1.863)		
Top Personal Income Tax Rate lagged three years	0.145***	0.154***	0.147***
	(3.061)	(3.155)	(3.169)
Unemployment Rate lagged three years	-0.264	-0.268	-0.255
	(-0.998)	(-1.145)	(-0.956)
Percentage of Dependent Population lagged three years	-1.012**	-1.188***	-0.955**
	(-2.299)	(-2.849)	(-2.178)
Openness lagged three years	-0.123*	-0.202***	-0.117*
	(-1.761)	(-2.696)	(-1.695)
Public Social Expenditure lagged three years	-1.145***	-1.197***	-1.154***
	(-3.939)	(-4.377)	(-3.949)
Size lagged three years	-2.348*	-3.309***	-2.309*
	(-1.948)	(-2.818)	(-1.907)
NAFTA Dummy lagged three years	0.0890***	0.0902***	0.0900***
	(3.262)	(3.277)	(3.370)
EU Membership Dummy lagged three years	0.0265	0.0393	0.0259
	(1.009)	(1.559)	(0.996)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		0.599**	
		(2.000)	
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights			0.604
			(1.617)
Observations	245	245	245
R-squared	0.594	0.617	0.597
Number of country	23	23	23
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	33.52	36.58	33.67
p	0	0	0
j	16.81	6.857	10.79

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.5: 1996-2010, one year lag	(1)	(2)	(3)
VARIABLES	y1	y1	y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights	2.074*		
	(1.880)		
Top Personal Income Tax Rate lagged one year	0.137***	0.109***	0.134***
	(4.934)	(4.540)	(4.903)
Unemployment Rate lagged one year	-0.119	-0.0812	-0.0921
	(-0.764)	(-0.557)	(-0.597)
Percentage of Dependent Population lagged one year	1.519***	1.551***	1.528***
	(3.380)	(3.721)	(3.439)
Openness lagged one year	-0.121***	-0.130***	-0.129***
	(-4.036)	(-4.604)	(-4.385)
Public Social Expenditure lagged one year	-0.476**	-0.445**	-0.460**
	(-2.148)	(-2.151)	(-2.158)
Size lagged one year	1.620***	1.615***	1.561***
	(4.362)	(4.712)	(4.444)
EU Membership Dummy lagged one year	0.00884	0.0120	0.00898
	(0.747)	(1.030)	(0.779)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		-0.264	
		(-0.925)	
ivy3			1.362**
			(2.014)
Observations	347	347	347
R-squared	0.581	0.643	0.603
Number of country	29	29	29
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	41.46	45.59	43.39
p	0	0	0
j	6.591	13.80	3.020

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.6: 1996-2010, two year lag	(1)	(2)	(3)
VARIABLES	y1	y1	y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	1.318		
	(1.570)		
Top Personal Income Tax Rate lagged two years	0.118***	0.108***	0.120***
	(5.518)	(5.312)	(5.616)
Unemployment Rate lagged two years	-0.109	-0.0823	-0.107
	(-0.780)	(-0.626)	(-0.772)
Percentage of Dependent Population lagged two years	1.233***	1.362***	1.254***
	(3.160)	(3.607)	(3.226)
Openness lagged two years	-0.154***	-0.150***	-0.151***
	(-5.486)	(-5.755)	(-5.389)
Public Social Expenditure lagged two years	-0.433**	-0.358*	-0.425**
	(-2.400)	(-1.953)	(-2.381)
Size lagged two years	1.160***	1.256***	1.144***
	(3.414)	(3.852)	(3.431)
EU Membership Dummy lagged two years	0.0189*	0.0254***	0.0187*
	(1.897)	(2.596)	(1.920)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		-0.574*	
		(-1.761)	
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights			0.936**
			(2.058)
Observations	371	371	371
R-squared	0.626	0.666	0.637
Number of country	29	29	29
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	46.02	48.25	45.07
p	0	0	0
j	12.89	18.02	8.743

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.7: 1996-2010, three-year lag			
Weighting Scheme	Uniform	Size	Openness
Chi-sq P-val	0.0247	0.0005	0.0559

Table A.8: 1996-2010, three year averages	(1)	(2)	(3)
VARIABLES	y1	y1	y1
Other Countries Weighted Average Statutory Corporate Tax Rate_Uniform Weights	1.012*		
	(1.659)		
Top Personal Income Tax Rate lagged three years	0.173***	0.148***	0.180***
	(6.014)	(5.468)	(6.000)
Unemployment Rate lagged three years	-0.0888	-0.0361	-0.0837
	(-0.539)	(-0.232)	(-0.509)
Percentage of Dependent Population lagged three years	1.165***	1.332***	1.165***
	(2.773)	(3.270)	(2.772)
Openness lagged three years	-0.121***	-0.138***	-0.123***
	(-3.433)	(-4.085)	(-3.489)
Public Social Expenditure lagged three years	-0.321	-0.352*	-0.306
	(-1.482)	(-1.685)	(-1.417)
Size lagged three years	1.355***	1.448***	1.309***
	(3.893)	(4.292)	(3.837)
EU Membership Dummy lagged three years	0.0133	0.0197	0.0136
	(0.979)	(1.439)	(0.994)
Other Countries Weighted Average Statutory Corporate Tax Rate_Size Weights		-0.441	
		(-1.521)	
Other Countries Weighted Average Statutory Corporate Tax Rate_Openness Weights			1.035**
			(2.166)
Observations	377	377	377
R-squared	0.605	0.639	0.604
Number of country	30	30	30
Country FE	YES	YES	YES
Country Time Trend	YES	YES	YES
F	42.43	45.73	43.19
p	0	0	0
j	12.30	16.58	7.989

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1