The impact of TaxEs on TRADe Competitiveness

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# ABSTRACT

This study contributes to the scarce empirical macroeconomic literature on the impact of various taxes on international trade. The argument often made is that higher tax rates reduce economic competitiveness thus leading to a decrease in exports in the long run. We test this hypothesis in a gravity model with panel data from 25 OECD countries. We use average effective tax rates on consumption, labor income and capital income and examine their impact on bilateral trade. We conclude that high tax burdens significantly negatively impact exports.

Keywords: average effective tax rate, tax ratio, gravity equation, international trade

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## the impact of TaxEs on TRADe Competitiveness

Various groups advocate national tax policies on the grounds that they will encourage international competitiveness. Surprisingly little empirical research exists to substantiate their arguments. Many articles examine the role of commercial policy on international trade, however relatively few focus on national tax policy. The aim of our study is to fill this important gap in the literature.

1. **Previous literature**

Studies that examine the macroeconomic effects of fiscal policy on international trade mostly focus on government spending (e.g., Clarida and Findlay, 1992; Anwar, 1995 and 2001; Müller, 1998). Most research on the effects of tax policy on trade has been theoretical (e.g., Helpman, 1976; Baxter, 1992; Frenkel, Razin, and Sadka, 1991). An exception is Summers (1988) who conducted an empirical investigation on the hypothesis that decreases in capital income taxes lead to capital inflows and a corresponding decrease in net exports; he did not find empirical support for this hypothesis. Another is Keen and Syed (2006) who estimated the effect of commodity and corporate income taxes on country net exports using panel data from OECD countries. They found that commodity taxes have no impact on trade whereas an increase in corporate taxes initially increases the trade surplus, then reduces it.

Our study examines the cumulative impact of changes in three tax rates: consumption, labor income and capital income, on bilateral exports in a panel of 25 OECD countries. Frenkel, Razin, and Sadka (1991) showed theoretically that, to minimize their distortionary impact on trade, taxes should be levied on the least elastic goods and factors of production. If labor supply is inelastic in the short run, tax incidence is likely to fall on workers rather than being passed forward into factor costs. Effects on trade are likely to be small or insignificant in the short run. However, long-run supply elasticities may be large enough to shift tax incidence back toward the demand side of the market, and into factor costs, thus forcing producers to raise prices. Beck and Coskuner (2007) found evidence to support this conjecture. Our study is directed at answering a follow-up question: Do exporters located in high-tax countries lose market share? We investigate whether changes in different types of tax rates do, in fact, affect export volume in the long run and by how much.

We use gravity models to estimate tax impacts on bilateral trade flows. The following describes the data. Tax rates are proxied by average effective tax rates (AETRs), also known as tax ratios. We update the AETR dataset, originally developed by Mendoza, et al. (1994) and expanded by Carey and Rabesona (2002) among others, to include 25 OECD countries from 1970 to 2006. The last two sections discuss estimation results and conclusions.

We hypothesize that increases in the capital income tax make investment abroad more attractive, this leading to a capital outflow and an increase in net exports in the short run. In the longer run, net exports will decline since production has been moved abroad. This hypothesis is similar to that of Keen and Syed. In addition, we hypothesize that producers’ attempts to pass labor income tax increases through to workers in the form of reduced wages will not be complete if labor supply is elastic.[[1]](#footnote-1) There will be a reduction in labor supply and producers will substitute capital for labor. This will be reflected in an increase in capital inflows accompanied by a decrease in net exports. An increase in consumption tax may have a similar effect in reducing labor supply although there will also be an effect on consumption so the overall effect of a consumption tax on net exports is likely to be smaller.

### Model and specification

We use the gravity model which has been derived from various theoretical models (e.g., Bergstrand, 1985; 1989; Anderson and van Wincoop, 2001). Variants of the model in the literature have included measures of distance, the relative sizes of the exporting and importing economies and price levels. Some authors included additional factors such as country borders (McCallum, 1995), mulitilateral trade resistance (Anderson and van Wincoop, 2001), membership in preferential trading groups (Aitken, 1973), or shared social networks (Rauch, 2001).

In this study we take the approach of Egger and Pfaffermayr (2003). These authors suggest that a panel gravity model that includes bilateral fixed effects is often a better option than including time-invariant variables, e.g., distance, adjacency, etc. We empirically test whether the fixed effects model is superior to a set of commonly used time-invariant variables following the procedure of Egger and Pfaffermayr. In a subsequent paper, Egger (2005) also suggests measures to test the appropriateness of a fixed effects model over a random effects model.[[2]](#footnote-2) Based on these tests we conclude, as do Egger and Pfaffermayr, that the bilateral fixed effects model is appropriate. We also include time effects which appear significant based on the results of likelihood ratio tests (Egger, 2000). All these results are reported in the Appendix.[[3]](#footnote-3)

Our base specification, with tax rates included, is:

|  |  |  |
| --- | --- | --- |
|  |  | (1) |

Here is the value of aggregate export volume from country *i* to country *j* in year *t*. Real gross domestic product of exporting country *i* and importing country *j* in year *t* is and respectively. Costs of production in countries *i* and *j* are measured by producer price indices and in year *t.* The real exchange rate, expressed as the value of country *i*’s currency in terms of country *j*’s currency in year *t,* is is a matrix of dummy variables equal to unity in year *t* when countries *i* and *j* are both members of a trade organization.[[4]](#footnote-4) and are included for countries *i* and *j* to control for the effects of GDP fluctuations in each country. Tax effects are measured by *TX* which is denoted generally but is a vector containing one or more lags of the tax ratios examined in this study. The taxes in this vector include, and which are the differences of the tax rate in year *t* levied between country *i* and country *j,* on capital income, consumption, and labor income, respectively. We estimate this specification on subsamples as well as variations of it on the full sample to assess the robustness of our results. The development of these data will be discussed in the next section.

### Data

Average effective tax rates have advantages over two other tax measures that are also used in the literature: statutory tax rates and marginal effective tax rates (METRs). Average effective tax rates measure realized differences in actual tax burdens, unlike statutory tax rates (Hajkova et al., 2006). For example, Egger and Radulescu (2008) observed that AETRs are much more strongly correlated with FDI than statutory tax rates. Marginal effective tax rates are tax rates computed for hypothetical firms (see, e.g., Yoo, 2003; Hajkova et al., 2006; Egger, 2009). However, the advantage of AETRs is that they provide data on taxes that have actually been paid and so incorporate all exemptions and deductions of which cost minimizing firms have taken advantage. It is reasonable to expect that they are good proxies for the actual tax burdens faced by exporters.

Average effective tax rates are constructed from tax revenue data published by the OECD. Tax revenue, divided into the components that are levied on consumption and labor and capital, form the numerators of the ratios. The denominators are the base on which each of these taxes were levied. These are derived from each country’s national accounts data. Mendoza et al. (1994) first calculated AETRs for the G-7 countries for 1965-1988.[[5]](#footnote-5) Carey and Tchilinguirian (2000) and, subsequently, Carey and Rabesona (2002) produced new measures of AETRs using the SNA93 National Accounts data for 25 OECD countries for 1975-2000. We extended their database to cover 25 OECD countries from 1970-2006. Tables 1 through 3 contain descriptive statistics. The tax variables used in our specification are tax differentials, defined as the difference between the exporting and the importing countries’ tax ratios in year t.

International trade data were obtained from the OECD International Trade by Commodity Statistics via OECD.stat. These data are an unbalanced panel of annual data in current (nominal) domestic currency containing both export and import trade flows between each pair of the 25 OECD member countries. These trade data are converted to real US dollar values using the OECD’s annual exchange rates and export deflators.

Data for other explanatory variables were obtained from the OECD.stat database, with a few exceptions. Real annual GDP was obtained from the OECD national accounts. The real exchange rate, was calculated using the nominal exchange rate from the OECD’s Reference Series for Revenue Statistics (which calculates the annual exchange rate as the average of daily closing interbank rates of national markets) and was adjusted using the exporter and importer producer price index as suggested by Chinn (2006) in the following way:

The industrial producer price index, is obtained from the IMF’s International Financial Statistics Database with missing values in some cases filled in using OECD.stat. This measure of the price level is based on the revenue received by producers of goods and services so it is free from sales and excise taxes. Dummy variables for trade agreement membership were included.[[6]](#footnote-6) The business cycle variables are equal to real GDP in year *t* divided by the average of real GDP during the previous ten years for countries *i* and *j*, respectively (Beck and Coskuner, 2007).

### Estimation

The dependent variable, bilateral exports in year *t*, could influence some of the independent variables in year *t*. For example, a large increase in exports from country *i* in year *t* could lead to a significant increase in GDP of country *i*. To deal with the issue of endogeneity, all of the time variant independent variables are lagged by one year in the final specification. In the case of the exchange rate, we considered a longer lag because past empirical observation has indicated that the lag in the relationship between the exchange rate and the total exports may be significantly longer. To determine the appropriate lag of the exchange rate, we used our baseline model below and compared the same specification with the exchange rate lagged one, two and three years. The value of the exchange rate lagged one year had the highest level of significance based on the t-statistic and thus we chose to use this for the final specification.

It is possible that the AETRs are correlated with real GDP because they are constructed using a portion of GDP as the tax base.[[7]](#footnote-7) Our analysis of the data shows that although there is significant correlation between GDP and the AETRs, the impact that this correlation has on the estimates is minimal.[[8]](#footnote-8) Another potential source of collinearity is between the different tax variables. Correlation between tax variables could be positive or negative. Governments may use expansionary or contractionary policies and thereby decrease or increase all types of taxes. Alternatively governments may shift the tax burden from one base to another while maintaining minimum revenue levels. Analysis of the data shows that both types of correlation exist. Countries that have positively correlated labor and capital tax ratios, which are each negatively correlated with the consumption tax ratio, include Austria, Belgium, Canada, France, Greece, Japan, the Netherlands, Portugal and the US. Countries for which all three tax ratios are positively correlated include Australia, Finland, Germany, Hungary, Ireland, Italy, Korea, New Zealand, Norway, Poland, Spain and Sweden.

Further checks were performed by comparing estimates when one or more variables were removed or when small portions of data were removed. Coefficient estimates and significance levels were largely unchanged. Nevertheless, in Table 5 we report estimates for regressions where all three types of tax variables are included and those where only one type of tax at a time is included.

The main specification for the gravity model is also tested for the presence of heteroskedasticity by calculating a modified Wald statistic for groupwise heteroskedasticity in the residuals of the fixed effect regression models. In all three cases, the null hypothesis of homoskedasticity is rejected. As a result, all of the estimations included in this research are reported with heteroskedasticity-robust standard errors.

The specification was tested for evidence of first order serial correlation in the residuals of the heteroskedasticity-robust fixed effect regression models. Without serial correlation present, the residuals from the regression of the first-differenced variables should have an autocorrelation of -0.5 (Wooldridge, 2002). To determine whether this is the case, we use a Wald test of whether in a regression of the lagged residuals on the current residuals the coefficient of the lagged residuals is equal to -0.5. In all three cases, the null hypothesis of no serial correlation was rejected. A fixed effects model assumes that error components within a group (or country in the current case) are equally-well correlated with every other observation within the group (Nichols and Schaffer, 2007). However, the presence of serial correlation in the fixed effects model shows that in this case that assumption is not valid. Instead, there is evidence that the errors are clustered, i.e., observations for each exporting country are correlated although they are not correlated across country pairs. The same is true for the importing countries. Since these groups overlap, the errors in the current research are subject to non-nested two-way clustering. The assumptions under a model with clustered errors are more relaxed than under the fixed effects model since one still assumes that there is no correlation of the error terms across groups, but the errors within each group may have any correlation (Nichols and Schaffer, 2007).

Cluster-robust standard error estimators converge to their true values as the number of clusters approaches infinity, which in practice has been shown to be around 50 (Nichols and Schaffer, 2007). In addition, these estimators have been shown to be less accurate in cases when the cluster sizes are unequal. Both of these issues pose difficulties in the current study where there are 25 countries (hence 25 clusters) and some countries have more complete time series than others. Therefore, it is quite possible that cluster-robust standard error estimates are less accurate than those produced by the model that does not account for serial correlation.

In Cameron et al. (2006) the authors evaluate a method of estimating cluster-robust standard errors in the presence of multi-level clustering by comparing its hypothesis test rejection rates with those of other estimation methods for different numbers of clusters. The results most relevant to the current research are those produced for a model with random effects common to each group and a heteroskedastic error term where the number of two-way clusters is equal to 30. Although this analysis is not perfectly analogous to the current research, it sheds some light on the appropriateness of using this type of estimation procedure. The authors find the most accurate rejection rates for the estimation models that assume independently and identically distributed errors (no serial correlation) or that allow for only one-way clustered errors. Following this result, we believe that the standard errors produced by a two-way cluster-robust model would be farther from their true values than if the clustered errors are ignored. Hence we ignore serial correlation in the current study.

In order to capture the cumulative impact of the tax, each specification was tested with up to ten lags of the respective tax variable. Only eight lags are retained based on the significance of the t-statistics. We also estimate other forms of the gravity model that have appeared in the literature. In Table 8 we report estimates for specifications that dropped the two producer price indices, then the real exchange rate, then the two producer price indices plus the real exchange rate. In Table 9, we added population variables, then we replaced aggregate real GDP with real GDP per capita. Our results were largely unchanged for the labor income tax. However, the consumption and capital income taxes show sensitivity to the model specification.

### Results

The results are reported in Table 5 for the full sample of 25 countries. In that table and in the discussion below, the short-run refers to the impact on exports from changes in the tax rate of the same year, which is instrumented by the tax rate in the year immediately preceding (*TX­t-1*). The cumulative impact refers to the sum of the coefficients of the lagged variables from one to eight years and its statistical significance is determined by a test of the hypothesis that the sum of the coefficients on these lags is equal to zero.

Labor income taxes have significant negative effects on bilateral trade flows in nearly all cases. Capital income and consumption taxes also show some signs of having significant effects on trade flows, but the sign and significance of their impacts are sensitive to changes to the model specification. Nearly all of the other explanatory variables also exhibit the hypothesized values. Real GDP for the exporting and importing country have consistently positive signs as expected. The business cycle variables, which are measures of the relative performance of the economy compared with the previous ten years, have negative effects in the case of the exporting countries and positive effects on importing countries as expected. The price level and exchange rate variables have the same signs as they did in Bergstrand (1985; 1989) although the results in our study are stronger and more consistent. Common membership in the EU and NAFTA was also shown to increase exports, which is consistent with the findings of Aitken (1973), Nilsson (2002) and Gould (1998). The exception to the expected results was the coefficient on the WTO dummy variable which had an inconsistent sign across different specifications, a result also found by Rose (2004).

The significance levels of estimated coefficients of the tax rate differentials indicate that tax changes take several years to affect trade volumes. This fits in with our hypothesis that capital and labor supply elasticities are high enough in the long run for taxes to be passed forward into input costs, thus affecting the high-tax country’s exports. Subsample data include country exports to other countries in the same subsample but exclude exports elsewhere. Our first subsample drops countries with shorter time series to produce a balanced panel, then splits the balanced panel into a European subsample and a Pacific Rim subsample. Table 7 lists the countries included in each subsample.

#### **6.1. Consumption Tax**

We did not find the impact of the consumption tax to be significant for our full sample, whether we include the consumption tax rate singly or in conjunction with the capital and labor income tax rate (see Table 5). However, the cumulative impact is negative within our balanced panel and between European countries, indicating that countries with relatively high consumption taxes tend to export less (Table 6). The effects at a one year lag are similar to the cumulative results. There is also fairly consistent evidence that there are significant impacts at lags 4 and 5 but these offset each other across all regressions, including those in Tables 8 and 9. The only exceptions are the European (which instead has the same effect at lags 3 and 4) and Pacific Rim subsamples. Nonetheless, the cumulative impact is still significantly negative in all cases other than in the Pacific Rim subsample and the baseline specification. Our results extend those of Keen and Syed (2006) who found empirically that a consumption tax has no effect on exports within a three year horizon in their sample of 27 countries. Because we include eight years of data, we allow time for consumption tax effects to be reflected in labor supply decisions, which affect labor costs thus impacting export volume.

#### **6.2. Labor Income Tax**

The estimates for the cumulative impact of increases in the labor income tax rate are negative whether included singly or in conjunction with the consumption tax rate and capital income tax rate (Table 8). There appear to be significant negative impacts from increases in the labor income tax rate at lags 4 through 6 consistently throughout Tables 5-6 and 8-9 with one exception: the European subsample. The European subsample shows that changes in labor income tax rates have no impact on exports at all, either in the short run or the long run. In contrast, the subsample of Pacific Rim countries shows that labor income tax increases have significantly negative impacts. Moreover, the cumulative impact for Pacific Rim countries is large compared to the overall sample. It is possible that this result reflects higher labor supply elasticities in Pacific Rim countries relative to European countries. Another is that European labor income tax rates in this subsample do not vary much from each other.

#### **6.3. Capital Income Tax**

The capital income tax differential has a statistically significant positive effect at lag 3 in most of the regressions; the exceptions are the Europe and Pacific Rim subsamples. In most cases, there is a negative impact around lag 7 with the exception of the Pacific Rim subsample where it is positive. Our results are largely in accord with the conclusion of Keen and Syed: that in the short run an increase in capital income taxes creates financial outflows which are reflected in an increase in exports. Moreover, by using a longer horizon, our results show that tax increases eventually reduce exports. The effect on cumulative net exports is significantly negative but small in the full sample. In the subsamples it is significantly negative for Europe and significantly positive for the Pacific Rim.

The estimated tax rate coefficients are semi-elasticities, that is, the percentage change in exports with respect to a one percentage point change in the difference between the exporting and importing countries’ taxes. For instance, the coefficient of the labor income tax ratio differential lagged one year is -0.0045 and the cumulative coefficient is -0.0123 (column 1 of Table 8). The interpretation of these coefficients is that if a country increases its average effective labor income tax by one percentage point while its trading partners keep their labor income taxes constant, the result will be a decrease in exports of 0.45 percent in the current year and a cumulative decrease in exports of 1.23 percent over eight years. To put this into perspective, using the most recent data available in this dataset from 2006, if the US increased its tax rate, measured by the tax ratio, from 23 percent of labor income to 24 percent of labor income while its trading partners left their tax rates unchanged, US exports would decrease by 0.0045 times $1.148 trillion (U.S. exports in 2006), or $5.2 billion in the year of the tax increase. If the analysis is extended to the cumulative impact over eight years for the same level of exports it would be 0.0123 times $1.148 trillion, or a $14.1 billion cumulative decrease in exports.

### Conclusions

Regression estimates on the full sample and subsamples nearly all show that increases in the labor income tax differential decrease bilateral exports; the exception is the European subsample. There is some evidence that increases in consumption tax differentials also reduce bilateral exports but this is not as consistent. The impacts of increases in capital income tax differential are positive in the near term (the exception is the European subsample) but negative in the longer term (the exception is the Pacific Rim subsample). Work by previous authors and ours elsewhere suggest that the cumulative impacts of capital income taxes on trade are cloaked by the capital outflows that they induce. Tax effects on trade take several years to become apparent, as we hypothesized. Overall, our evidence suggests that economies with low tax burdens export more than countries with high tax burdens. To summarize, our results indicate what many have asserted: *when it comes to international trade, taxes matter*. There is reason to be concerned about the impacts of tax policy on the economy’s international competitiveness.

# REFERENCES

Aitken, Norman D., (1973) "The Effect of the EEC and EFTA on European Trade: A Temporal Cross-Section Analysis." *American Economic Review* 63, (Dec. 1973): 881-892.

Anwar, Sajid. “An Impure Public Input as a Determinant of Trade.” *Finnish Economic Papers.* (Autumn 1995): 91-95.

Anwar, Sajid. "Government Spending on Public Infrastructure, Prices, Production and International Trade." *Quarterly Review of Economics and Finance* 41, no. 1 (Spring 2001): 19-31.

Baxter, Marianne. "Fiscal Policy, Specialization, and Trade in the Two-Sector Model: The Return of Ricardo?" *Journal of Political Economy* 100, no. 4 (Aug. 1992): 713-744.

Benassy-Quere, A., L. Fontagne and A. Lahreche-Revil. “Tax Competition and Foreign Direct Investment,” Mimeo, CEPII, Paris. (2001).

Beck, Stacie, and Cagay Coskuner "Tax Effects on the Real Exchange Rate." *Review of International Economics* 15, no. 5 (2007): 854-868.

Bergstrand, Jeffrey H. “The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade.” *Review of Economics and Statistics*. 71, no. 1 (Feb. 1989): 143-153.

Bergstrand, Jeffrey H. “The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence.” *Review of Economics and Statistics*. 67, no. 3 (Aug. 1985): 474-481.

Cameron, A. Colin, Jonah B. Gelbach and Douglas L. Miller. “Robust Inference with Multi-way Clustering.” [*NBER Technical Working Paper* No. 327](http://papers.nber.org/papers/t0327). (Sept. 2006).

Carey, David, and Josette Rabesona.. "Tax Ratios on Labour and Capital Income and on Consumption." *OECD Economic Studies* (2002): 129-174.

Carey, David, and Harry Tchilinguirian. "Average Effective Tax Rates on Capital, Labour and Consumption." (2000).

Clarida, Richard H. and Ronald Findlay. “Government, Trade, and Comparative Advantage.” *American Economic Review.* (May 1992): 122-27.

Egger, Peter. "Alternative Techniques for Estimation of Cross-Section Gravity Models." *Review of International Economics* 13, no. 5 (2005): 881-891.

Egger, Peter. "A Note on the Proper Econometric Specification of the Gravity Equation." *Economics Letters* 66, no. 1 (Jan. 2000): 25-31.

Egger, Peter. “Firm-Specific Forward-Looking Effective Tax Rates.” *International Tax and Public Finance* 16, no. 6 (December 2009): 850-70.

Egger, Peter, and Michael Pfaffermayr. "The Proper Panel Econometric Specification of the Gravity Equation: A Three-Way Model with Bilateral Interaction Effects." *Empirical Economics* 28, no. 3 (Jun. 2003): 571-580.

Egger, Peter, and Doina Maria Radulescu. "Labour Taxation and Foreign Direct Investment." *CESifo Working Paper* No. 2309 (May 2008).

Frenkel, Jacob A., Assaf Razin, and Efraim Sadka. *International Taxation in an Integrated World* Cambridge and London. (1991).

Gould, David M. "Has NAFTA Changed North American Trade?" *Federal Reserve Bank of Dallas Economic Review* (1st Quarter 1998): 12-23.

Hajkova, Dana, Giuseppi Nicoletti, Laura Vartia, and Kwang-Yeol Yoo. "Taxation and Business Environment as Drivers of Foreign Direct Investment in OECD Countries." *OECD Economic Studies* (2006): 7-38.

Helpman, Elhanan. "Macroeconomic Poli cy in a Model of International Trade with a Wage Restriction." *International Economic Review* 17.2 (Jun. 1976): 262-277.

Keen, Michael and Murtaza H. Syed. "Domestic Taxes and International Trade: Some Evidence." *IMF Working Papers* 06/47 (2006).

Mankiw, N. Gregory and Matthew Weinzieral "Dynamic Scoring: A\_Back-of-the-Envelope Guide." *Journal of Public Economics* 90, nos. 8-9 (September 2006): 1415-1433.

McCallum, John. "National Borders Matter: Canada-U.S. Regional Trade Patterns." *American Economic Review* 85, no. 3 (June 1995): 615-623.

Mendoza, Enrique G., Gian Maria Milesi-Ferretti, and Patrick Asea. "On the Ineffectiveness of Tax Policy in Altering Long-Run Growth: Harberger's Superneutrality Conjecture." *Journal of Public Economics* 66, no. 1 (Oct. 1997): 99-126.

Mendoza, Enrique G., Razin, Assaf, and Linda L. Tesar. "Effective Tax Rates in Macroeconomics: Cross-Country Estimates of Tax Rates on Factor Incomes and Consumption." *Journal of Monetary Economics* 34, no. 3 (Dec. 1994): 297-323.

Müller, Gernot J. “Understanding the Dynamic Effects of Government Spending on Foreign Trade.” *Journal of International Money and Finance,* no 27 (2008): 345-371.

Nichols, Austin and Mark Schaffer. “Clustered Errors in Stata.” *Research Papers in Economics* (Sept. 2007): http://repec.org/usug2007/crse.pdf.

Nilsson, Lars. "Trading Relations: Is the Roadmap from Lome to Cotonou Correct?" *Applied Economics* 34 no. 4 (Mar. 2002): 439-452.

Rauch, James E. "Business and Social Networks in International Trade." *Journal of Economic Literature* 39, no. 4 (Dec. 2001): 1177-1203.

Rose, Andrew K. "Do We Really Know That the WTO Increases Trade?." *American Economic Review* 94, no. 1 (Mar. 2004): 98-114.

Summers, Lawrence H. "Tax Policy and International Competitiveness." *International Aspects of Fiscal Policies*. 349-375. National Bureau of Economic Research Conference Report series (1988).

Volkerink, Bjorn and Jakob de Haan. “Tax Ratios: A Critical Survey.” *OECD Tax Policy Studies* No. 5 (2000).

Wooldridge, J. M. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, Massachusetts: The MIT Press (2002).

Yoo, Kwang-Yeol. “Corporate Taxation of Foreign Direct Investment Income 1991-2001.” *OECD Economics Department Working Papers,* No. 365 (2003).

1. Descriptive Statistics for Consumption Tax Rate

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Observations** | **Years Spanned** | **Mean** | **Minimum** | **Median** | **Maximum** | **Standard Deviation** |
| Australia | 37 | 1970-2006 | 12.69 | 10.79 | 12.48 | 14.96 | 1.05 |
| Austria | 37 | 1970-2006 | 19.35 | 18.01 | 19.27 | 21.15 | 0.73 |
| Belgium | 37 | 1970-2006 | 18.97 | 16.23 | 17.57 | 33.48 | 3.80 |
| Canada | 37 | 1970-2006 | 15.18 | 12.87 | 15.30 | 18.39 | 1.44 |
| Czech Republic | 14 | 1993-2006 | 17.31 | 16.06 | 17.27 | 19.08 | 1.13 |
| Denmark | 36 | 1971-2006 | 25.50 | 20.50 | 25.36 | 28.00 | 2.03 |
| Finland | 37 | 1970-2006 | 22.38 | 19.55 | 22.58 | 25.38 | 1.41 |
| France | 37 | 1970-2006 | 17.91 | 16.13 | 18.05 | 20.44 | 1.09 |
| Germany | 37 | 1970-2006 | 14.43 | 13.42 | 14.36 | 15.96 | 0.64 |
| Greece | 37 | 1970-2006 | 13.93 | 11.88 | 13.85 | 16.13 | 1.05 |
| Hungary | 16 | 1991-2006 | 23.33 | 21.31 | 23.02 | 25.54 | 1.22 |
| Ireland | 37 | 1970-2006 | 20.21 | 16.22 | 21.08 | 22.88 | 1.85 |
| Italy | 37 | 1970-2006 | 14.30 | 11.30 | 14.93 | 16.81 | 1.68 |
| Japan | 37 | 1970-2006 | 7.02 | 6.13 | 6.72 | 8.30 | 0.65 |
| Korea | 35 | 1972-2006 | 14.46 | 9.33 | 14.57 | 16.93 | 1.73 |
| Netherlands | 37 | 1970-2006 | 17.33 | 16.00 | 17.28 | 19.21 | 0.82 |
| New Zealand | 21 | 1986-2006 | 17.96 | 13.85 | 18.12 | 19.79 | 1.13 |
| Norway | 37 | 1970-2006 | 24.73 | 22.26 | 24.49 | 26.93 | 1.31 |
| Poland | 12 | 1995-2006 | 17.09 | 15.51 | 17.09 | 18.58 | 0.93 |
| Portugal | 30 | 1977-2006 | 16.78 | 12.20 | 17.76 | 19.18 | 2.07 |
| Spain | 37 | 1970-2006 | 11.53 | 6.58 | 13.62 | 15.33 | 3.43 |
| Sweden | 37 | 1970-2006 | 19.84 | 16.53 | 20.55 | 21.96 | 1.50 |
| Switzerland | 37 | 1970-2006 | 9.15 | 8.02 | 9.03 | 10.47 | 0.68 |
| UK | 37 | 1970-2006 | 15.37 | 12.63 | 15.47 | 20.55 | 1.57 |
| US | 37 | 1970-2006 | 6.64 | 5.98 | 6.60 | 7.54 | 0.42 |

1. Descriptive Statistics for the Labor Income Tax Ratios

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Observations** | **Years Spanned** | **Mean** | **Minimum** | **Median** | **Maximum** | **Standard Deviation** |
| Australia | 37 | 1970-2006 | 19.44 | 12.17 | 20.15 | 23.05 | 2.60 |
| Austria | 37 | 1970-2006 | 37.15 | 30.28 | 36.94 | 42.28 | 3.75 |
| Belgium | 37 | 1970-2006 | 39.94 | 30.51 | 41.64 | 44.05 | 3.71 |
| Canada | 37 | 1970-2006 | 25.47 | 19.93 | 26.75 | 30.22 | 3.70 |
| Czech Republic | 14 | 1993-2006 | 39.03 | 38.24 | 39.02 | 39.70 | 0.42 |
| Denmark | 26 | 1981-2006 | 38.85 | 35.41 | 39.70 | 41.92 | 2.16 |
| Finland | 37 | 1970-2006 | 38.58 | 26.04 | 38.79 | 49.47 | 6.47 |
| France | 37 | 1970-2006 | 36.52 | 27.95 | 39.00 | 40.26 | 4.29 |
| Germany | 37 | 1970-2006 | 35.13 | 29.39 | 35.60 | 37.27 | 1.72 |
| Greece | 12 | 1995-2006 | 31.34 | 28.42 | 31.80 | 33.22 | 1.53 |
| Hungary | 16 | 1991-2006 | 38.23 | 35.42 | 38.06 | 41.67 | 1.80 |
| Ireland | 32 | 1975-2006 | 23.90 | 15.70 | 25.25 | 28.38 | 3.32 |
| Italy | 37 | 1970-2006 | 32.12 | 13.54 | 33.93 | 42.17 | 7.70 |
| Japan | 37 | 1970-2006 | 21.25 | 15.52 | 22.39 | 25.23 | 2.83 |
| Korea | 32 | 1975-2006 | 7.59 | 2.02 | 8.26 | 15.17 | 4.00 |
| Netherlands | 37 | 1980-2006 | 36.83 | 30.42 | 36.77 | 42.60 | 3.97 |
| New Zealand | 21 | 1986-2006 | 24.85 | 21.98 | 24.48 | 28.67 | 1.81 |
| Norway | 32 | 1975-2006 | 35.89 | 33.73 | 36.04 | 38.01 | 1.10 |
| Poland | 15 | 1992-2006 | 9.69 | 6.16 | 10.22 | 12.51 | 2.07 |
| Portugal | 12 | 1995-2006 | 26.98 | 25.41 | 27.12 | 28.48 | 1.04 |
| Spain | 37 | 1970-2006 | 26.51 | 14.91 | 28.39 | 31.22 | 4.85 |
| Sweden | 37 | 1970-2006 | 46.30 | 34.81 | 47.15 | 52.48 | 4.56 |
| Switzerland | 37 | 1970-2006 | 21.87 | 15.08 | 22.70 | 28.38 | 2.50 |
| UK | 32 | 1970-2006 | 23.62 | 21.70 | 23.57 | 25.94 | 1.22 |
| US | 37 | 1970-2006 | 21.97 | 17.89 | 22.46 | 25.23 | 1.92 |

1. Descriptive Statistics on Capital Income Tax Rate

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Observations** | **Years Spanned** | **Mean** | **Minimum** | **Median** | **Maximum** | **Standard Deviation** |
| Australia | 37 | 1970-2006 | 29.65 | 22.17 | 30.55 | 32.70 | 2.80 |
| Austria | 37 | 1970-2006 | 49.32 | 44.43 | 49.59 | 53.38 | 2.86 |
| Belgium | 37 | 1970-2006 | 51.46 | 48.33 | 51.92 | 53.78 | 1.38 |
| Canada | 37 | 1970-2006 | 36.82 | 32.27 | 37.56 | 39.81 | 2.35 |
| Czech Republic | 14 | 1993-2006 | 49.59 | 48.77 | 49.33 | 50.83 | 0.70 |
| Denmark | 26 | 1981-2006 | 55.00 | 51.19 | 55.78 | 58.03 | 2.16 |
| Finland | 37 | 1970-2006 | 52.27 | 41.48 | 53.97 | 61.08 | 5.63 |
| France | 37 | 1970-2006 | 47.92 | 42.08 | 49.36 | 51.16 | 3.00 |
| Germany | 37 | 1970-2006 | 44.49 | 40.66 | 44.59 | 46.70 | 1.34 |
| Greece | 12 | 1995-2006 | 41.12 | 38.74 | 41.12 | 42.55 | 1.22 |
| Hungary | 16 | 1991-2006 | 52.64 | 50.38 | 52.86 | 54.99 | 1.59 |
| Ireland | 32 | 1975-2006 | 39.47 | 29.93 | 41.14 | 44.19 | 3.94 |
| Italy | 37 | 1970-2006 | 41.76 | 25.94 | 43.79 | 51.24 | 7.30 |
| Japan | 37 | 1970-2006 | 26.78 | 21.60 | 27.67 | 30.94 | 2.63 |
| Korea | 32 | 1975-2006 | 21.37 | 13.99 | 21.68 | 26.39 | 3.03 |
| Netherlands | 37 | 1980-2006 | 47.79 | 42.65 | 47.53 | 52.63 | 3.11 |
| New Zealand | 21 | 1986-2006 | 38.35 | 35.59 | 37.95 | 41.01 | 1.63 |
| Norway | 32 | 1975-2006 | 51.88 | 49.73 | 51.76 | 54.13 | 1.08 |
| Poland | 12 | 1995-2006 | 24.63 | 21.82 | 24.50 | 27.62 | 1.82 |
| Portugal | 12 | 1995-2006 | 40.31 | 38.67 | 40.23 | 42.20 | 1.05 |
| Spain | 37 | 1970-2006 | 34.86 | 22.16 | 38.46 | 41.56 | 6.48 |
| Sweden | 37 | 1970-2006 | 56.91 | 46.43 | 57.71 | 62.25 | 4.21 |
| Switzerland | 37 | 1970-2006 | 29.02 | 22.99 | 29.59 | 34.54 | 2.31 |
| UK | 32 | 1970-2006 | 35.55 | 33.91 | 35.26 | 41.16 | 1.55 |
| US | 37 | 1970-2006 | 27.15 | 24.08 | 27.27 | 29.93 | 1.59 |

1. The Impact of Various Taxes on Bilateral Exports

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **All Tax Ratios** | **Consumption Tax Ratio** | **Labor Income****Tax Ratio** | **Capital Income****Tax Ratio** |
| *ln GDPit-1* | 1.3544\*\*\* | 1.5760\*\*\* | 1.3757\*\*\* | 1.3745\*\*\* |
| *ln GDPjt-1* | 1.0667\*\*\* | 1.1090\*\*\* | 1.0285\*\*\* | 1.0370\*\*\* |
| *ln PPIit-1* | -0.5904\*\*\* | -0.6573\*\*\* | -0.6045\*\*\* | -0.6244\*\*\* |
| *ln PPIjt-1* | -0.1344 | -0.1141 | -0.0864 | -0.0865 |
| *ln Eijt-1* | -0.2190\*\*\* | -0.1793\*\*\* | -0.2234\*\*\* | -0.1665\*\*\* |
| *EUijt-1* | 0.1613\*\*\* | 0.1762\*\*\* | 0.1691\*\*\* | 0.1685\*\*\* |
| *NAFTAijt-1* | 0.1115\*\*\* | 0.1186\*\* | 0.1123\*\*\* | 0.1132\*\*\* |
| *lnBusCycle it-1* | -0.4976\*\* | -0.4765\*\* | -0.4133\*\* | -0.4522\*\* |
| *lnBusCycle jt-1* | 0.4948\*\* | 0.3252 | 0.5188\*\* | 0.4288\* |
| *TCit-1-TCjt-1* | -0.0085 | -0.0026 |  |  |
| *TCit-2-TCjt-2* | 0.0024 | 0.0012 |  |  |
| *TCit-3-TCjt-3* | -0.0015 | 0.0012 |  |  |
| *TCit-4-TCjt-4* | -0.0076\*\* | -0.0076\*\*\* |  |  |
| *TCit-5-TCjt-5* | 0.0086\*\*\* | 0.0079\*\*\* |  |  |
| *TCit-6-TCjt-6* | -0.0047\* | -0.0036\* |  |  |
| *TCit-7-TCjt-7* | -0.0014 | -0.0030 |  |  |
| *TCit-8-TCjt-8* | -0.0033 | 0.0002 |  |  |
| *TCi-TCj Cumulative1* | -0.0160 | -0.0063 |  |  |
| *F-test2* | 2.506 (8, 599)\*\* | 3.437 (8, 599)\*\*\* |  |  |
| *TLit-1-TLjt-1* | -0.0045\* |  | -0.0040 |  |
| *TLit-2-TLjt-2* | 0.0006 |  | 0.0012 |  |
| *TLit-3-TLjt-3* | 0.0002 |  | 0.0007 |  |
| *TLit-4-TLjt-4* | -0.0041\*\*\* |  | -0.0033\*\* |  |
| *TLit-5-TLjt-5* | -0.0022\* |  | -0.0020 |  |
| *TLit-6-TLjt-6* | -0.0027\* |  | -0.0031\*\* |  |
| *TLit-7-TLjt-7* | -0.0007 |  | -0.0024\* |  |
| *TLit-8-TLjt-8* | 0.0011 |  | -0.0004 |  |
| *TLi-TLj Cumulative1* | -0.0123\*\*\* |  | -0.0134\*\*\* |  |
| *F-test2* | 2.716 (8, 599)\*\*\* |  | 2.856 (8, 599)\*\*\* |  |
| *TKit-1-TKjt-1* | 0.0018 |  |  | -0.0005 |
| *TKit-2-TKjt-2* | -0.0009 |  |  | -0.0014 |
| *TKit-3-TKjt-3* | 0.0036\*\*\* |  |  | 0.0033\*\*\* |
| *TKit-4-TKjt-4* | -0.0012 |  |  | -0.0021\*\* |
| *TKit-5-TKjt-5* | -0.0007 |  |  | -0.0013 |
| *TKit-6-TKjt-6* | -0.0015 |  |  | -0.0016\* |
| *TKit-7-TKjt-7* | -0.0022\*\* |  |  | -0.0025\*\*\* |
| *TKit-8-TKjt-8* | 0.0009 |  |  | -0.0002 |
| *TKi-TKj Cumulative1* | -0.0001\*\*\* |  |  | -0.0064\*\* |
| *F-test2* | 3.259 (8, 599)\*\*\* |  |  | 4.356 (8, 599)\*\*\* |
| *Sample Size* | 9,071 | 10,720 | 9,364 | 9,195 |
| *Country Pairs* | 600 | 600 | 600 | 600 |
| *R-Squared* | 0.7630 | 0.7503 | 0.7566 | 0.7588 |
| *RMSE* | 0.248 | 0.268 | 0.252 | 0.250 |

\* = 10%, \*\* = 5%, \*\*\*=1% significance level.

1Cumulative is the sum of the 8 lags of the tax variable, significance is indicated by a test of the null hypothesis that the sum of the lags is equal to zero.

2 F-test statistic from a test of joint significance of all lags of the tax variable. Degrees of freedom are in parentheses.

1. Subsample Results for Tax Effects on Exports

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Full Set** | **Balanced Set** | **Europe** | **Pacific Rim** |
| *ln GDPit-1* | 1.3544\*\*\* | 1.4074\*\*\* | 1.1571\*\*\* | 1.8673\*\*\* |
| *ln GDPjt-1* | 1.0667\*\*\* | 1.0585\*\*\* | 0.9985\*\*\* | 0.9363\*\*\* |
| *ln PPIit-1* | -0.5904\*\*\* | -0.6111\*\*\* | -0.3957\*\* | -0.8399\*\*\* |
| *ln PPIjt-1* | -0.1344 | -0.1503 | 0.1417 | -0.1003 |
| *ln Eijt-1* | -0.2190\*\*\* | -0.2334\*\*\* | -0.1897 | -0.3160\*\* |
| *EUijt-1* | 0.1613\*\*\* | 0.1721\*\*\* | 0.1348\*\*\* |  |
| *NAFTAijt-1* | 0.1115\*\*\* | 0.1098\*\*\* |  | 0.4811\*\*\* |
| *lnBusCycle it-1* | -0.4976\*\* | -0.6437\*\*\* | -0.4927 | -1.6615\*\*\* |
| *lnBusCycle jt-1* | 0.4948\*\* | 0.5048\*\* | 0.5450 | 1.2303\*\*\* |
| *TCit-1-TCjt-1* | -0.0085 | -0.0165\*\*\* | -0.0155\*\* | -0.0279\* |
| *TCit-2-TCjt-2* | 0.0024 | 0.0021 | -0.0033 | 0.0100 |
| *TCit-3-TCjt-3* | -0.0015 | 0.0017 | 0.0076\*\*\* | -0.0267\*\* |
| *TCit-4-TCjt-4* | -0.0076\*\* | -0.0079\*\* | -0.0101\*\* | 0.0030 |
| *TCit-5-TCjt-5* | 0.0086\*\*\* | 0.0060\*\* | 0.0014 | 0.0128 |
| *TCit-6-TCjt-6* | -0.0047\* | -0.0027 | 0.0011 | -0.0036 |
| *TCit-7-TCjt-7* | -0.0014 | 0.0005 | -0.0004 | 0.0124 |
| *TCit-8-TCjt-8* | -0.0033 | -0.0010 | -0.0044 | -0.0011 |
| *TCi-TCj Cumulative1* | -0.0160 | -0.0178\* | -0.0237\* | -0.0211 |
| *F-test2* | 2.506 (8, 599)\*\* | 2.226 (8, 305)\*\* | 2.914 (8, 155)\*\*\* | 2.970 (8, 19)\*\* |
| *TLit-1-TLjt-1* | -0.0045\* | -0.0057\* | -0.0054\* | -0.0243\*\*\* |
| *TLit-2-TLjt-2* | 0.0006 | 0.0003 | -0.0006 | 0.0139\*\* |
| *TLit-3-TLjt-3* | 0.0002 | -0.0025 | -0.0011 | -0.0056 |
| *TLit-4-TLjt-4* | -0.0041\*\*\* | -0.0031\*\* | -0.0002 | -0.0145\* |
| *TLit-5-TLjt-5* | -0.0022\* | -0.0016 | -0.0013 | -0.0124\* |
| *TLit-6-TLjt-6* | -0.0027\* | -0.0030\* | -0.0004 | -0.0169\*\* |
| *TLit-7-TLjt-7* | -0.0007 | -0.0001 | 0.0003 | -0.0298\*\* |
| *TLit-8-TLjt-8* | 0.0011 | 0.0009 | 0.0015 | 0.0046 |
| *TLi-TLj Cumulative1* | -0.0123\*\*\* | -0.0150\*\*\* | -0.00725 | -0.0850\*\*\* |
| *F-test2* | 2.716 (8, 599)\*\*\* | 2.621 (8, 305)\*\*\* | 0.815 (8, 155) | 4.210 (8, 19)\*\*\* |
| *TKit-1-TKjt-1* | 0.0018 | 0.0019 | -0.0012 | -0.0002 |
| *TKit-2-TKjt-2* | -0.0009 | -0.0000 | -0.0012 | -0.0032 |
| *TKit-3-TKjt-3* | 0.0036\*\*\* | 0.0030\*\* | -0.0003 | 0.0065 |
| *TKit-4-TKjt-4* | -0.0012 | -0.0012 | -0.0013 | 0.0068 |
| *TKit-5-TKjt-5* | -0.0007 | -0.0003 | -0.0003 | 0.0037 |
| *TKit-6-TKjt-6* | -0.0015 | -0.0011 | -0.0018 | -0.0004 |
| *TKit-7-TKjt-7* | -0.0022\*\* | -0.0036\*\*\* | -0.0033\*\* | 0.0116\*\* |
| *TKit-8-TKjt-8* | 0.0009 | 0.0020 | -0.0011 | 0.0030 |
| *TKi-TKj Cumulative1* | -0.0001\*\*\* | 0.0007 | -0.0106\*\*\* | 0.0278\*\*\* |
| *F-test2* | 3.259 (8, 599)\*\*\* | 2.181 (8, 305)\*\* | 1.901 (8, 155)\* | 3.667 (8, 19)\*\*\* |
| *Sample Size* | 9,071 | 6,999 | 3,453 | 496 |
| *Country Pairs* | 600 | 306 | 156 | 20 |
| *R-Squared* | 0.7630 | 0.7831 | 0.8491 | 0.8947 |
| *RMSE* | 0.248 | 0.259 | 0.199 | 0.167 |

\* = 10%, \*\* = 5%, \*\*\*=1% significance level.

1Cumulative is the sum of the 8 lags of the tax variable, significance is indicated by a test of the null hypothesis that the sum of the lags is equal to zero.

2 F-test statistic from a test of joint significance of all lags of the tax variable. Degrees of freedom are in parentheses.

1. Subsample Composition

|  |  |  |
| --- | --- | --- |
| **Subsamples** | **Countries Included** | **Countries Dropped** |
|  | Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States. |  |
|  |  |
| Full (25 countries) |  |
|  |  |
|  | Australia, Austria, Belgium, Canada, Finland, France, Germany, Ireland, Italy, Japan, Korea, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom, United States | Czech Republic, Denmark, Greece, Hungary, New Zealand, Poland, Portugal. |
| Balanced (18 countries) |  |
|  |  |
| Europe (13 countries) | Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom.  | Australia, Canada, Czech Republic, Denmark, Greece, Hungary, Japan, Korea, New Zealand, Poland, Portugal and U.S. |
|  |  |
| Pacific Rim (5 countries) | Australia, Canada, Japan, Korea, and U.S.  | Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom. |

1. Results after Dropping Price and Exchange Rate Variables

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **With PPI & RER (Base Specification)** | **No PPI** | **No Real Exchange Rate** | **No PPI or Real Exchange Rate** |
| *ln GDPit-1* | 1.3544\*\*\* | 1.2935\*\*\* | 1.3448\*\*\* | 1.2745\*\*\* |
| *ln GDPjt-1* | 1.0667\*\*\* | 1.0470\*\*\* | 1.0384\*\*\* | 1.0291\*\*\* |
| *ln PPIit-1* | -0.5904\*\*\* |  | -0.5747\*\*\* |  |
| *ln PPIjt-1* | -0.1344 |  | -0.1479 |  |
| *ln Eijt-1* | -0.2190\*\*\* | -0.1906\*\*\* |  |  |
| *EUijt-1* | 0.1613\*\*\* | 0.1429\*\*\* | 0.1606\*\*\* | 0.1506\*\*\* |
| *NAFTAijt-1* | 0.1115\*\*\* | 0.0898 | 0.1132\*\*\* | 0.1050\* |
| *lnBusCycle it-1* | -0.4976\*\* | -0.6113\*\*\* | -0.5246\*\* | -0.5442\*\* |
| *lnBusCycle jt-1* | 0.4948\*\* | 0.5019\*\* | 0.5618\*\* | 0.5598\*\* |
| *TCit-1-TCjt-1* | -0.0085 | -0.0100\* | -0.0084 | -0.0109\*\* |
| *TCit-2-TCjt-2* | 0.0024 | 0.0016 | 0.0012 | 0.0020 |
| *TCit-3-TCjt-3* | -0.0015 | -0.0006 | -0.0018 | -0.0025 |
| *TCit-4-TCjt-4* | -0.0076\*\* | -0.0095\*\*\* | -0.0087\*\* | -0.0085\*\* |
| *TCit-5-TCjt-5* | 0.0086\*\*\* | 0.0078\*\*\* | 0.0073\*\*\* | 0.0074\*\*\* |
| *TCit-6-TCjt-6* | -0.0047\* | -0.0041 | -0.0036 | -0.0039 |
| *TCit-7-TCjt-7* | -0.0014 | -0.0019 | -0.0011 | -0.0003 |
| *TCit-8-TCjt-8* | -0.0033 | -0.0065\*\* | -0.0019 | -0.0058\*\* |
| *TCi-TCj Cumulative1* | -0.0160 | -0.0232\*\* | -0.0169\* | -0.0225\*\* |
| *F-test2* | 2.506 (8, 599)\*\* | 2.954 (8, 599)\*\*\* | 2.279 (8, 599)\*\* | 2.812 (8, 599)\*\*\* |
| *TLit-1-TLjt-1* | -0.0045\* | -0.0054\*\* | -0.0032 | -0.0055\*\* |
| *TLit-2-TLjt-2* | 0.0006 | 0.0009 | -0.0000 | 0.0002 |
| *TLit-3-TLjt-3* | 0.0002 | 0.0004 | -0.0003 | 0.0002 |
| *TLit-4-TLjt-4* | -0.0041\*\*\* | -0.0039\*\*\* | -0.0042\*\*\* | -0.0027\*\* |
| *TLit-5-TLjt-5* | -0.0022\* | -0.0029\*\* | -0.0022\* | -0.0009 |
| *TLit-6-TLjt-6* | -0.0027\* | -0.0027\* | -0.0011 | -0.0026\* |
| *TLit-7-TLjt-7* | -0.0007 | -0.0008 | -0.0004 | -0.0023\* |
| *TLit-8-TLjt-8* | 0.0011 | 0.0014 | 0.0015 | 0.0012 |
| *TLi-TLj Cumulative1* | -0.0123\*\*\* | -0.0130\*\*\* | -0.0099\*\* | -0.0124\*\*\* |
| *F-test2* | 2.716 (8, 599)\*\*\* | 3.216 (8, 599)\*\*\* | 2.495 (8, 599)\*\* | 2.229 (8, 599)\*\* |
| *TKit-1-TKjt-1* | 0.0018 | 0.0005 | 0.0015 | 0.0004 |
| *TKit-2-TKjt-2* | -0.0009 | -0.0003 | -0.0003 | 0.0000 |
| *TKit-3-TKjt-3* | 0.0036\*\*\* | 0.0036\*\*\* | 0.0038\*\*\* | 0.0034\*\*\* |
| *TKit-4-TKjt-4* | -0.0012 | -0.0013 | -0.0012 | -0.0015\* |
| *TKit-5-TKjt-5* | -0.0007 | -0.0007 | -0.0007 | -0.0022\*\* |
| *TKit-6-TKjt-6* | -0.0015 | -0.0019\* | -0.0020\*\* | -0.0016\* |
| *TKit-7-TKjt-7* | -0.0022\*\* | -0.0025\*\*\* | -0.0019\*\* | -0.0010 |
| *TKit-8-TKjt-8* | 0.0009 | 0.0010 | 0.0006 | 0.0014 |
| *TKi-TKj Cumulative1* | -0.0001\*\*\* | -0.0016 |  -0.0002 | -0.0011 |
| *F-test2* | 3.259 (8, 599)\*\*\* | 3.495 (8, 599)\*\*\* | 3.333 (8, 599)\*\*\* | 3.576 (8, 599)\*\*\* |
| *Sample Size* | 9,071 | 9,071 | 9,071 | 9,374 |
| *Country Pairs* | 600 | 600 | 600 | 600 |
| *R-Squared* | 0.7630 | 0.7525 | 0.7613 | 0.7493 |
| *RMSE* | 0.248 | 0.253 | 0.249 | 0.257 |

\* = 10%, \*\* = 5%, \*\*\*=1% significance level.

1Cumulative is the sum of the 8 lags of the tax variable, significance is indicated by a test of the null hypothesis that the sum of the lags is equal to zero.

2 F-test statistic from a test of joint significance of all lags of the tax variable. Degrees of freedom are in parentheses.

**Table 9 Results Using Population and Real GDP per Capita**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Real GDP** **(Base Specification)** | **Real GDP and Population** | **Real GDP per Capita** |
| *ln GDPit-1* | 1.3544\*\*\* | 1.4348\*\*\* | 1.6503\*\*\* |
| *ln GDPjt-1* | 1.0667\*\*\* | 1.0532\*\*\* | 1.1267\*\*\* |
| *ln POPULATIONit-1* |  | -0.0000\*\*\* |  |
| *ln POPULATIONjt-1* |  | 0.0000 |  |
| *ln PPIit-1* | -0.5904\*\*\* | -0.5925\*\*\* | -0.5367\*\*\* |
| *ln PPIjt-1* | -0.1344 | -0.1396 | -0.1023 |
| *ln Eijt-1* | -0.2190\*\*\* | -0.2150\*\*\* | -0.2281\*\*\* |
| *EUijt-1* | 0.1613\*\*\* | 0.1541\*\*\* | 0.0936\*\*\* |
| *NAFTAijt-1* | 0.1115\*\*\* | 0.1669 | 0.2923\*\*\* |
| *lnBusCycle it-1* | -0.4976\*\* | -0.5962\*\*\* | -0.6084\*\*\* |
| *lnBusCycle jt-1* | 0.4948\*\* | 0.5208\*\* | 0.5715\*\*\* |
| *TCit-1-TCjt-1* | -0.0085 | -0.0091\* | -0.0091\* |
| *TCit-2-TCjt-2* | 0.0024 | 0.0025 | 0.0023 |
| *TCit-3-TCjt-3* | -0.0015 | -0.0014 | -0.0016 |
| *TCit-4-TCjt-4* | -0.0076\*\* | -0.0090\*\*\* | -0.0082\*\* |
| *TCit-5-TCjt-5* | 0.0086\*\*\* | 0.0083\*\*\* | 0.0080\*\*\* |
| *TCit-6-TCjt-6* | -0.0047\* | -0.0048\* | -0.0050\* |
| *TCit-7-TCjt-7* | -0.0014 | -0.0013 | -0.0018 |
| *TCit-8-TCjt-8* | -0.0033 | -0.0047\* | -0.0039 |
| *TCi-TCj Cumulative1* | -0.0160 | -0.0196\*\* | -0.0192\*\* |
| *F-test2* | 2.506 (8, 599)\*\* | 2.758 (8, 599)\*\*\* | 2.658 (8, 599)\*\*\* |
| *TLit-1-TLjt-1* | -0.0045\* | -0.0051\* | -0.0049\* |
| *TLit-2-TLjt-2* | 0.0006 | 0.0006 | 0.0006 |
| *TLit-3-TLjt-3* | 0.0002 | 0.0001 | 0.0001 |
| *TLit-4-TLjt-4* | -0.0041\*\*\* | -0.0039\*\*\* | -0.0041\*\*\* |
| *TLit-5-TLjt-5* | -0.0022\* | -0.0019 | -0.0025\*\* |
| *TLit-6-TLjt-6* | -0.0027\* | -0.0027\* | -0.0029\*\* |
| *TLit-7-TLjt-7* | -0.0007 | -0.0006 | -0.0007 |
| *TLit-8-TLjt-8* | 0.0011 | 0.0004 | 0.0006 |
| *TLi-TLj Cumulative1* | -0.0123\*\*\* | -0.0131\*\*\* | -0.0136\*\*\* |
| *F-test2* | 2.716 (8, 599)\*\*\* | 2.465 (8, 599)\*\*\* | 3.035 (8, 599)\*\*\* |
| *TKit-1-TKjt-1* | 0.0018 | 0.0016 | 0.0021 |
| *TKit-2-TKjt-2* | -0.0009 | -0.0007 | -0.0006 |
| *TKit-3-TKjt-3* | 0.0036\*\*\* | 0.0038\*\*\* | 0.0037\*\*\* |
| *TKit-4-TKjt-4* | -0.0012 | -0.0012 | -0.0009 |
| *TKit-5-TKjt-5* | -0.0007 | -0.0007 | -0.0007 |
| *TKit-6-TKjt-6* | -0.0015 | -0.0015 | -0.0015 |
| *TKit-7-TKjt-7* | -0.0022\*\* | -0.0021\*\* | -0.0022\*\* |
| *TKit-8-TKjt-8* | 0.0009 | 0.0002 | 0.0009 |
| *TKi-TKj Cumulative1* | -0.0001\*\*\* | -0.0005 | 0.0008 |
| *F-test2* | 3.259 (8, 599)\*\*\* | 3.310 (8, 599)\*\*\* | 3.323 (8, 599)\*\*\* |
| *Sample Size* | 9,071 | 9,071 | 9,071 |
| *Country Pairs* | 600 | 600 | 600 |
| *R-Squared* | 0.7630 | 0.7660 | 0.7686 |
| *RMSE* | 0.248 | 0.246 | 0.245 |

\* = 10%, \*\* = 5%, \*\*\*=1% significance level.

1Cumulative is the sum of the 8 lags of the tax variable, significance is indicated by a test of the null hypothesis that the sum of the lags is equal to zero.

2 F-test statistic from a test of joint significance of all lags of the tax variable. Degrees of freedom are in parentheses.

**Appendix**

**Tests Justifying Bilateral Fixed Effects Model Over Models with Time-Invariant Variables**

We compare the bilateral fixed effects model against the specification below.

|  |  |  |
| --- | --- | --- |
|  |  | (A1) |

 is the physical distance between countries *i* and *j.* the physical distance between the two most populous cities for any two country pairs. A dummy variable, , equals one if countries *i* and *j* share a physical border. is a dummy variable equal to unity when countries *i* and *j* share a common language. For the *Tariff* variable, information on trade agreements for the General Agreement on Tariffs and Trade (GATT) and, later, World Trade Organization (WTO) members were found on the WTO website. Information on the years of membership in regional agreements, e.g., EEC, NAFTA, was obtained through the WTO Regional Trade Agreements Information System.

Three versions of (A1) appear in the first three columns of Table 9: the first includes fixed effects for each country pair but no other time-invariant bilateral terms, the second is ordinary least squares (OLS) that also excludes time-invariant bilateral terms and contains main country fixed effects, which are two sets of dummy variables (one for exporting (*i*) country and one for importing (*j*) country), the third version is identical to the second but adds in the time-invariant bilateral terms of distance, adjacency, language and a dummy variable for trade agreement membership[[9]](#footnote-9). The results of Wald tests lead to the conclusion that the first of these, the bilateral fixed effects model, is the superior model, as in Egger and Pfaffermayr (2003).

In a subsequent paper, Egger (2005) also suggests measures to test the appropriateness of a fixed effects model over a random effects model.[[10]](#footnote-10) First, a Hausman test results in a χ2 statistic that is highly significant (column 1 of Table 9), indicating that a fixed effects model is preferred over random effects. Second, a Wald test rejects the null hypothesis that the set of bilateral fixed effects is equal to zero. The third criterion, the H-T over-identification test, rejects the null hypothesis that the extra instruments, or the exogenous variables in the model, are uncorrelated with the error term.[[11]](#footnote-11) Hence the fixed effects model is appropriate. The results of the Hausman specification and of the overidentification test appear in the last column of Table 9.

Egger (2000) finds that time effects have a significant impact on his model and are thus included. The results of likelihood ratio tests performed on each of the three models described above appear in Table 4. These results show that the χ2 statistic is highly significant in all three cases, indicating that the null hypothesis of restricting the year effects to zero is rejected. Hence time effects are also included in the models estimated in this paper.

1. Choice of Model Specification

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | Bilateral Fixed Effects(1) | OLS with Country Dummies, no Time-Invariant Bilateral Terms(2) | OLS with Country Dummies and Time-Invariant Bilateral Terms(3) | Hausman-Taylor(4) |
| Number of Observations | 15,409 | 15,409 | 15,409 | 15,398 |
| Adj. R-Squared | 0.966 | 0.734 | 0.889 |   |
| Root Mean Square Error | 0.376 | 1.046 | 0.6771 |   |
| Akaike Information Criterion | 14,986.1 | 45,207.3 | 31,809.3 |  |
| Bayesian Information Criterion | -20,687.6 | -45,948.6 | -32,581.2 |  |
| Hausman FE vs. RE χ2(44) | 128.31\*\*\* |  |  |  |
| Hausman Overidentification Test χ2(6) |  |  |  | 39.928\*\*\* |
| Wald tests:  |
| Exporter Effect | 400.50\*\*\* | 134.84\*\*\* | 222.19\*\*\* |   |
| Importer Effect | 253.04\*\*\* | 36.35\*\*\* | 128.65\*\*\* |   |
| Time Effect | 52.02\*\*\* | 7.54\*\*\* | 15.31\*\*\* |   |
| Bilateral Effect |   |   | 3768.94\*\*\* |   |
| Bilateral Fixed Effects | 296.20\*\*\* |   |   |   |
| Estimation:  |
| *Constant* | -33.550\*\*\* | -22.892\*\*\* | -20.226\*\*\* | -39.115\*\*\* |
| *ln GDPit-1* | 1.374\*\*\* | 1.082\*\*\* | 1.392\*\*\* | 1.674\*\*\* |
| *ln GDPjt-1* | 1.224\*\*\* | 0.916\*\*\* | 0.980\*\*\* | 1.318\*\*\* |
| *ln PPIit-1* | -0.581\*\*\* | -0.760\*\*\* | -0.615\*\*\* | -0.916\*\*\* |
| *ln PPIjt-1* | 0.100\*\*\* | -0.018 | 0.087\*\*\* | 0.085\*\*\* |
| *ln Eijt-1* | -0.147\*\*\* | -0.110\* | -0.096\*\* | 0.004 |
| *Language* |   |   | -1.039\*\*\* | 0.896\*\* |
| *Adjacency* |   |   | 0.493\*\*\* | 1.472\*\*\* |
| *Distance* |   |   | 0.633\*\*\* | 0.000\*\*\* |
| *EUijt-1* | 0.200\*\*\* | 0.830\*\*\* | 0.123\*\*\* | 0.254\*\*\* |
| *WTOijt-1* | -0.181\*\* | 0.105 |  -0.176  | 0.039 |
| *NAFTAijt-1* | 0.128\*\* | 3.333\*\*\* | 0.559\*\*\* | 0.080 |
| *EFTAijt-1* |   |   | -0.422\*\*\* |   |
| *ln BusCycle it-1* | 0.471\*\*\* | 0.494\*\* | 0.493\*\*\* | 0.179\*\* |
| *ln BusCycle jt-1* | 0.666\*\*\* | 0.882\*\*\* | 1.124\*\*\* | 0.592\*\*\* |

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

1. Alternatively, employers may not be able to pass costs to workers because of market imperfections, such as union power, minimum wage laws, employer mandates, etc. and elect to reduce hiring instead. [↑](#footnote-ref-1)
2. Under Egger’s criteria, the fixed effects model is appropriate if: (i) the Hausman test rejects the random effects model, (ii) “at least one of the tests of zero exporter and zero importer fixed effects rejects zero” and (iii) the H-T over-identification test rejects (the null hypothesis of which states that the instruments, or the exogenous variables in the model, are uncorrelated with the error term). Our fixed effects model differs slightly from that of Egger in that a full set of bilateral fixed effects is used rather than just fixed effects for exporter and importer countries per the conclusions following Egger and Pfaffermeyer (2003). [↑](#footnote-ref-2)
3. Fixed and time effects are included in the model, although these estimates are suppressed in the results reported in our tables [↑](#footnote-ref-3)
4. These include the European Economic Community (EEC) and European Union, the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO), the European Free Trade Association (EFTA), and the North American Free Trade Agreement (NAFTA). [↑](#footnote-ref-4)
5. Volkerink and de Haan (2000) provide an organized and thorough overview alongside their own calculations of these ratios. [↑](#footnote-ref-5)
6. The European Trade Association was the only trade agreement to not have changes in membership over the time span of this study. [↑](#footnote-ref-6)
7. This issue has been ignored by some authors, e.g., Bénassy-Quéré et al (2001). Mendoza et al. (1997) use lagged AETRs as instruments for tax rates. [↑](#footnote-ref-7)
8. The analysis involved the comparison of several versions of the basic model each including combinations of tax ratios lagged by between one and ten years. Based on the fact that the t-statistics of the GDP and AETR coefficients and the R2 value were little changed by these variations, there is little evidence that collinearity between GDP and the AETRs affects the results. [↑](#footnote-ref-8)
9. This equals one if both countries belonged to the European Trade Association, which was the only trade agreement to not have changes in membership over the time span of this study. [↑](#footnote-ref-9)
10. Under Egger’s criteria, the fixed effects model is appropriate if: (i) the Hausman test rejects the random effects model, (ii) “at least one of the tests of zero exporter and zero importer fixed effects rejects zero” and (iii) the H-T over-identification test rejects (the null hypothesis of which states that the instruments, or the exogenous variables in the model, are uncorrelated with the error term). Our fixed effects model differs slightly from that of Egger in that a full set of bilateral fixed effects is used rather than just fixed effects for exporter and importer countries per the conclusions following Egger and Pfaffermeyer (2003). [↑](#footnote-ref-10)
11. The specification used was (1) where the endogenous variables are $GDP\_{it}^{ }$, $GDP\_{jt}^{ }$, $Business Cycle\_{it}$, $Business Cycle\_{jt}$, and in some specifications, the tax variables. [↑](#footnote-ref-11)