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CYCLICALITY OF STATUTORY TAX RATES

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Abstract

Most studies on cyclical fiscal policy ignore statutory taxes due to a lack of data. In this paper I build on singular data on statutory tax rates in Israel, in order to study how they are changed by the government in expansions and recessions. After differentiating between ideological (exogenous) tax changes, and those that react to the cycle (endogenous) using the Romer and Romer (2010) technique, I check whether endogenous statutory tax rates are acyclical or countercyclical, as recommended by theoretical models. I find that while direct taxes are a-cyclical, indirect taxes (and in particular VAT) are changed procyclically. A pseudo-panel analysis based on the different types of taxation and a panel analysis based on indirect taxation show that the main reason for statutory tax changes is the existence of economic crises. This explanation is stronger than economic considerations like population or expenditure growth, legal considerations like the rigidity for changing statutory taxes, and income distribution considerations like the incidence on the bottom income decile.

JEL Classification Numbers: H21, H60.

1. INTRODUCTION

As a reaction to the recent crises many OECD countries raised tax rates as a way to cope with the high budget deficit. Figure 1 shows that the main reaction was through indirect taxation, represented by the Value Added Tax (VAT).

Note that this reaction is opposite to the normative prescription by economic models. It is generally agreed that during recessions fiscal policy should be countercyclical, i.e., statutory taxes should remain constant or be lowered and expenditure increased, with a higher tolerance for increasing the deficit.[1] While almost all existing studies on cyclical

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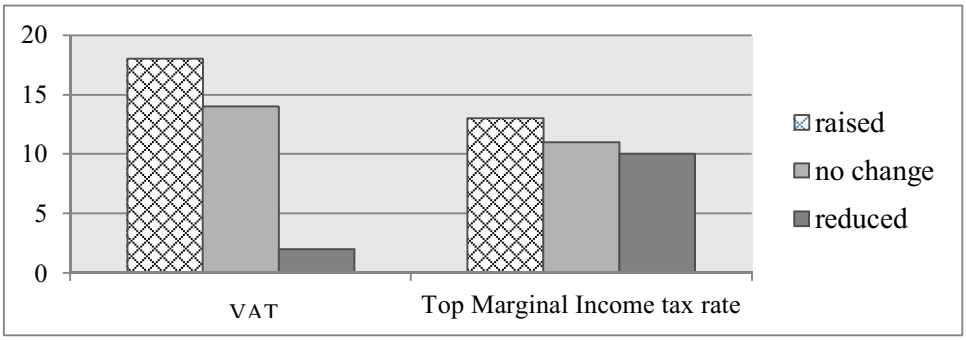
[1] Constant tax rates as a reaction to the cycle has been emphasized by Barro (1979); a countercyclical policy is emphasized by Spilimbergo, Symanski, Blanchard and Cotarelli (2008).

policy check the reaction of expenditure and deficit, almost none of them include a test for taxes, due to lack of data on statutory tax rates.

Figure 1
Number of OECD Countries That Changed Statutory Tax Rates During the Crisis (between 2008 and 2012)



Lane (2002) and Strawczynski and Zeira (2009) show that fiscal policy is countercyclical in OECD countries, based on total expenditure and on expenditure composition (transfers, government consumption and investment). Gavin and Perotti (1997) and Strawczynski and Zeira (2013), show that fiscal policy is pro-cyclical in Latin American countries, based on total expenditure and on budget deficit. Also for Israel, Strawczynski and Zeira (2007) show an improvement in countercyclicality after 1985, based on these two variables.

With respect to taxation, while in normative terms we would expect an acyclical or countercyclical policy, we frequently see that in recessions, when governments are required to reduce their deficits, they tend to raise statutory taxes; i.e., a procyclical policy. Recent examples during the world crisis are Spain, Greece and Italy. In Israel as well taxes were raised in response to the crisis. This paper will investigate whether these casual observations form a pattern, by checking the reaction of statutory tax rates to cycles in a systematic analysis, using Israeli historical data.

Two papers have so far addressed the issue of cyclicality of statutory tax rates. Vegh and Vuletin (2011) performed tests on cyclicality of statutory tax rates at the sub-national level for both Argentina and the US. Their finding was puzzling: while tax rates in Argentina tend to be countercyclical, they found that in the US statutory tax rates tend to be procyclical. This result is opposite to what was found at the federal level for the expenditure side, at which advanced economies are usually countercyclical and emerging economies are procyclical. They also found that both in Argentina and the US, the higher the influence of the federal budget on the sub-national budget, the more procyclical statutory tax policy is, since at good times it becomes optimal to reduce statutory tax rates. This finding hints at possible procyclicality in the reaction of statutory tax rates at the sub-national level, an issue that has not been studied yet at the federal level. Vegh and Vuletin (2012) checked cyclicality of statutory tax rates at the central government level, in a sample

of both developed and developing countries. They found an acyclical tax policy in developed economies, and a procyclical policy in developing economies. Concerning the composition of taxes in developed economies, they found some evidence of a procyclical policy for indirect taxes.

In this paper I work on a single country, Israel, allowing me to use a broader database including many different sources of taxation. For this purpose I build on a singular data base using data on statutory tax rates during the period 1960 to 2012, covering 87 percent of tax revenues. The data covers both direct sources of taxation – income tax, corporate tax, social insurance taxes and capital taxes – and indirect taxes – VAT, car customs duties, housing purchase taxes and excise taxes.

In Israel the concern for fiscal deficits during recessions has repeatedly been a driving force for raising statutory tax rates. While reform of income tax rates requires discussion and approval by the parliament, indirect taxes, and in particular the VAT, can be amended by a decision taken by the Finance Minister. This characteristic makes this source more prone to be used as a quick reaction to the cycle. Thus, our prior hypothesis is that indirect taxation is a clear candidate for procyclicality. In order to check the plausibility of a political / institutional explanation, I build an index that considers the complexity of the decision-making process for changing the different statutory tax rates.

A well-known concern for checking cyclicality of fiscal variables is the endogeneity of these variables, since they have an effect on the GDP. (See Ilzetsky and Vegh, 2008, for a thorough discussion of this topic.) We cope with this problem by using world trade growth as an instrumental variable for GDP growth, as shown in section 4. Another concern is related to causality: do statutory tax rates affect growth or the opposite? This issue is analyzed by using Granger causality tests.

The paper is organized as follows: In section 2, I describe the data. In section 3, I present a framework for analyzing the cyclicality of statutory tax rates, and perform a time series analysis. In section 4, I proceed by showing pseudo-panel regressions in which the different tax channels are considered as cross-section units in the analysis. Finally, I summarize and conclude in section 5. The three appendices at the end show the details for building exogenous and endogenous statutory tax rates (Appendix A), Granger causality tests (Appendix B) and the long-run equations (Appendix C).

2. THE DATA

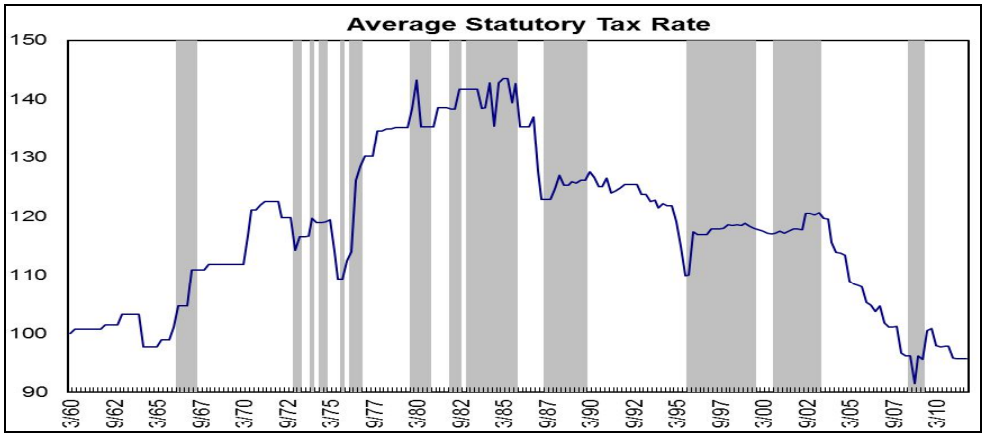
I collect data on nine sources of taxation, which cover 87 percent of tax revenues. The sources of direct taxation are: income tax, corporate tax, national insurance (payroll) tax, and capital gains tax. The sources of indirect taxation are: VAT (for consumers, non-profit organizations – NPO – and the financial sector), fuel excise tax, car tax, tobacco tax, and housing purchase tax. I build an aggregate index based on all sources of taxation (STAT_TOTAL), and a direct (STAT_DIR) and indirect (STAT_IND) measure, composed of the taxes mentioned above. The weights are calculated according to the proportion of each tax on total revenues in the period 1980-2009. In Table 1, I show the average weights for 2008/2009.

Table 1
The Weights of the Different Taxes

	Tax Revenues (% of GDP)	Weight (%)
Total Direct Taxes	**14.95**	**59.79**
Income tax	6.00	28.35
Corporate tax	3.25	12.98
National Insurance	5.4	17.18
Capital gains	0.3	1.27
Total Indirect Taxes	**12.76**	**40.21**
VAT for consumers	8.00	25.66
VAT for Non Profit Organizations	0.98	2.89
VAT for financial institutions	0.28	0.87
Fuel Excise Tax	2.04	4.85
Car Tax	0.96	3.59
Tobacco Tax	0.1	0.65
Housing Taxes	0.4	1.71
Total	**27.71**	**100**

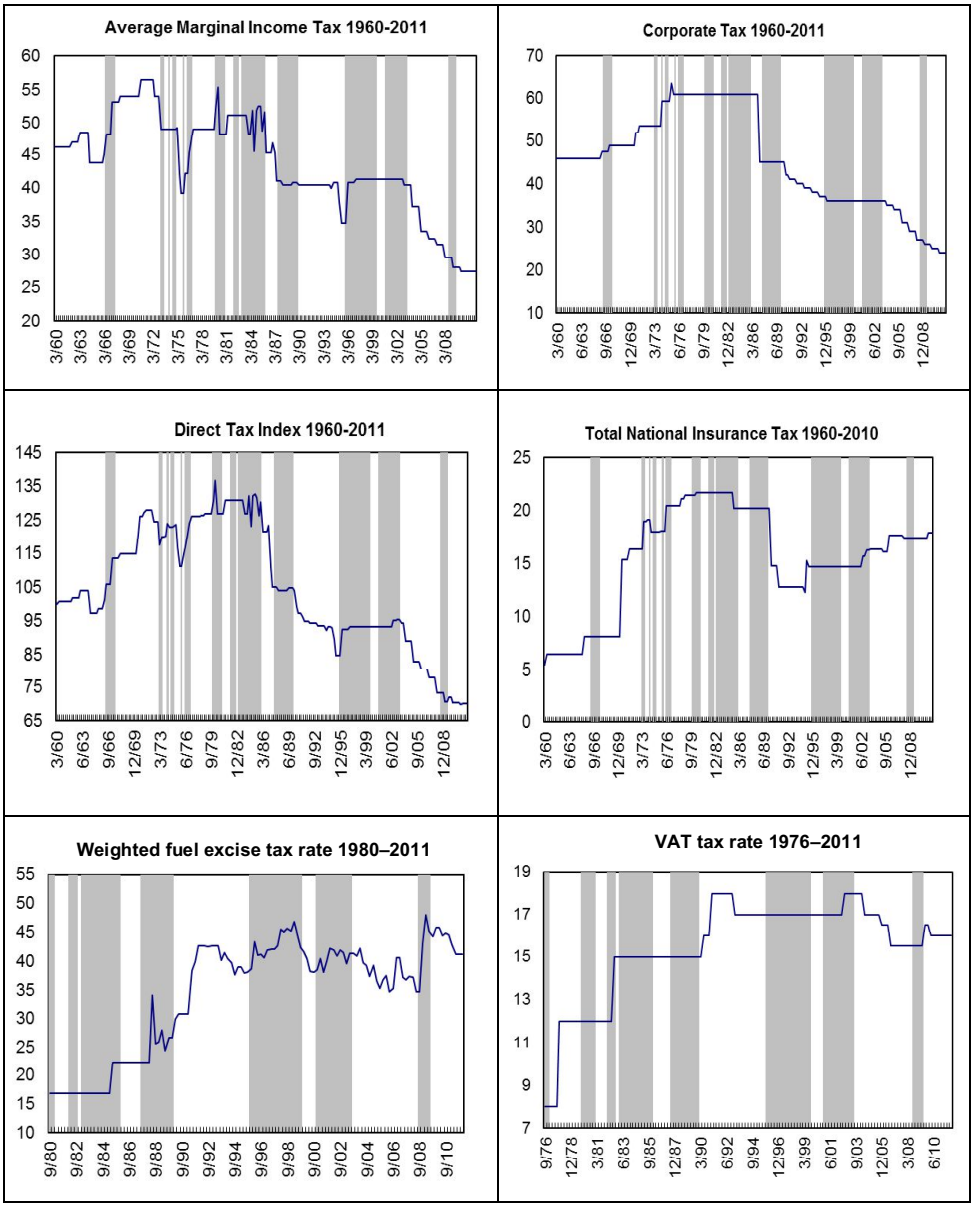
Figures 2 and 3 show the developments of statutory tax rates over time. The shaded areas represent recession periods, using the dates according to previous research.[2] Figure 2 refers to total taxation, and Figure 3 shows the behavior of specific channels of direct and indirect taxation.

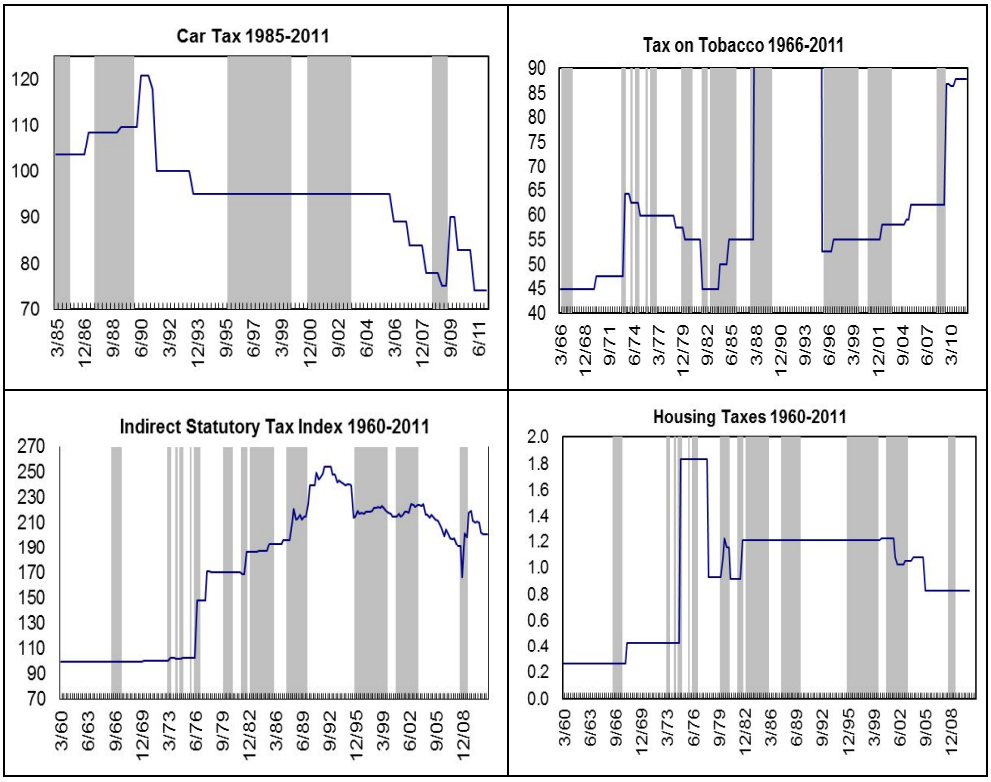
Figure 2
Average Statutory Tax Rate and Business Cycles
(Shadowed Areas Represent Recessions)



[2] Unlike the U.S. where the NBER characterizes business cycles, in Israel they have been characterized by different research papers. While there are some discrepancies among different papers, recession periods are quite similar in all of them. The figures here are based on Flug and Strawczynski (2007).

Figure 3
Specific Statutory Tax Rates and Business Cycles
(Shadowed Areas Represent Recessions)





As a general pattern, indirect taxes are raised during recessions (shadowed areas) as a way to alleviate the budget deficit that arises in these periods, following the shortfall in tax revenues as a consequence of the decline in the GDP. Since some of these may be exogenous (ideological) changes that happened to be implemented in a particular phase of the cycle, we shall first classify taxes as either exogenous (ideological) and endogenous (cyclical), using the methodology introduced by Romer and Romer (2010). I will then check whether procyclicality is corroborated by an econometric analysis, which controls for relevant additional variables that explain statutory tax rates. According to the Romer and Romer (2010) methodology, I look at the legislative background of each one of the changes in statutory tax rates during Israeli history. After analyzing the environment of statutory tax rate decisions I aim at understanding whether they were exogenous—i.e., motivated by ideological reasons—which are independent of economic activity; or whether they were endogenous—i.e., a reaction to the economic conditions. Appendix A summarizes the changes in taxation that fulfill the exogenous criteria. Endogenous changes (symbolized by including the word ENDO in the name of the relevant variable) are all other changes in statutory tax rates made during the sample period. The next stage is to use the cyclical observations to check whether the government increases (decreases) direct or indirect taxes during recessions, thus pursuing a procyclical (countercyclical) fiscal policy.

The use of the Romer and Romer (2010) methodology in the present paper merits a detailed discussion. If the ideological changes in taxes are in fact exogenous, they should be orthogonal to the state of the business cycle. In this sense, the use of the endogenous sources of tax changes for checking cyclicality should increase the plausibility of finding an empirical relationship between statutory tax rates and the business cycle. Thus, this kind of analysis helps for differentiating between the relative importance of ideology and business cycle considerations in determining fiscal policy. Nevertheless, we might be interested in checking whether the politically-motivated tax changes happened to reinforce or counteract the business cycle. For this purpose, we will run regressions that look both at the endogenous statutory tax rates and at the total statutory tax rates (which include the exogenous sources as well).

One possible claim against the Romer and Romer (2010) methodology is that the timing of exogenous reforms may become endogenous. If this is the case, we shall see that exogenous changes are affected by the GDP. In appendix B, I show that exogenous changes in taxes Granger-cause GDP and not the opposite, while changes in GDP Granger-cause endogenous changes in indirect taxation and not the other way round. The interesting question of estimating the impact of exogenous taxes on GDP is beyond the scope of the present paper.

3. STATUTORY CHANGES AND CYCLICALITY

a. The Framework of the Analysis

Assume that taxes finance government expenditure:

$$T(Y) = t(Y)Y = G \quad (1)$$

Where t is a statutory tax function, Y is the GDP and G symbolizes government expenditure. For simplicity let us assume that:

$$t(Y) = tY^{\theta} \quad (2)$$

Where t is a (linear) statutory tax rate and θ is a parameter related to the convexity of the function, implying that the elasticity of the average statutory tax rate to GDP is higher than 1.3 After plugging (2) back into (1) it is easy to see that T'(Y) is positive, and T''(Y) is also positive. This means that the tax system is characterized by progressivity, i.e., the higher Y is the higher the marginal aggregate average tax rate is. This characterization is in line with most basic tax modeling. In terms of real life taxation, the progressivity is mainly related to the Income Tax schedule; the progressivity of the National Insurance taxes is softer. Concerning indirect taxes, progressivity is related to some goods—in particular private cars.

[3] The elasticity of taxes to GDP was estimated by Brender and Navon (2010).

Assume that the production function is Cobb-Douglass:

$$(3) \quad Y = AK^{\alpha}L^{1-\alpha}$$

Where K symbolizes capital and L labor.

Plugging (3) and (2) into equation (1), and taking logs results in the following equation:

$$(4) \quad \ln(t) = \ln(G) - \theta \ln(Y) - \ln A - \alpha \ln(K) - (1-\alpha)\ln(L)$$

In order to test this equation, I will run co-integration equations, and I will afterwards check cyclicality in the framework of the short run regression.

Since the focus of my work is to check the cyclicality of statutory tax rates, the analysis will be performed at two dimensions: first, I check the relationship between statutory tax rates and the cycle as measured by changes in the GDP; and second, I use the Romer and Romer (2010) methodology which, as explained above, separates between exogenous and endogenous statutory tax changes. This classification allows me to test whether the endogenous statutory tax changes are correlated with the cycle—and in particular, whether these reactions are counter or procyclical. In Appendix B, I show Granger causality tests, which reinforce the conclusion that causality goes from the cycle to endogenous indirect taxes.[4]

It is important to stress that this research concentrates on statutory tax rates, as opposed to effective tax rates. Statutory tax rates include only the official rates, ignoring deductions or exemptions, which also affect tax collection. Ideally it would be desirable to take all taxation changes into account, since some of these exemptions or deductions may have a cyclical pattern as well. However, due to lack of data, I concentrate in this research on statutory tax rates only. It is worth stressing that the changes in statutory tax rates in Israel are significantly more frequent and quantitatively significant than changes in provisions related to deductions or exemptions.

b. Cyclicality of Direct and Indirect Statutory Tax Rates

According to the co-integration technique, the first stage is to run a long-run equation of the model, which is given in equation 4, augmented to additional variables that are candidates for contributing to co-integration. Since the short-run equation requires lags in order to check for a possible lagged cyclical reaction, we include a symmetric structure in the long-run equation, and then compute the residuals which will be used in the short-run equations. As required by co-integration, all variables are I(1) using the ADF criterion. The specification requires separate consideration of the total factor productivity (A), which is correlated to the GDP. Since I do not aim to estimate a structural version of the production function, I run a regression using measurable variables and I only use a co-integration interpretation.[5] Since the main specification includes real government expenditure, the sample starts in 1988, since quarterly data for this variable is available only since that year.

[4] In order to check the consistency of the data, I also test whether exogenous taxes affect GDP.

[5] Estimating the effect of taxes on a consistent framework that respects a production function is beyond the present research. For a paper that studied these effects see Lavi and Strawczynski (2002).

The main long-run equations are presented in Appendix C, and they corroborate co-integration at a 5 percent level of significance, using McKinnon's (1991) critical variables.

Table C.1 checks the basic framework, using capital, labor and productivity together with government expenditure. The regression shows co-integration at 10 percent, with standard production function coefficients (two-thirds for labor and one-third for capital). The coefficient of total productivity is negative as expected. The next two regressions add additional variables which show that coefficients have the expected sign and co-integration is obtained at 10 percent.

Using this information I turn back to equation (4) and try to build co-integration regressions that include cyclical variables. From now on the single purpose is obtaining a significant co-integration relationship. The lagged residual of this regression will be used in the short-run regression in order to check the reaction of statutory tax rates to GDP in the short run—which is the main question asked in this study.

Results of co-integration are shown in Table C.2. The use of cyclical variables contributes significantly to the regressions, especially for endogenous indirect taxes, in which co-integration is obtained at a high level of significance. While co-integration is not obtained at 10 percent in the specification for direct taxes, I will be able to cross-check the long-run relationship by looking at the significance of the lagged error term in the short-run regressions, which according to the Engle-Granger hypothesis will be significant if a co-integration relationship exists.

The short-run analysis is presented in Table 2. Error terms are significant at 5 and 1 percent, corroborating the existence of co-integration. Concerning cyclicality, the coefficient for endogenous direct taxes is not significant; i.e., direct taxes are acyclical. The cycle coefficients are significant for indirect taxes—both for total indirect taxes (at 5 percent) and in particular for endogenous indirect statutory tax rates (at 1 percent). The sign of the coefficient is negative, which means that indirect tax rates are lowered during expansions and raised during recessions—a procyclical policy.

The tax burden of indirect taxes is higher for poor families, since a high percentage of income is spent on consumption. Given this fact, procyclicality implies an increase in the burden on the poor at the most difficult periods. Assuming an inequality-averse social utility function, this result raises serious questions about the desirability of this policy, which may be dominated by short-run political considerations. (This feature is further investigated in the next section.) In particular, it raises a question on whether there should be political restrictions on changing tax rates during recessions, contrary to what happens in reality: indirect taxes in Israel can be changed by a decision of the Minister of Finance requiring only the advice (with no further restrictions) of the Economics Committee of the parliament. A measure of the legal flexibility for changing statutory taxes is shown in the next section.

Table 2
Cyclicality of Statutory Tax Rates (standard deviations in parentheses)

Period	**1988:Q1–2011:Q4**					
	Dependent Variable					
	Dlog (stat_total)	Dlog (stat_dir)	Dlog (stat_ind)	dlog(stat_ endo_total)	Dlog(stat_ endo_dir)	dlog(stat_ endo_ind)
	(1)	(2)	(3)	(4)	(5)	(6)
C	-0.0 (0.0)	-0.0 (0.0)	-0.01 (0.01)	-0.0 (0.0)	0.0 (0.0)	-0.0 (0.0)
dlog (HP_Gov.Sp.)	-0.7 (0.8)	-0.7 (1.0)	-0.2 (1.5)	-0.8 (0.5)	-0.6 (0.6)	-1.2 (1.5)
dlog (population)	1.0 (0.8)	-0.9 (0.9)	4.3 (1.4)***	1.0 (0.5)**	-0.4 (0.5)	4.0 (1.4)***
dlog (capital stock)	0.5 (0.3)	0.8 (0.4)**	-0.3 (0.6)	0.1 (0.2)	0.3 (0.2)	-0.1 (0.6)
dlog (GDP))	-0.2 (0.1)*	-0.04 (0.1)	-0.5 (0.2)**	-0.1 (0.07)*	-0.0 (0.0)	-0.7 (0.2)***
d (Debt)	0.002 (0.002)	0.0005 (0.002)	0.004 (0.003)	-0.00 (0.0)	-0.0 (0.0)	0.0 (0.0)
dlog (Immigr.)	0.01 (0.004)	0.005 (0.006)	0.02 (0.008)*	0.0 (0.0)	-0.0 (0.0)*	0.02 (0.008)**
d(Gini)	1.4 (1.0)	2.1 (1.2)*	-0.04 (1.8)	0.8 (0.6)	0.8 (0.7)	0.7 (1.9)
d(Trade_Par-tners_Income)	0.01 (0.003)***	0.01 (0.004)*	0.02 (0.01)***	0.006 (0.002)***	0.002 (0.002)	0.01 (0.006)***
Residuals (-1)	-0.4 (0.1)***	-0.3 (0.1)***	-0.7 (0.1)***	-0.5 (0.1)***	-0.4 (0.1)***	-0.7 (0.1)***
AdjR²	0.26	0.15	0.37	0.28	0.16	0.23
D.W.	1.9	1.8	2.1	1.9	1.8	2.2

The lack of data for historic monthly government expenditure limits regressions to a shorter sample. In order check the sensitivity of the results to the size of the sample, I performed a regression that does not include government expenditure as an explanatory variable, allowing me to enlarge the sample to 1970. After running the long-run and short-run regressions, I confirmed the result of procyclical behavior of endogenous indirect taxes (not reported). Since the longer sample includes the 1980s, which was a period characterized by hyper-inflation, both the long- and short-run regressions included a control dummy variable with a value of 1 for the period 1981:Q1 to 1985:Q2, and 0 otherwise.

c. Cyclicality of Specific Taxes: VAT and Fuel excise

To complete the picture I tested the cyclical behavior of the specific categories of indirect taxes. In this section I present results on VAT and fuel excise. As before, I start with the long-run analysis.

Co-integration regressions are shown in appendix table C3. In the endogenous sources of taxation there is a co-integration relationship, as corroborated by the significant ADF statistic (at 5 and 1 percent).

The regressions on cyclicality are presented in Table 3. In all regressions the error correction term is significant, corroborating the co-integration relationship. The most interesting result is related to procyclicality: both the VAT and the fuel excise statutory taxes show a procyclical behavior, especially when we look at the endogenous statutory tax rates.

Table 3
Cyclicality of Specific Indirect Taxes (standard deviations in parentheses)

Period	**1988:Q1–2011:Q4**			
Dependent Variable				
	dlog(vat)	dlog(gasoline)	dlog(vat_endog)	dlog(gasoline_endog)
	(1)	(2)	(3)	(4)
C	-0.0	-0.0	-0.0	-0.0
	(0.0)	(0.0)	(0.0)	(0.0)
dlog(HP_Gov. Sp.)	-0.3	-0.9	1.1	0.0
	(1.0)	(0.9)	(2.6)	(2.8)
dlog (population)	2.9	3.3	3.4	2.3
	(1.0)***	(0.9)***	(2.6)	(2.7)
dlog (capital stock)	0.03	-0.2	-0.3	0.2
	(0.4)	(0.4)	(1.1)	(1.2)
dlog (GDP))	-0.3	-0.4	-1.0	-0.8
	(0.1)**	(0.1)***	(0.5)**	(0.5)*
d (Debt)	0.0	-0.0	-0.0	-0.0
	(0.0)	(0.0)	(0.0)	(0.0)
dlog (Immigrants)	0.0	0.0	0.0	-0.0
	(0.0)	(0.0)	(0.0)	(0.0)
d(Gini)	0.4	-0.2	0.0	4.8
	(1.2)	(1.1)	(0.0)	(3.4)
d(Trade Partners Income)	0.0	0.0	0.0	0.0
	(0.0)	(0.0)	(0.0)	(0.0)
Residuals (-1)	-0.3	-0.4	-0.3	-0.3
	(0.1)***	(0.1)***	(0.1)***	(0.1)***
AdjR²	0.25	0.32	0.16	0.18
D.W.	2.1	2.0	2.0	1.9

4. ADJUSTMENT OF STATUTORY TAXES: A PSEUDO-PANEL ANALYSIS

In this section I perform a pseudo-panel analysis in which the dependent variables are the average indices of taxation, and the independent variables are formed by the characteristics of the 11 categories of taxation as shown in Table 1; the sample period is based on 52 quarters in the period 1997:Q1 until 2009:Q4.[6] I learned in the previous section that endogenous direct taxes are not sensitive to the cycle; as a consequence, running standard panel regressions with all tax sources as a dependent variable results in a low explanatory

[6] In this analysis I use data from the expenditure survey, which is regularly available only in this period. In appendix D, I extend the analysis to the period 1960:Q1–2011:Q4.

power.[7] In order to learn more about statutory tax behavior I use a pseudo-panel approach, in which the value added comes from the specific characteristics of the tax sources; these characteristics are not tested in a time series analysis because of the need to consider variation among the different types of taxes. These characteristics include the elasticity of the tax base, the number of households that pay the tax, income distribution characteristics, and additional variables as described below. I collected the following data on new variables that are candidates for explaining the adjustment of tax rates:

- Macroeconomic Variables—Tax rates are usually increased in difficult times. In order to pick this phenomenon I use a macroeconomic index (see Flug and Strawczynski, 2007) that incorporates inflation, government deficits, black market premium and exchange rate disalignment and variability.[8] This index is used in order to build a dummy variable called 'crisis', which takes the value of 1 in years in which the macroeconomic index is below a threshold. Two definitions of the variable 'crisis' will be used: a) for years in which the macroeconomic index falls for more than two consecutive quarters until it comes back to its previous level (CRISIS); b) for years in which the macroeconomic index falls for more than two consecutive quarters until it changes direction (CRISIS2). Figure 4 shows the direct and indirect statutory average tax rate at different recession periods in Israeli economic history; these periods are all included in the CRISIS and CRISIS2 variables. In five periods (73-76, 77-79, 80-82, 87-90, 2001-04 and 2008-10) there is a clear change in policy characterized by a substantial rise in indirect statutory tax rates as a way to cope with the budget deficit created during the recession. For this type of tax the maximum tax rate is higher than the one at the beginning of the period. This is particularly notable at the beginning of the seventies and in the recent crisis. Ex-ante I expect that an economic crisis should have a procyclical effect on statutory tax rates during recessions as a reaction to the persistent reaction of GDP. Additional macroeconomic variables are the level of debt and the forecasted growth of the budget (not reported in the regressions because it was not significant).
- Economic variables – I use estimates of elasticities of the different taxes (ELAST). According to economic theory (Ramsey optimal taxation) we expect that taxes are inversely related to the elasticity. Thus, the question is whether governments that are forced to change tax rates put some weight on efficiency issues. I use elasticities for income tax (Gruber and Saez, 2000), for corporate tax (Wolswijk, 2007), for VAT (Wolswijk, 2007), for cars (Jorgensen and Dargay, 2006), for housing (Hanushek and Quigley, 1980), for fuel excise (Hughes, Mintel and Sperling, 2008) and for cigarettes (Gruber, Sen and Stabile, 2002).
- Political variables – The variable ELECT picks four quarters before election; the standard argument used in the political economy literature is that a populist policy would imply reducing tax rates in election periods – i.e., a negative coefficient.

[7] In fact, in the regular panel regressions I got a low R squared and the coefficients of dlog(gdp) were not significant. For a further explanation of this point see appendix D.

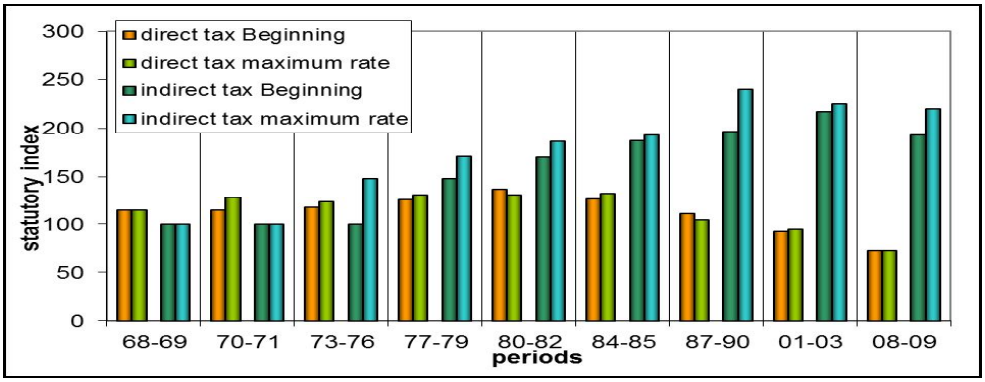
[8] The formula shown in that paper (using a principal component approach) is:
macro_index=0.334*budget surplus-0.447*inflation-0.585*black market premium-0.347*overvaluation-0.475*exchange rate variability.

GOV_TIME is the de-facto term of the governments, which is supposed to be four years but in practice frequently lasts for a shorter period. It is difficult to analyze the sign of its coefficient ex-ante: while a short period may mean a weak government, which may follow a populist policy, a sudden fall of the government may impede such a policy.

- Legal Variables (LEGAL) – I build an index that considers the simplicity of changing statutory tax rates. According to Israeli law, changing the VAT requires advice from the parliament's Economics Committee, while changing the income tax requires approval of the parliament, implying a long process. Clearly I expect that a shorter process implies ex-ante that politicians are more prone to change this type of tax. After analyzing the details included in the laws, I have chosen two categories: the VAT, fuel excise and tobacco tax rates take on a value of 2, while the income tax, car taxes and the rest of taxes mentioned in Table 1 take on a value of 1. In times of crisis I expect a positive coefficient for the interaction between CRISIS and LEGAL: the easier it is for politicians to change the statutory tax rate, the more frequently it is expected to be adjusted in crisis periods.
- Taxation Revenue Considerations – When the government adjusts a tax rate, the burden is concentrated on the households that form part of the tax base. An interesting question is whether the government takes into account this kind of consideration when adjusting the statutory taxes. In order to check this issue I include as an explanatory variable the number of households (HOUSE_NUM) affected by the tax rate.
- Income Distribution Variables – the variable TOP10 represents the highest decile (the highest ten percent of income earners) as a percentage of the tax base by using data from the expenditure survey of Israel's Central Bureau of Statistics. Thus, for example, for VAT it represents their share in consumption; for the income tax their share of wages; and for the fuel excise tax their share of gasoline consumption. The variable BOTTOM40 represents the lowest 40 percent of income earners as a share of the tax base.

Finally, I add the economic cycle as an additional explanatory variable and interaction term with CRISIS.

Figure 4
The Reaction of Statutory Taxes During Recessions



Tables 4, 5 and 6 show the results of the pseudo-panel analysis. These results are comparable to results shown in the literature on cyclicality of fiscal policy since, similar to those papers, I cope in these tables with the endogeneity issue. For this purpose I take changes in world trade (with one and two lags) as an instrumental variable for changes in GDP. Before starting the analysis, I performed a test for the validity of the instrumental variable, as suggested by Yitzhaki and Schechtman (2004), which turned out successful.[9]

In all tables the lagged residuals are significant, which means that the panel regressions satisfy the long-run relationship, and the DW statistic is at a level that allows for rejecting autocorrelation.

Table 4 is the first step for extending the time series analysis of the previous section. From this table I learn that the CRISIS variable is significant for indirect taxes in general, and for total endogenous taxes. Other variables that are significant for total statutory taxes are ELECT and GOV_TIME, both with a negative sign. These results mean that in election periods and in governments that last for long periods, there is a trend to reduce taxes. When taking out exogenous taxes from the regression, I differentiate between the legislated changes and the discretionary changes performed by the government. Thus, the significant short-term political considerations are attributed the latter.

A remarkable result is that among endogenous taxes, the single source that is significant at 1 percent is endogenous indirect taxation. Thus, this analysis confirms the result I obtained in the previous section—that indirect endogenous taxes are raised in difficult periods and reduced in good ones.

In the next tables I use world trade as an instrument for GDP. In table 5, I perform different kinds of sensitivity analysis for analyzing the result on indirect endogenous taxation, which is the dependent variable in all the regressions that appear in this table. In the first regression I omit the d(macro) variable, to avoid a possible correlation with the crisis variable. The result of procyclicality of endogenous indirect taxes remains significant. In column 2, I analyze procyclicality only in crisis periods, by looking at the interaction between changes in GDP and CRISIS. Interestingly, the coefficient is higher than in the first regression, which means that in periods of crisis there is a remarkable procyclicality. In the third regression I check whether the reaction is with a lag, and found that procyclicality is related to a lagged response to GDP. Finally, I check sensitivity to the second definition of crisis: as explained above CRISIS2 takes the value of 1 when the macro index falls for at least two consecutive quarters, and 0 otherwise. Thus, this definition is sharper in the sense that a crisis is related to a deterioration of macroeconomic management and not to its level. The result shows that the coincident coefficient of GDP is -0.66, and in periods of crisis it rises (in the same quarter) by an additional -0.52 (with 10 percent significance).

[9] These authors show that in order to use the instrumental variable the concentration curves of the original and instrumental variables should not cross each other, as turned out to be the case with dlog(gdp) and dlog(wt). This result implies that the use of the instrumental variable (or a transformation) is clean of possible "manipulations" on the sign of the independent variable.

Table 4
Cyclicality of Statutory Tax Rates: Panel Analysis[(1)] (Standard deviations in parentheses)

Period	**1997:Q3–2009:Q3**					
	Dependent Variable					
	dlog(stat_ total)	dlog(stat_ dir)	dlog(stat_ ind)	dlog(stat_ endo_total)	dlog(stat_ endo_dir)	dlog(stat_ endo_ind)
	(1)	(2)	(3)	(4)	(5)	(6)
C	0.017	0.021	0.008	0.001	-0.001	0.007
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Crisis	0.000	-0.007	0.008	0.003	0.002	0.005
	(0.0)	(0.0)**	(0.0)***	(0.0)***	(0.0)*	(0.0)*
dlog(debt)	0.142	0.241	0.023	-0.065	-0.079	0.024
	(0.1)*	(0.1)**	(0.1)	(0.0)**	(0.0)***	(0.0)
dlog(G)	-0.049	-0.004	-0.116	-0.031	-0.019	-0.080
	(0.0)***	(0.0)	(0.0)***	(0.0)***	(0.0)***	(0.0)***
dlog(house_ num)	-0.015	-0.022	0.023	0.013	0.018	-0.038
	(0.1)	(0.1)	(0.1)	(0.0)	(0.0)	(0.1)
d(macro_ index)	0.022	0.030	0.060	-0.007	-0.008	0.000
	(0.0)***	(0.0)***	(0.0)	(0.0)***	(0.0)***	(0.0)
Elect	-0.009	-0.010	-0.007	0.003	0.001	0.011
	(0.0)***	(0.0)**	(0.0)*	(0.0)**	(0.0)	(0.0)***
gov_time	-0.001	-0.001	0.000	0.000	0.000	0.000
	(0.0)***	(0.0)***	(0.0)	(0.0)	(0.0)	(0.0)
Residuals (-1)	-0.199	-0.149	-0.388	-0.327	-0.098	-0.295
	(0.0)***	(0.0)***	(0.1)***	(0.0)***	(0.0)***	(0.0)***
dlog(GDP)	-0.243	-0.245	-0.205	-0.035	0.029	-0.265
	(0.1)***	(0.1)**	(0.1)*	(0.0)	(0.0)	(0.1)***
AdjR²	0.17	0.18	0.22	0.28	0.24	0.25
D.W.	1.8	2.1	1.6	1.7	1.9	2.1

(1) The regression includes the ELAST, LEGAL, TOP10 and BOTTOM40 variables, which were not significant and are not reported for space considerations.

Table 5
Endogenous Indirect Taxes During Crisis[(1)] (Standard deviations in parentheses)

Period	**1997:Q2–2009:Q3**			
	Dependent Variable			
	d(log(stat_ endo_ind))	d(log(stat_ endo_ind))	d(log(stat_ endo_ind))	d(log(stat_ endo_ind))
	(1)	(2)	(3)	(4)
C	0.014 (0.0)	-0.003 (0.0)	-0.018 (0.0)	0.006 (0.0)
Crisis	-0.002 (0.0)	0.008 (0.0)**	0.008 (0.0)	
crisis2				-0.002 (0.0)
dlog(debt)	0.157 (0.1)	0.182 (0.2)	0.663 (0.3)*	0.208 (0.1)*
dlog(G)	-0.125 (0.0)***	-0.128 (0.0)***	-0.175 (0.0)***	-0.127 (0.0)***
dlog(house_num)	-0.005 (0.1)	-0.065 (0.1)	-0.082 (0.1)	-0.004 (0.1)
Elect	0.007 (0.0)*	0.012 (0.0)***	0.017 (0.0)***	0.009 (0.0)*
top10	-0.016 (0.0)	-0.007 (0.0)	-0.010 (0.0)	-0.015 (0.0)
bottom40	-0.016 (0.0)	-0.009 (0.0)	-0.011 (0.0)	-0.013 (0.0)
gov_time	0.000 (0.0)	0.000 (0.0)	0.001 (0.0)	0.000 (0.0)
Residuals (-1)	-0.268 (0.0)***	-0.281 (0.0)***	-0.402 (0.1)***	-0.329 (0.1)***
dlog(GDP)	-0.756 (0.2)***		-0.266 (0.2)	-0.661 (0.2)***
dlog(GDP)*(crisis)		-0.822 (0.3)**	-0.672 (0.7)	
dlog(GDP(-1))			0.778 (0.2)***	0.149 (0.1)
dlog(GDP(-1)* (crisis(-1))			-0.952 (0.3)***	
dlog(GDP)*(crisis2)				-0.521* (0.3)
dlog(GDP(-1)* (crisis2(-1))				0.152 (0.3)
AdjR²	0.18	0.16	0.11	0.20
D.W.	2.2	2.3	2.1	2.1

(1) Using world trade with one and two lags as an instrumental variable for the GDP and past values (with two lags) as instrumental variables for debt and for government spending ; the regression includes the ELAST and LEGAL variables, which were not significant and are not reported for space considerations.

In table 6, I check whether the changes in total endogenous taxes in periods of crisis are related to other characteristics of the different taxation channels. Regression 1 checks whether endogenous taxes are affected by the legal difficulty of changing taxes. The positive and significant result (at 10 percent) means that in times of crisis government tends to raise taxes that are easier to change. The coefficient is comparable to the one of Regression 4 of Table 4 (0.003): two-thirds of the changes made in periods of crisis are done through channels that are easier to change from a legal point of view. In the next two regressions I found that during crisis, taxes are raised for items that are elastic and with a

Table 6
Legal, Economic and Income Distribution Considerations During Crisis[1]
(Standard deviations in parentheses)

Period	**1997:Q2–2009:Q3**				
	Dependent Variable				
	dlog(stat_ endo_total))	dlog(stat_ endo_total)	dlog(stat_ endo_total)	dlog(stat_ endo_total)	dlog(stat_ endo_total)
	(1)	(2)	(3)	(4)	(5)
C	0.004 (0.0)	0.004 (0.0)	0.007 (0.0)	0.005 (0.0)	0.006 (0.0)
dlog(DEBT)	-0.020 (0.0)	-0.065 (0.0)**	-0.069 (0.0)**	-0.005 (0.0)*	-0.060 (0.0)**
dlog(G)	-0.037 (0.0)***	-0.038 (0.0)***	-0.037 (0.0)***	-0.037 (0.0)***	-0.038 (0.0)***
d(macro_index)	-0.006 (0.0)**	-0.006 (0.0)***	-0.007 (0.0)***	-0.006 (0.0)***	-0.006 (0.0)***
Elect	0.000 (0.0)	0.006 (0.0)	0.001 (0.0)	0.001 (0.0)	0.001 (0.0)
Residuals(-1)	-0.040 (0.0)***	-0.043 (0.0)***	-0.004 (0.0)***	-0.041 (0.0)***	-0.043 (0.0)***
dlog(GDP)	-0.101 (0.0)***	-0.089 (0.0)***	-0.087 (0.0)***	-0.092 (0.0)***	-0.090 (0.0)***
crisis*legal	0.002 (0.0)*				
crisis*elast		0.004 (0.0)***			
crisis*house_num			0.000 (0.0)***		
crisis*bottom40				0.011 (0.0)***	
crisis*top10					0.010 (0.0)***
AdjR²	0.21	0.23	0.24	0.22	0.23
D.W.	2.1	2.1	2.1	2.1	2.1

[1] Using world trade with one and two lags as an instrumental variable for GDP, and past values (with two lags) as instrumental variables for debt and for government spending; the regression includes the ELAST, LEGAL, dlog(HOUSE_NUM), GOV_TIME, TOP10 and BOTTOM40 variables, which were not significant and are not reported for space considerations.

high number of households, which allows for collecting more revenues. In the last two regressions I found that the revenues collected in crisis affect the bottom 40 percent and the top 10 percent of the income distribution in a similar way—i.e., changes made in times of crisis are not progressive.

5. SUMMARY AND CONCLUSIONS

This paper analyzes the cyclicality of statutory tax rates in Israel, using data that covers 87 percent of tax revenues. I found that while direct taxes are acyclical, indirect taxes (and in particular VAT) are changed procyclically. A pseudo-panel analysis based on the different types of taxation shows that the main reason for statutory tax changes is the existence of economic crises, as opposed to economic considerations like population or expenditure growth, legal considerations like the rigidity for changing statutory taxes, or income distribution considerations like the burden on the bottom income decile. A panel analysis for indirect sources of taxation confirms the significance of economic crises and the economic cycle as explanatory variables for adjusting indirect taxes.

A direction for further research is to check whether the pattern that I found for Israel concerning direct and indirect sources of taxation also occurs in a cross-section sample of countries, differentiating between developed and developing economies. For this purpose it is necessary to collect data on statutory tax rates over time. A first attempt in this direction, using annual data, was recently performed by Vegh and Vulletin (2012).

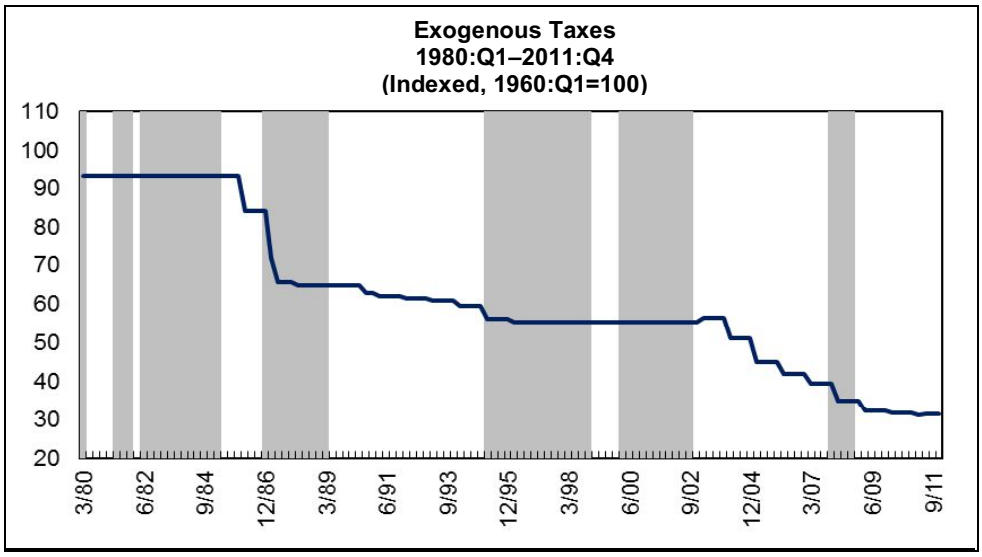
APPENDIX A – The Romer and Romer Methodology

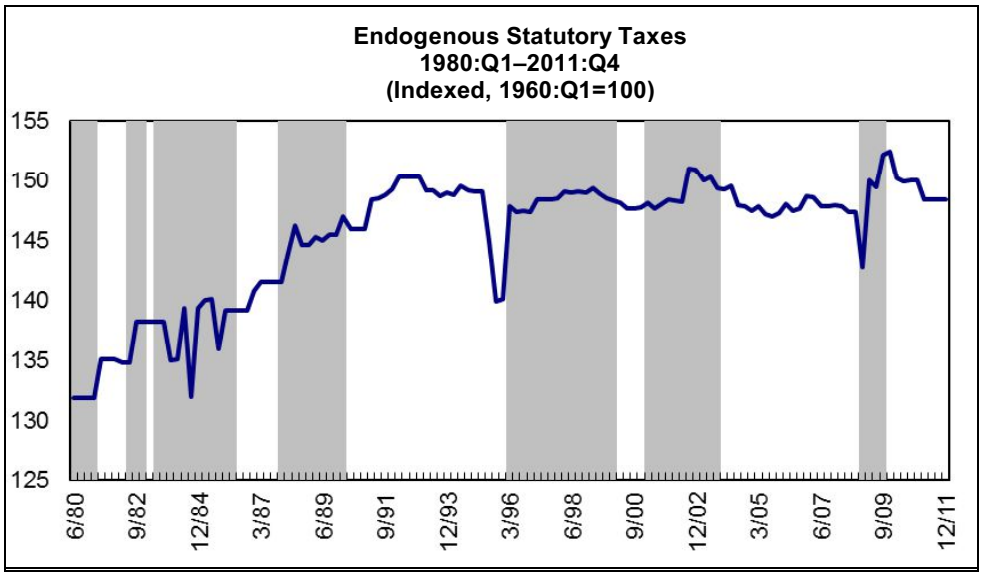
Following the Romer and Romer (2010) approach, I divided the statutory tax changes into two categories: exogenous and endogenous. In order to perform this task, I analyzed the Tax Revenues Report of the Ministry of Finance and the newspapers at the time of the decision, and I looked at the explanations given by policy makers. If the change was presented as a reform or a structural change, and it was previously announced (as opposed to a decision taken close to the implemented change), the statutory change was considered as exogenous; otherwise, it is considered as endogenous.

Table A.1
Main Exogenous Tax changes in Israel

Year	Statutory Change
1964	Reduction of income taxes to low income individuals
1974	Imposition of housing purchase tax (before there existed similar taxes)
1976	Imposition of the VAT
1981	Abolition of the wealth tax on housing, corporate property, and agricultural property
1986-1988	Reduction of income and corporate taxes
1990-1994	Reduction of corporate tax
1991-1993	Reduction of car taxes
1994-1996	Reduction of income and corporate taxes, addition of a reduced tax rate for low incomes in the National Insurance contributions.
2000	Abolition of the wealth tax
2003	Imposition of the capital gains tax
2004 onwards	Reduction in income and corporate taxes
2000-2006	VAT reduction
2006-2009	Reduction of car taxes
2009	Green tax reform (rise in car taxation)

The following charts show the endogenous and exogenous statutory changes in Israel. While endogenous taxes were changed in both directions, exogenous taxes were mainly reduced. From the chart it is evident that the reduction of income taxes since 2004 was exogenous. Another characteristic is that endogenous taxes were raised in the recessions (see 2001-2003 and 2009-2010).


Exogenous Taxes
1980:Q1–2011:Q4
(Indexed, 1960:Q1=100)
110
100
90
80
70
60
50
40
30
20
3/80
6/82
9/84
12/86
3/89
6/91
9/93
12/95
3/98
6/00
9/02
12/04
3/07
6/09
9/11


Endogenous Statutory Taxes
1980:Q1–2011:Q4
(Indexed, 1960:Q1=100)
155
150
145
140
135
130
125
6/80
9/82
12/84
3/87
6/89
9/91
12/93
3/96
6/98
9/00
12/02
3/05
6/07
9/09
12/11

APPENDIX B

I do not aim to test the impact of exogenous taxes on GDP, which requires a separate study. However, I perform Granger Causality tests in order to analyze the classification of endogenous and exogenous taxes. I expect exogenous taxes to Granger-cause the GDP, and that the GDP Granger-causes endogenous taxes.

Granger Causality Tests (two lags)

Null hypothesis	Period	F-statistic	Result
Exogenous Statutory Taxes and GDP			
Statutory_Tax_FULL does not Granger Cause log(GDP_SA)	1960:Q1-2011:Q4	2.2	We **cannot** reject the null hypothesis
log(GDP_SA) does not Granger Cause Statutory_Tax_FULL	1960:Q1-2011:Q4	0.9	We **cannot** reject the null hypothesis
Statutory_tax_EXOG does not Granger Cause log(GDP_SA)	1960:Q1-2011:Q4	3.2*	We **can** reject the null hypothesis
log(GDP_SA) does not Granger Cause Statutory_tax_EXOG	1960:Q1-2011:Q4	0.9	We **cannot** reject the null hypothesis
Endogenous Statutory Taxes and GDP			
dlog(Statutory_Tax_ENDO) does not Granger Cause dlog(GDP_SA)	1960:Q1-2011:Q4	0.9	We **cannot** reject the null hypothesis
dlog(GDP_SA) does not Granger Cause dlog(Statutory_Tax_ENDO)	1960:Q1-2011:Q4	0.3	We **cannot** reject the null hypothesis
dlog(Statutory_Tax_ENDO_INDIRECT) does not Granger Cause dlog(GDP_SA)	1960:Q1-2011:Q4	0.0	We **cannot** reject the null hypothesis
dlog(GDP_SA) does not Granger Cause dlog(Statutory_Tax_ENDO_INDIRECT)	1960:Q1-2011:Q4	3.0	We **can** reject the null hypothesis
dlog(Statutory_Tax_ENDO_DIRECT) does not Granger Cause dlog(GDP_SA)	1960:Q1-2011:Q4	0.9	We **cannot** reject the null hypothesis
dlog(GDP_SA) does not Granger Cause dlog(Statutory_Tax_ENDO_DIRECT)	1960:Q1-2011:Q4	0.1	We **cannot** reject the null hypothesis

Results show GDP causes mainly endogenous indirect taxation.

APPENDIX C – Long-Run Equations

Table C.1
Basic Framework (standard deviations in parentheses)

Period: 1987:Q2-2011:Q4	**log(stat_total)**	**log(stat_total)**	**log(stat_total)**
	(1)	(2)	(3)
C	6.0 (0.4)***	3.1 (0.3)***	6.4 (0.6)***
log(HP_ Government spending)	0.8 (0.2)***		0.1 (0.2)
log (population)	-0.7 (0.2)***		-0.1 (0.3)
log (capital stock)	-0.3 (0.1)***		-0.1 (0.1)*
log (Productivity)	-1.2 (0.1)***		-1.3 (0.1)***
HP_Gov. Sp. / GDP		1.9 (0.2)**	
Immigrants		0.5 (0.3)*	0.9 (0.3)***
Log(Debt)		0.2 (0.04)***	-0.1 (0.06)**
Gini		0.9 (0.3)***	
Log (FW)		-0.04 (0.02)**	
Trade_Partners_Income		0.02 (0.005)***	0.02 (0.006)***
Gov_Time		-0.01 (0.001)***	
AdjR²	0.89	0.91	0.91
D.W.	0.6	0.9	0.9
ADF	-4.1*	-4.8*	-5.2**

Table C.2
Cyclicality of Statutory Tax Rates: Long-Run Equation (standard deviations in parentheses)

Period	**1988:Q4 – 2011:Q4**					
	Dependent Variable					
	log(stat_ total)	log(stat_ dir)	log(stat_ ind)	log(stat_ endo_total)	log(stat_ endo_dir)	log(stat_ endo_ind)
	(1)	(2)	(3)	(4)	(5)	(6)
C	7.4 (0.5)***	9.8 (0.7)***	3.6 (0.8)***	4.5 (0.3)***	5.1 (0.4)***	2.6 (0.9)***
log(HP_ Government spending)	-1.1 (0.2)***	-1.1 (0.3)***	-1.0 (0.3)***	-0.5 (0.1)***	-0.2 (0.2)	-1.1 (0.2)***
log (population)	0.5 (0.2)**	-1.2 (0.3)***	3.1 (0.4)***	0.9 (0.1)***	-0.1 (0.2)	4.1 (0.6)***
log (capital stock)	0.5 (0.1)***	1.0 (0.1)***	-0.2 (0.1)*	0.06 (0.04)*	0.2 (0.05)***	-0.1 (0.1)
log (GDP)	-0.6 (0.1)***	-0.3 (0.2)**	-0.9 (0.2)***	-0.3 (0.1)***	-0.02 (0.1)	-1.5 (0.3)***
log (Debt)	-0.1 (0.04)**	-0.09 (0.06)	-0.1 (-0.07)*	-0.1 (0.03)***	-0.1 (0.03)**	-0.2 (0.08)**
log (Immigration)	0.02 (0.004)***	0.008 (0.005)	-0.04 (0.006)***	0.003 (0.002)	-0.01 (0.003)***	-0.04 (0.007)***
Gini	2.5 (0.3)***	3.8 (0.4)***	0.7 (0.5)	-0.005 (0.2)	-0.3 (0.2)	-0.5 (0.6)
Trade Partners Inc.	0.03 (0.004)***	0.02 (0.005)***	0.03 (0.006)***	0.008 (0.002)***	0.005 (0.003)	0.03 (0.006)***
AdjR^2	0.96	0.96	0.86	0.40	0.83	0.84
D.W.	1.1	0.8	1.6	1.1	0.8	1.7
ADF	-5.9***	-4.7	-7.6***	-6.1***	-4.6	-8.2***

Table C.3
Specific Indirect Taxes: Long-Run Equation (standard deviations in parentheses)

Period	**1988:Q1 – 2011:Q4**			
Dependent Variable				
	log(vat)	log(gasoline)	log(vat_endo)	log(gasoline_endo)
	(1)	(2)	(3)	(4)
C	0.5	6.6	1.8	7.7
	(0.8)	(2.4)***	(0.6)***	(2.4)***
log(HP_Government Spending)	-0.6	0.7	-0.9	1.6
	(0.3)*	(0.9)	(0.3)***	(0.9)*
log (population)	2.2	6.2	2.9	5.6
	(0.4)***	(1.3)***	(0.3)***	(1.3)***
log (capital stock)	0.002	0.5	-0.1	0.3
	(0.1)	(0.3)	(0.08)*	(0.3)
log (GDP)	-0.9	-5.5	-0.8	-5.7
	(0.2)***	(0.7)***	(0.1)***	(0.7)***
log (Debt)	-0.2	-1.8	-0.2	-1.8
	(0.1)**	(0.2)	(0.05)***	(0.2)***
log (Immigrants)	0.03	0.06	0.03	0.06
	(0.006)***	(0.02)***	(0.005)***	(0.02)***
Gini	1.5	-3.4	-0.06	-3.7
	(0.5)***	(1.6)**	(0.4)	(1.6)**
	0.02	0.03	0.01	0.03
	(0.006)***	(0.02)*	(0.005)***	(0.02)*
AdjR²	0.71	0.73	0.78	0.76
D.W.	0.8	1.4	0.9	1.4
ADF	-4.6	-7.0***	-5.2**	-7.1***

Table C4
Pseudo-Panel Analysis: Long-Run Equation (standard deviations in parentheses)

Period	**1997:Q1 – 2009:Q3**					
	Dependent Variable					
	log(stat_ total)	log(stat_ dir)	log(stat_ ind)	log(stat_ endo_total)	log(stat_ endo_dir)	log(stat_ endo_ind)
	(1)	(2)	(3)	(4)	(5)	(6)
C	5.529 (0.3)***	5.783 (0.4)***	5.322 (0.2)***	5.128 (0.1)***	4.591 (0.1)***	9.843 (0.2)***
Crisis	0.019 (0.0)***	0.018 (0.0)***	0.020 (0.0)***	0.008 (0.0)***	0.004 (0.0)***	0.006 (0.0)
log(debt)	0.500 (0.0)***	0.533 (0.0)***	0.400 (0.0)***	0.011 (0.0)*	-0.090 (0.0)***	0.653 (0.1)***
log(G)	-0.240 (0.0)**	-0.313 (0.0)***	-0.134 (0.0)***	-0.012 (0.0)	0.004 (0.0)	0.015 (0.0)
Elast	0.010 (0.0)	0.017 (0.0)	0.000 (0.0)	-0.001 (0.0)	-0.001 (0.0)	-0.002 (0.0)
log(house_ num)	-0.009 (0.0)*	-0.013 (0.0)*	-0.001 (0.0)	0.000 (0.0)	0.000 (0.0)	0.002 (0.0)
Legal	0.000 (0.0)	0.000 (0.0)	0.000 (0.0)	0.000 (0.0)	0.000 (0.0)	0.000 (0.0)
macro_ind ex	0.008 (0.0)*	0.016 (0.0)***	-0.005 (0.0)	-0.006 (0.0)***	-0.013 (0.0)***	0.048 (0.0)***
Elect	0.001 (0.0)	0.001 (0.0)	0.003 (0.0)	0.004 (0.0)***	-0.001 (0.0)	0.030 (0.0)***
top10	0.101 (0.1)	0.170 (0.1)*	-0.013 (0.0)	-0.010 (0.0)	-0.008 (0.0)	-0.029 (0.0)
bottom40	0.083 (0.0)	0.145 (0.1)*	-0.013 (0.0)	-0.009 (0.0)	-0.007 (0.0)	-0.026 (0.0)
gov_time	-0.012 (0.0)***	-0.016 (0.0)***	-0.005 (0.0)***	0.000 (0.0)**	0.001 (0.0)***	0.004 (0.0)***
log(GDP)				-0.004 (0.0)	0.054 (0.0)***	-0.401 (0.0)***
AdjR²	0.90	0.88	0.84	0.45	0.91	0.84
D.W.	0.9	0.9	1.1	0.9	0.8	1.1

APPENDIX D – Panel Analysis of Indirect Endogenous Tax Rates

I have shown that endogenous direct and indirect tax rates behave differently against the cycle. Thus, running an unconstrained panel analysis results in insignificant behavior against the cycle and in a low R squared.

Thus, in this appendix I build a panel analysis that is based only on endogenous indirect tax rates; i.e., the dependent variable is formed by the seven categories of indirect taxation as shown in Table 1. In a panel analysis taxation sources are not independent, and thus a correction for the co-integration framework is needed, along the lines of Pesaran (2006). In order to enrich the historical analysis, I choose all possible independent variables that go back to 1961:Q1.

I then run a long-run panel equation, first assuming that taxes are independent (see Equation (1)), and then correcting for dependence using the methodology suggested by Pesaran (2006) (see Equation (2)). This correction requires adding the average values of the dependent variable and independent variables, as explained by Eberhardt and Bond (2009).

After obtaining the long-run relationships I run short-run equations that include the change in the same variables, including 2 lags, and the residual with one lag.

Table D.1 shows the long-run regressions with the Im, Pesaran and Shin (IPS) W statistic, which turned out to be significant at 1 percent.

Table D.2 shows the short-run regressions. The lagged residual is significant. The crisis dummy is significant at 1 percent, and the coefficient that testifies to procyclical policy continues to be significant in this analysis.

Table D.1
Panel Analysis for Endogenous Indirect Taxes—Long-Run Equation (standard deviations in parentheses)

Period	**1961:Q2–2011:Q4**		**1827 Observations**	
Dependent Variable				
	log(endo-genous indirect)	log(endo-genous indirect)	log(endo-genous indirect)	log(endo-genous indirect)
	(1)	(2)	(3)	(4)
C	2.1 (0.2)***	2.1 (0.04)***	2.1 (0.2)***	2.1 (0.04)***
Crisis	-0.1 (0.004)***	0.0 (0.0)		
Crisis2			-0.04 (0.004)***	0.004 (0.001)***
log (Debt)	0.08 (0.009)***	-0.03 (0.004)***	-0.1 (0.009)***	-0.03 (0.004)***
Macro Index	0.002 (0.002)	-0.03 (0.004)***	-0.005 (0.002)*	-0.03 (0.004)***
log (GDP)	0.3 (0.03)***	-0.03 (0.008)***	0.3 (0.03)***	-0.02 (0.004)***
log (world Trade)	-0.04 (0.02)*	-0.02 (0.004)***	-0.05 (0.02)**	-0.02 (0.004)***
Trade Partners Income	-0.02 (0.003)***	0.02 (0.03)***	-0.01 (0.003)***	0.02 (0.03)***
War	0.007 (0.008)	-0.03 (0.003)***	0.02 (0.008)***	-0.03 (0.003)***
Average Independent		0.5 (0.002)***		0.6 (0.002)***
Average Dependent		0.4 (0.06)***		0.4 (0.06)***
AdjR²	0.85	0.99	0.85	0.99
D.W.	0.1	0.1	0.1	0.1
W Statistic (IPS)	-3.8***	-5.1***	-3.8***	-5.5***

Table D.2
Panel Analysis for Endogenous Indirect Taxes—Short-Run Equation[(1)]
(Standard deviations in parentheses)

Period	**1962:Q1–2011:Q4**		**1800 Observations**	
Dependent Variable				
	dlog(endogenous indirect)	dlog(endogenous indirect)	dlog(endogenous indirect)	dlog(endogenous indirect)
	(1)	(2)	(3)	(4)
C	0.002	0.002	0.006	0.006
	(0.001)	(0.001)	(0.1)***	(0.1)***
Crisis	0.01	0.01		
	(0.001)***	(0.001)***		
Crisis2			0.003	0.003
			(0.0016)**	(0.0016)*
dlog (Debt)	-0.09	-0.04	-0.06	0.002
	(0.03)***	(0.03)	(0.003)**	(0.03)
d(Macro Index)	-0.005	-0.006	-0.005	-0.008
	(0.003)*	(0.003)**	(0.003)*	(0.003)***
dlog (GDP)	-0.07	-0.06	-0.08	-0.08
	(0.03)**	(0.03)**	(0.03)***	(0.03)***
dlog (world Trade)	-0.06	-0.06	-0.07	-0.07
	(0.03)*	(0.03)*	(0.03)**	(0.03)**
d(Trade Partners Income)	-0.0004	-0.0001	0.0008	0.0005
	(0.0)	(0.0)	(0.0009)	(0.001)
War	-0.01	-0.01	-0.01	-0.01
	(0.003)***	(0.003)***	(0.003)***	(0.003)***
War(-1)	0.01	0.01	0.01	0.02
	(0.003)***	(0.003)***	(0.003)***	(0.003)***
Residual(-1)	-0.02	-0.1	-0.03	-0.2
	(0.007)***	(0.005)***	(0.006)***	(0.05)***
AdjR^2	0.06	0.06	0.05	0.04
D.W.	1.9	1.9	1.9	1.9

(1) All the regressions include one and two lags of dlog(gdp), dlog(world trade) and d(trade partners income).

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