Fiscal policy and saving under distortionary taxation

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Abstract

An empirical investigation of the effects of fiscal policy on saving is carried out using Israeli data, which display large variability in both the saving rate and the fiscal variables. The framework is a small open economy model with distortionary taxation. The theoretical analysis of the partial effect of each fiscal variable on the national saving rate takes into account the necessary adjustment in future taxes. The present model predicts, for example, that the income-tax rate should have a negative effect on saving – in contrast to the Keynesian view – and that transfer payments and interest payments on the public debt should have positive effects – in contrast to the Ricardian view under lump-sum taxation. The empirical results partly support the predictions of the model – in particular for the income-tax rate. The methodology consists of two steps. First, quantitative predictions are obtained via simulation, and then the simulated effects are compared with the estimated coefficients. © 1998 Elsevier Science B.V. All rights reserved.

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1. Introduction

The national saving rate in Israel is highly volatile, ranging from 13\% to 28\% during 1960–1994 (Fig. 1). This is consistent with a model of a small open economy subject to large exogenous shocks. The role of saving as a shock

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absorber can be observed, for example, during and after the main war years, the Six Days War in 1967 and the Yom Kippur War at the end of 1973, when the saving rate declined dramatically. The corresponding increases in defense spending as a share of GDP can be observed in Fig. 2. Another example is the 1984–1986 episode, when the high saving rates were accompanied by unusually large unilateral transfers from abroad to the public sector, as shown in Fig. 3. In 1985 and 1986, these transfers reflect economic assistance from the US.
government, following the drastic economic stabilization program of July 1985. Tax rates also underwent dramatic changes during the 1960–1994 sample, as expected from the development of the other fiscal variables. This is shown in Figs. 4 and 5, which display income and consumption tax rates, respectively. Interestingly, the consumption tax rate shows sharp swings, e.g. in 1981, which seem unrelated to financing needs.

The large variability of the fiscal variables and the small open economy character of the Israeli economy – which imply that saving should be very sensitive to shocks – make it a potentially interesting case for an econometric
Fig. 5. Consumption tax rate.

The present paper pursues this line.

The theoretical framework used in this analysis is a small open economy model. Fiscal policy includes an adjustment mechanism, which means that the partial effect of each current fiscal variable is analyzed in conjunction with a rule for distortionary tax adjustment, as in Dotsey (1994). This implies that the current effect of an increase in spending should also reflect the expectation of a corresponding future increase in tax rates. The fiscal adjustment rule adopted here is income-tax smoothing with a white noise error. Income-tax smoothing is arbitrary in the present context. The idea, of course, rests on Barro (1979), where tax smoothing minimizes the deadweight loss from taxation. The error in tax smoothing is dictated by econometric considerations. A consumption tax is also incorporated, along with a calibrated rule for the tax structure.

To illustrate the econometric implications of the present framework, consider a regression of the national saving rate on government spending variables, income and consumption tax rates, and relevant non-fiscal variables. Take, for example, the coefficient of the income-tax rate. The present analysis predicts that this coefficient should be negative, in contrast to the standard Keynesian view, in which higher income taxes reduce consumption and increase the national saving rate. Basically, the negative effect can be explained as follows: given that all other fiscal variables are held constant, an exogenous income-tax increase (an

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1 An early analysis of the way fiscal policies affect macroeconomic outcomes under the neoclassical approach, which the present paper follows, is Aschauer and Greenwood (1985), Kotlikoff (1984), Boskin and Kotlikoff (1985), and others focus on the saving rate.
error in tax-smoothing) should be temporary.\(^2\) In response, current labour effort (and hence output) are low relative to future labour and output, inducing a decline in current national saving.

Another example is the coefficient of government transfers to the public (or of interest payments on the domestic public debt). This coefficient should be zero if one considers only the direct effect of transferring funds from one sector of the economy to another. However, since current tax rates are included in the regression, and are thus held constant, transfers today signal a future increase in the smoothed income-tax rate. This depresses expected future income because of lower current investment and lower future labour. Correspondingly, current income is relatively high, and hence it is accompanied by higher saving, implying that transfers should have a positive coefficient.

The present econometric analysis of fiscal effects on savings is related to the empirical literature on the Ricardian equivalence, surveyed in Seater (1993). In a typical regression equation in this literature, of consumption on government spending, tax rates, the public debt, etc., Ricardian equivalence is rejected if the debt has a significant coefficient. In the present framework, the partial effect of the debt (or interest payments) on saving, holding constant the current tax rates, is expected to be positive because it signals a future tax rate increase.

The paper is organized as follows. Section 2 presents the model and Section 3 discusses the empirical equation implied by this framework. The methodology followed thereafter consists of two steps. First, the model is calibrated and simulated in Section 4 in order to obtain predictions for the parameter values in the empirical equation. Then the model is estimated in Section 5 and the empirical results are compared with the model’s predictions. Section 6 concludes the paper.

2. The model

2.1. The economic environment

Consider a competitive small open economy with a private sector, composed of a large number of identical agents, and a government. Capital is mobile internationally, but labour is not.

The utility function of the representative household is

\[
E_0 \sum_{i=0}^{\infty} \beta^i U(C_t, L_t), \quad 0 < \beta < 1
\]

\(^2\)More precisely, the expected future tax rate should be slightly lower than the rate before the change.
with
\[ U(C_t, L_t) = \theta \ln C_t + (1 - \theta) \ln (1 - L_t), \quad 0 < \theta < 1, \]
where \( C_t \) and \( L_t \) represent consumption and labour, respectively.

The production of final output, \( Y_t \), requires the services of labour and capital, \( K_{t-1} \), predetermined from the previous period. The production technology is then described by
\[ Y_t = F(K_{t-1}, L_t, \tau_t) = \exp(\zeta_t)K_{t-1}^{1-\zeta}L_t^{1-\zeta}, \quad 0 < \zeta < 1, \]
where \( \zeta_t \) is a stochastic productivity shock.

Capital accumulation depends on gross investment, \( I_t \), and on the depreciation rate \( \delta \). The capital evolution equation is then:
\[ K_t = (1 - \delta)K_{t-1} + I_t. \]

Changing the capital stock involves adjustment costs of the form
\[ \Phi_t = \Phi(K_t, K_{t-1}) = \frac{\phi}{2}[(K_t - \zeta K_{t-1})/K_{t-1}]^2, \quad \phi, \zeta > 0. \]

The economy faces a perfect world capital market, where borrowing and lending at time \( t \) can be undertaken at the constant real interest rate \( r = 1/\beta - 1 \). Given no capital controls, the domestic real interest equals \( r \). The net stock of foreign bonds in the economy at the beginning of period \( t \) is \( B_{t-1} \), the sum of the private component \( B^p_{t-1} \) and the government’s component \( B^g_{t-1} \). There are also domestic bonds: the private sector holds \( D^p_{t-1} \) of these bonds, and the public sector holds \( D^g_{t-1} = -D^p_{t-1} \).

The government levies taxes on income at rate \( \tau^i_t \), and on consumption at the rate \( \tau^c_t \). Government income also includes \( UT^g_t \), unilateral transfers from abroad. Government expenditures consist of purchases of goods and services, \( G_t \), which have the permanent component \( G^p_t \) and the transitory component \( G^t_t \), and lump-sum transfers to the public, \( V_t \). No government investment is assumed. Government saving is then given by
\[ S^g_t = \tau^i_t Y_t + \tau^c_t C_t + UT^g_t + r(D^p_{t-1} + B^g_{t-1}) - G_t - V_t. \]

Private saving is, correspondingly
\[ S^p_t = (1 - \tau^i_t)Y_t + UT^p_t + V_t + r(D^p_{t-1} + B^g_{t-1}) - (1 + \tau^c_t)C_t, \]
where \( UT^p_t \) are unilateral transfers from abroad to the private sector.

National saving is then obtained by adding Eqs. (2.5) and (2.6):
\[ S_t = Y_t + UT^p_t + UT^g_t + r(B^p_{t-1} + B^g_{t-1}) - C_t - G_t. \]
Defining $g_{it}^{tr} \equiv G_{it}^{tr}/Y_t$, $g_{it}^{tr} \equiv G_{it}^{tr}/Y_t$, etc., the following variables are considered exogenous and governed by the autoregressive processes:

$$
g_{it}^{tr} = (1 - \rho_1)g_{it}^{tr} + \rho_1 g_{i,t-1}^{tr} + \lambda_{1t}, \quad \rho_1 = 1,$$

$$
g_{it}^{tr} = (1 - \rho_2)g_{it}^{tr} + \rho_2 g_{i,t-1}^{tr} + \lambda_{2t}, \quad 0 < \rho_2 < 1,$$

$$
v_t = (1 - \rho_3)v_{t-1} + \rho_3 v_t + \lambda_{3t}, \quad 0 < \rho_3 < 1,$$

$$
vt = (1 - \rho_4)vt + \rho_4 vt - 1 + \lambda_{4t}, \quad 0 < \rho_4 < 1,$$

$$
u_{it-1} = (1 - \rho_5)u_{it-1} + \rho_5 u_{it-1} + \lambda_{5it}, \quad 0 < \rho_5 < 1$$

and

$$
z_t = \rho_6 z_{t-1} + \lambda_{6t}, \quad 0 < \rho_6 < 1.$$

A time trend in the productivity factor $z_t$, and hence in output, does not affect saving, and hence is not included. It is assumed that $\{\lambda_{1t}, \ldots, \lambda_{6t}\}$ are serially independent with zero mean.

### 2.2. Equilibrium

#### 2.2.1. Government behaviour

The government is not an optimizing entity in this model. Its behaviour is characterized as follows. First, it faces the intertemporal budget constraint:

$$
\sum_{t=0}^{\infty} R_t [\tau_i^t Y_t + \tau_i^t C_t + U T_{it} - G_t - V_t] + (1 + r)(D_{t-1}^g + B_{t-1}^g) = 0, \quad (2.8)
$$

where $R_0 = 1$ and $R_{j+1} = R_j(1 + r)$.

The next issue is the specification of the tax structure, which should be consistent with its actual behavior. One theoretical possibility is that income and consumption tax rates are smoothed jointly, given the innovations in other fiscal variables. This would lead to a tight positive correlation between the two tax rates. Figs. 4 and 5 show these two tax rates (its construction is reported in Section 4) are not tightly positively correlated. On the contrary, the correlation coefficient is $-0.26$. Hence, joint smoothing is not a realistic specification. The negative correlation suggests that if one tax rate is changed exogenously (i.e. not because of budget finance needs), the other moves in the opposite direction to comply with the intertemporal budget constraint. Historical evidence suggests that it is the consumption tax rate that evolves exogenously, i.e. in a way that it is not dictated by spending needs. For example, the large decline in the consumption tax in 1981, shown in Fig. 5, was due to a massive increase in consumption subsidies and a decrease in indirect taxation. The purpose of this
policy was peculiar: to reduce the inflation rate (130% in 1980) by lowering the cost of consumption to the public.\(^3\) Fig. 5 also shows that starting in 1976 the consumption tax has an upward trend, which, for the reason mentioned above was interrupted in 1981, and has accelerated since then. This trend is due to the introduction of a value-added tax in 1976, which is levied only on consumption production, following its adoption in European countries. This event can also be treated as exogenous to current financing needs; it reflects an attempt to reduce overall tax distortion.\(^4\) Econometric evidence also indicates that taxation income does appear to be related to government spending needs, while consumption taxation does not.\(^5\) Furthermore, there is some evidence of income-tax smoothing (see footnote 6). We therefore adopt the following two assumptions:

1. \(\tau^c_t\) is exogenous, and treated in the same way as the other exogenous variables:
   \[
   \tau^c_t = (1 - \rho_\gamma)\hat{\tau}^c + \rho_\gamma \lambda_t, \quad 0 < \rho_\gamma < 1.
   \]
2. \(\tau^v_t\) is smoothed with a random error. This implies that if \(\hat{\tau}^v_t\) is the smooth income-tax rate satisfying Eq. (2.8), given time-\(t\) information, the current tax rate \(\tau^v_t\) equals \(\tau^v_t = \eta_t\), where \(\eta_t\) is white noise. Correspondingly, the planned \((\tau^v_t)^* = \tau^v_{t+1} = \tau^v_{t+2}, \ldots\) is adjusted in the opposite direction to \(\eta_t\) (Note that the computation of \(\tau^v_t\) and \((\tau^v_t)^*\) should take into account their effects on the Y’s in Eq. (2.8)). The econometric importance of the error is elaborated in Section 3. This tax rule is arbitrary in the present context, although

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\(^3\)"The government’s policy in 1981 was aimed at cooling inflation through direct action on the price front (subsidies and taxes) and by dampening inflationary expectations”. ‘Bank of Israel, Annual Report 1981, May 1982, p. 84.’ Inflation did decline from 130% in 1980 to 117% in 1981, but increased again in 1982 to reach 370% in 1984.

\(^4\)"The law proposed is part of a proposed reform of the tax system in Israel. In the framework of this reform, direct taxation will be reduced, and in particular the income tax, and the tax base of direct and indirect taxes will be enlarged”. From the introduction to The Value Added Tax Law, 1975, Law Proposal # 1178 (authors’ translation from Hebrew).

\(^5\)In the following regressions \(g\) is defined as the sum of all current government spending less \(ut^c\):

\[
\tau^c_t = -0.85 + 0.13g_t + 0.40g_{t-1}, \quad R^2 = 0.73,
\]

\[\begin{align*}
( -0.33) & \quad (0.94) \\
(3.10)
\end{align*}\]

\[
\tau^v_t = -0.23 - 0.20g_t - 0.06g_{t-1}, \quad R^2 = 0.18,
\]

\[\begin{align*}
( -5.53) & \quad (0.84) \\
(0.28)
\end{align*}\]

where \(t\)-statistics are in parentheses. Income taxation is found to be related to budget financing, and consumption taxation is not.
consistent with the behaviour of the income-tax rate in the Israeli data. Both the current $\tau^r_t$ and the planned $(\tau^r_t)^*$ are public information, and hence $(\tau^r_t)^*$ represents the expected future income-tax rate as of time $t$.

2.2.2. The representative private sector agent

The dynamic programming problem facing the representative agent is

$$V[\tau^r_t(\tau^r_t)^*, \tau^r_t, ut^p_t, B^p_{t-1}, D^p_{t-1}, K_{t-1}]$$

$$= \max_{C_t, L_t, B^p_t, D^p_t, K_t} \{ U(C_t, L_t) + E_t V[\tau^r_{t+1},(\tau^r_{t+1})^*, \tau^r_{t+1}, ut^p_{t+1}, B^p_{t+1}, D^p_{t+1}, K_t] \}, \quad (2.9)$$

subject to

$$C_t = \frac{1}{1 + \tau^r_t} \left[ F(K_{t-1}, L_t, z_t)(1 - \tau^r_t + v_t + ut^p_t) + (1 - \delta)K_{t-1} - K_t - \phi_t \right]$$

$$+ (1 + r)(D^p_{t-1} + B^p_{t-1}) - (D^p_t + B^p_t), \quad (2.10)$$

and the solvency constraint $\lim_{t \to \infty} (D^p_t + B^p_t)/R_t = 0$.

Note that $(\tau^r_t)^*$ is a state variable, representing current information about the smooth income-tax rate planned for period $t + 1$ onwards.

2.2.3. Summary

The variables in the model can be clustered in three groups:

1. Exogenous variables: $g^p_t, g^r_t, v_t, ut^p_t, ut^p_t, z_t, \tau^r_t$ and $\tau^r_t$ (the latter because of error $\eta_t$)
2. Endogenous, but predetermined state variables: $B^p_{t-1}, B^p_t, D^p_{t-1}$ (or $-D^p_{t-1}$) and $K_{t-1}$.
3. Endogenous variables: $C_t, L_t, B^p_t, B^p_t, D^p_t$ (or $-D^p_t$) and $K_t$.

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Changes in the tax rate should be white noise under exact tax-smoothing. In the presence of error $\eta_t$, which is corrected in the following period, changes in the tax rate should have a small negative serial correlation. The regression results obtained using annual data for the 1960–1994 period are

$$\Delta \tau^r_t = 0.41 \pm 0.02 \quad \Delta \tau^r_{t-1}$$

$$0.83 \quad 0.09$$

($t$-statistics in parentheses). This evidence seems to support exact tax smoothing rather than smoothing with an error. However, given that the tax reversal is theoretically very small, this regression does not contradict the assumption of an error.
Dividing the national saving Eq. (2.7) by $\upsilon_t$, the national saving rate (defined as national saving as a percentage of GDP) can be expressed as

$$s_t = 1 + ut_t^p + ut_t^q + \frac{r(B_{t-1}^p + B_{t-1}^q) - C_t}{F(K_{t-1}, L_t, \zeta_t)} - g_t,$$

(2.11)

where $C_t$ and $L_t$ depend on the variables in (1) and (2) above.

3. The empirical equation

The formulation of the regression equation for the national saving rate is based on a linearization of Eq. (2.11), using the exogenous and predetermined variables as independent variables. For convenience, the independent variables are divided into two groups: fiscal – i.e. the components of government saving; and nonfiscal:

$$s_t = x_0 + x_1\gamma_t^p + x_2\gamma_t^q + x_4\tau_t + x_5\tau_t^q + x_6\upsilon_t^q + x_7\upsilon_t + x_8\upsilon_t^q - 1 - g_t,$$

(3.1)

where $x_t = \{ut_t^p, \zeta_t, B_{t-1}, K_{t-1}\}$ is the vector of nonfiscal variables, $\gamma$ is the corresponding vector of coefficients and $\epsilon_t$ is an error term, which is discussed below. Given the long-run trend present in the actual data, the state variables $B_{t-1}, D_{t-1}, B_{g-1}$ and $K_{t-1}$ are expressed as ratios to lagged output, i.e., $b_{t-1}^p = B_{t-1}/\upsilon_{t-1}$, etc.7

Note that the coefficient on each fiscal variable captures a partial effect with respect to the other current budget variables, which are held constant by virtue of their inclusion in the equation. However, future budget variables are not held constant. This implies, for example, that the coefficients of the spending variables reflect two combined effects: (a) the direct effect of the change in current spending, holding $\tau_t^q$ and the other current budget variables constant, and (b) an indirect effect of the expected adjustment of $\tau_t^q$ to the new level.

The fact that the other current fiscal variables are held constant implies that each coefficient $x$ in Eq. (3.1) refers to the short-run effect – i.e. the impact in the same period. The dynamic effect, or ‘impulse response’ pattern, can be computed, in principle, by adding the effects of the resulting evolution of the income-tax rate and other state variables.8

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7 Eq. (3.1) is interpreted as a linearization of Eq. (2.11) at the steady state. This is important for the simulation of the coefficient values in Section 4, where the simulation was performed from the steady state.

8 This implies, of course, that Eq. (3.1) by itself cannot be used to compute the long-run effect of altering only one of the fiscal variables. In the long run, the fiscal variables are linked by a zero sum constraint.
Note that the error in income-tax smoothing has an important implication for the interpretation of \( z_4 \) (the coefficient of \( \tau^r_t \)). If there were exact tax smoothing, \( \tau^r_t \) would be an exact (but, in general, nonlinear) function of the other fiscal variables. In this case, \( z_4 \) could not be interpreted as a partial derivative because \( \tau^r_t \) would vary only if there is a change in some other fiscal variable. The error in tax smoothing breaks this exact relationship between \( \tau^r_t \) and the other fiscal variables, allowing for a partial effect interpretation of the income-tax rate coefficient.

Finally, consider error \( \varepsilon_t \). The model says nothing on the properties of this term, which reflects many macroeconomic factors omitted from the model – such as shifts in the terms of trade, financial changes, technological progress other than that captured by \( z_t \), immigration, etc. The high likelihood that \( \varepsilon_t \) is serially correlated raises the following econometric problem. The fiscal variables are strongly serially correlated, as can be seen in Figs. 2–5. If both the fiscal variables and the error term follow AR processes, they are weighted infinite sums of past innovations. Hence, for the fiscal variables to be exogenous, i.e. uncorrelated with \( \varepsilon_t \), innovations to these policy decisions should be independent at all leads and lags from the innovations in factors represented by the error term. This is obviously a very strong assumption. Finding instrumental variables is highly problematic because they, too, should be serially uncorrelated – in order not to be subject to the same problem as the fiscal variables, and uncorrelated with the array of factors represented by \( \varepsilon_t \). Lagged independent variables are not valid instruments either under serial correlation. Furthermore, since the theory implies that saving serves as a shock absorber, the effects of the independent variables should take place contemporaneously, and hence lagged variables are theoretically not useful instruments. The simultaneity problem can be alleviated, however, if Eq. (3.1) is estimated in first differences

\[
\Delta s_t = \alpha_1 \Delta g^r_t + \alpha_2 \Delta g^l_t + \alpha_3 \Delta v_t + \alpha_4 \Delta \tau^r_t + \alpha_5 \Delta \tau^l_t + \alpha_6 \Delta u_t^g + \alpha_7 \Delta (rd^q_t - 1) + \alpha_8 \Delta (rb^q_t - 1) + \gamma \Delta x_t + \Delta \varepsilon_t,
\]

where \( \Delta s_t = s_t - s_{t-1} \), etc. If \( \Delta \varepsilon_t \) turns out to be serially uncorrelated, the exogeneity requirement in this case is much weaker: independence of the current changes in the regressors from the current innovation in \( \varepsilon_t \). If \( \Delta \varepsilon_t \) turns out to have positive serial correlation, further correction for serial correlation is necessary, not only for the usual reason, but also, as explained above, to alleviate a possible simultaneity bias. Negative serial correlation in \( \Delta \varepsilon_t \) would suggest over-differencing.

\[\text{Note that if the regressors in levels are correlated with the true } \varepsilon_t, \text{ the residuals from the regression in levels will probably not reflect the true serial properties of } \varepsilon_t.\]
4. Determination of the saving rate

This section provides quantitative predictions for the coefficients in the saving rate equation (3.2) by simulating a realistically calibrated version of the model. The procedure adopted is as follows: (a) the model is calibrated to Israeli data; (b) using the deterministic version of the model, all the exogenous and predetermined variables are shifted one at a time by one unit, using the steady state as the initial situation. The resulting changes in the current saving rate correspond to the coefficients in Eq. (3.2), or Eq. (3.1), where the linearization of Eq. (2.11) is taken at the steady state. In this computation, expected future income-tax rates are adjusted to satisfy the intertemporal budget constraint of the government, and the expected future path of each exogenous variable depends on its autocorrelation coefficient.\(^\text{10}\)

4.1. The data

The sample used in the calibration of the model in this section and in its estimation in Section 5 below, is composed of annual Israeli data from 1960 to 1994. The following empirical counterparts to the theoretical variables are constructed, unless otherwise specified, by dividing nominal values by nominal GDP.

\begin{align*}
s & \quad \text{gross national saving}, \\
g^{\text{pr}} & \quad \text{no empirical counterpart found. This variable is nevertheless included in the simulation for comparison purposes}, \\
g^{\text{tr}} & \quad \text{in the econometric implementation this variable was separated into two components of government consumption:} \\
g^{\text{def}} & \quad \text{defense expenditures}, \\
g' & \quad \text{civilian spending on goods and services}, \\
v & \quad \text{gross government transfer payments to the private sector (excluding interest payments on the domestic debt, less import duties and property taxes (these are not included in the calculation of income and consumption tax rates),} \\
\tau^v & \quad \text{income-tax rate, calculated by dividing the revenue from income taxation and social insurance taxes by national income at factor prices,}
\end{align*}

\(^{10}\) An alternative route would be to simulate the model stochastically, producing artificial series for all the variables involved, and then to perform the regression of Eq. (3.2). The main complication in this procedure is to incorporate the intertemporal budget constraint of the government, and the adjustment of future taxes.
consumption-tax rate, computed as the ratio of revenue from indirect taxes on domestic production to total consumption before tax. This revenue includes a small component of taxes on domestically-produced investment goods. Import duties, however, include a large component from investment goods, and were therefore excluded.

unilateral transfers from abroad to the public sector,

net interest payments on the domestic public debt (current nominal interest payments multiplied by current nominal GDP multiplied by the gross growth rate of real GDP),

net interest payments on the external public debt (computed similarly to rd_{t-1}^{-1}),

unilateral transfers from abroad to the private sector,

net capital stock in the business sector (stock in constant prices at the end of t – 1, divided by real GDP at t – 1),

‘Solow residual’ computed from the production function in Eq. (2.3), the gross product of the business sector, k_{t-1} and hours of work in the business sector,

private net foreign assets.

4.2. Calibration

Values must be assigned to the following parameters and initial conditions:

Preferences: β and θ,

Technology: α, δ, φ, and ζ,

Exogenous variables: g, z, x, ut^{g} and ut^{p} (determining together v), p_{2}, ..., p_{7},

World interest rate: r,

Initial state variables: b_{t-1}, g_{t-1}, d_{t-1}, (k_{t-1} follows in the steady state from the parameter values and the other state variables).

Standard values are assigned to the parameters:

β = 0.96, r = 1/β - 1,

α = 0.35, capital share in gross income,

δ = 0.08.

The rest of the parameter values are determined as follows.

θ = 0.75.

11 What needs to be computed is the actual counterpart of rd_{t-1}^{-1} = rD_{t-1}^{x}/Y_{t-1}, while the available data on nominal interest payments can be expressed as rD_{t-1}^{x}P, where P is the current price level. Hence, the data transformation has the form:

\[
\frac{rD_{t-1}^{x}P}{PY} \frac{Y}{Y_{t-1}} = rb_{t-1}^{g}.
\]
This value is determined so that the compensated real wage elasticity of labour supply at the steady state equals 0.5, which is a relatively low elasticity for aggregate labour supply. The purpose of imposing low elasticity is to obtain conservative model effects of distortionary taxation on labour and capital accumulation. The procedure is to find $\theta$ so that the steady-state $L = \frac{2}{3}$, given that under the present utility function, that elasticity equals $(1 - L)/L$. These values for $\theta$ and $L$ are high (and the implied elasticity low) compared to values obtained in the literature to match the observed average share of hours worked in the total non-sleeping time available to the working-age population.

\[
\begin{align*}
\bar{g}^{rt} &= 0.34 & \rho_2 &= 0.86, 0.85 \\
\bar{v} &= 0.054 & \rho_3 &= 1 \\
\bar{ut}^g &= 0.07 & \rho_4 &= 0.74 \\
\bar{\tau}^y &= 0.26 & \rho_5 &= 0.77, \rho_6 = 0.91 \\
\bar{\tau}^c &= 0.13 & \\
\bar{ut}^p &= 0.05 & \\
\bar{b}^{n-1} &= -0.12 & \\
\bar{b}^{n-1} &= -0.30 & \\
\bar{d}^{n-1} &= -1.1 & 
\end{align*}
\]

The first column contains sample averages (except for $\bar{v}$) and the second contains sample autocorrelations. The estimate of $\bar{v}$ is computed residually so that the initial government budget is balanced. The two estimates of $\rho_2$ were obtained with $g^{\text{def}}$ and $g^{*}$, respectively. The hypothesis that $\rho_3 = 1$ cannot be rejected, and hence $\rho_3$ is set equal to one. The parameter $\rho_6 = 0.91$ is the autocorrelation coefficient of $z$. Given the unavailability of good data on the stock of the internal debt, the value $d^{n-1} = -1.1$ is obtained indirectly, dividing the average of the corresponding interest payments/GDP ratio by $r = 0.04$.

Finally, the parameter values in the adjustment costs function are the following. Given the assumption of zero trend, $\zeta$ is set equal to one. This implies that if the capital stock does not change, the adjustment cost is zero. The parameter $\phi$ was chosen so that when a permanent change occurs, it takes 8–10 years for the capital stock to reach the neighborhood of the new steady state value.

4.3. Model simulation

First, given the above parameter values and initial state variables, the corresponding steady state is computed. If the first period of the dynamic simulation is date $t$, the economy is at the steady state in $t - 1$. Then, one by one, the variables affecting the saving rate in Eq. (3.2) are altered at time $t$ by one unit, and the resulting $\Delta s_i$ values, corresponding to the coefficients in the equation, are
computed. This computation takes into account the serial correlation of each variable, and the ensuing changes in the future income-tax rate. Note that setting the economy at the steady state in period $t - 1$ reflects the assumption that the linearization of the saving rate equation (2.11) is taken at the steady state.

The results of the simulations are shown in Table 1, column 1. To facilitate the discussion of the results, the variables are grouped as follows: (a) government spending variables, (b) tax rates, (c) non-fiscal variables. Unilateral transfers to the government from abroad are included in the first group since they amount to negative spending.

4.3.1. Government spending variables

- $g^{pr}, -rb^g_{-1}$: Although there is no empirical counterpart to $g^{pr}$, the simulation is carried out as a useful benchmark for the following discussion. A permanent increase in government spending affects national saving in three different ways. The first can be referred to as the direct/wealth effect, which takes place even without capital accumulation or distortionary taxation.\(^\text{12}\) Without the

\(^{12}\) In other words, this is the effect that would take place in a simpler model without capital in the production function and with lump-sump taxation.
latter two features of the model, the direct negative effect of $g^{pr}$ on national saving is fully and immediately offset by the wealth effect on consumption and on labour effort, leaving national saving unchanged. The second is the capital accumulation effect. In the presence of capital accumulation, the higher labour effort resulting from the decline in wealth induces higher current investment – given complementarity between capital and labour. Because current investment affects production only in the next period, output in the future is higher than in the present, causing a decline in the saving rate. The third is the distortionary taxation effect, which works in the opposite direction. Given that current $\tau^*_t$ is held constant (as in the regression), the intertemporal budget constraint of the government implies that permanently higher spending should be accompanied by a future increase in the income-tax rate. This expectation reduces the motivation to work in the future and to invest in the current period – both of which reduce future income. Hence, current income is relatively high, inducing an increase in current savings. Interest payments on the foreign debt, $-rb^g_{-1}$, play a role similar to permanent government expenditures, and, hence, the simulated coefficient is the same. As column 1 in Table 1 shows, the third effect is dominant (the simulated coefficient is 0.66).

- $v_t - rd^g_{-1}$: Transfers payments to the public affect saving only through the third channel described above, i.e., the distortionary taxation effect. Hence, the simulated coefficient is positive (0.82), and higher than that of $g^{pr}$ (0.66) because it is not partially offset by the capital accumulation effect. A redistributive effect of transfers, as suggested by Feldstein (1982), is that the receiving sector may be cash constrained, and hence total consumption may increase. This consideration, not present in the model, would generate a negative coefficient. Interest payments on the internal debt, $-rd^g_{-1}$, have a similar effect as transfers and therefore the coefficient is the same.

- $g^{fr}, ut^g$: All three factors described above for $g^{pr}$ are at work here as well. However, in the present case the direct/wealth effect on saving is negative, because spending is temporary and thus the offsetting wealth effect on saving is weaker than for $g^{pr}$. The temporary nature of the change in spending also implies that the other two effects are weaker than for $g^{pr}$: the smaller wealth effect implies that labour effort responds more moderately – and thus the capital accumulation effect is weaker, and the income-tax rate adjustment is expected to be smaller – implying a weaker distortionary taxation effect. Unilateral transfers from abroad, $ut^g$, work like temporary spending, but in the opposite direction.\(^\text{13}\)

\(^\text{13}\) The small difference in the magnitude of the two coefficients is related to the serial correlation coefficients of $v^r$ and $ut^g$, $-0.64$ and $0.77$, correspondingly. Hence, changes in $ut^g$ are more temporary, and thus the wealth effect is weaker.
4.3.2. Tax rates

- $\tau^t$: An increase in the current income-tax rate (a positive $\eta_t$) generates expectations of a slightly lower tax rate starting from $t + 1$. The currently higher tax rate motivates a decline in labour at time $t$, and the ensuing future tax decline has a small but positive effect on future labour. Accordingly, current income is relatively low, and hence the effect of income-tax rate on saving is negative: the resulting coefficient is $-0.31$.

- $\tau^c$: An increase in the consumption-tax rate implies a temporarily high price for current consumption, leading to higher saving.\(^{14}\)

4.3.3. Non-fiscal variables

Distortionary taxation has minor implications for changes in variables that do not enter directly in the government budget constraint. The reason is that the ensuing changes in output affect both government expenditures (except interest payments, which are predetermined) and income proportionally – because their shares in output are held constant in the simulation of the partial effects.

- $z, k_{-1}$: The productivity shock, being persistent but not permanent (autocorrelation coefficient of 0.91) has a positive effect on saving, reflecting temporarily high income.\(^{15}\) This effect is accompanied by the positive response of labour effort to higher marginal labour productivity. The capital stock has a similar type of effect: when it is high it adjusts gradually to the steady state level, generating the same type of temporarily high income and marginal labour productivity. For both variables, there is a partly offsetting income effect on consumption. The resulting coefficients are 0.46 for $z$ and 0.21 for $k_{-1}$.

- $u^p$: Transfers from abroad to the private sector have a similar effect as transfers to the public sector. The main effect is one of temporary income, which increase savings.

- $b^p_{-1}$: Private foreign assets have a minor effect on savings via the income effect on labour effort. The income effect induces less labour and thus less current investment, which reduces future income. The positive effect on savings is very small because what matters for this effect is $r$ times the change in $b^p_{-1}$.

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\(^{14}\)Given the intertemporal budget constraint of the government, a currently higher $\tau^c$ generates expectations of lower $\tau^t$ in the future, which increase future labour and output and thus reduce current saving. Hence, this channel works in the opposite direction to that referred to in the text. However, given that the change in $\tau^c$ is temporary, the expected future tax reduction and the ensuing negative effect on saving are small.

\(^{15}\)Finn (1990) annalizes together this effect and that on investment, in the context of the correlation between saving and investment in a small open economy.
5. Empirical results

Columns 2 and 3 in Table 1 display the estimated coefficients (t-statistics in parentheses) to be compared with the simulated values in column 1. Note in column 2, which reports OLS results, the DW statistic of 1.53. Hence, even in first differences there is some evidence of positive serial correlation in $\Delta \epsilon_t$, strongly suggesting that $\epsilon_t$ is not stationary. Therefore, we can conclude now that estimation of the savings equation in levels would not be appropriate. Column 3 reports results when an AR(1) term is included. Overall, the estimated model resembles the simulated model. In particular, the estimated coefficient of the income-tax rate, $\tau^y$, is negative and statistically significant. The private foreign assets variable was deleted, given the negligible coefficient predicted. When included, this variable yields a t-statistic of only 0.16.

The coefficients of $g^{\text{def}}$ (−1.02 and −1.05 in columns 2 and 3, respectively) are lower than the expected value, and even lower than −1. Two possible explanations for this result are the following. First, an increase in military spending may signal good news about the future, such as the removal of an external threat or an increased inflow of financial assistance from abroad. These expectations would trigger higher private consumption. An alternative explanation is that higher military spending is a reaction to the creation of a new external threat, which is not fully neutralized. Hence, $g^{\text{def}}$ may accompany bad future prospects, such as higher personal risk and the possible shortening of the private planning horizon, inducing a depletion of private assets. Of these two explanations, it seems to us that the second may have some relevance in the present case, given Israel’s quick military reactions to external threats.

The difference in size between the coefficients of $g^{\text{def}}$ (−1.02, −1.05) and $g^c$ (−0.35, −0.56) may also be related to the fact that civilian spending is a closer substitute for private consumption than military spending. Hence, when $g^c$ increases, private consumption declines by more than when $g^{\text{def}}$ rises, resulting in relatively less national dissaving.\(^\text{16}\)

The consumption tax variable, $\tau^c$, has positive coefficients, as expected, but they are not significantly different from zero at standard significance levels (t-statistics of 1.39 and 1.56). The transfers variable $v$ has negative but very small and insignificant coefficients, compared to the positive and large coefficient expected. A possible explanation for the sign and lack of significance may be the

\(^{16}\)Corbo and Schmidt-Hebbel (1991) use panel data on developing countries and find, as we do, that increasing government spending has a stronger (negative) effect on national saving than increasing taxes. However, they find a positive effect of taxation, in the 0.35, 0.52 range, while here the results indicate a negative effect.
setting distributional effect mentioned in Section 4: transfers benefit individuals who are likely to be cash-constrained, thus increasing overall consumption and reducing saving.

Unilateral transfers from abroad to the public sector, $ut^g$, have the expected negative coefficients, but they are too high (1.06,1.07), similarly as defense spending but in the opposite direction.

The coefficients of interest payments on the internal debt, $-rd^g_{-1}$ are, as predicted, positive and large (1.01,1.05), but with relatively low $t$-statistics of 1.7 and 1.5. A problem with the model’s interpretation of the positive coefficient – that it is due to expectations of a future tax increase – is the lack of significance of interest payments on the foreign public debt, $-rb^{u}_{-1}$. The latter variable was also predicted to have a positive coefficient, although smaller, for the same reason.\(^\text{17}\)

Unilateral transfers from abroad to the private sector $ut^p$, and the productivity shock $z$, have positive and significant coefficients, as predicted, but the $t$-statistic of $z$ in column 3 is only 1.5. Finally, the capital stock has very small – 0.03, 0.05 – and insignificant coefficients, compared to the 0.21 value expected.\(^\text{18}\)

6. Conclusions

This paper developed a procedure for interpreting the coefficients of fiscal variables in a saving rate equation, given a rule for distortionary-tax adjustment. The rule adopted in the model is income-tax smoothing subject to a white noise error. This procedure is not specific to a saving rate equation; it can be applied to the analysis of the effects of fiscal policies on any other macroeconomic variable.

\(^\text{17}\)To test whether the low significance levels of some variables is due to multicollinearity, the theoretical restrictions that the coefficients of $v$ and $rd^g_{-1}$ are the same, and that the coefficients of $g^{du}$ and $g^r$ are the same, were imposed. In general, the results remain similar, indicating that multicollinearity seems not to be a problem.

\(^\text{18}\)Lavi (1995) finds, using Israeli data, a positive and significant correlation between the share of wages in national income and total consumption, and suggests that this may be due to liquidity constraints faced by wage earners. When the ratio of wage payments to national income is added to the equation, the coefficient on the consumption tax increases in size and in statistical significance, while the $t$-statistic of the income-tax rate becomes $0.9$. The rest of the results are qualitatively similar to those in Table 1. The coefficient on the wage share is negative and significant, agreeing with the results in Lavi. However, the wage share effect is difficult to interpret in a structural way, unless one is willing to assume that the production function parameter $\alpha$ shifts exogenously over time.
The empirical results obtained from Israeli data are mixed. An interesting empirical result is the negative partial effect of the income-tax rate, as predicted by the model. This stands in contrast with the Keynesian framework, in which higher income taxes are expected to generate a positive comovement between the income-tax rate and the national saving rate. The interpretation of the negative effect is that, given the values of the other fiscal variables, a higher income tax in the current period signals a lower tax rate in the future owing to the intertemporal budget constraint. Hence, current labour and income are low relative to the future, and thus consumption smoothing implies a decline in saving.

Defence spending has a strong negative effect, and unilateral transfers to the public sector have a strong positive effect, both larger than predicted. Speculative explanations have been advanced regarding defense spending, but these results remain unexplained. It may be interesting to explore the joint determination of defense spending and unilateral transfers to the public sector, which increased during the war years, particularly in and after 1973.

The consumption tax rate has a positive effect on saving, as one may expect for temporary changes in the relative price of consumption. However, the coefficients are not statistically significant at standard significance levels. Nevertheless, the results provide some evidence that a temporary shift in taxation from income to consumption increases the saving rate, at least as a result of the reduction in income taxation.

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