Two-Sector Perspectives on the Effects of Payroll Tax Cuts and Their Financing

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Abstract

This paper analyzes the consequences of lifting from labor some of the burden of taxation in a life-cycle two-sector setup where a consumption good is produced alongside a capital good. The analysis focuses on the implications of alternative ways of financing payroll tax cuts in closed and small open neoclassical economies. In our model payroll tax cuts do not necessarily stimulate hours worked in the stationary state. We show, for example, that in the closed economy—paradoxically—long-run aggregate labor hours and the capital stock will be reduced if labor tax proceeds are replaced by capital taxation. If instead government purchases of the capital good or labor services are decreased, manhours are left unchanged in the long-run, while capital formation is spurred. Hours worked and nonhuman wealth are increased if the payroll tax cut is offset by cuts in welfare entitlements, public spending on the consumption good or the value-added.

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tax. In the small open economy it is only if the offsets are a fall in entitlement spending or a rise in the wealth tax that aggregate manhours are increased—otherwise steady state hours worked are invariant. In general, permanent changes in the tax rate on labor impact on labor supplied in the short-run whether or not hours worked are asymptotically effected.

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1 Introduction

Payroll taxes and other fiscal weights imposed on labor are often blamed as being the most prominent factor at the root of the reduced manhours per worker and the elevated structural unemployment rates in continental Europe. This exegesis is provided and supported, among others, by Dreze and Malinvaud (1994), Daveri and Tabellini (2000), and Prescott (2004).

The effects of the labor tax wedge –the reduction of which is advocated as a policy panacea for stimulating labor hours, worker employment, and raising the level of economic activity (eventually also through an indirect effect on capital formation)– are, however, subject to disputable empirical and doctrinary interpretations. On the empirical ground, the evidence on the association between labor taxes and manhours/employment is not so strong or significant. See, for example, Layard and Nickell (2000), Nickell (2003), Blanchard (2004), Phelps and Zoega (2004), and Alesina, Glaeser and Sacerdote (2005).

Layard and Nickell (2000), and Nickell (2003) find that, while the role of labor taxes on employment and growth is undeniable from an empirical point of view, its magnitude is relatively small and cannot account for the high unemployment rates in western economies; social security systems and unions are identified as the major institutional factors behind the poor labor market performance of continental Europe. Blanchard (2004), by emphasizing that the labor productivity has increased much faster in Europe than in the U.S. in the last decades (although the differences in terms of output per capita have remained invariant), attributes the lower hours worked per capita in Europe to preferences that have favored leisure over income, and not to labor taxes. Phelps and Zoega (2004) show that the labor tax wedge and the unemployment rate are uncorrelated for a cross-section of countries; this is because the rise in labor taxation, in practice, has been accompanied by
several offsetting effects, like the enlargement of the welfare state and/or the adjustment of social and private wealth. Alesina, Glaeser and Sacerdote (2005) argue that the differences between the U.S. and Europe in terms of manhours per capita cannot be ascribed to labor tax differentials, but rather to the unions’ policies and labor market regulations.

On the theoretical ground, while for textbook experiments (without complicating side-effects) the implications of labor taxes for hours worked and employment are quite intuitive, in more articulate experiments they are, instead, largely obscured by the simultaneous changes in other fiscal determinants of labor. This is because the accompanying budgetary regime —whether based on government spending or alternative distortionary taxation or deficit financing options— is not inconsequential for the macroeconomic effects of labor taxation. Several articles that have analyzed the consequences of labor taxes through intertemporal optimizing frameworks support this consideration by showing that widely different conclusions are reached according to the financing regime assumed; see, e.g., Auerbach and Kotlikoff (1987), Judd (1987), Kotlikoff and Summers (1987), Hoon and Phelps (1996), Daveri and Tabellini (2000), Prescott (2004), Petrucci and Phelps (2005), and Van der Ploeg (2006).\(^1\)

For example, in a model with infinitely lived agents and a competitive labor market, Judd (1987) finds that a rise in labor income taxes reduces the labor supply and the capital stock when tax revenues are lump-sum distributed to consumers;\(^2\) with government expenditure financing, instead, Turnovsky (1992) shows that labor and capital are ambiguously affected by wage taxation if preferences are nonseparable in consumption and leisure. By

\(^{1}\text{These contributions employ dynamic general equilibrium one-sector setups. Analyses of labor taxation based on partial equilibrium models, instead, are provided, for example, by Layard, Nickell, and Jackman (1991), and Pissarides (1998).}\)

\(^{2}\text{Adverse effects of the labor tax wedge on the factors of production and the output growth rate are obtained by Prescott (2004) in the same setup as in Judd (1987).}\)
employing a life-cycle simulation model of a closed economy, Auerbach and Kotlikoff (1987) discover that a higher tax on labor accompanied by a rise in public expenditure is detrimental for capital formation, but is steady state neutral for the labor supply; such a fiscal shift contracts both employment and investment if the labor market is unionized—see Daveri and Tabellini (2000). In a similar demographic setting, Hoon and Phelps (1996) show that a payroll tax used to substitute a value-added tax leads to a reduction in labor and nonhuman wealth in the closed economy case, while it leaves labor invariant in the small open economy case. According to Petrucci and Phelps (2005), a per employee labor subsidy (financed by either consumption or \textit{ad valorem} payroll taxes) raises employment in an OLG incentive-wage model of an open economy; if the labor subsidy is initially zero, the subsidy has no effects on the capital stock and saving; if instead the labor subsidy is initially positive, the subsidy decreases physical capital and nonhuman wealth.

In this paper we investigate the consequences of lifting from labor some of the burden of taxation in nonaltruistic life-cycle two-sector economies. We focus on the effects of payroll tax cuts on manhours worked, nonhuman wealth, sectorally employed inputs, and asset and factor prices in a context where a consumption good is produced alongside a capital good, and diversified accommodating schemes for the government budget are employed. The analysis considers both closed and small open neoclassical models with no equilibrium unemployment, where wages adjust to equate labor supply and demand, and changes in labor are only due to variations in hours worked. In understanding the relationship between payroll taxes and the macroeconomic equilibrium, the article tries to consider, in particular, the separate and possibly contrasting effects of the various fiscal components on manhours worked.

\footnote{The Hoon and Phelps (1996) results are independent of the labor market structure as they hold in a competitive-wage model and a labor-turnover model of the 'natural rate'.}
The simultaneous consideration of three analytical features renders our analysis of payroll taxes original: the two-sector production structure of the economy, the various ways of financing labor tax reductions, and the non-altruistic OLG demographics. Regarding the former aspect, instead of considering the standard neoclassical one-sector growth model, which, although simplifying, is sometime restrictive, we use a model of fixed investment incorporating differences in the relative labor intensiveness in the consumer and capital-good sectors, as in Uzawa (1961 and 1964). A two-sector structure is particularly important for the differential consequences of labor taxes on the various sectors of the economy, the incidence questions, and the role of the compensatory finance. The investigation is developed under the conventional assumption that the production of the consumption good is always more capital-intensive than the production of the capital good.

The financing regimes analyzed are rather articulate as the labor tax cuts are accompanied either by shrinking the welfare state through the alternative reductions in welfare entitlements, government purchases of the different goods, and public employment, or alternatively by raising other types of distortionary taxes, like taxes on physical capital, consumption and nonhuman wealth. Moreover, the life-cycle demographics allow us to distinguish between intra- and intergenerational consequences of the policy experiments studied and focus on the role played by nonhuman wealth for the adjustment of the macroeconomic system.

Contrary to what is perentorily asserted by the supply-siders, the general discovery of the paper is that payroll tax cuts do not necessarily stimulate hours worked in the long-run, as found in Auerbach and Kotlikoff (1987), and Hoon and Phelps (1996). A long-run labor stimulation at aggregate level strictly depends on the budgetary regime and the type of economy. However, permanent changes in the tax rate on labor impact on aggregate manhours in the short-run, whether or not hours are asymptotically effected. In general,
payroll taxes are more effective in terms of physical capital and nonhuman wealth formation than in terms of hours worked stimulation.

In the close economy we show–paradoxically– that long-run aggregate labor hours and the capital stock will be reduced if labor tax proceeds are replaced by capital taxation. If instead government purchases of the capital good or labor services are decreased, manhous are left unchanged in the long-run, while capital accumulation is spurred. Hours worked, nonhuman wealth and capital formation are stimulated if the payroll tax cut is offset by cuts in welfare entitlements, public spending on the consumption good or the value-added tax. In the small open economy it is only if the offsets are a fall in entitlement spending or a rise in the wealth tax that aggregate manhours and the capital stock are increased –otherwise steady state hours worked are invariant, while nonhuman wealth and capital may be stimulated. In the small open economy, payroll tax shifts imply a high short-run volatility of hours worked.

The structure of the paper is as follows. Section 2 provides, for the closed economy, the description of the analytical setup and the investigation of labor tax cuts under different budgetary schemes. In section 3, we present the small open economy version of the model and examine the implications of payroll tax shifts. Section 4 contains some final considerations.

2 Closed economy

2.1 The model

Consider a real closed economy, producing competitively two goods: a consumption good, $Z_C$, and a capital good, $Z_I$. The consumption good, considered to be the numeraire, is produced by using capital, $K$, and sectoral labor hours, $L_C$, by means of a constant-returns-to-scale production function
\( Z_C = \Phi(K, L_C) \). This production function can be expressed in intensive form by denoting the output-manhours ratio in the \( C \)-sector as \( \phi(k_C) = \Phi \left( \frac{K}{L_C}, 1 \right) \), where \( k_C \equiv \frac{K}{L_C} \) is the capital-labor ratio, \( \phi' > 0 \), and \( \phi'' < 0 \).

To keep the analysis simple, let us assume that the capital (investment) good is produced by using labor alone,\(^4\) according to a linear production function \( Z_I = \omega L_I \), where \( \omega > 0 \) is the fixed average product of labor and \( L_I \) labor hours used in the capital good sector.

The demand for capital is given by

\[
\phi'(k_C) = R^f, \tag{1a}
\]

where \( R^f \) denotes the real rental on capital faced by firms. Assuming that capital is taxed proportionally at the rate \( \tau_K \), the firms’ cost of capital is given by \( R^f \equiv (1 + \tau_K)R^h \), where \( R^h \) is the real reward on capital received by households.

As perfect labor mobility between sectors prevails, the labor cost for firms, which is equated to the value of the marginal product of labor in each sector, is equalized across sectors; that is,

\[
[\phi(k_C) - k_C \phi'(k_C)] = \omega q = v^f, \tag{1b}
\]

where \( v^f \) is the firm labor cost and \( q \) the real price of the capital good. Denoting an \textit{ad valorem} tax rate on labor as \( \tau_L \), the labor cost faced by

\(^4\)This assumption, consistent with a classic postulate of the Austrian theory of capital, is borrowed from Phelps (1988) and Phelps (1994, ch. 16); it incorporates the radical version of the conventional hypothesis that the consumption good sector is more capital-intensive than the capital good sector at every factor-price ratio; see, for example, Uzawa (1961 and 1964), and Foley and Sidrauski (1971). None of our results is invalidated by this simplification as long as the usual assumption on factor intensity is considered in the more general case.
firms is given by \( v^f \equiv (1 + \tau_L)v^h \), where \( v^h \) is the household hourly real wage.

The households’ behavior derives from the “perpetual youth” setup developed by Blanchard (1985) along the lines traced by Yaari (1965), extended to incorporate an endogenous labor supply, as in Phelps (1994, ch. 16). Such an apparatus describes the OLG demographics with no intergenerational altruism and bequest motives, where the individuals’ lifetime is uncertain as agents face a constant mortality rate \( \theta \) for the entire life. We postulate that the birth rate coincides with the death rate. This implies that the population, composed of chronologically heterogeneous cohorts, remains constant over time.

If households have logarithmic preferences, the consumption function and the static efficiency condition for the labor-leisure choices at aggregate level are given by\(^5\)

\[
X = (\theta + \rho)(W + H),
\]

\[
\tilde{L} - L = \frac{X}{v^h},
\]

where \( X \) denotes consumption expenditure, \( \rho \) the constant subjective rate of time preference, \( W \) nonhuman wealth, \( H \) human wealth, \( \tilde{L} \) the time endowment (given), and \( L \) labor hours supplied. Since a value-added tax is assumed to be levied on consumption, consumption expenditure is given by \( X \equiv \frac{C}{(1 - \tau_C)} \), where \( C \) represents physical consumption and \( \tau_C \) a proportional value-added tax rate. Human wealth \( H \) is defined as the present discounted value of expected future labor income gross of welfare entitlements.

\(^5\)The detailed derivation of the demand-side of model is reported in an unpublished Mathematical Appendix (hereafter MA), available from the authors.
The law of motion of human wealth and the aggregate household budget constraint, which describes the dynamics of nonhuman wealth, are respectively given by

\[
\dot{H} = (r + \theta)H - v^h L - y^g, \tag{2c}
\]

\[
\dot{W} = rW + v^h L + y^g - X, \tag{2d}
\]

where \( r \) is the real interest rate and \( y^g \) the welfare entitlements.

Using (2a)-(2d), the Blanchard-Yaari version of the Euler equation for consumption growth is obtained

\[
\frac{\dot{X}}{X} = r - \rho - \theta(\theta + \rho) \frac{W}{X}. \tag{2a'}
\]

Nonhuman wealth is given by the value of the capital stock measured in terms of the consumption good, i.e. \( W \equiv qK \).\(^6\)

We assume that the government uses part of aggregate labor hours in amount \( L^g \) for public administration purposes. Labor supply available for the private sector, \( L - L^g \), is freely allocated between the two sectors of production:

\[
L - L^g = L_C + L_I. \tag{3}
\]

\(^6\)Notice that nonhuman wealth is untaxed; it is \textit{de facto} taxed indirectly through the fiscal levy imposed on physical capital; as capital is the unique asset of the economy, a tax on physical capital and a tax on financial wealth are qualitatively equivalent in terms of the resource allocation.
The perfect arbitrage between the interest rate and the total yield obtained by holding capital implies

\[ r = \frac{R^h}{q} + \frac{\dot{q}}{q} - \delta, \]  

(4)

where \( \delta \) represents the capital depreciation rate; perfect foresight has been assumed.

The capital good is partly accumulated, partly used for replacing depreciated capital, and partly acquired by the government in amount \( \gamma_I L_I \), where \( \gamma_I \) represents government purchases of the capital good per unit of labor; that is,

\[ \omega L_I = \dot{K} + \delta K + \gamma_I L_I. \]  

(5)

The equilibrium in the consumption good market requires that output \( Z_C = \phi(k_C)L_C \) is equal to the sum of physical consumption and government purchases of the consumption good; hence, we have

\[ \phi(k_C)L_C = X(1 - \tau_C) + \gamma_C L_C, \]  

(6)

where \( \gamma_C \) is the government-purchases-to-labor ratio in the \( C \)-sector.

The government keeps its budget in equilibrium by balancing exactly tax proceeds and public expenditure; that is,

\[ \tau_L v^h(L - L^g) + \tau_K R^h K + \tau_C X = y^g + \gamma_C L_C + q \gamma_I L_I + v^h L^g. \]  

(7)

We analyze the effects of payroll tax cuts under alternative budgetary schemes. The two general financing options considered are:
a) the *downsizing of the welfare state*, i.e. a compensatory reduction of government expenditures; specifically, the shrinking of the public sector is investigated under four alternative budgetary sub-cases: i) welfare entitlement accommodation; ii) government purchases of the consumption good financing; iii) government purchases of the capital good financing; iv) government labor services adjustment;

b) the *change in the tax mix*, i.e. a compensatory switch in distortionary taxation; the specific budgetary modes are: i) capital tax financing; ii) value-added tax financing.

2.2 Dynamics

Instead of discussing the dynamic properties of the economy in each budgetary regime, we study the equilibrium dynamics in the pilot case of $y^g$ financing. This is didascalic for all the other financing schemes as the properties of stability remain qualitative unaffected.

Solve equation (1b) for the capital intensity in the consumption good sector as follows$^7$

\[
k_C = k_C(q), \quad k_C' > 0.
\]  

(8a)

By using (1a) and (1b), factor prices faced by households can be expressed, with the aid of (8a), as

\[
R^h = R^h(q), \quad R^h_q < 0;
\]  

(8b)

$^7$Suppose, for simplicity, that $\gamma_C = \gamma_L = L^g = \tau_K = \tau_C = 0$. The derivate of the $k_C(\cdot)$ function as well as all the functional expressions of derivatives and parameter combinations used below are relegated to the MA.
Using these relationships, the various indicators for labor hours and consumption can be solved in terms of \( q, K \), and eventually \( \tau_L \), as follows:\(^8\)

\[
v^h = v^h(q, \tau_L), \quad v^h_q > 0; \quad v^h_{\tau_L} < 0. \tag{8c}
\]

\[
L_C = L_C(q, K), \quad L_{C,q} < 0; \quad L_{C,K} > 0; \tag{8d}
\]

\[
X = X(q, K), \quad X_q < 0; \quad X_K > 0; \tag{8e}
\]

\[
L = L(q, K, \tau_L), \quad L_q > 0; \quad L_K < 0; \quad L_{\tau_L} < 0; \tag{8f}
\]

\[
L_I = L_I(q, K, \tau_L), \quad L_{I,q} > 0; \quad L_{I,K} < 0; \quad L_{I,\tau_L} < 0. \tag{8g}
\]

Substituting (8g) into (5) and linearizing around the steady state yields

\[
\dot{K} = \Lambda_K (K - \bar{K}) + \Lambda_q (q - \bar{q}), \tag{9}
\]

where overbars denote long-run values, and \( \Lambda_K < 0 \) and \( \Lambda_q > 0 \) are parameter combinations.

Inserting (2a') and (8b) into (4), for \( r \) and \( R^h \) respectively, and linearizing around the steady state, we have: \( \dot{q} = \Gamma_K \bar{K} + \Gamma_q (q - \bar{q}) \), where \( \Gamma_K > 0 \) and \( \Gamma_q > 0 \). Plugging (9) into this equation for \( \dot{K} \) and rearranging, we get

\[
\dot{q} = \Pi_K (K - \bar{K}) + \Pi_q (q - \bar{q}), \tag{10}
\]

\(^8\)Equation (8d) is obtained by substituting (8a) into the relationship \( L_C = K/k_C \). (8e) derives from (6) and (8a). The joint use of (2b) and (8c) makes it possible to derive (8f). (8g) is, instead, obtained from (3), after (8d) and (8f) have been employed.
where $\Pi_K = \Gamma_K \Lambda_K < 0$ and $\Pi_q = \Gamma_q + \Gamma_K \Lambda_q > 0$.

(9) and (10) give us a system of two differential equations in the two variables $K$ and $q$. $q$ is a jump variable, moving instantaneously, while $K$ is a predetermined variable, evolving gradually. (9) is depicted in the phase diagram of Fig.1 for $\dot{K} = 0$; the $\dot{K} = 0$ schedule is upward-sloping. The $\dot{q} = 0$ schedule, obtained from (10), is positively sloped in the $q - K$ plane of Fig. 1 and flatter than the $K = 0$ schedule. Fig. 1 displays the dynamics implied by the equations of motion (9) and (10) in each of the four regions. The economy exhibits saddle-point stability. This is guaranteed by the fact that the $K = 0$ schedule is steeper than the $\dot{q} = 0$ one. The saddle-path SS is positively sloped, and flatter than the $\dot{q} = 0$ schedule.

[Insert Fig. 1]

### 2.3 Steady state effects of payroll tax cuts

Some key long-run relationships that simplify the comparative static analysis can be conveniently derived. From (1b), the real price of the capital good can be expressed as follows

$$\bar{q} = q(\bar{k}_C), \quad q' > 0. \quad (11)$$

Plugging $\bar{R}^h$ from (4) into (1a), once the definition $\bar{R}' \equiv (1 + \tau_K) \bar{R}^h$ and (11) are taken into account, and solving for the real interest rate yields

$$\bar{r} = r(\bar{k}_C, \tau_K), \quad r_{k_C} < 0, \quad r_{\tau_K} < 0. \quad (12)$$

Inserting $\bar{X}$ from (6) into the long-run version of (2a’), and using $\bar{V} \equiv \bar{q} \bar{K}$, we obtain

14
\[
\phi(\kC) - \gamma_C = (1 - \tau_C) \frac{\theta(\theta + \rho)}{[r(\kC, \ktau) - \rho]} q(\kC) \kC .
\]  
(13)

This equation can be employed—either in isolation or together with the government budget constraint if \(\gamma_C, \tau_K\) or \(\tau_C\) are endogenously accommodated—to derive the reduced-form for the capital-labor ratio in the C-sector. Once \(\kC\) is obtained, the real price of the capital good and the real interest rate can be computed through (11) and (12), respectively.\footnote{When \(\tau_K\) is endogenously adjusted, the reduced-form for \(\bar{r}\) is obtained by also considering the government budget constraint (7).}

To determine aggregate manhours, substitute (2d) into (2b) for \(X\) and get

\[
\frac{\bar{L}}{L} = \frac{1}{2} \frac{\bar{r}}{2} \frac{\Wbar}{L} - \frac{1}{2} \frac{y^0}{L} .
\]  
(14)

This relationship expresses the labor supply in manhours in terms of the nonhuman-wealth-to-wage ratio. Next, plugging (2d) into (2a') yields

\[
\frac{\bar{L}}{L} = \Theta(\bar{r}) \frac{\Wbar}{L} - \frac{y^0}{L} , \quad \Theta_r < 0 ,
\]  
(15)

where \(\Theta(\bar{r}) = \frac{[\theta(\theta + \rho) - \bar{r}(\bar{r} - \rho)]}{(\bar{r} - \rho)} > 0\). Equation (15) describes the combinations of labor hours and the nonhuman-wealth-to-wage ratio compatible with the asset market equilibrium as established by the Blanchard-Yaari intertemporal arbitrage condition (2a').

The joint consideration of (14) and (15) allows us to determine \(\frac{\bar{L}}{L}\) and \(\frac{\Wbar}{L}\), once the reduced-form for the real interest rate and eventually the
government budget constraint –when $y^g$ is endogenously accommodated– are taken into account.

Finally, the consequences of the exogenous shifts on the capital stock and labor hours used in the $C$-sector can be easily identified by employing the relationship $\tilde{K} = k_C(\cdot) L_C$ together with (5),\(^{10}\) which in the long-run can be expressed as\(^{11}\)

$$\tilde{K} = \frac{(\omega - \gamma I)}{\delta} [\bar{L}(\cdot) - L^g - \bar{L}_C].$$

Labor employed in the $I$-sector can then be derived residually from (3) after the solutions for $\bar{L}_C$ and $\bar{L}$ are considered.

A synoptical view of the various comparative static results in qualitative terms is provided in Table 1.

### 2.3.1 Welfare state downsizing

i) $y^g$ compensatory finance

Consider the case in which the cut in $\tau_L$ is matched –in order to balance the government budget– by a reduction in welfare entitlements. To simplify matters, we set, with a negligible loss of generality, government expenditures and the tax rates that are not directly involved in the current experiment equal to zero.\(^{12}\)

As $\tau_L$ and $\bar{y}^g$ do not enter (13), the capital intensity in the $C$-sector remains unperturbed. From (11) and (12), the relative price of the capital good and the rate of interest are invariant; therefore, also factor prices paid

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\(^{10}\) $k_C(\cdot)$ represents the reduced-form for the capital intensity in the consumption good sector obtained from (13).

\(^{11}\) In (16), (3) has been used to eliminate $\tilde{L}_I$; $\bar{L}(\cdot)$ gives the reduced-form for manhours, determined through the system (14)-(15).

\(^{12}\) These simplifying assumptions will be implicitly reiterated in the subsequent experiments, although adjusted case by case.
by firms are unchanged. The fall in $\tau_L$ does raise the take-home wage $\bar{v}^h$, however, since the firm labor cost $\bar{v}^f = (1 + \tau_L) \bar{v}^h$ is constant.

Plugging the government budget constraint, i.e. $\frac{\bar{v}^f}{\bar{v}^h} = \tau_L \frac{\bar{L}}{L}$, into (14) and (15), the following relationships are easily obtained

\[
\frac{\bar{L}}{\bar{L}} = \frac{\Theta(\bar{r})}{[(2 + \tau_L)\Theta(\bar{r}) + (1 + \tau_L) \bar{r}]^\gamma}, \quad (17a)
\]

\[
\frac{\bar{W}}{\bar{v}^f \bar{L}} = \frac{1}{\Theta(\bar{r})} \frac{\bar{L}}{\bar{L}} \quad (17b)
\]

With the real interest rate staying unaltered, equations (17) imply that the drop in the labor tax rate increases aggregate labor hours and, as $\bar{v}^f$ is given, nonhuman wealth; consumption and human wealth are consequently pulled up, from (2a’) and (2c) respectively.\textsuperscript{13} The nonhuman-wealth-to-household-wage ratio is however reduced; hence, consumption, which remains constant taken as a ratio of nonhuman wealth, increases proportionally less than the take-home wage; it is for this reason that the hours worked increase. The rise in $\bar{W}$ stems from an increase in the stock of physical capital, as $\bar{q}$ is constant. Labor hours used in both sectors expand.

These results can be explained as follows. The invariance of the capital intensity in the $C$-sector (and hence of the real price of the capital good and the real interest rate) is to be attributed to the fact that the payroll tax rate and welfare entitlements do not affect the Blanchard-Yaari arbitrage condition and the consumption good market equilibrium. By increasing the household take-home wage, the cut in $\tau_L$ induces, through a substitution effect, workers to supply more labor. Despite the fact that government transfers are reduced, household disposable income is unambiguously driven up.

\textsuperscript{13} Long-run human wealth can be expressed as $\bar{H} = \frac{\bar{v}^f \bar{L}}{\bar{r} + \theta}$.
by the higher wage; this in turn gives rise to an income effect that increases consumption as well as leisure and hence curtails the supply of labor. The substitution effect overwhelms the income effect leading to a net increase in hours worked, and therefore a rise in human and nonhuman wealth. The increase in aggregate labor hours, by raising the amount of the mobile factor available for the private sector, expands in turn the capital stock and labor employed in the two sectors.

ii) $\gamma_C$ compensatory finance

Now a fall in government spending on the consumption good accompanies the payroll tax cut. Plugging (3) and (5) into the government budget constraint (7) yields

$$\gamma_C = \frac{\tau}{1 + \tau_L} q(k_C)(\omega + \delta k_C).$$  \hspace{1cm} (18)

Substituting $\gamma_C$ from (18) into (13) and differentiating, we get the following multiplier for the capital intensity

$$\frac{d \bar{k}_C}{d\tau_L} = \frac{(\bar{r} - \rho) \bar{q}(\omega + \delta \bar{k}_C)}{(1 + \tau_L)^2 \Delta} < 0,$$

where $\Delta < 0$ is a parameter combination.

Thus, the reduction in $\tau_L$ drives up the capital-labor ratio in the consumption good sector. The real price of the capital good and the labor cost for firms are increased, while the rental on capital and the real interest rate decline. The reduction in the real interest rate leads to an increase in aggregate manhours and a fall in the nonhuman-wealth-to-wage ratio. Nonhuman wealth and consumption expand proportionally less than the take-home

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14 The same type of results would be obtained if a compensatory contraction of government debt were considered instead of a reduction in $\gamma_C$.  
15 These effects can be understood as follows. Using (14) and (15) jointly, and setting $y^\theta = 0$, we get
wage rate. From (13) and (16), the capital stock and labor used in the $I$-sector rise, while $\tilde{L}_C$ may rise or fall.

The intuition behind these results is immediate. The rise in the consumers’ disposable income (due to the reduction in labor taxes) together with the drop in government expenditure crowd in private consumption; aggregate demand of the consumption good actually declines, as $\tilde{X}$ rises less than the change of $\tilde{\gamma}_C\tilde{L}_C$ in absolute value. The excess supply of the consumption good brings about a drop in its price so $\tilde{q}$ increases. The rise in $\tilde{q}$ in turn causes a rise in the real wage paid by firms and the workers’ take-home wage, and a fall in the rental on capital and the real interest rate.¹⁶ A higher firms’ labor cost implies a higher capital intensity in the consumption good industry. As the relative rise in the workers’ wage rate is greater than the one in consumption, the consumption-worker-wage ratio declines, while hours worked are pulled up.

iii) $\gamma_I$ compensatory finance

When the drop in $\tau_L$ is balanced by a decrease in the government expenditure directed toward the capital good, $\frac{\tilde{L}}{L}$ and $\frac{\tilde{W}}{\tilde{v}^h\tilde{L}}$ remain constant, since

\[
\frac{\tilde{L}}{L} = \Psi(\tilde{r}), \quad \Psi' < 0, \quad (17a')
\]

\[
\frac{\tilde{W}}{\tilde{v}^h\tilde{L}} = \Omega(\tilde{r}), \quad \Omega' > 0, \quad (17b')
\]

where $\Psi(\tilde{r}) = \frac{\Theta(\tilde{r})}{2[\Theta(\tilde{r}) + \tilde{r}]}$, and $\Omega(\tilde{r}) = \frac{1}{2[\Theta(\tilde{r}) + \tilde{r}]}$; $\Theta(\cdot)$—with $\Theta_r < 0$—has been defined above. From (17'), the implications of a fall in $\tau_L$ for $\frac{\tilde{L}}{L}$ and $\frac{\tilde{W}}{\tilde{v}^h\tilde{L}}$ are immediately clear through the induced effect on $\tilde{r}$.

¹⁶The consequences on factor prices faced by firms are due to a mechanism à la Stolper-Samuelson, induced by the change in $\tilde{r}$. 19
the capital-labor ratio in the consumption sector, the relative price of the
capital good and the real interest rate are invariant.

Nonhuman wealth and consumption are driven up in equal proportion to
the higher household wage. The capital stock and labor used in the C-sector
expand, because the fall in government expenditure from the labor-intensive
sector leaves resources available for capital formation, while labor hours used
in the I-sector compensatorily contract so as to preserve the invariance of
aggregate manhours.

iv) \( L^g \) compensatory finance

When labor hours used by the government for public administration pur-
poses are reduced in order to finance the labor tax cut, the same qualitative
effects of a compensatory accommodation in \( \gamma_I \) apply, with the only differ-
ence that now \( \tilde{L}_I \) increases. In fact, the reduction in \( L^g \) expands the labor
endowment disposable for the private sector, stimulating the capital stock
and sectoral labor hours.

2.3.2 Change in the tax mix

In the experiments on taxation swap, we assume, to simplify the analysis,
that tax revenues are simply used for financing government expenditure on
output of the consumer-good industry.

i) \( \tau_K \) compensatory finance

Suppose that the reduction in \( \tau_L \) is compensated by an increase in \( \tilde{\tau}_K \).
After inserting (1a), (3) and (5) into (7) it yields

\[
\frac{\tilde{\tau}_K}{1+\tilde{\tau}_K} = \frac{\gamma_C}{\phi'(\bar{k}_C) \bar{k}_C} - \frac{\tau_L \left( \frac{q(\bar{k}_C)(\omega + \delta \bar{k}_C)}{\phi'(\bar{k}_C) \bar{k}_C} \right) (1+\tilde{\tau}_K)}{(1+\tau_L) \phi'(\bar{k}_C) \bar{k}_C}.
\]

This equation can be solved for the capital tax rate as follows
\[ \tau_K = \tau_K(\tilde{k}_C, \tau_L), \quad \tau_{K1} < 0, \quad \tau_{K2} < 0. \]  

(19)

Plugging (19) into (13) for \( \tau_K \), and totally differentiating, we obtain

\[ \frac{d \tilde{k}_C}{d \tau_L} = - \frac{\phi r \tau_K \tau_{K2}}{\Delta} > 0, \]

where \( \tilde{\Delta} < 0 \).

Thus, the capital-labor ratio in the capital-intensive sector and hence the relative price of the capital good are driven down by the drop in \( \tau_L \), as the real rental on capital faced by firms is increased by the change in the tax structure. The consequence on the interest rate is in principle ambiguous as the shifting of the capital tax brings \( \tilde{r} \) down, while the lower capital intensity pulls it up; if a Cobb-Douglas production function of the type \( Z_C = K^\alpha L_C^{1-\alpha} \) is chosen, the interest rate will be unambiguously increased when \( \alpha < 0.5 \).\(^{17}\) The firms’ labor cost falls, while the workers’ take-home wage moves unclearly.

The rise in the interest rate reduces aggregate labor hours and increases the nonhuman–wealth-to-wage ratio.\(^{18}\) The capital stock and labor used in the \( I \)-sector shrink, while labor employed in the \( C \)-sector may rise or fall. Nonhuman wealth and consumption are decreased.

ii) \( \tau_C \) compensatory finance

A shift to increased value-added taxation offset by a lighter payroll tax occasions the same qualitative results obtained under \( \gamma_C \) compensatory financing.\(^ {19}\) These findings are not surprising as a shift in \( \tau_C \) accompanied

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\(^{17}\)This condition is assumed to be satisfied because of its empirical plausibility.

\(^{18}\)See equations (17') in footnote 15.

\(^{19}\)The correspondence between these two financing schemes can be shown as follows. Combining (6) and (7), consumption expenditure can be expressed as \( \tilde{X} = \phi(\tilde{k}_C) \tilde{L}_C \).
by a balanced-budget change in $\gamma_C$ is neutral for the macroeconomic equilibrium.$^{20}$

2.4 Dynamic effects of payroll tax cuts

To understand how the economy dynamically adjusts, we study the short-run consequences of a $\tau_L$ cut when $y^d$ or $\gamma_C$ are endogenously accommodated. Then, we shall briefly comment the short-run implications of payroll taxation when aggregate labor hours are left unchanged in the steady state.

Let us consider an unexpected permanent cut in $\tau_L$ accompanied by a compensatory reduction in welfare entitlements. The long-run effect is for $\bar{q}$ to remain unchanged and for $\bar{K}$ to rise. The unanticipated shock shifts the saddle-path downward in Fig. 1. There is an immediate decline in the relative price of the capital good (for a predetermined value of the capital stock) with a corresponding fall in the capital intensity $k_C$ and therefore an increase in labor hours and output of the capital-intensive sector. The wage rate faced by firms suddenly declines, while the workers’ take-home wage and the real rental on capital are pulled up; the instantaneous real interest rate $r$ rises, despite its long-run invariance. Consumption is also abruptly increased; however, $X$ rises more than $Z_C$ so that an excess demand for the consumption-

$\tau_L \tilde{V}_h L$. Substituting this relationship into the long-run version of (2a') yields

$$\phi(\bar{k}_C) - \frac{\tau_L}{(1 + \tau_L)} q(\bar{k}_C)(\omega + \delta \bar{k}_C) - \gamma_C = \frac{\theta(\theta + \rho)}{[r(\bar{k}_C) - \rho]} q(\bar{k}_C) \bar{k}_C. \quad (13')$$

Once (13') is confronted with (13), inclusive of (18), the equivalence between $\gamma_C$ and $\tau_C$ financings becomes transparent. The welfare implications however may differ, since in the $\tau_C$ financing exercise physical consumption can be reduced.

$^{20}$It is well-known that in a non-altruistic life-cycle setup there is no equivalence between consumption taxation and labor income taxation, as a consumption tax effectively combines a wage tax with a lump-sum tax on existing wealth; see, for example, Gravelle (1991).
tion good occurs. As the workers’ wage rises on impact proportionally more than consumption, aggregate labor hours supplied are increased, but less than in the long-run. $L_I$ initially expands as well, increasing the output of the capital good. Along the adjustment path, the capital stock accumulates, because of the excess supply in the labor-intensive sector, while $q$ returns asymptotically to its original level. The transitional dynamics are characterized by a decline in the interest rate, and a further increase in consumption, aggregate manhours and labor used in the capital good sector.

In the case of $\gamma_C$ financing, the saddle path of Fig. 1 shifts upward as soon as an unanticipated payroll tax reduction takes place. The relative price of the capital good immediately rises. The compensatory fall in government expenditure crowds in private consumption; as the rise in private consumption is smaller than the fall in government expenditure, aggregate demand of the consumption good actually falls; $Z_C$ drops as well, but less than the demand for the consumption good, so that an excess supply in the $C$-sector arises; the relative price of the capital good is therefore increased. The higher $q$ pulls up the real wage and the capital intensity, but diminishes the user cost of capital. The interest rate is reduced on impact. The rise in $k_C$ lowers labor hours used in the capital-intensive sector. Aggregate manhours rise immediately; it is not clear whether or not an overshooting of $L$ occurs. Labor used in the investment good sector expands. The excess supply of the capital good spurs capital formation along the transition path; $q$ further increases during the convergence toward the new stationary state.

When the $\tau_L$ shift is long-run neutral for aggregate labor hours, as for example in the $\gamma_I$ financing case, a short-run change of aggregate labor is registered. In fact, the impact drop of $q$ (stemming from a downward shift of the saddle-path, as in Fig. 1) raises consumption; the concomitant rise in $v^h$ pulls the consumption-to-wage ratio down as consumption increases proportionally less than the workers’ wage rate. Consequently, hours worked
jump up abruptly.

3 Small open economy

3.1 The model

Let us extend the analysis to a small open economy, having an unlimited access to the world capital market, and presenting the production and demographic structures studied before. Assume that the consumer good $Z_C$ is internationally tradable and perfectly substitutable with the analogous foreign-produced good, while the capital good $Z_I$ is internationally nontradable.

The asset menu is now composed of physical capital and net foreign interest-earning assets, $F$. Hence, financial wealth is defined as $W = qK + F$. Because of perfect capital mobility, the domestic interest rate is given by the exogenous world interest rate $r^*$. However, we postulate that interest income from financial wealth is taxed domestically at the proportional rate $\tau_W$.\footnote{Unlike the closed economy, in the small open economy a wealth tax differs from a tax on capital because net foreign assets enter agents’ portfolios.} Thus, the interest rate that households face is given by $(1 - \tau_W)r^*$; such an after-tax interest rate enters (2a’), (2c) and (2d).\footnote{As we consider the case in which nonhuman wealth is strictly positive, the condition $(1 - \tau_W)r^* > \rho$ must hold from (2a’).}

The perfect asset substitutability requires the equalization of the expected after-tax returns, namely,

$$r^* = \frac{R^h}{q} + \frac{\delta}{q} - \delta. \tag{20}$$

As the capital good is nontradable, the equilibrium condition in the investment good market is still given by (6). As the consumption good is per-
fectly tradable internationally, (7) must be replaced by the current account balance

\[ \tilde{F} = \phi(k_C)L_C - X(1 - \tau_C) - \gamma C L_C + r^* F. \quad (21) \]

According to (21), the sum of the trade balance, given by the consumption good output less the private and public absorption of the consumption good, and the interest income earned by holding net foreign assets gives the rate of accumulation of \( F \).

Finally, the government budget constraint now contemplates on the revenue-side also the item \( \tau W^* W \). This implies that, in the small open economy, the financing options based on a change in the tax mix also include the additional case of \( \tau W \) accommodation.

### 3.2 Dynamics

Let us investigate the properties of dynamic stability of the open economy in the representative case of \( y^g \) compensatory finance.

The semi-reduced forms (8a)-(8d) remain valid in this context. The semi-reduced forms for \( L \) and \( L_I \) are, instead, given by\(^{23}\)

\[ L = L(q, X, \tau_L), \quad L_q > 0; \quad L_X < 0; \quad L_{\tau L} < 0; \quad (22a) \]

\[ L_I = L_I(q, X, K, \tau_L), \quad L_{I,q} > 0; \quad L_{I,X} < 0; \quad L_{I,K} < 0; \quad L_{I,\tau_L} < 0. \quad (22b) \]

Inserting \( R^h \) from (8b) into (20), we have

\(^{23}\)Equation (22a) is obtained by plugging (8c) into (2b), while (22b) derives from jointly using (3), (8c) and (22a). 25
\[ \dot{q} = (r^* + \delta)q - R^h(q). \]

This is an unstable differential equation in \( q \). A finite long-run value for \( q \) is obtained if and only if \( (r^* + \delta)q = R^h(q) \); such a condition implies that the relative price of the capital good remains constant over time, eventually jumping from one equilibrium to another in response to exogenous \( \tau_L \) shocks that change its long-run value. Therefore, also \( k_C, R^h, \) and \( \nu^h \) exhibit jump solutions, with no transitional dynamics.

The dynamics require the analysis of a three equation system with one jump variable, \( X \), and two backward-looking variables, \( K \) and \( F \); such an equation system is composed of (2a’), (5) and (21), once (8d), (22b), \( q = \tilde{q} \) and \( W = \tilde{q} K + F \) have been taken into account. This investigation is performed in the unpublished Appendix, where it is shown that the properties of saddle-point stability are satisfied.

However, as \( K \) and \( F \) are both given in the short-run and \( q \) remains constant during the dynamic evolution of the economy (being unchanged in the long-run by a \( \tau_L \) shift under \( y^g \) finance), nonhuman wealth \( W = \tilde{q} K + F \) can be considered predetermined.\(^{24}\) This fact allows us to investigate the impact dynamics of an unanticipated exogenous \( \tau_L \) shock in a very simple manner. Plugging (2b) into (2d) for \( \nu^h L \) and using \( (1 + \tau_L)\nu^h = \omega \tilde{q} \), we obtain

\[ \dot{W} = r^*W + \omega \tilde{q}L - (2 + \tau_L)X. \]  

(23)

The core dynamics of the economy can be described by the linear differential equations (2a’) –once \( r = r^* \) is used– and (23) in the two variables

\(^{24}\)In this setup, \( W \) is an index of wealth at fixed prices, cousin of the capital income component of Friedman’s (1957) permanent income and Phelps’ (1994) income from wealth (given by interest income and actuarial dividend on nonhuman wealth).
$X$ and $W$. The phase diagram is depicted in Fig. 2. Saddle-point stability requires that the $\dot{X} = 0$ schedule, positively sloped, must be steeper than the upward sloping $\dot{W} = 0$ schedule. The saddle-path SS has a positive slope that lies in between the slopes of the $\dot{X} = 0$ and $\dot{W} = 0$ loci.

While the saddle-path of Fig. 2 can be used to detect the impact consequences of $\tau_L$ shifts, the transitional effects are less clear as they involve the adjustment of the two predetermined variables $K$ and $F$, which may exhibit oscillatory transitional behavior.

We show below that under the several budgetary regimes analyzed the only case in which $\tilde{q}$ is altered by a shift in $\tau_L$ is registered under the capital tax financing. Therefore, in all the experiments studied, except for the case of $\tau_K$ financing, the comparative dynamics remain qualitatively unchanged. When the capital tax rate is endogenously accommodated, $W$ is not fixed on impact, as $\tilde{q}$ jumps instantaneously to the new long-run level after a change in $\tau_L$ occurs; consequently, in this case the graphical apparatus of Fig. 2 is no longer valid for detecting the impact effects of payroll taxation.

### 3.3 Steady state effects of payroll tax cuts

The workings of the economy in the steady state can be easily captured through some crucial analytical relationships. The long-run determination of manhours and the nonhuman-wealth-to-wage ratio can be performed by

\[ \theta(\theta + \rho)(2 + \tau_L) > r^*(r^* - \rho) \]

This condition is satisfied if the inequality $\theta(\theta + \rho)(2 + \tau_L) > r^*(r^* - \rho)$ holds, as we assume.
using the same procedure seen for the closed economy; such variables are
determined through (14) and (15), once the interest rate faced by households
in this open economy, \((1 - \tau_W)\overline{r}^*\), is taken into account. It is immediately
evident that \(\frac{\overline{L}}{L}\) and \(\frac{\overline{W}}{\overline{L}}\) are modified by \(\tau_L\) shifts only in the \(y^\theta\) and \(\tau_W\)
financing experiments.

Employing \(\tilde{R} \equiv (1 + \tau_K) \tilde{R}^h\), and the asset arbitrage condition (20), the
demand for capital (1a) can be solved as follows

\[ \tilde{k_C} = \Phi(\tilde{q}, \tau_K), \quad \Phi_q < 0, \quad \Phi_{\tau_K} < 0. \]

Plugging (11) into this equation for \(\tilde{q}\), and rearranging yields

\[ \tilde{k_C} \equiv \frac{\tilde{K}}{\overline{L}_C} = \kappa(\tau_K), \quad \kappa' < 0. \tag{24} \]

The capital-labor ratio in the capital-using sector (and hence the real price
of the capital good) remains constant after a change in \(\tau_L\) takes place, being
fixed by the world interest rate, except when the government budget is bal-
anced through the accommodation of \(\tau_K\). The capital stock and labor hours
in the \(C\)-sector are determined through (13) and (24). Manhours used in the
\(I\)-sector follow from (3), after plugging in the solutions for \(\tilde{L}\) and \(\tilde{L}_C\).

We are now ready to develop the comparative static analysis. Table 2
summarizes the steady state effects of the different labor tax cuts.

### 3.3.1 Welfare state downsizing

i) \(y^\theta\) compensatory finance

This payroll tax shift reproduces the qualitative results shown in the
closed economy case for the corresponding experiment. The new element
of the small open economy is the effect on net foreign assets, which may
be positive or negative, although the behavior of nonhuman wealth remains unaltered.

ii) $\gamma_C$ compensatory finance

Since the domestic interest rate is tied down by the given world interest rate, labor hours and the nonhuman-wealth-to-wage ratio are left undisturbed by a cut in $\tau_L$. As the capital intensity in the $C$-sector and aggregate manhours are given, the capital stock and sectoral labor do not move. The fall in $\tau_L$, by increasing the workers’ wage, drives nonhuman wealth up; the rise in nonhuman wealth stems entirely from the increase in the holdings of net foreign assets, as the value of physical capital $qK$ is constant. Consumption is increased in equal proportion to $\bar{v}^h$, like nonhuman wealth.

iii) $\gamma_I$ compensatory finance

Under this financing regime, aggregate labor hours, the financial-wealth-to-wage ratio, the capital-labor ratio in the consumer-good industry and the price of the capital good are not influenced. The required reduction in $\gamma_I$ brings about an expansion in the capital stock and labor employed in the consumption good sector. As $\bar{L}$ is unchanged, labor used in the $I$-sector compensatorily decreases. Nonhuman wealth and consumption are raised. The net claims on foreigners may rise or fall.

iv) $L^g$ compensatory finance

When government labor services adjust to keep the government budget balanced, the macroeconomic effects of the payroll tax observed under the $\gamma_I$ financing are qualitatively reproduced, with the only difference that now labor used in the $I$-sector increases as well.
3.3.2 Change in the tax mix

Let us assume, as before, that government revenues are used to finance government purchases of the consumption good.

i) $\tau_K$ compensatory finance

This shock does not affect aggregate labor hours and the wealth-to-wage ratio. The capital-labor ratio in the consumption good sector is driven down, as the real rental on capital faced by firms increases because of the hike in capital taxation;\footnote{Using (19) together with (24) yields $\frac{dK_C}{d\tau_L} = \frac{\kappa'\tau_K^2}{(1 - \kappa'\tau_K)} > 0$.} hence, the relative price of the capital good falls. The rise in the capital tax rate, in turn, lowers the capital stock and increases labor in the $C$-sector; consequently, $\tilde{L}_I$ declines. Since the household wage may rise or fall, the effects on financial wealth and consumption are unclear. Net foreign assets also move ambiguously.

ii) $\tau_C$ compensatory finance

If the payroll tax is substituted with the value-added tax, the same effects observed in the $\gamma_C$ compensatory experiment are obtained. This is because of the equivalence, already noticed for the closed economy case, between the two accommodating procedures for the overall resource allocation.

iii) $\tau_W$ compensatory finance

When the wealth tax rate is elevated to compensate the revenue drop due to the cut in $\tau_L$, the real interest rate faced by households falls, implying, from (14) and (15), a rise in labor hours and a decrease in $\frac{\tilde{W}}{\tilde{V}^h}$.\footnote{These effects are immediately obtained by operating through equations (17') in footnote 15, once $\tilde{r}$ is replaced by $(1 - \tau_W)r^*$ and the reduced-form for $\tilde{W}$ is used. To get the reduced-form for $\tilde{W}$, we can substitute (15) with $y^g = 0$ into (7) for $\tilde{W}$, and, after some manipulations, have:}
the real price of the investment good are not modified, while the capital stock and sectoral labor hours in both sectors are pulled up by the rise in manhours. As the labor cost for firms does not change, the take-home wage is increased. Human wealth, which is pulled up, increases proportionally more than $v^h$. Nonhuman wealth and consumption rise, but less than the workers’ wage in relative terms. The effect on net foreign assets is, however, unclear.

Within the small open economy, there exists a qualitative correspondence in terms of macroeconomic equilibrium between wealth tax and welfare entitlement anxencings of a $\tau_L$ cut. Such a correspondence is to be ascribed to the same consequences exerted by the payroll tax rate on human wealth in the two budgetary regimes.\(^{28}\)

### 3.4 Dynamic effects of payroll tax cuts

Consider the comparative dynamics of an unexpected permanent reduction in $\tau_L$ when $y^g$ is endogenously accommodated. The real price of the capital good, the capital-labor ratio in the $C$-sector, and input prices faced by firms remain unaltered. The workers’ take-home wage is immediately increased to its new long-run level. The saddle-path shifts upward in Fig. 2 after the unanticipated drop in $\tau_L$ is implemented.\(^{29}\) For a given level of nonhuman

\[
\frac{q(k_C)(\omega + \delta k_C)}{(1 + \tau_L)} \{\tau_L + \frac{\tau_W r^*}{\theta[(1 - \tau_W)r^*]}\} = \gamma_C.
\]

Considering that $k_C$ is invariant and $\gamma_C$ exogenously given, we can solve this equation for $\tau_W$ and obtain the implicit function $\tau_W = \tau_W(\tau_L)$, where $\tau_W < 0$.

\(^{28}\)This can be understood by considering that, in the general case in which all fiscal variables are non-zero, long-run human wealth is, from (2c), given by: $H = \frac{v^h L + y^g}{[1 - \tau_W r^* + \theta]}$.

\(^{29}\)It is assumed for simplicity that the $W = 0$ schedule and saddle-path slopes are not influenced by the $\tau_L$ shift; in Fig. 2, the $W = 0$ schedule and the saddle-path are moved upward for an invariant $X = 0$ schedule.
wealth, consumption suddenly rises (proportionally less than the impact rise in \( v^h \)), undershooting its new long-run level. As the consumption-worker-wage ratio falls, labor hours supplied expand on impact more than in the long-run. \( L_I \) rises initially, while \( L_C \) does not move. The convergence toward the new stationary state is characterized by a gradual accumulation of nonhuman wealth, a further increase in consumption and a transitional fall in aggregate hours worked. The capital stock may increase; it is not clear whether its adjustment is monotonic or cyclical. The stock of net foreign assets also moves ambiguously in the medium-run.

Consider next the comparative dynamics of a cut in the payroll tax rate under \( \gamma_C \) financing. The increase in \( v^h \) suddenly raises consumption and, as \( X \frac{1}{v^h} \) declines, the supply of labor. \( L_I \) jumps up as well, while \( L_C \) remains invariant as the capital-labor ratio in the consumption industry is unchanged and the capital stock predetermined. Aggregate labor hours, however, increase only transitorily, as they come back to the original level asymptotically. After the economy has been placed on the new saddle-path, nonhuman wealth accumulates monotonically; net foreign assets may evolve in an oscillatory manner toward the higher steady state value. The capital stock increases first and declines next to return to its original level; the same dynamic behavior is observed for \( L_C \). Also \( L_I \) returns to its pre-shock level.

In the \( \tau_K \) financing regime, \( W \) immediately falls, because of the sudden adjustment of \( \bar{q} \), implying an abrupt fall in consumption and leisure. Labor hours may either rise or fall depending on how the workers’ wage moves; an impact reduction in labor hours is more likely to occur when the hourly wage (and therefore long-run nonhuman wealth) declines. Along the transition path, the cyclical behavior may involve nonhuman wealth, physical capital and net foreign assets as well as consumption and aggregate hours worked.
4 Concluding remarks

The macroeconomic consequences of labor taxation have been largely studied through intertemporal optimizing one-sector models. One-sector setups, while easily tractable from an analytical standpoint and hence useful to detect the principal aggregate effects of taxes on labor, have some limitations, which could affect their policy prescriptions. Moreover, the analysis of labor taxes has generally considered simple financing schemes; a deepened understanding of the role played by the budgetary regimes accompanying labor tax shifts is required as many offsetting effects that may arise risk annihilating the expected goals of the policy actions.

In this paper, a two-sector overlapping-generations model of investment in fixed capital has been developed with the scope of reconsidering in a richer environment the causal association between payroll taxation and the main macroeconomic variables. Neoclassical two-sector closed and small open economies with endogenous labor-leisure choices have been considered.

The effects on manhours, wealth formation, and economic growth, and the financing schemes of the payroll tax cuts have been at the center stage of the investigation. Two general budgetary strategies accompanying the labor tax cuts have been studied, one in which the drop in the tax revenues is balanced through the compensatory reduction in government expenditure, and one in which the structure of distortionary taxation is modified in a revenue-neutral form; in each of the two general financing regimes, we have explored a variegated constellation of sub-cases. As in a two-sector life-cycle economy, the structure of demand and the financing regimes of the tax shift matter, the type of government expenditure that is compensatorily accommodated has profound implications for the consequences of the labor tax reforms; obviously, the type of distortionary taxation used to balance the government budget has strong implications too.
In the setup studied here, where a consumption good is produced along- side an investment good, the real price of the capital good plays a crucial role in the functioning of the economy; in fact, it accomplishes the dual role of being an asset price and therefore reconciling the asset market equilibrium, on the one side, and equilibrating the good markets, on the other.

Surprisingly, we discovered that there are cases in which a payroll tax cut is an ineffective instrument to influence labor hours in the stationary state, while in general (with the only exception of a compensatory hike in capital taxation) such a shock is benign for both capital and nonhuman wealth formation. As labor supplied ultimately depends on the worker take-home wage relative to (income from) private and social wealth, the neutrality of payroll taxes for hours worked is obtained in those cases in which (income from) nonhuman wealth and the household wage change by the same proportion. Steady state neutrality is, however, always accompanied by short-run changes in the aggregate labor supply, disappearing asymptotically. The cases of long-run invariance of aggregate manhours, which depend upon the financing regime that accompanies the tax shift, are more likely to occur in the small open economy than in the closed one.

Some principles of public finance can be drawn from the differential payroll tax analysis conducted in the two-sector life-cycle economies. First of all, a qualitative equivalence in terms of the resource allocation between welfare entitlement and wealth tax financings of labor taxation emerges in the small open economy case. This equivalence does not hold for the closed economy case, where the two types of budgetary schemes remain clearly distinct as long as the payroll tax effects are concerned. Second, government expenditure on the consumption good and consumption tax accommodation represents equivalent financing schemes, both in closed and small open economies. Third, financing procedures based on public expenditure on the capital good or government labor adjustment are basically equivalent for the
macroeconomic equilibrium, except for the disparate effect exerted on labor hours used in the capital-good sector. Furthermore, in a two-sector (as in the single-sector) setup, taxing nonhuman wealth in a closed economy or in a small open one is a totally different thing. While in the closed economy, a labor tax cut accompanied by a hike in the wealth tax exerts adverse effects on the capital stock, nonhuman wealth and manhours worked, in the small open economy such a payroll tax shift spurs capital and nonhuman wealth formation, but is long-run immaterial for hours supplied.

Our results have been obtained under the hypothesis that the capital-good-producing sector is labor-intensive. The case of a reversed assumption on factor-intensities should be investigated to detect the robustness of our findings.\(^{30}\)

The analysis has also incorporated the simplifying hypotheses that government expenditure on goods and labor services do not affect consumption and leisure choices, on the one hand, or the productive capacity of the economy, on the other. These assumptions could be realistically removed for those types of welfare state expenditure that impinge directly on the behavior of households or firms.

Moreover, as the rise in payroll taxes in many European countries in the last decades has been the result of population ageing (which led to the expansion in the social security systems, mainly organized on a "pay-as-you-go" basis), a life-cycle model with retirement would be required to properly discuss the macroeconomic implications of pension reforms aimed at alleviating the tax burden on labor. Unfortunately the Blanchard-Yaari model does not consider retirement; it could however be amended to incorporate mandatory

\(^{30}\)As in such a case the analysis may become difficult to manage, it could be considered—parallelly to our analysis—the extreme and simplifying case in which the consumption good is produced by using labor alone, while the capital good is obtained by employing physical capital and sectoral labor.
retirement, as done in Hoon and Phelps (2004).31

Finally, there is another important extension of our two-sector analysis that is worth exploring: the case of a labor market with structural unemployment. This modification, which is interesting *per se* for reconsidering all the experiments discussed in the paper, has also the advantage of making it possible to investigate in a dynamic general equilibrium context payroll tax cuts financed by reductions in unemployment benefits. Such a proposal for reforming the welfare state, largely debated in academic and political circles, has been mainly discussed through partial equilibrium frameworks.32

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31 Alternatively, the Diamond-Samuelson OLG demographics could be employed in the two-sector models developed here.
32 See, for example, Layard, Nickell, and Jackman (1991), and Atkinson (1999).
References


Table 1. *Closed economy*: Steady state effects of a *reduction in* $\tau_L$ *under different budgetary regimes*.

<table>
<thead>
<tr>
<th>Budgetary regimes:</th>
<th>$\bar{k}_c$</th>
<th>$\bar{q}$</th>
<th>$r$</th>
<th>$\bar{R}^f$</th>
<th>$\bar{R}^h$</th>
<th>$\bar{v}^f$</th>
<th>$\bar{v}^h$</th>
<th>$\bar{L}$</th>
<th>$\frac{W}{\bar{v}^hL}$</th>
<th>$\bar{X}$</th>
<th>$\bar{W}$</th>
<th>$\bar{X}$</th>
<th>$\bar{K}$</th>
<th>$\bar{L}_c$</th>
<th>$\bar{L}_I$</th>
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<tr>
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</table>
Table 2. **Small open economy**: Steady state effects of a reduction in $\tau_L$ under different budgetary regimes.

| Budgetary regimes: | $\bar{k}_C$ | $\bar{q}$ | $\bar{r}^*(1-\tau_W)$ | $\bar{R}_f^h$ | $\bar{R}_b^h$ | $\bar{v}_f^b$ | $\bar{v}_b^b$ | $\bar{L}$ | $\bar{W}/\bar{v}_b^b\bar{L}$ | $\bar{X}/\bar{v}_b^b\bar{L}$ | $\bar{W}$ | $\bar{X}$ | $\bar{K}$ | $\bar{L}_C$ | $\bar{L}_f$ | $\bar{F}$ |
|------------------|-------------|-------------|------------------------|----------------|----------------|----------------|----------------|---------|----------------------------|-----------------------------|---------|---------|---------|------------|------------|---------|---------|
| ↓ $\gamma^g$     | 0           | 0           | 0                      | 0              | 0              | 0              | 0              | +       | +                          | −                          | −       | +       | +       | +          | +          | +       | ?       |
| ↓ $\gamma_C$     | 0           | 0           | 0                      | 0              | 0              | 0              | 0              | +       | 0                          | 0              | 0       | +       | 0       | 0          | 0          | +       | +       |
| ↓ $\gamma_I$     | 0           | 0           | 0                      | 0              | 0              | 0              | 0              | +       | 0                          | 0              | 0       | +       | +       | +          | +          | +       | −       |
| ↓ $L^g$          | 0           | 0           | 0                      | 0              | 0              | 0              | 0              | +       | 0                          | 0              | 0       | +       | +       | +          | +          | +       | +       |
| ↑ $\tau_K$       | −           | −           | 0                      | +              | −              | −              | ?              | 0       | 0                          | 0              | ?       | −       | +       | −          | −          | ?       | ?       |
| ↑ $\tau_C$       | 0           | 0           | 0                      | 0              | 0              | 0              | 0              | +       | +                          | 0              | 0       | 0       | 0       | 0          | 0          | +       | +       |
| ↑ $\tau_W$       | 0           | 0           | −                      | 0              | 0              | 0              | 0              | +       | +                          | −              | −       | +       | +       | +          | +          | +       | +       |


Figure 1

Closed economy: $\gamma^c$ compensatory financing. Comparative dynamics.
Small open economy: $y^e$ compensatory financing. Comparative dynamics.