

SEPARATE APPENDIX

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Abstract

This separate Appendix accompanies our paper “Transition Strategies in Enacting Fundamental Tax Reform”, forthcoming in *National Tax Journal*.

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Appendix A: Investment and Financing Decisions

The Appendix derives investment and financing choices from intertemporal optimization. The costs of debt and equity at the firm level depend on personal capital income taxes. Given tax rates t^B on interest, t^D on dividends and t^G on capital gains, no-arbitrage dictates identical net rates of return on perfectly substitutable assets. With the residence principle of interest taxation, gross interest rates are equal across countries, $i = i^*$, leaving a net interest $r = (1 - t^B) i^*$ on internationally tradeable bonds. In a small country, the world interest i^* is fixed. If interest on business debt is taxed at the same rate, no-arbitrage requires a gross rate $i^B = i^*$ which is the cost of debt to firms. Holding equity shares yields dividends and capital gains (D and ∇) subject to effective tax rates t^D and t^G where V is the firm value and V^N is the value of new share issues (net of share repurchases). Firm valuation must satisfy the no-arbitrage condition

$$r \cdot V = (1 - t^D) D + (1 - t^G) \nabla, \quad \nabla \equiv V_{t+1} - V^N - V. \quad (\text{A.1})$$

Gross income on firm ownership is $D + \nabla$. Given that dividends amount to a share θ of total returns, $D = \theta \cdot (D + \nabla)$, while the remaining share accrues in terms of capital gains, firm

valuation is equivalently written as $rV = (1 - t^E)(D + \nabla)$, or

$$(1 + i^E)V = D - V^N + V_{t+1}, \quad i^E \equiv r/(1 - t^E), \quad t^E = \theta t^D + (1 - \theta)t^G. \quad (\text{A.2})$$

The investor's required return i^E reflects an average of dividends and capital gains. In turn, the marginal tax rate t^E is an average of dividend and effective capital gains tax rates, weighed together with the pay-out ratio θ . The higher the pay-out ratio, the more the firm relies on new share financing, and the more the old view of dividend taxation applies.¹

Firms maximize the present value of dividends net of new share issues, see (A.2). A firm's financial policy is constrained by the identity $D + I = \pi + V^N + (B^N - \delta B)$, i.e. dividends and *gross* investment must be financed out of profits (*gross* of depreciation), new share issues and net new debt. Using the financial identity yields net dividends $\chi = D - V^N = \pi - I + B^N - \delta B$. Defining the end of period value function by $V^e \equiv (1 + i^E)V$ results in a dynamic program $V^e(K, B, K^T, K^D) = \max_{I, B^N} \chi + V_{t+1}^e / (1 + i_{t+1}^E)$ subject to (1-2). Use $\tilde{Y}$ and π in (2), define shadow prices $\eta^K = dV^e/dK$, $\eta^B = -dV^e/dB$, $\eta^T = dV^e/dK^T$ and $\eta^D = dV^e/dK^D$, and observe τ^K as given in (A.3). Optimality conditions for investment and new debt are

$$\begin{aligned} \eta_{t+1}^K / (1 + i_{t+1}^E) &= (1 - t^K) J_I + 1 - \epsilon^I \tau^K - (1 - \epsilon^I) \eta_{t+1}^T / (1 + i_{t+1}^E), \\ \eta_{t+1}^B / (1 + i_{t+1}^E) &= 1 - \epsilon^N \tau^K, \quad \tau^K \equiv \epsilon^0 t^K + (1 - \epsilon^0) \eta_{t+1}^D / (1 + i_{t+1}^E), \end{aligned} \quad (\text{A.3})$$

and envelope conditions for the four stock variables are

$$\begin{aligned} \eta_t^K &= (1 - t^K)(F_K - J_K) + \epsilon^E i^E \tau^K \\ &\quad + (1 - \epsilon^B \tau^K)(bm' - m) + (1 - \delta) \eta_{t+1}^K / (1 + i_{t+1}^E), \\ \eta_t^B &= i^B + m' + \delta - [\epsilon^N \delta - \epsilon^E i^E + \epsilon^B (i^B + m')] \tau^K + (1 - \delta) \eta_{t+1}^B / (1 + i_{t+1}^E), \\ \eta_t^T &= t^K \delta^T + (1 - \delta^T) \eta_{t+1}^T / (1 + i_{t+1}^E), \\ \eta_t^D &= t^K \delta^D + (1 + i^E - \delta^D) \eta_{t+1}^D / (1 + i_{t+1}^E). \end{aligned} \quad (\text{A.4})$$

In a steady state, the shadow price of unused deductions is $\eta^D = (1 + i^E)t^K$, implying $\tau^K = t^K$. It doesn't matter *when* deductions are used up, as long as they are carried forward with interest. Using this, interpretations of the other conditions are standard, see Section 2.1. Combining (A.3-A.4) to eliminate η^B yields optimal capital structure in (3).

The effective tax subsidy to the purchase cost of new capital in (A.3) is

$$Z \equiv \epsilon^I t^K + (1 - \epsilon^I) \eta^T / (1 + i^E), \quad \eta^T / (1 + i^E) = \delta^T t^K / (i^E + \delta^T), \quad (\text{A.5})$$

¹To be more flexible with respect to the old and new views of dividend taxation, we actually distinguish between marginal and average pay-out ratios, see Keuschnigg and Keuschnigg (2010) for details.

where η^T is the present value of tax depreciation from (A.4). Normalizing adjustment costs to be zero in a stationary state, $J_I = J_K = 0$, the shadow price of capital in (A.3) becomes $\eta^K = (1 - Z)(1 + i^E)$. Using this in (A.4) and eliminating m' by the condition for optimal capital structure in (3) yields the *user cost of capital*

$$\begin{aligned} u^K &\equiv F_K - \delta = \frac{\delta t^K - (i^E + \delta)Z + (1 - \epsilon^B t^K)m}{1 - t^K} \\ &: + \frac{(1 - \epsilon^E t^K)i^E}{1 - t^K} \cdot (1 - b) + \frac{(1 - \epsilon^B t^K)i^B + \epsilon^N t^K i^E}{1 - t^K} \cdot b. \end{aligned} \quad (\text{A.6})$$

Using P^I for the first term and noting (A.5) results in (4).

Appendix B: Behavioral Elasticities

Table 1 reports the most important parameters. Some of them are standard and are, thus, not discussed in much detail (see Altig et al., 2001, for a comparison). The interest rate and the growth rate of labor productivity and of GDP reflect long-run averages for Germany. About 60% of investment is externally financed (see OECD Economic Outlook, December 2004). The elasticity of substitution between capital and labor is chosen to replicate empirical estimates of the elasticity of investment with respect to the user cost of capital (see Table 2 below). The effective tax rates on hours worked of actively employed and on job search of unemployed workers summarize the total tax burden from wage income taxes, (employee) social security contributions and indirect taxes. The effective tax rate on hours worked amounts to 35% for the youngest age group (20-30 years-old) and rises to 40% for the 40-50 years-old with higher earnings. The effective tax rate on job search is substantially larger and amounts to 69%. Like a participation tax rate, this rate summarizes the total fiscal burden that accrues when switching from unemployment into employment. Essentially, it corresponds to the wage and contribution tax burden *plus* the forgone unemployment benefit as a share of earnings. The replacement rate of unemployment benefits alone amounts to roughly 50%. Such high participation tax rates are usual in Europe, see Immervoll et al. (2007). The bargaining power of employees in wage negotiation and the matching elasticity determine the wage and unemployment rates in labor market equilibrium. When the bargaining power is larger than the matching elasticity as in Table 1, the unemployment rate is inefficiently high (see Hosios, 1990). A reduction in the unemployment rate would yield significant welfare gains.

Table B1: Model Parameters

<i>Investment and Financing:</i>		
g	Growth rate of labor productivity	0.015
i	Real interest rate, gross	0.052
r	Real interest rate, net	0.040
δ	Depreciation rate of capital	0.076
b	Share of external debt financing	0.600
α	Share of capital income	0.350
τ^I	Effective tax rate, investment	0.133
τ^S	Effective tax rate, savings	0.237
τ	Effective tax rate, total capital	0.338
<i>Consumption and Labor Supply:</i>		
σ^C	Intertemporal elasticity of substitution	0.350
τ^L	Effective tax rate, young, hours worked	0.350
τ^{JS}	Effective tax rate, young, job search	0.688
<i>Frictional Labor Market:</i>		
ξ	Bargaining power employees	0.750
η	Matching elasticity w.r.t. job search	0.500
$\bar{u}$	Average unemployment rate	0.105

Table 2 summarizes behavioral elasticities in long-run equilibrium. Given the econometric evidence discussed in Immervoll et al. (2007) and Blundell and MaCurdy (1999), the elasticity of intensive labor supply (effective hours worked) with respect to the net real wage is set to $\epsilon_L = 0.2$. Accordingly, a 1 percent larger net real wage results in a reduction of the effective hours worked by 0.2 percent. The fiscal effects on the unemployment rate reflect evidence from OECD countries. Scarpetta (1996) estimated that an increase by 10 percent in the replacement rate for unemployment benefits results in an increase of 1.3 percentage points in the unemployment rate. This value is consistent with estimates of 1.7 in Layard, Nickell and Jackman (1991), 1.1 in Nickell (1997) and similar in Blanchard and Wolfers (2000), see Holmlund (1998) for a survey. We parametrize our model such that an increase in the replacement rate by 10 percent raises the unemployment rate by 1.4 percentage points, i.e. $\epsilon_U = 1.4$.

The sensitivity of firms' debt behavior is based on Gordon and Lee (2001). The study estimates an elasticity $\epsilon_B = 0.36$, implying that an increase in the profit tax by 10 percentage

points would raise the debt ratio by 3.6 percentage points. Graham, Lemmon and Schallheim (1998) get a similar elasticity of 0.426. The growth effects of a tax reform depend crucially on how sensitive investment and capital accumulation are to a tax induced cut in the user cost of capital. Hassett and Hubbard (2002) review the literature and put the elasticity of capital demand with respect to the user cost in the range between -0.5 and -1. According to De Mooij and Ederveen (2003), the response of direct investment of multinational firms is even stronger. Hence, we set the elasticity of capital demand at $\epsilon_K = -1$ and calibrate the elasticity of substitution between capital and labor to replicate this elasticity.

Table B2: Behavioral Elasticities in Equilibrium

Elasticity hours worked	ϵ_L	0.205
Elasticity unemployment rate	ϵ_U	1.417
Elasticity debt ratio	ϵ_B	0.365
Elasticity investment	ϵ_K	-0.951
Half-life of capital stock adjustment	$T_{0.5}$	8.000

Legend: ϵ_L %-increase in hours worked wrt. 1% higher real wage. ϵ_U %-points unemployment rate wrt. 10% higher replacement rate of un employment insurance. ϵ_B %-points debt ratio wrt. 1%-point higher corporate tax rate. ϵ_K %-decrease in capital stock wrt. 1% higher user cost. $T_{0.5}$ half-life of capital adjustment in years.

Capital accumulation is a slow process and affects output, wages and tax revenue only after some delay. In an open economy, and according to the q-theory of investment (see Hayashi, 1982), the length of the transition phase is controlled by adjustment costs to investment. It is optimal for firms to spread investment over several periods and avoid excessive fluctuations. We calibrate adjustment cost parameters to replicate estimates of the transition speed as measured by the half-life of capital stock adjustment. According to estimates by Cummins, Hassett and Hubbard (1996), and the overview of the empirical literature in Hassett and Hubbard (2002), about half of the long-run adjustment in the capital stock is achieved within 7 to 8 years.

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