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MARGINAL EXCESS BURDEN IN A DYNAMIC ECONOMY

Kenneth L. JUDD
Northwestern University, Evanston, IL 60201, USA

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This note describes the computation of the marginal welfare cost of factor taxation in a dynamic representative agent perfect foresight general equilibrium model. We find that this excess burden varies substantially across instruments and is sensitive to anticipation effects.

1. Introduction

The assessment of the excess burden of tax structures is one of the most basic questions in public finance. This note describes an analysis of marginal excess burden in a perfect foresight representative agent model.

Earlier analyses of dynamic models have concentrated on approximating total excess burden and large tax changes, and have often used an ad hoc savings formulation. Auerbach, Kotlikoff and Skinner (1983) study numerical approximations of large tax changes in an overlapping generations model. Chamley (1981) approximated total excess burden using quadratic approximations around untaxed steady states of growth models. Ballard, Shoven and Whalley (n.d.) is a recent example of the ad hoc savings function approach.

In this note we exactly compute the marginal excess burden of labor and capital income taxation and of the investment tax credit. The marginal excess burden is an important index of taxation costs since it gives the rate of gain of small tax reforms, which are more frequent, and since it is an important determinant of appropriate cost–benefit criteria for public goods.

2. The model

We assume all agents have an intertemporal utility function

$$U=\int_0^\infty e^{-\rho t}u(c,\ l)\,\mathrm{d}t, \tag{1}$$

where c is consumption flow and l is labor. Output is produced via a concave production function, $F(K,\ l)$, using capital K and labor l. The output can be used either for consumption or investment, implying

$$F(K,\ l)=c+\dot{K}+\delta K, \tag{2}$$

where δ is the rate of depreciation of capital. Individual agents invest in value-maximizing firr paying taxes at the proportional rate τ_K on all income, dividends or interest payments. The fir receive an investment tax credit at rate θ on gross investment. Agents also supply labor, paying wa taxes at the rate τ_L. All revenues are lump-sum rebated.

3. Equilibrium

Let λ be the marginal value of capital, w the wage rate and r the rate of return on an investme net of depreciation. Then, utility maximization implies $-u_l = w(1-\tau_L)u_c$, and that the margi value of capital must equal its consumption opportunity cost as well as the increment to U achie by the future extra net income,

$$u_c(1-\theta) = \lambda(t) = \int_t^{\infty} e^{\rho(s-t)} u_c(c,\, l)\left[r(1-\tau_K) + \delta\theta\right] \mathrm{d}s.$$

In competitive equilibrium, we have marginal product factor pricing

$$r = F_K(K,\, l) - \delta, \qquad w = F_l(K,\, l) = -u_l/\left(u_c(1-\tau_L)\right).$$

Since revenues are lump-sum rebated, the material balance identity is

$$\dot{K} = F(K,\, l) - c - \delta K.$$

We express equilibrium as a pair of differential equations. Combining (3) and (4), we can expr consumption demand and labor supply as functions of the contemporaneous λ, K and parameters, $C(\lambda, K, \tau_L, \theta)$ and $L(\lambda, K, \tau_L, \theta)$, respectively. Differentiation of (3) yields, using

$$\dot{\lambda} = \lambda\left(\rho - \left[(F_K - \delta)(1-\tau_K) - \delta\theta\right]/(1-\theta)\right).$$

When we substitute $C(\lambda, K, \tau_L, \theta)$ and $L(\lambda, K, \tau_L, \theta)$ for c and l in (5) and (6), eqs. (5) and become the equilibrium system of differential equations, yielding a unique solution when we imp asymptotic stability.

4. Computation of excess burden

To examine excess burden of the tax structure, we perform the following exercise: suppose that economy is at the steady state of the old tax structure when an unanticipated permanent margi change is made in a tax instrument. The impact on the economy is achieved by linearizing the sys (5)–(6) as described in Judd (1983a). The marginal excess burden, *MEB*, is the change in welfare unit of revenue gain. More precisely, an *MEB* of -0.50 means that if the revenue gain could incr the lump-sum rebate to agents by \$1.00 per unit of time forever, then the drop in welfare relativ the old steady state is equivalent to a reduction in consumption of 50¢ per unit of time forever.

Space limits discussion of quantitative examples. [See Judd (1983b) for a more complete dis sion.] Table 1 examines the effects of changes in τ_K, τ_L and θ, around the steady state correspon to $\tau_K = 0.4$, $\tau_L = 0.3$ and $\theta = 0.05$. [1] Each row corresponds to a (T_1, T_2) pair, where T_1 is the tim

[1] Chamley's (1981) independent attempt to generalize Judd (1981) to the case of elastic labor supply yields incorrect e burdens since he uses f' to discount marginal flows, whereas Judd (1983a) shows that ρ is correct.

Table 1
Marginal excess burdens and investment impacts. [a]

T_1	T_2	τ_L		τ_K		θ	
		MEB	d*I*	*MEB*	d*I*	*MEB*	d*I*
0	∞	−0.124	−0.106	−0.98	−0.514	16.2	0.690
4	∞	−0.110	0.153	−1.24	−0.302	−41.2	−0.257
8	∞	−0.101	0.090	−1.47	−0.177	−10.5	−0.151
20	∞	−0.087	0.018	−1.90	−0.036	−4.4	−0.030
40	∞	−0.082	0.001	−2.11	−0.002	−3.5	−0.002
0	4	−0.207	−0.259	−0.14	−0.213	2.9	0.947
0	8	−0.188	−0.196	−0.26	−0.338	3.3	0.841
0	20	−0.154	−0.124	−0.55	−0.479	4.9	0.720
0	40	−0.134	−0.108	−0.80	−0.512	8.4	0.692
0	1	−0.227	−0.335	−0.04	−0.064	2.6	1.07
4	5	−0.178	0.019	−0.34	−0.038	3.6	−0.03
8	9	−0.146	0.011	−0.65	−0.022	5.9	−0.19
20	21	−0.102	0.002	−1.45	−0.004	−11.2	−0.00
40	41	−0.084	0.00	−2.02	−0.00	−3.8	−0.00

[a] $\beta = -1$, $\bar{\eta} = 0.2$, $\epsilon = -0.1$, $\sigma = 1.0$

which an instrument is raised marginally and T_2 is the time when it falls back to its initial value. A unit of time is that period during which utility is discounted by 1 percent. For each tax instrument, there are two columns, the first being the *MEB* of the tax change announced at $t = 0$, and the second being dI, the impact on investment at $t = 0$. If a tax parameter is increased by 0.01, investment at $t = 0$ changes by dI percent of net output. We assume capital share of net output to be 0.25 and depreciation is 0.12 of net output, values suggested by national income accounts. Our results are insensitive to these choices. Table 1 assumes values for the intertemporal elasticity of consumption demand, β, uncompensated wage elasticity of labor supply, $\bar{\eta}$, income elasticity of labor supply, ϵ, and elasticity of factor substitutability in net output, σ, which lie in the range of current econometric estimates. [2]

Some striking results are immediately apparent. *First*, note the wide disparity in the *MEB* for the various taxes. For all parameter values, the excess burden of θ (or, equivalently, the marginal benefit of raising θ) substantially exceeds that of τ_K, which in turn exceeds that of τ_L except when the capital tax increase is current and short-lived. In fact, temporary investment tax credits are self-financing, since positive *MEB* implies that utility and revenue move in the same direction. *Second*, note the level of these distortions. They substantially exceed those computed in Chamley (1981), which used a linear-quadratic approximation around the untaxed steady state instead of linearizing around the taxed steady state as is done here. This shows that global extensions of linearized systems gives misleading results when applied to dynamic behavior away from the base of the linearization. *Third*, the one period tax increases, i.e., when $T_2 = T_1 + 1$, have the interesting property that the excess burden rises rapidly in T_1 for τ_K but drops for τ_L and θ. The reason that future labor taxation is less distortionary than current labor taxation is that it encourages investment, as reflected in the positive dI entries – future labor taxation reduces lifetime welfare, causing current consumption to drop and investment to rise, reducing the distortion in the capital market. *Fourth*, we can determine short-run

[2] See Killingsworth (1983) for discussion of aggregate labor supply estimates. See Judd (1983a) for discussion of estimates of σ and β.

effects of balanced budget tax changes. For example, suppose that τ_L is reduced for four perio then raised permanently at $T=4$ sufficient to balance the intertemporal budget. Both the short-run reduction and the later τ_L increase causes investment to rise initially, as indicated in table 1. T same is true in the short run if θ is raised then lowered. In particular, short-run debt may have anti-Keynesian effect on consumption since consumption (not displayed in table 1) falls.

We make no claim that this parameterization is the best one. However, these results surprisingly robust across the alternative parameterizations suggested by the empirical literature [Judd (1983b)]. The levels of MEB are substantially affected by different β, $\bar{\eta}$, ϵ and σ, but neit the rankings discussed above nor the conclusions concerning short-run effects are affected.

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