Economics 230a, Fall 2013
Lecture Note 13: Taxation and Business Investment

We now turn now to the real side of firm decisions, in particular to investment behavior. Although we traditionally think of plant and equipment, of growing importance is investment in intangible assets, as through R&D spending. We will confront several issues, including the role of expectations, temporary incentives and the connection between investment and market value.

The User Cost of Capital

A basic concept for analyzing the impact of taxes on investment is the user cost of capital, as originally derived by Jorgenson (*AER* 1963) and used in both theoretical and empirical analysis. We consider the decisions of a firm wishing to maximize its value at date *t*,

(1) $$V_t = \int_t^{\infty} e^{-r(s-t)} X_s ds,$$

where *r* is the discount rate relevant for the corporation's cash flows from real activities at each date *s*, X_s. One can show that *r* is a weighted average of the firm's debt and equity capital costs. Note that, under the new view of dividend taxation, the right-hand side would also incorporate an adjustment for the ratio based on dividend and capital gains taxes, $\left(\frac{1-\theta}{1-c}\right)$, but as this correction has no influence on the optimization decision we will ignore it for now. (We touch on it below when discussing the determination of the market value of the firm's capital stock.)

We assume that the firm uses capital and labor in production, so that its cash flows at date *s* are:

(2) $$X_s = (1-\tau_s)\left[p_s F(K_s, L_s) - wL_s\right] - q_s I_s (1-k_s) + \tau_s \int_{-\infty}^{s} D_u(s-u) q_u I_u du$$

where p_s is the output price, *w* is the wage (assumed constant), K_s and L_s are capital and labor used in production $F(\cdot)$, q_s is the price of new capital, and I_s is the flow of real investment. The corporate tax system has three components: τ_s, the corporate tax rate, k_s, the initial subsidy to investment (e.g., an investment tax credit), and $D_u(s-u)$, the date-*s* depreciation deduction per dollar of investment made at an earlier date *u*. This deduction depends not only on the age of the asset, $(s-u)$, but also on the tax depreciation rules as of date *u*. Inserting (2) into (1) yields:

$$V_t = \int_t^{\infty} e^{-r(s-t)} \left((1-\tau_s)\left[p_s F(K_s, L_s) - wL_s\right] - q_s I_s (1-k_s) + \tau_s \int_{-\infty}^{s} D_u(s-u) q_u I_u du \right) ds$$

$$= \int_t^{\infty} e^{-r(s-t)} \left((1-\tau_s)\left[p_s F(K_s, L_s) - wL_s\right] - q_s I_s (1-k_s) + \tau_s \int_{t}^{s} D_u(s-u) q_u I_u du + \tau_s \int_{-\infty}^{t} D_u(s-u) q_u I_u du \right) ds$$

$$= \int_t^{\infty} e^{-r(s-t)} \left((1-\tau_s)\left[p_s F(K_s, L_s) - wL_s\right] - q_s I_s (1-k_s) + \tau_s \int_{t}^{s} D_u(s-u) q_u I_u du \right) ds + \overline{V}_t$$

where we break depreciation allowances down into those attributable to investment after date *t* and before *t*. The second piece, with value $\overline{V}_t$, affects firm value at date *t*, but not decisions from date *t* onward, and so may be ignored in the optimization. (It will be relevant later.) The remaining expression for firm value can be simplified by changing the order of integration for depreciation allowances (starting with date of allowances, rather with date of investment):

$$(3)\quad \begin{aligned} V_t &= \int_t^\infty e^{-r(s-t)}\left((1-\tau_s)\left[p_s F(K_s,L_s) - wL_s\right] - q_s I_s(1-k_s) + q_s I_s \int_s^\infty e^{-r(u-s)}\tau_u D_s(u-s)du\right)ds + \overline{V}_t \\ &= \int_t^\infty e^{-r(s-t)}\left((1-\tau_s)\left[p_s F(K_s,L_s) - wL_s\right] - q_s I_s(1-\Gamma_s)\right)ds + \overline{V}_t \end{aligned}$$

where $\Gamma_s = k_s + \int_s^\infty e^{-r(u-s)}\tau_u D_s(u-s)du$ is the value of tax benefits per dollar invested at *s*.

The firm seeks to maximize its value at time *t*, as defined in expression (3), through the choice of labor and investment at each subsequent date. For labor the first-order condition will be simple, that $p_s F_L = w$. Determining the optimal investment policy requires further specification of the firm's technology. It is usually assumed that capital depreciates exponentially at rate δ, that is:

$$(4)\qquad \dot{K}_t = I_t - \delta K_t$$

Note that δ is capital's rate of actual, or <u>economic depreciation</u>, and is generally distinct from the pattern of depreciation allowances specified by the function $D(\cdot)$ defined above. Inserting (4) into (3), one can then solve for the optimal capital stock path using the calculus of variations. The Euler equation, $\frac{\partial V_t}{\partial K_s} - \frac{d\left(\partial V_t/\partial \dot{K}_s\right)}{ds} = 0$, yields the following solution for marginal product of capital:

$$(5)\qquad F_K = \frac{q_s^*}{p_s}\frac{\left(r + \delta - \dot{q}_s^*/q_s^*\right)}{(1-\tau_s)}$$

where $q_s^* = q_s(1-\Gamma_s)$, which one may think of as the effective price of capital goods, taking into account the present value of tax benefits directly associated with investment. The expression on the right-hand side of (5), the implicit rental price of capital, is commonly referred to as the user cost of capital. With a constant tax system, $\dot{q}_s^*/q_s^*$ is just $\dot{q}_s/q_s$ and the term in parentheses in the numerator is just the real required return to investors $r - \dot{q}_s/q_s$ plus the rate of depreciation, δ.

Special Cases (with tax parameters constant over time):

Immediate expensing: $\Gamma_s = \tau_s$, so the user cost becomes $\frac{q_s}{p_s}\left(r + \delta - \dot{q}_s/q_s\right)$; the tax system affects investment only through its impact on the required rate of return, *r*.

Economic depreciation allowances (at replacement cost): $D_s(u-s)=\frac{q_u}{q_s}\delta e^{-\delta(u-s)}$; for a constant inflation rate, this implies that $\Gamma_s=\tau\frac{\delta}{r+\delta-\dot{q}/q}$, so the user cost becomes $\frac{q_s}{p_s}\left(\frac{r-\dot{q}_s/q_s}{1-\tau}+\delta\right)$. The tax system effectively taxes the net (after depreciation) return to investment, $r-\dot{q}_s/q_s$.

Temporary Tax Policy and Costs of Adjustment

Tax policy is not static. Particularly when investment incentives are concerned, tax policy may change frequently. For example, the United States adjusted the value of Γ, as defined above, through a program known as "bonus depreciation," several times within the past decade, in response to two recessions. (See House and Shapiro for an analysis.) How do such changes affect the incentive to invest and the timing of investment? Also, the above derivation of the user cost of capital assumes that firms can adjust their capital stock as quickly as desired, to set the marginal product of capital equal to the user cost at each instant. If this is not a realistic short-run assumption, what modifications to the model would be appropriate?

On the first question, we can consider the impact on the user cost expression in (5) when tax policy is changing. In particular, note that $\dot{q}_s^*/q_s^*=\dot{q}/q-\dot{\Gamma}/(1-\Gamma)$, so that the user cost is:

$$(5') \qquad \frac{q_s}{p_s}\frac{(r+\delta-\dot{q}_s/q_s)(1-\Gamma_s)+\dot{\Gamma}_s}{(1-\tau_s)}$$

Thus, there is an extra term influencing the incentive to invest, $\dot{\Gamma}$. When tax incentives are increasing, it is like deflation in the price of capital goods, increasing the user cost and discouraging immediate investment. Let us consider now the incentives associated with an increase in the value of Γ, through bonus depreciation. When the system is in place and assumed permanent, it lowers the user cost (encouraging investment) by raising Γ. If the incentive is perceived to be temporary, this reduces the user cost even more, as $\dot{\Gamma}$ is negative. On the other hand, just prior to the incentive being introduced, if it is anticipated, the user cost will be elevated above its value with no special incentives, as $\dot{\Gamma}$ is positive. Thus, there is a danger that frequent use of investment incentives can be destabilizing by leading firms to delay investment as a downturn approaches, as discussed in the classic paper by Kydland and Prescott (*JPE* 1977); and, as discussed in Auerbach (*AER* 2009), changes in US investment incentives have been quite predictable in recent decades, giving cause for concern.

What if there are convex costs of adjusting the capital stock, so that firms can respond only gradually to changes in the user cost of capital? In this case, as shown in Auerbach (*IER* 1989), firms will invest to partially close the gap between the current capital stock and the desired capital stock, where the desired capital stock is based on a weighted average of the capital stocks called for by the user cost of capital now and in the future. The intuition is that because firms know that it takes time to adjust their capital stocks, they will base their current investment decisions on where they want their capital stocks to be over a period of time, rather than just at present. That investment only partially adjusts to movements in the desired capital stock and that the desired capital stock reflects expected conditions over a period of time will both tend to smooth the volatility of investment swings in response to changes in tax policy.

Investment, Tobin's *q* and Market Value

Let us go back to the last line of expression (3):

$$(3) \qquad V_t = \int_t^{\infty} \left((1-\tau_s) p_s \left[p_s F(K_s, L_s) - wL_s \right] - q_s I_s (1-\Gamma_s) \right) ds + \overline{V}_t$$

We know that firms will invest until the present value of the marginal investment project is zero. Since the marginal unit of capital costs q and the investment also generates investment deductions and related benefits of $q\Gamma$, it must be the case that the present value of future after-tax marginal products equals $q(1\text{-}\Gamma)$. Now, consider the existing capital stock, K. Since capital is homogeneous, existing capital must also generate after-tax marginal products per unit with a present value $q(1\text{-}\Gamma)$. But the present value of investment deductions for such capital, in the aggregate equal to $\bar{V}$ in (3), may not equal $q\Gamma K$. That is, the value of the firm's capital will equal

$$(6) \qquad q(1\text{-}\Gamma)K + \bar{V} = qK + (\bar{V} - q\Gamma K)$$

A simple illustration comes from the case where there is complete expensing of investment, in which case $\bar{V} = 0$ – once purchased and deducted, capital provides no further tax deductions. In this case, the value of the firm's capital stock according to (6) is $q(1\text{-}\Gamma)K$. This can lead to a substantial gap between the replacement cost of capital and its market value within the firm. Indeed, McGrattan and Prescott (*RES* 2005) argue that an important component of postwar stock price movements in the US and UK is attributable to fluctuations in this discount as well as the one, already discussed, that occurs under the "new view" of dividend taxation. This is another illustration of tax capitalization. Here, existing capital is less valuable than new capital because it does not carry the investment tax deductions that new capital receives.

Another reason for market values to fluctuate in response to taxation relates to adjustment costs. If capital stocks are fixed, then an increase in after-tax returns resulting from a tax cut will increase the value of capital. On the other hand, if capital adjusts immediately to a tax cut, so that the marginal product of capital always equals the user cost, after-tax returns will be driven down to the lower user cost and market values won't rise. In the intermediate case where it is costly for firms to adjust capital, we would expect an increase in after-tax returns to lead to more investment, but not enough to offset fully the increase in the value of capital. Put another way, we would expect the value to the firm of having a new unit of capital, q, to move in the same direction as investment. This is Tobin's q theory of investment, which predicts that increases in market value should be associated with increases in investment. But one must be careful, in light of the previous discussion of tax capitalization. For example, suppose there is an increase in depreciation deductions for new investment. This will reduce the user cost of capital, spurring investment and increasing q, the value per unit of new capital. But, from (6), we can also see that the tax change will reduce the term $(\bar{V} - q\Gamma K)$, the value of existing capital *relative* to new capital, since both q and Γ rise. Thus, the value of the firm's existing capital could rise or fall.

Empirical evidence on fixed investment suggests that firms do respond to changes in the user cost of capital, and also that investment is associated with Tobin's *q* in the manner expected, once one adjusts for the capitalization effect just discussed. See Hassett and Hubbard, section 4. One issue not fully resolved is the extent to which liquidity influences investment, that is, the extent to which capital market imperfections have an important effect, in the aggregate, on business investment. Also, evidence on the responsiveness of investment to tax incentives is clearer when looking across different categories of investment, using a type of difference-in-difference approach when there are tax reforms that affect assets differently (as also in the House-Shapiro paper) than in estimates based on aggregate time series data.

Intangible Investment

Investment in Research and Development can be tangible (e.g., laboratories) or intangible (e.g., intellectual property). There is a small separate literature on R&D investment because many governments offer special tax incentives in this area. In the United States, for example, there is an R&D tax credit (which would show up as the term k in the user cost expression). Also, much of R&D spending (on researchers' wages, for example) is deducted immediately; as discussed above, immediate expensing eliminates the effective corporate tax on investment. Why give such generous tax treatment to R&D investment? The most common argument is that R&D spending produces social spillovers, i.e., that companies can't fully appropriate the social returns to their investments; thus, a Pigouvian subsidy may be in order. The paper by Bloom, Griffith and Van Reenen finds that R&D spending in a panel of OECD countries responds to tax incentives, as measured by the user cost of capital.

More on Corporate Tax Incidence and Distortions

We have already discussed a variety of important elements missing from the Harberger model of the corporate tax. One is dynamics; another is investor taxation and corporate financial policy. Both factors affect our conclusions regarding both the incidence and the distortions associated with corporate taxation. Another issue is Harberger's assumption that the corporate and noncorporate sectors represent different industries. While this may have been roughly true 50 years ago, when much of noncorporate capital was found on farms and residences, it is no longer true now, when roughly half of US business income is not subject to the corporate income tax, much of it in the industries we think of as "corporate." How should we model a firm's decision of whether to operate as a corporation? For very large companies, capital market access may still require organization as a corporation, but for smaller (but still reasonably large) firms, there may be a substantive choice. Among the factors that might be relevant are differences between corporate and individual tax rates. Also, the tax treatment of losses differs between the two sectors; noncorporate losses can be deducted by owners, while corporate losses cannot. Thus, companies might want to start as noncorporate entities and make the transition to corporate form when profitability is more assured and capital market access is more important. But the relative benefit of doing so will still be affected by the relative tax rates faced by individuals and corporations. Cullen and Gordon find that corporate-individual tax rate differentials affect the level of entrepreneurial activity in the noncorporate sector. They also find that the level of activity depends on how the tax system treats risk, in terms of risk-sharing and also asymmetric treatment of gains and losses.