TAXATION, INVESTMENT, AND FINANCE

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Empirical Evidence on Tax Incentives and Investment

1. Neoclassical Accelerator (closely linked to user cost derivation – yields an optimal capital stock but optimal adjustment path comes from ad hoc assumptions)

- Classical treatment beginning with Jorgenson (1963) but empirical roots are much deeper
- After-tax Profits:

$$(1-\tau_{c,t})[F(K_t,L_t)-w_tL_t] - (1-\tau_{c,t}z_t - ITC_t)p_tI_t$$

z_t = present discounted value of depreciation allowances in place at time t

$\tau_{c,t}$ = corporate tax rate at time t

ITC_t = investment tax credit rate at time t

- Capital Stock Equation of Motion:

$$\dot{K}_t = I_t - \delta K_t \qquad \left(\dot{K}_t = dK_t / dt\right)$$

- $$V = \max_{\{L_t, I_t, K_t\}} \int_0^\infty e^{-\rho t}\{(1-\tau_{c,t})[F(K_t,L_t)-w_tL_t]-(1-\tau_{c,t}z_t - ITC_t)p_tI_t - \lambda_t(\dot{K}_t - I_t + \delta K_t)\}dt$$

- $$\frac{\partial V}{\partial K}: \quad -e^{-\rho t}(1-\tau_{c,t}\, Z_t - ITC_t)p_t + \lambda_t = 0$$

- $$\frac{\partial V}{\partial K}-\frac{d}{dt}\left(\frac{\partial V}{\partial \dot{K}}\right)=e^{-\rho t}\left[\left(1-\ {}_{c,t}\right)F_K\left(K_t,L_t\right)-\ {}_t\delta\right]+\dot{\lambda}_t=0$$

- From the first FOC we can find $\dot{\lambda}_t$:

$$\dot{\lambda}_t=-\rho\lambda_t-e^{-\rho t}p_t\left[\left(\tau_{c,t}z_t\right)+I\dot{T}C_t\right]+e^{-\rho t}\left(1-\tau_{c,t}z_t-ITC_t\right)\dot{p}_t$$

- Special case: if $\tau_{c,t}, ITC_t, p_t$ are <u>all constant</u> then

$\dot{\lambda}_t=-\rho\lambda_t$ and

- $$e^{-\rho t}\left[\left(1-\tau_{c,t}\right)F_K\left(K_t,L_t\right)-\lambda_t\delta\right]-\rho\lambda_t=0.$$

- These expressions imply
- $$e^{-\rho t}\left(1-\tau_{c,t}\right)F_K\left(K_t,L_t\right)-\left(\delta e^{-\rho t}+\rho\right)\lambda_t=0$$
- $$e^{-\rho t}\left(1-\tau_{c,t}\right)F_K\left(K_t,L_t\right)-\left(\delta e^{-\rho t}+\rho\right)e^{-\rho t}\left(1-\tau_{c,t}z_t-ITC_t\right)p_t=0$$

- Now we evaluate this expression at *t=0*:

$$\left(1-\tau_{c,0}\right)F_K\left(K_0,L_0\right)-\left(\delta+\rho\right)\left(1-\tau_{c,0}z_0-ITC_0\right)p_0=0$$

- Rewrite this expression to obtain:

$$F_K\left(K_0,L_0\right)=\frac{(\rho+\delta)\left(1-\tau_{c,0}\,z_0-ITC_0\right)}{1-\tau_{c,0}}=c$$

- This is the standard user cost of capital expression.

- Note that when there are changes in the net-of-tax price of investment goods from changes in p, τ_c , z, or ITC, the user cost becomes

- $$F_K(K_0, L_0) = \frac{\left(\rho + \delta + \frac{(\tau_{c,0} z_0) + I\dot{T}C_0}{1 - \tau_{c,0}\, z_0 - ITC_0} - \frac{\dot{p}_0}{p_0}\right)(1 - \tau_0 z_0 - ITC_0)p_0}{1 - \tau_{c,0}}$$

- Rising investment good prices <u>reduce</u> the cost of capital, rising tax subsidies (z, ITC) <u>raise</u> the cost of capital.
- This expression is an implicit expression for K_0^*, the <u>optimal</u> capital stock at time zero.
- With Cobb-Douglas production technology, optimal capital stock K* = αY/c where Y = output and c = cost of capital
- Assume that I is a simple function of difference between optimal and existing capital stock: example would be $I_t = \omega(K^*_t - (1-\delta)K_{t-1})$ (is ω a structural parameter? It will determine shape of distributed lag)
- Empirical challenges:
  - Effects of Y and c are linked together – but we would like to know effect of tax parameters on I through c
  - Y is endogenous (simple Y = C+I+G analysis!)

  - This is a backward-looking framework: no allowance for positive future effects on output if investment has macro stimulative effects, no capacity to analyze prospective changes in taxes
  - Open question: could adjustment lags change as a function of price incentives
- Empirical strength:
  - "accelerator" type models fit the data well
  - Can be implemented with asset-specific user costs BUT no analogue to output from specific asset classes

2. Tobin's Q (and tax-adjusted variants)
   - Forward-looking investment model: level of investment depends on the difference between current purchase price of capital goods (net of tax) and shadow value of capital to the firm
   - Empirical Challenge: Measuring the shadow value of capital
   - Standard assumption: Average value of capital equals marginal value (examples when clearly wrong: factor price shock like energy price change, old capital not as valuable as new capital)
   - Implementation:
     q=(value of equity+debt)/(replacement cost of assets)
   - Standard Investment Specification: (derived by Summers 1981 BPEA)

$$(I_t/K_{t-1}) = \beta_0 + \beta_1 * [(q_t - \{1-\tau_{corp} * z - ITC\})/(1-\tau_{corp})] + \varepsilon_t$$

- Alternative specification ("trapped equity view"): multiply q_t by $(1- \tau_{cg})/(1- \tau_{div})$ to reflect use of internal funds as marginal source of finance
- Q models can be implemented with aggregate or firm-level data but NOT with asset-class data (no information on firm-specific q's)

Recent Q-Model Estimates: Desai/Goolsbee 2004
Compustat Firm-Level Data, 1962-2003

	No Tax Incentives (q)	Tax-Adjusted Q
Estimate of β_1	0.0007 (0.00002)	0.0005 (0.0001)
Adjusted R2	0.368	0.367
Sample Size	161,416	142,882

- Separating q and tax terms:

β_1 on q variable: 0.0231 (0.0011)
β_1 on $1-\tau_{corp}*z$ – ITC for equipment: -0.8895 (0.3173)
β_1 on $1-\tau_{corp}*z$ – ITC for structures: -0.0169 (0.0452)
Open question: why are the reactions to equipment incentives much greater than structures?

- Why the much larger coefficient on the tax variable than the average q variable? Measurement error seems likely explanation.

Let $q_t = q_t^* + v_t$ where v_t is classical measurement error
plim (β_1) becomes $\beta_1 * Var(q_t^*)/[Var(q_t^*) + Var(v_t)]$
if most of the variation in q_t is noise, then coefficient estimate is badly biased toward zero

- Alternative specification ("trapped equity view"): multiply q term by $\{(1-\tau_{cg})/(1-\tau_{div})\}$ to reflect use of retained earnings as marginal source of funds – evidence supports this alternative specification
- Appeal of Q models:
    - Easy to analyze pre-announced future tax policies (phase plane diagrams)

   - Conceptually well grounded: estimating first order condition from adjustment cost model
   - High-frequency variation in q
- Empirical Shortcomings:
   - Empirical fit is almost always weak
   - Lagged values of q or Q often have more explanatory power than contemporaneous values (why? Time to build? Slow adjustment of expectations by managers?)

3. Cash Flow Models
   - Long empirical history, cash flow had substantial predictive value for investment at the firm level but was obviously endogenous
   - Fazzari-Hubbard-Petersen (BPEA 1988) rehabilitate these models by emphasizing both asymmetric information insights from corporate finance theory AND possibility of using q to control for endogeneity of cash flow
   - Recognize heterogeneity across firms and stratify firms by payout behavior

Effects of q and Cash Flow on Investment (FHP 1988)

	Lowest Dividend	Middle Dividend	Highest Dividend
Tobin's Q	0.0008 (0.0004)	0.0046 (0.0009)	0.0020 (0.0003)
Cash Flow/K	0.461 (0.027)	0.363 (0.039)	0.230 (0.010)
R2	0.46	0.28	0.19

- Open question of interpretation: is the 0.23 coefficient for "Highest" Group a measure of misspecification?
- Large applied theory literature in corporate finance (Myers "Pecking Order Hypothesis") suggesting internal cash flow should be less expensive for firms
- Many subsequent studies using creative identification strategies to explore effects of cash flow
    - Kaplan/Zingales comment on FHP: low dividend firms in FHP sample are actually issuing new securities so appear to have access to capital markets
    - Owen Lamont: investment decisions of multinational oil companies with chemical processing subsidiaries
    - Josh Rauh: required pension contributions under ERISA as shocks to corporate cash flow
    - Conclusion: access to internal cash flow appears to affect investment decisions

4. "Nonparametric" Investment Models
- Focus on investment decisions by asset category (aircraft, computers, general industrial machines, etc.)
- Difficult to use any of previous models at the asset-specific level (how to map cash flow, or q, or sales to particular assets)
- Focus on "reduced form" models of investment, and either an asset-specific measure of $\{\tau_{corp}*z - ITC\}$ or something similar (bonus depreciation in case of House/Shapiro AER 2008 study).
- Illustration using bonus depreciation analysis

- Conceptual Framework Recognizes that Price of Investment Goods is Endogenous: $p_{i,t} = (I_{i,t})^{\eta}$
- Bonus Depreciation Allows Expensing for Some Assets that Would Otherwise be Depreciated (let b = bonus depreciation share)
- After-tax price of investment goods:
  $p_{after\text{-}tax} = \{1 - (1-\tau_{corp}*(b + (1-b)*z)\}p(b)$
  since p is endogenous and depends on b
- Note $dp_{after\text{-}tax,i,t}/db = \tau_{corp}*(1-z_{i,t})p_{i,t}(b)$; starting from b=0 the percentage change in the after-tax price is:
  $dp_{after\text{-}tax,i,t}/p_{after\text{-}tax,i,t} = \tau_{corp}*(1-z)*b/(1- \tau_{corp}*z)$
- Inelastic Supply of Capital Goods: changes in $p_{i,t}(b)$ could offset most of the impact of b on after-tax price
- Regression specification: construct forecast errors from reduced form investment models - Cummins/ Hassett/Hubbard strategy
- Let ($_{p,i,t}$,$\varepsilon_{I,i,t}$) denote pair of forecast errors for the price of investment goods and the level of investment
- Use data before tax policy change to estimate model for predicting investment and prices during tax policy regime change, THEN regress forecast errors on bonus depreciation rate
- Estimate “forecasting” models using quarterly aggreage data 1965:1-2000:4, project through period 2001:1-2006:4

Forecasting Model/Controls in Error Eqn.	Investment Effects		Price Effects	
	OLS	WLS	OLS	WLS
Contemporaneous aggregates / aggregate cons	4.61 (2.53)	6.13 (1.79)	-0.48 (1.78)	-0.56 (1.69)
Contemp aggregates / time dummies	9.60 (3.39)	13.21 (2.96)	-0.83 (21.5)	-0.97 (1.87)

- Finding suggest substantial investment effects of bonus depreciation effect

5. Effects of Investment Incentives on Asset Prices
   - Widely recognized that tax incentives may be capitalized into prices of fixed factors
   - Application to ITC: Do Producers Just Raise Pre-tax Prices? (Goolsbee QJE 1998 study – suggests 10% ITC raises equipment prices between 3.5 and 7%)
   - Simple specification: regress capital goods deflators from Bureau of Economic Analysis (annual, 1959-1988) on fixed asset effect, time trend (but NOT year effects!), rate of asset-specific investment tax credit; 22 asset categories

Example results

Furniture	0.0243 (0.1370)
Engines	0.6637 (0.2479)
Tractors	0.7101 (0.1328)
Agricultural Machinery	0.9762 (0.1954)
Office / Computers	-0.7607 (0.4924)
Aircraft	1.010 (0.1836)
Instruments	-0.3491 (0.1718)

- Further analysis of effects of concentration measures on degree of price change – some support
- More recent study: Edgerton 2009 (MIT Ph.D.): looks at prices of USED assets (asset price theory offers strong predictions about capitalization of tax incentives into prices of used assets)
- Much less evidence of price reaction – focus is on tractors and trucks, arguably markets with large international component during early 2000s

Taxation and Corporate Debt

1. Benchmark: Modigliani-Miller Theorem (1958)
   - In a tax-free world in which investors and firms face identical debt markets, corporate debt policy has <u>no effect</u> on corporation value
   - WHY? "Home-Made Leverage"
   - Consider a firm that invests in a project that costs \$100, and that generates a payoff of \$X. Assume it is initially all-equity financed with 100 shares outstanding (one share costs \$1).
   - Payoff per share: \$X/100
   - Now imagine the firm borrows \$50 at an interest rate of r. Then it issues \$50 in equity to finance remainder of project. Payoff per \$1 of equity (now 50 shares): \$(X – 50r)/50 = \$X/50 – r.
   - Does offering equity a payoff stream of \$(X/50 – r) per dollar of equity investment lead investors to pay a different amount for the shares than when they were offered with a payoff of \$X/100?
   - Say investor wants a payoff of \$X/100 but the firm has debt. Investor buys \$0.50 of equity, and \$0.50 of debt, which pays r. The payoff: (0.50)(X/50 – r) + (0.50)*r = \$X/100. Thus by lending the investor can undo leverage; by borrowing she could create it.

2. Almost immediate response: What About Taxes? Since after-tax cost of borrowing is $(1-\tau)r$, but after-tax cost of equity is just r_{eq} (the pre-investor-tax required return on

equity – equity payouts are not tax deductible), the after-tax cost of debt seems lower.

- If the investor demands a constant required return ρ on all investments, what return must the firm earn to deliver that investor after-tax return?
- Debt: $f'(k) = \rho/(1-\tau_{int})$
- Equity (if pay dividends): $f'(k) = \rho/[(1-\tau_{corp})(1-\tau_{div})]$
- Equity (if retain earnings & generate capital gains): $f'(k) = \rho/[(1-\tau_{corp})(1-\tau_{cg})]$
- Seems like firm can maximize after-tax value of payments to investors by using debt (alternatively: cost of capital is lower for debt than equity)

3. Why are firms NOT 100% debt?
   - Leverage is costly: risk of bankruptcy. If probability of bankruptcy is $\psi(D/K)$ and bankruptcy imposes a cost C, then firm trades off tax saving $(\tau_{corp})*r$ with marginal increase in bankruptcy costs $\psi'(D/K)*C/K$. This could yield an interior optimal $(D/K)^*$. This is the "static tradeoff theory."
   - Agency Costs of Higher Debt: Highly levered firms may forego some profitable projects because returns accrue to debt-holders not providers of new equity finance. (This is also a "static tradeoff.")
   - Miller (1977) Model: clientele formation makes the marginal investor in corporate debt <u>indifferent</u> between debt and equity. Clear illustration of separating equilibrium that is common with regard to taxation.

4. Miller Clientele analysis:
   - Assume no tax on equity (could argue $\tau_{cg} \approx 0$).
   - Distribution of investor tax rates $\{\tau_{int}\}$ in the population.
   - Return to an investor from a corporate project: Equity delivers $f'(k)*(1-\tau_{corp})$. Debt delivers $f'(k)*(1-\tau_{int})$. Investors segregate into clienteles based on which return is higher: $\tau_{int} > \tau_{corp}$ specialize in holding equity, and vice versa.
   - Generalization to case with differential risk of equity and debt is difficult: can investors find a matched portfolio of stocks and bonds that deliver the same risk attributes?

5. Empirical tests of what determines debt capacity
   - Studies of firms that "exchange" one security for another: event study analysis of share price changes
   - Issuing debt tends to raise value – issuing equity reduces it (puzzle: why do firms do things that reduces equity value? Maybe they are forced to…)
   - Estimates of bankruptcy cost: Warner on railroads (5% of value of enterprise); Cutler-Summers on Texaco-Pennzoil

Company	Value Change from Litigation	Value Change from Settlement
Texaco	-4.1B	+2.0B
Pennzoil	+1.1B	+0.3B
Total	-3.0B	+2.3B

- Cross-sectional studies of decisions to issue securities: do "static tradeoff variables" seem to work?
- Mackie-Mason, 1990 Journal of Finance: probit models for issuing debt versus equity

Tax Loss Carryforward	-9.36 (prob. derivative)
Bankruptcy Predictor	Negative, not statistically significant
Variance of earnings	-31.5
R&D intensity	-6.9

6. Open Question: What are the Social Externalities of Debt Issue?

- Financial Crisis Raises New Questions: Does Borrowing at one firm impose externalities on the system?
- Zingales analysis of "Paulson's Gift": Government Transfer to Bond-holders
- Future policy: leveling tax burdens on debt and equity? "ACE" system (Allowance for Corporate Equity) – firm deducts θ*MVEQ in addition to interest payments

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