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:

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

\[z_t = \text{present discounted value of depreciation allowances in place at time } t\]

\[\tau_{c,t} = \text{corporate tax rate at time } t\]

\[ITC_t = \text{investment tax credit rate at time } t\]

- Capital Stock Equation of Motion:

\[
\dot{K}_t = I_t - \delta K_t \\
\left(\dot{K}_t = \frac{dK_t}{dt}\right)
\]

\[V = \max \{L_t, I_t, K_t\}\]

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

\[\frac{\partial V}{\partial K} : \quad -e^{-pt}(1 - \tau_{c,t} Z_t - ITC_t)p_t + \lambda_t = 0\]
\[ \frac{\partial V}{\partial K} - \frac{d}{dt} \left( \frac{\partial V}{\partial K} \right) = e^{-\rho t} \left[ (1 - \tau_{c,t}) F_K(K_t, L_t) - \lambda_t \delta \right] + \dot{\lambda}_t = 0 \]

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

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

- Special case: if \( \tau_{c,t}, ITC_t, p_t \) are all constant then \( \dot{\lambda}_t = -\rho \lambda_t \) and

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

- These expressions imply

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

\[ e^{-\rho t} \left( 1 - \tau_{c,t} \right) F_K(K_t, L_t) - \left( \delta e^{-\rho t} + \rho \right) e^{-\rho t} \left( 1 - \tau_{c,t} z_t - ITC_t \right) p_t = 0 \]

- Now we evaluate this expression at \( t=0 \):

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

- Rewrite this expression to obtain:

\[ F_K(K_0, L_0) = \frac{(\rho + \delta) \left( 1 - \tau_{c,0} z_0 - ITC_0 \right)}{1 - \tau_{c,0}} = c \]
• 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 \( p, \tau_c, z, \) or ITC, the user cost becomes

\[
F_K(K_0, L_0) = \frac{\left( \rho + \delta + \frac{(\tau_{c,0}z_0)}{1-\tau_{c,0}} + \frac{ITC_0}{p_0} - \frac{\dot{p}_0}{p_0} \right)(1-\tau_0z_0 - ITC_0)p_0}{1-\tau_{c,0}}
\]

• Rising investment good prices reduce the cost of capital, rising tax subsidies (\( z, ITC \)) raise the cost of capital.

• This expression is an implicit expression for \( K^*_0 \), the optimal capital stock at time zero.

• With Cobb-Douglas production technology, optimal capital stock \( K^* = \alpha Y/c \) 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 \( \omega \) 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:
  \[ q = \frac{\text{value of equity} + \text{debt}}{\text{replacement cost of assets}} \]

- Standard Investment Specification: (derived by Summers 1981 BPEA)

\[
\left( \frac{I_t}{K_{t-1}} \right) = \beta_0 + \beta_1 \left[ \frac{(q_t - \{1 - \tau_{\text{corp}} \cdot z - \text{ITC}\})}{(1 - \tau_{\text{corp}})} \right] + \varepsilon_t
\]
• 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

<table>
<thead>
<tr>
<th></th>
<th>No Tax Incentives (q)</th>
<th>Tax-Adjusted Q</th>
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<tbody>
<tr>
<td>Estimate of $\beta_1$</td>
<td>0.0007 (0.00002)</td>
<td>0.0005 (0.0001)</td>
</tr>
<tr>
<td>Adjusted R2</td>
<td>0.368</td>
<td>0.367</td>
</tr>
<tr>
<td>Sample Size</td>
<td>161,416</td>
<td>142,882</td>
</tr>
</tbody>
</table>

- Separating q and tax terms:
  - $\beta_1$ on q variable: 0.0231 (0.0011)
  - $\beta_1$ on $1-\tau_{corp}*z - ITC$ for equipment: -0.8895 (0.3173)
  - $\beta_1$ 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

$\text{plim } (\beta_1)$ becomes $\beta_1 \frac{\text{Var}(q_t^*)}{\text{Var}(q_t^*) + \text{Var}(v_t)}$ 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)

<table>
<thead>
<tr>
<th></th>
<th>Lowest Dividend</th>
<th>Middle Dividend</th>
<th>Highest Dividend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobin’s Q</td>
<td>0.0008 (0.0004)</td>
<td>0.0046 (0.0009)</td>
<td>0.0020 (0.0003)</td>
</tr>
<tr>
<td>Cash Flow/K</td>
<td>0.461 (0.027)</td>
<td>0.363 (0.039)</td>
<td>0.230 (0.010)</td>
</tr>
<tr>
<td>R2</td>
<td>0.46</td>
<td>0.28</td>
<td>0.19</td>
</tr>
</tbody>
</table>
• 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 \( \{\tau_{\text{corp}}z - \text{ITC}\} \) 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: \( p_{i,t} = (I_{i,t})^n \)
• Bonus Depreciation Allows Expensing for Some Assets that Would Otherwise be Depreciated (let \( b \) = bonus depreciation share)
• After-tax price of investment goods:
  \[
p_{after-tax} = \{1 - (1-\tau_{corp}*(b + (1-b)*z)}\}p(b)
\]
since \( p \) is endogenous and depends on \( b \)
• Note \( \frac{dp_{after-tax,i,t}}{db} = \tau_{corp}*(1-z_{i,t})p_{i,t}(b) \); starting from \( b=0 \) the percentage change in the after-tax price is:
  \[
  \frac{dp_{after-tax,i,t}}{p_{after-tax,i,t}} = \tau_{corp}*(1-z)*b/(1- \tau_{corp}*z)
  \]
• 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 \( ( p_{i,t},\varepsilon_{i,t} ) \) 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
### Forecasting Model/Controls in Error Eqn.

<table>
<thead>
<tr>
<th></th>
<th>Investment Effects</th>
<th>Price Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OLS</td>
<td>WLS</td>
</tr>
<tr>
<td>Contemporaneous aggregates / aggregate cons</td>
<td>4.61 (2.53)</td>
<td>6.13 (1.79)</td>
</tr>
<tr>
<td>Contemp aggregates / time dummies</td>
<td>9.60 (3.39)</td>
<td>13.21 (2.96)</td>
</tr>
</tbody>
</table>

- 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

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furniture</td>
<td>0.0243</td>
</tr>
<tr>
<td>Engines</td>
<td>0.6637</td>
</tr>
<tr>
<td>Tractors</td>
<td>0.7101</td>
</tr>
<tr>
<td>Agricultural Machinery</td>
<td>0.9762</td>
</tr>
<tr>
<td>Office / Computers</td>
<td>-0.7607</td>
</tr>
<tr>
<td>Aircraft</td>
<td>1.010</td>
</tr>
<tr>
<td>Instruments</td>
<td>-0.3491</td>
</tr>
</tbody>
</table>

- 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 no effect 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-τ)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 $\rho$ 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 indifferent 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

<table>
<thead>
<tr>
<th>Company</th>
<th>Value Change from Litigation</th>
<th>Value Change from Settlement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texaco</td>
<td>-4.1B</td>
<td>+2.0B</td>
</tr>
<tr>
<td>Pennzoil</td>
<td>+1.1B</td>
<td>+0.3B</td>
</tr>
<tr>
<td>Total</td>
<td>-3.0B</td>
<td>+2.3B</td>
</tr>
</tbody>
</table>
• 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

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<thead>
<tr>
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<tbody>
<tr>
<td>Tax Loss Carryforward</td>
<td>-9.36 (prob. derivative)</td>
</tr>
<tr>
<td>Bankruptcy Predictor</td>
<td>Negative, not statistically significant</td>
</tr>
<tr>
<td>Variance of earnings</td>
<td>-31.5</td>
</tr>
<tr>
<td>R&amp;D intensity</td>
<td>-6.9</td>
</tr>
</tbody>
</table>

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 $\theta \cdot \text{MVEQ}$ in addition to interest payments