# R&D and innovation expenditures in the crisis

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# Outline

- R&D as an investment and implications for financing R&D
  - Further reading: Hall and Lerner (2010), in Hall and Rosenberg (eds.), Handbook of the Economics of Innovation, Elsevier.
- Empirical evidence on the cyclicality of R&D

# R&D vs innovation

- R&D only part of innovation expenditure, in addition we have
  - Worker training, etc.
  - New capital equipment (process innov)
  - Marketing, etc for new and improved products
- However
  - Data available in these only recently
  - Much of the data is qualitative only
  - => most empirical literature uses R&D as an indicator of innovation

# R&D as investment

- Similarity:
  - Expenditure undertaken today to secure (uncertain) returns in the future
  - => creates a capital asset for the firm
- Differences:
  - Composition – wages of scientists and engineers are more than half of spending
  - Asset created is intangible
    - Unknown share is human capital (partly owned by employees)
    - Not easily tradeable (low salvage value)
  - Level of uncertainty much more extreme

Characterizes most other innovation-related expenses as well

# Implications for policy and practice

- Production of knowledge is not intemporally separable → adjustment costs high
  - Policy changes take time to have an impact
  - Measurement difficulties - R&D does not exhibit much variation over time within a firm
    - Responds slowly to changes in capital cost
    - Little variation to identify its productivity
- Uncertainty – in some cases, distribution of returns is Pareto (and without a second moment)
  - Scherer, Harhoff, etc.
  - risk adjustment problematic

# Choosing the level of R&D

Stylized model: profit-maximizing firm invests in R&D until the marginal product of the resulting capital asset is equal to the tax-adjusted user cost of capital.

Therefore, R&D will depend on

- Investor's required rate of return
- (Economic) depreciation rate of the asset
- Marginal adjustment cost of R&D program
- Corporate tax rate
- Tax depreciation allowances
- Tax credits, if present

If R&D is expensed and no tax credit, tax effects will not matter

# Implications for R&D finance

- Depreciation (private obsolescence) highly variable and endogenous to other firms' behaviors
  - possibly higher than aggregate rate of 12 or 15%
- Debt versus equity finance
  - Debt sometimes cheaper than equity due to interest deductability
  - However, debtholders prefer physical assets as collateral and R&D creates an intangible asset that is not easily collaterizable
- Evidence that equity strongly preferred over debt for external financing in R&D firms, but that financing by internal funds most preferred

# Recent evidence

- Brown & Petersen 2010 – US firms 1970-2006
  - Costly for firms to adjust R&D to transitory shocks
  - => firms facing constraints hold cash to smooth R&D, dampens effect of financing constraints
  - Less true of large unconstrained firms with profit flows
- Brown, Martinsson & Petersen 2010 – European firms from 16 countries 1995-2007
  - Cash flow alone does not matter much
  - Changes in cash holding are negatively related to R&D investment, especially for firms in active stock markets (UK and Sweden)
  - Financial factors more important for younger, smaller, and lower payout firms

# Conclusions from empirical work

- Small and startup firms in innovative industries face a higher cost of capital than their larger competitors.
- Cash holdings are used by these firms to smooth R&D in the presence of financial frictions
- Evidence for a financing gap for large established firms less clear, although they do seem to prefer internal funds for R&D.
- VC solution to asym info/moral hazard problems has some limitations and is not widely diffused successfully across countries.
- Even though they often focus on quarterly rather than long term performance, thick public financial markets seem to be better at financing innovative activity.

# Implications for R&D in the crisis

- Current crisis:
  - Lower demand => lower expected rate of return, demand shifts down
  - Cost of funds rises due to tightened lending standards => supply shifts up
- Result: lower R&D expenditure – However---
  - Desire to smooth R&D and retain human capital suggests counter-cyclicality (a form of the more general opportunity cost theory)
  - Financial constraints and lower demand suggest pro-cyclicality

# What do we know about this empirically?

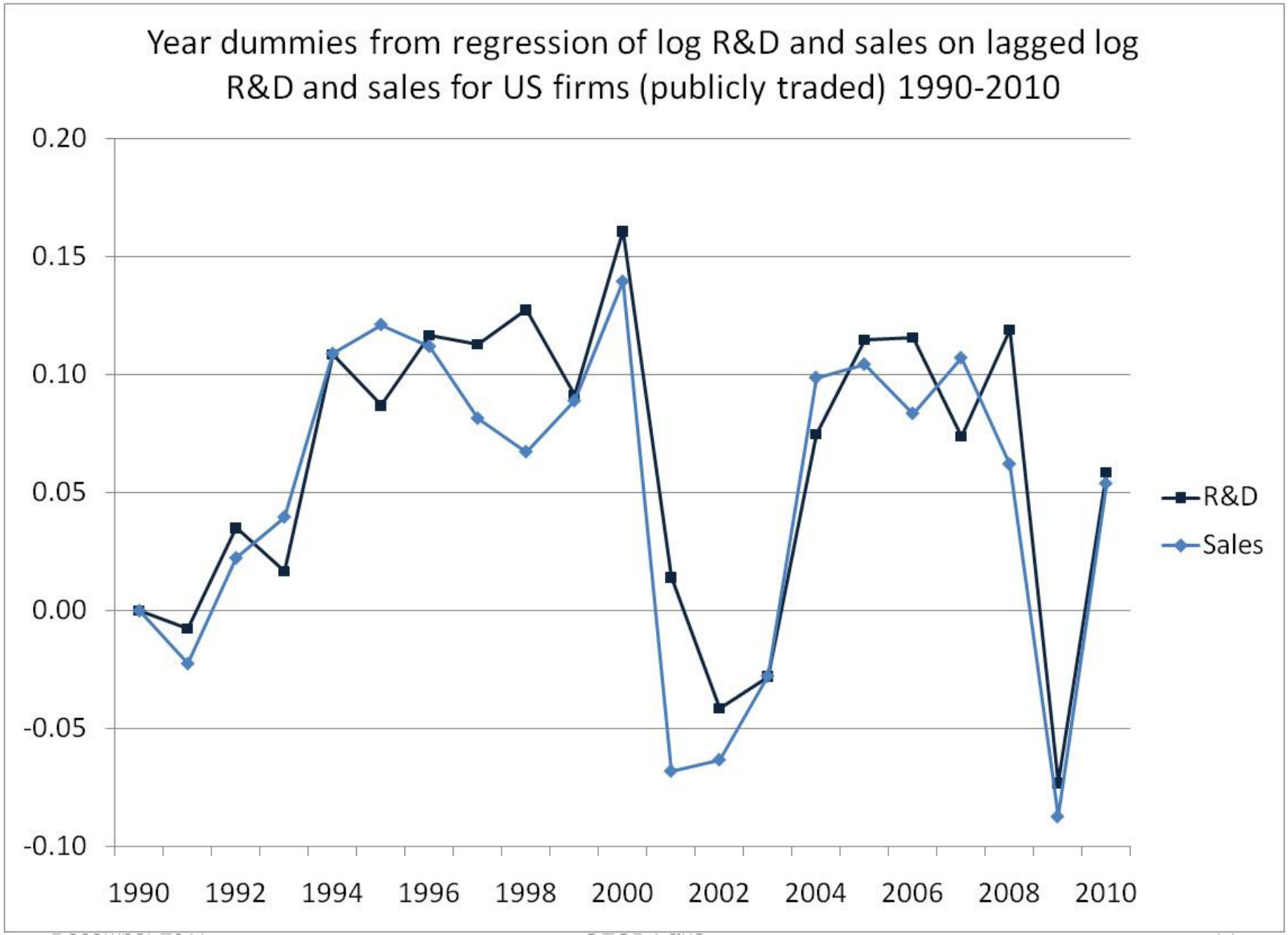
- Rafferty-Funk (2004) – US firms 1981-1990; error correction model
  - Used demand shocks at industry level (weighted sum of downstream shipments)
  - Find R&D in largest firms shows evidence of counter-cyclicality - increased R&D in response to fall in industry demand
- Cosh, Hughes, and co-authors at the Centre for Business Research, Cambridge University – UK SMEs 1991-2008
  - 18% sought to grow in 2004; 9% in 2008
  - Constraints on growth:
    - <20% mention financial
    - Lack of demand more important
  - However, loans and mortgages more difficult to obtain, and cost has risen; less financing obtained.
  - High growth innovative firms appear to be more resilient, but worried about demand (consistent with Brown and Petersen evidence)
  - In general, not as bad as early 1990s for SMEs in the UK

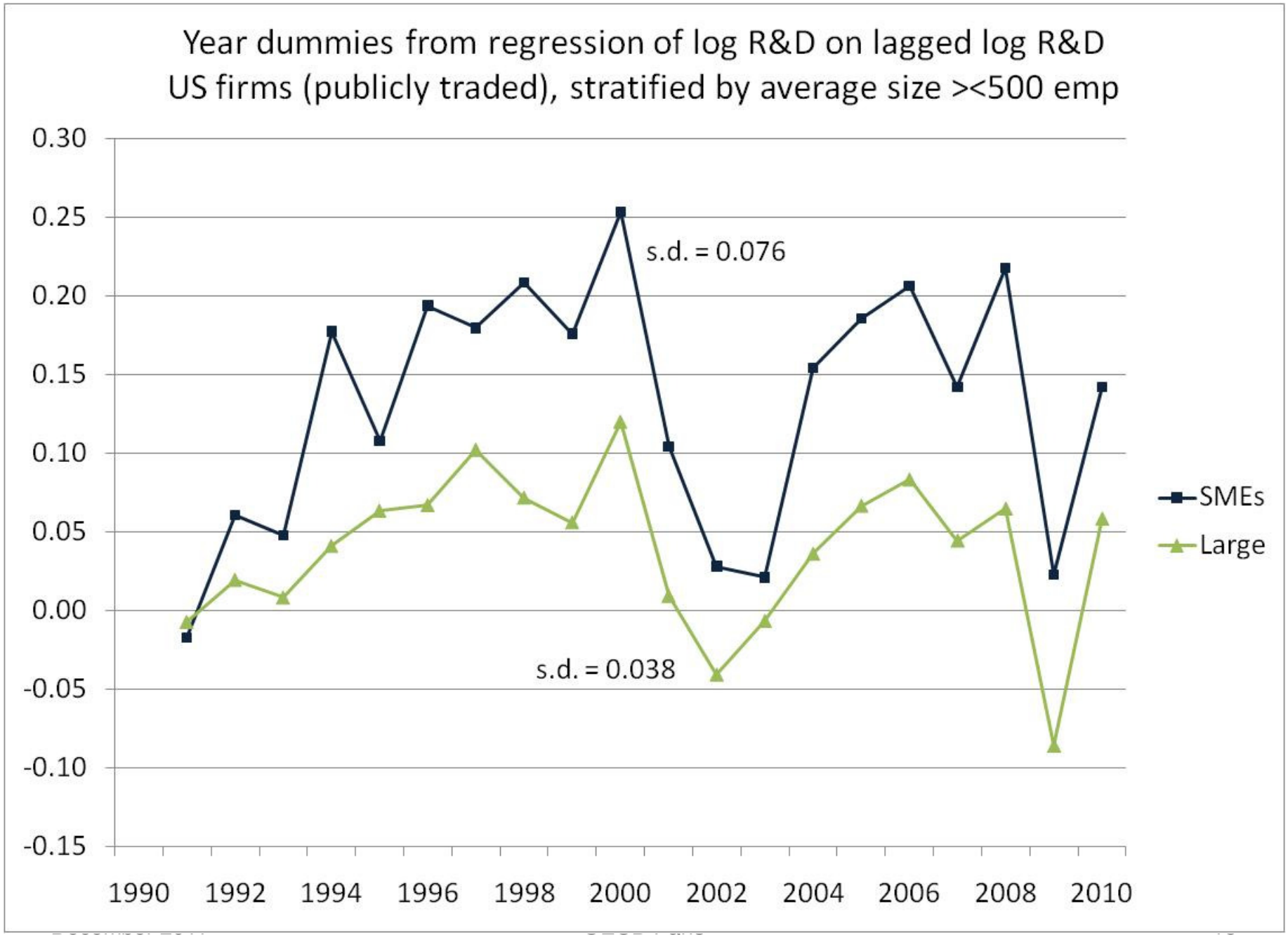
# What do we know about this empirically?

- Aghion et al (2007) – French firms 1993-2004
  - share of R&D over total investment counter-cyclical without credit constraints - becomes more pro-cyclical as firms face tighter credit constraints
  - Larger result for firms in sectors that depend more heavily upon external finance
  - in more credit constrained firms, R&D investment share plummets during recessions but does not increase proportionally during upturns
- Lopez-Garcia, Montero, & Morat-Benito (2011) – Spanish firms 1991-2009
  - Model similar to Aghion et al.
  - R&D counter-cyclical for firms whose internal resources increase more than 4%
  - Otherwise pro-cyclical
  - On-the-job training is counter-cyclical
  - Goodwill, purchases of patent rights acyclical

# US firms 1990-2010

- Naïve model – log variable on own lag with annual dummies
  - Log R&D – R-squared = 0.90
  - Log Sales – R-squared = 0.92
- Examine year dummies to see average effects of business cycle – R&D tracks sales pretty closely.
- Stratify by firm size (<>500 employees) – R&D is twice as volatile for small firms.
- Aghion et al. equation estimates (within firm):
  - Large firms R&D share ~ -0.20 (0.01) Δsales
  - SME firms R&D share ~ -0.14 (0.01) Δsales
  - Note: very coarse size cut; no info on credit constraints


Year dummies from regression of log R&D and sales on lagged log R&D and sales for US firms (publicly traded) 1990-2010
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
R&D
Sales


Year dummies from regression of log R&D on lagged log R&D
US firms (publicly traded), stratified by average size ><500 emp
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
s.d. = 0.076
s.d. = 0.038
SMEs
Large

# Conclusions

- R&D less pro-cyclical than investment
  - for large established firms, it may be counter-cyclical with respect to sales
  - for credit-constrained and smaller firms, more strongly pro-cyclical, in spite of their attempts to smooth via cash holdings
  - French, US, and Spanish firms shift towards R&D and away from tangible investment during downturns
- Less known about other innovation expenditures
  - OJT may be counter-cyclical, at least if employment is sticky
- Liquid stock markets facilitate financing for innovative small or new firms, but also create some volatility in financing, leading to cash hoarding
- Some hints that things may vary across countries – what about the role of employment flexibility?
- Effects on entry?