MACROECONOMIC CONDITIONS AND THE DETERMINANTS OF COMMERCIALISATION

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(based on paper with Paul H. Jensen)

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**CONTEXT**

- Relationship between innovative activity and macroeconomic conditions studied several times (Geroski & Walters 1995; Saint-Paul 1997)

- Previous studies use proxies for innovation such as R&D expenditure or counts of innovations/patents

- This study uses a more downstream measure of commercialisation activities

- This is an empirical study – not just a deductive analysis

**RESEARCH QUESTION**

- Are commercialisation activities pro-cyclical or counter-cyclical?

- Given invention has taken place: what determines decisions to commercialise
WHY (ON EARTH) DO ECONOMISTS DO THESE SORT OF STUDIES?

• Empirical studies needed because:
  – Deductive theory can be ambiguous
  – To know the magnitude of effects

• Anecdotes cannot determine policy (but can guide empirical investigation)

• Series of empirical studies needed for ‘stylised facts’

• Empirical studies rely on statistical regularities – data does not have to be 100% accurate to give useful information

• Random samples of people or events are good approximations for whole population

• Empirical studies give us confidence in a particular view, convince skeptics
FOR THIS TALK

• Analytic context
• What others have said
• Describe how we collected the data
• Model and estimation

• Find:
  - clear evidence that macroeconomic conditions matter for commercialisation and that they are pro-cyclical
  - supply-side factors (overdraft rates, the tax price of R&D, and changes in government R&D expenditure) > demand-side factors (growth of demand).
ANALYTIC CONTEXT

• Commercialisation is an (intangible) investment

• Almost all theories of firm investment behaviour are pro-cyclical.
  - aggregate theories of (tangible) investment. Keynes (1936), Lundberg (1937), Samuelson (1939), Harrod (1939), Schumpeter (1934, 1943), Kalecki (1939, 1968).
  - macro-economy has both a push and pull effect, both pro-cyclical
  - current sales are basis of future expectations of sales & source of investment funds

• Research & invention --------development --------commercialisation---

• This study takes invention as given

• Not consider effect of macro-economy to the decision to invent

• NOT look at micro factors such as organisational capabilities, managerial style and the firm’s marketing strategy on innovation
WHAT THE OTHERS HAVE SAID ABOUT MACROECONOMY & COMMERCIALIZATION OF INVENTIONS

• Francois and Lloyd-Ellis (2003) argue that R&D is pro-cyclical but downstream commercialisation is counter-cyclical (Saint-Paul, 1997; Walde and Woitek 2004 have related arguments).

• Pro-cyclical camp (Ioannidis 1997; Fatas 2000; Piva and Vivarelli 2007; Geroski and Walters, 1995; Himmelberg and Petersen, 1994).
  – Increased confidence
  – Increased profits and means to invest

• Aside from these studies, little hard evidence (much loose conjecturing)
OUR DATA

• Our survey:
  – 2007 survey of Australian inventors
  – 5,446 inventions with currently-valid addresses (= 68% response rate)
  – Respondents:
    ▪ small–medium sized enterprise (36.4%)
    ▪ large companies (10.5%)
    ▪ public research organisations (6.6%)
    ▪ individuals (46.6%).
• Date of the patent application

• Whether ‘Commercialisation event’ occurred. Defined as an attempt to:
  – develop (proof of concept, testing and validation, prototype)
  – license
  – transfer to a spin-off company
  – ‘make and sell’ (gathering market intelligence, validating the commercial opportunity, trialing the manufacturing process, and market launch)
  – mass produce
  – export

...the invention.
## A FEW DESCRIPTIVES

### Commercialisation event

<table>
<thead>
<tr>
<th>Commercialisation event</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply for a patent</td>
<td>3,736</td>
<td>100.0</td>
</tr>
<tr>
<td>Attempt at least one development stage</td>
<td>3,399</td>
<td>91.0</td>
</tr>
<tr>
<td>Attempt to license</td>
<td>1,525</td>
<td>40.8</td>
</tr>
<tr>
<td>Attempt to spinout</td>
<td>531</td>
<td>14.2</td>
</tr>
<tr>
<td>Attempt at least one make and sell stage</td>
<td>2,700</td>
<td>72.3</td>
</tr>
<tr>
<td>Attempt mass production</td>
<td>1,383</td>
<td>37.0</td>
</tr>
<tr>
<td>Export</td>
<td>798</td>
<td>21.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,736</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>
MODEL AND ESTIMATION

• Link the events with the state of the macroeconomy in each year

• model the decision to attempt commercialisation event using duration analysis (Cox Hazard function)

• multiple event model and define the ‘event’ as an attempt made at one of the commercialisation stages

• Main issue: limited information on the timing of events – we know the date of lodgment of a patent application only

• We test a number of assumed timetables of the commercialisation stages
Assume following lags between the year the patent application was filed (which we observe) and attempts (if made):

- development (1 year)
- licensing (3 years)
- spin-off a company (4 years)
- make and sell (5 years)
- mass production (7 years)
- export (9 years)

Undertook a comprehensive sensitivity analysis of lags:

- seven other lag structures which involved 21 other estimated models
- treated development & make and sell as 8 separate events rather than 2
- put in larger lags for chemicals/pharma
• Following Guellec and Ioannidis (1997) use a parsimonious model
• firm’s ‘demand’ for commercialisation is a function of exogenous prices and events
  
  – Demand-side variables

  ▪ Demand Growth
    ◦ annual rate of growth in real wages OR
    ◦ annual rate of growth in industry value

  ▪ Business Confidence
    ◦ quarterly index of confidence in the Australian investment and business community
- **Supply-side variables**

  - *Cost of Commercial Borrowing*
    - official small business overdraft rate
  
  - *Business R&D Subsidies*
    - B-index= general incentives available to all firms via accelerated depreciation and allowable tax credits
    - =Present value of pre-tax income required to cover the cost of R&D investment and corporate income tax.
    - Lower B-index indicates more favorable tax regime for firms

  - *Public R&D*
    - annual change in intramural R&D designed for economic development in government organisations (GovRD)
    - excludes universities
### Results from the estimated hazard of (multiple) ‘success’

<table>
<thead>
<tr>
<th></th>
<th>MODEL 1</th>
<th>MODEL 2</th>
<th>MODEL 3</th>
<th>MODEL 4* (extra lags chemicals)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demand-side variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth real wages</td>
<td>0.097***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth industry value-added</td>
<td></td>
<td>0.777***</td>
<td>0.715**</td>
<td>1.372***</td>
</tr>
<tr>
<td>Business confidence</td>
<td>-0.003</td>
<td>-0.005**</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Supply-side variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small business overdraft rate</td>
<td>-0.059***</td>
<td>-0.097***</td>
<td>-0.080***</td>
<td>-0.068***</td>
</tr>
<tr>
<td>B-index</td>
<td>-1.127***</td>
<td>-1.788***</td>
<td>-1.373***</td>
<td>-0.985**</td>
</tr>
<tr>
<td>Change in the real level of</td>
<td>1.373***</td>
<td>1.777***</td>
<td>1.903***</td>
<td>2.581***</td>
</tr>
<tr>
<td>GovRD</td>
<td></td>
<td></td>
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*Extra lags on 2-digit industry -Petroleum, Coal, Chemical and Associated Product Manufacturing - since can have longer commercialisation lags than other fields.
Frequency of events since patent filed.

Effect of a change in independent variable from (mean less one standard deviation) to (mean plus one standard deviation) on the linear prediction $X\beta$

<table>
<thead>
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<th>Change in the linear prediction $X\beta$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth in industry value-added</td>
<td>0.067</td>
</tr>
<tr>
<td>Small business overdraft rate</td>
<td>-0.306</td>
</tr>
<tr>
<td>B-index</td>
<td>-0.170</td>
</tr>
<tr>
<td>Change in GovRD</td>
<td>0.164</td>
</tr>
</tbody>
</table>

- Overdraft rate was found to have the largest effect
- Followed by the level of tax incentives for R&D and changes to the level of public sector R&D.
- Supports findings of Guellec and Ioannidis (1997), 18 country dataset from 1972 to 1995
CONCLUSIONS

• While supply side factors appear to have the largest effect...

• Demand versus supply dichotomy can be misleading

• Both factors are necessary but not sufficient. A new product or process would not be commercialised if it clearly had no market. Nor would it be commercialised if funding was unavailable

• The real question for policy makers is: what constitutes the short side of the market? That is, which factor is the bottleneck?

• Is the rate of interest the major bottleneck?
THANK-YOU

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