A Theoretical Framework on the Dynamics of Innovation and Investment: Lessons from Empirical and Simulation Findings

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Investment Framework

- From Kaleckian perspective, causes of investment is the essential dynamic of business cycles and trend growth
- Three aspects to this investment (I) dynamic:
  - Time lag in *ex ante* decision (orders) and in *ex post* implementation (expenditure)
  - Feedback loop from profits to investment
  - Instability from exposure to risk and fundamental uncertainty

Kaleckian Theory of Investment

Three endogenous variables:

- profits and the mark-up - P
- financial constraints (increasing risk) - *g*
- excess capacity and accumulation - *c*

Institutional (convention-based) elements to be considered:

- competition between firms
- role of agents in the firm
- financial behaviour of firms
- role of innovation
- role of the state

Susceptibility Cycle

- Cyclical behaviour of investment based on fragile confidence of entrepreneurs given the level of investment orders already committed in relation to risk and uncertainty exposure
- Increasing fragility in convention-based investment decisions arises as confidence is eroded by cumulative investment expenditure pressures
- Susceptibility = f (degree fragility)

Susceptibility Cycle

- Surface manifestations of the degree in fragile confidence are Kalecki's observable endogenous variables
- Objective reflection of susceptibility:

$D_t = f(P_{t-1}, \Delta P, g_{t-1}, c_{t-1})$

Peak occurs when D_t at max.: P is high and ΔP begins to decrease, g >min. desired retained earnings (RE), c rises above desired degree of utilisation

Trough occurs when D_t at min.: P is low and ΔP begins to increase, lowest desired level of g reached, c falls below desired degree of utilisation

Empirical Support

Case Study Approach:

Courvisanos (1994) developed thesis from study of three manufacturing industries in Aust.: Steel, Aluminium, Motor Vehicles

Courvisanos (1996) pattern-matching published American and European studies in many manufacturing and some service industries

Econometric Approach

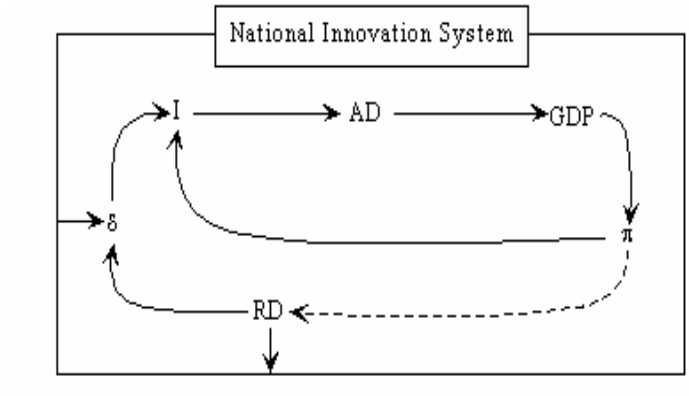
Laramie, Mair, Miller (2004; 2007) estimation of Susc. Cycle model against UK data 1980-96 with impact $P > c > g$ and lag cascade effect of D to: output(3qs), P(2/1qs), RE(0)

Kaleckian Theory of Investment and Innovation: Version III Business Cycle

- Explicit innovation factor determining new investment's ability to capture profit increments
- Technical progress increases productivity by new capital stock, makes old capital relatively obsolete – *e.g. innovation embodied in info-processing capital*
- Diverts profit away from existing capital
- Evidenced by positive change in profit and by increased volatility of investment

Innovation Framework

Set up a link to investment based on the Kaleckian feedback dynamics:



AD: aggregate demand GDP: economic activity π: aggregate profit level

Flow-chart of Innovation

Innovation (δ): New knowledge application - technology or organisation-based

Investment (I): expenditure on new capital goods with particular level of technical progress incorporated and some organisational structural changes

R&D (RD): research and development spending on discovering (R) and adapting (D) new technical knowledge into forms of capital goods and human resource skills. R&D investment based on variable profit flow (π) – broken line

Flow-chart of Innovation

- **National Innovation System** (NIS) carries the institutional and cultural characteristics of an economy which provides the climate for this mechanism.
- Economic growth is driven by aggregate demand (**AD**) incorporating I, and measured by the level of **GDP**, which generates a particular aggregate profit level (π).
- π has a direct short period effect on the flow of funds for investment (solid line) – 'P' from Susc. Cycle model (can also include ΔP, *g*, *c*)

Susceptibility and Innovation

Virtuous circle (during expansion phase)

Increase in RD leads to rise in δ, encourage expansion in I then on to AD and GDP. This creates accelerationist effect on I.

Destruction of old capital through technological obsolescence (TO) leads to increased susceptibility as investment expenditure rises

Vicious circle (during contraction phase)

Decrease in RD leads to less δ, discouraging I, negative impact on AD and GDP. This creates negative accelerationist effect on I.

Empirical Support

Regressions & Evolution

Courvisanos & Verspagen (2002) 1870-2000 data on patents in five major economies indicate *clustering* of basic innovation and *bunching* of investment around volatile susceptibility cycles.

Courvisanos (2007) 1984-98 Australian RD expenditure data in 13 manufacturing industry groups show:

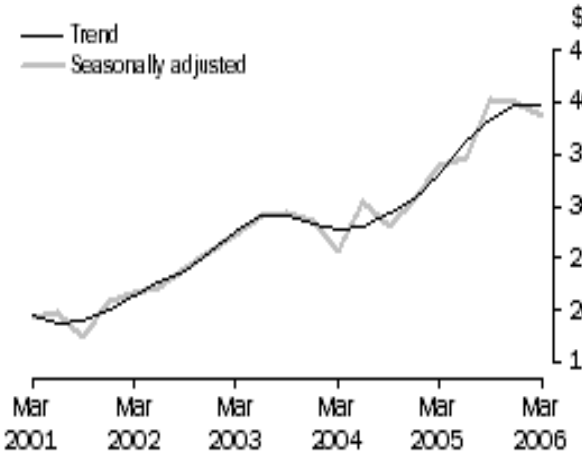
- virtuous circle effect in growth industry groups
- vicious circle effect in mature industry groups.
- latter monopoly power groups tend to weaken "cluster-bunching" effect

Empirical Support

Bloch, Courvisanos & Mangano (2007)

- Salter (1960) links innovation and technical change (**tc**) to investment via "decision rule"
- "Margin of obsolescence": $\mathbf{a_1}$-total cost of new capacity = $\mathbf{a_2}$-operating cost of existing capacity
- Invest in **tc** when $\mathbf{a_1}$ becomes less than $\mathbf{a_2}$
- Formal rule operationalising Kalecki's innovation factor – embodying technical change in capital
- Derive AUS Manf. 1968-2000 estimates of technical change impact on labour (RLS), capital (RKS), materials (RMS)

Australian Manufacturing Investment March 2001-06



Investment rate 2001/02-20004/05 Regression results: no lag	Estimated coefficient		
	RLS	RKS	RMS
Intercept	0.0289 (0.0317)	0.0683 (0.0252)	0.0679 (0.0254)
Avg Operating Profit/Avg IVA	0.16276* (0.0947)	0.1453 (0.1003)	0.1444 (0.0993)
Change in Operating Profit/Avg IVA	0.0679 (0.0471)	0.0768 (0.0507)	0.0791 (0.0558)
RLS	1.2590* (0.6729)		
RKS		0.00603 (0.1112)	
RMS			0.0350 (0.5582)
R-squared	0.2312	0.1472	0.1472
F-statistic	3.208**	1.841	1.842

Notes: Standard errors in parentheses
Observations = 36
** indicates significance at the 5% level
* indicates significance at the 10% level

Investment rate 2001/02 to 20004/05 RLS with 4-year Profit Lag	Estimated Coefficient
Intercept	0.0360 (0.0229)
Lag 4-year block of Avg Operating Profit/Avg IVA	0.2526*** (0.0754)
RLS	1.0602* (0.6280)
R-squared	0.3210
F-statistic	7.5630***

Notes: Standard errors in parentheses
Observations = 35
*** indicates significance at the 1% level
** indicates significance at the 5% level
*indicates significance at the 10% level

Variation in Investment rate	Variance of Investment Rate	Standard Error of Investment Rate
Intercept	-0.0028 (0.0023)	-0.0092 (0.0167)
Avg Operating Profit / Avg IVA	0.0035 (0.0067)	0.0411 (0.0500)
Change in Operating Profit / Avg IVA	0.0169*** (0.0033)	0.0950*** (0.0248)
RLS	0.0738 (0.0477)	0.7185** (0.3548)
R-squared	0.4965	0.4120
F-statistic	10.5192***	7.473***

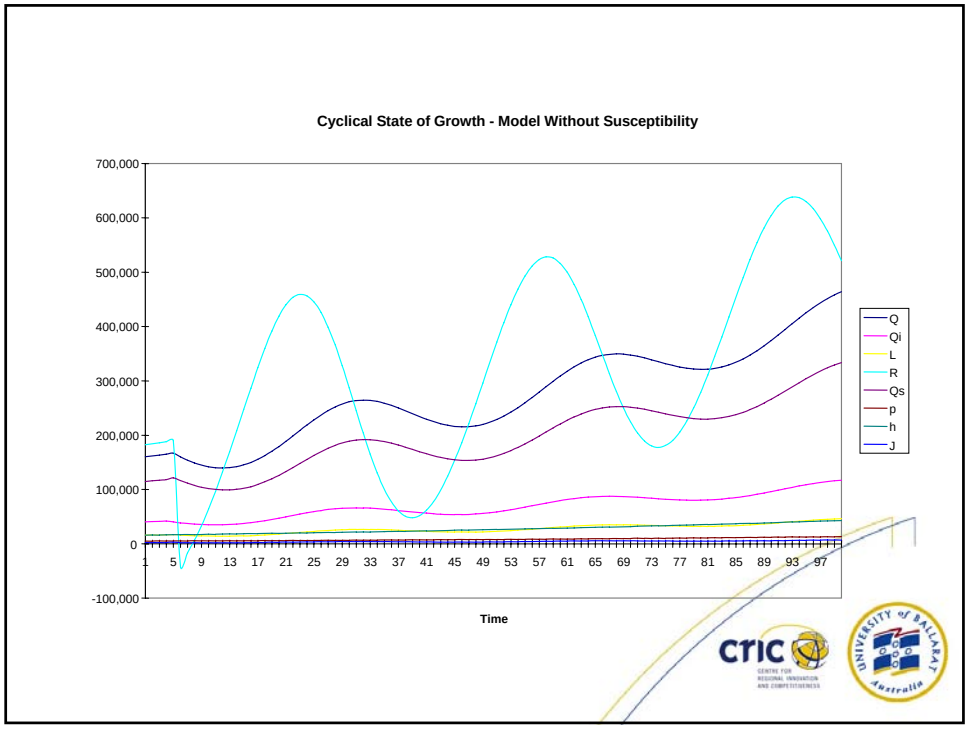
Notes: Standard errors in parentheses
Observations = 36
*** indicates significance at the 1% level
** indicates significance at the 5% level
*indicates significance at the 10% level

Simulation Modelling I

Richardson (2004) developed Kaleckian corn-credit economy to map traverses in economic development using computer simulation dynamic deterministic model.

Courvisanos and Richardson (2006) applied model to susceptibility cycle: Identify impact of reaction coefficient that determines rate of accumulation as a fraction of economy's profitability gap.

Result: no optimal path, alternative scenarios that reflect susceptibility to profitability and increasing risk in a “corridor of viability”


Cyclical State of Growth - Model Without Susceptibility
700,000
600,000
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400,000
300,000
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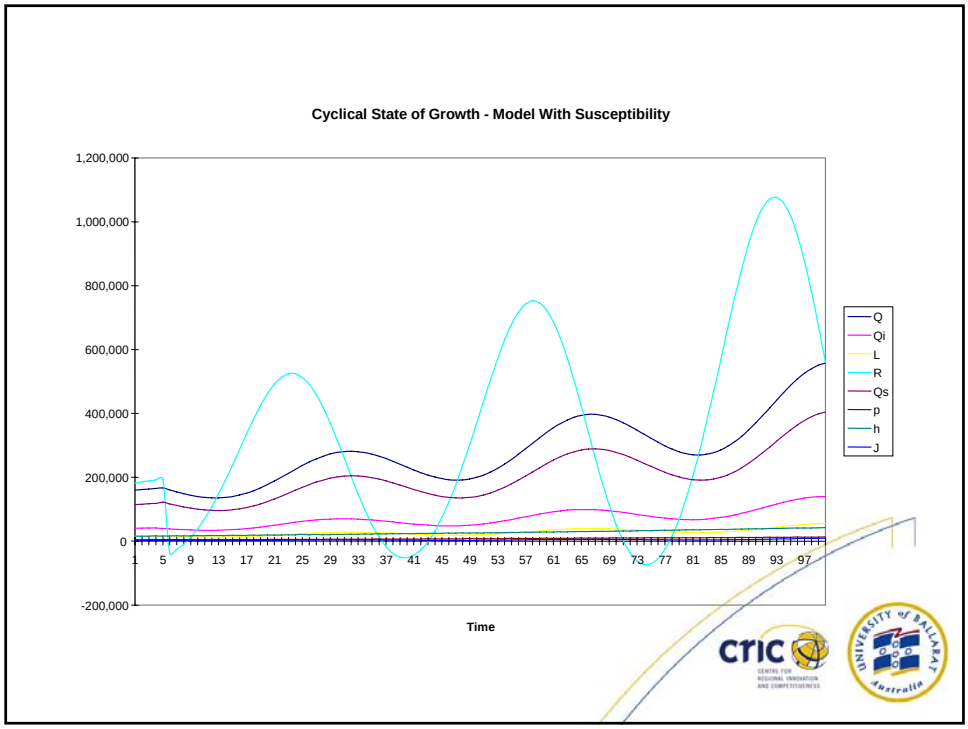
Cyclical State of Growth - Model With Susceptibility
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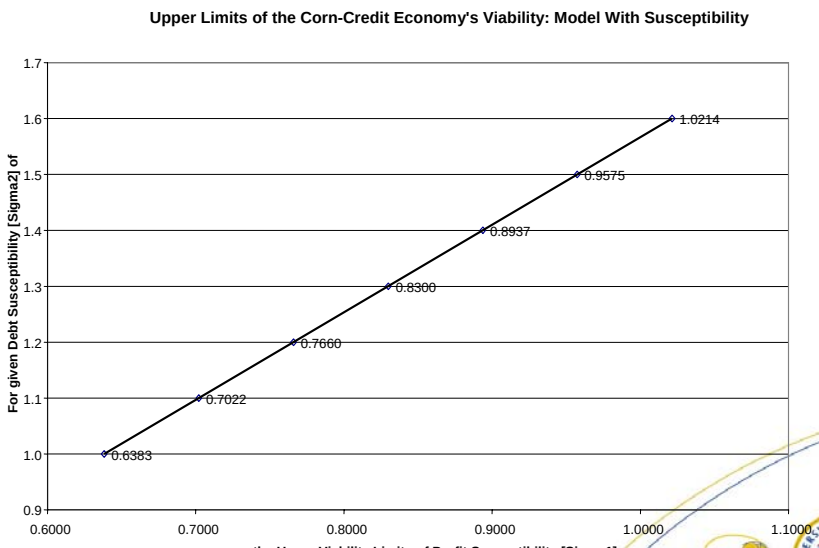


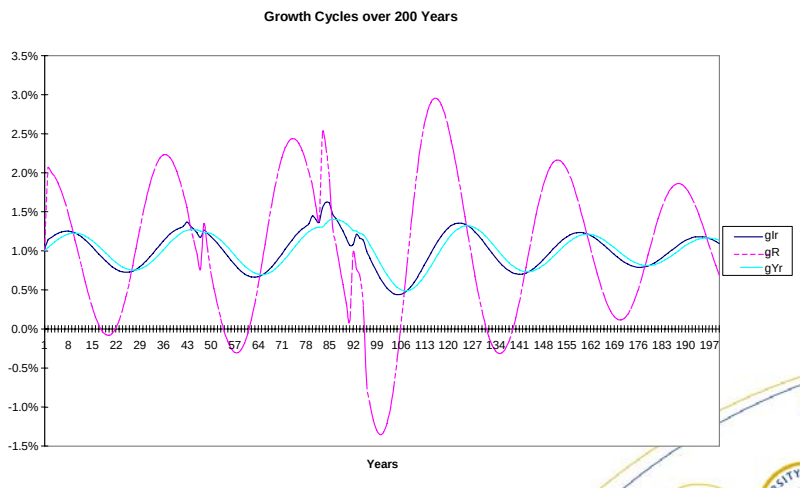
Simulation Modelling II

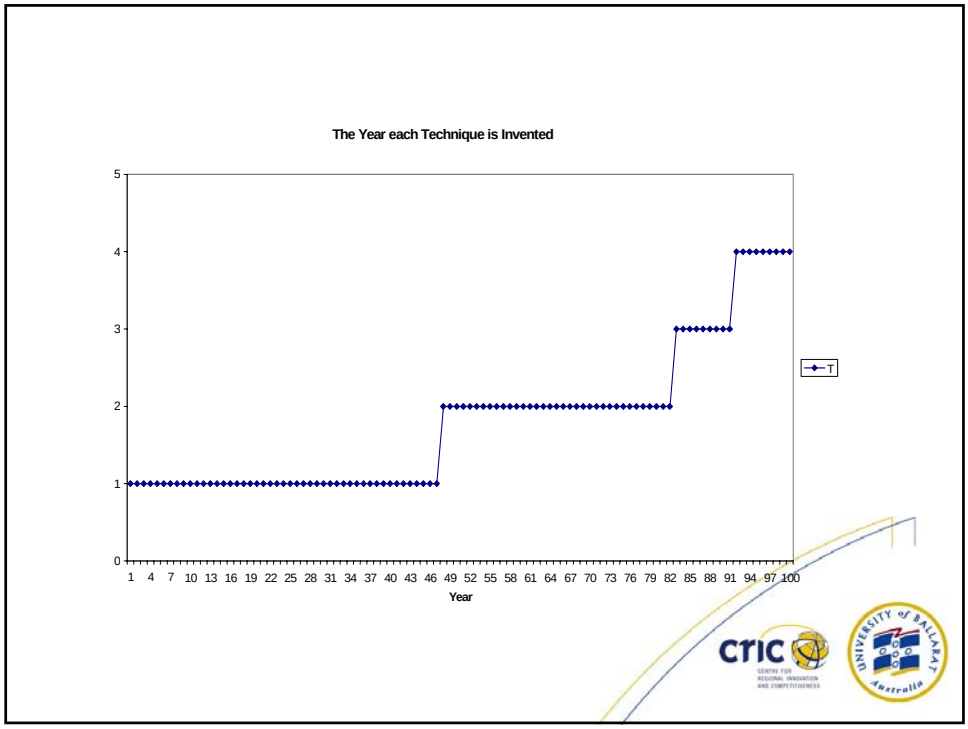
Courvisanos and Richardson (2007) adds the role of innovation into the simulation model.

- Based on "clust-bun" effect, study models 4 increasingly complex radical innovation regimes in the corn-credit economy.
- Model tracks the traverses in 3 stage (invention – innovation – investment) process
- RD exp. in "manyears" activates invention with Technique B-40, Tech C-100, Tech D-680
  - one tech. is a prerequisite for next technique
  - π gap >2% devoted to RD

Simulation Modelling II

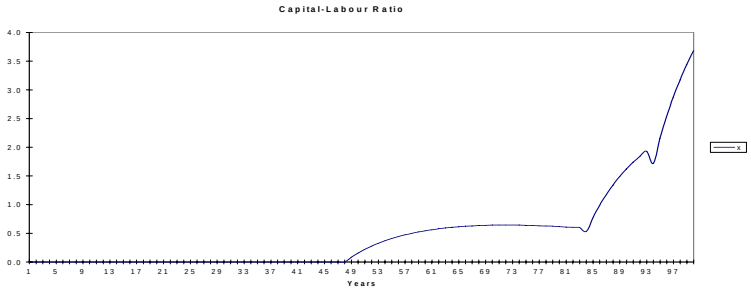
- In first cycle, π gap does not rise above 2% - no "investors" hired for RD
- 2nd cycle generates enough to bring forth B-technique, with stronger investment cycle
- Once invented, profit max. algorithm decides annually the proportion of existing A tech-based workforce should be equipped with newly invented B technique, etc...
- 3rd cycle generates two techniques in quick succession – "clust-bun" effect boosts I peak
- 4th cycle produces largest trough/peak amplitudes in profits due to major shift in technologies

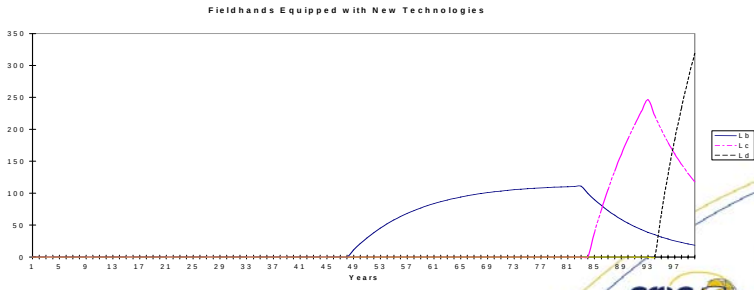




Simulation Modelling II

- 2nd Century simulated historical time has consecutively reducing amplitudes – economy settling down to a production regime using the D technology
- Salter-inspired result in I and TO due to δ reflects putty-clay investment-production process - see K/L ratio graph
- Also shows neo-Austrian "truncation" of long gestation processes in the previous technique (e.g. C) when newer technology (D) makes previous relatively new one TO
  - see "fieldhands" graph





Conclusions

- Investment cycles drive business cycle and growth
- Investment instability stems from susceptibility to convention-based investment decisions under uncertainty
- Investment in innovation exacerbates susceptibility within a “corridor of viability” as increasing risk limits need for profits
- “Cluster-bunch” effect of innovation/investment strongly driven by monopoly power
- Technological obsolescence determined by investment decisions on new technology

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