Australian Bureau of Statistics

statistics for informed decision making

Flexible Working Arrangements, Collaboration, ICT and Innovation

A Panel Data Analysis

Cristian Rotaru and Franklin Soriano

Analytical Services Unit

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Disclaimer

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Outline

- Motivation
- Data
- Methodology
- Model application
- Summary of findings

Motivation

- Capability building in longitudinal analysis
- Exploration of the longitudinal aspect of the Business Longitudinal Database (BLD)
- Examining an important topic which has received little empirical attention
- Extending the previous ABS cross-sectional analyses to the longitudinal front

Data

- 2007-2008, 2008-2009, and 2009-2010 waves of the BLD

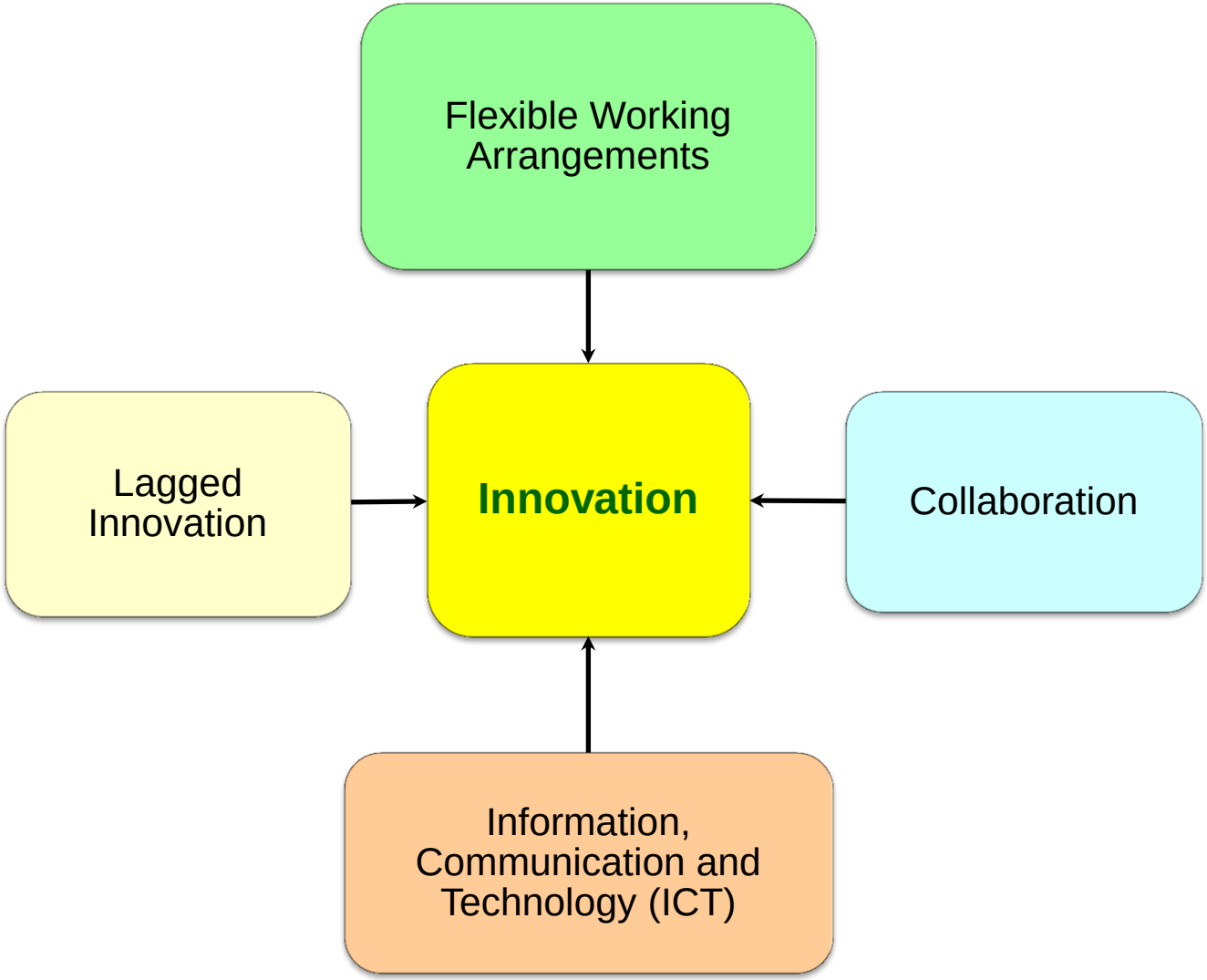
  (Business Characteristics Survey is the instrument)

- Small and medium-sized enterprises (SMEs)

More descriptive statistics available at:

- ABS "*Summary of IT Use and Innovation in Australian Business", 2010–11*, cat. no. 8166.0
- ABS *"Selected Characteristics of Australian Business", 2010–11*, cat. no. 8167.0
- ABS "*Microdata: Business Longitudinal Database"*, 2004-05 to 2009-10, cat. no. 8168.0.55.001
- ABS "Technical Manual: Business Longitudinal Database, CURF", 2004-05 to 2009-10, cat. no. 8168.0.55.002

Key relationships being investigated



Definition

Innovation:

- The definition of innovation follows the Oslo manual:

  " The implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations."

  (OECD, 2005, p. 46)

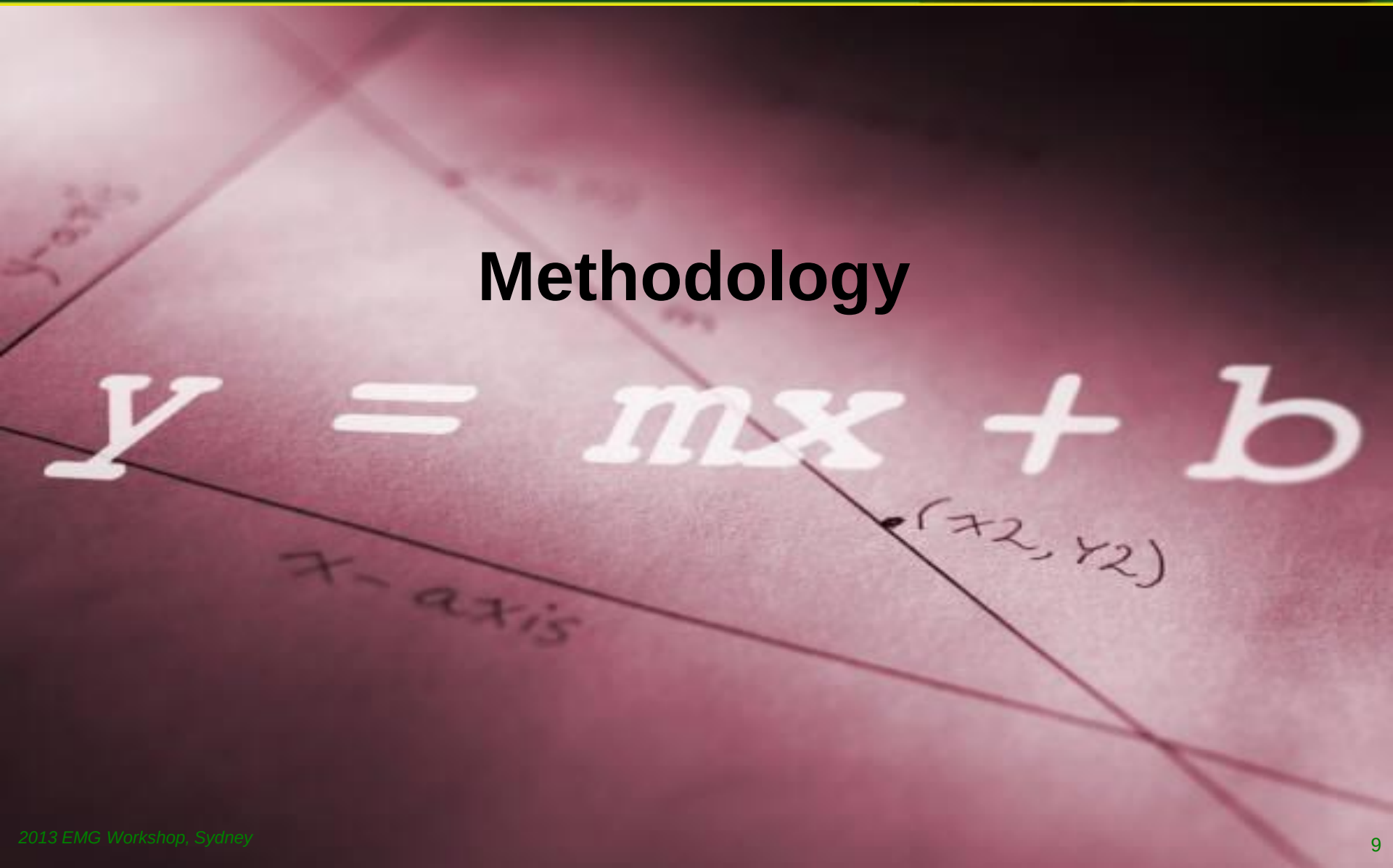
- Four types of Innovation:
  - New Goods and Services
  - New Operational Processes
  - New Organisational/Managerial Processes
  - New Marketing Methods

Definition

Flexible Working Arrangements

- Flexible hours
  - Flexible work hours
  - Selection of own roster or shifts
- Flexible leave
  - Ability to buy or cash out extra leave, or take LWOP
  - Paid parental leave
  - Flexible use of personal sick, unpaid, or compassionate leave
- Flexible Job
  - Job sharing
- Flexible Location
  - Ability for staff to work from home

Methodology



Models

Five models were implemented:

1. The Pooled Model
2. The Standard Random Effects (RE) Model
3. The Correlated (Mundlak/Chamberlain) RE Model
4. The Standard Dynamic Probit Model
5. The Dynamic RE Probit (Wooldridge) Model

Generalised Model

The overall model:

$$y_{it}^{*} = \rho y_{i,t-1} + x_{it}\beta + v_{it} \quad (y_{it} = 1\,[y_{it}^{*} > 0])$$

$$v_{it} = c_i + u_{it}$$

$$c_i \mid z_i, y_{i0} \sim N(\xi_0 + \xi_1 y_{i0} + \xi_2 z_i; \sigma_c^2)$$

- *True state dependence is implied by* $\rho \neq 0$
- *Effect of the initial values by* ξ_1
- *Heterogeneity by* c_i
- *Correlation of the individual effects with the regressors by* ξ_2

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Methodology

	Model 1	Model 2	Model 3	Model 4	Model 5
Treatment of unobserved heterogeneity (α_i)	Ignored; panel-robust standard errors are computed instead.	Treated as a random variable with a specified distribution.	Treated as a random variable with a specified distribution.	Ignored; panel-robust standard errors are computed instead.	Treated as a random variable with a specified distribution.
Inclusion of lag effects	Not included.	Not included.	Not included.	Included (first lag).	Included (first lag).
Allowance for correlation between α_i and covariates	Not Applicable.	Assumes independence.	Allows for correlation between α_i and the covariates.	Not Applicable.	Similar to model 3 but it also includes the correlation between α_i and the initial conditions.
Disadvantage		specific effects.			estimation and ementation of the el are much more plex. The model res distributional mptions for firm-ific effects.
Advantage	The model is relatively simple to use and implement. No need for distributional assumptions of the firm-specific effects.	The model is relatively simple and it makes direct allowance for individual-specific effects.	Similar to model 2. The model also allows for correlation between α_i and the regressors.	Similar to model 1 but it also includes lag effects.	Similar to model 3 but it also includes lag effects.
Complexity (implementation and interpretation)*	1	3	4	2	5

- Advantages vs. Disadvantages
- Trade-off between flexibility and complexity
- The complexity and computation power for some of the models

** = Relative complexity across the five models, with ranking of 1 standing for the least complex model, while 5 for the most complex*

Application

Application

Regression Results for the five models for innovation

Variables	Model 1 **Pooled**		Model 2 **Standard RE**		Model 3 **Mundlak**		Model 4 **Dynamic**		Model 5 **Dynamic RE**	
	Coefficient		Coefficient		Coefficient		Coefficient		Coefficient	
Innovation (t-1)							1.076	***	0.423	***
Innovation (t=0)									0.746	***
Industry (*Manufacturing*)	...	...	...	...	...	...	...	...	...	...
Size (*Very Small*)										
Small	0.052		0.135		0.036		0.040		0.052	
Average	0.140	**	0.323	***	0.124		0.104	**	0.092	
Flexible Work Hours	0.239	***	0.326	***	0.259	***	0.218	***	0.249	***
Flexible Leave	0.186	***	0.201	***	0.025		0.131	***	0.015	
Job Sharing	0.184	***	0.189	**	0.099		0.174	***	0.108	
Working from Home	0.085		0.119	*	0.032		0.066		0.025	
Competition (*No competition*)										
Minimal	0.142		0.183		-0.015		0.121		0.016	
Moderate or Strong	0.270	***	0.276	**	-0.073		0.188	**	-0.040	
ICT Intensity (*Most Intense*)										
Low	-0.556	***	-0.689	***	-0.170		-0.364	***	-0.128	
Moderate	-0.522	***	-0.638	***	-0.043		-0.344	***	-0.038	
High	-0.344	***	-0.390	***	-0.140		-0.221	***	-0.094	
Market Location (*Only Local*)										
Only Overseas	-0.456	**	-0.779	**	-0.823	***	-0.420	**	-0.594	**
Both local and overseas	0.232	***	0.328	***	0.240	***	0.176	***	0.172	**
Financial Year (*2007/2008*)										
2008/2009	-0.232	***	-0.340	***	-0.313	***	-0.359	***	-0.333	***
2009/2010	-0.167	***	-0.241	***	-0.216	***	-0.193	***	-0.205	***
Collaboration	0.394	***	0.502	***	0.339	***	0.337	***	0.324	***
Intercept	-0.063		-0.019		-0.164		-0.554	***	-0.672	***
Group Means										
Flexible Hours					0.132				0.027	
Flexible Leave					0.389	***			0.262	**
Job Sharing					0.254				0.153	
Working from Home					0.111				0.103	
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Moderate or Strong					0.598	**			0.359	*
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Low					-0.880	**			-0.461	
Moderate					-0.915	***			-0.506	***
High					-0.603	***			-0.352	**
Collaboration					0.391	**			0.172	
Log Likelihood	-3370.4		-3078.8		-3029.8		-2971.4		-2898.3	
AIC	6798.9		6217.6		6139.6		6002.9		5880.7	
BIC	6990.5		6415.8		6404.0		6201.1		6158.2	
Sigma			1.135		1.154				0.768	
rho			0.563***		0.571***				0.371***	
Observations (n)	5481		5481		5481		5481		5481	

*** = significant at the 0.01 level; ** = significant at the 0.05 level ; * = Significant at the 0.10 level.

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Average Partial Effects (APEs)

	Model 1		*Model 2*		*Model 3*		*Model 4*		*Model 5*	
*Variables**	*Pooled*		*Standard RE*		*Mundlak*		*Dynamic*		*Dynamic RE*	
Innovation (t–1)	…	…	…	…	…	…	0.380	(0.015)	0.113	(0.025)
Collaboration	0.138	(0.020)	0.119	(0.018)	0.165	(0.028)	0.104	(0.016)	0.126	(0.025)
Flexible working arrangements										
Flexible work hours	0.085	(0.017)	0.079	(0.016)	0.091	(0.027)	0.068	(0.014)	0.071	(0.023)
Flexible leave	0.066	(0.017)	0.048	(0.016)	0.096	(0.025)	0.041	(0.014)	0.071	(0.024)
Job sharing	0.064	(0.022)	0.045	(0.020)	0.080	(0.034)	0.053	(0.018)	0.066	(0.029)
Working from home	0.030	(0.019)	0.029	(0.017)	0.033	(0.026)	0.020	(0.014)	0.032	(0.022)
ICT intensity**										
Low	–0.204	(0.040)	–0.170	(0.036)	–0.250	(0.074)	–0.116	(0.033)	–0.156	(0.064)
Moderate	–0.191	(0.020)	–0.157	(0.019)	–0.229	(0.025)	–0.110	(0.016)	–0.144	(0.022)
High	–0.126	(0.025)	–0.095	(0.023)	–0.177	(0.038)	–0.070	(0.020)	–0.118	(0.033)

* = Overall Innovation being the dependent variable
** = Comparative to the most intense ICT intensity
Standard Errors included in brackets (computed using bootstrapping with 200 replications)

Selected results for different types of innovation#

Variables	Goods & Services		Organisational		Operational		Marketing	
	Coefficient		Coefficient		Coefficient		Coefficient	
Innovation (t-1)	0.371	***	0.482	***	0.541	***	0.447	***
Innovation (t=0)	0.961	***	0.637	***	0.672	***	0.528	***
Flexible Work Hours	0.164	**	0.110		0.252	***	0.142	*
Flexible Leave	0.036		0.092		0.036		0.068	
Job Sharing	0.130		0.245	***	0.169	*	0.246	***
Working from Home	0.134		0.068		-0.006		0.001	
Collaboration	0.283	***	0.294	***	0.279	***	0.168	**
Group Means								
Flexible Hours	0.009		0.131		-0.059		0.088	
Flexible Leave	0.046		0.276	***	0.330	***	-0.001	
Job Sharing	0.029		-0.094		0.103		0.002	
Working from Home	-0.014		0.101		0.066		0.099	
ICT Intensity (*Most Intense*)								
Low	-0.332		-0.284		-0.353		-0.985	***
Moderate	-0.511	***	-0.352	***	-0.288	**	-0.529	***
High	-0.187		-0.130		-0.269	*	-0.083	
Collaboration	0.225	*	0.048		0.311	***	0.333	***
Log Likelihood	-2640.8		-2707.6		-2594.4		-2562.9	
AIC	5365.5		5499.1		5272.8		5209.8	
BIC	5643.1		5776.7		5550.4		5487.4	
Sigma	0.868		0.616		0.688		0.688	
rho	0.430	***	0.275	***	0.321	***	0.321	***
Observations (n)	5481		5481		5481		5481	

*** = significant at the 0.01 level; ** = significant at the 0.05 level; * = Significant at the 0.10 level; Reference category is in brackets.

- Estimates for industry, size, competition, market location and financial year variables are not shown in this table

Summary of findings

Methodological:

- The results are robust across models
- There is evidence of:
  - Persistence of innovation
  - Heterogeneity
  - Individual effects being correlated with the regressors

Summary of findings

Application:

- Positive effects of flexible working arrangements
- Collaboration plays an important role
- ICT intensity is also significant

Thank you