Modeling Regional Endogenous Growth

A Structural Equation Model Approach

Patricio Aroca[1], Robert Stimson[2] and Roger Stough[3]

[1] Universidad Católica del Norte [2] University of Queensland [3] George Mason University

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Outline

Evolution of modeling approaches

Traditional regional economic development approaches were embedded in neo-classical economic growth theory.

Based on the Solow (1956, 2000) model.

In the new growth theory, the focus is directed towards endogenous factors and processes.

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Endogeneous Factors

Rees (1979) and Malecki (1991)

Technical progress as it generates economic development.

Henderson, Kuncoro & Turner (1995) Gordon & McCann (2000)

Regional industrial diversity and a trend to diversification enhance opportunities for regional growth and development.

Hanushek & Kimko (2000) and Goetz & Rapasingla (2001)

Human capital skills and income as important factors in explaining differential levels of regional economic performance.

Taylor, Catalano & Gane (2002) and Duranton & Puga (2000)

The power of urban scale and agglomeration on regional performance.

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Additional Endogenous Factors

Leadership

Judd & Parkinson (1990); Bryson & Crosby (1992); Fosler (1992); Hansen (1992); Fairholm (1994); de Santis & Stough (1999)

Institutions

Doig & Hargrove (1987); Gray (1989); North (1990); Fukuyama (1996); Putman (1993); Mouritzen & Svara (2000)

Entrepreneurship

Schumpeter (1934); Kirzner (1973); Acs (1999); Jessop (1998); Acs, Audretdsch, Braunerhjelm & Carlsson (2004); Audretsch & Kreilbach (2004); High (2004); Stough, Kulkarni & Paelinck (2004).

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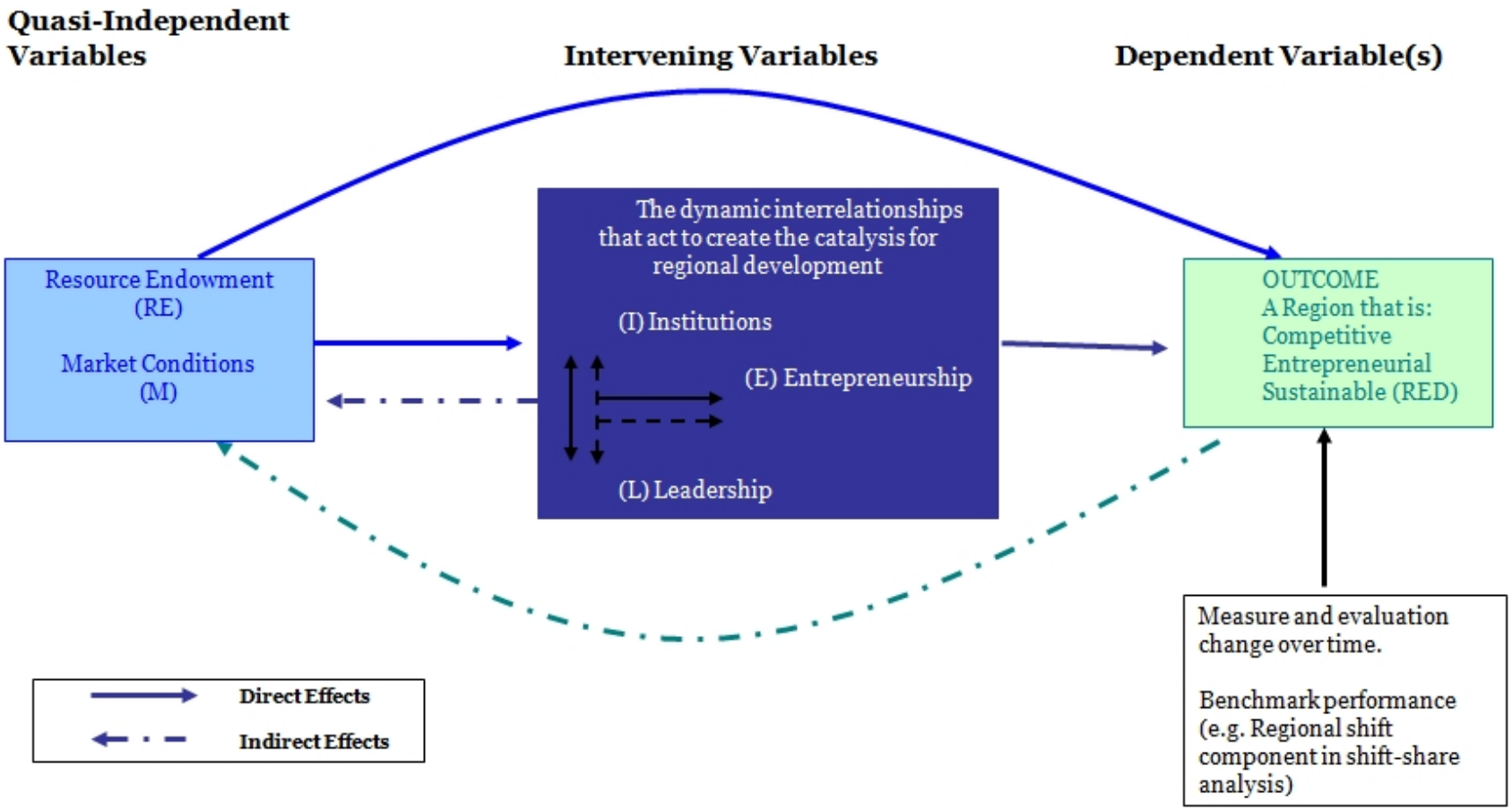
The Stimson-Stough-Salazar Model



Current Advances in Growth Theory

Rodrick, D. (2008). Second Best Institutions, AER. May 2008.

Entry regulations and entrepreneurship.
Entrepreneurship can be suppressed for a variety of reasons. Entry costs may be high, property rights may not be well protected, the contracting environment may be poor (either because relational contracting does not work well or the courts are ineffective), or the perceived returns may be low.

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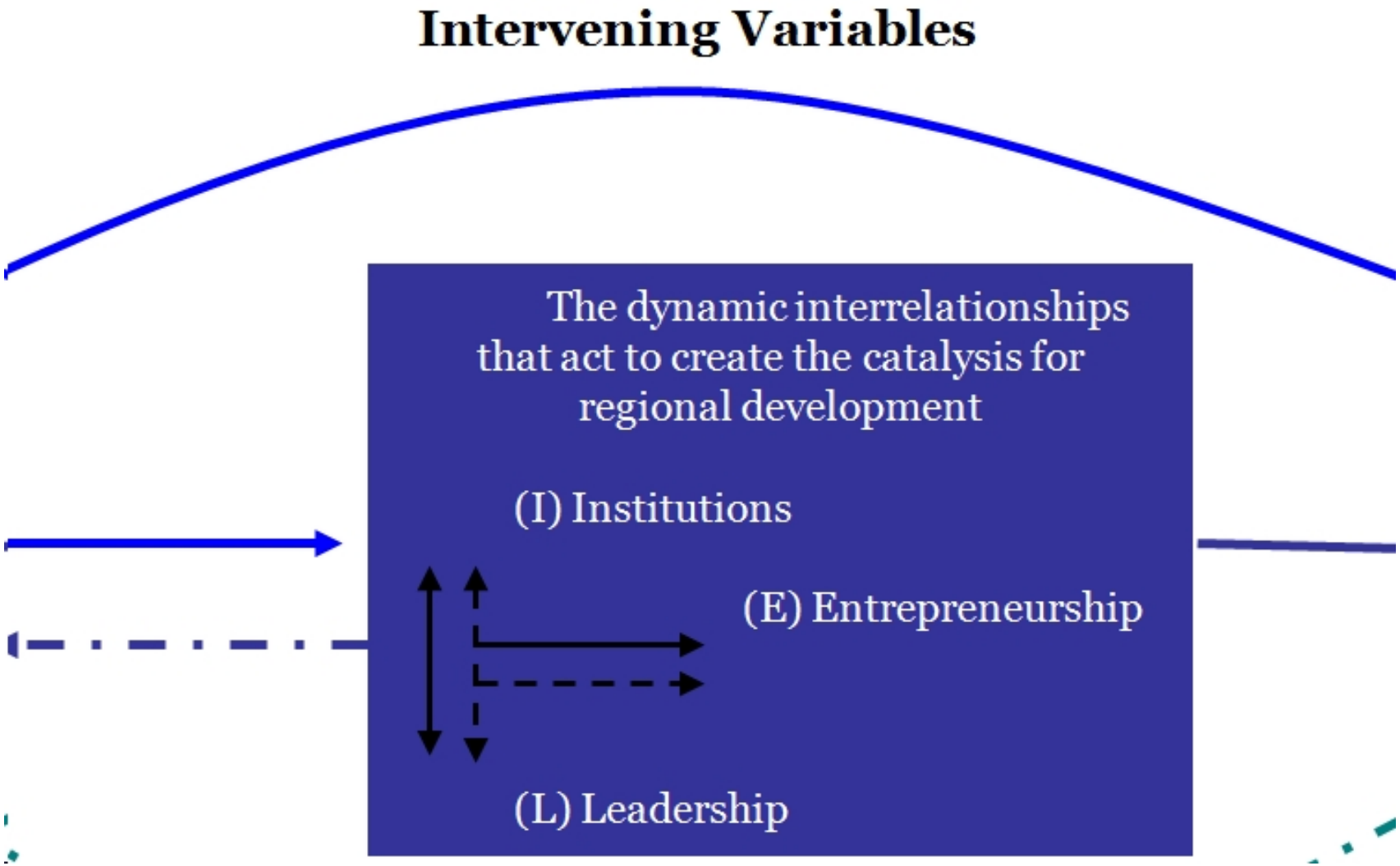

Methodological Challenges

Measurement

There are good measures for traditional variables: output, labor, investment - capital. However, it is difficult to find good measures for variables o factor like Leadership, Institutions, Entrepreneurship among others.

Endogeneity

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Traditional Econometric Approach

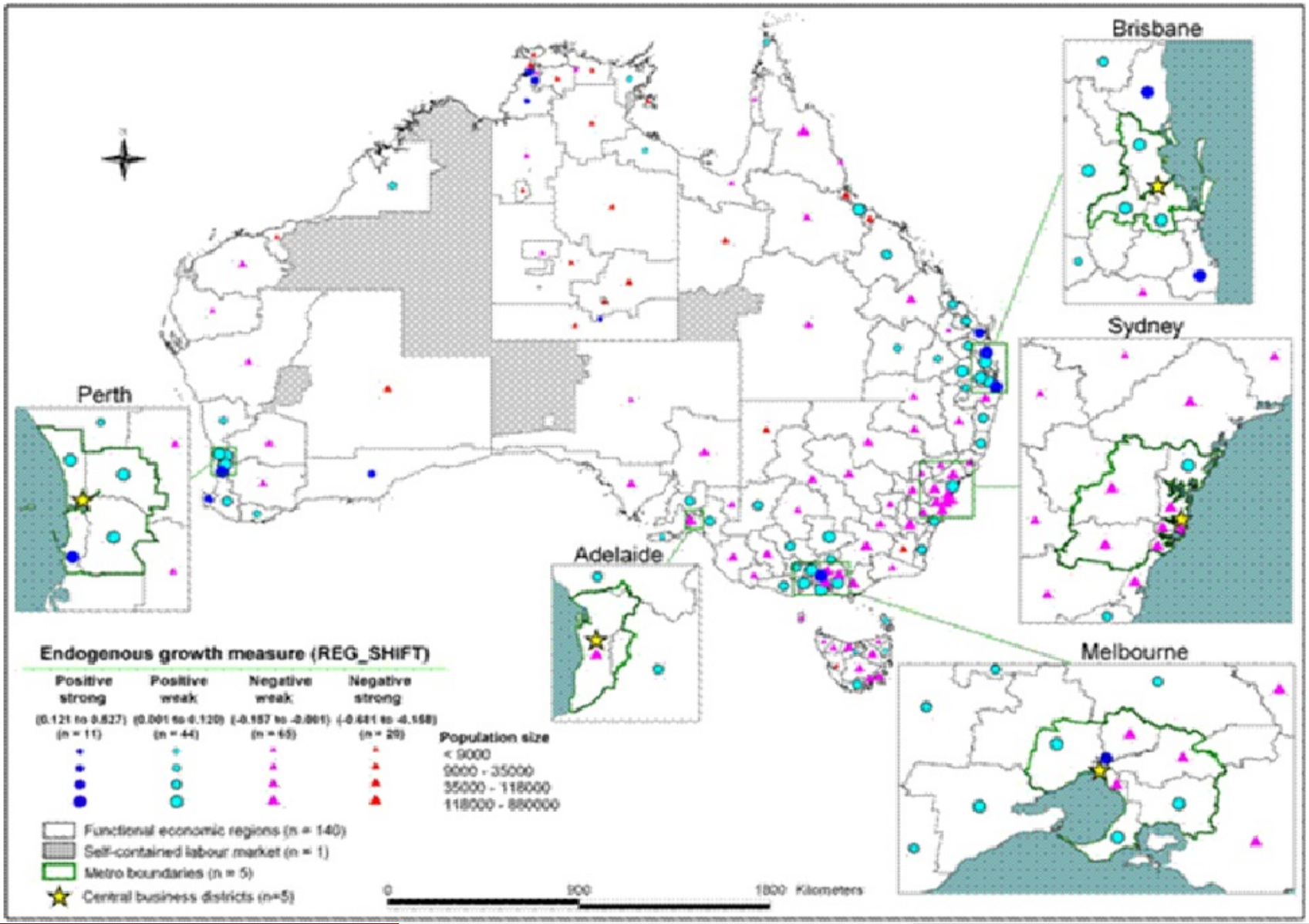
Regressions

OLS corrected by autocorrelation, heterocedasticity, specification errors, etc.

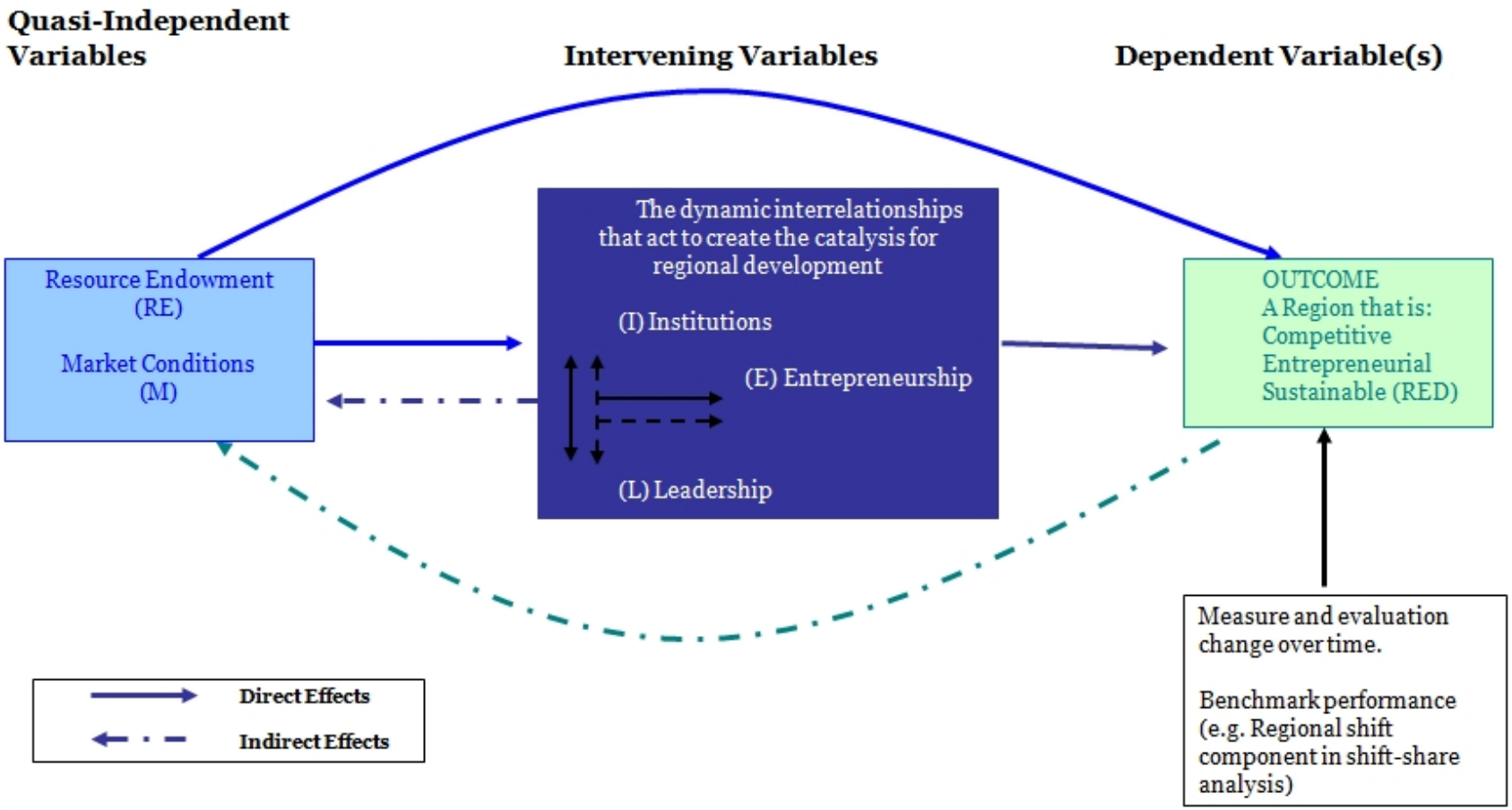
Instrumental Variables to tackle endogeneity

GMM

Map


Brisbane
Sydney
Perth
Adelaide
Melbourne
Endogenous growth measure (REG_SHIFT)
Positive strong
(0.121 to 0.827)
(n = 11)
Positive weak
(0.001 to 0.120)
(n = 44)
Negative weak
(-0.187 to -0.001)
(n = 65)
Negative strong
(-0.681 to -0.188)
(n = 20)
Population size
< 9000
9000 - 35000
35000 - 118000
118000 - 860000
Functional economic regions (n = 140)
Self-contained labour market (n = 1)
Metro boundaries (n = 5)
Central business districts (n=5)
0
900
1800 Kilometers

The Stimson-Stough-Salazar Model



Variables

Variable label	Variable description
Dependent variable	
REG_SHIFT	Regional Shift (1996 to 2006) / Labour Force (1996)
Explanatory variables	
SPEC_96	Specialization Index for 1996 (Herfindahl-Hirschman Index)
SPEC_CH	Change in Specialization Index from 1996 to 2006 (Herfindahl-Hirschman Index)
SCI	Structural Change Index (1996 to 2006)
SCI_CH	Change in the Structural Change Index (from 1996 - 2001 TO 2001-2006)
L_INC_96	(Approximate) Mean Individual Income - 1996 Annual (Log) (real)
L_INC_CH	Change in (Approximate) Mean Individual Income - 1996 to 2006 Annual (Log) (real)
UNEMP_96	Unemployment rate in 1996 (%)
UNEMP_CH	Change in Unemployment rate from 1996 to 2006 (pps)
L_POP_96	Log of population (1996)
L_POP_CH	Change in Log of population (1996 TO 2006)
LQ_MAN_96	Location Quotient for the Manufacturing Industry in 1996
LQ_INF_96	Location Quotient for the Information media & telecommunications Industry in 1996
LQ_FIN_96	Location Quotient for the Financial & insurance services Industry in 1996
LQ_PRO_96	Location Quotient for the Professional, scientific & technical services Industry in 1996
LQ_MAN_CH	Change in the Location Quotient for the Manufacturing Industry, 1996 to 2006
LQ_INF_CH	Change in the Location Quotient for the Information media & telecommunications Industry, 1996 to 2006
LQ_FIN_CH	Change in the Location Quotient for the Financial & insurance services Industry, 1996 to 2006
LQ_PRO_CH	Change in the Location Quotient for the Professional, scientific & technical services Industry, 1996 to 2006
POST GRAD_96	Proportion of labour force with a Postgraduate Degree of higher in 1996
BACHELOR_96	Proportion of labour force with a Bachelor Degree of higher in 1996
TECHQUALS_96	Proportion of labour force with technical qualifications in 1996
POST GRAD_CH	Change in the Proportion of labour force with a postgraduate degree of higher, from 1996 to 2006
BACHELOR_CH	Change in the Proportion of labour force with a bachelor degree of higher, from 1996 to 2006
TECHQUALS_CH	Change in the Proportion of labour force with technical qualifications, from 1996 to 2006
SYMBA_96	Proportion of Symbolic Analysts (Managers + Professionals) in Employment in 1996
SYMBA_CH	Change in the proportion of Symbolic Analysts (Managers + Professionals) in Employment from 1996 to 2006
VOLUNTEER_06	Proportion of Volunteers in Working Age Population (15-64) in 2006
CREATIVE_06	Proportion of Total employment in Creative Industries in 2006
A_COAST	Border is adjacent to coastline (No = 0; Yes = 1)
P_METRO	Border is adjacent to metropolitan statistical division (No = 0; Yes = 1)
D_URBAN	Classified as Urban under Australian Classification of Local Government system (1 = Yes, 0 = No)
D_REMOTE	Classified as Remote under Australian Classification of Local Governments system (1 = Yes, 0 = No)

OLS Results. Dependent Variable: Regional-Shift

	Estimate	Std. Error	*t* value	Pr(>|*t*|)	
(Intercept)	1.148	0.289	3.972	1.21E-04	***
SPEC_CH	0.423	0.150	2.818	5.64E-03	**
SCI	-1.324	0.146	-9.054	2.71E-15	***
SCI_CH	1.306	0.159	8.189	2.96E-13	***
L_INC_96	-0.392	0.087	-4.475	1.73E-05	***
UNEMP_96	-1.385	0.321	-4.316	3.25E-05	***
UNEMP_CH	-2.432	0.338	-7.192	5.61E-11	***
L_POP_CH	2.392	0.121	19.822	5.86E-40	***
LQ_PRO_96	0.069	0.034	2.027	4.48E-02	*
LQ_MAN_CH	0.067	0.024	2.840	5.28E-03	**
LQ_PRO_CH	0.116	0.049	2.355	2.01E-02	*
POSTGRAD_96	-5.368	1.756	-3.057	2.75E-03	**
TECHQUALS_96	-0.522	0.262	-1.991	4.87E-02	*
TECHQUALS_CH	1.328	0.532	2.497	1.39E-02	*
SYMBA_CH	-0.119	0.057	-2.081	3.96E-02	*
VOLUNTEER_06	0.571	0.098	5.819	4.87E-08	***
CREATIVE_06	1.099	0.344	3.198	1.76E-03	**

Significance codes: 0.000‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-square = 0.89

Traditional Econometric Approach

Simultaneous Equation System

2SLS, 3SLS

FIML, LIML

Simultaneous Equation System

Structural Form

$$B_{y_t} + \Gamma_{x_t} = u_t \quad t = 1, 2, ..., T.$$

Reduced Form

$$y_t = \Pi_{x_t} + v_t \quad t = 1, 2..., T.$$

$$Where \quad \Pi = -B^{-1}\Gamma \quad and \quad v_t = B^{-1}u_t$$

Problems

- Endogeneity in the model
- Endogeneity by measurement problems

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Structural Equation Approach

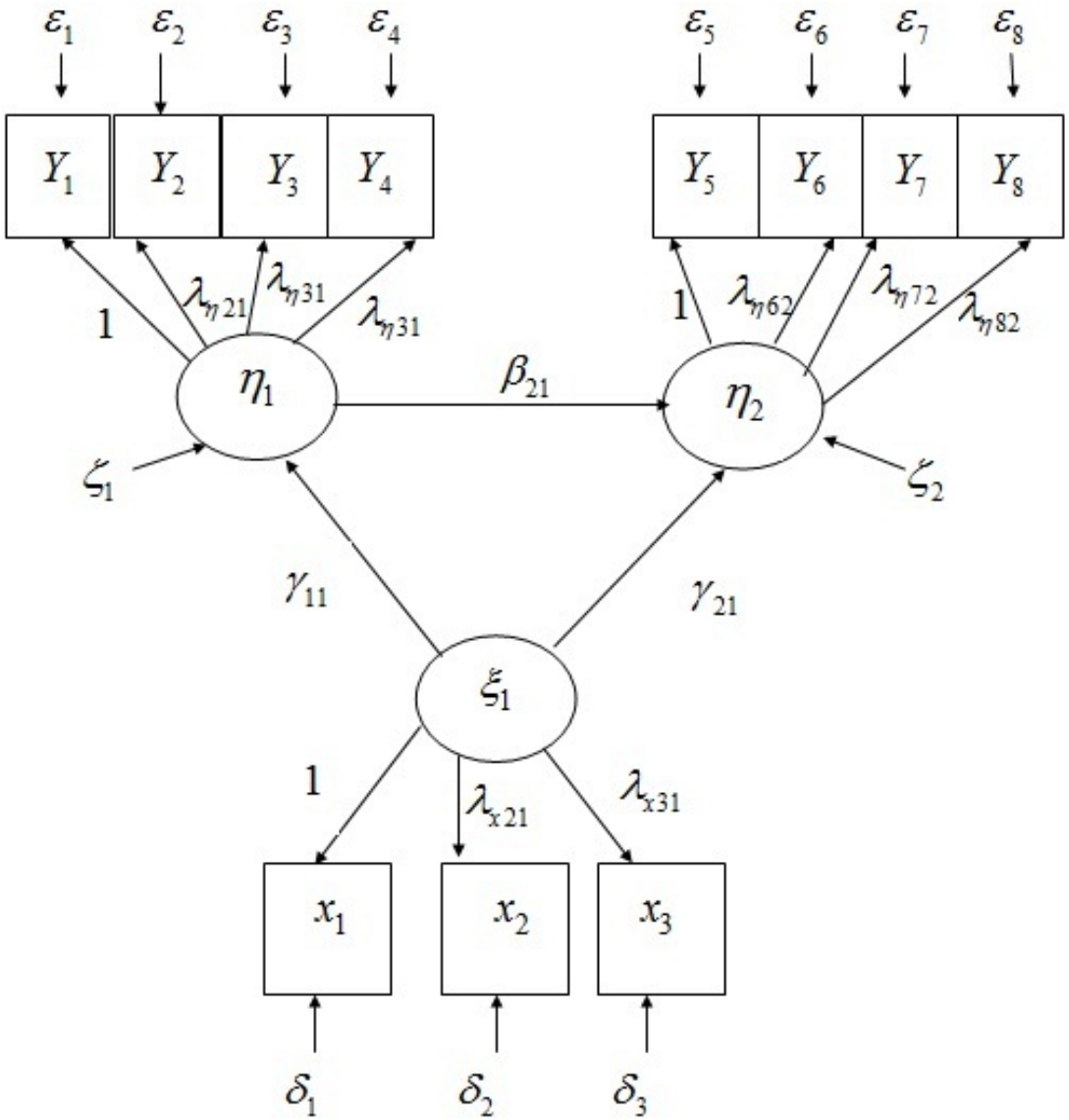
The Structural Model (Kolenikov et al, 2010 and Kaplan, 2009)

$$\eta_i = \alpha_\eta + \beta\eta_i + \tau\xi_i + \zeta_i$$

where η_i is a vector of the latent endogenous variables, α_η a vector of the intercept terms for the equation, β the matrix of coefficients giving the impact of the latent endogenous variable on each other, ξ_i the vector of latent exogenous variables, τ the coefficient matrix giving the effects of the latent exogenous variables on the latent endogenous variables, and ζ_i the vector of disturbances.

$$\begin{bmatrix}\eta_1\\ \eta_2\end{bmatrix} = \begin{bmatrix}\alpha_{\eta_1}\\ \alpha_{\eta_2}\end{bmatrix} + \begin{bmatrix}0 & 0\\ \beta_{21} & 0\end{bmatrix}\begin{bmatrix}\eta_1\\ \eta_2\end{bmatrix} + \begin{bmatrix}\gamma_{11}\\ \gamma_{21}\end{bmatrix}|\xi_1| + \begin{bmatrix}\xi_1\\ \xi_2\end{bmatrix}$$

Structural Equation Approach



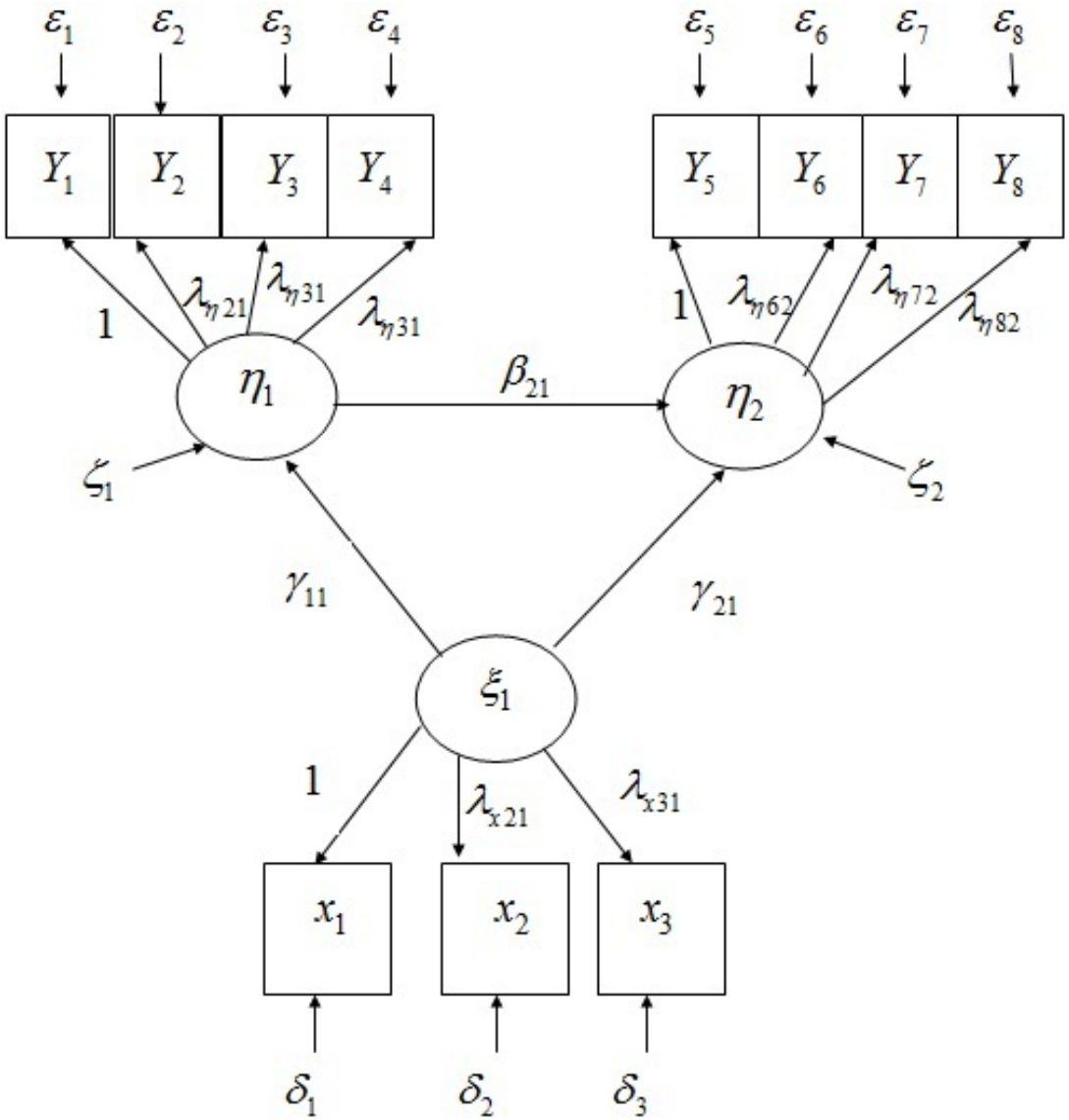
The Measurement Model, (Kolenikov et al, 2010 and Kaplan, 2009)

$$\mathbf{y}_i = \alpha_y + \Lambda_y \eta_i + \epsilon_i$$
$$\mathbf{x}_i = \alpha_x + \Lambda_x \xi_i + \delta_i$$

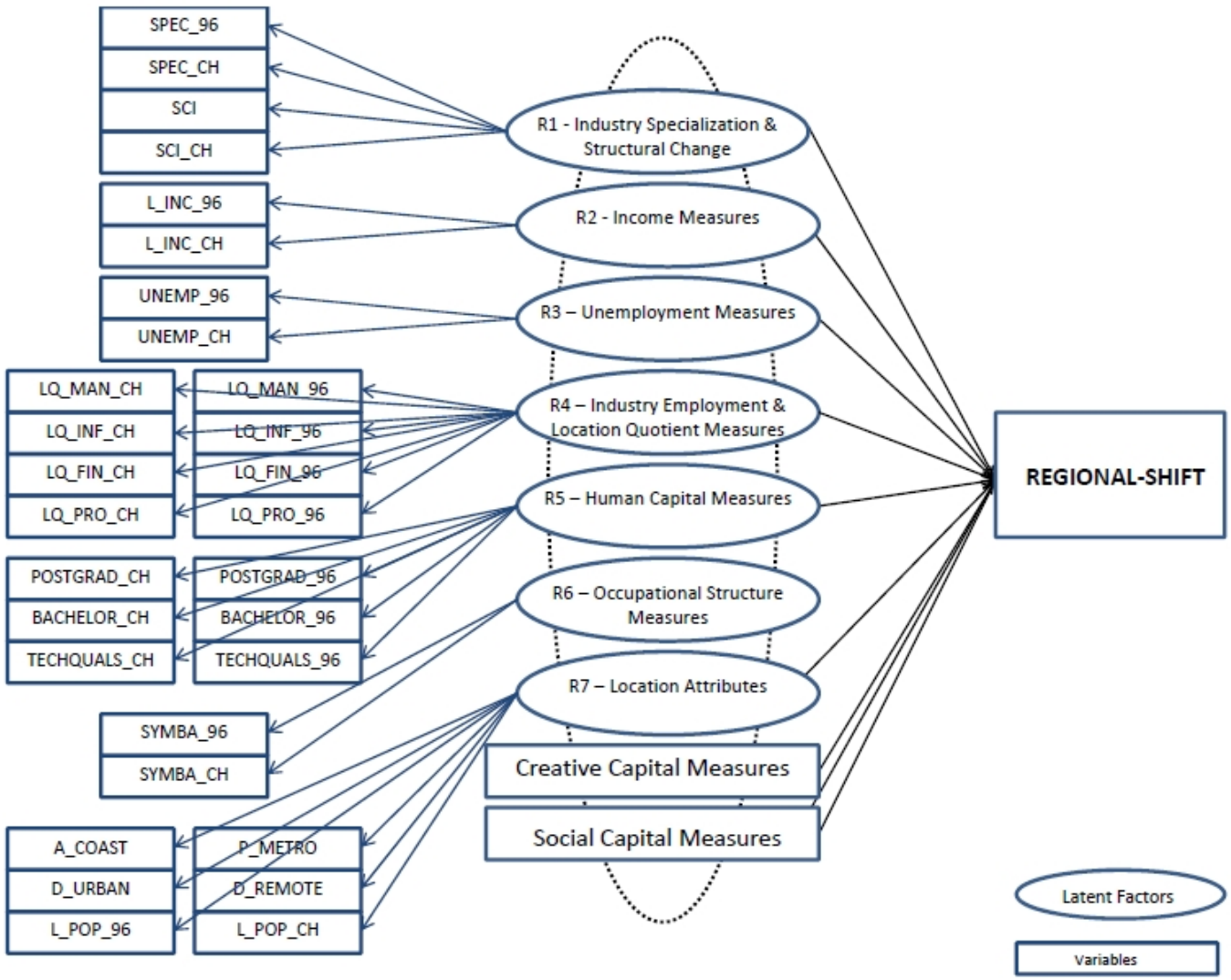
where y_i and x_i are vectors of the observed indicators of η_i and ξ_i,respectively; α_y and α_x are intercept vectors;Λ_y and Λ_x are matrices of factor loadings or regression coefficients giving the impact of the latent η_i and ξ_i on y_i and x_i, respectively; and ϵ_i and δ_i are the unique factors of y_i and x_i.

$$\mathbf{x} = \alpha_x + \Lambda_x \xi + \delta$$
$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 \\ \alpha_{x2} \\ \alpha_{x3} \end{bmatrix} + \begin{bmatrix} 1 \\ \lambda_{x21} \\ \lambda_{x31} \end{bmatrix} |\xi_1| + \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \end{bmatrix}$$

Structural Equation Approach



Application to Australia Functional Economic Regions: Model Specification



SEM Stages

- Model Identification
- Model Estimation
- Model Fit
- Model Respecification
- Repeat until getting the best Model

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Results for the Structural Model

FACTORS AND EXPLANATORY VARIABLE		Estimate	S.E.	C.R.	P	Standarized
R1 - Industry Specialization & Structural Change Measures	REG_SHIFT <--- R1	-2,075	,322	-6,444	***	-,730
R2 - Income Measures	REG_SHIFT <--- R2	,870	,312	2,785	,005	,266
R3 - Unemployment Measures	REG_SHIFT <--- R3	-,908	,202	-4,493	***	-,329
R4 - Industry Employment & Location Quotient Measures	REG_SHIFT <--- R4	-,772	,243	-3,176	,001	-1,597
R5 - Human Capital Measures	REG_SHIFT <--- R5	25,100	9,089	2,761	,006	,817
R7 - Location Attributes	REG_SHIFT <--- R7	,285	,145	1,974	,048	,585
Population Size	REG_SHIFT <--- L_POP_CH	2,091	,286	7,304	***	,632

Results for the Measurement Model

FACTORS				Estimate	S.E.	C.R.	P	Standarized
R5 - Human Capital Measures	POSTGRAD_96	<---	R5	1,000				,919
	BACHELOR_96	<---	R5	4,256	,150	28,281	***	1,008
	TECHQUALS_96	<---	R5	3,276	,541	6,055	***	,460
R7 - Location Attributes	A_COAST	<---	R7	,377	,131	2,871	,004	,253
	P_METRO	<---	R7	1,000				,800
	D_URBAN	<---	R7	1,099	,097	11,303	***	,870
	D_REMOTE	<---	R7	-,867	,123	-7,029	***	-,584

Correlations Among Factor

COVARIANCES			Estimate	S.E.	C.R.	P	CORRELATIONS
R2	<-->	R3	-,001	,000	-4,564	***	-,491
R1	<-->	R5	,000	,000	-4,063	***	-,365
R1	<-->	R7	-,012	,002	-5,552	***	-,617
R5	<-->	R7	,001	,000	5,473	***	,588
R2	<-->	R5	,000	,000	-4,504	***	-,244
R3	<-->	R5	,000	,000	4,029	***	,175
R4	<-->	R5	,001	,000	7,175	***	,857
R1	<-->	R4	-,012	,002	-6,005	***	-,657
R4	<-->	R7	,094	,014	6,595	***	,855
R6	<-->	R7	,000	,000	-4,587	***	-,505
R6	<-->	R5	,000	,000	-6,613	***	-,952
R6	<-->	R1	,000	,000	3,102	,002	,275
R6	<-->	R2	,000	,000	4,253	***	,303
R6	<-->	R3	,000	,000	-3,802	***	-,212
R6	<-->	R4	,000	,000	-5,963	***	-,769

R5 - Human Capital Measures

R6 - Human Capital Changes Measures

Conclusions

- Human Capital Factor in a region at the beginning of the period 1996-2006 is the most important factor explaining variation in endogenous regional growth across FERs in Australia.
- Location attributes factor suggest that endogenous growth will be higher for metropolitan and other urban regions, and while still positive it will be lower for regions located on the coast. While this factor will be negative for regions in remote locations.
- The Population Change Variable tends to be dominated in some regions by the impact of internal migration flows, is well known to often be a driver of regional endogenous growth.
- If we compare this results with the ones obtained using traditional econometric methods for the same data, we get more information and a better understanding of the process that is generating the data.

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