

Testing for Linkages in Sectoral Development: A SVAR-Approach to South Africa

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TIPS Annual Forum 2008
South Africa's economic miracle—has the emperor lost his
clothes?



Syllabus

- 1 Motivation**
 - Linkages in Economic Theory
 - South African Industrial Development
- 2 The Model
 - Vector Autoregression
 - SVAR with Linkages
- 3 The Data
- 4 Estimation Results
 - Diagnostics
 - Impulse responses
- 5 Conclusion



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- Forward and backward linkages defined by Hirschman
- Important role in development economics after 1945
- Recent contributions: sectoral composition of output matters for economic development (Imbs and Wacziarg, Ocampo, Rodrik)



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South African Industrial Development I

- Industrialization triggered by discovery of rich minerals endowment
- Linkage-induced development of input sectors (e.g. explosives/ chemicals, electricity, mining machinery)
- State intervention in upstream industries such as chemicals, steel—Minerals-Energy Complex (MEC) dominated economy



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South African Industrial Development II

- Capital intensive industries despite abundant unskilled labor supply—high unemployment
- Pattern continued after 1994 despite policy goal of diversification
- Strong growth in chemicals and other capital-intensive sectors close to the mineral endowment
- To what extent do linkages shape this development pattern?



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Vector Autoregression I

- In time-series econometrics, autoregressive models explain a variable's behaviour by its past performance
- In a Vector Autoregression (VAR), a set of variables are explained by their own and the others' past performance
- All variables are endogenous, there are no a priori restrictions on the system
- Used in forecasting, to calculate impulse responses (effect of a shock in one variable on the other variables)



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Vector Autoregression II

- Problem of identification: in reduced form, shocks cannot be uniquely attributed to a variable without further restrictions

$$y_t = b_{10} - b_{12}z_t + \gamma_{11}y_{t-1} + \gamma_{12}z_{t-1} + \epsilon_{yt} \quad (1)$$

$$z_t = b_{20} - b_{21}y_t + \gamma_{21}y_{t-1} + \gamma_{22}z_{t-1} + \epsilon_{zt} \quad (2)$$

- with ϵ_{it} pure and uncorrelated shocks
- To estimate, the system has to be rewritten in its reduced form, where endogenous variables are expressed only as a function of lagged variables



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Vector Autoregression III

- The reduced form equations can be estimated, but the shocks e_{it} are composites of ϵ_{yt} and ϵ_{zt}

$$y_t = a_{10} + a_{11}y_{t-1} + a_{12}z_{t-1} + e_{1t} \quad (3)$$

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- To isolate the effect of a pure shock, further restrictions have to be introduced (e.g. ordering of variables)
- Structural VARs use economic theory to arrive at restrictions



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Formulation of the SVAR model

- We explain sectoral performance as a function of its own and other sectors' past performance
- Sectors enter weighted according to linkage strength

$$y_{it} = \lambda_i + \sum_{j=1}^p \phi_{ji} y_{it-j} + \sum_{j=0}^p \beta_{ji} y_{it-j}^f + \epsilon_{jt} \quad (5)$$

with $y_{it}^f = \sum_{j=1}^n w_{ij} y_{jt}$

- Equations can be estimated because output growth of other sectors enters as a weighted aggregate
- We also get estimates for the pure shocks ϵ_{jt} and can calculate impulse responses without further restrictions



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Data description

- Data from Quantec Database, at various levels of disaggregation
- We use total output data at basic prices from 1970 to 2007
- The weighting matrix is calculated for each year and reflects domestic intermediate inputs used in the respective sector
- Specifications: Primary, secondary, tertiary sector; nine 3-digit sectors; ten 4-digit manufacturing subsectors



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Diagnostics

- Treated as a system of equations, therefore estimation by OLS, 2SLS, and 3SLS possible
- 3SLS yields best results with regards to the diagonality of the matrix of residual correlations—no (or very few) significant correlations of the errors ϵ_{it}
- The model thus seems to be properly specified
- Exception: estimation of manufacturing sub-sectors performs worse, results therefore must be treated carefully



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Primary, Secondary and Tertiary Sector I

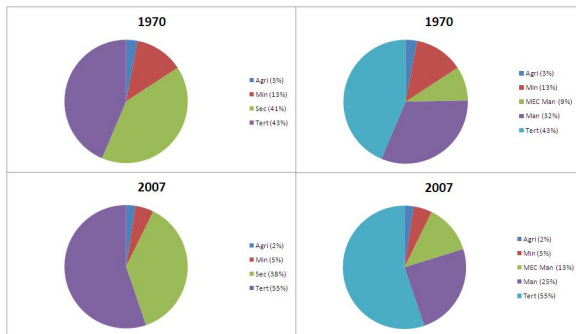


Figure: Share of Sectoral Output in Total Output in 1970 and 2007

Source: Quantec



Primary, Secondary and Tertiary Sector II

<i>Shock in</i>	Agri	Min	Sec	Tert
	<i>Cumulated impulse response</i>			
Agri	0.742	0.033	0.056	0.070
Min	-0.040	1.198	-0.121	-0.258
Sec	0.338	0.592	1.049	0.505
Tert	0.085	0.153	0.247	1.627

Table: Cumulated impulse response after 4 periods

- Secondary sector displays strongest pulling power, while agriculture and mining have negligible effects
- Growth spurts in the tertiary sector do not affect other sectors much despite its size



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Agri	0.721	0.026	0.040	0.041	0.047
Min	-0.029	1.327	-0.070	-0.084	-0.156
MEC	0.044	0.563	1.101	0.113	0.194
Sec	0.437	0.355	0.408	1.330	0.503
Tert	0.151	0.232	0.307	0.433	1.592

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- Positive spillovers stemming from secondary sector are mostly due to non-MEC manufacturing
- MEC manufacturing displays much weaker linkage effects with the obvious exception of the mining industry itself



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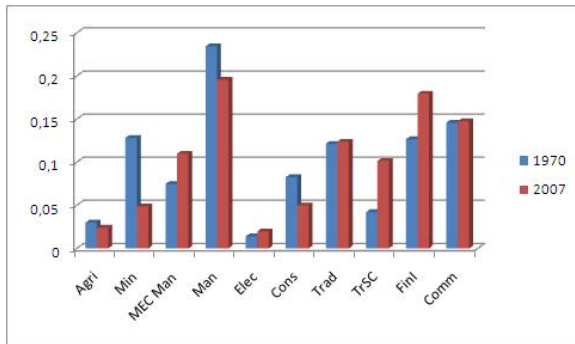


Figure: Share of Sectoral Output in Total Output in 1970 and 2007

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Ten 3-digit sectors II

<i>Shock in</i>	Agri	Min	MEC	Man	Elec	Cons	Trad	TrSC	Finl	Comm
	<i>Cumulated impulse response</i>									
Agri	0.737	0.031	0.037	0.040	0.049	0.039	0.043	0.032	0.062	0.056
Min	0.007	1.223	0.011	0.012	0.024	0.014	0.013	0.020	0.017	0.013
MEC	0.163	0.728	1.111	0.279	0.637	0.315	0.362	0.308	0.611	0.343
Man	0.822	0.629	0.651	1.522	0.834	0.612	0.882	0.487	1.224	0.709
Elec	0.028	0.190	0.043	0.052	1.799	0.188	0.050	0.034	0.091	0.036
Cons	0.211	0.319	0.364	0.386	0.346	2.366	0.342	0.221	0.550	0.257
Trad	0.312	0.385	0.410	0.550	0.751	0.972	1.916	0.584	1.452	0.456
TrSC	0.265	0.369	0.412	0.482	0.717	0.596	0.649	1.492	0.976	0.403
Finl	0.150	0.205	0.211	0.273	0.337	0.600	0.326	0.258	2.793	0.397
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Table: Cumulated impulse response after 4 periods

- Results largely confirmed, MEC manufacturing impact mining and electricity
- Given its size, a shock in the construction sector has a comparatively strong effect



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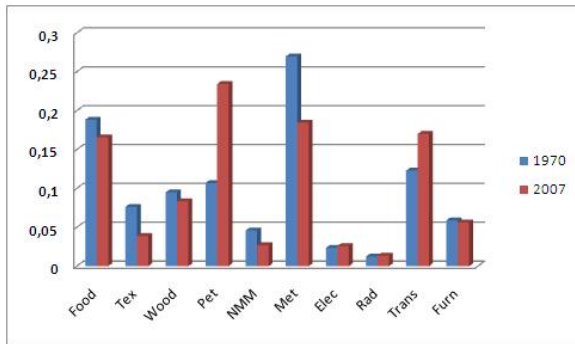


Figure: Share of Sectoral Output in Total Manufacturing Output in 1970 and 2007, Source: Quantec



Manufacturing subsectors II

<i>Shock in</i>	Food	Tex	Wood	Pet	NMM	Met	ElecM	Rad	Trans	Furn
	<i>Cumulated impulse response</i>									
Food	1.332	0.067	0.083	0.090	0.092	0.074	0.066	0.056	0.096	0.053
Tex	0.519	1.071	0.077	0.159	0.085	0.094	0.079	0.070	0.110	0.156
Wood	0.115	0.079	0.987	0.149	0.049	0.067	0.057	0.076	0.073	0.176
Pet	0.372	0.215	0.130	1.346	0.201	0.193	0.170	0.153	0.236	0.200
NMM	0.068	0.064	0.061	0.099	1.003	0.085	0.065	0.053	0.087	0.057
Met	0.198	0.231	0.136	0.331	0.194	1.223	0.437	0.312	0.312	0.251
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Rad	0.031	0.037	0.027	0.040	0.023	0.040	0.111	0.979	0.028	0.128
Trans	0.508	0.781	0.227	0.583	0.475	0.760	0.896	0.723	1.442	0.380
Furn	0.101	0.140	0.144	0.121	0.055	0.120	0.075	0.117	0.074	1.226

Table: Cumulated impulse response after 4 periods

- Transport equipment sector has strong impact on other subsectors
- Among the other large sectors, both metal products and particularly petroleum, chemical products and plastics provide little stimulus



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ElecM	0.079	0.080	0.064	0.164	0.117	0.190	1.113	0.338	0.099	0.128
Rad	0.031	0.037	0.027	0.040	0.023	0.040	0.111	0.979	0.028	0.128
Trans	0.508	0.781	0.227	0.583	0.475	0.760	0.896	0.723	1.442	0.380
Furn	0.101	0.140	0.144	0.121	0.055	0.120	0.075	0.117	0.074	1.226

Table: Cumulated impulse response after 4 periods

- Transport equipment sector has strong impact on other subsectors
- Among the other large sectors, both metal products and particularly petroleum, chemical products and plastics provide little stimulus



Manufacturing subsectors II

<i>Shock in</i>	Food	Tex	Wood	Pet	NMM	Met	ElecM	Rad	Trans	Furn
	<i>Cumulated impulse response</i>									
Food	1.332	0.067	0.083	0.090	0.092	0.074	0.066	0.056	0.096	0.053
Tex	0.519	1.071	0.077	0.159	0.085	0.094	0.079	0.070	0.110	0.156
Wood	0.115	0.079	0.987	0.149	0.049	0.067	0.057	0.076	0.073	0.176
Pet	0.372	0.215	0.130	1.346	0.201	0.193	0.170	0.153	0.236	0.200
NMM	0.068	0.064	0.061	0.099	1.003	0.085	0.065	0.053	0.087	0.057
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- The secondary sector, particularly non-MEC manufacturing, reveals strongest pulling power
- Shocks in agriculture and mining, but also in the much bigger services sector have smaller effects
- Thus, the 'premature deindustrialisation' of South Africa is indeed problematic
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Policy Conclusions II

- Within manufacturing, the transport equipment sector is of supreme importance
- Spillovers to other sectors as an argument for continued support, prolongation of MIDP
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Caveats and Further Research

- Exogenous variables could and should be controlled for—requires a more complicated econometric model
- Might be explanation for problems in the manufacturing subsectors estimation
- Forecast errors to test the reliability of results



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