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INTERINDUSTRY LINKAGES AND BUSINESS BANKRUPTCY RATES: EVIDENCE FROM AUSTRALIA, 1973-1991

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ABSTRACT

This paper explores the potential relationships among bankruptcy rates in Australia's major industries during the observed period 1973–1991 within the framework of cointegration tests and simultaneous-equation systems. The empirical findings obtained from national and cross-state observations lend support to the existence of relationships between the bankruptcy rate in the building and construction industry and the bankruptcy rate in the finance and property industry as well as between the bankruptcy rate in the manufacturing industry and the bankruptcy rate in the transport, storage and communication industry.

Note: the authors have been listed alphabetically. This paper is a preliminary output of a research project supported by a small grant from the Australian Research Council and lead by Amnon Levy.

1 Introduction

Although business bankruptcy in itself is essentially a microeconomic process, it is likely to be affected by the economic environment in which a firm operates. These aggregate and interindustry effects have attracted little attention by researchers in the field of corporate bankruptcy. Most of the empirical studies in this field have dealt with the microeconomic aspects of bankruptcy. In particular, financial ratios have been used to predict failure of firms within the context of Beaver's (1966) univariate approach which has been broadened and improved upon by Altman, Haldeman and Narayanan (1977), Ohlson (1980), Zavgren (1983 and 1985) and Johensen and Melicher (1994). A major empirical study on predicting corporate bankruptcy in Australia with financial ratios has been conducted by Castagna and Matolcsy (1981). Altman and Izan (1983) have also investigated factors associated with corporate distress in Australia and developed a business-failure classification which can be applicable to a number of industry groups.

In spite of the analytical improvements and modifications that have led to a fairly high predictive ability, all the above-mentioned studies have exhibited a common feature of limiting the set of variables explaining business failure to financial characteristics. That is, they have implicitly assumed that bankrupt firms can be distinguished entirely by their financial characteristics and independently from the surrounding global economic environment. Only a few studies, most notably Altman (1971, 1980), have focused on the effects of macroeconomic factors and the business cycle on business bankruptcy.

In an attempt to incorporate more aggregate aspects into the empirical study of business failure, this paper tests the existence of inter-industry linkages with regards to business bankruptcy. The underlying rationale is that a high rate of business failure in a given industry might have a considerable effect on the rest of the economy. On the one hand, a slowdown in the economic activity in an industry might reduce the demand for production inputs produced by other industries as well as the demand for their products as the level of unemployment rises and aggregate consumer income declines. On the other hand, if labour mobility is possible and requires only low costs of adjustment, a high rate of business failure in one industry might lower the wage rate in other industries and subsequently reduce their production costs. Thus, the net effect of a rise in the bankruptcy rate in one industry on other industries is not clear *a-priori*.

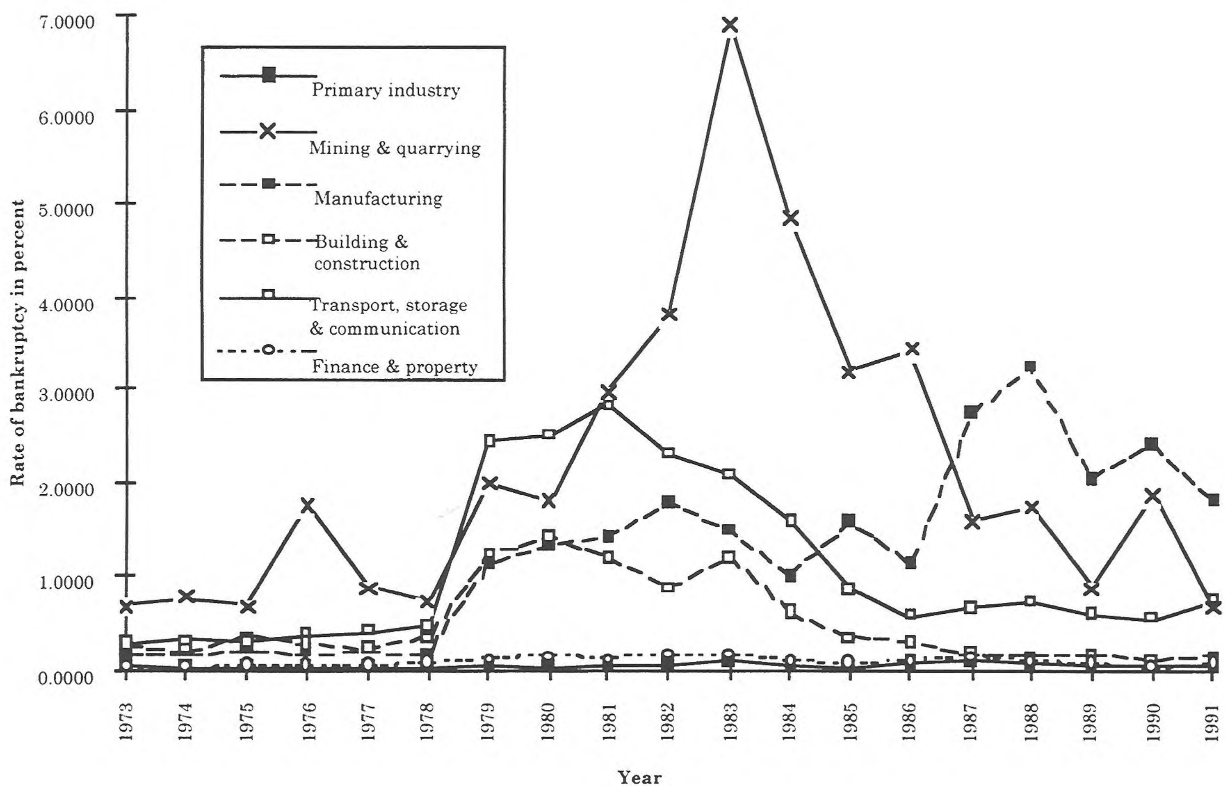
In particular, this paper explores the potential relationships among bankruptcy rates in Australia's major industries; namely, primary production, mining and quarrying, manufacturing, building and construction, transport, storage and communication and finance and property; during the period 1973–1991 for which data on business bankruptcy by industry are available. This period was a very significant one to a country such as Australia which depends on the export of coal, wheat and other primary goods, as it includes the oil crises of the 1970s, the American ban on the export of cereals to the Soviet Union that followed the invasion of Afghanistan, and the oil glut of the mid 1980s. To the best of our knowledge, such a database is not available for any other economy. Hence, the use of the Australian data provides a unique opportunity for analyzing interindustry bankruptcy linkages.

The analysis of the potential effect of inter-industry linkages on the bankruptcy rates in Australia is organized as follows. A brief description of the data sources and the evolution of the rates of bankruptcy in the aforementioned industries during the observed period, as well as the statistical correlations among these rates, is provided in section 2. This description is followed by unit-root tests that check whether the time-series of the industry bankruptcy rates satisfy the nonstationary requirement for performing cointegration tests. Section 3 describes the cointegration tests and their results. Section 4 complements the evidence of long-run relationships provided by the cointegration tests by estimating possible relationships between industry bankruptcy rates within a framework of simultaneous and dynamic equations.

2 Industry bankruptcy rates' trajectories and their properties

The industry bankruptcy rates displayed in Figure 1 are computed as the ratio of the number of business bankruptcies in an industry (available from the Bankruptcy Act 1966 Annual Reports 1972/73 to 1990/91) to the total number of businesses in that industry (approximated by the total number of business taxpayers as recorded in the Department of Taxation's Annual Taxation Statistics, 1972/73 to 1990/91). Figure 1 shows that the rate of bankruptcy was relatively high and volatile in the mining and quarrying industry and to a lesser extent in the transport, storage and communication industry, manufacturing industry and the building and construction industry. In contrast, the rates of bankruptcy in the finance and property industry and in the primary production industry were relatively low and stable. In the case of the primary production industry, and in the farm sector in particular, the low level of industry concentration has compensated for the large number of business failures. Table 1 reveals that during the observed period the rates of

Figure 1 Bankruptcy rates in Australia by industry (1973–1991)



bankruptcy among all industries, except manufacturing and building and construction, have been positively correlated. In particular, a very high degree of correlation has been recorded between the rates of bankruptcy in the building and construction industry and the transport, storage and communication industry. This table also indicates that the rate of bankruptcy in the finance and property industry has been positively and highly correlated with the bankruptcy rates in the other industries and that the rate of bankruptcy in the

Table 1
Correlation matrix of bankruptcy rates between industries

Industry	Primary production	Mining & quarrying	Manufact-uring	Building & Construct-ion	Transport, storage & communic-ation
Primary production					
Mining & quarrying	0.5582				
Manufact-uring	0.6891	0.2023			
Building & construction	0.1339	0.5246	–0.0350		
Transport, storage & communic-ation	0.2535	0.5676	0.2089	0.9390	
Finance & property	0.6771	0.6504	0.4775	0.7080	0.7864

manufacturing industry has been highly correlated with that in the primary production industry.

As indicated in the introduction, it is essential to check the nature of the industry bankruptcy rate time series ($IBR_1,\ldots,IBR_6$) before proceeding with the cointegration tests. If these time-series are nonstationary, the Engle-Granger two-step method of cointegration can be employed for testing long-run relationships between industry bankruptcy rates. A basic approach for testing whether a time series is nonstationary has been developed by Dickey and Fuller (1981). According to their approach, two forms of regression equations can be specified for any given industry bankruptcy rate:

$$\Delta IBR_t = \alpha_0 + \alpha_1 IBR_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta IBR_{t-j} + \varepsilon_t \qquad (1)$$

and

$$\Delta IBR_t = \alpha_0 + \alpha_1 IBR_{t-1} + \alpha_2 t + \sum_{j=1}^{p} \gamma_j \Delta IBR_{t-j} + \varepsilon_t \qquad (2)$$

where ε_t is assumed to be a Gaussian white noise. The difference between these two specifications is that the latter includes a time-trend variable. When $\alpha_1=0$, the time series IBR_t is nonstationary. The corresponding F-tests are computed under three different null hypotheses, namely $\phi_1(H_0: \alpha_0= \alpha_1=0)$, $\phi_2(H_0: \alpha_0= \alpha_1= \alpha_2=0)$ and $\phi_3(H_0: \alpha_1= \alpha_2=0)$. The test associated with ϕ_2 can be viewed as the most comprehensive one as the test equation has both a constant term and a trend on top of the autoregressive terms. This unit-root test has been modified by Phillips (1987) and Perron (1988) who used non-parametric correction for serial correlation rather than including lags. In their method the unit-root tests are computed from the aforementioned Dickey-Fuller regression equations with p equal to zero, and the statistics are then transformed to remove the effects of serial correlation.

The Phillips-Perron unit-root test results for each of the time series of the industry bankruptcy rates (as obtained by SHAZAM version 7.0) are summarized in Table 2 below. The number of lags has been selected by Akaike (AIC) information criterion. The tests of the null hypotheses ϕ_1, ϕ_2 and ϕ_3 indicate that the time series of industry bankruptcy rates are all nonstationary.

Table 2
Results of Phillips-Perron unit-root tests

Variables		*Phillips-Perron test statistic*		
	No. of lags	ϕ_1	ϕ_2	ϕ_3
IBR_1	2	2.245	1.934	2.900
IBR_2	1	1.380	0.934	1.401
IBR_3	4	1.348	2.307	2.916
IBR_4	1	1.146	1.100	1.646
IBR_5	1	1.241	0.947	1.402
IBR_6	1	1.960	1.238	1.839

3 Cointegration Test Results

Following Engle and Granger (1987), the test for evidence of long-run relationships between the nonstationary industry bankruptcy rates is based on two alternative forms of the cointegrating regression equations as regards the inclusion or exclusion of a trend. Let i and j denote industry indexes, then the cointegration regression equation can be expressed as:

$$IBR_{it} = b_0 + \sum_{j \neq i}^{K} b_j IBR_{jt} + u_{it} \ , \qquad (3)$$

or

$$IBR_{it} = \beta_0 + \beta_1 t + \sum_{j \neq i}^{K} \beta_j IBR_{jt} + u_{it} \qquad (4)$$

where K≤6. In this context, a test for no cointegration is given by a test for a unit root in the estimated residuals. The Phillips-Perron test results are summarized in Table 3 and Table 4. While the former table presents the test results for long-run relationships between industry bankruptcy rates within a multivariate model, the latter displays the test results for long-run relationships between industry bankruptcy rates for pairs of industries.

In general, the multivariate cointegration-test results support the proposition of long-run relationships among all the industry rates of bankruptcy except that of the mining and quarrying sector. In particular, the pairwise cointegration tests indicate a possible long-run relationship between the rates of bankruptcy in the manufacturing sector and finance and property sector as well as a long-run relationship between the rates of bankruptcy in the building and construction sector and the transport, storage and communication sector for which a very high positive correlation had been recorded (0.9390).

Table 3
Engle-Granger cointegration test within a multivariate model

Dependent variable	Explanatory variable	*Phillips-Perron test statistic* No. of lags	z-test	τ-test
IBR_1	IBR_2, IBR_3, IBR_4, IBR_5, IBR_6	1	–20.980	5.500*
	t, IBR_2, IBR_3, IBR_4, IBR_5, IBR_6	1	–21.212	5.270*
IBR_2	IBR_1, IBR_3, IBR_4, IBR_5, IBR_6	1	–11.287	–2.762
	t, IBR_1, IBR_3, IBR_4, IBR_5, IBR_{6_2}	1	–12.466	–2.796
IBR_3	IBR_1, IBR_2, IBR_4, IBR_5, IBR_6	4	–17.093	–4.212
	t, IBR_1, IBR_2, IBR_4, IBR_5, IBR_6	4	–17.311	5.341*
IBR_4	IBR_1, IBR_2, IBR_3, IBR_5, IBR_6	2	–21.238	6.673*
	t, IBR_1, IBR_2, IBR_3, IBR_5, IBR_6	2	–19.859	6.256*
IBR_5	IBR_1, IBR_2, IBR_3, IBR_4, IBR_6	2	–23.033	7.323*
	T, IBR_1, IBR_2, IBR_3, IBR_4, IBR_6	2	–22.661	7.380*
IBR_2,	IBR_1, IBR_2, IBR_3, IBR_4, IBR_5	4	–23.817	9.082*
	T, IBR_1, IBR_2, IBR_3, IBR_4, IBR_5	4	–23.376	8.792*

* An asterisk denotes the presence of a cointegrating relationship.

Table 4
Engle-Granger cointegration test for pairs of industries

Dependent variable	Explanatory variable	*Phillips-Perron test statistic* No. of lags	z-test	τ-test
IBR_1	IBR_2	2	–9.141	–2.393
IBR_1	t, IBR_2	2	–11.852	–2.915
IBR_1	IBR_3	2	–11.408	–2.747
IBR_1	t, IBR_3	2	–11.741	–2.899
IBR_1	IBR_4	2	–7.640	–2.167
IBR_1	t, IBR_4	2	–11.559	–2.701

Table 4 (continued)
Engle-Granger cointegration test for pairs of industries

Dependent variable	Explanatory variable	*Phillips-Perron test statistic* No. of lags	z-test	τ-test
IBR_1	IBR_5	2	–8.072	–2.226
IBR_1	t, IBR_5	2	–11.628	–2.716
IBR_1	IBR_6	1	–10.110	–2.608
IBR_1	t, IBR_6	1	–14.356	–3.330
IBR_2	IBR_3	1	–5.627	–1.716
IBR_2	t, IBR_3	1	–5.239	–1.586
IBR_2	IBR_4	1	–6.021	–1.844
IBR_2	t, IBR_4	1	–6.950	–1.856
IBR_2	IBR_5	1	–7.473	–2.047
IBR_2	t, IBR_5	1	–7.823	–2.016
IBR_2	IBR_6	4	–10.750	–2.721
IBR_2	t, IBR_6	4	–10.729	–2.694
IBR_3	IBR_4	4	–4.013	–1.635
IBR_3	t, IBR_4	4	–10.314	–3.259
IBR_3	IBR_5	4	–3.690	–1.483
IBR_3	t, IBR_5	4	–10.460	–3.213
IBR_3	IBR_6	1	–3.426	–1.332
IBR_3	t, IBR_6	1	–15.919	3.615*
IBR_4	IBR_5	2	–11.495	–2.832
IBR_4	t, IBR_5	2	–19.409	7.414*
IBR_4	IBR_6	1	–6.951	–2.000
IBR_4	t, IBR_6	1	–12.634	–2.988
IBR_5	IBR_6	1	–10.405	–2.641
IBR_5	t, IBR_6	1	–12.536	–2.983

* An asterisk denotes the presence of a cointegrating relationship.

4 Simultaneous-Equation Results and Conclusion

In view of the cointegration-test results, it is sensible to explore further the relationship between the rates of bankruptcy in the manufacturing sector and finance and property sector and the relationship between the rates of bankruptcy in the building and construction sector and the transport, storage and communication sector within a framework of simultaneous equations. In addition to the simultaneity aspects each equation includes a lag of the dependent variable in order to test whether the reduced excess production capacity in an industry exceeds inertia; i.e., whether a high bankruptcy rate in any given year is associated with a lower bankruptcy rate in the following year. The inclusion of these lags also makes the simultaneous-equation systems identifiable. The estimated systems also incorporate the potential effect of the interest rate on bankruptcy rates. If at all, it is expected that the effect of this variable would be most noticeable in the building and construction industry, where, in addition to a hike in production costs, a rise in the interest rate might lower the demand for new houses and apartments substantially as the costs of servicing home loans increase. The interest rate employed in the analysis is the interest rate on ninety-day discounted bank bills. Since there is a considerable time differential between insolvency and the juridical declaration of bankruptcy, it is more appropriate to consider a one-year lag of the interest rate rather than the current one.

It is important to note that in spite of being unique, the Australia-wide time series of annual observations on industry bankruptcy rates is not sufficiently large to yield statistically significant estimation results. Therefore, the systems were also estimated with cross-state and time-series observations.

Moreover, since the states of Australia differ in their economic and business transaction volume, a three-stage least squares estimation procedure has also been applied to the cross-state and time-series database where each observation is weighted by the square root of the relevant state's (or territory's) aggregate product share in the national gross domestic product. The three-stage least squares (3SLS) estimation results with nation-wide observations and with unweighted and weighted pooled cross-state and time-series observations with (model 1) and without (model 2) the interest rate are summarized in Table 5 for the manufacturing industry and the finance and property industry and in Table 6 for the building and construction industry and the transport, storage and communication industry.

With the exception of model 1, when estimated with national observations, the 3SLS estimation results for the building and construction and the transport, storage and communication industries indicate that the effect of the rate of bankruptcy in the building and construction industry on the rate of bankruptcy in the transport, storage and communication industry is significantly different from zero and substantial — a one per cent rise in the rate of bankruptcy in the former industry is likely to increase the rate of bankruptcy in the latter by 1.243 to 1.432 per cent. In contrast, a reciprocal effect is not found to be statistically significant. The estimation results with weighted cross-state and time-series observations reveal further a statistically significant inertia effect in both the building and construction industry and the transport, storage and communication industry. They also indicate that low rates of bankruptcy in the building and construction industry is associated with relatively high interest rates. This seemingly surprising result can be reconciled by the hikes of the interest rate during

Table 5

3SLS estimates of the manufacturing industry and the finance & property industry bankruptcy rates equation system*

Explanatory Variables	Estimation Results with											
	Nation-wide Time-Series Observations				Pooled Cross-States Time-Series Observations				Pooled and Weighted Cross-State Time-Series Observations			
	MODEL 1		MODEL 2		MODEL 1		MODEL 2		MODEL 1		MODEL 2	
	$IBR3_t$	$IBR6_t$	$IBR3_t$	$IBR6_t$	$IBR3_t$	$IBR6_t$	$IBR3_t$	$IBR6_t$	$IBR3_t$	$IBR6_t$	$IBR3_t$	$IBR6_t$
Constant	-0.006 (-1.202)	-0.001 (-0.752)	0.001 (0.267)	3.67E-04 (1.760)	-0.005 (-0.524)	0.001 (2.242)	0.004 (0.554)	0.001 (4.118)	-0.001 (-1.114)	8.13E-05 (1.420)	0.001 (2.275)	8.01E-05 (2.925)
$IBR3_t$		-0.056 (-1.165)		-0.012 (-0.731)		0.016 (3.271)		0.015 (3.522)		0.008 (0.488)		0.007 (0.695)
$IBR6_t$	3.751 (0.872)		0.711 (4.734)		0.636 (6.198)		0.658 (6.460)		0.477 (4.988)		0.610 (6.736)	
$IBR3_{t-1}$	0.492 (2.517)		3.920 (0.879)		0.935 (0.114)		2.365 (0.290)		1.719 (0.624)		0.776 (0.267)	
$IBR6_{t-1}$		0.894 (2.413)		0.781 (3.063)		0.235 (.2307)		0.231 (2.280)		0.421 (4.048)		0.422 (4.263)
Interest $Rate_{t-1}$	0.001 (1.436)	7.26E-04 (1.267)			0.001 (1.732)	-1.48E-05 (-0.474)			1.69E-04 (2.935)	-1.42E-07 (-0.022)		

**The t-ratios are indicated in the parentheses.*

Table 6

3SLS estimates of the building & construction industry and the transport, storage & communication industry bankruptcy rates equation system*

Explanatory Variables	Estimation Results with: Nation-wide Time-Series Observations				Pooled Cross-States Time-Series Observations				Pooled and Weighted Cross-State Time-Series Observations			
	MODEL 1		MODEL 2		MODEL 1		MODEL 2		MODEL 1		MODEL 2	
	$IBR4_t$	$IBR5_t$	$IBR4_t$	$IBR5_t$	$IBR4_t$	$IBR5_t$	$IBR4_t$	$IBR5_t$	$IBR4_t$	$IBR5_t$	$IBR4_t$	$IBR5_t$
Constant	0.002 (1.372)	-0.008 (-0.622)	0.001 (0.419)	0.001 (0.880)	0.003 (0.619)	0.010 (1.585)	0.003 (0.404)	0.007 (2.949)	3.89E-04 (2.299)	-6.69E-05 (-0.222)	1.39E-04 (1.337)	1.42E-04 (1.560)
$IBR4_t$		2.630 (1.147)		1.329 (2.595)		1.243 (2.455)		1.293 (2.722)		1.432 (5.992)		1.372 (6.711)
$IBR5_t$	0.667 (1.046)		-0.123 (-0.1102)		0.058 (0.176)		-0.152 (-0.203)		0.111 (0.667)		-0.004 (-0.020)	
$IBR4_{t-1}$	-0.304 (-0.294)		0.977 (0.538)		0.697 (0.384)		0.939 (1.080)		0.615 (2.166)		0.811 (2.347)	
$IBR5_{t-1}$		-0.222 (-0.242)		0.310 (1.551)		0.124 (0.666)		0.100 (0.581)		0.287 (3.061)		0.312 (3.903)
Interest $Rate_{t-1}$	-2.78E-04 (-1.773)	0.001 (0.730)			-2.04E-04 (-1.029)	-3.79E-04 (-0.532)			-2.61E-05 (-1.967)	1.82E-05 (0.752)		

**The t-ratios are indicated in the parentheses.*

upturns in economic activity, which, to a certain extent, are engineered by the Reserve Bank of Australia in order to suppress inflationary pressures in boom periods.

The estimation results for the manufacturing and the finance and property industries indicate that only when unweighted cross-state and time-series observations are employed is there evidence that the effect of the rate of bankruptcy in the manufacturing industry on the current rate of bankruptcy in the finance and property industry is significantly different from zero and that a rise of one percent in the rate of bankruptcy in the former industry is likely to raise the rate of bankruptcy in the latter by 0.015–0.16 percentage points. The effect of the rate of bankruptcy in the finance and property industry on the rate of bankruptcy in the manufacturing industry was found to be statistically insignificant for every specification of the database. Note further that statistically significant and substantial inertia effects have been found for both industries with all three data-sets employed. Finally, the estimation results obtained from cross-state and time-series observations indicate further that a rise in the interest rate is likely to increase the rate of bankruptcy in the manufacturing industry but not the rate of bankruptcy in the finance and property industry. Moreover, the insignificant effect of the manufacturing industry's bankruptcy rate on the finance and property industry's bankruptcy rate implies that the adverse effect of a rise in the interest rate on the manufacturing industry is not transmitted to the finance and property industry.

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