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The Accord and Strikes: An International Perspective

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ABSTRACT

This paper examines the relationship between Australian and world strike activity between 1960 and 1998. Appropriate indices are constructed for which evidence of a long-run equilibrium relation is found between Australian and world strike activity. The evidence suggests Australian and world strike rate indices are cointegrated with a breakpoint in that relation occurring sometime in the very late 1960s or early 1970s. No breakpoints are in evidence before, during or after the period (1983-96) of the Accord. This result is consistent with the view that the decline in strike activity in Australia during the period of the Accord was not a singularly Australian experience.

1. INTRODUCTION

The purpose of this paper is to analyse the relation, if any, between local (Australian) strike activity and world strike activity. In section I we review the issues associated with strikes focussing on a number of studies that have argued that the moderation in the strike rate over the last decade or so in Australia can be attributed to the Accord (an incomes policy between government and trade unions). In section II we establish a framework for testing the presence or otherwise of a long-term equilibrium relation between local and world strike activity drawing on, in particular, the methodology of Zivot and Andrews (1992) and Gregory and Hanson (1996a, 1996b). Section III applies local and world strike data to the framework established in section II. It will be seen that the tests carried out suggest the presence of a long-term equilibrium relation between local and world strike activity, as well as the presence of structural changes in that relationship. Finally, conclusions are drawn in Section IV.

2. STRIKES: A BRIEF LITERATURE REVIEW

Strikes have been linked to changes in the domestic economy in a large number of studies. Most Australian studies focus on the relationship between working days lost due to strikes per worker and variables such as price level changes, measures of labour market demand, union density, profits and a range of shift (dummy) variables for various ‘special events’. Studies by Oxnam (1953), Bentley and Hughes (1971), Perry (1980), Beggs and Chapman (1987a) and Morris and Wilson (1994, 1995, and 1999) are examples.

Studies published since the introduction of the Accord have tried to tease out the possible impact of the Accord on strikes in Australia. The Accord was in place in Australia from 1983 to 1996 and involved a series of agreements between the government and the trade union movement on general wage setting practices. An early study by Beggs and Chapman (1987b) estimated an approximate 60% reduction in strikes attributable to the Accord while Gruen and Chapman (1991) estimated a 70% reduction. The latest Morris and Wilson (1999) study, which more or less subsumes the earlier studies (Morris and Wilson 1994 and 1995), argues that the Accord was associated with an approximate 40% drop in the strike rate. According to Morris and Wilson this drop in the strike rate appeared to continue beyond the period of the Accord, which raises the question of whether the shift effect that their study picked up was related to the Accord or to some other set of circumstances. Morris and Wilson (1999) and Chapman (1998) seem to favour the view that the sustained post-Accord decline in strike activity is attributable to ‘… a landscape or cultural transformation in Australian industrial relations …’ (Chapman, 1998, p.636) which was apparently ushered in by the 13 years of the Accord.

One criticism sometimes levelled against studies that focus on local explanatory variables to explain local strikes is that international influences on local strikes are overlooked (see Moore, 1989). Beggs and Chapman (1987b and 1987c) and later Gruen and Chapman (1991) suggested the influence of international forces were not sufficient to explain the decline in strike activity in Australia. However none of these studies benefited from the inclusion of 1990s data and those studies that have employed 1990s data have not tested for an Accord-effect in the presence of a relevant international variable or set of variables. The issue of the influence of international forces is therefore one that warrants further attention.

3. TOWARDS A TESTING FRAMEWORK

In this paper we depart from the practice of explaining strikes in terms of local economic variables and assorted dummy variables for numerous inconvenient 'incidents'. Instead we hypothesise that the dominating influence on local strike activity is world strike activity. We concede that local strike activity appears to be influenced by 'local' factors such as price changes and labour demand, particularly in the short run. However, we hypothesise that in the longer run the role of international influences overwhelm the influence of 'purely' domestic influences. An important reason for this is that apparent domestic factors such as price changes and labour demand are, we contend, largely governed by international influences anyway, but particularly in the long run.

The basis for our view on the dominating long-term influence of international factors involves recognition of all of the following considerations

1. The local economy is relatively small, about 5% the size of the world's largest economy, the US. The local economy draws heavily on international economies for its technology, cultural values and managerial practices.
2. The local economy has a well-known sensitivity to changes in the international economic climate (as well as the political and social climate). A major world recession is invariably mirrored in Australia. A major international supply shock (eg a 1970s-style energy shock) is similarly mirrored locally.
3. The local economy is strongly influenced by the practices of international corporations that play a major role locally and by locally-owned international corporations that generally emulate the behaviour of international rivals.
4. The local economy is directly affected by a generalised 'demonstration' or 'role-model' effect from the global economy. This basically implies a small local economy will tend, over time, to emulate international practices; especially those practices that are perceived to be leading edge and worthy of copying locally.

All in all, we postulate that over a long period of time (ie over several decades) local strike activity will tend to converge towards world strike activity. There may be occasional shifts in the relation, but once such shifts are allowed for, strike activity will move in a similar fashion to world strike activity.

Strike Activity and Dependency

Thus far the term 'strike activity' has been used in a loose manner. It is appropriate now to define precisely the meaning of this term.

Strike activity is defined in this paper to be the natural log of the number of working days lost due to strikes per 10000 employees (*S*). Correspondingly, the variable *SA* refers to strike activity (as defined) in Australia and *SW* refers to strike activity in the world. As will be seen, we will look at three alternative operational world strike activity variables: *SW*1, *SW*2 and *SW*3 – but more on this later.

We hypothesise a long-term relation between *SA* and *SW*, with *SA* as the dependent variable. The existence or otherwise of a long-term relation between *SA* and *SW* can be established by testing to see if the two variables are cointegrated.

The results of two cointegration methodologies are reported in this paper. One is the standard methodology associated with the Dickey-Fuller unit root test. The second methodology we employed is that developed by Zivot and Andrews (1992) and refined by Gregory and Hansen (1996a,b). The second methodology is used to test for the presence of breakpoints in the individual series (*SA* and *SW*) as well as the cointegrated series. In this regard we are particularly interested in testing to see whether the individual strike activity series had a unit root in the presence of structural breaks with unknown timing, and whether there is then any cointegrated relation between Australian and world strike activity once these breaks have been taken into consideration.

Zivot and Andrews Methodology

It is well established that the existence of cointegration between two (or more) data series implies the existence of some long-run equilibrium relationship between (amongst) these series. For instance, if SA_t and SW_t are cointegrated, then this will imply[1]:

Equation 1

$$SA_t = a + bSW_t + e_t \quad \text{for } t = 1, \ldots\ldots, T$$

where å$_t$ is a stationary error process (ie. I(0)). Cointegration of markets, either domestically or internationally, implies the existence of common factors.

Before tests of cointegration can be undertaken it is essential to test if all variables are integrated to the same order - i.e. require the same degree of differencing so as to achieve stationarity (most economic time series are I(1). The most common means of testing a series for stationarity is to apply the following conventional Augmented Dickey-Fuller (ADF) regression to the data series[2]:

Equation 2

$$\Delta y_t = a_0 + a_1 y_{(t-1)} + a_2 t + \sum_{j=1}^{k} g_j \Delta y_{(t-j)} + e_t$$

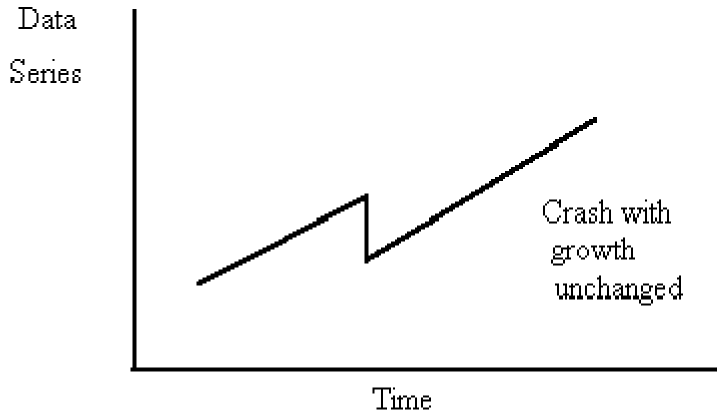
Where: *y* is the variable of interest, *t* is a trend variable, the k lagged differences are to ensure a white noise error series and the number of lags is determined by a test of significance on the coefficient γ_j.

The coefficient of interest is α_1: if $\alpha_1 = 0$, then the above equation is entirely in first differences and so has a unit root. The finding of a unit root in a time series indicates non-stationarity and differencing is required to achieve a stationary series. For cointegration tests to be valid each series in a cointegrating regression should be integrated to the same order (and for cointegration to exist a linear combination of any two series should exist which is integrated to a lower order than the individual series). The unit root hypothesis can be rejected (and the series is found to be stationary) if the test statistic is smaller than the appropriate Dickey-Fuller (1979) critical value[3]. A difficulty with a conventional unit root test is that, if there are structural breaks in the series, the critical value is too small (in an absolute sense) thereby resulting in the null hypothesis of a unit root being rejected too often (i.e. biasing the result).

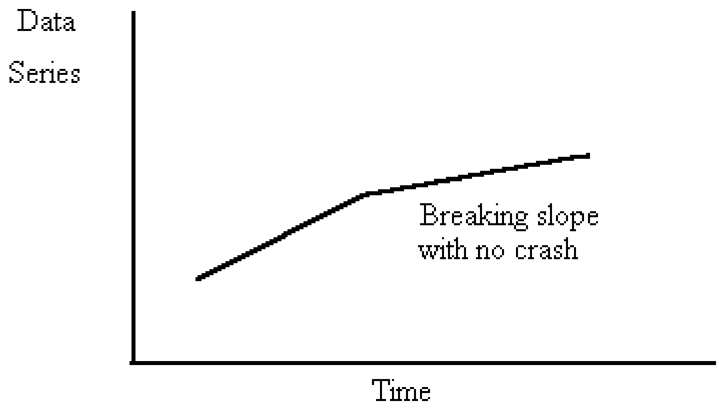
The Zivot and Andrews methodology was developed to address this problem of structural changes in time series generating misleading infereneces about the stationarity of time series data. An earlier study by Perron (1989) showed that allowing for *known* breakpoints in time series could change the stationarity properties of a series. Essentially, many time series that were originally tested (see Nelson and Plosser, 1982) as being non-stationary were found to be stationary when allowance was made for the presence of a breakpoint or a number of breakpoints in the series. However Z-A developed the Perron approach a step further by allowing the data themselves to indicate breakpoints rather than imposing a breakpoint from outside the system. The advantage of the Z-A approach is that it does not rely on arbitrary *apriori* judgements as to the relative importance of various shocks.

The Z-A methodology followed Perron (see Appendix A) in considering three possible types of structural break in a series, these were simply designated Models A (a 'crash' model with no change in growth i.e.), B (change in growth, but no change in level i.e.), C (the most general model permitting both occurrences). A visual impression of these model types is presented below.

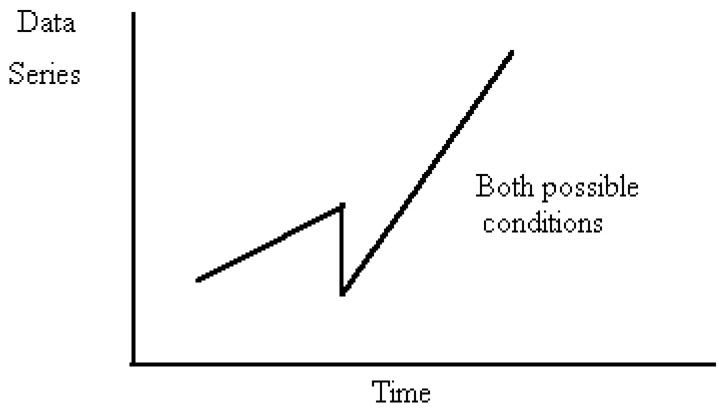
Model A



Model B



Model C



The Zivot and Andrews null hypothesis for all three Perron models was:

Equation 3

$$y_t = m + y_{t-1} + e_t$$

Here the null hypothesis is that the series $\{y_t\}$ is integrated without an exogenous structural break against the alternative that the series $\{y_t\}$ can be represented by a trend-stationary process with a once only breakpoint occurring at some unknown time (to test for multiple breakpoints the procedure is re-run commencing from each identified breakpoint). The aim of the Zivot-Andrews procedure is to sequentially test breakpoint candidates and select that which gives the most weight to the trend-stationary alternative. That is, the breakpoint DU_t is chosen as the minimum t-value on α^i (i = A,B,C) for sequential tests of the breakpoint occurring at time $1<T_B<T$ in the following augmented regressions:

Model A

Equation 4

$$y_t = \hat{m}^A + \hat{q}^A DU_t(\hat{l}) + \hat{b}^A t + \hat{a}^A y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^A \Delta y_{(t-j)} + \hat{e}_t$$

Model B

Equation 5

$$y_t = \hat{m}^B + \hat{b}^B t + \hat{g}^B DT_t^*(\hat{l}) + \hat{a}^B y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^B \Delta y_{(t-j)} + \hat{e}_t$$

Model C

Equation 6

$$y_t = \hat{m}^C + \hat{q}^C DU_t(\hat{l}) + \hat{b}^C t + \hat{g}^C DT_t^*(\hat{l}) + \hat{a}^C y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^C \Delta y_{(t-j)} + \hat{e}_t$$

where ë is the break fraction as discussed in Appendix A; DU_t (ë) =1 if t>Të, and 0 otherwise; DT^*_t (ë)= t-Të if t>Të and 0 otherwise.

To test the unit root hypothesis the *smallest t-values* are compared with a set of critical values estimated by Zivot and Andrews. Because the Zivot-Andrews methodology is not conditional on the prior selection of the breakpoint (all points are considered potential breakpoints) the critical values are larger (in an absolute sense) than the conventional ADF critical values, consequently it is more difficult to reject the null hypothesis of a unit root[***]. Table I (below) shows that for the Zivot-Andrews techniques there was

[***] We should note that the Zivot and Andrews procedure was not aimed at testing for structural change per se, but rather was oriented towards the issue of testing for a unit root in the presence of an unknown structural break.

only a moderate difference between the asymptotic critical values and the small sample critical values. For instance, the Zivot-Andrews asymptotic model A at the 5% level had an asymptotic critical value of -4.80, whereas for finite sample size of 111 the critical value was –5.14 and for sample size 62 the critical value was -5.32. That is, the sample size of 111 had a critical value about 7 percent smaller than the asymptotic value, with the sample size of 62 being a further 3 percent lower. This indicates that, in some instances, the asymptotic critical values may be too liberal in that these values may permit rejection of the unit root hypothesis too often. Therefore, in this analysis, we will present both asymptotic critical values along with the smallest finite sample critical values from the work of Zivot and Andrews.

Table I

Percentage Points for the Asymptotic and Small Sample Distribution of t-values on *‘á’* for Model Types A, B and C

Model Type		1%	2.5%	5%	10%	90%	95%	97.5%	99%
Zivot &	A	-5.34	-5.02	-4.80	-4.48	-2.99	-2.77	-2.56	-2.32
Andrews	B	-4.93	-4.67	-4.42	-4.11	-2.48	-2.31	-2.17	-1.97
Asymptotic	C	-5.57	-5.30	-5.08	-4.82	-3.25	-3.06	-2.91	-2.72
Finite Sample[4]									
Size = 62	A	-6.03	-5.63	-5.32	-5.01	-2.92	-2.52	-2.23	-1.62
111	A	-5.73	-5.41	-5.14	-4.86	-3.01	-2.74	-2.52	-2.15
159	B	-5.40	-5.14	-4.84	-4.57	-2.70	-2.49	-2.32	-2.20
71	C	-6.25	-5.92	-5.68	-5.38	-3.36	-3.04	-2.81	-2.57
100	C	-6.30	-5.93	-5.63	-5.31	-3.30	-3.09	-2.85	-2.64

Source: Zivot and Andrews (1992)

4. RESULTS

In this section we test for the presence of a cointegrated relation between Australian strike activity and world strike activity using quarterly data for the period 1960Q1 to 1998Q4. In addition, we test for the presence of any breaks in the relation between the variables.

Australian strike activity (*SA*) is defined as the natural log of the published number of working days lost due to strikes each quarter per 10000 employees for Australia.

Three measures of world strike activity are analysed. The first is *SW*1. This is defined as the natural log of the published number of working days lost due to strikes each quarter per 10000 employees for the world. ‘The world’ is proxied by the trade-weighted number of strikes per 10000 employees for the following countries: USA, Canada, Japan, UK, New Zealand, France, Italy, Korea, Philippines, Singapore, Indonesia, Malaysia, Honk Kong, Taiwan, Germany and China. The trade weights are calculated as a fraction of the sum of the three-year moving average of Australian exports (fob) and imports (cif) for countries that make up the index.

The second measure of world strike activity is *SW*2. This is the same as *SW*1 except it is adjusted to exclude the one-off effect of the extraordinary level of strike activity in France during the second quarter of 1968. During this particular quarter, the rebellious activities of French students and others produced an exceptional level of disputes, such that for that particular quarter 240% more strikes occurred worldwide than in any other quarter between 1960 and 1998. Arguably, this single event *might* best be treated as an outlier.

The third measure of world strike activity is *SW*3. This measure is *SW*2 adjusted to allow for the major change that occurred in the collection of USA strikes data in 1982. As from the first quarter 1982 the definition of strike activity in the USA changed from work stoppages involving *6 workers* to work stoppages involving *1000 workers*. This effectively meant the number of stoppages reported fell by an estimated 38% from 1982 onwards. Based on the overlap data, we magnified the data for the later period so as to give an estimated or synthetic series somewhat more harmonised with the original series prior to the change in definition. Table II presents the results from conventional ADF unit root tests applied to the full series without any attention to the possibility of structural breaks in the data. From this table we see that all the series (*SA*, *SW*1, *SW*2 and *SW*3) are I(1) or first difference stationary.

Table II

Conventional ADF Unit Root Tests on Series without Breaks being Identified

Series	Levels	Lags	1st Differences	Lags
SA	-1.76	8	-3.72	12
*SW*1	-1.68	8	-4.78	8
*SW*2	-1.61	8	-5.97	7
SW 3	-2.35	4	-6.99	5
Shazam CV*: Levels Differences *CV = Critical Value	 5% -3.41 10% -3.13 5% -2.86 10% -2.57	Mackinnon CV: Levels (As reported in EVIEWS) Differences Period: 1960Q1 to 1998Q4	 5% -3.44 10% -3.14 5% - 2.88 10% - 2.58	

Conventional Augmented Dickey-Fuller (ADF) cointegration tests for our three versions of world strike activity assuming no breaks are shown below in Table III.

Table III

Conventional ADF Cointegration Tests

Series	t-value on residuals	lags
SA & *SW*1	-3.81	3
SA & *SW*2	-3.60	6
SA & *SW*3	-3.90	3
Shazam CV:	5% -3.78 10% - 3.50	

Table III shows that all world series are cointegrated at the 10% level of significance while *SW*1 and *SW*3 are cointegrated with *SA* at the 5% level. These conventional ADF test results are more or less confirmed if we employ the Johansen procedure for determining the presence of a cointegrated relation. Table IV below suggests the presence of a cointegrated equation at the 1% level of significance for *SA* & *SW*1 and *SA* & *SW*3, and a cointegrated equation for *SA* & *SW*2 at the 5% level of significance. Recall that these results confirming the likely presence of cointegration are in the absence of allowing for any breakpoints in the relation.

Table IV
Cointegration Tests Using
Johansen Procedure

SA & *SW*1	Likelihood Ratio	5%	1%	Hypothesised No. of CEs
	31.7533	25.32	30.45	None
	6.18172	12.25	16.26	At most 1

LR (trace statistic) indicates 1 CE (cointegrating equation) at both 1% and 5% levels

SA & *SW*2	Likelihood Ratio	5%	1%	Hypothesised No. of CEs
	29.9848	25.32	30.45	None
	5.9332	12.25	16.26	At most 1

LR indicates 1 CE at 5% level

Aust & *SW*3	Likelihood Ratio	5%	1%	Hypothesised No. of CEs
	30.8537	25.32	30.45	None
	6.0260	12.25	16.26	At most 1

LR indicates 1 CE at both 1% and 5% levels.

Testing for Breakpoints

We next test for cointegration between Australian strike activity and world strike activity in the presence of breakpoints (or regime changes) in the individual series. The methodology we have employed is as follows. First, we test each of the individual series (*SA*, *SW*1, *SW*2 and *SW*3) for a unit root in the presence of breakpoints with unknown timing as per the Zivot and Andrews methodology described earlier. The results of these tests are reported in Table V.

Next we apply these identified breakpoints (ie the breakpoints in the individual series reported in Table V) when testing for cointegration between Australian strike activity and the various world strike activity series along the lines suggested by Gregory and Hansen (1996a, 1996b). Gregory and Hansen modify equation 1 to permit tests for cointegration in the presence of structural breaks as follows. First these authors define a dummy variable to incorporate potential series breaks in a somewhat similar manner to that undertaken by Zivot and Andrews (see discussion in Appendix A) viz. let

$$j_{tt} = \left\{ \begin{array}{l} 0 \quad = \quad if \quad t \leq (Tt) \\ \hline 1 \quad = \quad if \quad t > (Tt) \end{array} \right\}$$

where $\tau \in (0, 1)$ denotes the relative timing of the break. The three potential models (A,B,C) for cointegrated series can then be defined as:

The level shift model [5]

Equation 7

$$SA_{tt} = a_1 + a_2 j_{tt} + bSW_{tt} + e_{tt} \quad \text{for t = 1,….,T}$$

where α_1 represents the intercept before the shift and α_2 represents the change in the intercept at the time of the shift;

The slope change model

Equation 8

$$SA_{tt} = a + b_1 SW_{tt} + b_2 SW_{tt} j_{tt} + e_{tt} \quad \text{for t = 1,….,T}$$

where β_1 denotes the cointegrating slope coefficient before the shift and β_2 denotes the change in slope after the shift.

The most general change model

Equation 9

$$SA_{tt} = a_1 + a_2 j_{tt} + b_1 SW_{tt} + b_2 SW_{tt} j_{tt} + e_{tt} \quad \text{for t = 1,….,T}$$

with the coefficients as defined earlier.

Gregory and Hansen (1996a) point out that, for each of these models, if the timing of the shift is known *a priori* then a conventional unit root test can be applied to the regression errors. For the series in question, the Zivot and Andrews methodology is used to identify the timing of potential shifts which are then superimposed on the models represented by equations 7 through 9. These models are then subjected to conventional cointegration tests.

A number of observations can be made in reference to the results in Table V. First, recall that there are three models of regime shift being tested. Model A tests for a shift in the intercept value of the stationarity-testing equation. Model B tests for a shift in the time-sensitivity of the stationarity-testing equation. Lastly, Model C tests for a *simultaneous* shift in both the intercept value and in the time-sensitivity of the stationarity-testing equation.

A second observation is that the shifts identified in Table V include shifts that are significant relative to the asymptotic critical value estimates (which strictly speaking are relevant only when testing for very large samples). In other words we have not, at this stage, confined our list of possible breakpoints (regime shifts) to those compatible with the small-sample critical value estimates reported at the bottom of Table V. These are included to allow for the largest reasonable number of potential breakpoints to be tested in the cointegration-testing equation.

Table V
Zivot and Andrews Unit Root Tests with Unknown Breakpoints

Series and Model		Inf 't' statistic and Period in which break occurred			
SA	C	-11.20	-10.08	-9.90	-10.50
		1973Q1	1978Q1	1981Q4	1991Q4
	B	-11.04	-9.35	-9.17	-7.48
		1975Q1	1980Q1	1983Q4	1994Q1
	A	-9.68	-9.93	-9.87	-10.31
		1973Q1	1979Q1	1982Q1	1991Q4
SW1	C	-10.25			
		1969Q3			
	B	-6.51	-7.26	-7.77	
		1970Q2	1989Q2	1991Q2	
	A	-4.91	-9.87		
		1967Q1	1991Q3		
SW2	C	-9.87	-8.53		
		1969Q2	1995Q3		
	B	-4.48	-7.77		
		1971Q1	1992Q2		
	A	-9.05	-4.91		
		1970Q1	1991Q2		
SW3	C	-9.91	-5.41		
		1969Q2	1992Q4		
	B	-4.47	-4.18	-7.77	
		1971Q1	1989Q3	1992Q3	
	A	-9.10	-5.16		
		1970Q1	1991Q2		
5% Critical Value					
Asymptotic		Model A = -4.8 Model B = -4.42 Model C = -5.08			
Finite Sample		Model A = -5.14 Model B = -4.84 Model C = -5.63			

A third observation is that, while the Zivot and Andrews methodology is not directly designed to identify breakpoints in a series, it *does* however indirectly identify such breakpoints via the process of testing data series for changes in their unit-root properties.

Finally, attention should be drawn to one breakpoint that is of particular interest in this study. Model B for Australian strike activity (*SA*) shows evidence of a shift in 1983Q4 (t-test for a unit root significant at the

5% level) which is close enough to the beginning of the Accord period. This shift is *not* mirrored by any comparable shift in the various world indices.

The next step is to check for cointegration between Australian strike activity and the various world strike-activity proxies in the presence of possible breakpoints. Here an approach similar to that developed by Gregory and Hansen (1996a,b) is employed. Gregory and Hansen argue that if breakpoints are known *a priori,* then a conventional ADF approach (including the application of conventional ADF critical values) can be applied. We treat the breakpoints identified by the Zivot and Andrews unit root testing procedure of the individual series (in Table V) as being our *a priori* known breakpoints. Applying these known breakpoints to the models shown in equations 7 through 9 generates the results reported in Table VI.

Table VI
Gregory and Hansen Cointegration Procedure Applied to
A Priori Known Breakpoints*

Variables in Coint.Reg.	Model	Breakpoint	t-value
SA & *SW*1	C	1969Q3	-4.356
	B	1971Q1	-4.852
	A	1973Q1	-4.236
SA & *SW*2	C	1969Q2	-4.141
	B	1971Q1	-4.370
	A	1973Q1	-4.297
SA & *SW*3	C	1969Q2	-4.477
	B	1971Q1	-4.352
	A	1970Q1	-4.505
	A	1973Q1	-4.431
5% CV Models A and B		-3.74	Shazam Critical values
5% CV Model C		-4.10	

Table VI reports only those breakpoints in tests of a cointegrated relation between Australian and world strike activity that are statistically significant. A number of observations can be made in reference to the results in Table VI. First, all of the pairs of strike activity series show evidence of a break in the cointegrating relation at *some* of the breakpoints identified by tests on the individual series. Most models indicate a break in the cointegrating relation somewhere in the late 1960s or early 1970s. Second, there is no evidence of a break in the cointegrating relation between Australian and world strike activity immediately before, during or after the period of the Accord. This outcome is consistent with a view that the Accord had no discernible effect on Australian strike activity (as defined). The low incidence of strikes in Australia during and after the Accord is consistent with a similar low incidence of strikes experienced worldwide.

* If the breakpoints are not known *a priori* but need to be identified through a sequential testing procedure for the smallest t-value in an ADF regression on the residual series the critical values are higher. Gregory and Hansen provide approximate asymptotic 5% critical values of –4.61 for Model A, and –4.95 for Model C.

Interpreting Results

What then is the broad picture that emerges from this comparative analysis? There is evidence of a considerable degree of comparability in Australian and worldwide strike activity during the period (1960-98) under review. The Australian and world series are cointegrated, though with evidence of a permanent shift in the relation from around 1969 to 1973. This regime shift can be detected visually, albeit rather loosely, in Figures 1 and 2. Figure 1charts the series SA and SW3 between 1960 and 1998. Note the general decline in worldwide strike activity from around the early 1970s and the somewhat delayed but still similar decline in Australia. Note also the parting of the ways of the two series around the early 1970s. The world series fall somewhat more sharply on average than does the Australian series.

Another way of visualising the break in the cointegrated relation between Australian and world strike activity around the early 1970s is to look at the *cumulative* value of strikes per employee in Australia and worldwide. Figure 2 illustrates these two series. Note how these aggregated series part company somewhere in the early 1970s. The Australian series grows more rapidly than the world series from around the early 1970s. The series in figure two are simple I(2) transformations of the I(1) cointegrated series, but they arguably illustrate the sort of changes that the regime-shift results in Table VI are registering.

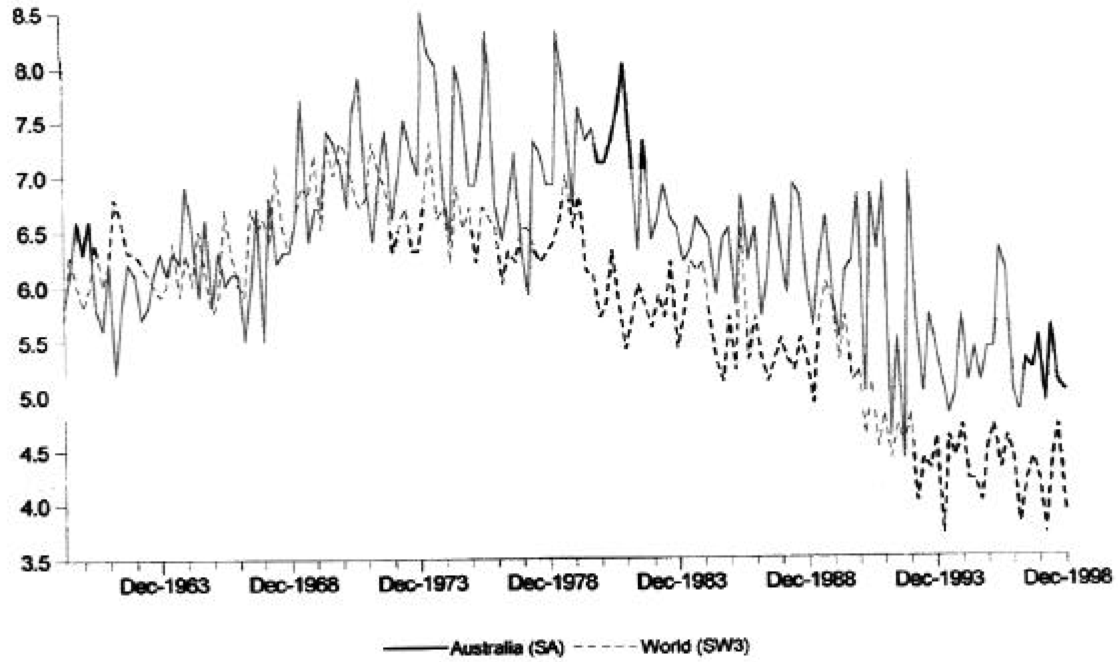
What might have caused the regime shift in the cointegrated variables? A number of events during the late 1960s and early 1970s might be rationalised as being of importance. Changes in government, energy crises, labour market changes, exogenous changes in union militancy and/or employer resistance and so on. We do not pretend in this paper to have an answer to the question as to why strike activity became somewhat higher in Australia than elsewhere. At this stage we simply report the change.

Finally, a comment on the effect of the Accord on Strike activity. If the Accord was responsible for the decline in strike activity above and beyond the average downward trend experienced internationally, it might be expected that this would be registered with a shift in the relation between domestic and international strike activity. This has not occurred for the variables we have tested. Thus the results are consistent with the view that the Accord had little if any effect on strikes. Figures 1 and 2 give a visual representation to this contention. There is barely a wobble in the kindred shapes of the series charted in Figure 2 during the period of the Accord. Similarly in Figure 1 the decline in strike activity during the period of the Accord is no more dramatic than that which occurred internationally.

5. CONCLUDING COMMENTS

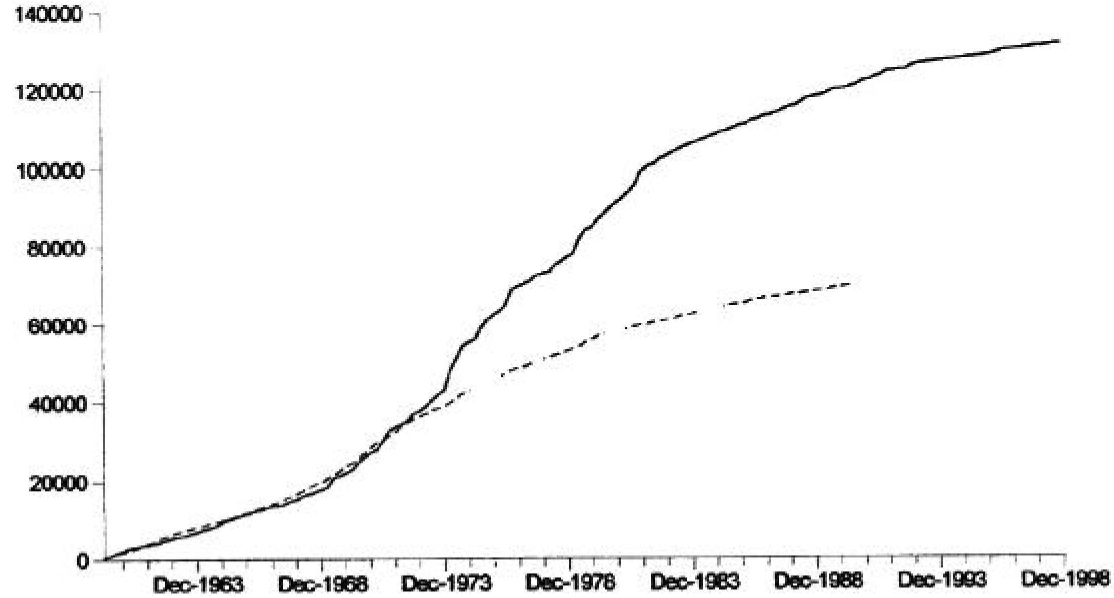
This paper has sought to examine the long-term relation between strike activity in Australia and the world. It has been argued that Australian economic activity in general and strike activity in particular are subject to direct and indirect international influences that dominate perceived local-only influences. As a consequence it is argued that there is a cointegrated relation between domestic strike

Figure 1 Australian and World Strike Activity
Natural Log of WDL per 10000 Employees



WDL = Working days lost due to strikes

Figure 2 Cumulative Value of WDL per 1000 Employees
Australian and World Series



WDL = Working days lost due to strikes activity and an appropriate measure of international strike activity.

To test for the presence or otherwise of a cointegrated relation, we use methodologies developed by Zivot and Andrews and further refined by Gregory and Hansen that allows for structural breaks in time series. Using these methodologies generates a number of interesting results. First, there is evidence of cointegration which is consistent with the view that there has been, for the period of the study, a long-term equilibrium relation between local and international strike activity. Second, there is evidence of a structural break in the cointegrated relation sometime in the very late 1960s or early 1970s. The break suggests that, though the *form* of the relation changed (ie parameter values changed), the relation itself did not. And third, the tests revealed no evidence of a break in the relation between Australian and world strike activity just before, during or after the period (1983-1996) of the Accord. This last result is consistent with a view that the decline in the strike rate in Australia over the last couple of decades is broadly compatible with a comparable decline worldwide.

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APPENDIX A

Perron Methodology

The Zivot and Andrews (1992) methodology modified an earlier approach developed by Perron (1989). In his original article Perron hypothesised three models - what he termed models A, B and C - that might be used to test the null hypothesis of a unit root with drift when an exogenous structural break occurs at time $1<T_B<T$ versus the alternative hypothesis that the series is stationary about a deterministic trend with an exogenous change in the trend function at time T_B. Perron's unit root null hypotheses were:

Model A

Equation A1

$$y_t = m + dD(T_B) + y_{t-1} + e_t$$

Model B

Equation A2

$$y_t = m_1 + y_{t-1} + (m_2 - m_1) DU_t + e_t$$

Model C

Equation A3

$$y_t = m_1 + y_{t-1} + dD(T_B) + (m_2 - m_1) DU_t + e_t$$

These unit-root null hypotheses were tested against the following trend-stationary alternatives:

Model A

Model B

Equation A4

$$y_t = m_1 + b\,t + (m_2 - m_1)DU_t + e_t$$

Equation A5

$$y_t = m + b_1 t + (b_2 - b_1)DT^*_t + e_t$$

Model C

Equation A6

$$y_t = m_1 + b_1 t + (m_2 - m_1)DU_t + (b_2 - b_1)DT_t + e_t$$

where $D(T_B)_t = 1$ if $t=T_B+1$, 0 otherwise; $DU_t = 1$ if $t>T_B$, 0 otherwise and $DT^*_t = t-T_B$ and $DT_t = t$ if $t>T_B$ and 0 otherwise.

Perron's unit root tests were based on the following augmented regression equations[6]:

Model A

Equation A7

$$y_t = \hat{m}^A + \hat{q}^A DU_t + \hat{b}^A t + \hat{d}^A D(T_B)_t + \hat{a}^A y_{t-1} + \sum_{j=1}^{k} \hat{c}^A_j \Delta y_{(t-j)} + \hat{e}_t$$

Model B

Equation A8

$$y_t = \hat{m}^B + \hat{b}^B t + \hat{g}^B DT^*_t + \hat{a}^B y_{t-1} + \sum_{j=1}^{k} \hat{c}^B_j \Delta y_{(t-j)} + \hat{e}_t$$

Model C

Equation A9

$$y_t = \hat{m}^C + \hat{q}^C DU_t + \hat{b}^C t + \hat{g}^C DT^*_t + \hat{d}^C D(T_B)_t + \hat{a}^C y_{t-1} + \sum_{j=1}^{k} \hat{c}^C_j \Delta y_{(t-j)} + \hat{e}_t$$

Note that in the Perron framework a specific structural break (either level, growth or both) was introduced exogenously to the null hypotheses which were tested against trend-stationary alternatives. Perron's model A (what he termed his 'crash' model) permitted an exogenous change in the level of the series and under his null hypothesis $á^{A} = 1$, $â^{A}=0$ and $è^{A}=0$. Model B permitted an exogenous change in the rate of growth but no change in the level of the series, the ‘breaking slope with no crash’ model and under the null hypothesis $á^{B} = 1$, $ã^{B}=0$ and $â^{B}=0$. Model C permitted both occurrences and under the null hypothesis $á^{C} = 1$, $ã^{C}=0$ and $â^{C}=0$. These three models were visually described in the body of the text.

The test statistics used by Perron were based on the break fraction $ë = T_{B}/T$ and were computed from the standard t statistics for testing $á_{i} = 1$, viz:

Equation A10

$$t_{â_i}(l) \quad i = A,B,C$$

Perron’s test was: reject the null hypothesis of a unit root if

Equation A11

$$t_{â_i}(l) < k_a(l)$$

where $ê_{á}$ (ë) denotes the critical value determined from Monte Carlo simulations of the asymptotic distribution of (eqn.A10) above.

Data Sources

The strike rate is defined the number of working days lost due to strikes per 10000 employees. Sources: OECD, *Main Economic Indicators Historical Statistics* and *Economic Outlook*; ILO Yearbook of Labour Statistics; B. R. Mitchell, *International Historical Statistics Africa, Asia and Oceania 1750-1993*, Third Ed. (Macmillan, 1998) and Directorate-General of Budget, Accounting and Statistics, Executive Yuan, *Statistical Yearbook of the Republic of China* and *Monthly Bulletin of Statistics*. Certain refinements and updates were communicated directly to the authors via direct correspondence with respective national statistical collection agencies (eg Japan, USA, Korea and Thailand). Employee series were centred and smoothed. Where employee series were incomplete, interpolations and or estimates based on labour force estimates were employed. Where strike data were available only on an annual basis, annual data were apportioned on a quarterly basis.

The trade weights are calculated as a fraction of the sum of the three-year moving average of Australian exports (fob) and imports (cif) for countries that make up the index. Sources: Australian Bureau of Statistics, *International Merchandise Trade*, 5422.0 and Commonwealth Bureau of Census and Statistics, *Overseas Trade*, Bulletin No. 56

ENDNOTES

1. We continue with the Nelson and Plosser (1982) procedure of using the natural logarithms of the series in our analysis due to the tendency of economic time series to exhibit variation that increases in mean and dispersion in proportion to absolute level.

2. This is the usual regression that is run for unit root tests. Note that the following two are equivalent expressions:

$$y_t = a_1 y_{t-1} + e_t$$
$$\Delta y_t = g\ y_{t-1} + e_t$$

The second equation is obtained by subtracting y_{t-1} from each side of the first equation. Thus ã = (á - 1). Testing for á = 1 in the first equation is equivalent to testing for ã = 0 in the second. The difference between the DF and the ADF unit root test is the extension from a first-order to a k^{th} order autoregression. The ADF test is run in preference to the DF test when the residuals in the DF regression do not appear to be white noise. The order of the ADF regression is determined by the significance of the last included lag.

3. We use the critical values developed by Mackinnon (1991).

4. Developed from Monte Carlo simulations based on sample sizes that Zivot and Andrews actually encountered in the original series. Zivot and Andrews fitted ARMA (p,q) models to the individual data series and then treated the optimal ARMA (p,q) model as the true data generating processes for the errors of each of the series. They then constructed a pseudo sample of size equal to the actual size of the series using the optimal ARMA (p,q) models and obtained breakpoints, lags and estimated t-values as described in the body of their paper. This was repeated 5,000 times to obtain the critical values. Zivot and Andrews found that the critical values differed little across the different ARMA (p,q) model specifications and finite sample sizes. For instance, at the 5% level with similar ARMA (1,0) model specifications the critical value was -5.32 for a sample size of 62 and -4.84 for a sample size of 159. With an ARMA (1,0) specification for a sample size of 62 the critical value was -5.32 while for an ARMA (0,1) specification and sample size of 100 the critical value was -5.63.

5. Which Gregory and Hansen (1996a) specify both with and without trend.

6. cf. Perron (1989) pp.1380-1