Uncovering the Sources of Sectoral Employment Fluctuations

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This paper explores the sources of fluctuations in sectoral employment growth rates across the Australian economy over three different periods: the pre-terms of trade boom period; the pre-global financial crisis (GFC) phase of the terms of trade boom; and the GFC and post-GFC phase. We find that common cyclical fluctuations, not just sector-specific shocks, can and do have an important effect on sectoral growth rate dispersion across the full sample. We also find that there is evidence of accelerated structural change in the latter phase of the terms of trade boom.

1 Introduction

Australian employment data reveal significant sectoral dispersion in employment growth over the last 35 years (see Fig. 1). This dispersion in employment growth is broadly indicative of changes in the underlying structure of the Australian economy, but it is also useful to identify the extent to which cyclical components play a role in each sector. This is because cycles are normally short-lived, and can potentially be managed by short-term policies targeting the individual sector, whereas trends reflect structural changes which are better managed through microeconomic reforms that allow factors to flow easily between sectors.

However, analysis of this sort is complicated by the variability in employment growth across the sectors. Sectors often have their own cyclical volatility, while also being responsive to a broader cycle affecting the entire economy. For example, Australian data reveal some coherence between aggregate and sectoral fluctuations over the first half of the data sample, with manufacturing, construction, wholesale trade, retail trade and other-services employment growth moving roughly in line with aggregate employment growth. However, these correlations are far from perfect, which suggests sectors are subject to significant sector-specific shocks, possibly in the form of different sensitivities to the aggregate cycle.

In this paper, we explore the sources of fluctuations in sectoral employment growth rates across the Australian economy over three different periods: the pre-terms of trade boom period before 2000Q1; from 2000Q1 to 2008Q2 to capture the effects on sectoral employment from the pre-global financial crisis (GFC) phase of the terms of trade boom; and the GFC and post-GFC phase from 2008Q3 to the end of the sample to capture the effects of the sustained high exchange rate and relatively weak world economy. These data point to greater dispersion in the second half of the sample (i.e., a shift towards sector-specific factors) marked by employment growth rates in all sectors resting significantly above or below the aggregate growth rate. Results from the manufacturing sector are the most revealing indications of these changes over the past 30 years.

Our work adds to a large empirical literature devoted to the sectoral composition of labour demand underpinned by methods described in Lilien (1982) and decomposing cyclical fluctuations in employment data, which largely stems from the work of Abraham and Katz (1986). Their research, like ours, focuses on whether fluctua-
tions in observed sectoral employment growth rates are due to shifts in trend growth rates (structural change) or temporary cyclical fluctuations. We find, as did Abraham and Katz, that common cyclical fluctuations, not just sector-specific shocks, can and do have an important effect on sectoral growth rate dispersion and that there is evidence of accelerated structural change in the latter phase of the terms of trade boom.

Abraham and Katz’s empirical methodology has been refined by a number of researchers, including Rissman (1997) who employed more sophisticated unobserved component techniques (state-space modelling) to decompose fluctuations in sectoral employment growth into their trend and common cyclical components. Our analysis extends the work of Rissman (1997) by following the modelling strategy of Kouparitsas (2002), developed in his work decomposing US regional economic growth, which allows for the cycle to be further decomposed into common and sector-specific components. This approach, when compared to Rissman’s, delivers a relatively parsimonious framework that identifies both permanent and temporary sector-specific factors in employment growth.

Our work also continues the tradition of applying the Lilien (1982) and Abraham and Katz (1986) approaches to the Australian context. Trivedi and Baker (1985) were the first to use Lilien’s (1982) methods in the Australian context when they found that the increase in the unemployment rate in the 1970s was attributable to frictional and non-structural issues. Groenewold and Hagger (1998) applied the approach to estimate a natural rate of unemployment in Australia over the period from the late 1970s to the late 1990s. Heaton and Oslington (2002) adapted the framework and decomposed the changes in sectoral unemployment rates in the common and sector-specific components using spectral techniques. They found that common shocks were the primary influence on changes in the unemployment rate over the period 1978–94.

Our work adds to this body of literature by using more recent data to describe the trends and cycles in key sectors of the Australian economy. We produce a structural model which allows for projections and policy simulation analysis. This information and approach is timely, because policy-makers in Australia are increasingly looking to non-mining sectors to sustain economic growth as the record level of mining investment drops away. Knowledge on the strength of trends, the amplitude of cycles, and the relationship of sectoral cycles to the overall economic cycle is all helpful in designing effective economic and labour market policies.

The implications of our work are best drawn out by exploring the results for the manufacturing sector. That sector has a strong downward trend in the later part of the series, while being responsive to both the broad economic cycle and its own idiosyncratic cycle. At the end of the series, both the sector-specific cycle and the broad economic cycle are found to be in phase at the bottom of the cycle. This all suggests that the volatility in the sector is likely short-lived, but that the trend path to which the sectoral employment will return will likely see less employment in the manufacturing sector than in the past. Policy-makers might be able to manage the short, deep cyclical downturn, but there is likely little they can do about the downward trend in the sector. Instead, these results suggest that policy-makers should ensure labour can easily flow to where it is most needed elsewhere in the economy.

The remainder of this paper is organised as follows: Section II describes in detail the structural model of sectoral employment growth; Section III describes the data sources and definitions used in the analysis; Section IV discusses the econometric method and reports parameter estimates, including the estimated unobserved components; and Section V concludes with a summary of the findings of the paper and a brief outline of plans for future research.

II Theory

(i) A Structural Model of Sectoral Employment Growth

Abraham and Katz (1986) pointed out that changes in the aggregate business cycle have disproportionate impacts on different sectors — the typical example being that the durable goods producing manufacturing sector will tend to experience more severe downturns (and upswings) than service sector counterparts. As such, what appears to be a structural shift towards services in a recession may be more accurately attributed to differing sectoral sensitivities to the common cycle.

Building on the ideas of Abraham and Katz, Rissman (1997) derived an unobserved component model decomposing fluctuations in sectoral employment growth into their trend and cyclical
components. The trend component captures permanent (structural) change in the economy. Temporary fluctuations around this trend are captured by the cyclical component. We extend the work of Rissman (1997) by following the modelling strategy of Kouparitsas (2002), developed in his work decomposing US regional economic growth, which allows for the cycle to be further decomposed into a common cycle and sector-specific economic cycle. This approach allows for permanent and temporary sector-specific factors in employment growth.

(ii) Unobserved Component Model

While we ultimately model through-the-year (tty) employment growth, we begin by developing a framework regarding the log-level of employment. We assume that the log of employment in each sector i at time t (n_{it}) can be decomposed into two basic components – a trend (τ_{it}) and cyclical component (c_{it}):

\[ n_{it} = τ_{it} + c_{it} \]  

The trend component is specific to each sector and is assumed to be a unit root with drift:

\[ τ_{it} = δ_i + τ_{i,t-1} + ε_{it} \]  

where \( δ_i \) captures average employment growth in sector i, while \( ε_{it} \) captures shocks to the trend component which is distributed with mean zero and standard deviation \( σ_{εi} \).

The cycle is composed of a common cycle (\( x_i \)) and a sector-specific or own cyclical component (\( x_{it} \)):

\[ c_{it} = γ_i x_i + x_{it} \]  

\( γ_i \) measures the coherence with the common cycle, with \( γ_i = 0 \) indicating no relationship with the common cycle, \( γ_i > 1 \) indicating relatively large amplitudes, \( γ_i < 1 \) indicating relatively smaller amplitudes, and \( γ_i < 0 \) indicating that the sector is counter-cyclical.

The common cycle is assumed to have a stationary second order autoregressive (AR(2)) structure:

\[ x_i = φ_1 x_{i,t-1} + φ_2 x_{i,t-2} + μ_i \]  

where shocks to the common cyclical component of employment are captured by \( μ_i \), which is distributed with mean zero and standard deviation of \( σ_μ \). To ensure stationarity \( 1 < φ_1, φ_2 < 0, lφ_1 + φ_2 < 1 \).

Identification of the sector-specific cycle requires a simpler time-series relationship, with these components assumed to have a first order vector autoregressive (AR(1)) structure:

\[ X_t = Φ X_{t-1} + λ_t \]  

where \( X_t = [x_{1t}, x_{2t}, \ldots, x_{nt}]' \), Φ is a \( 6 \times 6 \) matrix of coefficients and \( λ_t = [λ_{1t}, λ_{2t}, \ldots, λ_{6t}]' \) is the vector of innovations to the sector-specific cycles, which is distributed with mean zero and covariance matrix Λ. Sector-specific cycles are identified by limiting the analysis to case where shocks to \( x_{jt} \) do not affect \( x_{jt} \) for all \( i \neq j \) at time t. In other words, the covariance matrix Λ is assumed to be diagonal. The extent of the spillover of a cyclical shock from one sector to another is indicated by the off-diagonal elements of Φ.

Finally, identification demands that shocks to all three unobserved components and across sectors are orthogonal.

These components are then used to decompose sectoral employment growth into its trend, common cycle and sector-specific cycle components:

\[ n_{it} - n_{i,t-4} = (τ_{i,t} - τ_{i,t-4}) + γ_i (x_i - x_{i,t-4}) + (x_{i,t} - x_{i,t-4}) \]  

III Data

(i) Sources and Definitions

Data on employment disaggregated on an industry basis are published in the Australian Bureau of Statistics’ (ABS) Labour Force Detailed release (cat. 6291.0.55.003). These data are reported on a quarterly basis from November 1984 for the middle month of each quarter (i.e., February, May, August and November). Seasonally adjusted data are used for our analysis. The Labour Force Historical Timeseries release (ABS cat. 6204.0.55.001) contains employment in original terms disaggregated on an industry basis from February 1978 to November 1984. These data are seasonally adjusted using X12. For the period from November 1984 the level of employment in each sector is taken from the Labour Force Detailed release, while prior to November 1984 the level of employment is interpolated back to February 1978 according to the growth rates derived from the seasonally adjusted Labour Force Historical Timeseries release.
Employment in the farm sector was excluded from our analysis, given the small size of the sector and its propensity to be significantly impacted by idiosyncratic factors such as drought.

(ii) Summary Statistics

We divide these data into six sectors – mining, manufacturing, construction, wholesale and retail trade, government-related, and a residual other-services sector. This disaggregation allows us to isolate the effect of the resources boom on the resources and related engineering construction sectors via the observed changes in mining and construction employment growth, and other trade-exposed sectors via the observed changes in manufacturing and wholesale/retail employment growth. We further divide the data into the period from 2000Q1 to 2008Q2 to capture the effects on sectoral employment from the pre-GFC phase of the terms of trade boom (hereafter phase 1); and the GFC and post-GFC phase from 2008Q3 to the end of the sample to capture the effects of the sustained high exchange rate and relatively weak world economy (hereafter phase 2). We refer to the period before 2000Q1 as pre-boom.

Sectoral Growth Rates

Total employment recorded an average tty growth rate of 2.0 per cent over the full sample, from 1978 to 2012. Underlying this estimate are slightly lower average tty growth of around 1.8 per cent over the pre-boom period and 1.6 per cent during phase 2, and significantly higher average growth of around 2.6 per cent during phase 1 (see Table 1).

Table 1 reveals that the relatively high aggregate employment growth during phase 1 reflects relatively strong employment growth in the mining, construction, manufacturing and government-related sectors. In the case of the mining and manufacturing sectors this period represented a significant change in direction, with mining experiencing roughly no growth and manufacturing steadily declining in the pre-boom period. While aggregate average employment growth returned to around its pre-boom average growth rate in phase 2, the period was marked by significantly higher or lower average growth rates for sectors when compared to their average growth rates of the pre-boom period. Specifically, average employment growth in the mining and government sectors was significantly higher than in the pre-boom while average employment growth in manufacturing, construction, wholesale/retail trade and other services was well below those of the pre-boom phase.

Sectoral Co-movement

With the exception of the mining and government sectors, the correlation of sectoral growth rates has declined over time. In particular, the pairwise correlations of the employment growth rates of manufacturing, construction and wholesale/retail trade with the employment growth rate of the other-services sector were around 0.5 in the pre-boom period, which is significantly higher than the same statistic over the full sample or boom periods. This suggests that sectors were subject to greater common shocks in the pre-boom, which implies sector-specific shocks were relatively more important in the latter part of the sample.

The correlation statistics for mining and the government sectors reveal little to no correlation with the rest of the economy over the full sample or any of the sub-periods.

Sectoral Volatility

The volatility of employment growth has remained constant or declined for all sectors except mining over the boom period. For example, the other-services sector (which is also largest sector by employment) recorded a standard deviation of growth of 2.7 per cent in the pre-boom period, which compares with a standard deviation of 1.8 per cent over phase 1 and an even lower standard deviation of 1.2 per cent over phase 2. Mining, in contrast, displayed much greater volatility towards the end of the sample, with a phase 1 standard deviation of mining employment growth around 7.8 per cent (which is roughly on a par with the pre-boom volatility of 7.3 per cent) and a phase 2 standard deviation of employment growth of around 10.5 per cent. Given the earlier observation on declining sectoral employment growth correlations over the boom periods, this fall in volatility suggests there has been a shift to more sector-specific factors in the boom period that display little change in volatility over the sample.

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IV Results

(i) Econometric Method

The model described by Equations (1)–(5) is a variant of Watson and Engle’s (1983) general dynamic multiple indicator–multiple cause (DYMIMIC) model. This framework allows unobserved variables to be dynamic in nature, as well as being associated with observed variables. DYMIMIC models are typically estimated

Table 1

| Sector          | Sample    | Average | Correlation with other services | Correlation with total employment | Standard deviation |
|-----------------|-----------|---------|---------------------------------|----------------------------------|-------------------|
| Mining          | Full sample | 3.63    | 0.01                            | 0.26                             | 9.26              |
|                 | Pre-boom  | -0.07   | 0.21                            | 0.28                             | 7.26              |
|                 | Phase 1    | 7.58    | -0.12                           | 0.27                             | 7.79              |
|                 | Phase 2    | 12.92   | 0.14                            | 0.43                             | 10.46             |
| Manufacturing   | Full sample | -0.55  | 0.38                            | 0.60                             | 3.29              |
|                 | Pre-boom  | -0.56   | 0.51                            | 0.71                             | 3.14              |
|                 | Phase 1    | 0.39    | 0.06                            | 0.41                             | 3.77              |
|                 | Phase 2    | -2.19   | 0.05                            | 0.16                             | 2.39              |
| Construction    | Full sample | 2.07   | 0.35                            | 0.73                             | 5.94              |
|                 | Pre-boom  | 1.36    | 0.47                            | 0.78                             | 6.59              |
|                 | Phase 1    | 4.59    | -0.14                           | 0.33                             | 4.61              |
|                 | Phase 2    | 0.68    | 0.20                            | 0.68                             | 3.22              |
| Wholesale/retail| Full sample | 1.51   | 0.37                            | 0.69                             | 2.65              |
|                 | Pre-boom  | 1.78    | 0.51                            | 0.83                             | 2.61              |
|                 | Phase 1    | 1.60    | -0.15                           | 0.43                             | 2.91              |
|                 | Phase 2    | 0.15    | 0.26                            | 0.58                             | 1.97              |
| Government      | Full sample | 2.65   | -0.11                           | 0.27                             | 1.91              |
|                 | Pre-boom  | 2.19    | 0.01                            | 0.29                             | 1.97              |
|                 | Phase 1    | 3.33    | -0.29                           | 0.04                             | 1.59              |
|                 | Phase 2    | 3.49    | -0.34                           | 0.36                             | 1.56              |
| Other services  | Full sample | 2.68   | 1.00                            | 0.74                             | 2.36              |
|                 | Pre-boom  | 2.95    | 1.00                            | 0.81                             | 2.66              |
|                 | Phase 1    | 2.64    | 1.00                            | 0.52                             | 1.85              |
|                 | Phase 2    | 1.55    | 1.00                            | 0.56                             | 1.23              |
| Total           | Full sample | 2.00   | 0.74                            | 1.00                             | 1.72              |
|                 | Pre-boom  | 1.83    | 0.81                            | 1.00                             | 2.03              |
|                 | Phase 1    | 2.61    | 0.52                            | 1.00                             | 0.93              |
|                 | Phase 2    | 1.64    | 0.56                            | 1.00                             | 0.89              |

Source: Authors’ calculations based on data from ABS cat. 6291 and 6204.

Table 2

| d₀           | d₁           | d₂           | σₑ           |
|--------------|--------------|--------------|--------------|
| Coefficient  | SE           | Coefficient  | SE           | Coefficient  | SE           | σₑ           |
| Mining       | 0.00         | 9.61         | 2.59         | 0.00         | -            | 13.8         |
| Manufacturing| -0.50        | 0.50         | 0.25         | -1.93        | 0.67         | 0.0          |
| Construction | 2.23         | 0.00         | -            | 0.00         | -            | 7.5          |
| Wholesale/retail | 1.64   | 0.00         | -            | 0.00         | -            | 1.6          |
| Government   | 2.21         | 1.29         | 0.65         | 0.00         | -            | 2.1          |
| Other        | 2.99         | -0.74        | 0.39         | 0.00         | -            | 0.0          |

Source: Authors’ calculations based on data from ABS cat. 6291 and 6204. Note: SE, standard error.

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FIGURE 2
Employment Trend (Number, Log Scale)

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using maximum likelihood. In this setting, the likelihood function is evaluated using the Kalman filter on the model’s state-space representation. One of the requirements of maximum likelihood is that the data used in the estimation must be stationary. Augmented Dickey–Fuller unit-root tests applied to the log levels and log first differences of employment for the six sectors suggest that the null of a unit root cannot be rejected for any of the level data series at the 5 per cent level of significance. However, the null of a unit root is rejected for the first-difference data at the same level of significance. In light of this, we specify and estimate the model using the log first differences of employment, which gives a state-space representation of the model with measurement equation

\[
\begin{align*}
    n_t - n_{t-1} &= \delta_t + \gamma_i (x_t - x_{t-1}) + (x_{it} - x_{it-1}) + \epsilon_{it} \\
    & \quad (7)
\end{align*}
\]

and transition equations

\[
\begin{align*}
    x_t &= \phi_1 x_{t-1} + \phi_2 x_{t-2} + \mu_t \\
    X_t &= \Phi X_{t-1} + \lambda_t \\
    & \quad (8, 9)
\end{align*}
\]

**TABLE 3**

| Coefficient | Standard error |
|--------------|----------------|
| $\phi_1$ | 1.74 | 0.18 |
| $\phi_2$ | -0.77 | 0.18 |
| $\sigma_\mu$ | 0.24 | 0.15 |

*Source: Authors’ calculations based on data from ABS cat. 6291 and 6204*

**TABLE 4**

| Coefficient | Standard error |
|--------------|----------------|
| Mining | 0.42 | 1.62 |
| Manufacturing | 0.61 | 0.40 |
| Construction | 2.50 | 1.24 |
| Wholesale/retail | 1.17 | 0.64 |
| Government | 0.12 | 0.28 |
| Other | 1.00 | – |

*Source: Authors’ calculations based on data from ABS cat. 6291 and 6204*

**Figure 3**

*Common Cycle versus Gross Domestic Product (GDP) Cycle (Per Cent Deviation from Trend)*
FIGURE 4
Total versus Common Cycle (Per Cent Deviation from Trend)

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Identification of the model parameters requires one $\gamma_i$ to be normalised to 1. We use the other-services sector as the reference sector. As a result, the $\gamma_i$ for other sectors refer to the sensitivity of employment growth in sector $i$ to the common cycle relative to the other-services sector.

The data analysis of Section III suggests that there was a significant change in the trend growth rate of some sectors around 2000. We examine this further by allowing for a trend break to $d_i$ in 2000 and 2008. This implies the following measurement equation:

$$n_{it} - n_{i,t-1} = d_{i0} + D_1 \delta_{i1} + D_2 \delta_{i2} + \gamma_i(x_i - x_{i,t-1}) + (x_i + x_{i,t-1}) + e_{it} \tag{10}$$

where $D_1$ is a dummy variable set equal to 0 prior to February 2000 and 1 thereafter, $D_2$ is a dummy variable set equal to 0 prior to August 2008 and 1 thereafter, $\delta_{i0}$ is the trend quarterly growth rate for sector $i$ prior to February 2000, $\delta_{i0} + \delta_{i1}$ is the trend quarterly growth rate for sector $i$ from February 2000 to July 2008, and $\delta_{i0} + \delta_{i1} + \delta_{i2}$ is the trend quarterly growth rate for sector $i$ from August 2008 onwards.

Parameter estimates were then obtained using the state-space estimation module in EViews version 7.2 (see Quantitative Micro Software, 2010, Chapter 33). Likelihood ratio tests of the order of the autoregressive form were also carried out, and these indicated that lags were not significant beyond the first order for the idiosyncratic components, and the second order for the cyclical components for any of the sectors.

(ii) Estimation Results

Sectoral Trends

Estimates of the parameters that govern the trend components of sectoral employment are reported in Table 2. It is difficult to identify significant trend parameters without imposing zero and other constraints. The constraints we placed were informed by the identification of a number of patterns in trend growth that were supported by the data and historical factors. For example, the period before the resources boom was characterised by ongoing structural change in which employment in service-oriented sectors (government and other services) grew at a rate above the aggregate growth rate and employment in industrial sectors (mining and manufacturing) grew at a rate well below the aggregate growth rate. In the case of manufacturing, this ongoing structural change took the form of declining sectoral employment.

This pattern is estimated to have changed during phase 1, with both statistically and economically significant increases in the trend growth rates of employment growth in the mining, manufacturing, construction and government-related sectors. According to these estimates, the ongoing decline in manufacturing employment was arrested during this period, while mining, construction and government accelerated to growth rates that were respectively 8.4, 3.3 and 1.3 per cent above their pre-boom estimates. This is also demonstrated in Figure 2 with the gradual slopes of the earlier period shifting to be significantly higher during phase 1. For mining this growth spurt led to a doubling of its work force.

Table 5

| Sector-Specific Cycle Parameters | Mining | Manu. | Cons. | WRT | Govt. | Other | A |
|---------------------------------|--------|------|------|-----|------|-------|---|
| Mining                          | 0.54** | -0.18 | 0.89 | -1.00 | 0.30 | -0.03 | 3.44 |
| Manufacturing                   | 0.07   | 0.81*** | -0.18 | 0.16 | 0.04 | -0.02 | 1.48 |
| Construction                    | -0.06  | 0.44*** | 0.22 | 0.58** | 0.02 | -0.24 | 0.92 |
| Wholesale/retail                | -0.10* | 0.13  | 0.27 | 0.31 | 0.28 | -0.04 | 0.99 |
| Government                      | -0.04  | -0.08 | 0.09 | -0.06 | 0.63*** | 0.15 | 0.82 |
| Other                           | 0.04   | 0.14** | -0.00 | -0.01 | -0.03 | 0.75*** | 0.84 |

Source: Authors’ calculations based on data from ABS cat. 6291 and 6204

Notes: Table should be read as the spillover of the column sector’s cycle to the row sector’s cycle. *Significant at the 10% level, **significant at the 5% level and ***significant at the 1% level.

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Figu re 5

Total versus Sector-Specific Cycle (Per Cent Deviation from Trend)

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Figure 2 also captures the reversal of this change for manufacturing and construction during phase 2, over which time the trend decline in employment growth in the manufacturing sector is estimated to have accelerated from 0.5 per cent in the pre-boom to around 2.4 per cent, while construction is estimated to have returned to its pre-boom trend growth rate of 1.5 per cent. On the other hand, mining and government-related employment experienced no significant change in their trend growth rates during phase 2, which is highlighted in Figure 2 by the continuing upward trend in the actual data and estimated trend lines.

**Common Cycle**

We find that sectoral employment has a common cycle. In other words, there is a tendency for Australian sectors to expand and contract their employment at the same time. This cycle is described by an AR(2) process with a first lag coefficient of 1.79 and second lag coefficient of −0.83, which suggests the cycle has relatively large amplitudes and that the response to a common employment shock is quite persistent (see Table 3). The standard deviation of the shock to the common cycle is around 0.2 per cent of other-services employment, which implies a standard deviation of the common cycle of around 1 per cent of other-services employment.

Figure 3 plots the common cycle against the gross domestic product (GDP) cycle estimated using a Hodrick–Prescott filter. The common employment cycle has turning points that are similar to the GDP cycle, albeit with a lag of roughly 6–12 months. The common employment cycle also has similar amplitudes to the GDP cycle, especially during the downturns of the early 1980s and 1990s. Since the mid-1990s the fluctuations in the common employment cycle have mirrored the dampened GDP cycle, which reflects relatively stable economic conditions over this period, both domestically and internationally (for details see Stock & Watson, 2003, and references therein).

**Sensitivity to the Common Cycle**

Table 4 reports estimates of $\gamma_i$, which reveal the relative sensitivity of sectoral employment to
the common cycle, where the benchmark is the other-services sector. Employment in the construction, manufacturing and wholesale/retail trade sectors is more sensitive to fluctuations in the common cycle than the other-services sector. For example, employment in the construction sector is the most sensitive with an estimated coefficient of 3.6, which implies that it is 3.6 times more sensitive to the common cycle than the other-services sector. This estimate likely reflects the fact that construction goods are lumpy with a long time to build. At the other end of spectrum we find that employment in the mining and government sectors has statistically insignificant relationships with the common cycle (Fig. 4).

**Sector-Specific Cycles**

We find evidence of statistically significant sector-specific employment cycles. The coefficients describing the persistence of the sector-specific cycles (i.e., the diagonal terms in \( \Phi \)) were found to be statistically significant for the mining, manufacturing, government and other-services sectors (Table 5). The sector-specific cycles are generally less persistent than the common cycle, but the standard deviation of the sector-specific shocks tends to be larger than for the common-cycle shock. In light of the statistics reported in Table 1, this suggests the common and sector-specific cycles account for roughly similar shares of the variance of employment over the full sample.

We explore this idea further in Figure 5 by plotting the sector-specific cycle against the total sectoral employment cycle. Figure 5 shows that sector-specific cycles explain a significantly greater proportion of the variation in sectoral employment in the period following the mid-1990s. It also reveals that, in contrast to the declining volatility of the common cycle, the volatility of sector-specific cycles has been constant over the sample (the obvious exception is mining, which has somewhat larger own-cycle fluctuations in the resource boom period of phases 1 and 2). Combining these observations, we conclude that the observed decline in the volatility of employment growth is entirely due to the decline in the volatility of common cycle.
We also find evidence of cross-sector spillovers in the idiosyncratic cycles. The manufacturing sector has a statistically significant effect on the sector-specific cycles of the construction and other sector. In particular, an upturn in manufacturing employment is estimated to have a moderate impact on the employment in these sectors, perhaps reflecting the historically central role manufacturing has played in the Australian economy.

Construction sector employment is also responsive to the sector-specific employment cycle in the wholesale/retail trade sector, while wholesale/retail trade appears to be somewhat responsive to the sector-specific employment cycle in the mining sector.

(iii) Sectoral Growth Rate Decompositions

Mining
Variation in mining sector employment growth is driven almost entirely by fluctuations in its trend and sector-specific cycle (see Figure 6). Shocks to the trend were relatively large over the pre-boom period. Since then the trend growth of mining employment has increased, which, combined with rising volatility of the sector-specific cycle, has caused a significant rise in the volatility of growth rate of mining employment. Mining sector output is largely driven by foreign demand (at least 60 per cent of value added is due to exports), which causes the sector to be relatively insensitive to Australian economic cycles and far more sensitive to world economic cycles. In light of this observation, a possible explanation for the changing relative importance of the common cycle is that in the pre-boom phase these foreign demand cycles were driven by advanced economies with economic cycles that were similar to Australia’s, while in phase 1 and 2 there was a significant shift of demand to emerging markets (e.g., China) with somewhat different economic cycles.

Manufacturing
Fluctuations in the common and sector-specific cycles appear to be equally important sources of variation in manufacturing employment growth.
over the pre-boom period (see Fig. 7). The weight on these components shifted in phase 1 of the resources boom to sector-specific cyclical factors, which was complemented in phase 2 by a significant shift in the trend growth rate of manufacturing employment. The latter shift was likely due to the sustained high exchange rate.

Construction
Prior to 2000, fluctuations in construction sector employment growth were largely driven by the common cycle (see Fig. 8), possibly reflecting the strong cycles in residential and non-residential construction that were typical of that period. Since 2000, there has been a significant decline in the amplitude of construction cycles, with a significant share of the level and volatility of construction employment growth driven by fluctuations in the sector-specific trend.

Wholesale/Retail Trade
Variation in the growth rate of employment in the retail trade sector appears to be driven by its trend component and the common cycle during the pre-boom period (see Fig. 9). The relative importance of the common and sector-specific cycles shifted in phases 1 and 2, with fluctuations in the trend and sector-specific cycle explaining virtually all of the variation in growth over this period.

Government-related
Fluctuations in government-related employment growth are largely driven by fluctuations in the trend component (see Fig. 10). Similarly, the significant shift in the rate of employment growth over the boom period rate is also due entirely to a shift in the trend growth rate.

Other Services
Volatility in the growth rate of employment in the other-services sector has fallen steadily over the full sample period. This appears to be largely driven the declining volatility of the common cycle and the sector’s own cycle, which was quite volatile in the mid-1990s (see Fig. 11).
Conclusion

In this paper, we explore the sources of fluctuations in sectoral employment growth rates across the Australian economy over three different periods: the pre-terms of trade boom period before 2000Q1; from 2000Q1 to 2008Q2 to capture the effects on sectoral employment from the pre-GFC phase of the terms of trade boom; and the GFC and post-GFC phase from 2008Q3 to the end of the sample to capture the effects of the sustained high exchange rate and relatively weak world economy.

We find that the main sectors of the Australian economy share a common cycle. In other words, there is a tendency for Australian sectors to expand and contract their employment at the same time. The common employment cycle has turning points that are similar to the GDP cycle, albeit with a lag of roughly 6–12 months. The common employment cycle also has similar amplitudes to the GDP cycle, especially during the downturns of the early 1980s and 1990s. Since the mid-1990s the fluctuations in the common employment cycle have mirrored the dampened GDP cycle, which reflects relatively stable domestic economic conditions over this period.

We also find evidence of statistically significant sector-specific employment cycles. For example, mining sector output is largely driven by foreign demand (at least 60 per cent of value added is due to exports), which causes the sector to be relatively insensitive to Australian economic cycles and far more sensitive to world economic cycles.

Manufacturing, construction, wholesale/retail and other services appear to be jointly influenced by the common cycle and the sector-specific cycle over the full sample, while cyclical fluctuations in the mining and government sectors are largely driven by sector-specific shocks over the full sample. This pattern shifts over time, with sector-specific cycles explaining a significantly greater proportion of the variation in sectoral employment in the period following the mid-1990s. These findings lead us to argue that the observed decline in the volatility of aggregate sectoral employment growth is entirely due to the decline in the volatility of common cycle.
The results in this paper are highly relevant to the contemporary policy discussion. Sectors that have downward trends (such as manufacturing) are unlikely to be responsive to short-term policies that focus on sustaining employment in the sector, because the trend likely reflects shifts in comparative advantage and the relative productivity level of the sector. At the same time, weakness in employment in sectors that reflects either a sector-specific cyclical downturn or responsiveness to an economy-wide cyclical downturn could potentially be managed by policies that minimise the costly churn in employment over the period of the cycle.

Finally, we suggest two useful directions for this work. While Heaton and Oslington (2002) produced useful variance analysis of unemployment using their methods, the structural model that is laid out in this paper can also be used for forward-looking projections and policy simulation analysis. The presentation of those projections or simulations could also contribute meaningfully to the policy discussion. Additionally, the results of this paper could be used to derive measures of frictional and structural unemployment in the economy using the methodology outlined by Lilien (1982).

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Appendix A

Data Sources

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