Forecasting the Economic Impact of an Industrial Stoppage Using a Dynamic, Computable General Equilibrium Model

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Abstract
This paper demonstrates that dynamic computable general equilibrium (CGE) simulations can provide estimates of the economy-wide effects of industrial stoppages. Such estimates could be used in broad discussions of the contribution to economic welfare of improved industrial relations. They could also be used in narrowly focussed discussions, e.g. in the Australian Industrial Relations Commission in a determination under the Workplace Relations Act of the economic damage associated with a specific stoppage. An attractive feature of CGE simulation is that it can capture relevant details of particular circumstances. We illustrate this with a CGE analysis of the effects of a hypothetical stoppage in the Victorian non-residential construction industry. As explained in the paper, our simulation results reflect explicit assumptions about the nature of the industry in which the stoppage occurs, the wage adjustment process and the state of the business cycle.

1. Introduction
The Workplace Relations Act 1996 (Commonwealth) refers to bargaining periods for negotiating an agreement. Legal immunity applies to certain actions during a bargaining period. For example, employers are entitled to lock out employees and employees are entitled to engage in direct industrial action. The act (section 170MW(3)) states that one circumstance in which the Australian Industrial Relations Commission may suspend or terminate a bargaining period is when the

... industrial action that is being taken to support or advance claims in respect of the proposed agreement is threatening ... to cause significant damage to the Australian economy or an important part of it.

For this clause to be implemented, the Industrial Relations Commission would need to be presented with a forecast of economic damage. This raises the question of how such a forecast could be made.

There are many studies, both macro and micro, of the effects of industrial actions. Recent international macro studies include: Diduch (1998), who used cross-country data to establish relationships between strike frequency or strike duration and various macroeconomic indicators; Picchetti (2002),

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who undertook single-nation analysis along similar lines using Brazilian data; and Alvi (2001), who used time series data to estimate the impact of strikes on Canada’s balance of trade. For Australia, Beggs and Chapman (1987) investigated the relationships between inflation, unemployment and working days lost per employee through industrial action. At the microeconomic level, DiNardo and Hallock (2000) estimated the impact of strikes on the stock prices of U.S. firms for the period 1925 to 1937. In a study using Australian manufacturing data, McDonald and Bloch (1999) estimated the impacts of strikes on the profits of firms against which the strikes were directed and on the profits of competitor firms.

From the perspective of providing a forecast to the Industrial Relations Commission on economic damage, none of this literature is directly applicable. The macro studies do not deal with strikes in particular industries and regions. The micro studies do not provide measures of damage in terms of relevant macroeconomic indicators such as lost GDP and lost household consumption.

The purpose of this paper is to demonstrate that dynamic computable general equilibrium (CGE) simulations can provide economic damage forecasts of the type required by the Industrial Relations Commission. CGE simulation can incorporate the industrial and regional details of a strike, and can project effects to macroeconomic damage indicators. To illustrate the application of dynamic CGE simulation, we use the Monash Multi-Regional Forecasting (MMRF) model in an analysis of the effects of a strike in the Victorian non-residential building industry. While our example is hypothetical, the current work of the Royal Commission into the Building and Construction Industry (the Cole inquiry) makes it topical.

The paper is organised as follows. Section 2 describes MMRF and the shocks and assumptions in the current application. Sections 3 and 4 set out and justify the national and regional results. Section 5 contains concluding remarks.

2. The Model, the Shocks and the Key Assumptions

The Model

MMRF is a dynamic, multi-regional CGE model of Australia (Naqvi and Peter 1996; Adams et al. 2002). Potentially, it can distinguish 144 sectors and the 8 states and territories. In applications, it is computationally convenient to aggregate the model with the choice of aggregation determined by the focus of the study. For the application reported in sections 3 and 4, we use a two region (Victoria and the rest of Australia), 22 sector (including non-residential construction) version of the MMRF.1

1 The 22 sectors are Agriculture; Forestry; Fishing; Mining; Liquor; Cigarettes; Electronic equipment; Other Electrical Equipment; Other Manufactures; Utilities; Residential construction; Other construction; Trade; Hotels, cafes and restaurants; Transport; Communication services; Finance services; Ownership of dwellings; Other business Services; Government and defence; Education; and Other services.
The theory of MMRF is much the same as that in national dynamic CGE models such as MONASH (Dixon and Rimmer, 2002). Each industry in MMRF selects inputs of labour, capital and materials to minimise the costs of producing its output. The levels of output are chosen to satisfy demands and demands reflect prices and incomes. Investment in each industry reflects rates of return and capital reflects past investments and depreciation. However, instead of a commodity being produced by a single national industry, in MMRF the commodity is produced by an industry in each region. Instead of having just two varieties of each commodity (domestic and imported), MMRF has up to nine varieties (one from each state and territory plus imports). Instead of having a single government and a single household, MMRF has a national government, and a government and household in each region.

In structure, MMRF is like a multi-country model such as GTAP (Hertel, 1997). Regions are specified as separate economies, linked by trade. Unlike an international model, MMRF imposes fixed exchange rates and free trade between regions, and common external tariffs. The degree of inter-regional factor mobility assumed in MMRF is much higher than the degree of international mobility normally assumed in multi-country models.

MMRF can be run in two modes: forecasting and policy. In forecasting mode, it takes as inputs forecasts of macro and trade variables from organisations such as Access Economics and ABARE, together with trend forecasts of demographic, technology and consumer-preference variables. It then produces detailed forecasts for industries, regions and occupations. In policy mode, it produces deviations from forecast paths in response to shocks such as changes in taxes, tariffs, technologies, world commodity prices and industrial relations.

While CGE models such as MMRF are large and detailed, their simulation results can be explained in terms of familiar economic concepts and a manageable number of key assumptions. For understanding and assessing the results to be presented in sections 3 and 4, readers will require no more than persistence with elementary back-of-the-envelope arguments.

The Shocks

Our hypothetical stoppage is in the Victorian non-residential construction industry. We assume that it affects a major company and lasts long enough to cause a $30 million loss of wages and associated wastage of capital input worth $12 million. In our basecase forecast, total labour and capital input to the non-residential construction industry in 2003 in Victoria is $6,677 million. From this, we assume that the stoppage causes a direct loss of output in Victoria’s non-residential construction industry in 2003 of 0.63 percent [equals 100(42)/6677].

In modelling the stoppage, we were faced with two problems: how to reconcile demand for non-residential construction services in Victoria with

2 Returns to capital in the Victorian non-residential construction industry are 28 percent of the combined returns to labour and capital (0.28=12/42).
reduced supply; and how to represent the $42 million worth of idle labour and capital. To handle the first problem, we needed a device for rationing reduced supply among the demanders. The device we used was an overall increase in 2003 (relative to the base case) in required rates of return on capital in Victoria. This reduced investment and consequently the demand for output from the non-residential construction industry. We chose the increase in required rates of return so that demand for non-residential construction fell by 0.63 percent. Consequently, we assumed that none of Victoria’s stoppage-induced loss in non-residential construction output could be recovered by increased activity in the sector within the year of the stoppage. We adopted this assumption because in our base case forecast, 2003 is a year of high growth and tight capacity in the Victorian non-residential construction industry.

To handle the second problem (representation of idle labour and capital), we assumed that the stoppage causes no change in 2003 in the amount of labour and capital absorbed by the Victorian non-residential construction industry. Thus for 2003 we introduced a 0.63 percent reduction (relative to the base case) in the industry’s primary factor productivity.

In summary, we simulated the effects of a stoppage in the Victorian non-residential construction industry by introducing two shocks in 2003: an increase in required rates of return designed to reduce demand for non-residential construction services in Victoria, and a reduction in primary factor productivity in the Victorian non-residential construction industry designed to represent idle labour and capital. Both shocks were temporary. For 2004 onwards, we reset required rates of return and primary factor productivity to their base case forecast paths.

The Key Assumptions
CGE models such as MMRF can be run under many different sets of assumptions concerning the business cycle and macro- and micro-economic behaviour. The key assumptions underlying our simulation of the effects of the hypothetical stoppage are as follows.

Base Case Forecasts
The main input to the basecase forecast used in this paper is from Access Economics (2003). Access forecasts continuing strong growth in the Australian economy (between 3 and 4 percent) in four of the next five years with an average annual growth rate of 3.3 percent. The Access forecasts show particularly strong growth for non-residential construction output in 2003. As mentioned earlier, this is our justification for assuming that none of Victoria’s stoppage-induced losses in the non-residential construction industry are recovered by increased activity within the year of the stoppage. After 2003, Access’ forecast for growth in non-residential construction output in Victoria is subdued.

Public Expenditure and Taxes
We assume that the stoppage makes no difference to the paths of real public consumption and tax rates. This means that changes in government revenue
arise from stoppage-induced changes in the level of economic activity. Therefore, the stoppage alters budget balances relative to the basecase forecast. However, the simulated changes in budget balances were negligible. Consequently, we did not model fiscal responses.

**Labour Market**
We assume that workers throughout Australia are concerned with the real wage rate, that is, the average wage rate in Australia deflated by the CPI. If the labour market is hit by an adverse shock (e.g. a stoppage in the Victorian non-residential construction industry), then we assume that the immediate response is a reduction in employment rather a reduction in real wage rates. With a reduction in employment, we assume that the real wage rate declines with a lag in response to reduced worker bargaining power. The parameters of our labour market adjustment equation are set so that wage movements are consistent with a return to the base case forecast path for employment after about 3 years. This labour market assumption is consistent with conventional macro-economic modelling in which the NAIRU is exogenous. Other Australian models with exogenous NAIRUs include the Murphy Model (Powell and Murphy, 1997) and the Australian Treasury’s model (TRYM) (Taplin, et al. 1993).

**Rates of Return on Industry Capital Stocks**
In simulations of the effects of shocks, MMRF allows for short-run divergences in the ratios of actual to required rates of return from their levels in the base case forecasts. Short-run increases/decreases in these ratios cause increases/decreases in investment. Movements in investment are reflected with a lag in capital stocks. These adjustments in capital stocks gradually erode initial divergences in the rate of return ratios.

**Production Technologies**
MMRF contains variables describing: primary-factor and intermediate-input-saving technical change in current production; input-saving technical change in capital creation; and input-saving technical change in the provision of margin services (e.g. transport and retail trade). In our simulation, all these variables are held on their base case forecast paths with one exception. We capture the primary-factor-wastage effects of the stoppage in the Victorian non-residential construction industry by a temporary primary-factor-using deterioration in technology.

**Input-output Data and Behavioural Parameters**
CGE models such as MMRF make extensive use of input-output data in specifying the shares of different inputs in the costs of industries, and the shares of different users in the sales of commodities. A difficulty with CGE modelling is that published input-output data produced by statistical agencies is often outdated. In Australia, the latest input-output data published by ABS is for 1996-97. For MMRF, a considerable effort has been made to update the input-output data to 2002-03 using available statistics on macro, industry and regional variables. The updating technique, known as historical simulation, is described in Dixon and Rimmer (2002, sections 2.2 and 5). CGE models also require a vast array of parameters: e.g.,

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3 It is through this mechanism that we ration sales of non-residential construction services in Victoria (see the earlier discussion of results).
substitution elasticities between primary factors; substitution elasticities between imports and domestic products; transformation elasticities between different commodities; export demand elasticities; and elasticities of household consumption with respect to changes in prices and incomes. The parameters used in MMRF reflect econometric work carried out originally for the ORANI model and partially updated for later models such as MONASH (see Dixon and Rimmer, 2002, section 41). Fortunately, for understanding simulation results such as those presented in sections 3 and 4, it is not necessary to have a detailed knowledge of all the parameters. Simulation results can be normally understood via back-of-the-envelope explanations that draw on a few salient features of the model’s theory, database and parameter set.

3. National Results
Figures 1 to 5 show the effects of the stoppage on macro variables in Australia. With one exception, the results are percentage deviations from control (that is, the situation in the absence of the stoppage). For example, figure 1 shows that the stoppage reduces GDP in Australia by 0.0075 percent in 2003 relative to the level that would have been achieved in the absence of the stoppage. The exception is the result for the balance of trade in figure 3 which is expressed as a deviation in billions of dollars.

Figure 1 Effects of Stoppage on National GDP, Capital Stocks and Employment (% Deviation from Baseline)

Figure 2 Effects of Stoppage on Investment and Consumption: Australia (% Deviation from Baseline)
Figure 3  Effects of Stoppage on the Trade Balance and Volumes: Australia (% Deviation for Exports and Imports; $ bn Deviation for Balance of Trade)

Figure 4  Effects of Stoppage on the Real Exchange Rate and Terms of Trade (% Deviation from Baseline)

Figure 5  Effects of Stoppage on Employment and Wages: Australia (% Deviation from Baseline)
**GDP Impact**

The reduction in real GDP in 2003 of 0.0075 percent, worth about $57 million, has two main components. The first is the direct loss of effective primary factor input to the Victorian non-residential construction industry. This is about $42 million consisting of $30 million in lost labour input and $12 million in lost capital input. The second component is a reduction in national employment of 0.0033 percent, or about 300 full-time equivalent jobs. With a typical job being worth about $50,000, this amounts to approximately $15 million (=300 x 50,000).

**Employment**

The reduction in employment is explained by two factors: the switch in national expenditure away from investment and consumption towards exports and import replacement (figures 2 and 3); and the reduction in the terms-of-trade (figure 4). Both these factors will be explained shortly. Here, we explain how these factors affect employment. The switch in the composition of national expenditure reduces employment in the short run at any given wage because export and import-replacement activities are less labour-intensive than investment and consumption activities. The terms-of-trade reduction reduces employment in the short-run via the marginal product/wage relationship:

\[
MP_l(K/L) = \left( \frac{W}{P_c} \right) \left( \frac{P_c}{P_g} \right)
\]

In (1), the value of the marginal product of labour to employers, that is MP, times the price of GDP (P), is equated to the wage rate (W). By writing this relationship as shown in (1), we see that MP is the product of two ratios. The first is the real wage as seen by workers and the second is the consumer price index (P) divided by the price deflator for GDP (P). With a terms-of-trade decline, P/P increases because P includes the prices of imports but not exports, whereas P includes the prices of exports but not imports. Under our assumption of sluggish adjustment in the real wage (that is, little short-run change in W/P), an increase in P/P causes an increase in MP requiring an increase in the capital/labour ratio (K/L). Because K is fixed in the short run, L must fall.

Between 2003 and 2005, real wages fall allowing employment to return to control (figure 5). The reduction in wages reflects the stoppage-induced weakening in the labour market. Beyond 2005, when employment has returned to control, wages gradually return to control. Wages stay below control throughout the simulation period because the stoppage reduces the economy's capital/labour ratio.

**Investment and Capital Stocks**

Since virtually all sales of construction output are to investment, a stoppage in the non-residential construction sector has a marked impact on investment. Investment falls by 0.120 percent in 2003, worth about $225 million (figure 2). The reduction in investment is large relative to the direct loss of primary factor input in the Victorian non-residential construction industry ($42 million). The reduction in investment reflects not only the
loss of primary factor input but also associated reductions in intermediate inputs (e.g., building materials, machines and furnishings). In addition to the reduction in investment directly associated with the loss of non-residential construction output, there is a further reduction in investment associated with the economy-wide slowdown in employment.

Corresponding to the fall in investment in 2003, there is a fall in capital in 2004 of 0.015 percent (worth about $225 million). After 2003, investment is slightly above control, and capital gradually returns to control. With rates of return set on world capital markets (independently of stoppages in the Victorian non-residential construction industry), we would expect the economy’s capital/labour ratio to return to control. Thus with employment returning to control, we would expect capital to return to control. Because both capital and labour return to control and the inefficiency (stoppage) is eliminated, GDP returns to control (figure 1).

**The Balance of Trade**

With changes in investment at the margin being financed mainly by foreigners, a weakening of investment reduces demand for Australian currency. This causes depreciation of the real exchange rate (figure 4). The depreciation facilitates an increase in exports and inhibits imports (figure 3). Imports are also damped by the reductions in investment and GDP. The stimulation of exports causes a reduction in the terms of trade (figure 4). However, the changes in export and import volumes are sufficient for the trade balance to move towards surplus, by $0.246 billion (figure 3).

Beyond 2003, the balance of trade deviation becomes a small negative. This reflects two factors. First, Australia earns interest on foreign assets acquired with the additional trade surplus in 2003. The interest adds to disposable income and is consumed. Second, as mentioned earlier, investment is elevated above control (figure 2), thereby inducing a small real appreciation (figure 4).

**Private Consumption**

Private consumption is reduced in 2003 by 0.027 percent (about $120 million). This has three main components. The first is the direct loss of primary factor income in the Victorian non-residential construction industry, $42 million. The second is the reduction in economy-wide employment, $15 million. The third is the terms of trade effect. As is shown in figure 4, the terms of trade fall in 2003 by 0.036 percent. With Australia’s exports in 2003 being forecast at $168 billion, a terms-of-trade fall of 0.036 percent is equivalent to a loss in disposable income (and therefore consumption) of $60 million (=168x0.00036x1000).

By 2006, when employment has returned to control, consumption moves slightly above control (figure 2). Consumption stays above control throughout the rest of the simulation period, even though physical capital and hence GDP (figure 1) stay below control. Having physical capital and GDP below control does not reduce consumption because corresponding to the loss in physical capital, Australia has a compensating accumulation

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4 The increase in exports requires movements down foreign demand curves with resulting reductions in foreign currency prices of Australia’s exports.
of foreign financial capital. Once employment has returned to control, we might expect consumption to return to control. The slight positive deviation in consumption is explained by the positive deviation in the terms of trade associated with catch-up investment (and the resulting real appreciation and reduced exports).

In present-value terms (using a discount rate of 6 percent), the deviations in consumption from 2003 to 2014 are worth -$93 million. Most of this ($57 million out of $93 million) is explained by resource wastage in Victoria’s non-residential construction industry ($42 million) and by additional unemployment ($15 million) in the first year. Beyond the first year, there are further losses from unemployment. The terms of trade also makes a negative present value contribution, with the loss in 2003 being only partially offset by the gains thereafter.

4. Regional Results

Figures 6 and 7 give results for Victoria and the rest of Australia. Employment in Victoria is reduced in 2003 by 0.162 percent or 3900 full-time equivalent jobs (figure 6). In the rest of Australia, employment rises by 0.051 percent, or 3600 full-time equivalent jobs (figure 7).

Figure 6  Effects of Stoppage on Victoria’s Income, Employment and Capital Stocks (% Deviation from Baseline)

Figure 7  Effects of Stoppage on Rest of Australia’s Income, Employment and Capital Stocks (% Deviation from Baseline)
The stoppage reduces Victoria’s competitiveness by causing cost increases. The rest of Australia gains from reduced real wages without offsetting losses in efficiency. In effect, resources flow from Victoria to the rest of Australia. This does not necessarily require physical movements of people. It is consistent with unemployment rising in Victoria and falling in the rest of Australia.

In 2004, Victoria finds itself with lowered real wages and a shortage of capital. With the elimination of the inefficiency (the stoppage), the ratios of actual to required rates of return increase in Victoria, causing a strong recovery in investment. Catch-up investment in 2004 causes Victorian employment to move above control by 0.09 percent or 2160 jobs. Beyond 2004, Victorian employment returns approximately to control. Overall, Victoria experiences an employment loss of about 1740 person-years. This is made up of 3900 jobs lost in 2003 with a partial offset of 2160 jobs gained in 2004.

5. Concluding Remarks

In this paper, we have shown how a dynamic CGE model can be used to provide estimates of the economic effects of industrial stoppages. These estimates could be used in broad discussions of the contribution to economic welfare of improved industrial relations. They could also be used in narrowly focussed discussions. As suggested in the introduction, we see a potential role for dynamic CGE analysis in providing estimates of economic damage associated with specific stoppages. Such estimates could be relevant to the Australian Industrial Relations Commission in relation to section 170MW(3) of the Workplace Relations Act.

In illustrating the application of dynamic CGE analysis, we simulated the effects of a hypothetical stoppage in the Victorian non-residential construction industry. The stoppage was specified as causing direct wastage of $42 million through idle labour and capital. The main features of the results are as follows.

- The Australia-wide welfare loss ($93 million) from the stoppage is slightly more than twice the direct wastage ($42 million).
- The stoppage causes short-run employment losses outside the Victorian non-residential construction industry.
- By reducing investment in the short run, the stoppage has a negative impact on the real exchange rate. This has a short-run positive effect on exports, but causes a loss in welfare through a decline in the terms of trade.
- Most of the unfavourable effects of the stoppage occur in the year of the stoppage. However, national employment remains below its base-case forecast path for several years.
- In the year of the stoppage, Victoria (the state in which the stoppage occurs) suffers a considerable loss in employment. In other states, there is an increase in employment.
- In the year following the stoppage, the regional employment situation is reversed. Victoria benefits from an employment increase reflecting catch-up investment, while employment in other states falls.
All these results depend on: (a) the details of the assumed scenario; (b) the key macro assumptions; and (c) the base case forecasts. This is a strength of dynamic CGE modelling. It means that CGE analyses used, for example, to provide evidence for the Australian Industrial Relations Commission could capture relevant details of particular circumstances. In the application described in this paper, it matters for the results that the stoppage is in an investment-related industry, namely non-residential construction. By reducing investment the stoppage has effects on the real exchange rate, exports, imports and the terms of trade. It matters for the results that we assume sluggish adjustment in real wage rates. Under this assumption, shifts in the composition of national expenditure and reductions in the terms of trade cause short-run declines in aggregate employment. Finally, it matters for the results that the base case forecast exhibits very strong growth in non-residential construction output in 2003. This makes it reasonable to assume that stoppage-induced losses in non-residential construction output will not be recovered by increased activity in the sector in the year of the stoppage.

While CGE analysis could potentially provide forecasts of economic damage, it cannot answer all the questions relevant to an Australian Industrial Relations Commission hearing concerned with section 170MW(3). In acting on this section, the Commission would need to decide how much damage is “significant damage” and how much of the economy is “an important part of it”. The Commission would also need to take a position on inter-regional movements of labour and capital. As our modelling shows, an income loss in one region associated with an industrial action may be alleviated by income gains in other regions.

References
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