Industry Productivity and the Victorian Economy

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Paper presented to the
Regional Modelling Workshop

16-17 September 2004

1 Introduction

In this paper we examine the economy-wide impacts of industry specific productivity improvements. We attempt to identify the various factors and channels that enhance or reduce the economy wide impacts from a given productivity shock.

To examine industry specific productivity improvements computable general equilibrium (CGE) modelling is used in the form of the Victorian Department of Treasury and Finance version of the MMRF-GREEN model developed by the Centre of Policy Studies at Monash University. For the analysis, we separately examine the economy-wide impact of a 10 per cent improvement in the productivity of primary factors used in most Victorian industries identified in the model. This allows us to identify the relative impacts of a given (percentage) productivity improvement for Victoria as a whole and for different sectors within the Victorian economy.

We are specifically interested in determining which features or characteristics of industries (including their relationship with the rest of the economy) result in relatively large effects on GSP and per capita GSP. The distinction between a change in the size of the economy (GSP) and average living standards (per capita GSP) is important and will be emphasised throughout this chapter. These two measures respond differently to productivity improvements, because of the influence of different factors.

2 The MMRF-GREEN model

The distinguishing characteristic of the MMRF-GREEN model is that each state and territory economy is modelled individually with explicit recognition of interstate trade flows and economic variables determined nationally (such as the exchange rate). Economic shocks, including changes to underlying productivity in specific industries, can be applied to individual States. This contrasts with CGE models employing a "tops-down" approach in which economic shocks can only be applied to industries at the national level and which apportion the national impact to each State and Territory.

In the Victorian Department of Treasury and Finance version of MMRF-GREEN the 32 industry sectors identified in the model can produce a variety of products. Capital is sector- and state-specific. There is a representative household for each region. There is a federal government and eight state and territory governments. Finally, there are foreigners, whose behaviour is summarised by demand curves for international exports and supply curves for international imports. Further details on the MMRF-GREEN model can be found in Adams (2001).

The simulations used in this chapter are a stylised representation of the impact of productivity improvements. For illustrative and exploratory purposes, the modelling assumes that the productivity improvements occur in each Victorian industry in isolation. A 10 per cent increase in primary factor productivity (that is, land, labour and capital productivity) is chosen: the magnitude of the increase is arbitrary.

The modelling assumes a 10 per cent productivity improvement in Victoria relative to the other States and Territories and the rest of the world. Each simulation is long run in the sense that there is sufficient time for industry capital stocks to fully adjust to the productivity improvement. National employment is unchanged in the long run, but state employment (and population) levels can change in response to changes in the demand for labour by each industry. Employment is assumed to adjust across occupations, industries and states to equalise relative wage rates following a productivity improvement. Details of the standard long-run comparative static closure can be found in Adams (2001). Given the comparative static approach to the modelling, the results can be interpreted as providing a snapshot of differences between the Victorian economy with and without a productivity improvement in an industry, after the adjustments described above have been completed.

The productivity improvements do not rely on any form of fiscal support by the public sector (in the form of additional subsidies or taxation concessions), nor are they embodied in building or equipment in which the industry must invest. They could be characterised, for example, as organisational improvements, process innovations, technological advances applicable to existing physical capital, or the removal of regulatory or other impediments to productivity.

In the model, proportional changes in statewide labour productivity can be interpreted as changes in GSP per employed person or as changes in GSP per hour worked, because the model does not distinguish between numbers employed and hours worked as measures of labour input. Also, because state population levels respond to changes in state employment, there is no difference in the model between the response of GSP per employed person and per capita GSP.

Industry capital is not perfectly substitutable in the modelling approach adopted here. An increase in the stock of capital in one industry, relative to others, is associated with a permanent increase in the risk-adjusted required rate of return for investment in the industry, and needs to be matched by an increase in the expected rate of return to capital in the industry. Compared with an assumption of perfect substitutability of capital, this assumption tends to reduce the extent to which capital stocks adjust across industries in response to a productivity improvement in one of them. It does not affect the general conclusions drawn from the model results.

In each simulation conducted, the public sector budget balance of Victoria and the other States and Territories (as well as the Commonwealth Government) is determined within the model. Government spending has been assumed to move in line with overall GSP, assuming government services to be broadly proportional to the size of the relevant economy. Taxation rates are unchanged.

3 Conceptual issues

3.1 Industry level effects

Figure 1 traces out the key long-run impacts on a specific Victorian industry (industry 1) from an increase in primary factor productivity in that industry as treated by the MMRF-GREEN model.

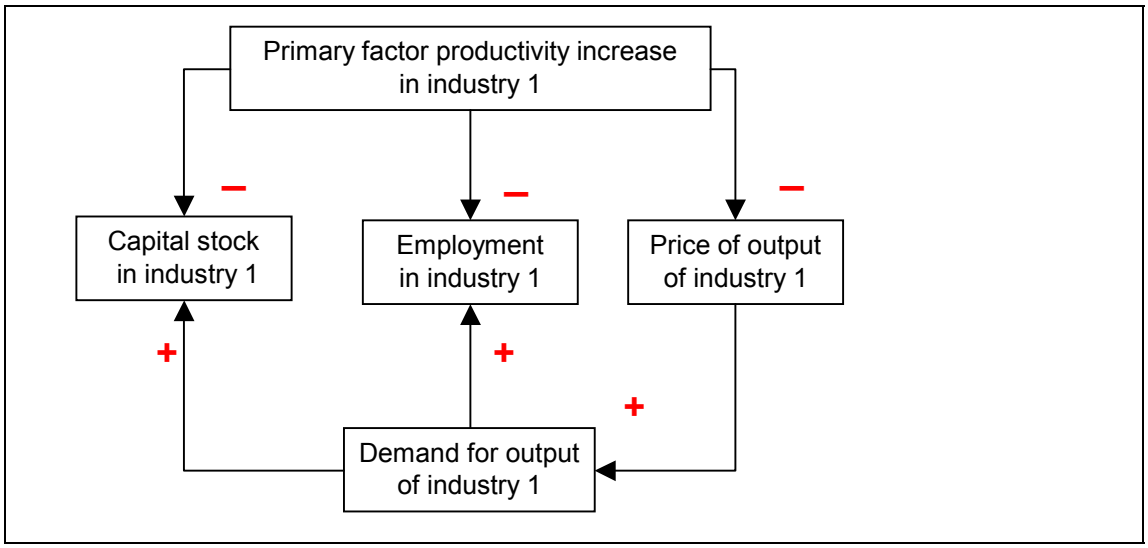
While the industry productivity improvement will reduce the industry demand for labour and capital (given the level of industry output), it should also contribute to a decline in the price of the industry's output, encouraging an increase in demand and output. It is unclear whether employment and capital stocks in the industry will rise or fall following a primary factor productivity improvement.

3.2 Economy-wide effects

Per capita GSP effects

Figure 2 illustrates some of the key economy-wide effects of an improvement in primary factor productivity in a specific Victorian industry (industry 1) on the state economy.

Figure 1 Direct or industry impacts of productivity improvement in industry 1 in Victoria



The direct impact of the industry productivity improvement is to increase output per employed person in industry 1, directly increasing GSP per employed person. The magnitude of this effect will depend on the size of industry 1 relative to the Victorian economy as a whole. This is the relationship shown in bold in Figure 2.

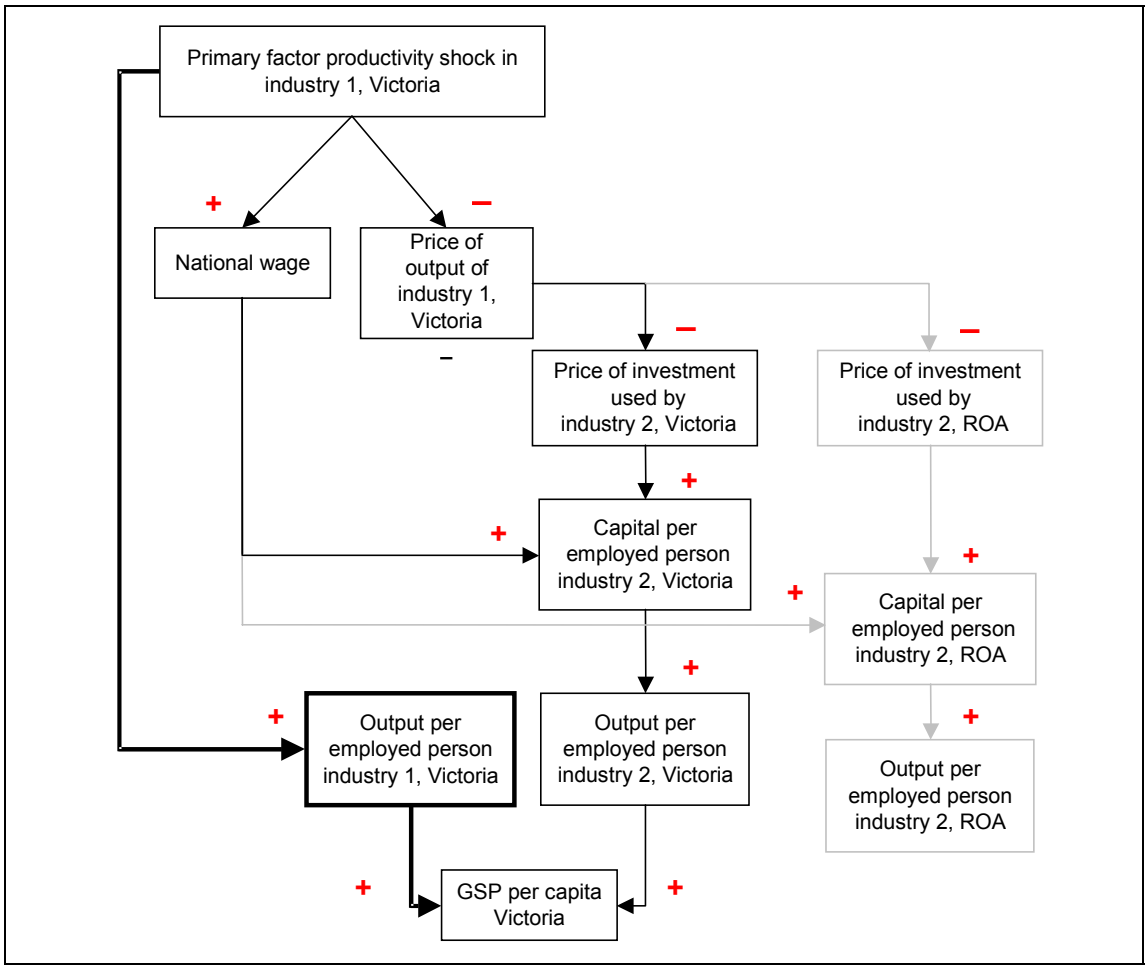
There is also potential for indirect effects through two broad channels in Figure 2. First, the national real wage will increase in response to a productivity improvement. National employment is assumed to be unchanged in the long run and relative wages are unchanged, so the benefits of higher productivity ultimately flow to all employed labour. Second, the decline in the price of output of industry 1 will also have indirect effects, for example, if industry 1 is a supplier of goods or margins (activities that facilitate trade, such as wholesale trade or road transport) associated with investment. In Figure 2, it is assumed that good 1, produced by industry 1 in Victoria, is used in industry 2 in Victoria and the rest of Australia (ROA) as an input to the production of investment goods (buildings, equipment, computer software and the like). A productivity improvement in industry 1 makes possible reductions in the price of good 1 and the price of investment goods used by industry 2.

Lower prices for investment goods are associated, in the long run, with a reduction in the cost of capital in industry 2. Combined with an increase in the wage rate, this will contribute to substitution of capital for labour in industry 2. An increase in capital per employed person in industry 2 can be expected to induce an increase in output per employed person in industry 2.

In Victoria, the overall impact on per capita GSP will comprise the combined effects of the direct impact on industry 1 and the indirect effects on industry 2. In the rest of Australia, where the linkages are shown in Figure 2 in grey lines, the effects will be confined to those on industry 2.

There may be further indirect effects on per capita GSP arising from the inter-industry linkages in the model, and from the macroeconomic impacts of the productivity improvement on other relative prices. However, the channels described in Figure 2 can be expected to be the primary means by which the productivity improvement affects per capita GSP in Victoria and other States.

Figure 2 Economy wide impacts on per capita GSP from productivity improvement in industry 1 in Victoria



In summary:

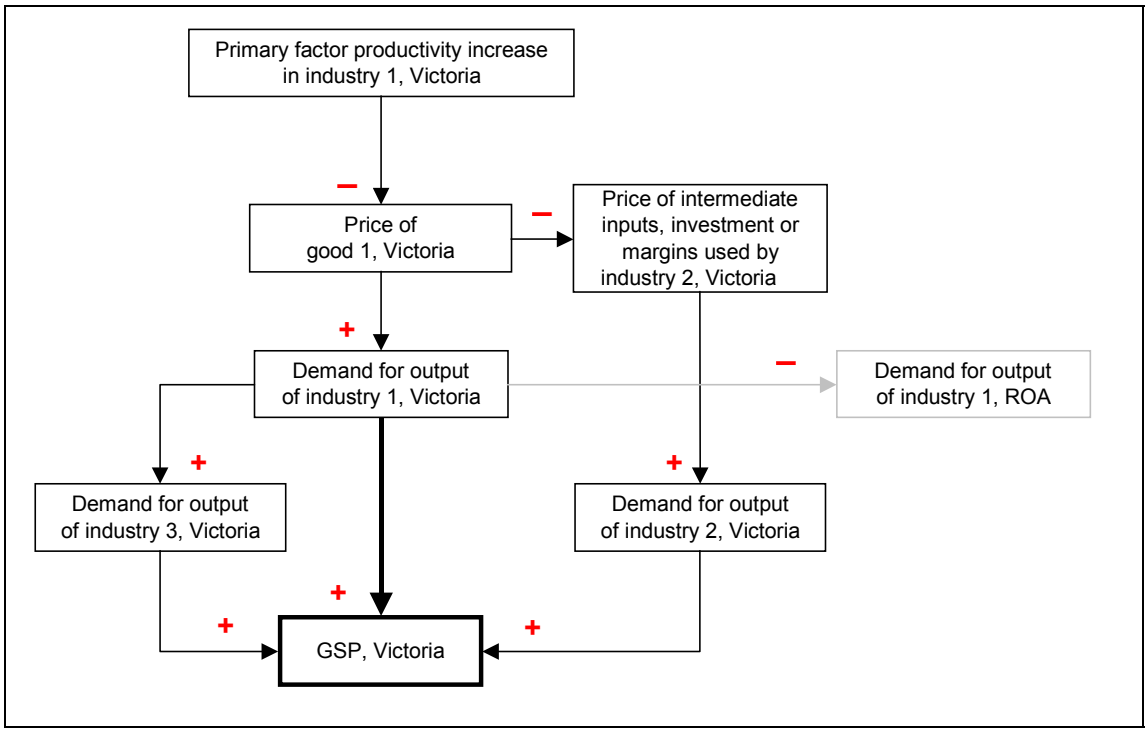
- The impact on per capita GSP of a given productivity improvement in an industry will be related to the size of the industry.
- A Victorian industry productivity increase can be expected to raise the national real wage, as labour is the fixed factor of production (at the national level in the long run in the model).
- Industry productivity improvements that lead to reductions in the cost of capital are likely to have additional second-round effects on capital and output per person.

GSP effects

There will also be an impact on the size of the state economy (measured by GSP). These are traced through Figure 3.

As described in Figure 1, an increase in primary factor productivity in industry 1 in Victoria can be expected to reduce the price of the output of that industry and increase demand for it. The extent of the increased demand will depend on the own-price elasticity of demand for the output. There will be substitution from other goods in production and consumption but, more importantly for GSP, there will be substitution from the same industry interstate and overseas. The expansion in the production of industry 1 will have a direct impact on GSP (shown in bold in Figure 3) depending on the size of the demand response and the relative size of industry 1.

Figure 3 Economy wide impacts on GSP from productivity improvement in industry 1 in Victoria



The output of industry 1 may be used by industry 2 in Victoria as an input in its own production (as an intermediate input or a component of investment) or it may be a margin industry that facilitates trade (such as wholesale and retail trade and road transport). The cost reduction made possible for industry 2 will have indirect expansionary effects on GSP in Victoria. In addition, increased demand for the output of industry 1 will increase its demand for intermediate inputs from industry 3. The magnitude of these effects will be related to the size of industry 1.

Reduced costs in Victoria will raise real incomes in the State, contributing further indirect effects to GSP. The expansion of incomes, employment and population in Victoria can be expected to draw resources away from other States. These income effects are likely to be greater when the productivity improvement occurs in a larger industry.

There will be substitution away from the demand for the output of industry 1 in the rest of Australia (ROA) because it is now relatively more expensive, and likewise for industry 2. However, the overall outcome for GSP in other States is unclear because the expansion in income in Victoria will contribute to increased imports of other goods and services from interstate.

In summary:

- The direct effects of an industry productivity improvement are to increase the industry's competitiveness and expand demand for its output, thereby increasing GSP.
- Cost reductions may flow through to other industries, through lower intermediate input prices, lower capital costs or reduced margins, enabling them to reduce prices and increase output. The expansion of the more efficient industry may increase its demand for intermediate input from supplier industries.
- Reduced costs will raise real incomes in Victoria, adding further to GSP and drawing resources away from other States.
- The magnitude of these indirect effects will depend on the size of the industry.

4 Model results: per capita GSP

As previously mentioned, the MMRF-GREEN model was used to illustrate the relative importance of these issues. Chart 1 shows the estimated impact on long-run Victorian per capita GSP, from a 10 per cent improvement in primary factor productivity in each selected industry[1]. The industries are grouped into four broad categories: (a) resources, (b) manufacturing, (c) infrastructure and (d) commercial services.

The modelling indicates that a 10 per cent primary factor productivity improvement in trade/hotels or financial/business services would increase Victorian per capita GSP by 2.6 per cent in the long run. A similar increase in construction productivity would increase Victorian per capita GSP by 2.0 per cent.

In Chart 1, the per capita GSP impact for each industry is divided into a “direct” and “indirect” impact.

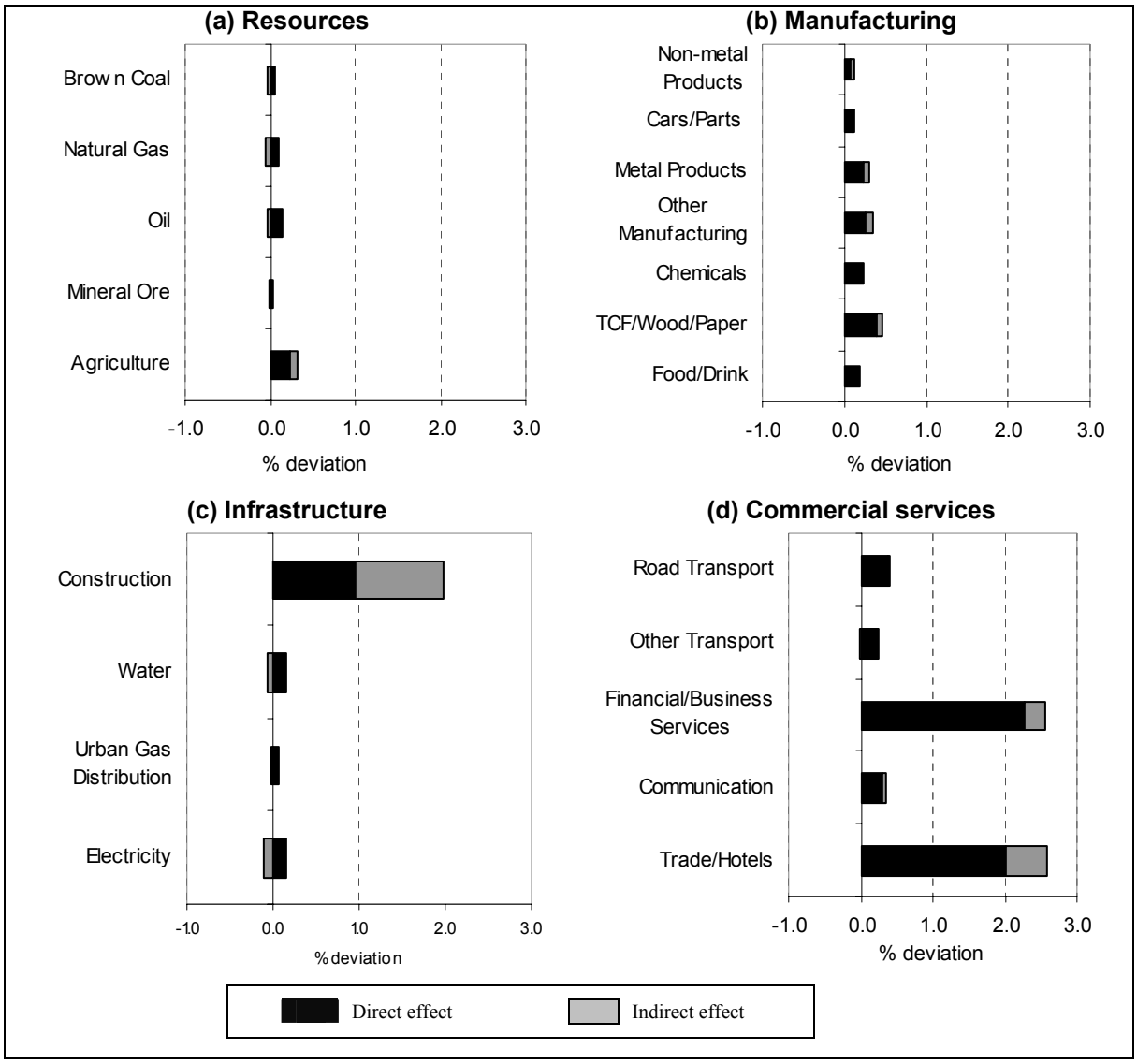
The direct impact is analogous to the bold lines in Figure 2. It is equal to the change in industry value added per employed person multiplied by the industry share of GSP. In general, it will be proportional to the relative size of the industry. For example, the largest direct effects are for the largest industries (financial/business services, trade/hotels and construction).

The indirect effect is the difference between the total effect and the direct effect. It represents the impact on per capita GSP from changes in the value added per employed person of all other industries. Large indirect effects are also evident for the larger industries. However, some industries appear to generate disproportionately large indirect effects, especially construction, trade/hotels, financial/business services and some manufacturing industries. This reflects the role of these industries as suppliers of investment goods, or of margins associated with investment goods, as described by the thin lines in Figure 2.

Productivity improvements in construction, financial/business services and trade/hotels are all associated with sizeable reductions in the cost of investment, with strong flow on effects to other Victorian industries. Construction represents about 60 per cent of the average cost of investment goods in Victoria. Financial/business services are a large industry (so indirect effects are greater) and represents about 4 per cent of the average cost of investment. Trade/hotels is also a large industry, and much of its output takes the form of margins (wholesale and retail trade), including on investment goods.

[1] Industries such as dwellings and private transport services, which represent the services of housing and vehicles to households, and the “other services” industry, which represents mainly public administration, health and education, have been excluded from the analysis. For electricity, only results for brown coal generated electricity are presented which, in the model database, represents over 90 per cent of all Victorian electricity generation.

Chart 1 Direct[(a)] and indirect[(b)] effects on per capita Victorian GSP from a 10% productivity improvement in each industry



Source: MMRF-GREEN simulations

Notes: *(a) Effect on Victorian GSP per capita from changes in value added per employed person of specified industry from 10 per cent improvement in primary factor productivity in specified industry.*

(b) Effect on Victorian GSP per capita from changes in value added per employed person of all other industries from 10 per cent improvement in primary factor productivity in specified industry.

Smaller industries with relatively large impacts on the cost of investment goods, for a given productivity improvement, include:

- industries supplying margins on investment goods;
- major suppliers of the construction industry (non-metal and metal products, TCF/wood/ paper and other manufacturing); and
- industries supplying a significant proportion of investment, such as other manufacturing (14 per cent).

Increases in the prices of investment goods in other States such as NSW are particularly evident for trade/hotels, financial/business services and construction. These increases reflect the model's use of the national consumer price index (CPI) as the numeraire price in the model: to ensure all prices are consistent with an unchanged CPI, the price declines in

Victoria must be matched by price increases in other States. The relative price changes (for each industry) are more relevant to the size of the indirect effects in each State.

The impacts of productivity improvements in the trade/hotels, financial/business services and construction industries on other Victorian industries are examined more closely in Chart 2. In each case, the direct impact on productivity in the industry experiencing the productivity improvement is immediately evident. The indirect impacts are broadly similar for each productivity shock:

- There are substantial indirect increases in labour productivity in the resources sector (mineral ores, oil, natural gas and brown coal) and in the utilities sector (electricity generation from brown coal, electricity supply, urban gas distribution and water). This may reflect the capital-intensity of production in these industries.

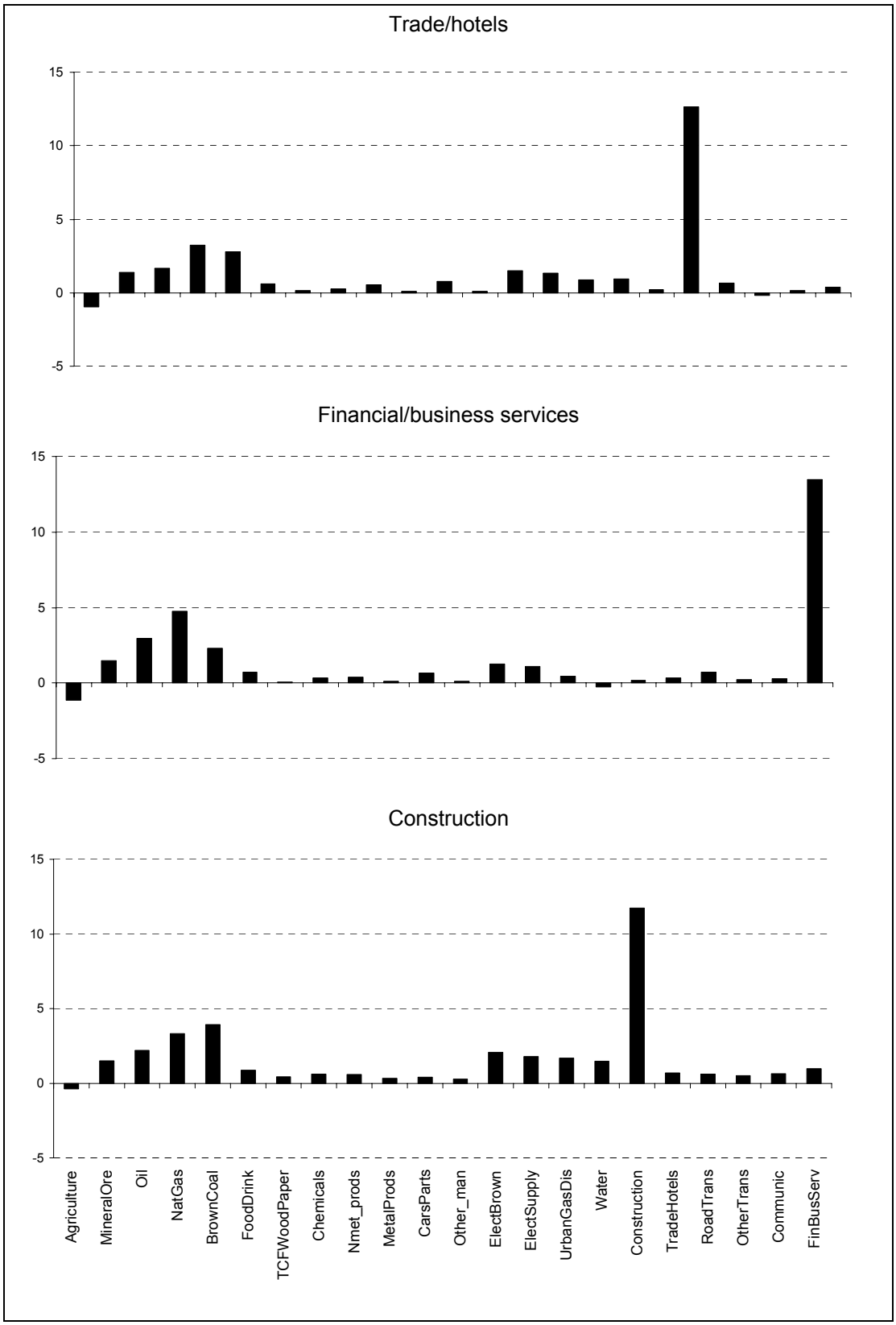
- Indirect impacts on labour productivity in the manufacturing and services sectors are relatively small.

- Labour productivity in agriculture declines. With land in fixed supply, there needs to be a larger increase in both capital and labour to achieve a given increase in output in this industry.

- Indirect labour productivity effects in other States (not shown) are relatively minor. Therefore, the interstate channel of influence shown in Figure 2 appears to be comparatively weak.

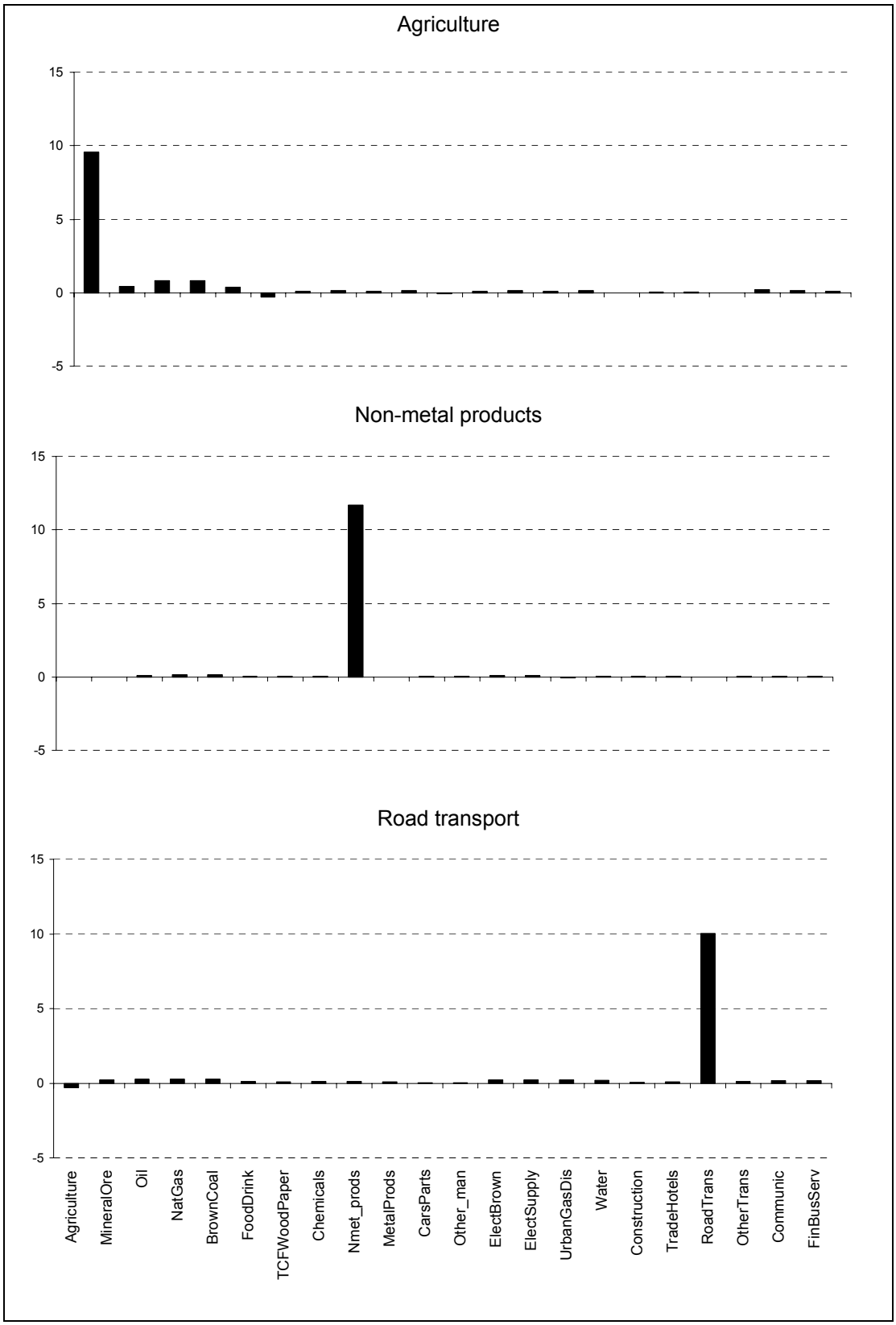
Other industries are much too small to have significant indirect effects on labour productivity in other industries. Chart 3 shows that indirect effects are quite small for agriculture, non-metal products and road transport.

Chart 2 Impact on industry labour productivity in Victoria from a 10% productivity improvement in trade/hotels, financial/business services and construction (% deviation)



Source: MMRF-GREEN simulations

Chart 3 Impact on industry labour productivity in Victoria from a 10% productivity improvement in agriculture, non-metal products and road transport (% deviation)

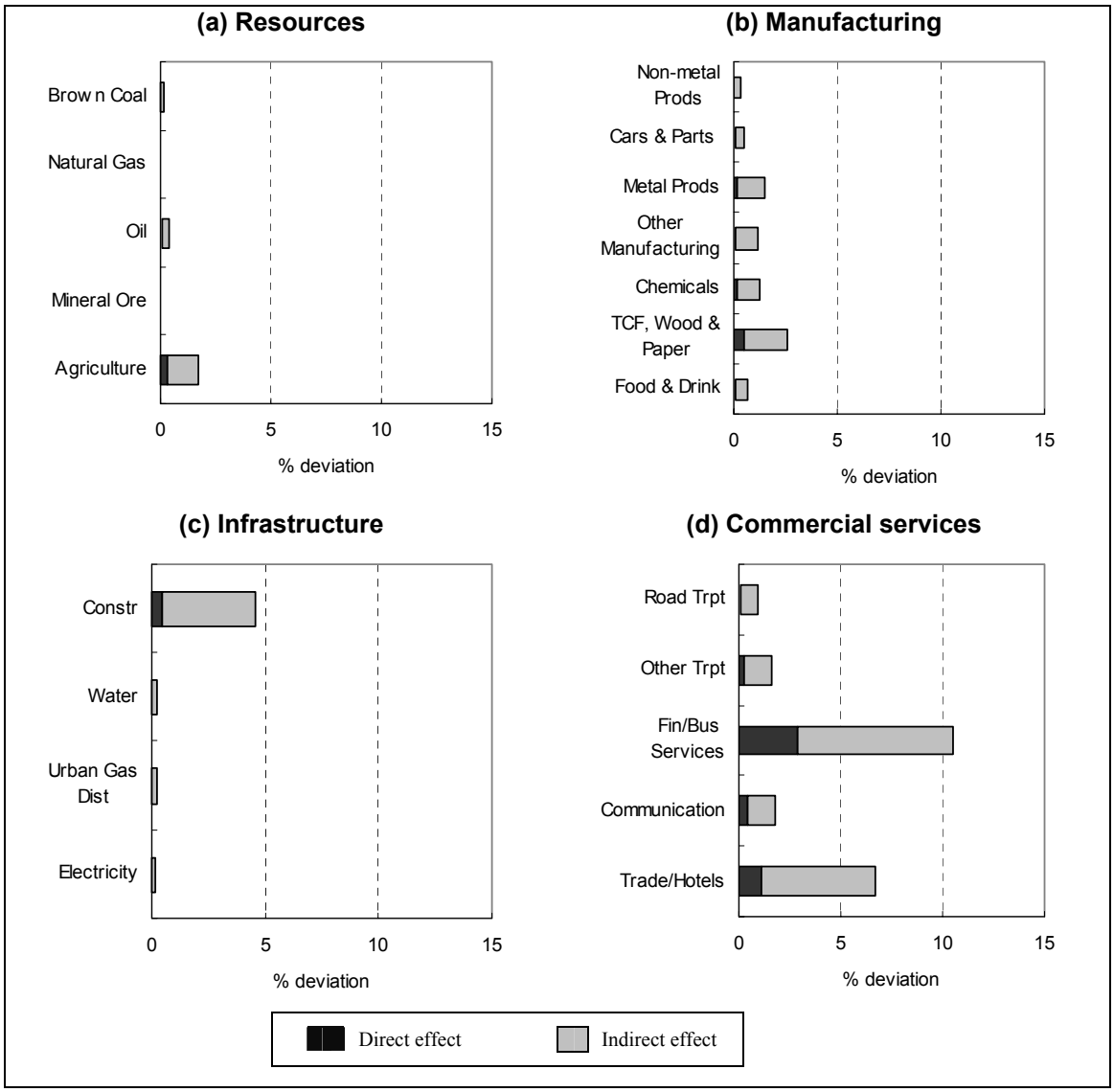


Source: MMRF-GREEN simulations

5 Model results: GSP

Chart 4 shows, for a 10 per cent improvement in primary factor productivity in each selected industry, the estimated "direct" and "indirect" effects on long-run Victorian GSP. These effects are defined analogously to Chart 1 dealing with per capita GSP. The "direct" effect is the empirical counterpart to the bold line in Figure 3.

Chart 4 Direct[(a)] and indirect[(b)] effects on Victorian GSP from a 10% productivity improvement in each industry



Source: MMRF-GREEN simulations

Notes: (a) Impact on Victorian GSP from changes in value added per employed person of specified industry from 10 per cent improvement in primary factor productivity in specified industry.

(b) Impact on Victorian GSP from changes in value added per employed person of all other industries from 10 per cent improvement in primary factor productivity in specified industry.

In contrast to the impact on per capita GSP, where direct effects tended to dominate, indirect effects are much more important in the case of impacts of GSP. In all industries shown in Chart 4, the indirect effect is dominant.

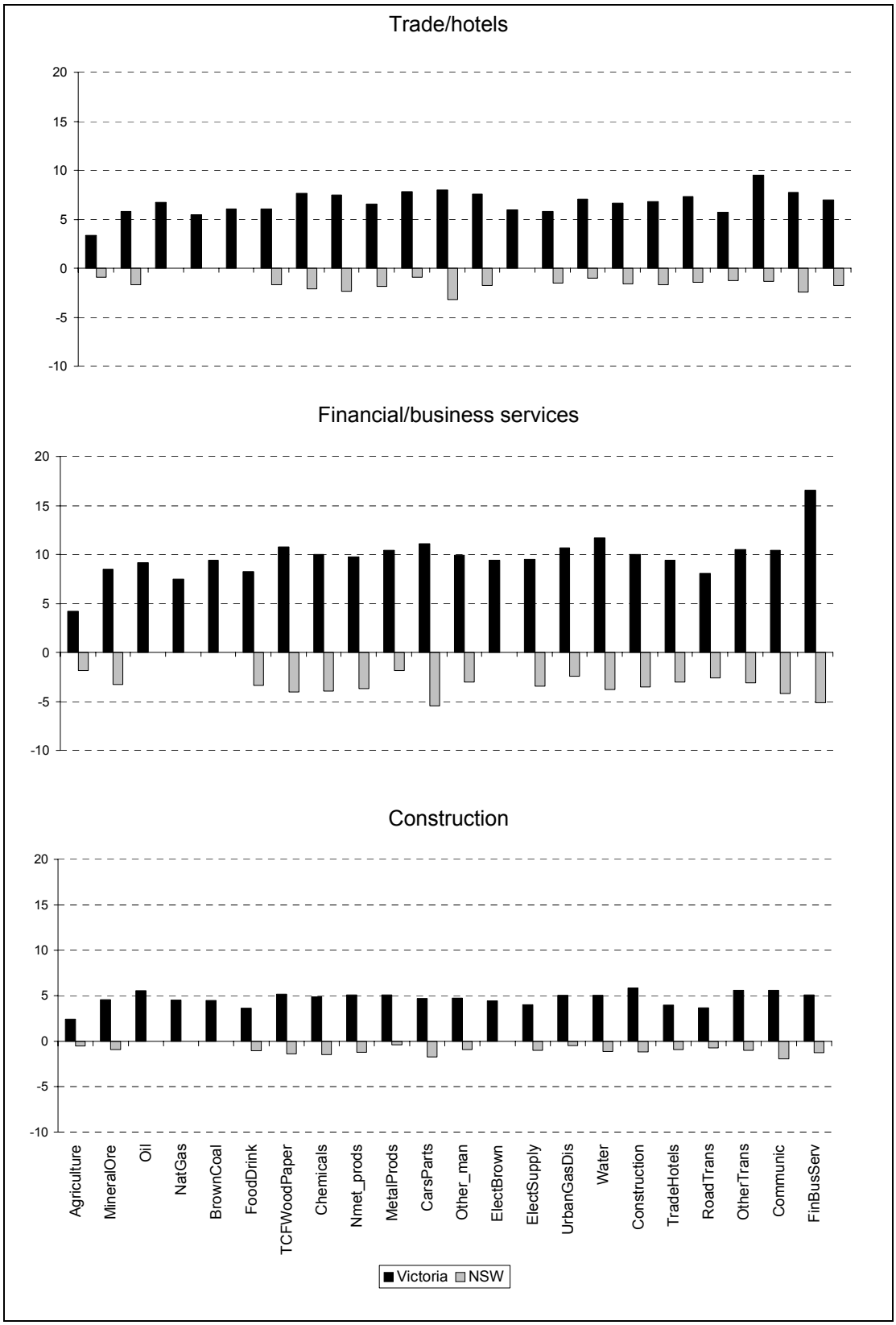
Large indirect effects on Victorian GSP are recorded for financial/business services, trade/hotels and construction, again reflecting the size of these industries and the impact of productivity improvements in them on the cost of capital, intermediate inputs and margins, and on incomes in Victoria. The pervasive nature of productivity increases in these industries

on the size of other Victorian industries is shown in Chart 5. They are also sufficient to draw resources away from corresponding industries across the board in NSW (and other States not shown).

Chart 6 shows that a similar effect is evident in the much smaller road transport industry, where a productivity improvement serves to reduce distribution costs for all industries throughout Victoria. Around 70 per cent of the output of the road transport industry involves adding margins to the output of other industries in Victoria. These effects are less apparent for other transport, where only 18 per cent of output is used as a margin by other industries, or in the communications industry. In these last two industries, the direct effect of the value added increase on the industry experiencing the productivity improvement is much larger, in relative terms.

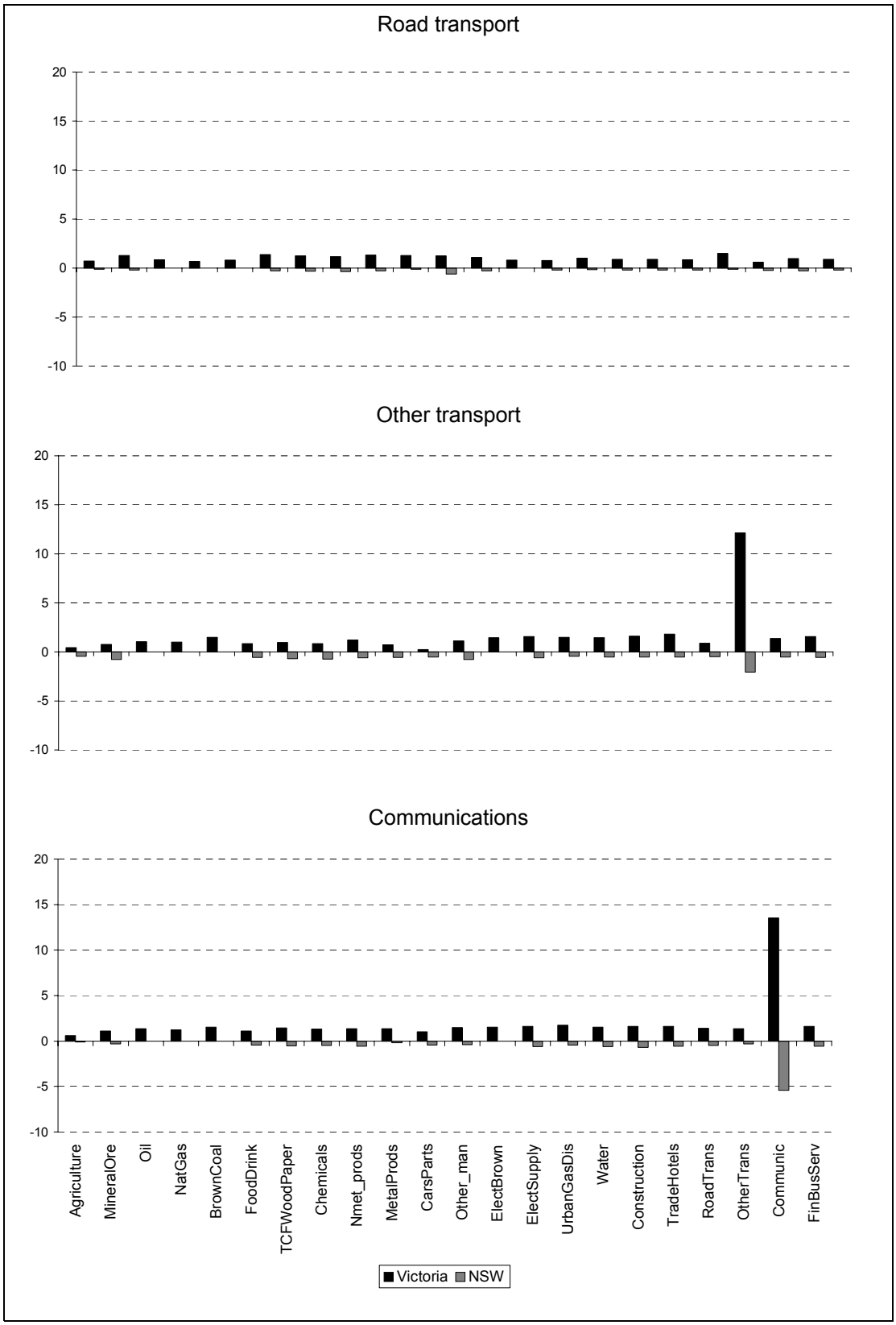
Chart 7 shows that a productivity improvement in agriculture can increase output in several industries using its output, especially food/drink manufacturing. Similarly, a productivity improvement in electricity generation reduces costs and raises demand for electricity supply as well as for brown coal. Finally, there is a relatively small indirect effect on demand for other industry output following a productivity improvement for non-metal products, despite its use in the construction sector.

Chart 5 Impact on industry value added in Victoria and NSW from a 10% productivity improvement in trade/hotels, financial/business services and construction (% deviation)



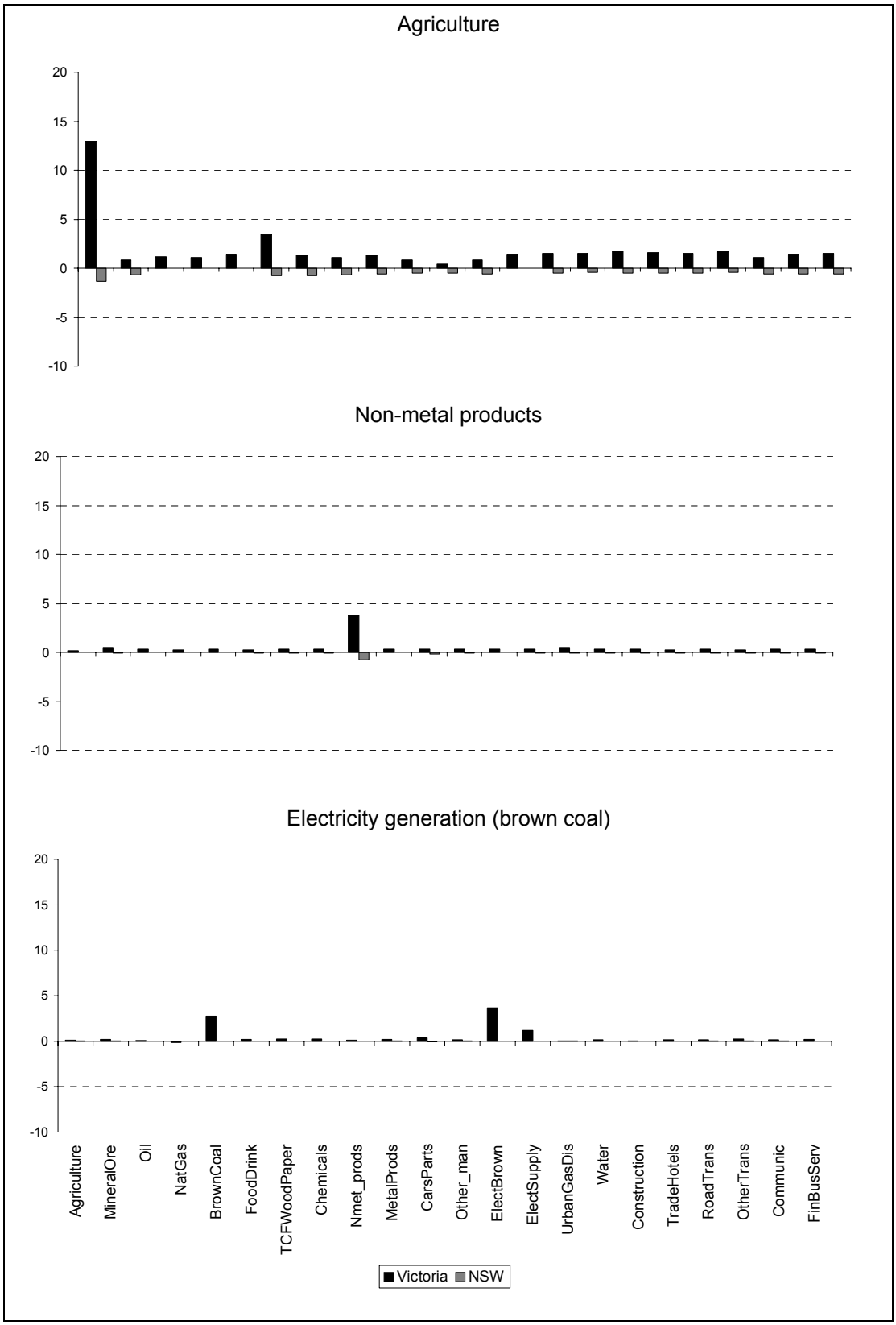
Source: MMRF-GREEN simulations

Chart 6 Impact on industry value added in Victoria and NSW from a 10% productivity improvement in road transport, other transport and communications (% deviation)



Source: MMRF-GREEN simulations

Chart 7 Impact on industry value added in Victoria and NSW from a 10% productivity improvement agriculture, non-metal products and electricity generation (% deviation)



Source: MMRF-GREEN simulations

6 Interstate improvements in productivity

The earlier results considered the economic impacts when an improvement occurs in one Victorian industry without the same industries in other Australian states also experiencing any improvement. We relax this assumption by considering the impact on the Victorian economy of an Australia-wide 10 per cent productivity improvement in each of a few selected industries. Three industries for which such a productivity improvement may apply are agriculture, trade/hotels (which includes retail trade) and financial/business services.

Chart 8 compares the impact for Victoria of a nationwide 10 per cent productivity improvement in these industries, against the case where the improvement only occurs in the Victorian industry. In all cases, Victoria experiences a much smaller boost to real GSP when the productivity improvement occurs across Australia. When the productivity gain is exclusive to Victoria, Victorian industry gains at the expense of the equivalent interstate industries, attracting both capital and labour (population) from interstate. However, when the productivity gains are nationwide Victoria does not attract labour and capital from interstate. The impact on aggregate labour productivity is largely independent of whether or not the improvement in productivity is confined to Victoria.

7 Limitations of the analysis

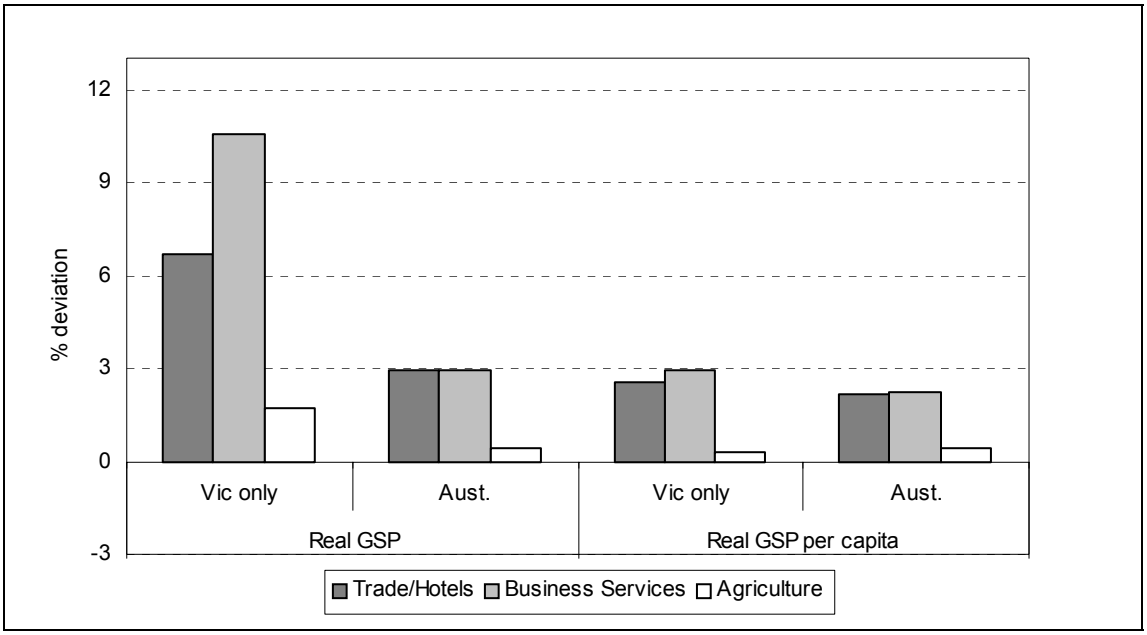
The empirical CGE modelling results presented in this chapter are necessarily conditioned by the assumptions and database used in the model. The database used in this exercise is based on inter-industry and commodity flows from 1996-97. The database does not give sufficient weight to several developments since then, including the growth of the national electricity market and increased interstate trade in natural gas. Therefore, the results for these, relatively small, industries, may be less reliable.

The results are also sensitive to assumptions concerning the substitutability of commodities between domestic, interstate and international sources.

It is worth reiterating that the long-run model assumptions used here mean that unemployment and participation rates do not change, and that adjustments to employment arising from a productivity increase are met by changes to state population levels through interstate migration. The modelling is silent about the adjustment path the economy follows to achieve its new long-run equilibrium following each productivity improvement.

Therefore, the modelling results presented here should be viewed as a means of gaining further insights into some of the major channels by which productivity improvements benefit the economy. It is inappropriate to place too much weight on the precise numerical results.

Chart 8 National industry productivity improvements — Victorian and national impacts



Source: MMRF-GREEN simulations.

8 Bibliography

Adams, Philip D. (2001), "MMRF-GREEN: A dynamic multi-regional applied general equilibrium model of the Australian economy, based on the MMR and MONASH models," Draft documentation, Centre of Policy Studies, Monash University, Melbourne.