Globalization, Commodity Prices and Wage Dynamics: Some results from a Dynamic CGE Model

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Abstract

We describe a multi-sector dynamic trade model of a three region economy, Australia, the USA and the Rest of The World. The model is used to asses the impact of manufacturing expansion in developing economies such as China and India. Specifically we consider the consequences of falling world prices in "low-tech" and intermediate manufactured goods sectors on factor returns and in particular, the relative wages of skilled and unskilled workers in Australia and the USA. The results show: (i) that short run and long run effects on wages are very different; (ii) that the path of relative wages between skilled and unskilled workers is non monotonic over the transition following external price shocks, and; (iii) that in Australia, contrary to the conventional wisdom, skilled wages tend to relative to unskilled wages.

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1 Australia and Global Trends

Reductions in trade barriers and the opening of countries such as China and India have bought significant changes to the world economy. Standard trade theory tells us that falling world prices should bring about gains to consumers, and substantial evidence suggest that trade liberalization and past episodes of globalization were responsible for dramatic increases growth. It is also well understood, however, that these gains can only be realized if economies can adjust. Changing commodity prices reduce alter factor returns through Stolper-Samualson effects. Likewise Rybczynski effects indicate that these changes effect the long run structure of the economy as well, with import competing industries downsizing to accommodate expanding demand for resources and employment from export sectors. In particular in relatively wealthy countries, increasing import competition over the last two decades has been argued to place downward pressure on wages of low-skilled workers, while raising the returns to skilled workers.

A third aspect of globalization stems from the political costs of structural adjustment and changes in income distribution, is the possibility that governments may respond by reversing current policy trends and increasing protection. In particular increasing protection levels featured heavily in the last US presidential election, and tends to gain support from a wide segment of society including charities, religious leaders, unions and the environmental lobby. Likewise the lack of progress in the Doha round of Multilateral negotiations is indicative of these pressures, with developing countries having born the brunt of Uruguay tariff reductions, and Japan, the USA and Europe, unable to commit to reducing remaining high levels of protection in their agricultural sectors.

As a small open economy, Australia is potentially highly exposed to changes in the global economy. Indeed much of the recent impetus to sign regional trade agreements can be seen as insurance against future anti-globalization sentiment in important trading partners, such as the USA, and ensure future markets in Asia. Other potential policy

options that have been discussed include raising savings rates, investing in education and further microeconomic reforms.

In this paper we access the potential impacts of some of these scenarios using a use a multi sector dynamic general equilibrium model. Our model incorporates aspects of trade and growth theory and is particularly suited to exploring the relationship between factor accumulation and international trade.

2 The Trade-Wages Debate

Historical evidence suggests that trade-liberalization in the past was responsible for dramatic increases growth rates and income levels. These gains however can only be realized if economies can adjust, factor returns and sectoral outputs. Thus episodes of Globalization have also been associated with also rapid changes in prices and factor returns. In recent decades successive reductions in trade barriers and opening-up of a number of East Asian and Latin American economies are likely to have similar effects.

More recently the emergence of China and India have brought large changes to the pattern of trade in world economy. Unsurprisingly these changes have caused concerns among import competing industries and labour unions in western developed countries as these groups face increased competition from these emerging economies.

The issue that has received the most attention recently in this context is the extent to which pressure on wages of relatively low-skilled workers has increased, while the returns to skilled workers has remained stable or increased. This is because there is substantial evidence that there has been a sharp decline in relative incomes. For example wages for Blue collar workers fell during 1980 and 1990s relative tow white collar workers for most industrial countries including Australia, Freeman and Katz (1994), Katz and Autor (1999). Likewise the returns to College graduates relative to early school leavers has risen

during these decades.

In the USA a number of factor content studies attribute this trend to the increasing trade deficit with developing countries. According to these studies, a trade deficit with labour abundant countries affects the effective factor supply and hence reduces wages; Wood(1994, 1995), Borjas, Freeman and Katz (1992, 1997). The alternative hypothesis is that these trends in relative wages are due to biased technological change, Berman, Bound Griliches (1994).

Freeman (1995) and Krugman (1995) pointed to several problems with the factor content approach. In particular since trade flows represent an equilibrium market outcome, they do not reflect all the market forces bought to bear on firms. Thus for example, if the world price of textiles falls, say due to China increased its output, firms in the USA may respond immediately by reducing wages. The resulting fall in costs may mean that imports from China do not change. Nevertheless, trade pressures caused wages to fall. Moreover this example highlights the key role of changes in commodity prices, as opposed to trade flows, on wages. This relationship is however the key insight of the Stolper-Samualson theorem.

Thus rather than measuring the factor content of imports, Lawrence and Slaughter (1993) explicitly examined changes in import prices across firms in the USA and whether changes in prices of low skilled intensive sectors had fallen relative to other sectors. They also examined whether employment of production workers had tended to increase relative to non production workers. Whereas the Stolper-Samualson theorem implies that all alls sectors the ratio of unskilled labour to skilled labour should rise when the price of the low skill labour intensive good falls. Other studies, such as Feenstra and Hanson (1995), have emphasized the potential role of intermediate goods and out-sourcing, arguing that these extensions give rise to observationally equivalent effects to technology change. Other literature has focused on multiple goods and factors and the effects of including non-

traded goods.

Despite the intense and ongoing interest in this issue in the US, it has received relatively little attention in Australia. This is perhaps encouraging since, as argued by Deardorf (2000), whether or not we attribute changes in wage distribution to technology or international trade, should not matter from a policy perspective. Nevertheless, it is likely that the political case for protectionism is significantly weakened if trade and global forces are thought to have relatively neutral effects on income distribution. Moreover, though the debate in Australia has not focus on inequality per se, there is substantial debate surrounding Australias responses to global change more generally, including the participation in Multilateral trade negotiations, the impetus to form regional trade agreements and policy responses such as increasing population and immigration intake, further microcosmic reform, increasing savings and investing in education.

All these can be seen as responses to increasing uncertainty regarding Australia future position in the world trading system. There are several reasons to suspect that dynamic factor accumulation effects may be important. Firstly since trade generates income gains and affects factor prices, it is likely alter investment patterns. Firstly with respect to human capital, a change in the returns to skilled labour will induce a higher rate of investment in human capital, thus tending to mitigate this effect. If trade induces a greater incentive to invest in education then this could be seen as desirable, and may have no long run consequences for income distribution. Second trade liberalization or other forces of globalization can affect the rate of investment in physical capital.

If the North is exporting capital intensive goods then the Rybczynski theorem suggests that capital accumulation is likely to be induced due to generate demand for capital room the expanding capital intensive sectors This will also tend to arise both skilled and unskilled wages. Thus while the gap may widen, dynamic considerations suggest that both skilled and unskilled incomes will rise. However this depends on whether capital

and skills are are compliments in production and we discuss this further below. Finally the short run effects on wages may differ substantially from longer run effects as the economy responds to the shocks. In the short run for example the economy may run a high rate of investment thus raising demand for building and construction services. This can impact on wages of low skilled labour in way that

To assess the likely impact of changes in the world economy on Australia, and the costs and benefits of policy alternatives we use multi-regional dynamic CGE model due to Harrris and Robertson (2005). This model as a number of advantages. First it is a dynamic model so that we can explicitly keep track of the effects of accumulation on factor returns, as discussed above. Second the multi-regional structure of the model allows us to consider no only the direct effects of changes in the world economy on Australia, but also indirect effects via other regions, in particular the USA. Third our model incorporates multiple capital goods. This is critical since the accumulation responses of Residential Housing and machinery and equipment are likely to be very different, especially when intermediate good prices can change.

3 The Model

We employ is a multi-region open economy growth model. It consists of a representative household in each region, that maximizes utility subject to initial conditions and expectations. An equilibrium in the model is a sequence of static competitive equilibria which satisfy perfect foresight. There is also a government which implements policy rules and firms who maximize profits at each point in time. In what follows we give a brief sketch of the main features of the model and refer the reader to Harris and Robertson (2005) for further details.

The world economy consists of with three regions, Australia, the USA and the rest of the

World (ROW). Australia and the USA are modelled as open economies facing exogenous world prices. There are 6 traded and 5 non-traded commodities and industries in each region. Each commodity is produced using intermediate inputs and seven factors of production. There are three reproducible capital goods, machinery (M), structures (B) and residential housing (D). These factor supplies evolve endogenously according to the investment decisions of households. There are two labour types; skilled and unskilled. Total labour supply is fixed, however the composition of labour into skilled and unskilled labour may vary over time due to changes in government education policy. The remaining factors of production are land (N) and resources (R) and, which evolve exogenously.

3.1 Production

Intermediate goods and factors of production to produce a gross output flow g_i in each industry i. Both intermediate goods and the intermediate and value added aggregates are combined with fixed coefficients.

$$g_i = \min\ (m_i,\ v_i) \tag{1}$$

$$m_i = \min_{j=1...n} \left(\frac{Y_{ji}}{a_{ji}} \right) \tag{2}$$

where a_{ji} is a technological parameter. The inputs of the valued added aggregating vector are the reproducible inputs, machinery capital, structures (non residential buildings), residential housing and skilled labour. There is also unskilled-labour, land and resources. Thus we have a value added function

$$v_i = v(v_{mi}, v_{bi}, v_{di}, , v_{si}, v_{ui},\ v_{ni}, v_{ri}) \tag{3}$$

Dual to the value added aggregator, v_i, is a cost function

$$c_i = c(w_{mi}, w_{bi}, w_{di}, , w_{si}, w_{ui}, \ w_{ni}, w_{ri}) \tag{4}$$

3.2 Commodity Supply

The model consists of traded and non traded goods. In the traded goods industries output is an aggregate of three destination specific goods-one good destined for the home market, and two others for the other respective export regions. Gross output for traded good sector, i, is then

$$g_i^N = g^{iN}(x_i^{RN}, x_i^{RS}, x_i^{RW}), \ R \in \{N, S, W\}$$

where g^r is convex and linear homogenous in its arguments. Dual to it defined by revenue maximization is the revenue function given by

$$r^{ir}(p_i^{RN}, p_{i,}^{RS}, p_i^{RW}), \ R \in \{N, S, W\} \tag{5}$$

The regional supply functions can then be recovered from the revenue function using the envelope theorem. In the non-traded goods industries gross output is simply a single output industry.

3.3 Commodity Demand

Consider the set of unit expenditure index functions

$$e^z(q), \ z \in \{C, G, M, B, D\} \tag{6}$$

where; C denotes consumption; G is government; M is investment in machinery and equipment; B is non-residential structures (buildings), and; D is residential structures. Shepherd's Lemma gives an n-vector of commodity demands generated by each component of final demand

$$d_z = e_q^z(q)\frac{z}{e^z(q)} \tag{7}$$

where $z = Q_z P_z$ and $P_z = e^z(q)$. Intermediate demands are given by;

$$i^N = A^N g^N \tag{8}$$

where A^N is the $n \times n$ matrix of intermediate use.

Consumers maximizing an inter-temporal utility function of consumption at each date, and the deviation in net foreign assets from a target stock. This problem is described in *Appendix 1*, and give rise to an aggregate consumption demand per person of;

$$c_t^r = c_{ss}^r(1+g_t)^t + \gamma(f_t - \bar{f}) \tag{9}$$

where c_{ss} is the steady state level of consumption per person and f_t and $\bar{f}$ are respectively the current and target level of net foreign assets per person.

As owners of capital stock, households also choose aggregate investment spending to maximize the present value of each capital stock. As shown in the appendix this gives rise to an investment demand equation for each asset type k, as

$$Q_k = \left(\frac{\Pi_k - p_k}{b_k\ u_k} + g + \delta_k\right) V_k \tag{10}$$

where Π_k is the shadow price of a unit of capital of type k, and b_k is a parameter of the adjustment cost function. Note that Π_k/p_k has the interpretation of Tobins Q, so that

investment demand is positive if $\Pi_k > p_k$.

Finally aggregate government spending is assumed to be determined by a simple policy rule that fixes aggregate spending as a proportion of GDP.

$$G_t^R/Y = \omega,\ R \in \{N, S\} \tag{11}$$

This completes the description of supply and demands in the model at a point in time.

Definition 1. A static equilibrium is a set of consumer prices, q_i^R; factor prices, w_j^R and; gross outputs g_i^R which satisfy:

Zero profits,

$$r^{iR}(p^{iR}) = \sum\nolimits_{j=1}^{n} a_{j,i}^R q_j^R - c_i^R(w^R),\ R \in \{N, S\};$$

Goods market clearing,

$$r_1^N(p)g_i^N + r_1^S(p)g_i^S + r_1^W(p)V^W = \sum\nolimits_{j=1}^{n} a_{ij}^N g_j^N + a_{ie}^N y_e^N + \sum\nolimits_{z=1}^{5} e_i^z(q)\ Q^{zN},\ j = 1 \ldots 6\ ,$$

$$r_2^N(p)g_i^N + r_2^S(p)g_i^S + r_2^W(p)V^W = \sum\nolimits_{j=1}^{n} a_{ij}^S g_j^S + a_{ie}^S y_e^S + \sum\nolimits_{z=1}^{5} e_i^z(q)\ Q^{zS},\ j = 1 \ldots 6\ ,$$

$$g_i^R = \sum\nolimits_{j=1}^{n} a_{ij}^R g_j^R + a_{ie}^R y_e^R + \sum\nolimits_{z=1}^{5} e_i^Z(q)\ Q^{z,R},\ j = 7 \ldots 10,\ R \in \{N, S\}\ ;$$

and; Factor market clearing,

$$V_k^R - C(Q_k^R,\ V_k^R) = \sum\nolimits_{i=1}^{n} c_{w_k}^{iR}(w_k^R)g^{iR},\ k \in \{M, B, D\},\ R \in \{N, S\}.$$

In a *static equilibrium* the Π_k^R, c_{ss}^R and f_t^R as given, along with the endowment vectors V_k^R, taxes, and technology parameters. Thus a *static equilibrium* consists of 22 zero profit conditions; 22 commodity market clearing conditions, and 14 factor marketplaces conditions solving 2×11 consumer prices, q_i^R; 2×7 factor prices, w_j^R and 2×11 gross

outputs g_i^R.

3.4 Dynamics

The dynamic path for the economy is described by the following equations of motion for 8x2+1 state variables. These are the 7 primary factors in each region, the population of each region and the world endowment.

$$\begin{aligned} V_{k,t+1}^R &= Q_{k,t}^R + (1-\delta_k)V_{kt}^R,\ R \in \{N,S\},\ k \in \{M,B,D\} \\ LS_{t,t+1}^R &= LS_t^R(1-\delta_s) + E_t^R,\ R \in \{N,S\} \\ V_{k,t+1}^R &= V_{kt}^R,\ R \in \{N,S\},\ k \in \{N,R\} \\ Pop_{t+1}^R &= (1+g_t)Pop_t^R,\ R \in \{N,S\} \\ V_{t+1}^W &= (1+g_t^W)V_t^W \end{aligned} \tag{12}$$

In addition there is a net foreign asset balance for each region which evolve as,

$$F_{t+1}^R = Surp_t^R + (1+r)F_t^R,\ R \in \{N,\ S\} \tag{13}$$

To complete the description of the economies optimal dynamic path model we need to describe the dynamic path for asset prices. As shown in the appendix we have;

$$\Pi_{k,t^R} = \frac{1}{1+\rho}\left[u_{k,t+1}^R\ (1-m_{k,t+1}^R)\ +\ (1-\delta_k)\Pi_{k,t+1}^R\right] \tag{14}$$

where $m_{k,t=1}^R$ is the marginal cost of adjustment to a change in the asst stock, $V_{k,t+1}^R$.

3.5 Steady-State

In the steady-state we have the requiems that the growth rate of each capital stock must be equal to g long run growth rate. This gives,

$$\frac{Q_{k,t}}{V_{k,t}} - (\delta + g) = 0.$$

From the investment demand equation (10) this is satisfied if,

$$\Pi_t - p_{k,t} = 0$$

Further if Π_t is stationary then,

$$\Pi_k{}^* = \frac{u_k{}^*}{\rho + \delta_k} = p_k{}^*.$$

Finally the steady-state condition for the target stock of foreign assets, $\bar{f}$ to be constant is,

$$\bar{f} = \frac{1+g}{g-r}\left(1 - (c_{ss}/y) + (tax/y) - gov_t - invest_t\right).$$

4 International Prices

The rapid growth of China is likely to extent significant downward pressure on world prices of low-tech and intermediate manufactured goods. It is difficult to put a figure on this effect though. In addition a growing attention is being given to China's relatively more skill intensive exports of goods out-sourcing of services to countries like India and China. despite this attention however, these service intensive sectors still remain a very small fraction of the India and Chinese economies In what follows therefore we consider the effects of a 20% permanent reduction in reduction in the world price and $LowTech$

and $IntermediateManufactured$ goods. These are anticipated in initial year, and phased in over a 10 year period.

As discussed we model three regions, Australia, the USA and the rest of the World (ROW). The model is calibrated to a year 2000 benchmark using primarily data from GTAP, aggregated to N=10 sectors given in Table 1. To this we add an education sector which produced skilled workers as an output. The interpretation these skilled workers is people will a tertiary education such as a university degree. The GTAP data is also scaled using PWT 5.6 data so that income in each region is expressed in terms of $intPPP$. Data on industry value added is scaled to be consistent with investment spending data in a steady state. Likewise trade flow data is scaled so that in the benchmark represents a hypothetical steady state with balanced trade.

4.1 Results

The principle result we are interested in is the effect of these changes ion relative factor returns,and in particular the wages paid to skilled workers relative to unskilled workers. The effect of a 20% reduction in low tech and intermediate manufactured goods prices can be divided in to aggregate and sector effects. We first discuss the aggregate response to these changes.

With the announcement of the price change and anticipated reduction in import prices, both regions reduce import spending and run trade surpluses. As shown in Figure 1, this allows them to build up foreign assets and then use these assets to fund trade deficits once the import prices fall. Thus domestic demand falls in the short run with reductions in consumption spending, and also a reduction in spending on machinery and equipment and structures.

Figure 2 shows the output index for each sector. At a sectoral level the initial phase

lead to an immediate in crease in Agriculture and Minerals outputs in both regions and increased exports in these sectors as they expand. All commodity imports commodities contract consist with the reduction in investment and consumption spending.

After about 7 years slightly before the full impact of the price reduction, the impact of the trade surplus is reversed. Consumption increases, investment restored. Real consumption spending becomes positive after about 6 years and peaks at year 11-12.

The accumulation and total output dynamics are shown in Figure 3. In Australia there is also a significant long run accumulation response and this capital deepening sustains a higher level of long run consumption. The long run structural changes in both economies is relatively similar with very large changes in sectoral composition of output, which reflects strong Rybczynski effects generated by sectoral factor mobility. In particular both regions there is a large expansion of the *Agriculture* and *Mineral* sectors Likewise in the long run imports of *Low-Tech* and *Int-Manufactured* goods rise by 60-80 percent over the benchmark and all other imports fall.

Long run investment and accumulation increase notably in Australia, in *Structures* and *Residential Housing*. In there are no long run accumulation responses except in *Residential Housing*. The housing investment reflects increased returns to Land. the demand for land from *Agriculture* increases housing costs. in the long run equilibrium the value of residential housing assets and the rental rate on housing must rise to offset this increased cost.

4.2 Impact on Relative Wages

The responses in factor returns across all sectors is given in Figure 5, which shows the real factor returns, where the consumption price index is used as a the price deflator. With respect to the returns to labour the results are quite remarkable in two respects.

The first point is the difference between the long run and short run impacts. In the very short run wages rise quite significantly. This response is quickly reversed however with wages falling up to 2 % in the USA and 3% in Australia. In the long run wages rise again and settle between these two short run extremes. Note that land rentals display an opposing pattern with a relatively large fall in the very short run but rising over time. Thus the land -labour relative factor price displays quite complex dynamics in the short to medium run.[1]

The second remarkable feature of these results concerns the ratio w_s/w_u. In the USA it can be seen that though there is significant furcation in real wages, the ratio w_s is always al=bove w_u so that w_s/w_u, is always higher the the benchmark. In the long run w_s/w_u raises with w_s increasing by about 1% and a slight fall in w_u. This is consistent with the bulk of the trade wage theoretical literature. It reflects Stolper-Samuelson effects of commodity price changes on factor prices, with gains to skilled labour which is likely to be used relatively intensively in the USA export sectors. Thus, consistent with the Stolper-Samuelson theorem, the ratio of skilled to unskilled workers Ls/Lu falls in each sector as the supply of unskilled labour from the contracting sectors reduce their relative wages and induce al sectors use more low-skilled intensive methods.

In Australia however we see precisely the opposite pattern. The ratio w_s/w_u falls below the benchmark actio in both the short and long run. After about 8 years this difference reaches a maximum of about with skilled wages falling to three percent relative to a 2% fall in unskilled real wages. In the long run the gap closes considerable, but nevertheless to the extent that there is a difference in relative returns, the direction of change is opposite to that of the conventional wisdom. As with the USA the changes in relative wages reflect a supply side response though, in the case of Australia, the skilled to unskilled labour employment ratio rises in every sector.

[1]These dynamics point to the dangers of trying to interpret a relatively short data series of price changes in terms of a static model.

The implication is that in these sectors Australia is relatively skilled labour intensive. Hence reductions in the prices tend to displace more skilled labour relative to unskilled labour. Table 2 explores this idea by reporting the Stolper-Samuelson matrix of derivatives $d\ln(w_i)/d\ln(p_j)$, where w_i is the factor return and p_j is a commodity price.[2] Thus it shows for example that a one percent rise in the price of Low tech goods, increases the return to unskilled labour by 0.13% and the return to skilled labour by 0.15%. Note however that for Intermediate manufactured goods the effect on skilled labour is greater than unskilled labour. Hence in the results above, it is the price reduction in the *Low-Tech* sector which dominates the direction of relative wages. Thus more generally the predicted effect of changes in world prices on the wage ratio in Australia depends largely on the extent to which *Low-Tech* manufactured goods prices fall relative to other prices, such as Durables and Intermediate goods.

5 Conclusion

We have considered some potential impacts of changes in the world economy on the wage structure of the Australian economy. To evaluate these changes we introduced a a multi-sector dynamic trade model of a three region economy, Australia, the USA and the Rest of The World. We showed that falling world prices in "low-tech" and intermediate manufactured goods sectors had interesting and poetically important consequences for relative wages of skilled and unskilled workers in Australia and the USA. In particular we found that short run and long run effects on wages are very different. Moreover we showed that the pattern of relative returns to unskilled labour in Australia is opposite to that in the USA and against the conventional wisdom. In particular in the medium to long run skilled wages tend to relative to unskilled wages in Australia.

[2]this is not a true Stolper-Samuelson matrix in that capital endowments are not being held constant. In addition of course the model has many features which differ from a standard H-O model, such as intermediate production and international product differentiation.

6 Appendix

6.1 Optimal Investment Decisions

Let: $V_{k,t}^R$ be the physical asset of type k in region R; $w_{k,t}$ be the rental rate, and; $u_{k,t} = (1 - t_k)\, w_{k,t}$ be the after-tax rate of return. Firms maximize the discounted value of the asset given a world bond market which pays a rate of interest of $1 + \rho$. The firm faces an installation cost, expressed in terms of units of the asst of, $C\left(Q_{k,t}, V_{k,t}\right)$. The purchase price of a unit of investment Q_k, t is $p_{k,t}$. Thus the net return on the asset at time t is $u_{k,t}V_{k,t} - u_{k,t}c\left(Q_{k,t}, V_{k,t}\right) - p_{k,t}Q_{k,t}$. Suppressing regional superscripts, the household's problem is then given by the following Lagrangian.

$$L = \sum_{t=0}^{\infty} \left(\frac{1}{1+\rho}\right)^t \left(u_{kt}V_{Kt} - u_{kt}\, C(V_{kt}, Q_{kt}) - p_{kt}\, Q_{kt} + \Pi_{kt}(K_{t+1} - K_t - Q_t + \delta K_t)\right)$$

where $k \in \{M, B, D\}$. The first-order conditions are:

$$\frac{\partial L}{\partial Q_{kt}} = -u_{k,t}C_{Q,t} - p_{k,t} + \Pi_{kt} = 0 \tag{15}$$

$$\frac{\partial L}{\partial V_{kt+1}} = \frac{1}{1+\rho}\left(u_{k,t+1}\left(1 - C_{V_k,t+1}\right) + \Pi_{k,t+1}\left(1 - \delta_k\right)\right) - \Pi_{k,t} = 0 \tag{16}$$

Next suppose that the form of the adjustment cost function is

$$C\left(Q_{k,t}, V_{k,t}\right) = \frac{b}{2}\, \frac{\left(Q_{k,t} - \left(\delta_k + g\right) V_{k,t}\right)^2}{V_{k,t}}$$

Hence we have

$$\frac{\partial C}{Q_{k,t}} = b\left(\frac{Q_{k,t}}{V_{k,t}} - \left(\delta_k + g\right)\right) \tag{17}$$

and

$$\frac{\partial C}{V_k} = -b\left(\delta_k + g\right)\left(\frac{Q_{k,t}}{V_{k,t}} - \left(\delta_k + g\right)\right) - \frac{b}{2}\left(\frac{Q_{k,t}}{V_{k,t}} - \left(\delta_k + g\right)\right)^2 \tag{18}$$

Substituting (17) into the first first order conditions (15) gives

$$\frac{\Pi_t - p_{k,t}}{u_{k,t}} = b\left(\frac{Q_{k,t}}{V_{k,t}} - \left(\delta_k + g\right)\right)$$

which can be rearranged to give the investment demand equation.

$$\frac{Q_{k,t}}{V_{k,t}} = \frac{1}{b}\left(\frac{\Pi_{kt} - p_{k,t}}{u_{k,t}} + \delta_k + g\right) \tag{19}$$

Likewise the asset price equation (14) is obtained from (16) and (18) where

$$m_{k,t+1} = \frac{\partial C(Q_{k,t+1},\ V_{k,t+1})}{V_{k,t+1}}.$$

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8 Tables and Figures

Table 1: Sectors, Factors and Regions in the Model

Commodities N+1	Factors 7 (V)	Regions 3 (R)	Spending Aggregates(z)
Agriculture	Machines	USA	Consumption
Minerals	Structures	Australia	Government
Low Tech	Residential Housing	ROW	Machines
Int Manufacture	Ls		Structures
Durables	Lu		Residential Housing
Traded Services	Land		
Construction	Resources		
Non Traded Services			
Public			
House			
Education			

Table 2: Long Run Stolper-Samuelson Matrix for Australia

	Agriculture	Minerals	Low Tech	Int Man	Durable	Traded Serv
Machines	0.27	0.16	0.14	0.26	0.11	0.08
Structures	0.19	0.11	0.14	0.23	0.29	0.04
Housing	0.19	0.11	0.14	0.23	0.29	0.04
Ls	-0.02	0.05	0.13	0.32	0.39	0.15
Lu	0.17	0.04	0.15	0.28	0.31	0.07
Land	0.84	0.03	0.03	0.06	0.02	0.05
Resources	-0.53	2.91	-0.44	-0.16	-0.59	-0.16

Figure 1: Trade Surplus and Net Foreign Assets: ratio to GDP

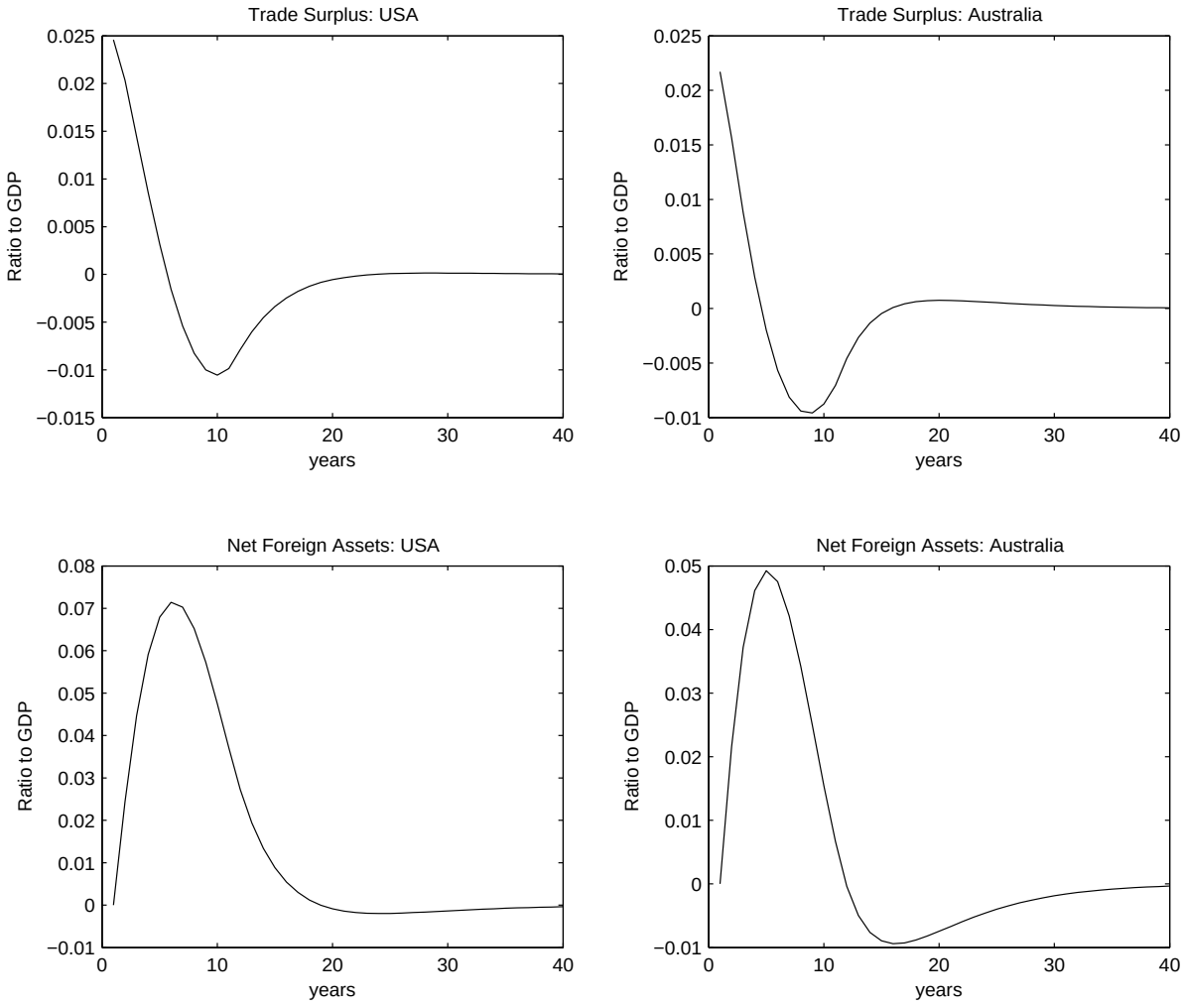

Figure 2: Sectoral Composition of Output: Percentage Changes from Base

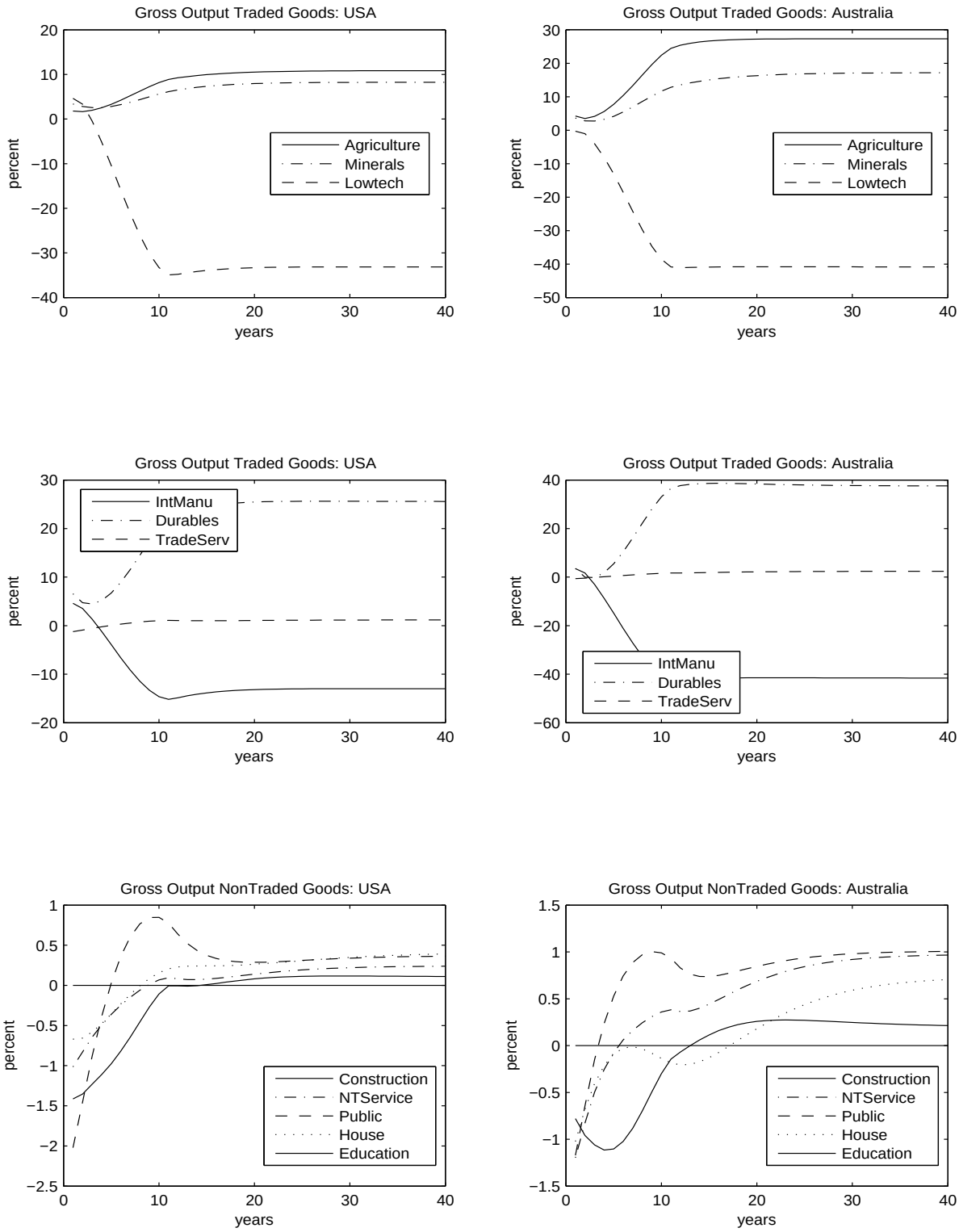

Figure 3: Real Output and Investment Responses: Percentage Changes from Base

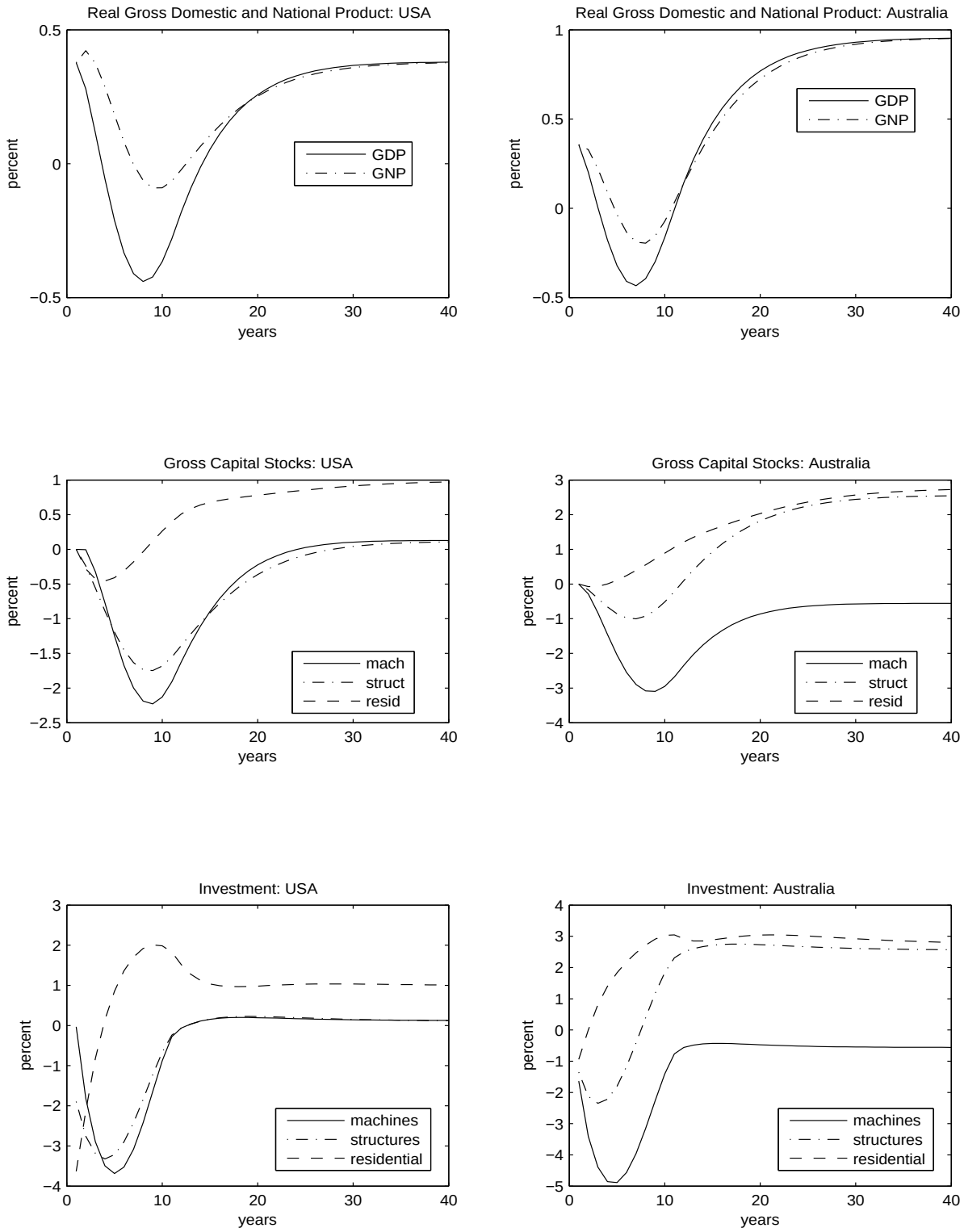

Figure 4: Real Factor Returns: Percentage Changes from Base