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Searching for the Smoking Gun: Did Trade Hurt Unskilled Workers?

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Abstract

We contribute to the trade-wage literature by conducting the first economy-wide analysis of the association between trade and wages in New Zealand. We find that increased imports since 1980 caused only a marginal increase in New Zealand wage inequality and, overall, increased trade (imports and exports) reduced wage inequality in this nation. As New Zealand imports of unskilled labour-intensive products relative to GDP are larger than those for other developed nations, we interpret these results as convincing evidence that trade is not responsible for rising wage inequality in developed nations.

JEL classification: F16, J24

Keywords: trade and wages; skill classification.

I Introduction

The cause(s) of rising wage inequality in developed nations has been the subject of heated debate in recent decades. In New Zealand, between 1986 and 2003 the wage paid to workers with a university, vocational or school qualification increased by 82.5% and that paid to workers without any formal qualifications increased by 62.3% (Household Economic Survey and Household Labour Force Survey). If the former group is categorised as skilled and the latter unskilled, these figures indicate that the skill premium (the ratio of skilled to unskilled wages) rose by 12.4% between 1986 and 2003. At the same time, the share of skilled workers in the economy increased by 22.3% and that of unskilled workers fell by 42.4% (Hyslop, Maré and Timmins, 2006). Therefore, although the rise in the New Zealand skill premium is not substantial, the large increase in the relative supply of skilled labour points towards a large increase in the relative demand for skilled labour.

One explanation for the shift in relative demand is increased imports from unskilled-labour abundant developing nations, particularly rapidly developing economies (RDEs), which have pursued export-orientated growth strategies.[1] Two well-know trade theorems – the Heckscher-Ohlin (H-O) and Stolper-Samuelson (S-S) theorems – support this view. Although trade and wages are closely tied in the H-O model, however, the strength of the S-S theorem is reduced when some of the restrictive assumptions of the H-O model are relaxed. As a result, the link between increased developed-developing trade and the deteriorating relative position of unskilled workers in developed nations has been the subject of a large number of empirical studies. The consensus in the trade-wage literature – see Greenaway and Nelson

[1] Countries categorised as RDEs are listed in Table 2.

(2000, 2001) for reviews – is that increased trade has not been a major contributor to increased wage inequality in developed nations.[2] We contribute to this literature by undertaking the first computable general equilibrium (CGE) study of link between trade and wages in New Zealand. Quantifying trade-induced changes in New Zealand wages is informative as it appears that New Zealand wages are more susceptible to trade changes than wages elsewhere. We elaborate by displaying cross-country comparisons for New Zealand, the US and the UK in Table 1.[3] The first row indicates that the New Zealand economy is much more open than either the US or the UK. The second and third rows, respectively, reveal that, relative to GDP, New Zealand imports more from RDEs than either the US or the UK, and New Zealand imports of unskilled-intensive manufacturing are greater than those for the other countries of interest.

Our study maps three different labour classifications, which are built on educational and occupational data, onto the New Zealand component of a CGE database. We find that increased imports since 1980 caused only a marginal increase in New Zealand wage inequality and approximately two-thirds of the rise in the skill premium due to imports can be attributed to increased imports from other developed nations. Moreover, as New Zealand has a comparative advantage in agricultural products and these commodities make intensive use of unskilled labour, we find that increased trade (imports and exports) over the 1980-2001 period placed downward pressure on the New Zealand skill premium. In light of our observation concerning the relative

[2] Wood (1994, 1998) reaches an alternative conclusion.

[3] We choose to compare New Zealand data with US and UK trade flows as rises in wage inequality in the US and UK have been more dramatic than elsewhere.

sensitivity of New Zealand wages, we interpret these results as convincing evidence that trade is not responsible for increased wage inequality in developed nations.

This paper has three further sections. Section 2 outlines the salient features of our model and chosen database, and describes features of the data likely to have a large influence on our results. Section 3 details the form and outcomes of our modelling exercises. Section 4 concludes.

II Trade and wages in an economy-wide context

Three divisions of empirical research have emerged in the trade-wage literature: (a) product price studies, (b) factor content of trade studies, and (c) CGE studies. Procedures (a) and (b) utilise properties present in the H-O model. Specifically, product price studies exploit the relationship between product and factor prices in zero profit conditions. Following Slaughter (1998), product price studies can be classified as either consistency checks or mandated wage studies. Consistency checks test whether or not changes in product prices have been in the right direction to drive an increase in wage inequality (Lawrence and Slaughter, 1993; Sachs and Shatz, 1994; Neven and Wyplosz, 1996; Haskel and Slaughter, 2001). Mandated wage studies estimate changes in factor prices required to maintain binding zero profit conditions in the presence of observed changes in product prices and technology (Leamer, 1998; Baldwin and Cain, 2000; Haskel and Slaughter, 2001). Factor content of trade studies make use of the property that trade in goods is a substitute for trade in factors by estimating changes in effective domestic supplies of skilled and unskilled labour due to trade (Wood, 1994, 1998; Deardorff and Lattimore, 1999).

Researchers who adopt the third approach set up a modified H-O model and solve this model numerically (Krugman; 1995; Lawrence and Evans, 1996; Cline, 1997; Tyers and Yang, 1997, 2000; Cortes and Jean, 1999; Nahuis, 1999; Abrego and Whalley, 2000; Jean and Bontout, 2000; Theirfelder and Robinson, 2002; De Santis 2002, 2003; Tokarick, 2005; Winchester, Greenaway and Reed, 2006; Winchester and Greenaway, 2006). We choose to conduct a CGE analysis as we wish to preserve the fundamental characteristics of the H-O model whilst also using a model complex enough to capture several important features of actual economies, such as intra-industry trade. Another advantage associated with CGE modelling is that the approach models interdependencies and feedback effects, which can be difficult to capture using other techniques, explicitly. In this connection, Francois and Nelson (1998, p. 1483) note, "when the issue at hand is the link between international trade and relative wages there is simply no substitute for general equilibrium analysis."

Our CGE framework is based on the GTAP6inGAMS model, which is a static, global model that captures both bilateral trade flows amongst regions and inter-sectoral linkages within regions. The GTAP6inGAMS framework is set out in detail by Rutherford (2005). Features of the model concerning production, trade and closure which are important for our analysis are outlined below. Starting with trade, imports are differentiated from domestic commodities and by region of origin according to the Armington assumption (Armington, 1969). That is, for each good, imports from different regions are gathered in a constant elasticity of substitution (CES) nest to create an imports composite. The imports composite is combined in a further CES nest with the domestically produced variety to generate a composite good that is purchased in the local economy. The specification of the Armington assumption is important as it affects the degree to which domestic product prices are affected by changes in international prices. In the H-O model, domestic goods and imported varieties are perfect substitutes. When the Armington assumption is employed (and elasticities in the Armington specification are less than infinity) domestic and imported varieties are imperfect substitutes. As a result, the proportional change in the domestic price of a particular variety due to a change in the world price of that variety is less than the proportional change in the corresponding world price.[4] Consequently, the effect of increased trade on wages is muted when the Armington assumption is introduced.

Turning to production in GTAP6inGAMS, output in each sector is governed by a Leontief nest of intermediate inputs, which are themselves composites of domestically produced and imported varieties, and a Cobb-Douglas aggregation of primary factors. As there is constant returns to scale, prices and factor rewards adjust so as to maintain zero profits (as in the H-O framework). The nature of the valued added nest can also have a large influence on the results. Specifically, the greater the substitutability between factors of production, the smaller the variation of changes in factor returns due to trade liberalisation. Guided by Johnson (1997), we modify the value added nest in GTAP6inGAMS by combining different types of labour using a CES aggregator with an elasticity parameter equal to 1.5, and amalgamating the labour composite with other primary factors using a Cobb-Douglas aggregator. Factor prices are endogenous

[4] As noted by Abrego and Whalley (2000, 2003) and Thierfelder and Robinson (2002), domestic and imported varieties can also be unrelated commodities or complements if the relevant Armington parameters are, respectively, equal to unity or less than one. We do not discuss these cases as estimates of Armington elasticities are typically much larger than one (see Hertel et al., 2004).

so there is full employment, and factors are perfectly mobile across sectors (but immobile internationally).

Our model is calibrated using Version 6 of the Global Trade Analysis (GTAP) database (Dimaranan and McDougall 2005). The database provides a representation of the global economy in 2001 and identifies 87 regions, 57 sectors and five factors of production (skilled and unskilled labour, capital, land and resources). To suit our needs, we aggregate the GTAP database into four regions (New Zealand, Other Developed, RDEs, and Rest of World) and seven sectors (agriculture, minerals, food manufacturing, mineral-based manufacturing, unskilled-intensive manufacturing, skilled-intensive manufacturing, and services). The compositions of regions and sectors identified in our model in terms of components recognised by GTAP are highlighted in Table 2.[5]

Our factor aggregation is non-standard. Specifically, we augment the New Zealand component of the database to incorporate two alternative skill classifications. We do this because the procedure used to identify skilled and unskilled labour in the GTAP database draws heavily on occupational classifications (see Liu et al., 1998), which can result in some workers being misclassified (Hall, 1993 and Leamer, 1998). Our skill classifications are based on educational attainment and draw on data from the 2001 New Zealand Census of Population and Dwellings and the 2001 New Zealand Income Survey. In one classification, we identify skilled (individuals with a university degree or a vocational or school qualification) and unskilled workers (individuals with no qualifications). Guided by Winchester, Greenaway and Reed (2006), who develop

[5] As our model produces similar results when a more detailed sectoral breakdown is employed, we choose to work with a relatively high level of aggregation for presentational convenience.

a skill classification using cluster analysis to determine both the appropriate composition and number of labour types, we identify four labour categories – degree qualification, vocational qualification, school qualification, and no qualification – in another classification.[6] Consequently, we conduct simulations using three alternative labour classifications for New Zealand: (a) GTAP's skill classification, which identifies skilled and unskilled labour using an occupation-based method, (b) a skill classification that recognises skilled and unskilled labour based on educational attainment (as described above), and (c) a skill classification that identifies four labour types based on educational attainment (as described above). Skill classification (a) is used in all regions other than New Zealand in all simulations, and capital, land and resources are identified in all regions throughout.

Before implementing our simulations, we eyeball the data to draw some qualitative conclusions about the possible impact of trade on wage inequality. Labour cost shares in value added when four types of labour are identified are displayed in Table 3. These data reveal that, with the exception of skilled manufacturing, there is not a large difference in labour cost shares across non-service sectors. Services, which has the highest degree qualification labour cost share and the lowest no-qualification labour cost share, is the most skill-intensive sector. Additionally, although skilled manufacturing is more skill intensive than other manufacturing sectors, it is much less skill intensive than services. Table 4 displays New Zealand sectoral imports, exports and sectoral labour cost shares. These data indicate that New Zealand imports are predominately made up of unskilled and skilled manufacturing, and that food

[6] Details of our labour classification and how we map these data onto the GTAP database are given in the appendix.

manufacturing, which accounts for more than one-third of total exports, is New Zealand's most significant export commodity. With respect to labour cost shares, the majority (nearly 70%) of all labour payments originate from services, and agriculture and food manufacturing combined account for a considerable proportion (just over 15%) of total payments to labour.

New Zealand trade shares by commodity and region are presented in Table 5. The last row in each segment presents regional trade shares (e.g., imports from Other Developed make up 71.8% of total New Zealand imports), and other cells display regional trade shares for each commodity (e.g., agriculture imports from Other Developed account for 64.6% of New Zealand's imports of this commodity). From a trade-wage perspective, several interesting features are present. First, although imports are dominated by goods sourced from Other Developed in every product category except minerals, it is interesting to note that the contribution of imports from RDEs towards New Zealand's two most significant import commodities (20.3% for unskilled manufacturing and 21.3% for skilled manufacturing) is higher than the overall incidence of imports from this region (18.0%). Second, the data reveal that the proportion of agriculture exports shipped to RDEs (35.4%) accounts for a significantly larger proportion of total exports of this commodity than the share of total New Zealand exports to this region (21.5%).

Taken together, Tables 3-5 suggest that it is possible that increased imports from RDEs hurt unskilled labour in New Zealand in recent decades but, as New Zealand exports are concentrated in unskilled-intensive commodities, growth of New Zealand exports over the same period may have produced an offsetting effect. Also, the data indicate that the size of the service sector, which is largely non-traded, may limit the impact of trade on relative wages.

III Simulation exercises

Before examining the role of trade we evaluate the impact of changes in labour supplies. Hyslop, Maré and Timmins (2006) report that the employment shares of degree, vocational, school and no-qualification labour changed by 103.4%, -25.2%, 64.3% and -42.4%, respectively between 1986 and 2003.[7] Our model suggests that the degree-vocational, degree-school and degree-no-qualification relative wages would have fallen by 49.0%, 14.0% and 57.6%, respectively, if these changes had occurred in isolation. When two labour types are identified according to qualifications, changes in employments shares result in a 39.9% decline in the skill premium. These results confirm our assertion regarding the magnitude of the increase in the relative demand for skilled labour.

We estimate the impact of increased imports on relative wages in New Zealand by imposing 1980 values of New Zealand sectoral imports relative to GDP on the 2001 database. Influenced by Tyers and Yang (1997) and Winchester, Greenaway and Reed (2006), we do this by introducing a set of endogenous taxes on exports to New Zealand from other regions.[8] Changes in imports occurring between 1980 and 2001

[7] We are unable to collect data on wage and employment movements for the same period for which we examine trade changes. Nevertheless, as there is large overlap in sample periods, we believe reported changes in actual wages and movements in wages due to changes in employments shares give a good indication of the sign and magnitude of movements in these variables occurring between 1980 and 2001.

[8] We choose to control imports by altering tax instruments in countries other than New Zealand as

are reported in Table 6. Unless stated otherwise, the shock imposed in our simulation exercises removes these changes from the 2001 database.[9] Simulated changes in New Zealand real wages for various skill classifications following our trade shock are reported in Table 7. In all labour classifications we observe increases in real wages for all labour types. When two labour types are identified, the estimated increase in the skill premium is 0.88% when labour types are identified by observing occupational data and 0.73% when a labour classification built on educational data is used. Given the downward pressure on relative wages applied by labour supply changes, these observation indicate that only a tiny fraction of the increase in New Zealand wage inequality over the 1980-2001 period can be attributed to increased imports.

When four labour types are identified, there is a positive relationship between skill level and proportional changes in real wages and the largest simulated increases in wage inequality (the wage paid to individuals with university degrees divided by the wage paid to workers with no qualifications) is 1.52%. The increase in the relative wage of skilled labour when there are four labour types (where the skilled wage is calculated as the employment weighted average of the degree, vocational and school wage and the wage for workers with no qualifications represents the unskilled wage) is 0.69%. These results also suggest that the influence of trade on wage inequality has been minor.

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changing trade policy instruments in New Zealand may have undesirable revenue effects.

[9] As disaggregated data concerning trade in services are scarce we are restricted to evaluating the impact of changes in merchandise imports. We do not think that this represents a major limitation as services are largely non-traded.

To appreciate what is driving our results, we report simulated changes in New Zealand sectoral prices, outputs and imports when two labour types are identified using occupational data in Table 8.[10] Given the exogenous changes in import volumes, the direction of output changes are not surprising: production declines in sectors where imports have increased (and vice versa). Evidence of S-S forces is that unskilled manufacturing experiences the largest price decline and this commodity and skilled manufacturing (which both use unskilled labour more intensively than services) experience large price reductions relative to the price of services. Taken together, the results in Tables 7 and 8 suggest that imports have influenced wage inequality in New Zealand via S-S channels. However, although our modelling exercises are able to replicate observed changes in wage inequality at a qualitative level, simulated changes in wage ratios are very modest. Accordingly, our findings concur with the majority view point that trade has not had a large influence on relative wages.

To assess the contribution of import changes by commodity and region, we report results from decomposition analyses in Tables 9 and 10. Table 9 displays movements in the skilled-to-unskilled relative wage when two labour types are identified using a skill classification built on occupational data.[11] Results presented in the last row of Table 9 represent changes in the skill premium when observed changes in New Zealand imports from each region (for all commodities) are simulated (e.g., the estimated increase in the skill premium due to increased imports from Other

[10] By design, reported changes in import volumes in Table 8 are the same as those in Table 6.

[11] Changes in the skill premium when two labour types are identified using educational data are similar to those reported in Table 9.

Developed is 0.48%). The last column of each table reports proportional changes in relative wages when exogenous changes in imports are simulated independently (across all regions) for each commodity (e.g., the estimated increase in the skill premium due to the change in agriculture imports is -0.04%). Other cells present simulated changes in the skilled-to-unskilled relative wage when imports of each commodity from each region are considered independently (e.g., the estimated change in the skill premium due to increased imports of agriculture from Other Developed is -0.003%). The cell in the bottom right-hand corner of Table 9 displays the proportional change in the skill premium when imports of all commodities from all regions are considered and is the same the corresponding change reported in Table 7.[12] The direction of changes in relative wages in the decomposition analysis have intuitive appeal. For example, the large proportional increase in imports of food manufacturing, which makes intensive use of unskilled labour, results in a relatively large increase in the skill premium. Another expected observation is that the simulated increase in the skilled-to-unskilled wage ratio due to imports of unskilled manufacturing (0.53%) is larger than the corresponding changes resulting from imports of other commodities. Also, as skilled manufacturing makes intensive use of unskilled labour relative to services, increased imports of skilled manufacturing have increased the skill premium (by about one-third of the amount resulting from increased imports of unskilled manufacturing). For the purpose of evaluating the contribution of developed-developing trade to increased wage inequality in New Zealand, two observations are noteworthy. First, the increase in the skill premium due to increased imports of unskilled manufacturing from Other Developed (0.26%) is

[12] Reported changes in the final columns and rows of Table 9 are not equal to the respective column and row sums as we do not attempt to apportion interaction terms.

larger than the increase in this variable resulting from imports from RDEs (0.20%). Second, the impact of imports (of all commodities) from Other Developed on the skill premium (0.48%) accounts for around three-fifths of the increase in the skill premium due to imports from all regions (0.88%).

Table 10, which is interpreted analogously to Table 9, reports changes in the wage paid to workers with degree qualifications relative to the wage paid to workers with no qualifications.[13] The data reveal that conclusions resulting from our decomposition analysis when there are two labour types are unchanged when a more detailed skill classification is used; that is, although imports of unskilled manufacturing have a large impact on wage inequality relative to imports of other commodities, imports from Other Developed account for a significant majority of the rise in wage inequality due to increased imports.[14]

The role of exports

In addition to causing an increase in New Zealand imports in recent decades, rapid growth in other regions and reduced trade frictions have also strengthened the demand for New Zealand exports. We now turn our attention to the overall impact of changes in trade (import and export) volumes on New Zealand wage inequality. In a similar fashion to how imports are controlled, we simulate observed changes in New Zealand exports using a set of endogenous import tariffs in other regions. The results, reported

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[13] Changes in the degree-no qualification relative wages in Table 10 are representative of movements in other measures of wage inequality when four types of labour identified.

[14] We also examine the sensitivity of our results to Armington elasticities and the elasticity of substitution between different labour types. Our conclusions are unaltered in these exercises.

in Table 11, reveal that, overall, trade has exerted downward pressure on wage inequality in New Zealand. The main driver of this result is a significant increase in New Zealand exports of (unskilled-intensive) food manufacturing. Consequently, as New Zealand's comparative advantage lies in agriculture-related products and these sectors make relative intensive use of unskilled labour, increased trade has decreased wage inequality in New Zealand.[15] This finding coupled with the expectation that New Zealand wages should be more sensitive to trade changes than wages in other skill-abundant nations offers strong support for the argument that trade has not caused wage inequality to rise in developed nations.[16]

Vulnerable labour

Our simulations thus far have assumed that adjustments in the New Zealand economy are instantaneous. We consider the impact of restricted labour mobility by defining labour with no qualifications employed in unskilled manufacturing as vulnerable

[15] This finding is supported by Deardorff and Lattimore (1999) and Lattimore et al. (2002). Authors who find a negative association between trade and wage inequality in other regions include Leamer (1997), Tokarick (2005) and Tyers and Yang (1997). Leamer (1997) finds that changes in US producer prices worked in favour of unskilled workers in the 1980s. Also in the US, Tokarick (2005) finds that, under certain assumption concerning non-traded goods, movements in the US terms of trade between 1982 and 1996 caused wage inequality to decline. Finally, Tyers and Yang (1997) observe declining skill-farm relative wages in developed nations due to trade.

[16] It is illuminating to compare our results with the findings of Winchester (2007). Winchester finds that the impact of changes in exports between 1980 and 2001 reinforces the impact of import changes on relative wages in the US and the UK (e.g., the increase in the UK skill premium due to imports is 0.66% and the rise due to imports and exports is 1.08%). Results for the US and the UK differ from those for New Zealand because, unlike New Zealand, the US and the UK are net exporters of skill-intensive commodities.

labour and specifying a constant elasticity of transformation (CET) function to control the allocation of aggregate no-qualification labour between "normal" no-qualification labour (no-qualification labour employed in all sectors except unskilled manufacturing) and vulnerable labour. Our CET specification captures three different types of vulnerable labour mobility: (a) when the elasticity parameter is equal to zero vulnerable labour is immobile, (b) when the elasticity parameter takes a value between zero and infinity vulnerable labour is imperfectly mobile, and (c) when the elasticity parameter is equal to infinity vulnerable labour and "normal" no-qualification labour are perfectly interchangeable (i.e., the specification is the same as in our base model). In all cases, as in our base model, unit factor payments adjust so that full employment is maintained. Although the assumption that no-qualification labour employed in unskilled manufacturing is immobile across sectors while all other factors are perfectly mobile is somewhat unrealistic, the specification is in mild agreement with the observation that unskilled labour is less mobile than skilled labour and, by prejudicing our model in favour of finding an adverse impact of trade on wage inequality, such an assumption provides an opportunity for us to search for a significant trade-induced change in relative wages in a setting where a strong association between trade and wages is likely to exist.

Changes in degree-no-qualification and degree-vulnerable relative wages due to import changes when vulnerable labour is imperfectly mobile are reported in Table 12. The results reveal that import changes, in isolation, decreased the degree-no-qualification relative wage by 13.64% when vulnerable labour is immobile. There are two main drivers behind this result. First, the price of unskilled manufacturing falls relative to prices for all other sectors. Second, the marginal product of vulnerable labour falls as mobile factors migrate from unskilled manufacturing to other sectors. Also of note, as vulnerable absorbs most of the pressure due to trade, the rise in wage inequality between degree and normal no-qualification labour diminishes when labour mobility is restricted. We assess the increase in wage inequality between aggregate no-qualification and degree labour when vulnerable is immobile by weighting movements in vulnerable and normal no-qualification wages by hours of employment. As vulnerable labour accounts for less than nine percent of aggregate no-qualification labour, the increase in the ratio of the degree to aggregate no-qualification wage is 1.53%. The results also suggest that a relatively small increase in the elasticity parameter governing labour mobility alleviates much of the downward pressure on the vulnerable wage. These findings indicate that, although increased imports have placed significant downward pressure on a small group of unskilled workers, increased imports could not have driven the observed change in New Zealand wage inequality.

IV Conclusions

This paper has implemented the first economy-wide analysis of the link between increased trade and rising wage inequality in New Zealand. The modelling exercises employed three different skill classifications, which were built on educational and occupational data. Although the results indicated that increased imports have affected New Zealand wages via S-S channels, it was found that imports have resulted in a minor increase in wage inequality in New Zealand and most of the increase due to imports can be attributed to increased imports from other developed nations. Significantly, as New Zealand's comparative advantage lies in agriculture-related products and these commodities make intensive use of unskilled labour, when changes in both imports and exports are considered, it was found that increased trade has decreased wage inequality in New Zealand. In other words, due to the structure of the New Zealand economy, the direction of changes in relative wages resulting from increased trade is different to that in most developed nations. As both the skill premium and the relative supply of skilled labour have risen in New Zealand, the US, and the UK (and other developed nations) in recent decades, these findings provide compelling evidence that a factor other than trade – such as skilled biased technical change – was responsible for the deteriorating relative position of unskilled workers in developed countries.

Two limitations concerning our study should be noted. First, our analysis does not disclose what forces increased wage inequality. Instead, like other studies (McDougall and Tyers, 1994; Cline, 1997; Tyers and Yang, 2000; Abrego and Whalley, 2000), in the absence of a strong link between trade and wages we presume that skill-biased technical change was the culprit. Second, we do not consider the indirect effect trade may have on relative wages via trade-induced technical change or outsourcing.

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Table 1: Cross-country comparisons, 2001

	New Zealand	US	UK
Trade (exports plus imports) relative to GDP, %	75.2	21.8	54.7
Imports from RDEs relative to GDP, %	5.8	3.1	3.1
Unskilled-intensive manufacturing imports relative to GDP, %	11.7	7.3	6.2

Note: Countries categorised as RDEs and unskilled-intensive manufacturing sectors are listed in Table 2.
Source: GTAP 6 database (Dimaranan and McDougall, 2006).

Table 2: Regional and commodity aggregation

Regions	Commodities
1. **New Zealand** 2. **Other Developed** Australia, Canada, EU15 (Austria, Belgium, Denmark, Finland, France, Germany, Great Britain, Greece, Ireland, Italy, Luxemburg, Netherlands, Portugal, Spain, Sweden), Japan, United States 3. **Rapidly Developing Economies** China, Hong Kong, Taiwan, Korea (Rep.), Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam 4. **Rest of World (ROW)** All other regions	1. **Agriculture** Vegetables, fruits and nuts; bovine cattle, sheep and goats, horses; animal products not elsewhere classified (nec); raw milk; wool; forestry; paddy rice; wheat; cereal grains; oil seeds; sugar cane, sugar beet; plant-based fibres; crops nec; fishing 2. **Minerals** Coal, oil, gas, mineral nec 3. **Food manufacturing** Bovine meat products; meat products nec, dairy products, vegetable oils and fats; processed rice, sugar, food products nec, beverages and tobacco products 4. **Mineral manufacturing** Petroleum, coal products; chemical, rubber, plastic products; mineral products nec 5. **Unskilled manufacturing** Textiles, wearing apparel, leather products, wood products, motor vehicles and parts, transport equipment nec, manufactures nec 6. **Skilled manufacturing** Paper products, publishing; ferrous metals; metals nec; metal products electronic equipment; machinery and equipment nec 7. **Services** Electricity; gas manufacture, distribution; water; construction; trade; transport nec; water transport; air transport; communication; financial services nec; insurance; business services nec; recreational and other services; public administration, defence, education, health; dwellings

Table 3: New Zealand labour cost shares in value added by qualification

	No qualification	School qualification	Vocational qualification	Degree qualification
Agriculture	0.281	0.397	0.233	0.088
Minerals	0.327	0.267	0.272	0.134
Food manufacturing	0.333	0.371	0.190	0.107
Mineral manufacturing	0.246	0.376	0.220	0.158
Unskilled manufacturing	0.270	0.388	0.273	0.069
Skilled manufacturing	0.175	0.360	0.316	0.149
Services	0.129	0.334	0.271	0.266

Source: Employment data are taken from the 2001 Census of Population and Dwellings and wage data are sourced from the 2001 New Zealand Income Survey.

Table 4: New Zealand sectoral exports, imports and labour cost shares

	Imports	Exports	Labour cost
Agriculture	0.018	0.122	0.091
Minerals	0.034	0.008	0.004
Food manufacturing	0.058	0.340	0.060
Mineral manufacturing	0.158	0.089	0.033
Unskilled manufacturing	0.239	0.109	0.060
Skilled manufacturing	0.291	0.146	0.065
Services	0.203	0.186	0.687
Total	1.000	1.000	1.000

Source: GTAP 6 database (Dimaranan and McDougall, 2006).

Table 5: New Zealand trade shares, 2001

	Other developed	RDEs	Rest of world
	Imports		
Agriculture	0.646	0.117	0.237
Minerals	0.133	0.108	0.759
Food manufacturing	0.799	0.133	0.067
Mineral manufacturing	0.706	0.188	0.106
Unskilled manufacturing	0.742	0.203	0.055
Skilled manufacturing	0.759	0.213	0.029
Services	0.720	0.132	0.148
Aggregate	0.718	0.180	0.102
	Exports		
Agriculture	0.559	0.354	0.087
Minerals	0.727	0.097	0.176
Food manufacturing	0.543	0.257	0.200
Mineral manufacturing	0.715	0.180	0.104
Unskilled manufacturing	0.775	0.144	0.081
Skilled manufacturing	0.685	0.226	0.089
Services	0.742	0.102	0.156
Aggregate	0.645	0.215	0.140

Note: The final row in each segment lists regional trade shares and other cells display regional trade shares for each commodity.
Source: GTAP 6 database (Dimaranan and McDougall, 2006).

Table 6: Exogenous changes in New Zealand imports relative to GDP, 1980-2001, %

	Other Develop.	RDEs	Rest of World	Aggregate
Agriculture	-4.27	-74.46	-42.10	-31.79
Minerals	77.07	-53.84	-5.17	-14.41
Food manufacturing	204.11	303.69	594.19	224.86
Mineral manufacturing	21.33	-39.64	-54.73	-8.56
Unskilled manufacturing	47.25	338.73	385.93	76.12
Skilled manufacturing	25.40	1238.08	392.20	59.04
Total	36.58	70.21	-6.13	36.02

Source: GTAP 6 database (Dimaranan and McDougall, 2006).

Table 7: Changes in New Zealand wages due to import changes, 1980-2001, %

Skill classification based on:	Occupations	Qualifications
	When there are two labour types	
$w_{skilled}$	4.580	4.104
$w_{unskilled}$	3.673	3.351
$w_{skilled}/w_{unskiled}$	0.875	0.729
	When there are four labour types	
w_{degree}		4.905
$w_{vocational}$		3.825
w_{school}		3.828
$w_{no\ qualification}$		3.339
$w_{degree}/w_{vocational}$		1.040
w_{degree}/w_{school}		1.037
$w_{degree}/w_{no\ qualification}$		1.515

Note: The skill classification based on occupational data is taken from the GTAP database (Dimaranan and McDougall, 2006), labour groupings based on educational attainment are described in the text, and wage changes are deflated by a consumer price index.
Source: Model simulations described in the text.

Table 8: Changes in New Zealand sectoral prices, output and imports when two labour types are identified using occupational data, 1980-2001, %

	Price	Output	Imports
Agriculture	0.000	0.977	-31.79
Minerals	1.951	11.777	-14.41
Food manufacturing	-0.738	-1.266	224.86
Mineral manufacturing	0.785	4.455	-8.56
Unskilled manufacturing	-4.315	-14.554	76.12
Skilled manufacturing	-4.078	-13.944	59.04
Services	0.866	2.221	-1.303

Note: The domestic price of agriculture in New Zealand is chosen as the numéraire
Source: Model simulations described in the text.

Table 9: Decomposition of changes in the skilled-to-unskilled relative wage due to imports when two labour types are identified using occupational data, 1980-2001, %

	Other Develop.	RDEs	ROW	All regions
Agriculture	-0.003	-0.027	-0.015	-0.044
Minerals	0.004	-0.016	-0.003	-0.014
Food manufacturing	0.135	0.026	0.015	0.189
Mineral manufacturing	-0.020	-0.016	0.012	0.012
Unskilled manufacturing	0.266	0.200	0.048	0.533
Skilled manufacturing	0.082	0.111	0.012	0.171
All sectors	0.476	0.317	0.071	0.875

Source: Model simulations described in the text.

Table 10: Decomposition of changes in the degree-to-no-qualification relative wage due to imports, 1980-2001, %

	Other Develop.	RDEs	ROW	All regions
Agriculture	0.000	0.003	0.002	0.005
Minerals	0.003	-0.012	-0.002	-0.011
Food manufacturing.	0.194	0.038	0.021	0.272
Mineral manufacturing	0.009	-0.013	-0.009	-0.011
Unskilled manufacturing	0.548	0.402	0.096	1.116
Skilled manufacturing	0.058	0.075	0.010	0.089
All sectors	0.833	0.510	0.121	1.515

Source: Model simulations described in the text.

Table 11: Changes in New Zealand wages due to changes in imports and exports, 1980-2001, %

Skill classification based on:	Occupations	Qualifications
	When there are two labour types	
$w_{skilled}$	2.274	3.786
$w_{unskilled}$	5.363	6.899
$w_{skilled}/w_{unskiled}$	-2.931	-2.912
	When there are four labour types	
w_{degree}		2.435
$w_{vocational}$		3.791
w_{school}		4.639
$w_{no\ qualification}$		6.930
$w_{degree}/w_{vocational}$		-1.307
w_{degree}/w_{school}		-2.103
$w_{degree}/w_{no\ qualification}$		-4.203

Note: The skill classification based on occupational data is taken from the GTAP database (Dimaranan and McDougall, 2006), labour groupings based on educational attainment are described in the text, and wage changes are deflated by a consumer price index.
Source: Model simulations described in the text.

Table 12: Changes in degree-no-qualification and degree-vulnerable wages due to import changes when vulnerable labour is imperfectly mobile

Elasticity of transformation	$w_{degree}/w_{vulnerable}$	$w_{degree}/w_{no\ qual.}$
0	13.638	0.366
2	6.170	1.052
4	4.394	1.225
6	3.599	1.304
8	3.148	1.349
10	2.858	1.378
∞	1.515	1.515

Appendix: Skill classification and augmentation of the GTAP database

Our skill classification draws on two data sources: (a) we collect data on employment by 1996 Australia New Zealand Standard Industry Classification (ANZIC96) four-digit industries and highest qualification attained from the 2001 New Zealand Census of Population and Dwellings (Statistics New Zealand 2001a); and (b) we source data on average hourly earnings and hours worked by highest qualification attained, from the 2001 New Zealand Income Survey (Statistics New Zealand 2001b). We use this data to calculate labour cost shares by qualification for each ANZIC four-digit industry.[17] For GTAP sectors not related to agriculture or food manufacturing (sectors 14-18 and 27-57) these data are mapped onto the New Zealand component of the GTAP database using an ANZSIC-International Standard Industrial Classification (ISIC) concordance taken from ABS (1993), and an ISIC-GTAP concordance provided by Dimaranan and McDougall (2002). For GTAP sectors not related to agriculture or food manufacturing, our mapping of cost shares draws on a concordance adapted from Mastoris and Travis (1998, Table 14.2.A2).[18]

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[17] Due to data limitations, these calculations assume that average hourly earning and hours worked by qualification do no differ across industries.

[18] It is necessary to create several aggregated GTAP sectors to complete our ANZIC-GTAP concordance. Composite sectors include: cereals and grains (paddy rice, wheat, cereal grains nec, oilseeds, sugar), other crops (fruits, vegetables and nuts; crops nec), animal products (bovine cattle, animal products nec, raw milk), oil and gas (oils and gas), other food (processed rice and vegetable oils and fats).