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EXPLAINING INTERNATIONAL DIFFERENCES IN THE PRICES OF TRADABLES AND NON-TRADABLES (WITH A NEW ZEALAND PERSPECTIVE)*

by

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with

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EXECUTIVE SUMMARY

The World Bank's International Comparison Program (ICP) data on national price levels for tradables and non-tradables (and goods compared to services) reveals that New Zealand has relatively high prices of both tradables and non-tradables when compared to a sample of over 40 OECD-Eurostat countries (Gemmell, 2013). The present paper seeks to explain both those observed international variations in non-tradables and tradables prices in general, and New Zealand's especially high prices in particular.

The paper outlines an established model of the determinants of international differences in the prices of non-tradables. This model essentially explains these non-tradables price differences as due to differences across countries in the prices of tradables, countries' factor endowments (capital, labour etc.) and population sizes – both of which potentially affect the supply of, and demand for, non-tradables in each country. The paper also argues that a country's price of non-tradables can be expected to affect its domestic consumer price of tradables due to the tendency for non-tradables to be 'embodied' within tradables at the consumer expenditure level – via non-tradable transport costs, warehousing, wholesale and retail margins, etc. The 'extended' model allows for this feedback effect of non-tradables prices onto tradables prices.

The overall empirical messages from this applying this analysis to the latest (2005) ICP data are:

Applying the international data to the extended FG model suggest that the model generally fits well especially for a group of OECD-Eurostat countries. Results differ from the earlier test of the model (in 1991, on 1980s data) with respect to the price effects of labour endowments: non-tradables now appear to be relatively intensive in their use of *skilled*, rather than *unskilled*, labour, especially for an OECD sample. Larger endowments of skilled labour (other things equal) tend to lower the price of non-tradables.

In addition, the model fits NZ fairly well. For example, in terms of understanding the determinants of *non-tradables* prices in NZ, the 'fit' for NZ is similar to that for other OECD countries on average. Understanding how far non-tradables prices might feed into domestic consumer prices of *tradables*, the model also produces plausible outcomes, including for New Zealand.

However, NZ's especially high price of tradables remains difficult to explain even after accounting for the effect of non-tradable costs on the domestic price of tradables. The 'best' regression model does a fairly good job of explaining tradables prices in general but, this produces a relatively large under-estimate of NZ tradables prices (see Figure 3). Also, though NZ's 'unexplained component' of the price of non-tradables is relatively large compared to the OECD-Eurostat sample average, NZ is **not** an outlier in the model.

This implies that for NZ, as for other countries, the impact of non-tradables prices on the consumer price of tradables is an important part of understanding why *tradables* consumer prices differ across countries. However, for NZ, there remains a relatively large component of tradables price differences that, within the model, are regarded as capturing exogenous trade impediments (broadly defined) or indirect taxes. In NZs case it seems more likely that the former dominate, since general indirect taxes such as GST/VAT are not unusually high in NZ.

Decomposing price differences into the factor endowments etc. that influence them, the evidence suggests that:

- *Non-tradables* prices are *higher* in association with higher values of capital and unskilled labour endowments, and trade deficits;
- *Non-tradables* prices are *lower* in association with higher values of skilled labour, and population;
- *Tradable* prices also tend to be *higher* where non-tradables prices are higher both because this raises the (non-tradable) input costs for tradables, and because high tradables prices are impacted by 'other (excluded) factors' such as trade impediments and indirect taxes.

For New Zealand in particular, the model suggests our relatively *small population* and *high tradables prices* tend to raise non-tradables prices relative to other countries. Also, it is often argued that NZ has relatively low capital endowments. If so, this relatively low capital endowment should serve to counter-act these high prices. However, NZ's capital endowment and capital-to-labour ratios in the dataset are not especially low within the OECD-Eurostat sample: for these two variables NZ ranks respectively 25th and 28th, among the 43 OECD-Eurostat countries. Most of the countries below NZ, however, are the emerging economies of Eastern Europe.

On labour endowments, examining the ratio of skilled labour (differences) to population (differences), NZ is ranked 29th out of the 43 OECD-Eurostat countries in this ratio. As a result, NZ's relatively low levels of skilled labour per capita also serve to raise its service prices.

According to our estimates, NZ's relatively high price of non-tradables adds, on average, around 35-40% to the domestic consumer price of tradables, compared to border or factory gate prices. This is around the OECD-Eurostat cost share sample average (37%), with a sample range of 18% to 56%. After accounting for this 'cost share of non-tradables' contribution, NZ's tradables prices remain fairly high by international standards. A potential candidate explanation for this is the effect of high transaction costs associated with NZ's distance from markets though we have not examined direct evidence on this.

Based on 'adjusted' tradables prices that remove the cost share of non-tradables element, NZ tradables prices are around 6th highest in the 43 country OECD-Eurostat sample – behind such countries as Iceland, Norway and Japan (see Figure 6). These are also countries that are relatively distant from many of their key markets. However, Australia is ranked 19th out of 43 countries in its adjusted tradables price, suggesting that to the extent that there are 'disadvantages of distance', Australia manages partially to avoid or overcome these (see also McCann, 2009).

Like NZ, a number of other *small* countries have high adjusted tradables prices (e.g. Cyprus, Malta, Denmark, Finland, Israel), suggesting that size or other characteristics of domestic markets/populations may also be important, in ways not already accounted for by the model we have tested.

Explaining International Differences in the Prices of Tradables and Non-tradables

1. Introduction

An earlier report to the Productivity Commission (NZPC)[1] examined International Comparison Program (ICP) data from the World Bank on the relative prices of goods and services across countries, in 2005. The objective was to identify how far these prices differ across countries and how far New Zealand's goods and service prices are similar to, or different from, those observed in other OECD countries and Australia in particular. That examination confirmed substantial differences across countries in the 'internationally comparable prices' (based on purchasing power parity (PPP) exchanges rates) of similar goods and services. It also identified a number of good/service categories where New Zealand (NZ) appeared to be especially high or low relative to an OECD average or Australia.[2]

The purpose of the present paper is three-fold:

1. To re-evaluate, using the 2005 ICP data, previous explanations for observed international differences in non-tradables prices;[3]
2. To extend the conceptual modelling of non-tradables price differences to *joint modelling* of tradables and non-tradables price differences and test this empirically on the same ICP data; and
3. To consider how far each of those modelling approaches helps understand the observed deviations of New Zealand's tradables and non-tradables prices from those in other countries.

Why are prices of comparable goods and services different across countries?

Answering the question of *why* prices of some goods and services differ across countries, and what determines New Zealand's price differences in particular, is not a straightforward exercise. This is in part due to difficulties devising suitable theoretical models to test, and in part due to problems identifying suitable data and empirical testing methods. In general, previous explanations of international price differences rely on different approaches for *tradables* and for *non-tradables*.

For tradables, the key question has been to query whether the 'law of one price' (LOOP) holds. Namely, are prices for the same tradable goods the same in different countries when converted to a common currency? If not, what trade impediments, exchange rate 'misalignments'

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1 See Gemmell (2013).

2 Goods and services associated with *investment* in general, and *property, construction* and *utilities* (water, gas, electricity) in particular, appear to be relatively expensive in NZ. These are largely non-tradable and/or service in nature. Public transport, alcohol, tobacco and the capital costs of public services also appear high in NZ. Among NZ's cheapest items by international standards were dairy and beef products. See Gemmell (2013).

3 Similar ICP price data have been collected for 2011 but are not yet publicly available. However national price level data, for GDP, are available and suggest that the New Zealand's aggregate price level is somewhat higher in 2011 (112) than in 2005 (105); the OECD average price level = 100 in both years. See Appendix 2 for a cross-country comparison.

or other factors might explain observed divergences? There is a diverse literature attempting to address this question, much of it at the macro level focused on identifying convergence of purchasing power parity exchange rates across countries over the long-run or, at the micro level, examining international prices of specific traded products such as household goods and cars.[4]

Goldberg and Verboven's (2005, p.50) conclusion from this evidence was that "the slow speed of convergence documented in international markets remains a puzzle". Their evidence that there are, at least across Europe, substantial country-specific differences in suitably measured tradable prices, is consistent with more recent observations, based on 2005 ICP data, that tradables prices seem a long way from equality.[5] Using PPP exchange rates, our earlier report confirmed substantial differences in tradables prices across ICP countries.

Surprisingly, the ICP dataset appears not to have been exploited previously to address *reasons* for international tradables price differences – an exception being the unpublished Falvey and Gemmell (2000) paper applied to a more limited 1980 ICP dataset.

Early contributions to explanations of international differences in *non-tradables* prices, including some based on earlier ICP data, include Bhagwati (1984), Clague (1985) and Bergstrand (1991).[6] They focused on the observation that international differences in non-tradables prices tended to be associated with differences in per capita income levels across countries.[7] Building on these contributions, Falvey and Gemmell (1991, 1995, 1996a,b, 1999) argued that prices and per capita income levels were jointly determined, hence the latter should not be used to 'explain' the former.

Instead, Falvey and Gemmell (1991) proposed a general trade model with a non-traded sector to explain the correlation between non-tradables prices and income levels. This relied on international differences in population sizes, factor endowments (agricultural land, labour, capital, mineral wealth), trade policies and trade balances. Applying the approach to an ICP sample of 60 countries in 1980, this suggested that non-tradables price levels tend to be higher in countries where capital and agricultural land endowments are higher, but labour endowments and population are lower.

A weakness of the Falvey-Gemmell (1991) approach is that it treats the prices of tradables as exogenous (as if fully determined on world markets plus exogenous country-specific 'impediments'), and then uses these to help 'explain' non-tradables prices. It therefore did not attempt to explain why these *tradables* prices are observed to differ across countries. However, since the ICP price data relates to final expenditure-based prices faced by consumers or investors, these tradables prices might be expected to be affected by any non-tradable inputs used to

4 See, for example, Haskel and Wolf (2001) who examine prices across countries of goods sold in IKEA stores, and Goldberg and Verboven (2005) who compare cross-European car prices. Rogoff (1996) provides a review of literature, up to the mid-1990s, on the 'PPP puzzle'.

5 See, for example, Thomas *et al.* (2008, 2013), Gemmell (2013).

6 For modelling purposes in this literature 'non-tradables' are often treated as synonymous with 'services'. In some empirical applications this is amended such that non-tradables equals services plus construction.

7 Thomas *et al.* (2013) find a similar association between per capita income levels and the prices of tradables and non-tradables.

transform or 'deliver' tradables from the border or factory gate to the consumer. As a result observed consumer prices of tradables are likely to be affected by the price of non-tradables as well as vice versa.[8] These effects are in addition to any international differences in indirect tax levels that have country-specific effects on domestic tradables prices, and any transaction costs such as country-specific trade impediments (e.g. tariff and non-tariff barriers) and international transport costs associated with geographic distance.[9] We explore this aspect with the ICP data below.

The remainder of this paper is organised as follows. Section 2 summarises the Falvey-Gemmell (FG) approach to non-tradables modelling and describes the extension to joint modelling of non-tradables on tradables prices. Section 3 highlights key features of the ICP and related data, applies both approaches to the data using regressions analysis, and interprets the regression results. Section 4 considers the implications of these results for understanding New Zealand's price differences. Section 5 concludes.

2. Modelling International Differences in Tradables and Non-tradables Prices

FG (1991) developed a model in which inter-country differences in non-tradables prices and real income per capita are expressed in terms of the underlying differences in factor endowments, trade balances, populations, and prices of traded goods.[10] FG assumed that all countries have access to the same productive technologies; hence abstracting from technology-based sources of per capita income and price differences.[11] Since the purpose was to estimate a resulting non-tradables price relationship, FG focused on developing a trade model with a non-traded good from which an empirical estimating equation could be obtained suitable for this purpose. That is, the model specified a set of non-tradables price determinants that involve observable exogenous variables and whose parameters can reasonably (or of necessity must) be treated as constant across countries. This model is described in detail in the Appendix 1. Below we give a non-technical summary and the resulting estimating equation.

The basic model

At the centre of the FG model is a representative individual, in a given country of N individuals, each maximising utility from consumption of a tradable and a non-tradable. For the non-tradable, the sum of all individuals' expenditure, Ne_n, must come entirely from of domestic production, G_n, whereas for the tradable, expenditure equals the value of domestic production consumed plus imported tradables, (Ne_t.= G_t + b_t), where b_t is net imports or, equivalently, the trade deficit. Aggregated across these N individuals, this gives an expression for total expenditure equal to total domestic production of tradables and non-tradable plus the trade deficit.

[8] This point was recognised by Heston *et al.* (1994, p.233-4), who adjusted some ICP tradables prices based on guesses regarding the possible magnitude of non-tradable components embedded in tradables price data.
[9] See, for example, Sarno *et al.* (2003), Juvenal and Taylor (2008) and Crucini *et al.* (2010).
[10] The FG analysis was generally explored in terms of 'services', rather than 'non-tradables'. However it is the non-tradable nature of the activities, rather than any service characteristic, that is essential to the model outcomes. We refer throughout below to non-tradables rather than services.
[11] See Falvey and Gemmell (1996b) for a model incorporating international productivity differences.

Domestic production of tradables and non-tradables both involve inputs from a set of (non-traded) factor endowments, V, where the intensity of use of each factor can vary across sectors. In their empirical analysis FG consider four factors: capital, labour, agricultural land and mineral wealth (with some attempt to split labour into skilled and unskilled components).

Now treat the above country as the 'numeraire' country against which a second country is being compared where, for the second country, equivalent variables are denoted by an asterisk superscript (*); e.g. V^*, N^*, etc. The model then considers how differences in factor endowments, population sizes etc. and expenditures give rise to differences in the non-tradables price across the two countries, involving pairwise comparisons of dp_n ($= p_n^* - p_n$), dV, dN etc. The domestic price of tradables in each country is determined by 'world prices' plus any (assumed exogenous) country-specific trade impediments, both natural and policy-induced. Cross-country differences in the price of non-tradables, however, are determined by whether, if the numeraire country price, p_n, held in the non-numeraire country - where the set of endowments, populations etc. may differ - this would generate an excess supply or demand of non-tradables.

An excess supply would imply a lower price of the non-tradable in the non-numeraire country and an excess demand would imply a higher non-tradable price. Imagine, for illustration that non-tradables use no capital in their production. In this case a higher endowment of capital in a country, holding all other characteristics constant, implies higher demand for non-tradables but no additional supply. The demand-side effect of this higher capital (via higher expenditures on non-tradables) would tend to raise the price of non-tradables relative to the numeraire country.

As Appendix 1 shows the model allows expressions for differences in per capita expenditure (de) and difference in the non-tradables price (dp_n) across countries to be derived, the latter taking the form:

$$dp_n = b_{1,i}dV_i + b_2e^*dN + b_3db + b_4dp_t \qquad (1)$$

where i represents the factor endowment differences: for i = capital (K), skilled labour (SL), unskilled labour (UL), land (D) and minerals (M); e^* is expenditure per capita in the non-numeraire country, and the b_j ($j = 1 \ldots 4$) are parameters to be estimated. These parameters represent terms treated as constant across countries – such as the shares of tradables/non-tradables in total expenditure that arise from assumed common consumer preferences and technology across countries. (See Appendix 1 for derivations)

A number of points about the b_j parameters should be noted:

1. The $b_{1,i}$ parameters capture the net effect of the relevant factor endowment on supply and demand. Where a factor, e.g. labour, contributes more to supply (because non-tradables are intensive in use of that factor) than to demand for non-tradables, the parameter is expected to take a negative sign. That is, more of this factor (in one country) reduces the price of non-tradables relative to the price in the numeraire country. A converse argument applies for a positively signed $b_{1,i}$ parameter. Note, however, that the theory predicts a zero, or near zero, parameter whenever the net effect of the factor

endowment difference on non-tradables demand and supply are similar in magnitude. Hence a zero parameter estimate in regressions on (1) need not indicate 'no effect'.[12]

2. It can be shown that, when all factor endowments are considered, at least one factor should take a negative sign, and at least one take a positive sign, in regressions on (1). This reflect the two-sector model's requirement that non-tradables must be *relatively* intensive in at least one factor (negative sign) and, by symmetry, relatively 'non-intensive' in at least one other (positive sign).
3. It can be shown that the income elasticity of demand for non-tradables can be derived from combining parameters b_2 and b_3. This elasticity is often of interest since it indicates the extent to which higher income countries might be expected to have higher or lower non-tradables real output, and real output share: an income elasticity larger than 1 indicating a higher non-tradables output share at higher income levels.
4. The parameter on ($e^* dN$), b_2, may be positive or negative. A higher population ($dN > 0$) raises or reduces the net demand for non-tradables at their initial prices, depending on whether the average propensity to spend on non-tradables (a_n) is greater or less than the corresponding marginal propensity (m_n) associated with the higher population; see Appendix 1. In effect, the same total real expenditure is now allocated over a larger number of 'representative' consumers, and b_2 captures the magnitude of this 'reallocated' expenditure on the non-tradables price.[13]
5. A higher price of tradables ($dp_t > 0$) or a higher trade deficit ($db > 0$), both unambiguously increase the net demand for non-tradables at the initial non-tradables price. Hence both serve to raise the non-tradables price.

Equation (1) therefore provides a number of clear predictions regarding the impact of differences in the various right-hand-side (RHS) variables on the cross-country price difference for non-tradables.

Extending the model

We noted above that, in the FG (1991) model, differences in the price of tradables across countries could arise from country-specific trade impediments – such as tariff and non-tariff barriers, transport costs etc. – which cause the domestic consumer price of tradables to vary across countries even when all countries face the same 'world price'. However that model ignored the possibility that, if tradables require some non-tradables to 'deliver' them from the border or factory gate to the consumer, then the observed consumer price of tradables can be expected to include the costs of those non-tradable inputs. These would include such inputs as domestic transport costs, warehousing, wholesale and retail trade costs and indirect taxes.

[12] Of course, a $b_{1,i}$ parameter that is small and statistically insignificantly different from zero could also indicate that the variable fails to affect non-tradables price differences for a variety of data-related and/or statistical reasons, or that the theory is not supported even by reliable data.

[13] Note that, for given since endowments (e.g. labour), the higher population effectively means a lower participation rate.

In Appendix 1 we show how these non-tradable costs of delivering tradables to the consumer can be incorporated into the model. In essence this distinguishes three tradables prices - the domestic consumer price (p_t), the domestic producer price π_t, and the 'international' price ($\overline{\pi}_t$). There are also two non-tradables prices – the domestic consumer price (p_n) and the domestic producer price (π_n). The tradables producer price can deviate from the 'international price' due to the impact of trade impediments, such as transport costs on prices. And the consumer price of tradables deviates from the producer price due to the additional cost of non-tradable inputs as described above. Allowance can also be made for indirect taxes adding further to the producer prices of both tradables and non-tradables. Thus the consumer price of tradables can be written as (where τ is the overall indirect tax rate - e.g. GST plus any excises expressed in ad valorem form):

$$p_t = [1 + \tau][\pi_t + \alpha\pi_n] = [1 + \tau]\pi_t + \alpha p_n \qquad (2)$$

In (2), the term α (which of necessity we treat as a constant across countries), measures the units of non-tradables required to deliver a unit of tradables from the factory or border to the consumer. The 'cost share' of non-tradable inputs in tradables prices is measured by $\alpha p_n/p_t$.

Appendix 1 shows that the effect of adding these influences on tradables prices is to generate a two-equation system similar to (1) explaining both prices. Thus:

$$dp_n = b_{1,i}dV_i + b_2e^*dN + b_3db + b_4d\Phi \qquad (3.1)$$

$$dp_t = \alpha b_{1,i}dV_i + \alpha b_2e^*dN + \alpha b_3db + \alpha b_4d\Phi \qquad (3.1)$$

where $d\Phi$ captures differences in the (combined) trade impediments and indirect taxes. It can be seen that the parameters in (3.2) are identical to the equivalent parameters in (3.1) except that they are each multiplied by α. In addition, without suitable cross-country data available on the impact on prices of trade impediments and indirect taxes (though a proxy for the latter is generally easier to obtain), empirical application of this system relies on subsuming the terms ($b_4d\Phi$) and ($\alpha b_4d\Phi$) into the regression intercepts and random error terms.

Together equations (3.1) and (3.2) suggest an estimate of α could be obtained by joint estimation of both equations, with α being derived as the ratio of the b_js from (3.2) to the b_js from (3.1). Two options to do this are:

(i) constrain the parameter estimates in (3.2) to be α times those in (3.1); or

(ii) jointly regress three equations: (3.1), (3.2) and (2) in the form of:

$$dp_t = b_0 + \alpha dp_n \qquad (3.3)$$

with unconstrained parameters.[14] The approach in (ii) yields both a direct estimate of α from (3.3), and indirect estimates from the ratios of the (3.2) to (3.1) parameters as above. We follow this latter approach, which allows testing for equality of the direct and indirect parameter estimates, in section 3.

3. Applying the Models to the Data

The Dataset

The dataset we work with is the ICP data on prices of around 150 'basic heading' items for 139 countries in 2005. These basic headings were divided into 'tradable' and non-tradable' categories based on Gemmell (2013) and an expenditure-share weighted average price for each was obtained. With the US price of both tradables and non-tradables equal to one (by construction of the ICP), this makes the US a convenient country to be the 'numeraire' country for our regressions such that other countries' values for the *dp* variables are simply their ICP prices minus one.

In addition to data on p_t and p_n, the ICP provides data on real expenditures per capita. We then obtained data for 2005 (or as close a year as possible) on countries' populations, and factor endowments for capital, skilled and unskilled labour, agricultural land area, and minerals. We used the sources, and followed the procedures, described in FG (1991); details are given in Appendix 1. As in FG, capital endowment data for 2005 was obtained by cumulating investment data for each country (sourced from the World Bank database) over the period 1980-2005, using an annual 10% depreciation rate.[15]

One difference from FG (1991) is that data limitations at the time meant their skilled/unskilled labour decomposition was fairly unreliable (they used school enrolment data) and they therefore focused on an aggregate labour endowment variable. However improved data on the primary, secondary and tertiary education skills *embodied in the labour force* are now available, covering a wide range of countries – though only for 79 of the 139 countries in the ICP sample.

We therefore constructed two alternative definitions of skilled/unskilled labour to be used in regressions:

(i) Only labour with *at least tertiary* education is regarded as 'skilled' with the remainder (secondary, primary and none) as 'unskilled'.
(ii) Labour with *at least secondary* education as 'skilled' and the remainder (primary and none) as 'unskilled'.

In general the distinction between the two measures has little impact on our results below.

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[14] The constant term, b_0, in (3.3) will include the omitted, $[1 + \tau]\pi_t$ in (2) – the numeraire country value. Provided these omitted variables (including those specified within $d\Phi$ in (3.1) and (3.2)) are uncorrelated with the included variables, their omission should not bias estimation of the parameters of interest.

[15] Using data from 1960 (which limits the sample,) and/or a 15% depreciation rate yielded country rankings of capital endowments that are very similar to those obtained using the lower depreciation rate and time-period.

Data on mineral endowments, proxied by mining share in GDP, is only available for a limited set of countries - around 76 of our 139 ICP sample, but only for 48 countries that also have data for the labour decomposition. In general, we therefore omit this variable from our regressions.[16] For the regressions below, we mainly work with the sample of 79 countries for which we have skilled/unskilled labour data and also with a sub-sample of 43 OECD-Eurostat counties as defined in the ICP dataset. Without the labour decomposition a maximum sample of 136 ICP countries is available.[17]

Cross-country data on non-tradables and tradables prices are shown in Figures 1A and 1B respectively. Figure 1A shows the 'top 70' non-tradables price countries ranked from highest to lowest with Figure 1B showing the tradables prices for the same countries and ordering. (Remaining ICP sample countries are shown in Appendix Figure A1.1 & A1.2).

It can be seen in Figure 1A that the relatively high income OECD countries feature prominently among the highest non-tradables price countries. Switzerland and Northern European countries such as UK, Ireland and the Scandinavian countries in particular have relatively high non-tradables prices on average. The US (= 1) is 16th highest and New Zealand is 19th highest.

The equivalent tradables prices, p_t, in Figure 1B (ranked by non-tradables price levels) display a similar pattern. They tend to decline from left to right, indicating the close correlation with p_n. (r = 0.88), but with some variations. New Zealand, for example, has the 9th highest average tradables price out of the 139 countries, whereas the US rank for tradables is 41st compared to 16th highest for non-tradables. It is clear then that, while New Zealand ranks relatively highly among international non-tradables prices, it has an especially high relative international price of *tradables*.[18]

Lastly, the close correlation between expenditure per capita and both of the price indices can be seen in Figure 2, which confirms the strong positive relationships. New Zealand is not obviously an outlier in the (partial) relationship with non-tradables prices, but is perhaps more likely to be a positive outlier for the equivalent tradables price relationship.

[16] Most sample countries' mining shares in GDP are, in any case, small with a few countries (such as major oil-producing economies) having atypically large mining shares.
[17] Iraq, Nigeria and Russia drop out of the 139 ICP sample due to lack of data on some other variables.
[18] Australia is ranked 18th highest and 16th highest respectively for non-tradables and tradables prices.

Figure 1A Average price of non-tradables by country (70 highest ranked countries out of 139; US = 1)

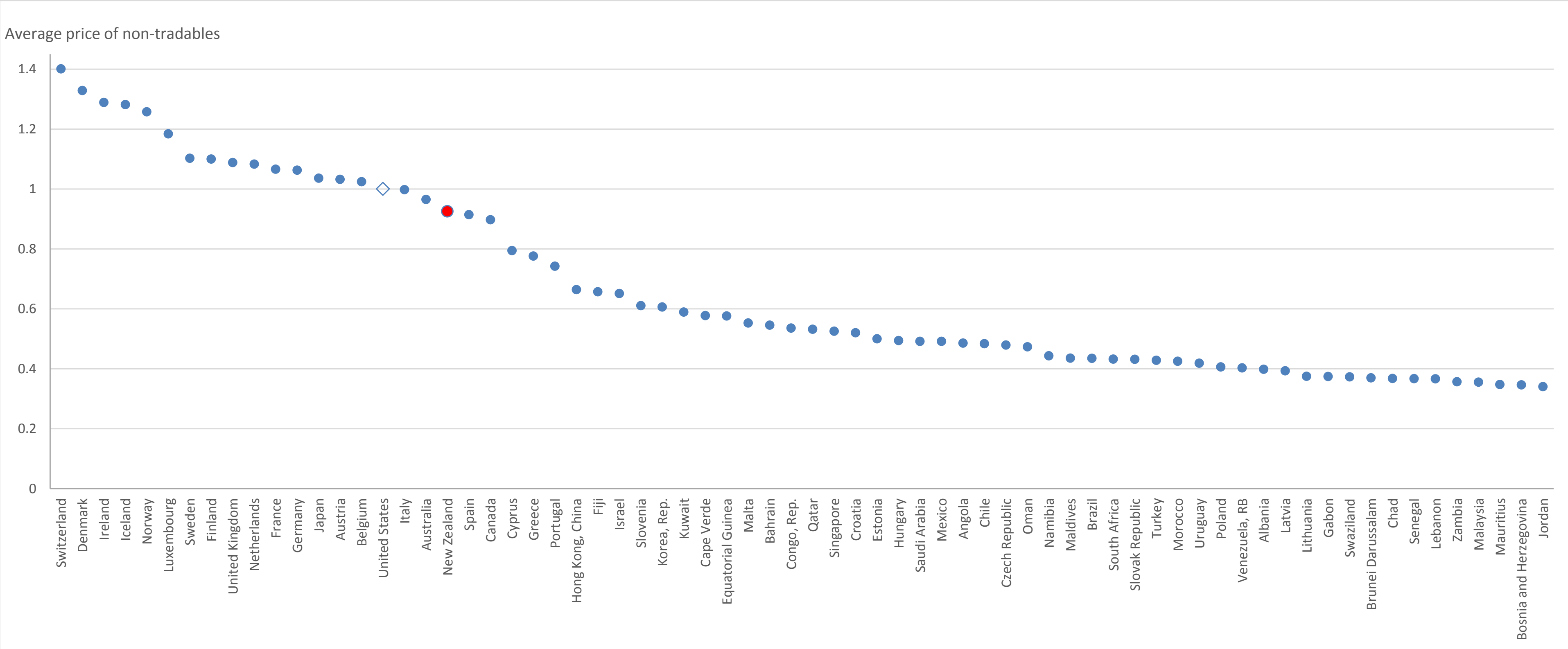

Figure 1B   Average price of tradables by country (70 highest ranked by *non*-tradables prices; US = 1)

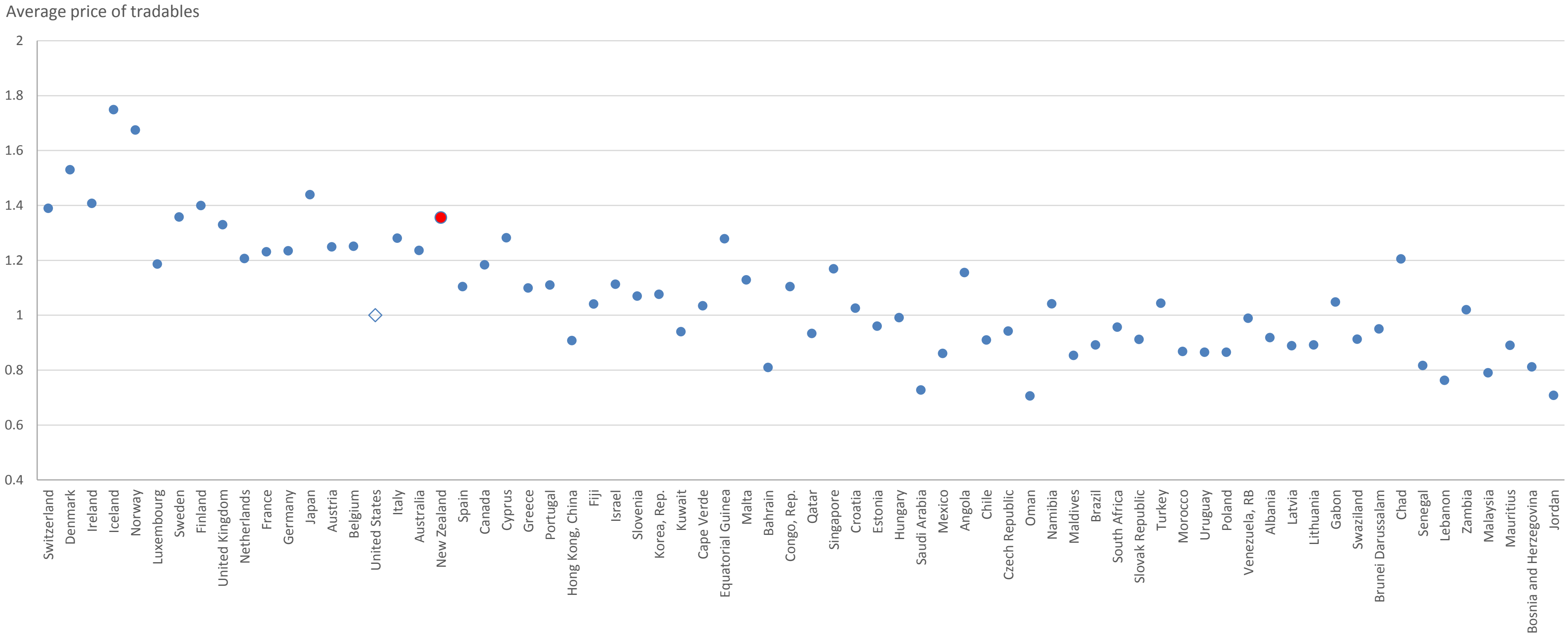

Figure 2 Average non-tradable and tradable prices and total expenditure per capita

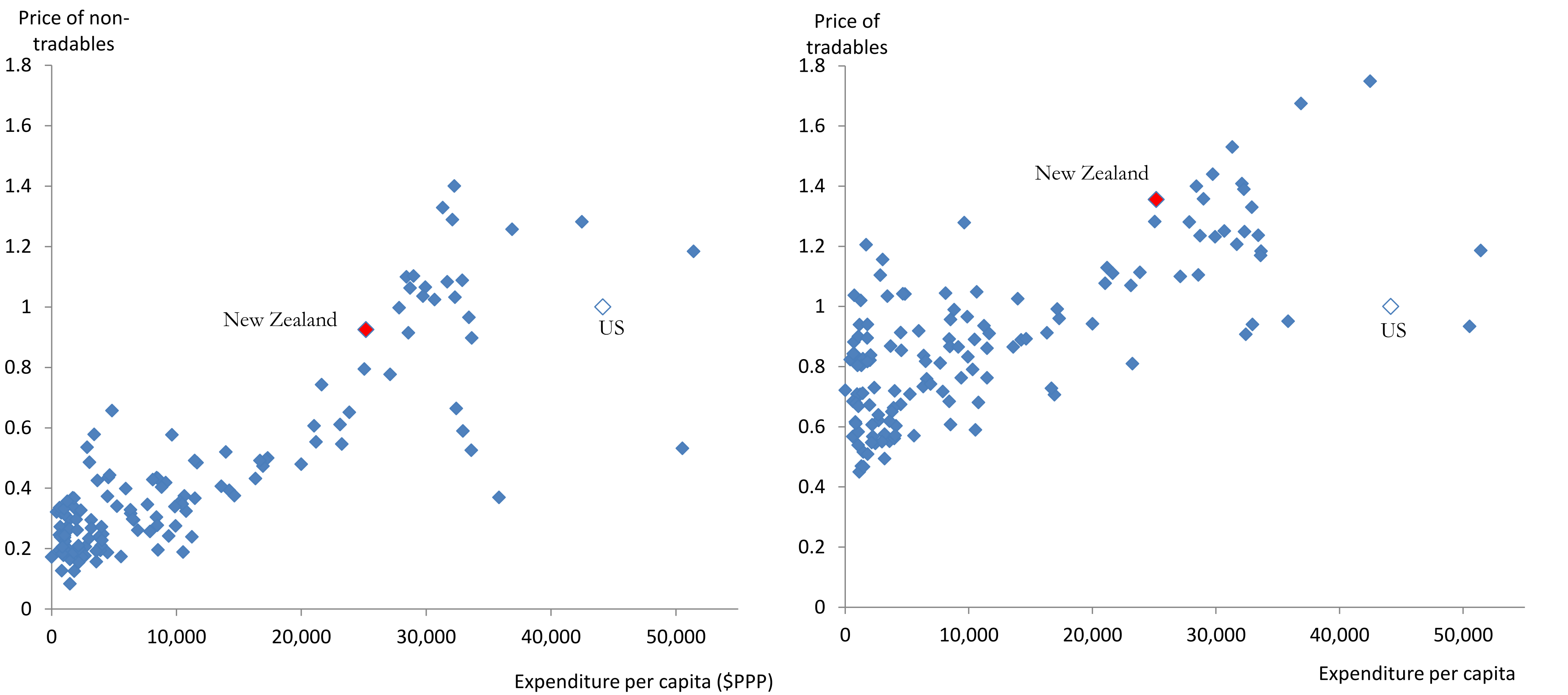

Table 1 Preliminary results for dp_n from single equation estimation

	OLS	Robust OLS	OLS	Robust OLS	OLS	Robust OLS
Tradables price	**0.655**	**0.464**	**0.668**	**0.529**	**0.682**	**0.530**
	0.077	0.050	0.083	0.072	0.086	0.072
	0.00	0.00	0.00	0.00	0.00	0.00
Land	**1.00E-05**	**-1.10E-03**	**0.001**	**-1.07E-04**	**4.14E-04**	**-5.13E-04**
	0.001	0.001	0.001	0.001	0.001	0.001
	0.99	0.15	0.54	0.89	0.65	0.54
Labour - skilled			**-2.18E-03**	**-1.55E-03**	**-8.69E-04**	**-2.39E-03**
			2.23E-03	1.78E-03	3.58E-03	4.07E-03
			0.33	0.39	0.81	0.56
Labour - unskilled			**1.43E-03**	**1.13E-03**	**2.85E-03**	**2.54E-03**
			7.73E-04	6.13E-04	1.11E-03	1.13E-03
			0.07	0.07	0.01	0.03
Labour	**1.27E-03**	**8.85E-04**				
	4.84E-04	4.61E-04				
	0.01	0.05				
Capital	**3.00E-05**	**7.40E-05**	**4.10E-05**	**8.10E-05**	**3.20E-05**	**8.30E-05**
	1.80E-05	1.00E-05	1.70E-05	1.10E-05	2.30E-05	2.10E-05
	0.09	0.00	0.02	0.00	0.17	0.00
Population	**-3.50E-05**	**-4.50E-05**	**-4.00E-05**	**-4.30E-05**	**-4.10E-05**	**-4.40E-05**
	7.00E-06	5.00E-06	7.00E-06	8.00E-06	7.00E-06	7.00E-06
	0.00	0.00	0.00	0.00	0.00	0.00
Trade Def.	**1.73E-04**	**-3.90E-05**	**2.78E-04**	**1.18E-04**	**2.28E-04**	**9.70E-05**
	4.56E-04	2.60E-04	5.68E-04	3.58E-04	5.49E-04	3.05E-04
	0.71	0.88	0.63	0.74	0.68	0.75
Intercept	**0.361**	**1.206**	**-0.211**	**0.553**	**0.133**	**0.933**
	0.506	0.350	0.576	0.398	0.571	0.377
	0.48	0.00	0.72	0.17	0.82	0.01
Sample size	132	132	79	79	76	76
Log-likelihood	104.7		65.5		62.6	

Note: For each parameter estimate (in **bold**), standard errors are shown below parameters, with p-values below standard errors.

Regression Estimates

Regression results based on equation (1) – with a constant and random error term added – for samples of 132, 79 and 76 countries are given in Table 1. The 132, rather than 136, sample is used because initial regressions suggested four substantial outliers (that remain influential for parameter estimates even when robust regression techniques are used). These are: China, India, Brazil and Russia: countries with *much* larger populations and labour endowments compared to the rest of the sample. Table 1 also reports on the 79 country sample for results involving the skilled/unskilled labour categories, and a 76 country sub-sample that again omits India, Brazil and Russia (China is not in the 79 country sample). Unless otherwise stated the skilled/unskilled classification used is the definition (ii) above of 'skilled' equal to 'at least secondary education'.[19]

Table 1 reports both linear OLS regressions and Robust OLS regressions in which outliers have been weighted according to their influence on the regression parameters.[20] This makes some difference to the statistical properties of the results but generally does not change the main interpretations.

For the largest sample, and no labour decomposition, Table 1 results suggest statistically significant positive effects on non-tradables prices from higher tradables prices, capital and labour endowments. There are no robust negative endowment effects, though 'at least one' was expected based on the FG (1991) model. Population differences, via their non-tradable expenditure effects, appear to have a negative impact on non-tradables prices. According to the model this reflects larger populations generating a marginal impact on non-tradable demand greater than the average (population) impact. We delay further discussion of this negative parameter till later results.

When the labour force is decomposed into skilled and unskilled components, albeit for smaller samples of 76 and 79 countries, the results suggest the previous robust positive effect of labour on non-tradables prices was due to *unskilled* labour effects. Skilled labour now takes a negative sign though p-values suggest a fair amount of 'noise' associated with these estimates. Also, trade deficits generally take the expected positive sign but again parameters are not precisely identified.

Compared to the original FG (1991) results, these new results suggest similar effects for this updated dataset except that FG found strong evidence in favour of negative labour impacts and positive land impacts, on non-tradables prices. This conformed to their expectation, at least for their sample of countries, that production of non-tradables – mainly services – tends to be labour-intensive (and perhaps unskilled labour-intensive) but not land-intensive, relative to tradables production. Our results here are more consistent with a hypothesis that non-tradables are more likely relatively intensive in *skilled* labour but not in *unskilled* labour, and merits some further investigation.

Distinguishing the labour-intensity of different non-tradables

The FG presumption that services/non-tradables would be labour intensive was based partly on the dominance of developing countries in their sample, where service sectors might be thought to be dominated by personal care services, restaurants/cafes etc, in which unskilled

[19] Regression parameters reported, for example in Table 1, often take small absolute values. This merely reflects the fact that variables are often measured in millions or billions (e.g. population or expenditure $s) whereas price indices take values around 1.

[20] We use the 'MM-estimation' robust regression technique in STATA. There are several different robust estimation methods, such as the M-estimation and S-estimation. The MM-estimation is chosen as it builds on both M and S estimation methods to achieve a breakdown point with high asymptotic efficiency (Yohai, 1987). In other words, regression estimates using the MM-estimation method are more robust to outliers and standard errors are expected to be smaller. The MM-estimation technique produces a set of robust weights: outliers are panelised by being given small weights (close to zero) and well-behave data receive larger weights (close to one). Robust weights are later used when applying the Seemingly Unrelated Regression Equation (SURE) methods.

labour is often presumed to be the primary input. Certainly capital inputs are generally thought to be relatively low compared with manufactures, most of which are tradable. However our sample includes 43 relatively developed OECD-Eurostat countries for which the presumed unskilled labour intensity may be incorrect. In addition, it is less clear for the 2005 dataset (compared to the 1980 data used by FG) that non-traded services are likely to be as intensive in unskilled labour. For example, modern service sectors in many countries are composed of large banking, finance and insurance services and government services, many of which might be best characterised as intensive in skilled labour use, rather than unskilled labour use. If so, the signs on the labour endowments in Table 1 may be plausible and consistent with the FG model.

To explore this, we first examined the expenditure shares in our sample at the basic heading level, and aggregated the non-tradable headings into groupings which we hypothesise are likely to be either skilled-labour intensive or unskilled-labour intensive. There is a residual category of presumed capital-intensive non-tradables such as 'housing rent'; see Table 2. (We are presuming here that these distinctions apply across all 79 sample countries, though clearly the technology for delivering a given non-tradable could differ across countries).

Table 2 Expenditure shares (%) of non-tradable sub-groups in total non-tradable expenditures

	Africa	Asia/Pacific	CIS	OECD-Eurostat	South America	West Asia	Total	Intensive in:
CLOTH. REPAIR SERVICES	1%	0%	0%	0%	0%	0%	0%	U
WATER, GAS, ELEC	4%	4%	5%	4%	4%	4%	4%	K
RENT (+ PROP SERV)	12%	15%	10%	16%	13%	15%	14%	K
APPLICANCE REPAIR	2%	1%	1%	1%	2%	2%	1%	U
PTE. MEDIC SERVICES	3%	3%	3%	5%	5%	3%	4%	S
PASS TRANSPORT SERVICES	6%	5%	6%	5%	9%	3%	6%	U
POSTAL SERVICES	2%	2%	4%	3%	4%	2%	3%	U
RECREATION SERVICES ETC	2%	2%	3%	4%	2%	1%	3%	U
EDUCATION (private)	6%	5%	4%	3%	5%	4%	4%	S
ACCOM, CATERERING	4%	6%	3%	7%	7%	3%	5%	U
PERSONAL CARE SERVICES	2%	2%	2%	4%	1%	1%	2%	U
FINANCIAL SERV. (FISIM)	0%	1%	0%	1%	0%	1%	1%	S
HEALTH (govt.)	2%	2%	5%	4%	4%	4%	3%	S
EDUCATION (govt.)	6%	5%	9%	7%	7%	9%	7%	S
GOVT. ADMIN.	23%	16%	16%	15%	15%	24%	18%	S
CIVIL ENG & BUILD.	26%	29%	30%	21%	20%	23%	24%	K
Skilled total	40%	33%	37%	35%	36%	45%	37%	
Unskilled Total	18%	19%	18%	25%	26%	13%	21%	

The far left-hand column of Table 2 shows the non-tradable groupings with the far right-hand column indicating the presumed intensity (S = skilled; U = unskilled; K = capital). Each row shows the average expenditure share for countries within each of the ICP regions, including the OECD-Eurostat region, and for all ICP countries. The final two rows show the sum of the skilled and unskilled categories. These suggest that the non-tradables which we hypothesise are more intensive in skilled, than in unskilled, labour account for around 33-45% of spending, which averages at 37% for the whole sample. Equivalent percentages for unskilled-intensive non-tradables are: 18-26%, averaging at 21% for the whole sample.

Clearly these allocations to skilled/unskilled categories are approximate and based on presumed factor intensities, but they at least suggest that spending on non-tradable services in our sample countries is not predominantly on items traditionally thought of as intensive in unskilled labour. Among the largest spending shares are education and health services, both private and government (the latter 'purchased' by governments on behalf of consumers). There is also a large share of expenditure (around 40%) on relatively capital intensive services such as civil engineering and household property rents. Hence it may not be correct to think of a country with a relatively large endowment of unskilled labour as likely to have a greater productive capacity for non-tradables.

If it is the case that some non-tradables are intensive in skilled labour while others are intensive in unskilled labour, we might expect this to be reflected in the labour endowment parameters in regressions of the form in equation (1), but where the dependent variable, dp_n, is replaced with the price of the relevant sub-aggregate of non-tradables: i.e. non-tradable, skilled (dp_{ns}) and non-tradable, unskilled (dp_{nu}).

Of course, as is shown in Appendix 1, equation (1) is derived as an 'exact' applied analogue of the theoretical equivalent in the FG model, with one tradable and one non-tradable sector. When separating the non-tradable sector into three sub-sectors, however, this is no longer the case. For example, as equation (A5) in the Appendix makes clear, a number of variables or parameters in the dp_n regressions include terms in the cross-price and own-price responses of the excess supply of the non-tradable. With three non-tradables there are potentially many more own-price and cross-price responses that become relevant, and a fully-specified version of equation (1) for three non-tradable sectors would be more complicated, with more ambiguity in parameter signs and interpretations that are less straightforward.

Nevertheless, under the assumption that these own- and cross-effects among the non-tradables sub-sectors are sufficiently small that they can be ignored here, separate regressions of the form in (1) for each of the skilled and unskilled non-tradables could be expected to reveal differences in the respective roles of labour endowments on non-tradables price differences.

We therefore re-ran the regressions in Table 1, but where the dependent variable is respectively dp_{ns} and dp_{nu}, for two sub-samples of countries: the full 79 countries available and the 43 country OECD-Eurostat sample. If it is the case that higher income countries tend to have relatively greater endowments of skilled labour, we might expect this to be reflected particularly in the parameter estimates for this OECD sub-sample. Results of this exercise are reported in Table 3.

To save space, only the parameters on the labour variables are shown in Table 3 (the regressions generally perform similarly to those in Table 1 in other respects). These Table 3 results at least partially support the above arguments. In particular, for *skill-intensive non-tradables* there is quite strong evidence (from both samples) that greater skilled labour endowments reduce the price of those non-tradables (as predicted), while higher endowments on unskilled labour raise prices.

For *unskilled-intensive non-tradables*, the evidence is less clear-cut. Though parameters on skilled labour endowments often also take a negative sign, a more reasonable interpretation for both skilled and unskilled endowment parameters is that these are indistinguishable from zero, with relatively large standard errors. In addition, even though the parameter on skilled labour is negative (in 3 of the 4 regressions), the point estimate is almost always less than its equivalent in the skill-intensive non-tradables regression (and, as noted, is statistically indistinguishable from zero).

A similar argument applies to the unskilled labour parameters: whereas these are robustly positive for skill-intensive non-tradables, they are smaller and statistically insignificantly different from zero for unskilled-intensive non-tradables. That is, as we would expect, there is less evidence that greater endowments of unskilled labour raise the price of unskilled-intensive non-tradables, than there is for skill-intensive non-tradables.

Overall, these results at least seem to confirm that especially for an OECD-Eurostat sub-sample, countries with larger skilled labour forces tend to have lower prices of those non-tradables that we hypothesised are skilled-labour intensive. This would be consistent with higher endowments of skilled labour boosting the supply of those non-tradables more than it boosts demand for them. That would appear not to be the case, however, for unskilled labour endowments. Unlike FG (1991), the evidence here suggests that greater unskilled labour endowments have either a net positive effect on non-tradables prices or an approximately net zero effect.

Table 3 Robust regressions for 'skilled-intensive' & 'unskilled-intensive' non-tradables

	Using skilled/unskilled (ii)		**Using skilled/unskilled (i)**	
	Skill-intens. nontradable	Unskill-intens. nontradable	Skill-intens. nontradable	Unskill-intens. nontradable
79 country sample:				
Labour - skilled	**-1.85E-03**	**-1.14E-03**	**-2.22E-03**	**-1.53E-03**
	1.83E-03	2.75E-03	3.62E-03	4.14E-03
	0.31	0.68	0.54	0.71
Labour - unskilled	**1.51E-03**	**7.47E-04**	**7.51E-04**	**3.15E-04**
	5.30E-04	9.67E-04	3.12E-04	2.76E-04
	0.00	0.44	0.02	0.26
Regr. Adj. R-sq	0.482	0.574	0.492	0.574
43 OECD-Eurostat sample:				
Labour - skilled	**-3.21E-03**	**3.31E-04**	**-1.25E-02**	**-2.99E-03**
	1.86E-03	2.44E-03	5.99E-03	4.83E-03
	0.08	0.89	0.04	0.54
Labour - unskilled	**3.80E-02**	**-2.30E-04**	**7.32E-03**	**1.03E-03**
	7.58E-03	2.66E-03	2.88E-03	2.79E-03
	0.00	0.93	0.01	0.71
Regr. Adj. R-sq	0.671	0.706	0.713	0.707

Note: For each parameter estimate (in **bold**), standard errors are shown below parameters, with p-values below standard errors.

Applying the extended FG model

As described earlier, we can test the extended FG model's hypothesis that the price of tradables is affected directly by the price of non-tradable inputs, captured via the endowment variables etc that are now hypothesised to affect both tradable and non-tradable prices in equation (3.1) and (3.2).

Returning to the case of a single, combined non-tradable sector, we do this by running both the dp_n and dp_t regressions simultaneously, using the Seemingly Unrelated Regression Equation (SURE) technique.[21] This allows for the possibility, explicit within our theoretical model, that the error terms of the two equations are correlated (since both error terms are acknowledged to include the same omitted variables: indirect tax differences, $d\tau$, and trade impediment differences, dz). We also include equation (3.3) in our set of equations to be tested simultaneously, which provides both a direct estimate, and a set of indirect estimates, of α - the units of non-tradables used to deliver tradables to the consumer.

Robust regression results for the 79 and 43 country samples are reported in Table 4a-c, using both of the skilled/unskilled definitions (Tables 4a, 4b) and for a larger sample with no labour decomposition (Table 4c). A number of features of these tables are worth noting:

1. Simultaneous estimation leads to much more precise parameter estimates for the endowment, population and trade deficit difference variables as manifested in lower p-values, and adjusted R-squared statistics (goodness of fit) generally around 0.7 – 0.9. Many of the parameter estimates are now significantly different from zero based on p-values of 10% or less.
2. Parameter estimates for skilled and unskilled labour now suggest much more robustly that higher endowments of skilled labour tend to reduce non-tradables prices and vice versa for unskilled labour.
3. Larger capital endowment and population differences are respectively (and robustly) associated with higher and lower non-tradables prices.
4. *Tradables* price differences also seem to be well explained by the endowment difference and other RHS variables suggesting that there is indeed a strong 'pass through' of the effect of these variables on *non*-tradable prices, onto *tradables* prices.
5. Simultaneous estimation of equation (3.3) to identify the value of α directly suggests a value around 0.81 based on the larger sample of 79 countries or around 0.62 based on the OECD-Eurostat sub-sample.
6. Indirect estimates of α based on the ratio of parameters in the first two regressions are generally close to the direct estimate and almost always lie within 2 standard errors of the direct estimate. (Exceptions are where the parameters in the first two regressions are themselves weakly identified – mainly land and trade deficit parameters). This provides

[21] SURE is a generalised regression model which contains a number of linear equations. Under SURE, liner equations are contemporaneously correlated via their error terms. In our case, contemporaneous relationships among equation (3.1), (3.2) and (3.3) are estimated by the weighted SURE method. This aims to provide a more robust estimate by down-weighting the impact of unusual observations from some countries, such as Japan and Russia. Weights are derived from robust regressions on dp_n.

fairly strong evidence that the data support a conclusion that a common value of α across countries can be identified (though clearly the precise value depends to some extent on country coverage).

7. This value of α has of course been necessarily assumed constant across countries as an approximation – reflecting an assumed 'common technology' to deliver each unit of tradables to the consumer in each country. The 'cost share' of non-tradables in tradables does however differ across countries depending on their respective values of p_n and p_t. Only for the US, where the dataset imposes $p_n = p_t = 1$, is α also a measure of the non-tradables cost share.
8. When the skilled/unskilled labour distinction is ignored – to allow a larger sample to be tested (Table 4c), this set of SURE regressions also performs well, with 'total labour' endowment taking a negative sign, though with relatively high p-values. This is consistent with the results with a labour decomposition showing different signs for the two labour types. In this case the negative sign on skilled labour seems to dominate for the total. The estimate of α from this set of regressions is very close, at 0.80, to that obtained for the sample of 79 countries using the 'skilled/unskilled' breakdown (of 0.81) in Tables 4a and 4b.

For New Zealand, where p_n = 0.925 (92.5% of average US non-tradables price), and p_t = 1.355 (135.5% of average US tradables price), estimates of the cost shares of non-tradables in tradables consumer prices can be obtained using the Table 4b estimates of α = 0.81 or α = 0.62. Thus, for New Zealand $\alpha p_n/p_t$ = 0.55 and 0.42 (for α = 0.81 and 0.62 respectively). If the OECD-Eurostat countries can more reasonably be thought of as a homogeneous grouping than the wider group of 79 countries, then a constant α around 0.62, rather than around 0.81, may be more reasonable to use here for NZ comparisons.

The 'adjusted price' of tradables in New Zealand (taking out the non-tradable component), can be obtained as: $p^a_t = p_t - \alpha p_n$. Using α = 0.62 gives a p^a_t of approximately 0.78 [1.355 – (0.62)(0.925)] for New Zealand compared to a US adjusted price of 0.38 (1 – 0.62). That is, excluding the impact on tradables prices that arise from different domestic consumer prices of non-tradables, New Zealand's tradables prices would otherwise be almost double those in the US. This suggests a substantial contribution from 'other factors', unrelated to non-tradable aspects, which could include, for example, the 'transactions costs' associated with geographic and economic distance.

However, the 43 country OECD-Eurostat sub-sample as a whole has an unweighted average costs share for this sample of $\alpha p_n/p_t$ = 0.40 and an average adjusted tradables price, p^a_t = 0.66. (For the same sample, average prices are: p_n = 0.773 (77.3% of the US non-tradables price), and p_t = 1.141 (114.1% of the US tradables price)). Thus New Zealand's cost share of non-tradables is almost identical to that of an (unweighted) 'average' OECD-Eurostat country, but New Zealand's adjusted tradables price is around 18% higher than the group average p^a_t (0.78 against 0.66). As shown below, this puts NZ among the highest 'adjusted tradables price' countries.

NZ's *observed* average tradables price is also 18% (1.335/1.141) higher than the OECD-Eurostat average equivalent, while NZ's observed non-tradables price is 20% (0.925/0.773) higher.

As noted earlier, as a relatively low income OECD country, NZ might be expected, other things equal, to have relatively low p_n and p_t (adjusted or unadjusted) relative to the average OECD country, rather than prices around 20% higher. However, within the ICP dataset, NZ has a PPP-converted expenditure per capita of US$25,159 which ranks 21st highest among the 43 OECD-Eurostat countries. The OECD-Eurostat unweighted mean (median) expenditure per capita is US$23,504 (US$25,051); i.e. NZ is around the 'average' of this group.

In the next section we examine how well the model explains the NZ data and whether, or in what respects, NZ is an outlier relative to the OECD-Eurostat sub-sample.

Table 4a SURE estimates of tradables and non-tradables price equations: using 'skilled/unskilled (i)' definition

	Skill/Unskill (i)		Skill/Unskill (i)			
Sample size:	74	43	74	43	74	43
	Equn. 1		Equn. 2		alpha	alpha
	dpnt	dpnt	dpt	dpt		
Land	**-3.98E-04**	**-1.58E-03**	**-1.36E-04**	**-9.71E-04**	0.341	0.614
	1.15E-03	1.87E-03	1.08E-03	1.43E-03		
	0.73	0.40	0.90	0.50		
Labour - skilled	**-2.75E-03**	**8.85E-04**	**-3.00E-03**	**-4.64E-04**	1.093	-0.524
	4.96E-03	9.58E-03	4.65E-03	7.30E-03		
	0.58	0.93	0.52	0.95		
Labour - unskilled	**6.18E-04**	**3.53E-03**	**4.57E-04**	**2.45E-03**	0.740	0.694
	3.99E-04	4.77E-03	3.75E-04	3.64E-03		
	0.12	0.46	0.22	0.50		
Capital	**1.15E-04**	**8.38E-05**	**9.13E-05**	**4.91E-05**	0.791	0.586
	1.52E-05	2.86E-05	1.46E-05	2.20E-05		
	0.00	0.00	0.00	0.03		
Population	**-7.64E-05**	**-8.96E-05**	**-6.22E-05**	**-5.61E-05**	0.813	0.626
	3.70E-06	6.90E-06	4.20E-06	6.24E-06		
	0.00	0.00	0.00	0.00		
Trade Def.	**-1.31E-04**	**1.88E-04**	**-1.24E-04**	**1.41E-04**	0.941	0.747
	4.29E-04	5.07E-04	4.03E-04	3.87E-04		
	0.76	0.71	0.76	0.72		
Intercept	**1.20E+00**	**6.02E-01**	**1.24E+00**	**5.56E-01**		
	4.41E-01	5.69E-01	4.16E-01	4.35E-01		
	0.01	0.29	0.00	0.20		

	Skill/Unskill (i)			
	74	43		
	Equn. 3		alpha	alpha
	dpt	dpt		
Non-tradables price	**8.11E-01**	**6.24E-01**	**0.811**	**0.624**
	2.87E-02	3.55E-02	0.029	0.035
	0.00	0.00	0.00	0.00
Intercept	**3.05E-01**	**2.80E-01**		
	1.82E-02	1.74E-02		
	0.00	0.00		

Statistics		
N	74	43
r-squared_1	0.90	0.88
r-squared_2	0.72	0.64
r-squared_3	0.87	0.83

Note: For each parameter estimate (in **bold**), standard errors are shown below parameters, with p-values below standard errors.

Table 4b SURE estimates of tradables and non-tradables price equations: using 'skilled/unskilled (ii)' definition

	Skill/Unskill (ii)		Skill/Unskill (ii)			
Sample size:	74	43	74	43		
	Equn. 1		Equn. 2		alpha	alpha
	dpnt	dpnt	dpt	dpt		
Land	**5.99E-05**	**-1.90E-03**	**9.03E-05**	**-1.21E-03**	1.507	0.636
	1.09E-03	1.65E-03	1.01E-03	1.20E-03		
	0.96	0.25	0.93	0.32		
Labour - skilled	**-2.71E-03**	**-1.00E-02**	**-2.19E-03**	**-6.27E-03**	0.810	0.625
	2.45E-03	6.35E-03	2.27E-03	4.64E-03		
	0.27	0.11	0.33	0.18		
Labour - unskilled	**1.62E-03**	**9.56E-03**	**1.25E-03**	**5.92E-03**	0.772	0.620
	8.65E-04	4.74E-03	8.03E-04	3.47E-03		
	0.06	0.04	0.12	0.09		
Capital	**1.23E-04**	**1.46E-04**	**9.69E-05**	**8.78E-05**	0.786	0.603
	1.64E-05	4.03E-05	1.56E-05	2.98E-05		
	0.00	0.00	0.00	0.00		
Population	**-7.62E-05**	**-8.63E-05**	**-6.20E-05**	**-5.32E-05**	0.814	0.617
	3.67E-06	6.39E-06	4.13E-06	5.66E-06		
	0.00	0.00	0.00	0.00		
Trade Def.	**7.32E-05**	**5.93E-04**	**3.39E-05**	**3.80E-04**	0.463	0.641
	4.56E-04	5.41E-04	4.22E-04	3.95E-04		
	0.87	0.27	0.94	0.34		
Intercept	**1.05E+00**	**-5.37E-02**	**1.12E+00**	**1.86E-01**		
	4.54E-01	6.10E-01	4.23E-01	4.45E-01		
	0.02	0.93	0.01	0.68		

	Skill/Unskill (ii)			
	74	43		
	Equn. 3		alpha	alpha
	dpt	dpt		
Non-tradables price	**8.10E-01**	**6.15E-01**	**0.810**	**0.615**
	2.78E-02	3.33E-02	0.028	0.033
	0.00	0.00	0.00	0.00
Intercept	**3.05E-01**	**2.81E-01**		
	1.79E-02	1.71E-02		
	0.00	0.00		

Statistics		
N	74	43
r-squared_1	0.90	0.88
r-squared_2	0.72	0.63
r-squared_3	0.87	0.82

Note: For each parameter estimate (in **bold**), standard errors are shown below parameters, with p-values below standard errors.

Table 4c SURE estimates of tradables and non-tradables price equations: using 'All labour'

	All Labour	All Labour			All Labour	
Sample size:	129	129			129	
	Equn. 1	Equn. 2	alpha		Equn. 3	alpha
	dpnt	dpt			dpt	
Land	**-3.19E-04**	**-2.77E-04**	0.869	Non-tradables price	**7.95E-01**	**0.795**
	5.39E-04	4.82E-04			2.14E-02	0.021
	0.55	0.57			0.00	0.00
				Intercept	**3.16E-01**	
					1.65E-02	
					0.00	
Labour	**-8.62E-05**	**-6.60E-05**	0.765			
	1.74E-04	1.56E-04				
	0.62	0.67				
Capital	**1.14E-04**	**8.94E-05**	0.786			
	1.27E-05	1.17E-05				
	0.00	0.00				
Population	**-6.86E-05**	**-5.44E-05**	0.793			
	3.00E-06	3.18E-06				
	0.00	0.00				
Trade Def.	**-4.69E-04**	**-3.72E-04**	0.793			
	3.39E-04	3.03E-04				
	0.17	0.22				
Intercept	**1.55E+00**	**1.52E+00**				
	3.68E-01	3.33E-01				
	0.00	0.00				

Statistics	
N	129
r-squared_1	0.86
r-squared_2	0.53
r-squared_3	0.76

Note: For each parameter estimate (in **bold**), standard errors are shown below parameters, with p-values below standard errors.

4. Implications for NZ

It is worth recalling that NZ values for both non-tradables and tradables prices (and therefore price differences relative to the US) are relatively high compared to both an OECD-Eurostat sample and a larger sample of 79 developed and developing countries; see left-hand panel of Figure 3 below. For non-tradables, a price difference from the US of dp_n = -0.075 (7.5% below the US value) is much higher than the two sample averages of dp_n = -0.437 (79 countries) or -0.227 (43 countries). A similar pattern applies to tradables prices where, for New Zealand, dp_t = 0.355 (35% above the US), while the two sample averages are dp_t = -0.047 (79) and 0.141 (43).

Table 5 shows prices for the OECD-Eurostat sample and NZ, together with values for the endowment and other 'difference' variables used on the RHS of the regressions. All those RHS variables are negative because, for both NZ and the sample average, the levels of these variables are less than their US equivalent.

Table 5 NZ and sample average values for regression variables

Sample of 43 OECD-Eurostat countries				
Variable	Mean[22]	Std. Dev.	NZ (Rank)**	NZ Difference
dp_n (non-tradables)	**-0.227**	0.34	**-0.075 (18)**	0.153
dp_t (tradables)	**0.141**	0.24	**0.355 (9)**	0.215
d-land	**-158**	21	**-166 (33)**	-8.3
d-labour	**-137**	17	**-146 (30)**	-9.5
d-labour (skilled)	**-120**	14	**-126 (29)**	-6.8
d-labour (unskilled)	**-17**	5	**-20 (29)**	-2.7
d-capital	**-17312**	1763	**-18108 (28)**	-796
e*d-pop	**-6429**	3030	**-7374 (27)**	-945
d-trade deficit	**722**	36	**712 (29)**	-9.9

** NZ rank (highest to lowest) out of 43 OECD-Eurostat countries

It can be seen that (i) NZ values for all RHS variables are less than the 43 country average values; and (ii) NZ values all lie well within one standard deviation of the sample average. That is, compared to the other 42 countries, NZ is not an outlier. However, whereas NZ has a *positive* difference for both prices (NZ prices are higher than the sample averages), NZ has a *negative* difference (smaller than average) for all the RHS variables.

To assess the impact of NZ's *lower than average* RHS variable values on NZ's *higher than average* prices, recall that the regressions indicate robust negative signs for skilled labour and population differences; see Table 4. NZ's lower than average values for each of these two variables would therefore contribute towards explaining its relatively higher tradables and non-tradables price levels. However, for the other RHS variables (at least those with robust parameter estimates – differences in capital, unskilled labour and trade deficits) positive parameters on these variables associated with NZ's lower than average values, will tend towards lower (not higher) prices in

[22] The units are as follows: d(land) is in million hectares; d(labour) is in thousands; d(Capital) is in billion dollars; e*d(population) is in thousand dollar per million people; d(Trade deficit) is in billion dollars.

NZ. That is, New Zealand's relative low values of capital, unskilled labour and trade deficits would lead us to expect lower non-tradables and tradables prices than in other OECD countries, but we observe the opposite. NZ's relatively high prices are therefore observed *despite* these three factors tendency towards lower prices.

But how well does the model fit the NZ data? Considering the regression models' predictions regarding NZ's price differences, Tables 6, 7 and 8 provide some details with SURE residual weights and absolute residuals shown in Figures 4 and 5 respectively.

Focussing on the robust OLS (single equation) and SURE (simultaneous three equation) estimation, Figure 3 (right-hand panel) and Table 6 confirm that both Robust OLS (R-OLS) and SURE estimations lead to under-estimates of NZ's non-tradables price difference (of -0.075). The SURE estimates (that is when dp_t is 'explained' rather than treated as exogenous), generates an especially large underestimate of NZ tradable and non-tradable prices. For the OECD-Eurostat sample, equivalent comparisons are: -0.224 compared with an actual of -0.075 for non-tradables, and 0.217 compared with an actual of 0.335 for tradables.

Nevertheless, NZ is not an outlier in these regressions. For example, the SURE regressions indicate that the NZ residual for dp_n takes a weight close to one in Figure 4 (that is, NZ values have minimal impact on parameter estimates). However, as Figure 5 shows, dp_n for NZ has a positive residual that is the 7^{th} largest (and 9^{th} largest among the absolute values of the residuals); that is, relative to other countries, the SURE regressions generate a relatively large underestimate of the price of non-tradables in NZ. Table 8 confirms that NZ's regression (actual and absolute) residuals rank relatively highly among the 129, 79 and 43 country samples: at 12^{th}, 12^{th} and 9^{th} largest respectively.

Figure 3 and Table 7 show the actual and predicted values of dp_n for the 79 and 43 country samples based on the OLS, R-OLS and SURE estimates (Table 7 focuses on R-OLS). This shows that, just as NZ's non-tradables price difference is high by OECD standards, so the regressions predicted values for the NZ non-tradables price difference is relatively high. For example, using the 43 sample, the sample average dp_n is -0.227 (and -0.437 for the '79' sample), NZ is predicted at -0.109 (not far below the actual of -0.075), a difference of +0.139 greater in NZ.

Table 7 then decomposes this difference of +0.139 into those associated with the various RHS variables. It is immediately obvious that the major source of difference in non-tradable prices is the tradables price and, to a lesser extent, population size differences. The importance of tradables prices in understanding NZ's non-tradables price difference is supported by the SURE-based results noted above - that when the tradables price is endogenous, the model generates a larger under-estimate of the NZ tradables price difference.

Table 6 Actual and predicted price differences for New Zealand

Sample size	Actual dp_n		Predicted dp_n OLS		Predicted dp_n Robust OLS		Predicted dp_n SURE		Predicted dp_t SURE	
	79	43	79	43	79	43	79	43	79	43
NZ	-0.075		-0.069	-0.060	-0.134	-0.109	-0.271	-0.224	0.244 Actual = 0.355	0.235

Table 7 Decomposing price difference predictions (using **R-OLS**)

Using Robust OLS:	'79'	NZ	Difference	'43'	NZ	Difference
Actual dp_n	-0.437	-0.075	0.362	-0.227	-0.075	0.153
Predicted dp_n	-0.437	-0.134	0.304	-0.248	-0.109	0.139
Contribution from:						
Tradables price	-0.025	0.188	**0.213**	0.090	0.227	**0.137**
Land	0.017	0.018	0.001	0.157	0.165	0.008
Labour - skilled	0.184	0.195	0.011	0.679	0.718	0.039
Labour - unskilled	-0.013	-0.022	-0.009	-0.096	-0.110	-0.015
Capital	-1.432	-1.467	-0.035	-1.662	-1.738	**-0.076**
Population	0.194	0.317	**0.123**	0.334	0.383	**0.049**
Trade Deficit	0.085	0.084	-0.001	0.214	0.211	-0.003
Intercept	0.553	0.553	0.000	0.036	0.036	0.000

Table 8 SURE regression residuals

SURE Residuals for dp_n (Robust)	Large sample	'79' sample	'OECD-Euro' sample
Median residual	-0.019	-0.021	-0.028
Mean residual	0.008	0.003	0.003
NZ residual	0.200	0.195	0.160
NZ Rank	9	7	7
Total sample	129	79	43
SURE Absolute Residuals (Robust)			
Median residual	0.066	0.064	0.074
Mean residual	0.087	0.107	0.127
NZ residual	0.200	0.195	0.160
NZ Rank	12	12	9
Total sample	129	79	43

Note: These residuals are 'weighted', from robust SURE regressions; therefore sample mean residuals are not necessarily zero.

5. Summary & Conclusions

This paper began by outlining a model (originally due to Falvey and Gemmell, FG, 1991) of the determinants of international differences in the prices of non-tradables (mainly services). This model essentially explains these non-tradables price differences as due to differences across countries in the prices of tradables, countries' factor endowments (capital, labour etc) and population sizes – both of which potentially affect the supply of and demand for non-tradables in each country. The paper also argued, following FG (2000), that the price of non-tradables can be expected to affect the domestic consumer price of tradables in each country due to the range of non-tradables 'embodied' within tradables at the consumer expenditure level – via non-tradable transport/distribution costs, wholesale and retail margins, etc. This 'extended' FG model allows for this feedback effect of non-tradables prices onto tradables prices.

The results of applying the extended FG model to the international ICP data for 2005 suggest that the model generally fits well and, in addition, fits NZ fairly well. In terms of understanding the determinants of *non-tradables* prices in NZ, the 'fit' for NZ is similar to that for other OECD countries on average.

However, it would seem that NZ's especially high price of tradables remains difficult to explain even after accounting for the effect of non-tradable costs on the domestic price of tradables. The SURE model does a fairly good job of explaining tradables prices in general but, this produces a relatively large under-estimate of NZ tradables prices; see Figure 3, right-hand panel for tradables prices. Also, though NZ's 'unexplained component' of the price of non-tradables is relatively large compared to the OECD-Eurostat sample average (the NZ residual is around 9th to 12th highest out of 43 countries), NZ is **not** an outlier in the model.

This implies that for NZ, as for other countries, the impact of non-tradables prices on the consumer price of tradables is an important part of understanding why *tradables* consumer prices differ across countries. However, for NZ, there remains a relatively large additional component of tradables price differences that, within the model, are regarded as capturing exogenous trade impediments (broadly defined) or indirect taxes. In the NZ case it seems more likely that the former dominate, since general indirect taxes such as GST/VAT are not unusually high in NZ.

The overall messages from this analysis are:

- Modelling the determinants of non-tradables prices using the extended FG model works fairly well in general, and especially for a group of OECD-Eurostat countries.
- This supports the hypotheses that:
  - Non-tradables prices are *higher* in association with higher values of capital and unskilled labour endowments, and trade deficits;
  - Non-tradables prices are *lower* in association with higher values of skilled labour, and population;

- ❖ Tradable prices also tend to be *higher* where non-tradables prices are higher both because this raises the (non-tradable) input costs for tradables, and because high tradables prices are impacted by 'trade impediments' and indirect taxes.

- The model suggests NZ's relatively *small population* and *high tradables prices* tend to raise its non-tradables prices relative to other countries. NZ's lower than average capital endowments should serve to counter-act these high prices, but modestly. (NZ has the 28th highest ranked capital endowment, and 25th highest capital/labour ratio, out of 43 countries).
- For labour endowments, taking a ratio of skilled labour (differences) to population (differences), NZ is ranked 29th out of the 43 OECD-Eurostat countries in this ratio, so that its relatively low skilled labour per capita also serves to raise its service prices.[23]
- NZ's relatively high price of non-tradables is estimated to add around 40% to the domestic consumer price of tradables, compared to border or factory gate prices. This is also around the OECD-Eurostat average cost share.
- However, after accounting for this 'cost share of non-tradables' contribution, NZ's tradables prices remain fairly high by international standards. A 'good candidate' to explain this are the transaction costs associated with NZ's distance from markets. Though we have not examined direct evidence on this here, numerous other studies have suggested the importance of such factors; see, for example, McCann (2003, 2009).
- Based on 'adjusted' tradables prices that removes the 'cost share of non-tradables' element, NZ's tradables prices are around 6th highest in the 43 country OECD-Eurostat sample – behind such countries as Iceland, Norway and Japan (see Figure 6).[24] These are also countries relatively distant from many of their key markets. (For Japan at least, other protectionist measures may also be relevant). However, Australia is ranked 19th out of 43 countries in its adjusted tradables price, suggesting that to the extent that there are 'disadvantages of distance', Australia manages partially to avoid or overcome these.
- As Figure 6 shows, NZ is like a number of other *small* countries with a high adjusted tradables prices (e.g. Cyprus, Malta, Denmark, Finland, Israel, in addition to the 'small and distant' economies of Iceland and Norway). This suggests that size or other characteristics of domestic markets/populations may be important in ways not already accounted for by the FG model's variables.

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[23] This is based on the skilled (ii) classification that includes secondary education and above in the skilled category. Similar results are obtained for the 'skilled/unskilled (i)' measure. This latter 'skilled/unskilled (i)' measure ranks NZ 32nd out of 43. NZ's equivalent rank out of 79 countries is 61st and 66th. Some caution should be exercised in interpreting these figures however, since most countries, including NZ, cluster close to sample mean values.

[24] These adjusted prices have been obtained using a value of $\alpha = 0.559$, the 'direct' estimate for the 43 country OECD-Eurostat sample, using the skilled/unskilled (ii) definition; see Table 4.

Figure 3 Actual and predicted price differences: NZ and sample average price differences (relative to the US price = 1.0)

Note: Actual values are in **red**; values predicted from regressions are in **blue**.

Figure 4 Residual robust weights for OECD-Eurostat sample

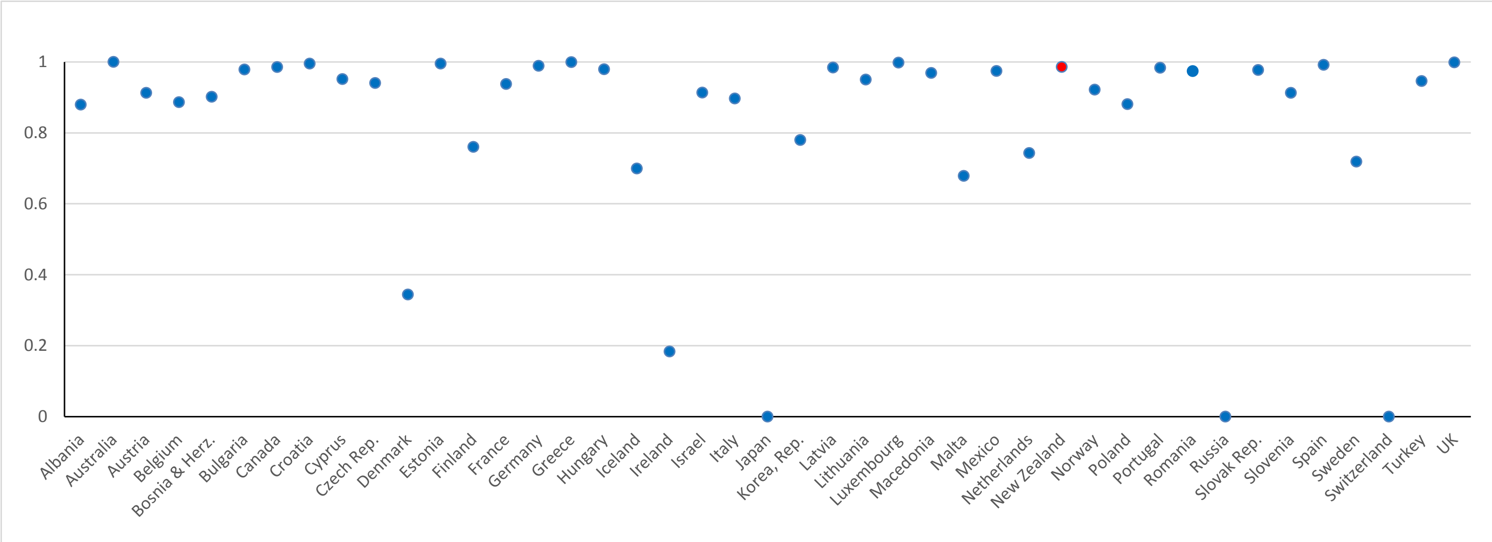


Figure 5 SURE Residuals for OECD-Eurostat sample

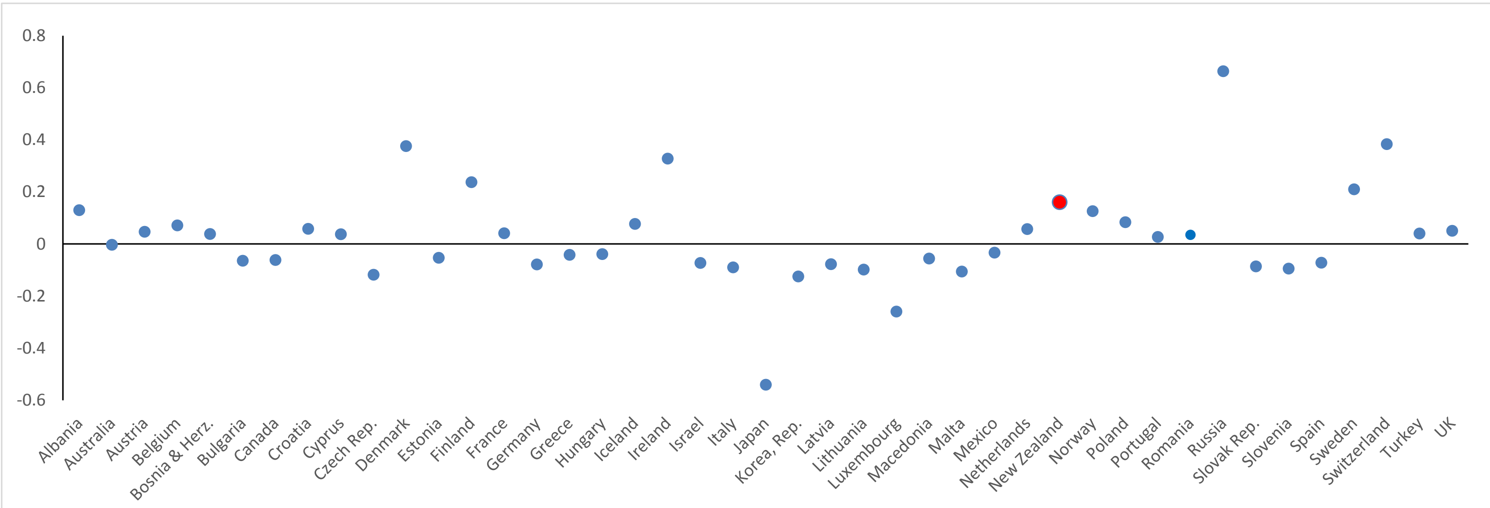
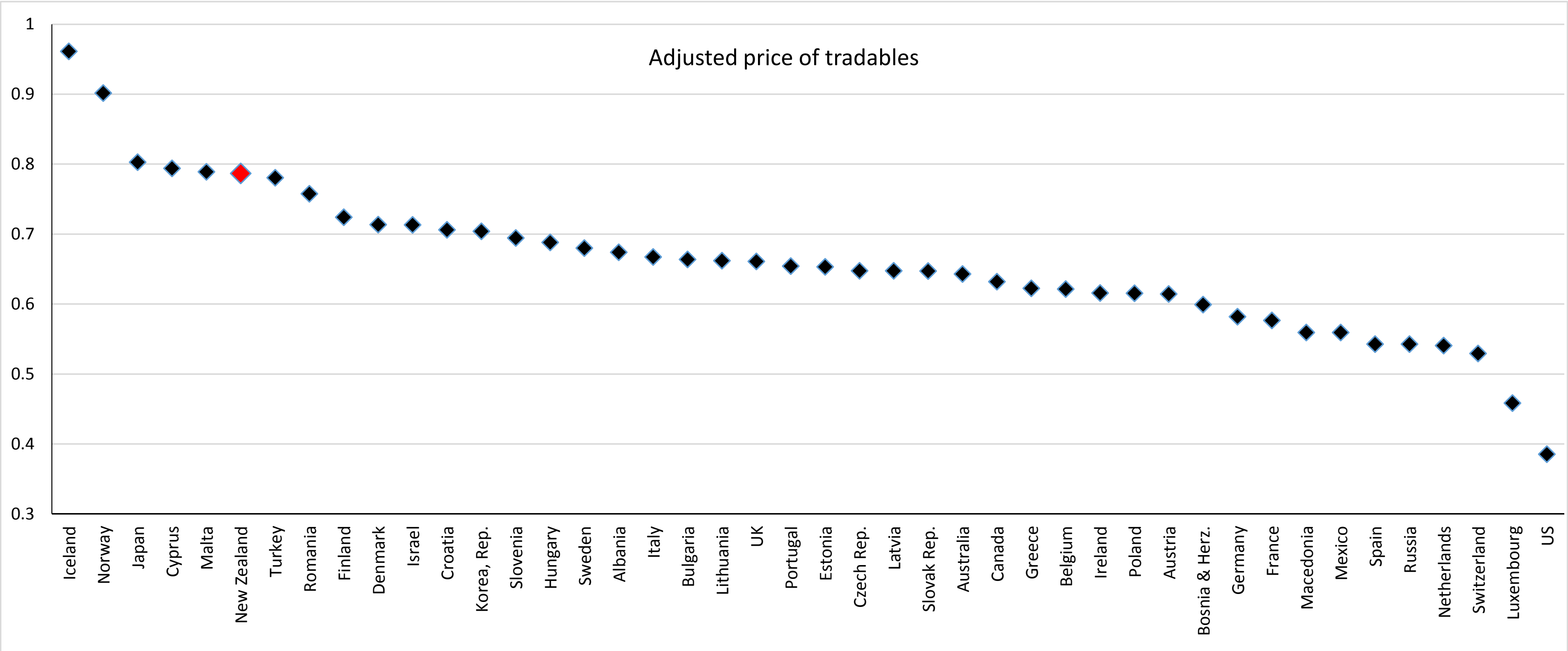


Figure 6 Adjusted price of tradables for OECD-Eurostat countries*



Note: * based on estimate of $\alpha = 0.559$; US *unadjusted* price = 1 (and US cost share = $\alpha = 0.559$).

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Appendix 1 The Falvey-Gemmell (1991) Non-tradables Price Model

A1. The original model

This section reproduces the basic two-sector (tradable, non-tradable) trade model from FG (1991) in which an expression for inter-country differences in the price of non-tradables is derived as a function exogenous differences in factor endowments, populations, trade balances and tradable good prices.

Consider an economy (which we shall refer to as the 'numeraire' country) with N 'representative' consumers, each with welfare level u and expenditure function $e(p, u)$, where $p = (p_t, p_n)$ is the domestic price vector, p_t representing the price of the (composite) traded good and p_n the price of (composite) non-traded services. Let G(p, V) denote the GNP function for this economy, where V is a v x 1 vector of factor endowments. In equilibrium, market clearing for the non-tradable implies that:

$$Ne_n(p, u) = G_n(p, V) \qquad \text{(A1)}$$

where $e_i = de/dp_i$ and $G_i = dG/dp_i$ (i = n, t) are the per capita compensated demand and aggregate supply of product i, respectively. The balance-of-trade equation requires that:

$$Ne_t(p, u) = G_t(p, V) + b \qquad \text{(A2)}$$

where b is the balance-of-trade deficit in real terms. Together (A1) and (A2) imply that total income equals total expenditure:

$$Ne(p, u) = G(p, V) + p_t b. \qquad \text{(A3)}$$

Now consider two countries with the same productive technologies, but which differ in their populations, factor endowments, and real trade balances and, hence, also in their real incomes and price of non-tradables. Prices of traded goods will also differ due to 'trade impediments', both natural (e.g. transport costs) and policy-imposed (e.g. import and export tariffs and quotas).[25] The effects of inter-country differences in these 'exogenous' variables on real income per capita and the price of non-tradables can be derived by expressing the analogous equations to (A 1) and (A 2) for the non-numeraire country and solving for du and dp_n. Using asterisks (*) to denote quantities in the non-numeraire country (e.g., e^*, N^*), equivalent expressions to (A1) and (A2) can be written as:

$$N^*e_n^* = (N + dN)(e_n + de_n) = G_n + dG_n = G_n^* \qquad \text{(A1')}$$

and

$$N^*e_t^* = (N + dN)(e_t + de_t) = (G_t + dG_t) + (b + db) = G_t^* + b^*. \qquad \text{(A2')}$$

The resulting expression for the (unobservable) du can then be converted to an expression for the difference in per capita real expenditure in terms of numeraire-country prices (de), yielding:

[25] Transport costs will raise (lower) the domestic price of importables (exportables) relative to world prices. Similarly, import taxes and export subsidies raise the domestic price of tradables, while export taxes and import subsidies reduce the domestic price of tradables. The net impact on the aggregate price of 'tradables' then will depend on the balance of these 'impediments'.

$$de = \frac{G_v dV + p_t db - e^* dN}{N} \tag{A4}$$

where $G_v = dG/dV$ is a 1 x v vector of factor returns,[26] and $e^* = p_n e_n^* + p_t e_t^*$ is expenditure per capita in the non-numeraire country evaluated at numeraire-country prices.

Interpreting de as representing the difference in 'real incomes', the predictions of (A4) are straightforward and unambiguous. An increase in any factor endowment, *ceteris paribus* (in particular with no change in population), raises real income per capita by the value of the increase in endowment per capita ($G_v dV/N$). An increase in population, *ceteris paribus*, reduces real income per capita by the average reduction in expenditures necessary to provide these additional people with the non-numeraire country's per capita real expenditure ($e^* dN/N$). An increase in the real trade deficit raises real income per capita by the corresponding increase in real per capita expenditure ($p_t db/N$).

Using equation (A1'), the analogous expression for the difference in the price of non-tradables is:

$$dp_n = \left\{-G_{nv} dV + e_n^* dN + \frac{Nm}{p_n} de - \varepsilon_{nt} dp_t\right\} / \varepsilon_{nn} \tag{A5}$$

where ε_{nt} ($= G_{nt} - Ne_{nt} < 0$) and ε_{nn} ($= G_{nn} - Ne_{nn} > 0$) are respectively the cross-price and own-price responses of the excess supply of non-tradables and $m = p_n e_{nu}/m$ is the 'marginal share of non-tradables in real expenditure'. Using (A4) to substitute for de, gives:

$$dp_n = \frac{\left\{\frac{mG_v}{p_n} - G_{nv}\right\}}{\varepsilon_{nn}} dV + \frac{\{a-m\}}{\varepsilon_{nn} p_n} e^* dN + \frac{m}{\varepsilon_{nn}} \frac{p_t}{p_n} db - \frac{\varepsilon_{nt}}{\varepsilon_{nn}} dp_t \tag{A6}$$

where a ($= p_n e_n^*/e^*$) is the 'average share of non-tradables in real expenditure'.

The interpretation of (A6) is again straightforward, but significantly, in contrast to (A4), some coefficient sign predictions are now ambiguous. Given a constant population, an increase in any factor endowment ($dV > 0$), raises or reduces the price of non-tradables depending on whether the marginal expenditure increase resulting from the corresponding increase in real income ($[mG_v/p_n]dV$ in terms of non-tradables) exceeds or falls short of the change in non-tradables output required to maintain full employment of factors at the initial prices ($G_{nv}dV$). The sign of $\{mG_v/p_n - G_{nv}\}$ therefore indicates whether there would be a net excess demand or supply for non-tradables at the initial prices, as a consequence of the endowment change.

Similarly, for a constant endowment of factors, an increase in population ($dN > 0$) raises or reduces the net demand for services at their initial prices, depending on whether the average propensity to spend on non-tradables (a) is greater or less than the corresponding marginal propensity (m). In effect the same total real expenditure is now allocated over a larger number of 'representative' consumers, and $e^* dN/p_n$ captures the magnitude of this 'reallocated' expenditure, measured in terms of non-tradables. A higher price of tradables ($dp_t > 0$) or an increase in the trade deficit ($db > 0$), will unambiguously increase the net demand for non-tradables (recall $\varepsilon_{nt} < 0$) at the initial non-tradables price.

[26] The corresponding expression for the change in real output (GDP) per capita is: $de = \frac{G_v dV - g^* dN}{N}$.

Since various studies have stresses per capita income levels in explaining non-tradables (and national) price level differences, it is interesting to consider the relationship between those two endogenous variables predicted by equations (A4) and (A6). An increase in the trade deficit unambiguously increases both variables; but only if $m > a$ will an increase in population induce movements in per capita real income and the service price in the same direction.

A similar ambiguity exists with respect to changes in factor endowments. As an illustration, suppose production involves both sector-specific and mobile factors. Then, an increase in the endowment of a factor specific to the tradables sector will increase real income ($G_v > 0$) and the net demand for non-tradables (since in this case $G_{nv} < 0$). An increase in the endowment of a factor specific to non-tradables will again raise real income ($G_v > 0$) but will reduce the net demand for non-tradables, since in this case $p_n G_{nv} > G_v > m_n G_v > 0$. For an increase in the endowment of a mobile factor, real income will increase, but the effect on the net demand for non-tradables is ambiguous a priori, since $G_v > p_n G_{nv}$.

Although *a priori* little can be said concerning the sign of any particular G_{nv}, results in the trade literature (see FG, 1991) imply that non-tradables output has at least one 'natural enemy' among the factors (with $G_{sv} < 0$ for this factor) and at least one 'natural friend' among the factors (with $p_n G_{nv} > G_v > 1 > m$ for this factor). It follows that, in equation (A6), at least one factor endowment must have a positive coefficient and another a negative coefficient.

The most important implication of these results is that of all the 'exogenous' variables, only differences in the trade balance and one factors endowment lead to an unambiguous prediction that real income and the price of non-tradables will be positively correlated. This suggests that the observed positive correlation between these two variables is more in the nature of an empirical regularity than a fundamental theoretical 'law'.

A2. Allowing for an endogenous price of tradables

The previous section presented a model explaining international differences in non-tradables prices in which the consumer price of tradables was exogenously determined. In this section we extend that model to include *endogenous* determination of domestic tradables prices. Again, each country produces two (composite) goods - tradables and non-tradables. As previously, all countries share the same technologies, but may differ in their populations (N), factor endowments (vector V), real trade deficits (b), trade 'impediments' (z), indirect tax rates (τ) and hence their prices of tradables and non-tradables.

To investigate the links between tradables and non-tradables prices, it is useful to distinguish three tradables prices - the domestic consumer price (p_t) the domestic producer price π_t and the 'international' price ($\overline{\pi}_t$); and two non-tradables prices – the domestic consumer price (p_n) and the domestic producer price (π_n). These prices are assumed to be related as follows:

$$\pi_t = [1 + z]\overline{\pi}_t \qquad \text{(A7)}$$

$$p_n = [1 + \tau]\pi_n \qquad \text{(A8)}$$

$$p_t = [1 + \tau][\pi_t + \alpha\pi_n] = [1 + \tau]\pi_t + \alpha p_n \qquad \text{(A9)}$$

In equation (A7) the domestic producer (factory gate) price of tradables is equated to their cost at the border including any costs associated with trade impediments (international transport costs, tariffs etc).[27] Equations (A8) and (A9) relate domestic consumer and producer prices. For non-tradables these prices differ by the indirect tax wedge, as shown in equation (A8). For tradables we assume that, in addition to this tax wedge, α units of non-tradables are required to 'deliver' one unit of tradables from the factory or border to the consumer, and that this 'delivery technology' is the same in all countries.[28] This yields the relationship between consumer and producer prices as shown by (A9).

Producer behaviour in this economy can then be captured using its GNP function $G(\pi_n, \pi_t, V)$, whose derivatives with respect to prices (G_n, G_t) represent domestic net outputs of non-tradables and tradables respectively. The derivatives with respect to factor endowments (G_V) represent the vector of factor returns. On the consumption side, we assume the economy is composed of N representative consumers each with welfare level *u* and expenditure function $e(p_n, p_t, u)$, whose derivatives with respect to prices (e_n, e_t) are the representative consumer's compensated demands for non-tradables and tradables respectively. In addition to this 'direct' demand for non-tradables for consumption purposes, the consumption of tradables itself generates an 'indirect' demand for non-tradables to be used to deliver these tradables to the consumer, and the 'aggregate' demand for non-tradables is therefore: $N[e_n + \alpha e_t]$.

As above, in equilibrium market clearing for non-tradables implies that:

$$N[e_n + \alpha e_t] = G_n \tag{A10}$$

and for tradables implies that

$$Ne_t = G_t + b \tag{A11}$$

where *b* is the balance of trade deficit in real terms.

Given that our primary objective is to examine the role of non-tradables prices in explaining international differences in the price of tradables, we again normalise by taking one country as our base or numeraire and denote quantities in a non-numeraire country by asterisks (*). The market clearing equations for this non-numeraire country can then be solved (see above) for dp_n and dp_t such that:

$$dp_n = \left[\frac{(mG_v/\pi_n) - G_{nv}}{\varepsilon_{nn}}\right] dV + \frac{\{a-m\}}{p_n \varepsilon_{nn}} e^* dN + \frac{\pi_t m}{\pi_n \varepsilon_{nn}} db - \frac{\delta_{nt}}{\varepsilon_{nn}} d\Phi \tag{A12}$$

$$dp_t = \alpha\left[\frac{(mG_v/\pi_n) - G_{nv}}{\varepsilon_{nn}}\right] dV + \alpha\left(\frac{\{a-m\}}{p_n \varepsilon_{nn}}\right) e^* dN + \alpha\left(\frac{\pi_t m}{\pi_n \varepsilon_{nn}}\right) db - \frac{\delta_{nt}}{\varepsilon_{nn}} d\Phi \tag{A13}$$

---

27 Note that the composite 'tradables' includes both, importables and exportables and that impediments to imports lead to domestic producer prices higher than international prices, while impediments to exports lead to domestic producer prices lower than world prices. The net outcome for the composite could therefore be positive or negative (ie $z \gtrless 0$).

28 In practice this delivery technology, may differ across countries, but, *a priori*, it is unclear what form these differences might take. We therefore prefer to extend our assumption of common technologies to this aspects of tradables production and delivery.

where $d\Phi = \bar{\pi}_t\{[1+\tau]dz + [1+z]d\tau\}$ is the difference in the consumer price of tradables due to trade impediments and indirect taxes.

Other terms in (A12) and (A13) are as defined previously. Namely, e^* is expenditure per capita in the non-numeraire country evaluated at numeraire country prices, *m* is the marginal propensity, and *a* is the average propensity, to spend on non-tradables in aggregate; ε_{nn} $(= \delta_{nn} + \delta_{nt} > 0)$ denotes the total own-price effect on the aggregate compensated excess supply of non-tradables, where δ_{nn} and δ_{nt} denote the partial effects of changes in the prices of non-tradables and tradables respectively, on the compensated excess supply of non-tradables.

Equation (A12) is analogous to the non-tradable price equation in (A5), except that there the tradables price had an exogenous impact on the non-tradables price. Equation (A13), which explains differences in the price of tradables, includes (i) the variables from the non-tradables equation with the same coefficients multiplied by α; (ii) trade impediments (*dz*); and (iii) indirect taxes ($d\tau$). Both (ii) and (iii) have positive coefficients in each equation. Indeed, homogeneity and symmetry imply that $p_n\delta_{nn} = -p_t\delta_{nt}$, so that differences in trade impediments and indirect taxes change the prices of both the tradable and the non-tradable in the same proportions.

To identify the impact of non-tradables on tradables prices empirically, suitable joint estimation of equations (A12) and (A13) can be used to identify the contributions of the right-hand-side variables to dp_n and dp_t, and also to obtain an estimate of α, the units of non-tradables required to deliver a unit of tradables to the consumer. This estimate, together with country-specific values for p_n and p_t, allows the 'cost share' of non-tradables in each country's tradables prices, $\alpha p_n/p_t$, to be estimated and, using (9), to adjust tradables prices to remove this non-tradables component.

Appendix Figure A1.1

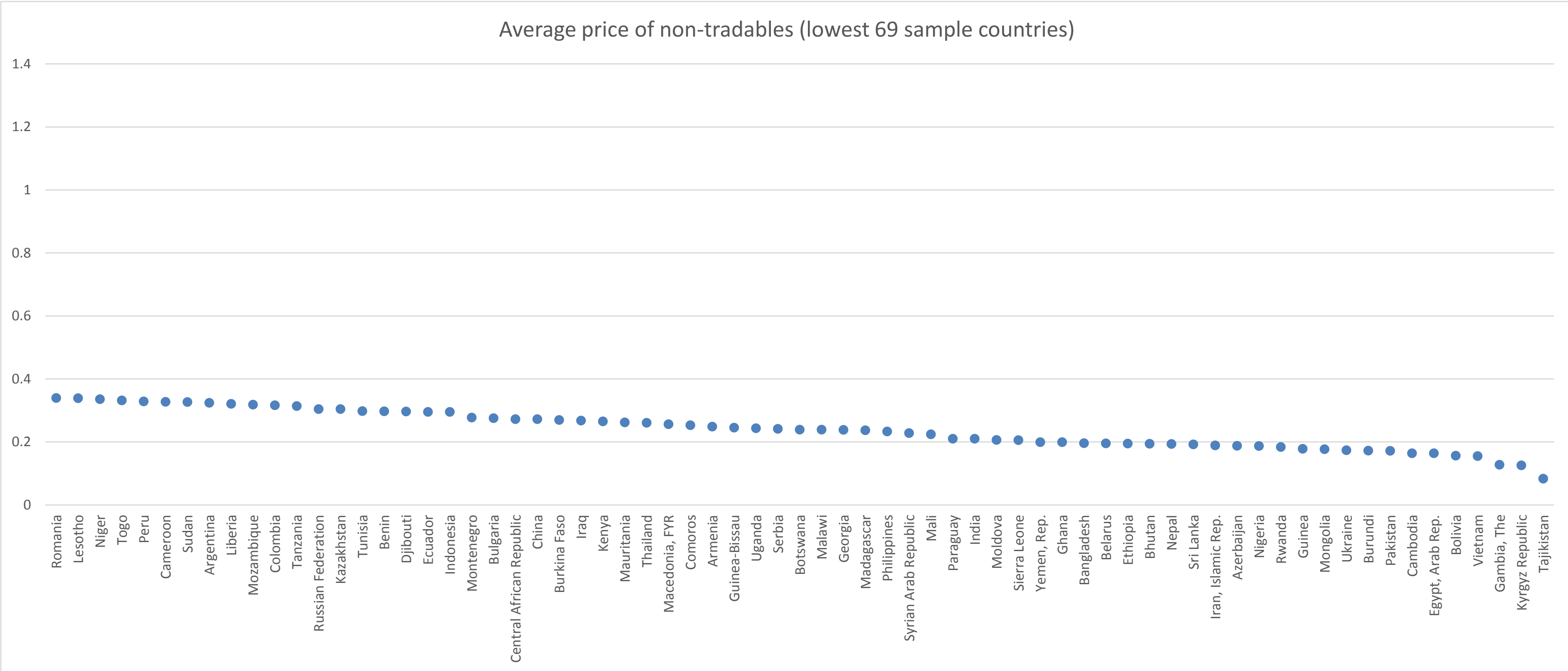
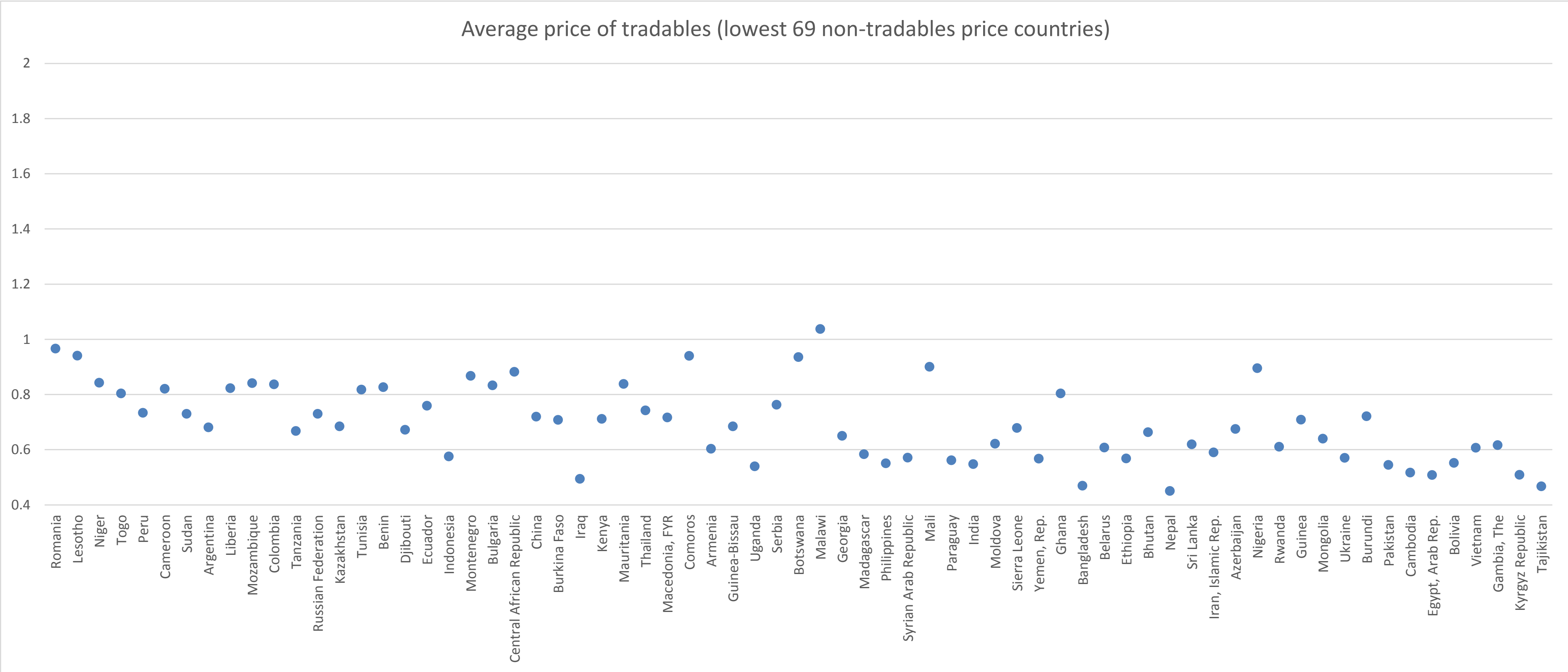


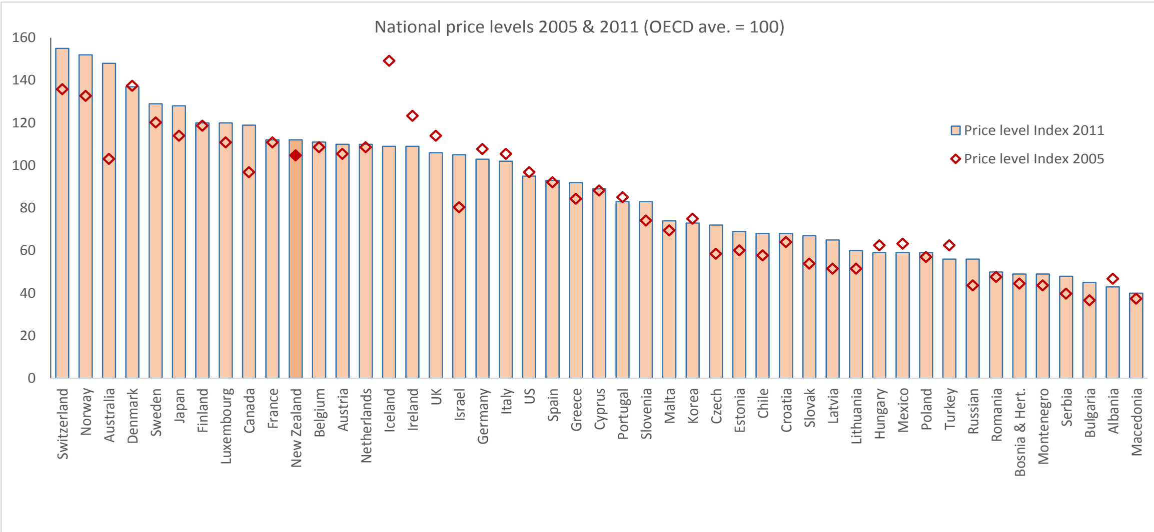
Figure A1.2


Average price of tradables (lowest 69 non-tradables price countries)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
Romania
Lesotho
Niger
Togo
Peru
Cameroon
Sudan
Argentina
Liberia
Mozambique
Colombia
Tanzania
Russian Federation
Kazakhstan
Tunisia
Benin
Djibouti
Ecuador
Indonesia
Montenegro
Bulgaria
Central African Republic
China
Burkina Faso
Iraq
Kenya
Mauritania
Thailand
Macedonia, FYR
Comoros
Armenia
Guinea-Bissau
Uganda
Serbia
Botswana
Malawi
Georgia
Madagascar
Philippines
Syrian Arab Republic
Mali
Paraguay
India
Moldova
Sierra Leone
Yemen, Rep.
Ghana
Bangladesh
Belarus
Ethiopia
Bhutan
Nepal
Sri Lanka
Iran, Islamic Rep.
Azerbaijan
Nigeria
Rwanda
Guinea
Mongolia
Ukraine
Burundi
Pakistan
Cambodia
Egypt, Arab Rep.
Bolivia
Vietnam
Gambia, The
Kyrgyz Republic
Tajikistan

Appendix 2 ICP National Price Levels in 2011 and 2014

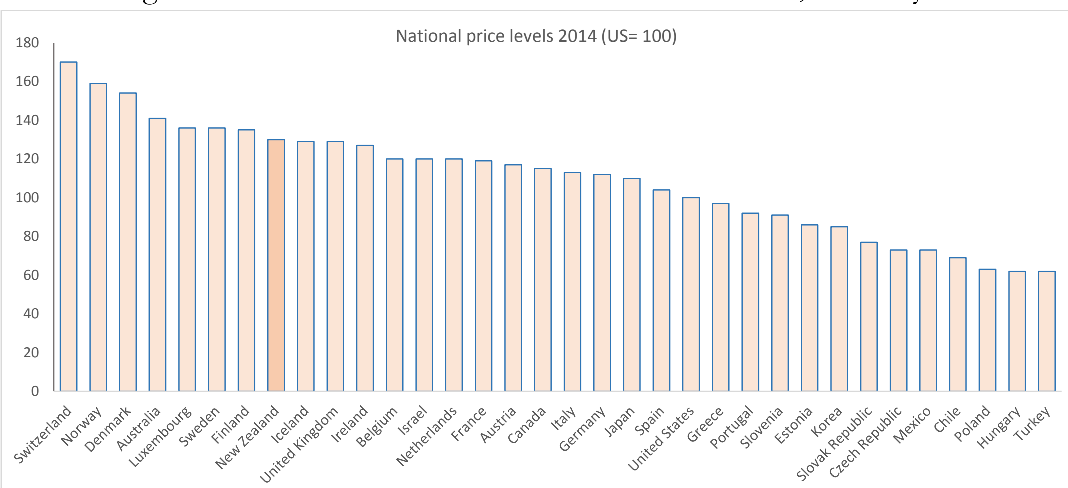
ICP price level data for aggregate GDP, various sub-aggregates and detailed spending categories are only collected for specific years. After 2005, the next (and latest) year is 2011. Sub-aggregate and detailed category data for 2011 are not yet publicly available however, but data are available for 'national price levels'; that is, the 'international price' of GDP in each country for a sample of 47 OECD-Eurostat countries. Figure A2 compares these national price levels for GDP in 2011 and 2005, relative to an 'average' OECD price level of 100 in each year. This reveals that the ranking of countries in both years is quite similar but with a few (e.g. Australia, Iceland) demonstrating substantial relative movement between the two years.

Figure A2.1 National Price Levels for GDP, 2005 and 2011



New Zealand, at 105 in 2005, was quite close to the average price level across OECD countries. However by 2011 New Zealand's national price level had risen to 112, which likely reflects the rise in New Zealand's real exchange rate over this period, on the back of rising commodity prices. This shifted NZ from a rank of 17th highest out of 34 OECD countries' prices in 2005, to being ranked 10th highest in 2011. NZ was also ranked 10th highest out of the larger 47-country OECD-Eurostat sample in 2011. National price level data available from the OECD for (February) 2014 suggest NZ has risen to a rank of 8th among the 34 OCED countries (Figure A2.2).

Figure A2.2 National Price Levels for GDP: OECD, February 2014



see http://stats.oecd.org/Index.aspx?DataSetCode=CPL#

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