The Size of the Tradable and Non-tradable Sector: Evidence from Input-output Tables for 25 Countries*

Giovanni Lombardo† Federico Ravenna ‡

First version: December 2010
This version: May 2012

Abstract

We compute the tradable and non-tradable input shares for consumption and investment from the latest release of OECD input-output tables. We document that input shares (the content of tradable and non-tradable goods per unit of final demand) differ substantially from final demand shares (the amount of tradable and non-tradable goods directly demanded for consumption or investment purposes). The deviation is especially large for investment expenditures. Non-tradable shares estimates are essential to correctly parameterize multi-sector DSGE open economy models.

JEL Classification Numbers: F1; F4.
Keywords: International Trade; Input-Output tables; Non-tradable Goods.

* We would like to thank Giovanni Nicolo' for excellent research assistance. Part of this work was performed while Federico Ravenna was a Visiting Scholar at the Federal Reserve Bank of San Francisco. The support is gratefully acknowledged. The views expressed in this paper do not necessarily reflect those of the European Central Bank or the Federal Reserve Bank of San Francisco.

†European Central Bank. Email: giovanni.lombardo@ecb.int
‡Institute of Applied Economics, HEC Montreal. Email: federico.ravenna@hec.ca.

1 Introduction

In this paper we provide new estimates of the share of tradable and non-tradable goods in consumption and investment expenditure for 25 industrial and emerging economies. Non-tradable goods are generally defined as those goods that are not traded internationally, due in particular to prohibitive transportation costs (e.g. Obstfeld and Rogoff, 1996, p. 199). Nevertheless, there are very few goods that would match this definition exactly, while a large number of goods and services are traded internationally in relatively negligible amounts.[1] In practice the literature extends the definition of non-tradable goods so to include the latter category of goods too (De Gregorio et al., 1994). This broader definition relies on conventionally accepted criteria proxing the "tradability" of a good, and requires estimation of the extent to which a good, or a set of goods, is actually traded.

There are two main dimensions along which the classification criteria used in the literature differ. The first concerns the numerical threshold of international trade relative to gross output used to define whether a particular sector should be classified as producing tradable or non-tradable goods. The second concerns whether the trade-shares should net out the content of tradable goods arising from the use of tradable intermediate inputs (*final demand shares*), or account for the total amount of tradable goods used throughout the production chain (*input shares*). We compare estimates based on alternative criteria along these two dimensions.

Estimates of the relative importance of tradable and non-tradable goods in the consumption and investment basket are relevant in addressing several issues. First, if the law of one price holds for tradable goods, a large enough share of non-tradable goods in the aggregate basket of goods may explain observed fluctuations in the real exchange rate. Burstein et al. (2006) estimate that over the 1971-2002 period about 61% of the US trade-weighted real exchange rate volatility is explained by volatility in the tradables-to-nontradables price ratio across countries. Engel (1999) and Betts and Kehoe (2008) report instead that over 90% of the variance of the US-EU real exchange rate is explained by deviations of the law of one price for the traded goods basket. A possible explanation for the behavior of traded goods prices argues that the retail price of imports includes an important non-tradable component, coming from local non-tradable wholesale and retail services, marketing, advertising and transportation costs (Burstein et al.,

[1] Fieleke (1995) shows that a number of services traditionally classified as non-tradables are increasingly traded internationally. An example of this phenomenon is "medical tourism"(e.g. The Economist, 2008).

2006, Corsetti and Dedola, 2005). Estimates of this distribution margin for imports range from 30% to 70% for the US (Goldberg and Campa, 2010). Our estimates use OECD data netting out the non-tradable component for each sector's output that can be ascribed to the distribution margin. Since the data provides the value of sectoral output "at site of production", where output is valued at so-called basic prices, rather than "at point of consumption", where output is valued at purchaser prices, our estimates of tradability for each sector accounts for the impact of the distribution margin.

Second, a number of papers in the international business cycle literature have shown that the presence of non-tradable goods can dramatically affect optimal policy prescriptions. For example, Lombardo and Ravenna (2010) show that the optimal volatility of the exchange rate depends both on the share of tradables in final demand as well as on the share of imports and tradables in intermediate goods. These shares determine the way in which exchange rate changes propagate through the economy.[2] Estimated models of open economies can provide accurate policy indications only inasmuch the share of tradables and non-tradables are correctly measured.

2 Tradable and Non-tradable Goods Shares from Input-Output Tables

Measurement

We measure tradability of the goods produced in each of the 48 industries in the 2009 release of OECD symmetric input-output tables as the sum of exports and imports for a given industry, relative to its gross output. The output from an industry is considered tradable if its tradability measure is above a critical threshold.

The value at purchaser price for both imports and domestic gross output of each good or service category includes the value of the (non-tradable) services rendered by intermediaries to make a good available to the unit of consumption, at the time and place required by the purchaser. The input-output tables provide gross output at basic prices, defined as the amount received by the producer for a unit of goods or services. Output value at basic prices can be obtained by subtracting from output value at purchaser prices the cost of retail and wholesale trade services, transportation services, and taxes on products and VAT. Thus, gross output at basic prices nets out the non-tradable component for each sector's output that can be ascribed to

[2] See also Duarte and Obstfeld (2008) for an important and related contribution.

the distribution margin, and provides the value of sectoral output "at site of production". The distribution margin is attributed to the output of the retail and wholesale trade sector, and the transportation sector.[3] Imported goods are valued in a similar fashion, since the input-output tables uses the CIF price, which relative to the purchaser price nets out trade margins, transportation costs on the domestic territory and taxes on products.

Once each good or service category has been classified as tradable or non-tradable, demand shares can be computed as *final demand shares* or as *input shares.* The final demand retail value of goods which are classified as tradable or non-tradable depends on the amount of value added and on the cost of intermediate inputs. The basket of intermediate inputs used by an industry is, in turn, composed by a mix of tradable and non-tradable goods. The most prominent example of an intermediate tradable is oil, which is not consumed directly by final consumers but is consumed indirectly in the production of most non-tradable goods. Input-output tables, by providing information on transactions of intermediate inputs across all industries, allow us to compute both the share of tradables demanded directly by final users (final demand share), and the share of tradables embedded in a dollar of final demand throughout the whole production chain (input share). Input shares are computed through the Leontiev inverse of the input-output table for each country.

Results

We provide two sets of results. First, we define as tradable all goods from sectors where the tradability measure is above a fixed number. To provide comparability with results in the literature, we adopt a 10% threshold, as in De Gregorio et al. (1994) and Betts and Kehoe (2001). Then, we provide results adopting a country-specific threshold, equal to the tradability measure of the wholesale and retail trade sector (which, in this case, is assumed to produce non-tradable output). Bems (2008) adopts this country-specific threshold when discussing the tradable content of investments.

Table 1 compares the tradables input shares in consumption and investment when the threshold is set at 10%. The tradable input share averages about 66% for both consumption and investment demand. The dispersion around the mean is substantial, equal to 13.79% for consumption, and

[3]The Eurostat Manual of supply, use and input-output tables (2008) specifies that the production of trade services (the distribution margin) is measured by means of the trade margins obtained from the resale of purchased goods, thus it includes any revenue from the markup of retailers over the purchased price.

11.02% for investment. Very large economies (such as US and Japan) appear to have a much smaller tradable share - and thus to be much less open - relative to small economies, which do not have as diversified a production structure. Smaller countries must satisfy a large share of the intermediate and final demand of goods with imports, and as the import (and export) share for an industry rises above the specified threshold, the good produced is classified as tradable. Belgium an Estonia, for example, appear within the three countries with the largest input share of tradables in both consumption and investment, around 80%.

The traditional definition of tradable and non-tradable goods that attributes non-tradable consumption to the CPI share of expenditures in the service sector, and tradable consumption to the CPI share of expenditures in the primary and manufacturing sector, returns for most countries lower values of the tradable share. For example, the 2009 HICP tradable share for Denmark is about 59%, while our measure gives a tradable final demand share of 65%, and a tradable input share of 73%. The non-tradable demand share can be smaller than the CPI service share if some services are classified as "tradable" according to the tradability criterion. Additionally, the non-tradable input-share can be even smaller than the non-tradable demand share if the share of tradable goods necessary to produce one unit of output exceeds the share of tradable goods demanded directly by consumers.

Cross-country differences in the share of tradable goods in consumption and investment can be attributed to two main factors: the classification of sectors as producing tradable goods (the *number* of tradable sectors), and the relative weight in consumption and investment demand of the sectors classified as producing tradable goods (the *size* of tradable sectors). While some sectors are consistently classified as tradable (for example, agriculture, food products, textiles, chemicals) or non-tradable (for example, construction, health services, education), the tradability of other sectors varies across countries. For example, using the 10% tradability threshold, the input share in consumption of computer and related business activities - which includes hardware and software consulting and supply, data processing and online distribution of electronic content - is classified as non-tradable output in 6 out of the 25 countries in the sample. The hotels and restaurant sector and the private business research and development sector, are examples of two industries with substantial cross-country dispersion in the degree of tradability.

In many countries within our sample, though not for all, the tradable input share for investment is not very dissimilar from the tradable consumption share. US and Japan have a substantially larger tradable input share for

investment demand, compared to consumption demand. Bems (2008) and Burstein et al. (2003) report an average tradable investment share close to 40% for a smaller sample of countries. Much of the difference with our data - where the average tradable investment input share is about 66% - is closed when we evaluate the tradable share with a final demand share measure, reported in the last column of Table 1. As documented by Bems (2008), a large share of investment expenditure is concentrated in the construction sector, which is classified as non-tradable. Nevertheless, the construction sector may use a substantial amount of tradables as intermediates in production, thus the final demand share may undervalue the tradable content of a unit of investment. Table 1 shows that in fact the final demand share in consumption and investments results in a larger expenditure share of non-tradable goods, relative to the input share, with the non-tradable share in investment showing the largest difference between the two measures. The Table also shows (last row) that the dispersion of the shares across countries is considerable but does not change dramatically across measurement criteria. By contrast, the difference in the mean is sizable.

Table 2 compares the tradables input shares in consumption and investment using the country-specific threshold. Overall, the tradable input share for the most closed countries, US and Japan, gets smaller, though this result cannot be generalized to the whole sample of countries. On average, both the input and the demand tradable share in consumption and investment are smaller using the country-specific threshold, since the external trade to gross output ratio for the wholesale and retail sector, used to define tradability, is on average higher than 10%. In addition, the tradability of the benchmark sector (wholesale and retail services) has substantial cross-country variability, as shown in Table 3. This introduces an additional source of volatility in the classification of sectors across countries. As a result, the cross-country range of the tradable shares increases. This result suggests that a uniform definition of tradability is more appropriate for cross-country comparisons.

3 Conclusions

In this paper we provide new estimates of the share of tradable and non-tradable goods in consumption and investment expenditure for 25 industrial and emerging economies using symmetric input-output tables. We can account both for the existence of a non-tradable distribution margin in the price of tradable goods, by using gross output data evaluated "at site of production", rather than "at point of consumption", and for the value con-

tent of tradable (non-tradable) goods in the production of non-tradables (tradables), by computing input shares.

We document a large variability in the tradable content of final expenditures across countries, regardless of the operational measure of tradable content we adopt - country specific or identical across countries. For consumption, and even more for investment expenditures, tradable input shares are substantially larger than final demand shares. Thus, neglecting the role of intermediates in the computation of demand shares would invariably underestimate the tradable content of demand.

References

Bems, R. (2008). Aggregate investment expenditures on tradable and nontradable goods. *Review of Economic Dynamics*, 11(4):852–883.

Betts, C. M. and Kehoe, T. (2001). Tradability of Goods and Real Exchange Rate Fluctuations. *Federal Reserve Bank of Minneapolis Staff Report*.

Betts, C. M. and Kehoe, T. J. (2008). Real Exchange Rate Movements and the Relative Price of Non-traded Goods. NBER Working Papers 14437, National Bureau of Economic Research, Inc.

Burstein, A. T., Eichenbaum, M., and Rebelo, S. (2006). The Importance of Nontradable Goods' Prices in Cyclical Real Exchange Rate Fluctuations. *Japan & The World Economy*, 18(3):247–253.

Burstein, A. T., Neves, J., and Rebelo, S. (2003). Distribution costs and real exchange rate dynamics during exchange-rate-based stabilizations. *Journal of Monetary Economics*, 50(6):1189–1214.

Corsetti, G. and Dedola, L. (2005). A macroeconomic model of international price discrimination. *Journal of International Economics*, 67(1):129–155.

De Gregorio, J., Giovannini, A., and Wolf, H. (1994). International evidence on tradables and nontradables inflation. *European Economic Review*, 38(6):1225–1244.

Duarte, M. and Obstfeld, M. (2008). Monetary Policy in the Open Economy Revisited: The Case for Exchange-Rate Flexibility Restored. *Journal of International Money and Finance*, 27(6):949–957.

Engel, C. (1999). Accounting for U.S. Real Exchange Rate Changes. *Journal of Political Economy*, 107(3):507–538.

Fieleke, N. (1995). The soaring trade in "nontradables". *New England Economic Review*, pages 25–36.

Goldberg, L. and Campa, J. M. (2010). The sensitivity of the CPI to exchange rates: Distribution margins, imported inputs, and trade exposure. *Review of Economics and Statistics*, 92:392–407.

Lombardo, G. and Ravenna, F. (2010). Openness and Optimal Monetary Policy. Working Paper Series 1279, European Central Bank.

Obstfeld, M. and Rogoff, K. (1996). *Foundations of International Macroeconomics*. MIT Press.

The Economist (2008). Globalization and health care: Operating profit. The Economist, 14th August.

	Input Shares		Demand Shares	
Country	Consumption	Investment	Consumption	Investment
Austria	76.26	73.72	69.43	57.14
Belgium	83.45	79.23	72.15	60.18
Canada	68.96	66.72	54.47	39.13
Czech Republic	77.33	71.17	70.69	52.17
Denmark	74.44	73.93	64.03	51.51
Estonia	79.29	85.64	65.98	73.54
Finland	48.7	57.96	28.31	34.51
France	62.19	59.43	52.12	40.87
Germany	70.52	71.31	63.97	57.25
Great Britain	68.93	60.66	63.67	50.13
Greece	52.95	51.02	41.66	28.77
Italy	55.1	58.25	45.5	46.13
Japan	31.28	41.48	23.02	30.4
Korea	65.51	73.06	50.35	49.96
Mexico	61.26	58.84	52.11	36.95
Netherlands	75.89	68.88	68.43	50.69
New Zealand	67.11	65.37	60.75	53.64
Poland	74.66	75.99	64.84	65.21
Portugal	69.7	60.11	59.33	40.98
Slovakia	81.71	74.85	78.66	58.04
Slovenia	64.14	63.8	48.79	46.89
Spain	62.2	58.02	44.35	37.14
Sweden	67.63	79.29	55.84	70.25
Turkey	78.31	71.3	71.22	48.59
USA	29.95	42.34	21.47	34.36
Mean	65.90	65.69	55.65	48.58
Stdev.	13.79	11.02	15.23	11.91

Table 1: Tradable share of consumption and investment (percentages): input and final demand measures (10% threshold)

	Input Shares		Demand Shares	
Country	Consumption	Investment	Consumption	Investment
Austria	64.62	65.5	61.43	53.33
Belgium	66.61	69.36	57.72	57.67
Canada	68.96	66.72	54.47	39.13
Czech Republic	81.51	74.38	76.05	54.67
Denmark	52.75	59.79	46.81	46.76
Estonia	78.6	76.2	65.77	48.83
Finland	77.03	70.66	63.41	38.95
France	50.08	51.91	35.86	35.07
Germany	45.85	55.88	40.87	49.58
Great Britain	42.02	44.25	34.42	37.75
Greece	54.11	51.77	42.4	28.83
Italy	68.22	68.17	57.6	52.55
Japan	34.42	43.64	27.18	30.78
Korea	63.21	71.24	50.39	49.96
Mexico	47.76	49.7	37.05	30.78
Netherlands	66.14	65.18	57.3	49.75
New Zealand	42.63	43.9	36.33	36.81
Poland	44.34	55.42	37.17	48.95
Portugal	60.98	53.54	55.15	38.14
Slovakia	65.79	69.27	62.72	56.23
Slovenia	69.4	65.77	55.74	47.08
Spain	67.56	60.05	52.55	38.6
Sweden	50.59	66	35.25	57.12
Turkey	78.31	71.3	71.22	48.59
USA	19.7	35.73	13.46	30.72
Mean	58.45	60.21	49.13	44.27
Stdev.	15.26	11.05	14.82	9.14

Table 2: Tradable share of consumption and investment(percentages): input and final demand measures (wholesale sector threshold)

Country	Share	Country	Share
Finland	1.6	Portugal	15.2
Slovenia	6.4	Estonia	15.4
Italy	6.9	Poland	16.9
Greece	8.8	Great Britain	18
Japan	9.3	New Zealand	18.2
Turkey	9.9	USA	19.4
Canada	10.1	Austria	21.7
Spain	11	Sweden	23.6
Czech Republic	11.1	Denmark	24.6
Korea	11.8	Netherlands	25.4
Mexico	12	Slovakia	26.5
Germany	13.4	Belgium	31.7
France	13.5		

Table 3: Country-specific threshold for tradability: Share of external trade to gross output for Wholesale and Retail Services sector (percentages).

The Size of the Tradable and Non-tradable Sector: Evidence from Input-output Tables for 25 Countries -Web Appendix-

Giovanni Lombardo* Federico Ravenna †

May 2012

*European Central Bank. Email: giovanni.lombardo@ecb.int
†Institute of Applied Economics, HEC Montreal. Email: federico.ravenna@hec.ca.

1. Computation of Tradable Input Share in Final Demand from Input-output Tables

Once each good or service category has been classified as 'tradable' or 'non-tradable' according to one of the criteria we follow, the content of tradable goods in a unit of consumption should account for the total amount of tradable goods used throughout the production chain. Sectoral input shares provide the amount of output from each sector needed to generate a given vector of consumption across all the goods and services categories. Summing the input shares of the sectors which are classified as 'tradable' provides our measure of 'tradable input share'.

We compute from the OECD input-output table B the matrix of shares A where each entry $a_{i,j}$ is defined as:

$$\begin{aligned} a_{i,j} &= \frac{b_{i,j}}{b_j} \\ &= \frac{p_i c_{i,j} d_j}{p_j d_j} \\ &= \frac{p_i c_{i,j}}{p_j} \end{aligned}$$

$b_{i,j}$ is total demand of industry j for goods produced by industry i, b_j is total gross production of good j, d_j is total real gross production of good j at price p_j, $c_{i,j}$ is the Leontief technical coefficient specifying the units of good i, sold at unit price p_i, needed to produce one unit of good j. b_j is equal to the sum of all intermediate inputs required by industry j and the value added (total payments to capital and labor). The entries in A are shares, and the sum of the column total a_j and of the value added shares in gross output for industry j is equal to one. The entry $a_{i,j}$ can be interpreted as the dollar amount of intermediate good i needed to produce one dollar's worth of good j.

For a given vector of value added $\overrightarrow{Y}$ where each element is final demand for good j, it must hold

$$\overrightarrow{R} = A * \overrightarrow{R} + \overrightarrow{Y}$$

where each element of $\overrightarrow{R}$ is gross output for good j. Any given vector of value added can be produced by the appropriate vector of gross output. For example, the vector of final consumption $\overrightarrow{C}$ is produced with gross output equal to:

$$\overrightarrow{R} = (I - A)^{-1} \overrightarrow{C}$$

To obtain input shares of each commodity in the total gross output needed to produce total consumption in the proportions of the vector $\overrightarrow{C}$ simply divide by

total gross output $R = e * \overrightarrow{R}$ where $e = (1, 1, 1, ...)$

$$\frac{\overrightarrow{R}}{R} = (I - A)^{-1}\frac{\overrightarrow{C}}{R} = \overrightarrow{S}$$

To know the input shares only for goods we define tradable (T), sum the appropriate rows for $\overrightarrow{S}$ using $e^T = (1, 0, 1, 0....)$ where 1s hit the rows of the goods which, according to a specified criterion, are defined as tradable:

$$\text{Consumption tradable input share} = e^T\overrightarrow{S}$$

Note that by definition $e * \overrightarrow{S} = e^T * \overrightarrow{S} + e^{NT} * \overrightarrow{S}$.