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Abstract

This paper documents a negative relationship between country size and the share of consumption goods in total exports. A model is developed, based on the division of labour and comparative advantage, to explain this relationship. Labour is used to produce traded intermediate inputs which are used in the production of traded final goods. Large countries gain relatively more from comparative advantage than from the division of labour, while the opposite is true for small countries. As in the data, large countries export a smaller share of final goods and a larger share of intermediate goods than small countries.

JEL Classification: F11.
Keywords: Country size; division of labour; comparative advantage; gains from trade; intermediate goods trade.

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1 Introduction

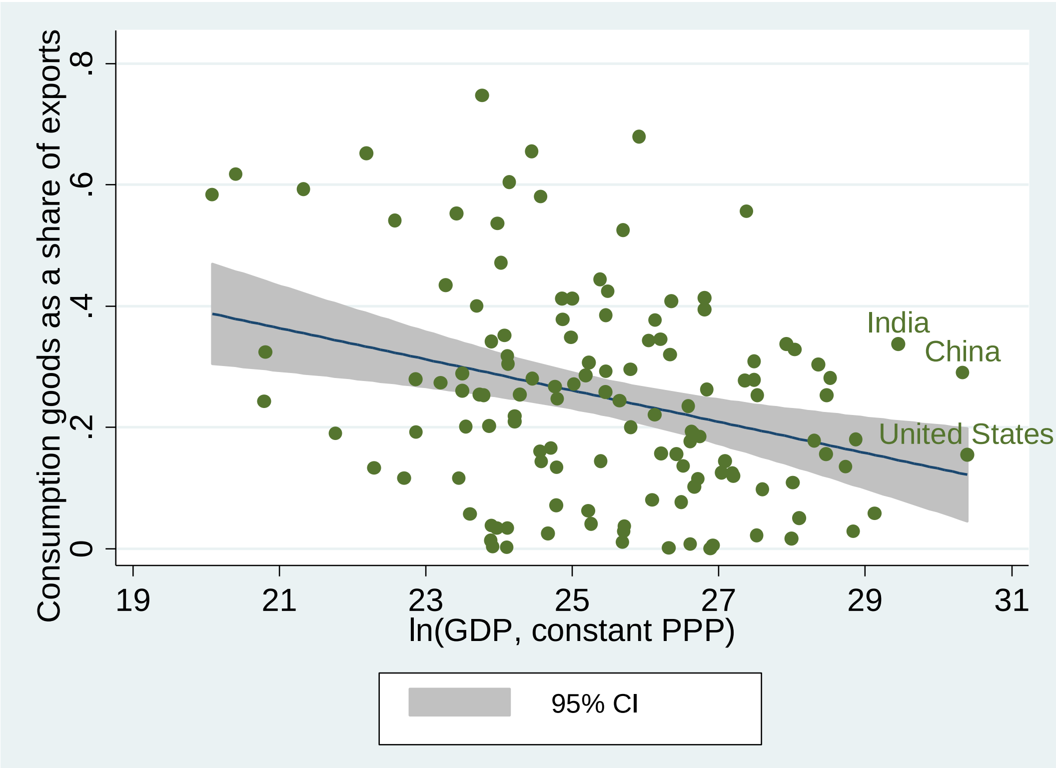
The recent rise of China has been associated with its (re-)integration with the world trading system. In some circles, China is now known as the "factory of the world", producing a large proportion of the world's manufactured goods (see for example The Economist (2015)). A concurrent trend has been the increasing fragmentation of production, as final goods are assembled from intermediate inputs which themselves are produced in different parts of the world (Jones (2000)). The article in The Economist cited above suggests a link between China's rise and its role in the global value chain. However, Hsieh and Ossa (2016) find only small effects on real income in the rest of the world, of China's productivity increase.

There is of course a large theoretical and empirical literature on the importance of intermediates trade. The theoretical side has been dominated by models of monopolistic competition and economic geography (see the synthesis provided by Helpman and Krugman (1985) and Fujita et al (1999)). On the empirical side, Miroudot et al (2009) and Sturgeon and Memedovic (2010) show that intermediate inputs represent over half of total goods trade, but that this fraction has actually decreased since the 1960s. Implicit in the discussion about the role of China in the world trading system is the role of China's size. The role of country size in determining the importance of intermediate goods trade has not heretofore been discussed in the literature, and is the main focus of the present paper.

Divide all commodities into consumption goods and intermediate goods (more details of the classification are in the next section). Figure 1 shows that, in 2012, there is a negative relationship between the share of consumption goods in total exports, and the size of the economy as measured by GDP in PPP terms. That is, *on average*, a larger country exports a larger fraction of intermediate goods, and a smaller fraction of consumption goods. The correlation coefficient is -0.3025, with a p-value of 0.0005. Note that both China and India are outliers; they have much larger shares of consumption goods in their exports than would be predicted given their size. Section 2 provides more formal econometric evidence using a panel of 172 countries from 1995 to 2015.

Having demonstrated the empirical significance of the negative relationship between country size and the share of consumption goods trade, we turn in Sections 3 and 4 to develop a simple model in which this relationship emerges. Two final goods can be produced using intermediate inputs which are produced using labour as the only factor of production. As in Adam Smith (1776), the more the production process can be divided into different stages, the larger will be the final output. The division of labour is combined with Ricardo's (1817) comparative advantage, so that countries specialise in different subsets of intermediate goods, then trade both intermediate and final goods. We show two main results. First, we show the relationship between the division of labour and comparative advantage in international trade. Large countries gain relatively more from comparative advantage than from the division of labour, while the opposite is true for small countries. Second, and consistent with the empirical evidence, country size is negatively associated with the share of consumption goods in its exports (equivalently, is positively associated with the share of intermediate goods in its exports).

Figure 1: Scatterplot of consumption goods as a share of total exports against GDP, 2012 ($N = 128$).



There has been a recent resurgence of interest in models of international trade based on the division of labour. A large portion of this literature revolves around models based on external scale economies, for instance Grossman and Rossi-Hansberg (2010) and Ethier and Ruffin (2009). Choi and Yu (2003) survey the earlier literature on international trade under external scale economies, while Wong (2001) offers an alternative treatment. Relative to this literature, the present paper develops an explicit model of the division of labour, rather than basing it on external economies.

More closely related to the present paper are Swanson (1999), Zhou (2004), Chaney and Ossa (2013), and Soo (2015). Swanson (1999) develops a model in which a larger market size leads to productivity gains, because workers specialize in a narrower subset of activities. Zhou (2004) develops a very different model which makes a similar point. Chaney and Ossa (2013) extend the new trade model of Krugman (1979) to allow for multiple production stages. However, Swanson (1999) does not explicitly consider the implications of international trade; the structure of the model means that this is not a straightforward analysis. In addition, unlike Zhou (2004) and Chaney and Ossa (2013), our model is based on perfect competition, so presents an alternative approach to the division of labour. In this sense the paper is similar to Soo (2015), who also develops a model of trade based on the division of labour, but in which the division of labour is limited by both the extent of the market and coordination cost. In Soo (2015), there is only trade in intermediate goods. Here, we do not consider coordination costs, instead focussing on the role of country size, and developing a model in which countries trade both intermediate and final goods.

Also closely related to the present paper are Ethier (1979, 1982). The nature of the division of labour in this paper is similar to that in Ethier (1979, 1982). The main difference is that here, we explicitly model the division of labour as in Ethier (1982), but the production of intermediate inputs is perfectly competitive, whereas Ethier (1982) assumes monopolistic competition in the production of intermediate goods. Indeed, where Ethier (1982) has two sources of scale economies (internal to the firm, and due to the division of labour) and one source of comparative advantage (factor endowment differences across countries), in the present paper, there is one source of comparative advantage (between final goods), and one source of scale economies (the division of labour). In addition, whilst in Ethier (1982) there is, by assumption, no trade in final goods, here we allow for trade in both intermediate and final goods.

The next section presents more formal econometric evidence on the relationship between country size and the consumption share of exports. Section 3 develops the model and outlines the autarkic equilibrium. Section 4 considers the implications of international trade, and the pattern of trade. Section 5 concludes.

2 Empirical evidence

The data used for the empirical analysis has been obtained from the UN Comtrade database, for all available countries between 1995 and 2015. We make use of the Broad Economic Categories (BEC) classification which divides all commodities into capital goods, intermediate goods, consumption goods, and "unclassified" (see United Nations (2002) for details of the classification). For our analysis, we drop the "unclassified" category before calculating the share of each type of good in total exports[1]. Our sample is an unbalanced panel of 172 countries, and, in the sample, the share of consumption goods in total exports is 27.7%, while the share of intermediate goods is 64.2%, and the share of capital goods is 8.1%. We obtain GDP in real PPP terms and population from the World Development Indicators of the World Bank.

We estimate the following equation:

$$\left(\frac{X_{cit}}{X_{it}}\right) = \alpha_{0i} + \alpha_{1t} + \alpha_2 \ln GDP_{it} + \alpha_3 \ln pop_{it} + \epsilon_{it} \qquad (1)$$

Where X_{cit} is exports of consumption goods, and X_{it} is total exports, of country i in year t. We include both country and year fixed effects, to control for unobserved time-invariant heterogeneity across countries (for example, differences in industrial structure across countries), and country-invariant heterogeneity across time (for instance, shocks which are common across countries). By controlling for both country and year fixed effects, the coefficient on $\ln GDP_{it}$ is identified through across-time variation within country. That is, α_2 shows how the consumption share of exports changes as a country's GDP changes.

Changes in the structure of the economy may also influence the consumption share of exports. To control for this, we also include a set of country-specific time trends, giving the following estimated equation:

$$\left(\frac{X_{cit}}{X_{it}}\right) = \alpha_{0i} + (\alpha_{0i} \times time) + \alpha_{1t} + \alpha_2 \ln GDP_{it} + \alpha_3 \ln pop_{it} + \epsilon_{it} \qquad (2)$$

The results from regressing equations (1) and (2) are reported in Table 1. Controlling for population, GDP is negatively and significantly related to the consumption goods share of exports in all specifications, whether we control only for country fixed effects (column (1)), country and year fixed effects (column (2)), or country and year fixed effects and a country-specific time trend (column (3)). A one percent increase in GDP reduces the consumption goods share of exports by between 0.06 percent and

[1] Including the "unclassified" category leads to similar results to those reported below.

0.09 percent. On the other hand, controlling for GDP, population has no statistically significant effect on the consumption goods share of exports. This suggests that, where size matters, it is the size of the economy rather than the population size which is important in determining the consumption good share of exports. In general these results are robust to various sensitivity analyses as described in Appendix A[2].

Table 1: The relationship between the consumption share of exports and country size. Dependent variable = consumption goods share of exports.

	(1)	(2)	(3)
$\ln(GDP, constant\ PPP)$	-0.074	-0.060	-0.088
	(0.019)**	(0.029)*	(0.032)**
$\ln pop$	0.039	0.039	0.007
	(0.035)	(0.036)	(0.087)
R^2	0.06	0.07	0.52
$N \times T$	2,583	2,583	2,583
N	172	172	172
Country FE	Yes	Yes	Yes
Year FE		Yes	Yes
Country time trend			Yes

Notes: Figures in parentheses are standard errors clustered by country. + Significant at 10%; * significant at 5%; ** significant at 1%. Estimation is by OLS with fixed effects as defined in the table. All specifications include observations from 1995 to 2015.

3 The model

In this section we outline the features of a simple model of international trade in which countries may export both intermediate and final goods. There are two interesting features of the model. First, it shows the relationship between the division of labour and comparative advantage. Second, it predicts a negative relationship between the size of the economy and the consumption goods share of exports as documented in Section 2 above.

There are two countries, $j = H, F$ for Home and Foreign. Labour is the only factor of production, and the two countries have labour endowments L_j. All markets are

[2] It is possible that GDP is endogenous in equations (1) and (2). However, whilst *total* exports may influence GDP, it is not immediately obvious how the *structure* of exports would do so.

perfectly competitive. There are two final consumption goods, 1 and 2. Consumer utility is identical across countries and takes a Cobb-Douglas form[3]:

$$U = C_1^{\theta} C_2^{1-\theta} \qquad\qquad 0 < \theta < 1 \tag{3}$$

Where C denotes consumption of a good. Final goods are produced with intermediate inputs. Each country has the ability to produce a number of intermediate inputs $n_j = rL_j$, where $r < 1$ is a constant[4], and n_j is small relative to the number of possible intermediate inputs. Assume that the intermediate inputs produced in one country are different from those produced in the other country. This is an Armington-type assumption made for convenience, and may be caused by (unmodelled) sector-specific inputs which are unique to each country, for instance natural resources. See Soo (2015) for an alternative, more complicated way of determining the intermediate goods produced in each country.

As a result, the number of intermediate goods produced by each country (hence the extent of the division of labour) is proportional to the size of the market, as in Adam Smith's example. The assumption that larger countries produce a larger variety of goods has empirical support from Hummels and Klenow (2005) and Hanson (2012). Let the production technology of intermediate inputs be identical across countries:

$$q_{ij} = l_{ij} \tag{4}$$

Production of intermediate inputs occurs under constant returns to scale. As a result of equation (4), the price of each intermediate good is, under perfect competition, equal to the wage rate in each country. Assume that wage rates are equalised across countries, and hence that all intermediate goods have the same price.

All intermediate inputs are used in fixed proportions in the production of final goods, and assembly of final goods is assumed to be costless[5]. Hence let the production functions of the final goods in the two countries be:

$$Q_{1H} = \gamma(n_H + n_F)^{\beta+1} x_{1H} \qquad\qquad Q_{2H} = (n_H + n_F)^{\beta+1} x_{2H} \tag{5a}$$

$$Q_{1F} = (n_H + n_F)^{\beta+1} x_{1F} \qquad\qquad Q_{2F} = \gamma(n_H + n_F)^{\beta+1} x_{2F} \tag{5b}$$

Output of each final good depends on the number of Home and Foreign produced inputs, n_H and n_F, and the quantity of each intermediate input, x. $\gamma > 1$ indicates

[3] The model can also be solved using CES preferences; the Cobb-Douglas form used here makes the solution much simpler, and does not detract from the main results of the paper.

[4] We ignore the integer constraint on n_j.

[5] Alternatively, some of the intermediate inputs may be interpreted as assembly services, so that assembly is not costless. This interpretation would leave the results unchanged.

that Home has a comparative technological advantage in final good 1, while Foreign has a comparative technological advantage in final good 2. $\beta > 0$ measures the payoff from the division of labour. The larger the number of intermediate inputs n, the greater the division of labour, and the larger the output of the final good, analogously to Adam Smith's pin factory example. Note that the production function of final goods exhibits constant returns to scale with respect to the quantity of each input, and increasing returns with respect to the number of different inputs. The constant returns to scale feature makes the production function compatible with perfect competition: a larger firm does not have a cost advantage relative to a smaller firm.

Consider the case where the two countries do not trade with each other. Here we analyse the Home country; the solution for the Foreign country is analogous. In this case, Foreign-produced intermediates are not available for use in the production of Home-produced final goods, and all Home-produced intermediates are used at Home. Because of the Cobb-Douglas preferences, each country will produce both final goods in autarky, and because of constant returns to scale with respect to the quantity of each input in final good production, the production possibilities frontier (PPF) is a straight line; there are constant opportunity costs. As a result, we can allocate the output of each intermediate good to the two final goods as follows (see Appendix B for a derivation):

$$x_{1H} = \theta q_{iH} \qquad\qquad x_{2H} = (1-\theta) q_{iH} \tag{6}$$

Where q_{iH} is the output of each intermediate good in Home. Hence, the production functions in Home are (making use of $n_j = rL_j$):

$$Q_{1H} = \gamma n_H^{\beta+1} \theta q_{iH} = \gamma (rL_H)^{\beta+1} \theta q_{iH} \tag{7a}$$

$$Q_{2H} = n_H^{\beta+1} (1-\theta) q_{iH} = (rL_H)^{\beta+1} (1-\theta) q_{iH} \tag{7b}$$

Since all intermediate inputs are produced using the same technology, and since all intermediate goods are used in fixed proportions in the production of final goods, the labour used in each intermediate input is also the same. Hence $q_{iH} = l_{iH} = L_H/n_H = 1/r$. The size of the labour force influences only the number of intermediate goods, not the output of each intermediate good. This result of the model is similar to Krugman (1980), in which changing labour endowments results in a different number of varieties produced, but not the scale of production of each variety.

Substituting into the production functions (7a) and (7b) gives:

$$Q_{1H} = (rL_H)^{\beta} \gamma \theta L_H \qquad\qquad Q_{2H} = (rL_H)^{\beta} (1-\theta) L_H \tag{8}$$

Since there is no international trade, Home consumers can only consume Home-produced output. Therefore, the Home consumer's per capita utility under autarky is:

$$U_H^A = (rL_H)^\beta (\gamma\theta)^\theta (1-\theta)^{1-\theta} \quad (9)$$

Per capita utility is increasing in the size of the Home labour force L_H, the parameter r indicating the number of intermediate sectors, the gain from the division of labour β, and the technology parameter γ. In addition, utility has a U-shaped relationship with the share of final good 1 in expenditure, θ.

4 International trade

When international trade is allowed, both intermediate inputs and final goods can be freely traded across countries. Proposition 1 shows that both countries are always specialized in free trade:

Proposition 1: In free trade, Home is specialized in final good 1 and Foreign is specialized in final good 2.

Proposition 1 follows from the fact that production of final goods from intermediate goods is costless. Therefore, the efficient allocation of resources (the integrated equilibrium; see Helpman and Krugman (1985)) is achieved when each country produces the good(s) in which it has a technological advantage. Note that this implies that, if a country is more productive at producing both final goods, then both final goods will be produced in that country; it is absolute advantage, not comparative advantage, which drives this result.

Making use of the results in the previous section and solving for the production functions (5a) and (5b) gives:

$$Q_{1H} = \gamma\theta(rL_H + rL_F)^\beta (L_H + L_F) \quad (10a)$$

$$Q_{2F} = \gamma(1-\theta)(rL_H + rL_F)^\beta (L_H + L_F) \quad (10b)$$

Production of each final good uses intermediate goods produced in both countries, and consumers wish to consume both final goods. Hence international trade occurs in both intermediate and final goods[6].

[6] If trade in intermediate goods is defined to be intra-industry trade, while trade in final goods is inter-industry, then the model predicts both inter- and intra-industry trade. More details are provided in Appendix C, where it is shown that the model's prediction of the share of intra-industry trade is the same as that of the imperfect competition model of Helpman and Krugman (1985).

Since preferences are homothetic and identical across countries, each country will consume a fraction of the total output of each final good which is proportional to its relative size $L_j/(L_H + L_F)$. Hence, the Home consumer's per capita utility under free trade is:

$$U_H^{FT} = \gamma(rL_H + rL_F)^{\beta}\theta^{\theta}(1-\theta)^{1-\theta} \quad (11)$$

Define the gains from trade as the ratio between free trade (11) and autarkic utility (9). The gains from trade for the Home country are:

$$G_H = \frac{U_H^{FT}}{U_H^A} = \left(\frac{L_H + L_F}{L_H}\right)^{\beta}\gamma^{1-\theta} > 1 \quad (12)$$

Hence there are gains from trade, which arise from two sources. First, international trade leads to more intermediate goods being available, which leads to greater division of labour. Second, international trade allows the two countries to specialize in their comparative advantage final goods. The following comparative statics results can be shown:

$$\frac{dG_H}{dL_H} < 0 \qquad \frac{dG_H}{dL_F} > 0 \qquad \frac{dG_H}{d\beta} > 0 \qquad \frac{dG_H}{d\gamma} > 0 \qquad \frac{dG_H}{d\theta} < 0 \quad (13)$$

As might be expected, the gains from trade increase the smaller is the country, or the larger is the trading partner. In fact, from equation (11), it can be seen that utility under free trade depends on the size of the world economy rather than the size of each country, and is identical for both countries. The larger the gains from the division of labour β or the larger the comparative technological advantage in the final good γ, the larger the gains from trade. Similarly, the larger the expenditure share of final good 1, θ, the smaller the gains from trade, since Home has comparative advantage in good 1.

It is possible to decompose the total gains from trade into the component derived from comparative advantage in final goods production and the component derived from the division of labour. To obtain the Home country's gains from trade based on comparative advantage alone, set $\beta = 0$ in the gains from trade equation (12) to obtain:

$$G_{CA} = \gamma^{1-\theta} \quad (14)$$

Similarly, set $\gamma = 1$ in equation (12) to obtain the Home country's gains from trade based on the division of labour alone:

$$G_{DL} = \left(\frac{L_H + L_F}{L_H}\right)^{\beta} \quad (15)$$

Total gains from trade are simply the product of the two components:

$$G_H = G_{CA} \times G_{DL} \quad (16)$$

Note from equation (14) that the gain from comparative advantage is independent of country sizes, whereas from equation (15) the gain from the division of labour increases the smaller is the country relative to its trading partner. Hence the primary source of the gains from trade for small countries is the division of labour, while for large countries it is comparative advantage. We have:

Proposition 2: The smaller is a country relative to its trading partner, the greater the importance of the division of labour relative to comparative advantage as a source of the gains from trade.

As noted in Section 3 above, the two countries are symmetric in every way except one: their size. Similarly, the two final goods and all intermediate goods are also symmetric in every way, and assembly of final goods from intermediate goods is costless. As a result, the total value of intermediate goods output is equal to the total value of final goods output, and the two final goods are produced in proportion to the parameters of the Cobb-Douglas utility function and have equal prices. However, with identical homothetic preferences, the larger country will consume a larger fraction of each final good, in direct proportion to the country's size. As a result, the share of the final good in a country's exports will be negatively related to the country's size, while the share of intermediate goods will be positively related to the country's size.

To make this more concrete, the value of Home's exports of the final good is:

$$\frac{L_F}{L_H+L_F} P_1 Q_1 = \frac{L_F}{L_H+L_F} P_1 \left(\frac{\gamma\theta}{r}\right) (rL_H + rL_F)^{\beta+1} = L_F P_1 \gamma\theta (rL_H + rL_F)^{\beta} \quad (17)$$

Where P_1 is the price of good 1. Recall from equation (6) that a fraction $1-\theta$ of each Home-produced intermediate good is used in the production of final good 2, which is produced in Foreign. The value of Home's exports of intermediate goods is:

$$(1-\theta) p_H q_H n_H = (1-\theta) p_H L_H \quad (18)$$

Where p_H is the price of each intermediate good. The price of each intermediate good does not depend on the country's size. Since we have assumed in Section 3 above that wage rates are equal across countries, the prices of intermediate goods are also the same across countries and can be normalised to 1. However, the price of the final good does depend on the size of the world economy, since a larger world economy implies more intermediate goods and hence lower production cost through greater division of labour. The relative price of the final good can be obtained from the assumptions that assembly of the final goods is costless and profits are zero, so the value of final good output is equal to the value of the intermediate inputs used in its production. That is, from equation (10a):

$$P_1 Q_{1H} = P_1 \gamma\theta(rL_H + rL_F)^{\beta}(L_H + L_F) \quad (19)$$

While the value of the intermediate inputs used in its production is, substituting from equation (6):

$$p_H(n_H + n_F)x_{1H} = p_H(rL_H + rL_F)\theta q_H = p_H(L_H + L_F)\theta \quad (20)$$

If profits are zero, equations (19) and (20) are equal to one another, and setting $p_H = 1$ gives the price of the Home-produced final good as a function of the endowments:

$$P_1 = \left[\gamma(rL_H + rL_F)^{\beta}\right]^{-1} \quad (21)$$

Substituting this into the value of Home's exports of the final good (17) and simplifying gives:

$$\theta L_F \quad (22)$$

Combining this with the value of Home's exports of intermediate goods (18), Home's exports of the final good as a share of Home's total exports is:

$$\theta L_F[\theta L_F + (1-\theta)L_H]^{-1} \quad (23)$$

Differentiating this expression with respect to L_H gives the relationship between the share of final goods exports and country size:

$$\frac{d}{dL_H} = -L_F\theta(1-\theta)[\theta L_F + (1-\theta)L_H]^{-2} < 0 \quad (24)$$

This gives:

Proposition 3: There is a negative relationship between country size and the share of final goods in its exports, and a positive relationship between country size and the share of intermediate goods in its exports.

Proposition 3 is of course the same as the empirical relationship obtained in Section 2. Since the two countries have symmetric technologies, country size as measured by GDP is the same as country size measured by population. It can be shown that, because preferences are homothetic and identical across countries, introducing a parameter which makes Home uniformly more productive than Foreign in all goods, has no impact on the results of the model, apart from giving Home workers a higher wage (the proof of this is left to the interested reader).

5 Conclusions

In this paper, we document the presence of a negative relationship between the size of a country, and the share of consumption goods in its total exports. We develop a simple model of international trade which is able to explain this negative relationship. The model is based on the division of labour and comparative advantage, going beyond the usual assumption of external scale economies to clarify the implications of the division of labour. Unlike most of the prior literature, the model is perfectly competitive throughout. The extent of the division of labour is determined by the size of the market, whereas the gains from international trade arise from the division of the production process into increasing numbers of stages and from comparative advantage in final goods. It is shown that large countries gain relatively more from comparative advantage than from the division of labour, whereas the opposite is true for small countries. Countries exchange intermediate inputs which are used in the production of final goods, which are then traded with each other. In addition, the model predicts, consistently with the empirical evidence, that larger countries will have a smaller share of consumption goods in their exports, and a larger share of intermediate goods.

The model developed in this paper relies quite heavily on several strong assumptions, especially those regarding the production of intermediate inputs and final goods. As discussed in the paper, these assumptions help sidestep some analytically difficult issues. Future work will address these issues directly, as well as developing a more general approach that would be amenable to the analysis of related issues such as trade costs. Nevertheless, the present paper helps to shed some light not only on the relationship between country size and intermediate goods trade, but also on the role of the division of labour, and the relationship between the division of labour and comparative advantage, in international trade.

Appendix A: Sensitivity analysis

We perform three sensitivity checks on the results of Table 1. First, note that the sample is an unbalanced panel; with 172 countries and 21 years, a balanced panel would have 3,612 observations, but Table 1 only has 2,583 observations. Therefore, we may be concerned with non-random sample attrition. To address this concern, we perform the analysis with a panel which includes only countries with at least 12 observations. This reduces the number of countries, to 137, and the number of observations, to 2,374, but increases the average number of observations per country, from 15.0 to 17.3.

A second concern is that the regression analysis in Table 1 gives equal importance to all countries in the sample. We consider two approaches to addressing this concern. First, we perform a regression in which the observations are weighted by the natural log of population, so that larger countries are given greater weight in the regression[9]. Second we drop all countries which are in the bottom decile in terms of population and GDP; this corresponds to a population threshold of approximately 440,000 people and a GDP threshold of approximately $8 billion. This results in the exclusion of 49 countries in total; these are mainly small island states such as Seychelles and Samoa, but also includes a few wealthy but small countries such as Brunei and Luxembourg.

The results of these sensitivity analyses are reported in Table A1, where the same three specifications as Table 1 are reported: with country fixed effects only, with country and year fixed effects, and with country and year fixed effects and country-specific time trends. Columns (1) to (3) report the results for the more balanced sample; columns (4) to (6) report the results for the weighted regression; and columns (7) to (9) report the results for dropping small countries. The results of Table 1 are robust to all of these specification changes, which suggests that the results presented in Table 1 are not driven by sample selection.

[9] Alternative weights, such as the natural log of GDP, yield very similar results.

Table A1: Sensitivity analysis. Dependent variable = consumption goods share of exports.

	More-balanced panel			Weighted regression			Excluding small countries		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\ln(GDP, constant\ PPP)$	-0.078	-0.058	-0.103	-0.075	-0.063	-0.089	-0.070	-0.052	-0.102
	(0.019)**	(0.030)+	(0.031)**	(0.018)**	(0.029)*	(0.032)**	(0.018)**	(0.024)*	(0.032)**
$\ln pop$	0.032	0.035	-0.003	0.041	0.041	0.005	0.050	0.053	0.008
	(0.037)	(0.038)	(0.090)	(0.035)	(0.036)	(0.090)	(0.033)	(0.033)	(0.090)
R^2	0.07	0.09	0.51	0.06	0.08	0.52	0.06	0.09	0.48
$N \times T$	2,374	2,374	2,374	2,583	2,583	2,583	2,140	2,140	2,140
N	137	137	137	172	172	172	123	123	123
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE		Yes	Yes		Yes	Yes		Yes	Yes
Country time trend			Yes			Yes			Yes

Notes: Figures in parentheses are standard errors clustered by country. + Significant at 10%; * significant at 5%; ** significant at 1%. Estimation is by OLS with fixed effects as defined in the table. All specifications include observations from 1995 to 2015.

Appendix B: The autarkic equilibrium

To obtain the autarkic equilibrium for the Home country, set the slope of the PPF equal to the slope of the indifference curve. From the Cobb-Douglas utility function (3), the slope of the indifference curve is:

$$\frac{P_{1H}}{P_{2H}} = \frac{\theta}{1-\theta}\frac{C_{2H}}{C_{1H}} \tag{A1}$$

To derive the PPF, first note that because of constant returns to scale in the production of intermediate goods, we have:

$$\frac{x_{1H}}{x_{1H}+x_{2H}} = \frac{L_{1H}}{L_{1H}+L_{2H}} \tag{A2}$$

Where L_{1H} and L_{2H} are the total labour used in the Home country in producing the intermediate inputs used in goods 1 and 2. Rearranging and substituting into the production functions, noting that in autarky, $x_{1H} + x_{2H} = q_{iH}$ and $L_{1H} + L_{2H} = L_H$, we have:

$$Q_{1H} = \gamma n_H^{\beta+1}\left(\frac{q_{iH}}{L_H}\right)L_{1H} \quad \text{and} \quad Q_{2H} = n_H^{\beta+1}\left(\frac{q_{iH}}{L_H}\right)L_{2H} \tag{A3}$$

Hence:

$$L_{1H} = \frac{L_H Q_{1H}}{q_{iH}\gamma n_H^{\beta+1}} \quad \text{and} \quad L_{2H} = \frac{L_H Q_{2H}}{q_{iH} n_H^{\beta+1}} \tag{A4}$$

Hence the equation of the PPF is:

$$L = L_1 + L_2 = \frac{L_H Q_{1H}}{q_{iH}\gamma n_H^{\beta+1}} + \frac{L_H Q_{2H}}{q_{iH} n_H^{\beta+1}} \tag{A5}$$

Rearranging in terms of Q_{2H}:

$$Q_{2H} = q_{iH} n_H^{\beta+1} - \frac{Q_{1H}}{\gamma} \tag{A6}$$

The slope of the PPF, which is also the no-trade relative price of good 1, is:

$$-\frac{dQ_{2H}}{dQ_{1H}} = \frac{P_{1H}}{P_{2H}} = \frac{1}{\gamma} \tag{A7}$$

Setting this equal to the slope of the indifference curve (A1), making use of the fact that in autarky $C_{1H}L_H = Q_{1H}$ and $C_{2H}L_H = Q_{2H}$, and substituting from the production functions (A3) gives the relationship between x_{1H} and x_{2H}:

$$x_{1H} = \frac{\theta}{1-\theta}x_{2H} \tag{A8}$$

Making use of $x_{1H} + x_{2H} = q_{iH}$ gives:

$$x_{1H} = \theta q_{iH} \qquad x_{2H} = (1-\theta)q_{iH} \tag{A9}$$

Which is equation (6) in the text.

Appendix C: Intra-industry trade

From Section 4, Home's exports and imports may be summarised as follows (assuming $p_H = p_F = 1$):

Home exports of final good 1: θL_F

Home imports of final good 2: $(1-\theta)L_H$

Home exports of intermediate goods: $(1-\theta)L_H$

Home imports of intermediate goods: θL_F

Suppose that the two final goods are defined as two separate industries, and intermediate goods as a third industry. Then, defining the Grubel-Lloyd index of intra-industry trade in each industry k as:

$$GL_k = 1 - \frac{|X_k - M_k|}{X_k + M_k} \tag{A1}$$

Where X and M are exports and imports. We have:

$$GL_{intermediates} = \begin{cases} 2\theta L_F[(1-\theta)L_H + \theta L_F]^{-1} & if \quad \theta L_F \leq (1-\theta)L_H \\ 2(1-\theta)L_H[(1-\theta)L_H + \theta L_F]^{-1} & if \quad \theta L_F \geq (1-\theta)L_H \end{cases} \tag{A2}$$

$$GL_{final\ good\ 1} = GL_{final\ good\ 2} = 0 \tag{A3}$$

And, defining the trade-weighted Grubel-Lloyd index as:

$$TWGL = \sum_k \left[GL_k \times \left(\frac{X_k + M_k}{\sum_k (X_k + M_k)}\right)\right] \tag{A4}$$

We have:

$$TWGL = \begin{cases} \theta L_F[(1-\theta)L_H + \theta L_F]^{-1} & if \quad \theta L_F \leq (1-\theta)L_H \\ (1-\theta)L_H[(1-\theta)L_H + \theta L_F]^{-1} & if \quad \theta L_F \geq (1-\theta)L_H \end{cases} \tag{A5}$$

Hence we can show that, if $\theta L_F \leq (1-\theta)L_H$, holding world endowment of labour constant:

$$\left.\frac{dTWGL}{dL_H}\right|_{dL_H + dL_F = 0} = -\left.\frac{dTWGL}{dL_F}\right|_{dL_H + dL_F = 0} = \frac{-\theta(1-\theta)(L_H + L_F)}{[(1-\theta)L_H + \theta L_F]^2} < 0 \tag{A6}$$

And, if $\theta L_F \geq (1-\theta)L_H$:

$$\left.\frac{dTWGL}{dL_H}\right|_{dL_H + dL_F = 0} = -\left.\frac{dTWGL}{dL_F}\right|_{dL_H + dL_F = 0} = \frac{\theta(1-\theta)(L_H + L_F)}{[(1-\theta)L_H + \theta L_F]^2} > 0 \tag{A7}$$

If θ is assumed to be equal to 0.5, then the interpretation is straightforward. If the Home country is larger than the Foreign country (the first case), the TWGL index is negatively related to Home country size, while the reverse is true if Home is smaller than Foreign (the second case). In other words, the TWGL index is positively related to the size of the smaller of the two countries, and negatively related to the size of the larger of the two countries. This of course is the same prediction as in models of trade under imperfect competition, and which has received empirical support elsewhere (see Helpman and Krugman (1985), Helpman (1987), Hummels and Levinsohn (1995)).

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