Carry-Along Trade*

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Abstract

Large multi-product firms dominate international trade flows. This paper documents new facts about multi-product manufacturing exporters that are not easily reconciled with existing multi-product models. Using linked production and export data at the firm-product level, we find that the overwhelming majority of manufacturing firms export products that they do not produce. Three quarters of the exported products and thirty percent of export value from Belgian manufacturers are in goods that are not produced by the firm, so-called Carry-Along Trade (CAT). The shares of CAT products and CAT exports are strongly increasing in firm productivity leading CAT exports to be concentrated in the largest and most productive firms. We develop a general model of Carry-Along Trade and examine the conditions under which it can rationalize the patterns observed in the data.

Keywords: heterogeneous firms, multi-product firms, exporting, sourcing, productivity, intermediation
JEL codes: F12, F13, F14, L11

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1 Introduction

Exports are well-known to be highly concentrated in a relatively small number of firms that ship many products abroad. Existing models of multi-product exporters describe firms that make one or more products and ship some or all of those products abroad.[1] We present the first evidence that these multi-product exporters are, in fact, not making most of the products that they export. Instead, the most productive firms both make and source products that they then sell to the market. In this paper, we explore this phenomenon both empirically and theoretically.

This research contributes to the small but growing literature documenting the prevalence and importance of multi-product firms in international trade. Unlike most previous work on multi-product firms, we are able to link data on domestic production and international trade at the firm-product level. This allows us to compare domestic output and exports at the firm-product level. We document the surprising fact that a large majority of manufacturing exporters export many products that they do not produce. In addition, a smaller set of the largest manufacturing firms produce goods where they export more than they produce. We refer to these export activities together as Carry-Along Trade (CAT).

We find that Carry-Along Trade, i.e. exports of goods where the firm exports more than it produces, is widespread and important, occurring at more than 90 percent of exporters, appearing in more than 95 percent of exported products and accounting for more than 30 percent of export value.

While most firms export products they do not make, it is the most productive firms that are most heavily engaged in Carry-Along Trade. Firm productivity has been shown to be positively related both to the number of products made by the firm and especially to the number of products exported.[2] Our findings confirm those results but highlight the relationship between measures of firm productivity and exported CAT products. The total number of products supplied to export markets is strongly increasing in firm productivity. While more productive firms do export more of their own produced products, most of the increase in export scope is due to a strong positive relationship between firm productivity and sourced (CAT) products that are exported. The share of CAT products in total exported products is rising in productivity.

Total firm exports are also known to be strongly positively associated with firm productivity. In contrast to the number of products, the majority of export value *does* come from products that are produced by the firm. The share of CAT exports in total export value is much smaller than that of produced products and does not systematically change with firm productivity.

To understand the observed phenomenon where firms sell more products to the market than

[1] Bernard et al. (2007) and Mayer and Ottavianio (2008) provide evidence on the importance of multi-product exporters. Theoretical models of multi-product exporting firms include Eckel and Neary (2010), Bernard et al. (2011), Arkolakis and Muendler (2011) and Mayer et al. (2011).

[2] See Bernard et al. (2011), Arkolakis and Muendler (2011) and Mayer et al. (2011).

they actually produce, we develop a general model of multi-product producers and Carry-Along Trade. Our modeling approach is intrinsically agnostic so we can consider a variety of potential explanations. For each, we outline the plausible underlying cause of CAT, formalize the implied relationship between CAT and firm characteristics, and then briefly evaluate the relative likelihood that the mechanism is at play given observed patterns in the data.

Our model features heterogeneous, multi-product firms that face a two-tiered problem: to choose the optimal *product scope* (how many varieties to sell to the market, and how much at what price for each variety), and a *make or source* decision – the question of whether (or to what extent) to produce goods in-house versus through arms-length suppliers, i.e. CAT. In the spirit of Mrazova and Neary (2011), we focus on equilibrium selection among heterogeneous firms – specifically the relationship between firm productivity, product scope, and the make-or-source decision margin – and purposely set aside derivation of the full general equilibrium. This approach has the important advantage that we are not compelled to make specific functional form assumptions, allowing us to develop a unified framework in which to identify and discuss important differences among broad classes of both supply side and preference structures.

We adopt a three step approach to the theoretical exercise. We begin by outlining a simple version of a multi-product heterogeneous firm model with a make-or-source decision. We observe that a broad class of models shares the common feature that core productivity and the extent of Carry-Along Trade is *sub-modular* in a firm's payoff structure. Intuitively, for any given total number of products delivered to the market by a firm, productive firms will make a greater share of those products in-house – and thus necessarily source *fewer* products via CAT – than will less productive firms. The empirical prediction from this baseline modeling structure is thus that the *least* productive firms would do the *most* Carry-Along Trade – which is the opposite of what we observe in the data.

We go on to introduce simple extensions of the model, first on the supply side, then on the demand side. In every case, we outline a set of necessary conditions that would have to hold for a model to rationalize the key features of the data. Again, the intuition is straightforward: higher productivity firms must have sufficiently greater total product scope than less productive firms, in order for both in-house *and* sourced product scope to be increasing in firm productivity. Many natural extensions of the basic multi-product model do not reconcile the theory with the data. However, we find that is is possible to match the empirical facts through certain adjustments to either the supply or demand side of the basic model.

On the supply side, allowing more productive manufacturers to have lower marginal costs for sourced products can generate the positive relationships between firm productivity and the numbers of both produced and sourced products. However, the positive correlation between marginal cost of production and marginal cost of sourcing has to be "just right" and cannot be either too strong or too weak.[3] Alternatively, if more efficient producers also have more efficient distribution networks, there can be a positive correlation between firm productivity and the numbers of both produced and sourced products.

Turning to preferences, we can reconcile the theory and the data if we introduce demand scope complementarity, i.e. when the demand for a given firm's variety increases in the total scope of product offerings by the firm. Again the complementarity must be sufficiently strong for the model to exhibit a positive relationship between firm productivity and both the number of produced and sourced products.

The rest of the paper is organized as follows. In the next section we discuss the trade data and document the prevalence and importance of multi-product exporters in Belgium. In Section 3, we explore the relationship between domestic production and exports in a sample of Belgian manufacturing firms and examine how firm characteristics vary with the number of exported products. Section 4 introduces definitions of Carry-Along Trade and explores the prevalence and importance of CAT for firms, products and export value. In section 5, we explore the relationship between CAT and firm characteristics. Sections 6-8 present a basic model of multi-product firms and sourced products and extensions needed to match the stylized facts about CAT. We consider empirical implications of the theoretical framework and discuss evidence from case studies of exporting firms in Section 9. The final section concludes.

2 Multi-Product Exporters in Belgium

To develop a more complete understanding of the relationship between a firm's production and exports, we link data from two different sources: one which records activities related to a firm's domestic production by product and another which tracks a firm's exports by product. The Belgian export data are obtained from the National Bank of Belgium's Trade Database, which covers the entire population of recorded trade flows.[4] The export data are recorded at the year-firm-product-country level, i.e. they provide information on firm-level export flows by 8-digit Combined Nomenclature (CN8) product and by destination country. In our empirical work we consider 6-digit product categories to facilitate comparison with datasets from other countries and to reduce the likelihood of product misclassification.[5]

We exclude transactions that do not involve a "transfer of ownership with compensation". This means that we omit transaction flows such as re-exports, the return, replacement and repair

[3] We refer to this as a "Goldilocks" result after the British and American fairy tale, see http://en.wikipedia.org/wiki/The_Story_of_the_Three_Bears .

[4] Results in this paper are for Belgian exports to all destinations and are robust to the inclusion or exclusion of intra-EU flows. For intra-EU trade, firms report export flows if the total annual intra-EU export value is higher than €250,000. For extra-EU trade, all transactions with a minimum value of €1,000 or weight of more than 1,000 kg are recorded. The National Bank of Belgium estimates that the share of omitted exports is 1.5 percent.

[5] The CN classification is available at the Eurostat Ramon server: http://ec.europa.eu/eurostat/ramon/ .

of goods, and transactions without compensation, e.g. government support, processing or repair transactions, etc. We further exclude export product classes that do not correspond to activities in the production data.[6] The remaining transactions cover more than 73 percent of total reported export value for 2005.

In Table 1 we report summary statistics on the cross-section of exporting firms for 2005. We categorize firms according to the number of six-digit products they export. In subsequent columns we include the number of firms, the value of exports, and the average number of export destinations for all firms exporting the reported number of products. In 2005 there are 20,848 exporting firms including both manufacturing and non-manufacturing firms operating in all sectors. Total value of exports at these firms is over €195 billion representing more than 712,000 firm-product-country transactions.[7]

Table 1 shows that multi-product exporters constitute the large majority of firms. Over 66 percent of all exporters are multi-product (MP) firms and they account for 98 percent of the total export value in 2005. Single-product exporters account for 34 percent of firms but represent only 2 percent of exports. These numbers are comparable to those for other countries; 58 percent of US exporters are multi-product and account for more than 99 percent of exports (see Bernard et al., 2007). Relatively few firms export more than 20 products but these 11 percent of firms still account for 45 percent of exports. These results are very much in line with what was reported by Bernard, Redding and Schott (2011) for the US, Mayer and Ottaviano (2008) for France and Goldberg et al (2010) for India and confirm the notion of "superstar" exporters where a small club of firms account for the large majority of exports.[8]

The average number of export destinations per firm is 7.15, but this average hides substantial heterogeneity across firms. Firms that export just one product ship it to only 1.82 destination markets whereas firms exporting more than 50 products on average reach 25 different destinations. This finding is in line with evidence from other countries and recent theory papers on multi-product exporters where firms with higher firm productivity export more products and reach more destinations.[9] A common feature of these models is that firms with higher productivity produce greater numbers of products, have higher total sales and larger total firm exports, and export more products.

[6]For examples of these types of products see the Data Appendix.

[7]The number of exporters in 2005 is very close to the average number of exporters for the period 1998-2005.

[8]Results are different for Mexico where most exports come from single product exporters (Iacovone and Javorcik, 2010).

[9]Models of multi-product exporters include Eckel and Neary (2010), Bernard, Redding, and Schott (2011), Arkolakis and Muendler(2011), Mayer, Melitz and Ottaviano (2011).

3 Manufacturing, Domestic Production and Exports

We now focus our attention on a sample of Belgian manufacturing firms where we can link production and exports at the firm-product level for 2005. The focus on manufacturing exporters is driven by existing multi-product theory models which assume that a producing, or manufacturing, firm produces one or more products and exports some or all of its produced products. Recent work on trade intermediaries highlights the role of non-manufacturing firms in aggregate exports, see Bernard, Jensen, Redding and Schott (2010), Ahn, Khandelwal and Wei (2011), Akerman (2010), and Bernard, Grazzi and Tomasi (2011). However, in these papers, manufacturing firms either export directly or through a non-manufacturing intermediary.

The theoretical literature on multi-product exporters is largely related to the joint production and export decisions of the firm and typically does not consider the role of intermediation. The existing empirical literature on multi-product exporters usually examines trade data alone or trade and production data separately.[10] We link export data to production data at the firm-product level.

The firm-product production data come from the Prodcom database. The export data are the same as described in Section 2. Several special attributes of the Prodcom database are worth noting here. First, two main types of firms are required to declare their domestic production activities at firm-product level and thus are present in the database: (1) firms with a primary activity in manufacturing employing at least ten employees and (2) firms with a primary activity outside manufacturing (but with manufacturing production) employing more than twenty employees.[11] Second, the variable we use to quantify domestic production by product is firm-product sales of produced goods rather than the value of physical production in that year. Third, while trade transactions are reported using the 8-digit CN classification system (CN8), domestic production activities are reported in Prodcom 8-digit codes (PC8). While the CN8 and PC8 classifications are designed to be similar and to allow product-level comparisons (see the data appendix and Table 4), the level of detail of the PC8 is lower than that of the CN8.

We choose to concord the two product classifications into categories that correspond as closely as possible to six-digit Harmonized System products (HS6). In particular, every product in our empirical analysis is either a unique HS6 category or a collection of related HS6 categories. In particular, there are 9,157 CN8 codes and 4,784 HS6 codes compared to 4,220 PC8 codes. Out of the 4,220 PC8 codes, 2,140 have a one-to-one match with a single HS6 product. The remaining

[10] An exception is Iacovone and Javorcik (2010) who consider both production and exports in Mexico. Their data come from a Monthly Industrial Survey that is unlikely to record information about exports of goods that are not produced by the firm.

[11] We examine a single year, 2005, in the remainder of the paper. Creating a panel of linked production and export firm-product data requires both concordances over time for the CN and PC classifications as well as a concordance between the classification systems. For a detailed description of the Prodcom Database and the selection criteria, see the data Appendix.

PC8 codes are many-to-one mappings from PC8 to HS6 (423 HS6 codes), one-to-many mappings (1750 HS6 codes) or many-to-many mappings (471 HS6 codes). We concord the PC8 product data to HS6 and henceforth refer to the 6-digit data as HS6+. Overall, there are 2,923 HS6+ products that feature in our data (either domestically produced or exported).

After linking the export and production datasets we have a sample of 3,631 exporting firms with €85.0billion of exports in over 192,000 firm-product-country transactions in 2005, accounting for 17 percent of Belgian exporters and 43 percent of total Belgian exports in these products. Among firms with a primary 2-digit NACE classification in manufacturing, the Prodcom sample accounts for 58 percent of exporting firms and 91 percent of total exports.[12] Table 2 reports summary statistics for these firms by the number of HS6+ products exported. Given the selection criteria, it is not surprising to find that firms in this sample are larger in terms of the number of products exported, total value of exports, and average number of destinations than the broader set of firms in Table 1.

Looking across firms with different numbers of exported products, we find similar patterns to those for the complete set of Belgian exporters considered earlier. Exports per firm and the average number of destinations are increasing as the number of exported products rises.

The last three columns of Table 2 use balance sheet data to study the link between the number of exported products and indicators of firm-level productivity and size.[13] We confirm findings from other research that firm productivity, value-added and employment are all higher for firms that export more products.

3.1 Exported versus produced products

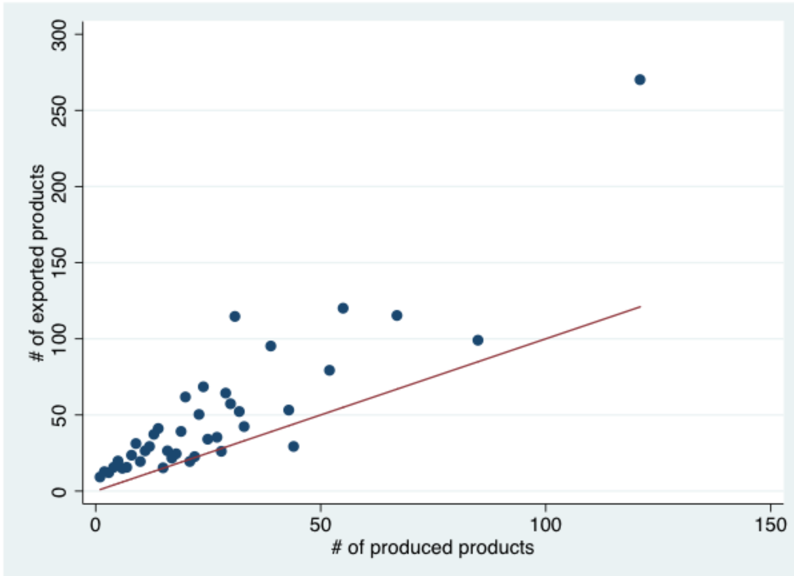
The most unusual finding from this simple overview comes in column 2 of Table 2. Except for the category of single-product exporters, firms in every other category report greater numbers of products exported than products produced.[14] Multi-product exporters are also multi-product domestic producers but the number of exported products increases much more rapidly than the number of produced products, see Figure 1.

It is this simple fact that firms export more products than they produce that we explore for the

[12]While all the firms in the Prodcom sample report positive manufacturing production, 521 exporting firms have a non-manufacturing sector as their primary NACE 2-digit activity in the annual accounts data. Our results on CAT trade are not affected by the inclusion or exclusion of these firms. Another 1,834 firms with positive manufacturing in the Prodcom data are non-exporters.

[13]Selection on availability of firm-level characteristics such as employment, value-added, tangible fixed assets etc. imposes another restriction on the sample selection, i.e. only those firms with positive values for all firm characteristics can be included in the analysis. To obtain comparable levels of total factor productivity (TFP) across firms, we apply the Caves et al. (1982) methodology. Hence, TFP is calculated as an index, calculated by comparing each firm to a hypothetical firm, where the hypothetical firm is defined as the average over all firms in a two-digit NACE sector.

[14]Production refers to sales of produced goods rather than the physical creation of the goods during the year. This concept of produced sales corresponds more closely to the recorded export numbers and helps to avoid problems of stockpiling and inventories.



Notes: Each point indicates the average number of exported products for firms producing that number of goods. The line indicates equal numbers of exported and produced goods.

Figure 1: Exported Products and Produced Products, 2005

rest of the paper. We develop a set of facts about the relationship between domestic production and exports at the firm-product level, discuss possible explanations including data error, explore robustness of the findings and examine the relationship between firm productivity and trade costs on the margins of trade for different types of products: those produced by the firm and exported and those exported but not produced by the firm. Finally we present a model to explain the facts and examine its implications for the data.

4 Carry-Along Trade

To guide our exploration of what firms make and what they sell or export, we first introduce a set of definitions of Carry-Along Trade for both products and firms. Products fall into three mutually-exclusive categories at the firm-product level: (1) *non-exported* firm-products which are reported as produced by the firm but are not recorded as exports; (2) *regular* export firm-products which are products both reported as produced by the firm and exported by the firm *and* where the recorded value of exports is less than or equal to the value of production; (3) *Carry-Along Trade* firm-products which are products where the value of exports is greater than the value of production by the firm,

$$\#\text{exported products} = \#\text{regular} + \#CAT.$$

Carry-Along Trade (*CAT*) firm-products can be further divided into two non-overlapping, exhaustive categories: (3a) *pure-CAT* firm-products where the firm export value is positive but there is no recorded production in that product (domestic produced $\text{sales}_{fp} = 0$), and (3b) *mixed-CAT* firm-products where the firm reports positive production and exports and the value of exports is greater than that of production. The number of exported products for each firm is the sum of types (2)-(3) while the number of produced products is the sum of types (1)+(2)+(3b),

$$\#\text{produced products} = \#\text{non-exported} + \#\text{regular} + \#\textit{mixed-CAT}.$$

Exporting firms can be divided into groups as well: *regular* exporters export only regular products while *Carry-Along Trade* (*CAT*) exporters export at least one CAT product and may also export regular products,

$$\#\text{exporters} = \#\text{regular exporters} + \#\text{CAT exporters}.$$

Finally, we can split the value of aggregate exports, $X = \sum_f X_f$, by these manufacturing firms into components related to *CAT* and *Regular* firm-products. We report information about two different splits of firm exports. First we focus on the firm-products themselves. Total firm exports is the sum of the value of exports of regular products, *Regular* exports, and the value of exports of CAT products,

$$X_f = \sum_p X_{fp} = \sum_{p \in \text{regular}} X_{fp} + \sum_{p \in \text{mixed or pureCAT}} X_{fp}.$$

A second method allocates firm exports into produced exports, PX_f, and sourced (or non-produced) exports, SX_f. Produced export value is the sum of Regular exports and the value of mixed CAT exports that are reported produced by the firm. Sourced exports equal the sum of all pure CAT firm-product exports and the portion of mixed CAT exports that are not produced by the firm:

$$\begin{aligned} X_f &= \sum_p X_{fp} = \sum_{p \in \text{regular}} X_{fp} + \sum_{p \in \text{CAT}} X_{fp} \\ &= \sum_{p \in \text{regular}} PX_{fp} + \sum_{p \in \text{mixed CAT}} PX_{fp} + \\ &\quad \sum_{p \in \text{mixed CAT}} SX_{fp} + \sum_{p \in \text{pure CAT}} SX_{fp} \\ &= PX_f + SX_f. \end{aligned}$$

In row 1 of Table 3 we explore Carry-Along Trade at the HS6+ level. As mentioned before, we have 3631 exporting firms in the concorded dataset. Most of these exporters are CAT exporters, 3233 or 89.0 percent. Indeed, most exporters, 3177, export at least one pure-CAT product, i.e. a product where they report no domestic production. CAT products are as pervasive as CAT exporters. Of the 2858 total unique HS6+ products (exported + non-exported), 2822 (98.7 percent) are reported as Carry-Along Trade by at least one firm.

While most firms export at least one CAT product and most products are exported as CAT by at least one firm, the share in the total value of exports is lower. Exports of CAT products account for €41.5billion or over 48 percent of the value of exports at these manufacturing firms. Sourced exports are €25.4billion, just under 30.0 percent of total exports for these firms. Pure-CAT products account for 96 percent of the number of CAT products and 74 percent of the value of sourced exports.

These results suggest that the traditional image of a manufacturing exporter that produces products and exports some or all of them is missing an important component. The large majority of products exported by the firm are not made by the firm and these sourced products account for a sizable fraction of firm export value.

4.1 Data Issues

Ideally to compare production and exports at the level of the firm–product, one would like to have data from a single source with both production and exports recorded in a common classification system.[15] For the combined production and export data, the export information is obtained from a combination of surveys for Intra-EU trade and customs records for exports to non-EU destinations and is based on the CN8 classification system, while the firm-product production data comes from an annual survey of manufacturing firms and is based on the PC8 classification system. It is possible that the same product might be classified in different 8-digit codes for the export records and production records. If there is some ambiguity about the correct classification for a product, different individuals filling out the different forms and surveys may choose related but distinct product classifications for the export and product information. Even the same individual faced with different product descriptions might record the same good in two different categories.

This can be seen in the context of a specific example from the CN and PC Codes and Descriptions for "Sweet Biscuits" in Table 4. Items in the HS6 category of "Sweet biscuits" can be classified into five different CN8 categories depending on whether they are coated with chocolate/cocoa, the weight of the immediate packaging, the level of the milk-fat content, and whether or not they are sandwich biscuits. There are two PC8 codes that encompass sweet biscuits based on the chocolate/cocoa covering. The CN8 codes map fairly simply into the PC8 codes but mistakes in classification are still possible. In such a case a slightly more aggregate view of the data will

[15]The preferred data are often administrative data which are collected in the normal course of business, e.g. records developed for social security payments are useful sources of wage and employment information at the establishment, as well as whether or not the establishment is in operation. Export values by product, firm and destination are often administrative data as they are collected from mandatory customs forms.

merge related product codes and eliminate spurious CAT exports. Our choice of a six-digit level of aggregation should remove many such cases of spurious misclassification.

In the remaining rows of Table 3, we examine how the prevalence of CAT trade changes at different levels of aggregation. Row 2 reports the same numbers after having aggregated both the production and the export data to the HS 4-digit level. This represents a substantial reduction in the number of categories as there are now only 1012 "products". Even at this more aggregate level we find that CAT firms and products are pervasive. 84 percent of firms export at least one CAT product and 98 percent of products are exported as a CAT product by at least one firm. Aggregating the product categories does reduce the value of exports of CAT products by more than 15 percent to €34.3billion.

Aggregating further to the 2-digit (90 "products") continues to reduce the number of CAT firms and the value of CAT exports. However, even with extremely aggregated 2-digit categories, 2669 firms (73 percent) report exporting in a category where they report no production and the export value of CAT products is more than a third of the total export value of these manufacturing firms. Our conclusion from this aggregation exercise is that product misclassification might play a role in some CAT exports but the phenomenon is widespread across firms and products and represents a substantial fraction of exports by manufacturing firms.

As an additional check of the robustness of the main facts about Carry-Along Trade, we consider a range of different samples of the data as reported in Table 5. Concerned that firms with large non-manufacturing operations might be distorting our results, we select firms with a primary activity in manufacturing and find no differences in the importance of CAT across firms, products or the value of exports. The results are not driven by the presence of any particular sector. For example, dropping firms in food-related manufacturing (a sector where large wholesaler/retailers are likely to perform some manufacturing) does not alter the results. One possibility is that firms are part of larger domestic or multinational group and might be exporting products made by other companies in the group. Dropping firms in either domestic or foreign groups does not appreciably reduce the presence of CAT.[16]

Another potential data error comes from combining six-digit products into larger categories. Including only products with a one-to-one concordance between the two 8-digit classification systems again does not noticeably alter the fractions of CAT exporters and CAT products or the CAT share of export value. We exclude any role for firm imports to avoid concerns that CAT is primarily the result of re-exporting that is not correctly captured by customs procedures. Again the results are not altered. In the final column, we see that the findings are robust to a change in the definition of CAT at the firm-product level, excluding the possibility that small differences in

[16]Multinational and foreign-owned firms are defined using the FDI survey (cfr. Data Appendix). Domestic groups are identified using ownership information from the Belfirst Database (BvDEP, 2006).

reported production and trade numbers are generating CAT.[17]

While the possibility remains that some fraction of CAT trade appears in the data due to misreporting or other measurement issues, the pervasive nature of CAT across firms and products is a robust stylized fact. In the next sections, we report characteristics of regular and CAT exporters and examine the relationship between firm productivity and regular versus CAT exports.

5 CAT and Firm Characteristics

Table 6 reports means of a variety of firm characteristics for all exporters, regular exporters and CAT exporters. The second and third categories are mutually exclusive and span the set of exporting firms.

A quick comparison of columns 2 and 3 reveals that the relatively low number of regular exporters are substantially smaller, less export intensive, and less productive than the CAT firms. On average, CAT exporters employ four times as many workers, have value-added more than four times larger and export more than eight times as much. However, the much greater export to production ratios at CAT exporters are driven by the CAT exports themselves; produced exports to produced sales ratios are about 0.33 for both regular and CAT exporters even though CAT exporters also export more regular products.

Revenue-based productivity measures, both TFP and value-added per worker, are 5-9 percent higher at CAT exporters who also reach many more export destinations. In addition, CAT firms display different ownership characteristics. CAT exporters are more likely to be part of a Belgian multinational, i.e. a Belgian firm that has at least one foreign subsidiary of which it owns at least 20 percent either directly or indirectly. CAT exporters are also more likely to have a foreign shareholder that directly or indirectly owns at least 20 percent of the firm.

5.1 CAT, Margins of Trade and Productivity

In this section, we follow the empirical strategy of Bernard, Redding, and Schott (2011) and relate the margins of firm trade to proxies for firm productivity. Total firm exports can be decomposed into the number of distinct products exported, P_f and the average exports per product, $\bar{X}_f$,

$$\begin{aligned} X_f &= P_f \bar{X}_f \\ \text{where } \bar{X}_f &= \frac{1}{P_f} \sum_p X_{pf}. \end{aligned} \tag{1}$$

Previous empirical work on US exporters has shown a strong positive correlation between measures of firm productivity and total exports as well as a positive relationship between productivity

[17] Firm-product exports are considered to be regular exports if the ratio of production to exports is greater than 0.99 and firm-product exports are consider to be pure CAT if the ratio is less than 0.01. Adjusting these cutoffs does not materially change the importance of CAT across firm and products.

and the number of exported products (Bernard, Redding, and Schott, 2011).[18] These results also hold for total firm exports in our sample of Belgian manufacturing exporters. In panel A of Table 7 we report pooled cross-section regressions for 2005 of log firm exports and its two constituent components on log firm TFP and fixed effects for the major industry of the firm,

$$\ln Y_f = c + \beta \ln \mathrm{Prod}_f + \delta_i + \varepsilon_f \tag{2}$$

where Y_f refers to the two components of the decomposition given by (1), i.e. P_f, and $\bar{X}_f$. By construction the specification only examines the relationship of productivity and exports for current exporters. Firm exports are strongly positively associated with firm productivity with an elasticity significantly greater than 1. Looking at the extensive and intensive margins, we find positive and significant coefficients for the number of products, and the average value of exports per product. More productive firms export more products and ship more of each variety.

However, our interest lies in the differential response of regular exports and CAT exports. In panels B and C of Table 7 we report a pooled cross-section regression for 2005 of log firm exports of type j and its constituent components where the export type is either regular or CAT on a dummy for export type, $d_{CAT} = 1$ for CAT exports , a proxy for firm productivity, and an interaction term including fixed effects for the major industry of the firm,

$$\ln Y_f^j = d_{CAT} + \beta \ln \mathrm{Prod}_f + \gamma d_{CAT} \cdot \ln \mathrm{Prod}_f + \delta_i + \varepsilon_f \tag{3}$$

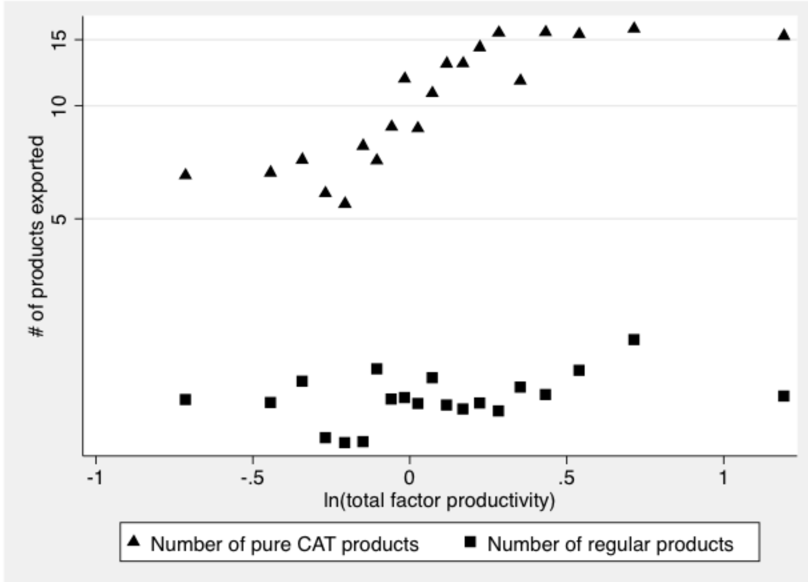
where Y_f refers to the two components of the decomposition given by (1), i.e. P_f^j and $\bar{X}_f^j$.

Panel B of Table 7 uses log TFP as the firm productivity measure while panel C uses log value-added per worker; the results are very similar for the two measures. Looking across the second row of coefficients in each panel, we find that the value of regular exports again increases in firm productivity. However the rise in regular exports is due mostly to the rise in the average exports per product; the number of regular products increases weakly with firm productivity.

CAT exports are significantly lower than regular exports within the firm (the CAT dummy is negative and significant), however, they increase at a similar rate as firm productivity rises so the share of CAT exports in total exports in not changing systematically with firm productivity.[19] However, both the levels and the response to firm productivity is quite different across the extensive and intensive margins. The number of CAT products is greater than regular products and increases much faster in firm productivity (column 2). The share of CAT products in total exported products rises as firm productivity increases. Figure 2 shows the relationship between the number of products, regular and CAT, and firm productivity. Average shipment size for CAT products is

[18] We focus in this paper on the number of products and the average exports per product. Results including the number of destinations as an additional extensive margin do not change the main results and are available upon request.

[19] The relationship between firm productivity and CAT exports can be obtained by summing the coefficient on the productivity measure and that on the interaction term.



Notes: Firms are sorted by TFP and placed in equal-sized bins. Each data point represents the average number of exported, or regular, products for firms in that productivity group.

Figure 2: Productivity and Exported Products, 2005

lower than that for regular products and increases at a much slower rate as firm productivity rises.

While the value of both regular and CAT exports increases with firm productivity, there are notable differences between the responses of produced and sourced products. The increase in regular export value comes largely through sizable increases in average shipments of each product and much less through an increase in the number produced products that are exported. For Carry-Along Trade, higher productivity is associated with increased export levels, but the increase is split roughy evenly between rising numbers of CAT products and an increase in average export value. The overall increase in exported products at more productive firms is due mostly to adjustments in the number of CAT products.[20]

One potential issue stems from the use of log TFP or log value-added per worker as the proxy for firm productivity.[21] We are less concerned about finding the perfect measure of productivity and are more interested in documenting robust relationships between firm efficiency in production and

[20]Adding log employment to the specification reduces the magnitude of the coefficients on productivity but the pattern of results is largely unchanged. Similarly running the regressions with regular and pure CAT products does not change the findings.

[21]There are many issues in constructing measures of firm-level productivity, see Foster, Haltiwanger, and Syverson (2008) for comparisons of quantity and revenue-based TFP and de Loecker (2011) and Bernard, Redding and Schott (2009) for some of the difficulties in constructing productivity measures for multi-product firms. The presence of sourced products adds yet another set of potential problems in multi-factor productivity measurement.

the number and value of produced and sourced products. Table 8 repeats the regression with the number of export products as the dependent variable with a set of additional firm characteristics that are likely to be positively correlated with underlying productive efficiency. We consider as proxies, total production by the firm and production of the largest product as well as total exports and exports of the largest product. Again we find that both the number of regular export products and the number of CAT export products are increasing in the level of the firm productivity proxy. In addition the number of CAT products increases much more rapidly than does the number of regular export products.

6 A Model of Carry-Along Trade

To our knowledge, the phenomenon of manufacturing firms exporting goods that they do not produce themselves is not present in either the theoretical or empirical literatures on international trade. While there has been work on the role of networks in facilitating trade, e.g. Rauch (2001), Rauch and Watson (2004) and Petropoulou (2007), and the presence of intermediaries in trade, e.g. Ahn, Khandewal and Wei (2011) and Akerman (2010), the typical assumption in that recent empirical and theoretical work is that the intermediary is a non-producing firm. Our work differs from and complements that new research by exploring the role of sourced and produced products in the manufacturing exporter's portfolio. In this section, we present a model of multi-product exporters that aims to explain the presence of CAT and its relationship to firm productivity.

6.1 Our Approach

Our goal is to construct a framework to identify the potential mechanisms and motivations underlying Carry-Along Trade (CAT). To this end, our model features multi-product firms that face a two-tiered problem: to choose the optimal *product scope* (how many varieties to sell to the market, and how much at what price for each variety), and a *make-or-source* decision – the question of whether (or to what extent) to produce goods in-house or through arms-length suppliers. The model is not one of vertical integration or intermediate products per se, though we readily acknowledge the relevance of supply chain integration.

Because we are the first to identify the CAT phenomenon, we start from a blank slate in our effort to explain it. Our modeling approach therefore is designed to maximize both breadth and generality. We take a somewhat agnostic approach and work through a range of potential explanations. For each, we outline a plausible underlying cause of CAT, formalize the implied relationship between CAT and firm characteristics, and then briefly evaluate the relative likelihood that the mechanism is at play given observed patterns in the data.

In the spirit of Mrazova and Neary (2011), we focus on equilibrium selection among heterogeneous firms – specifically the relationship between firm productivity, product scope, and the make-or-source decision – and purposely set aside derivation of the full general equilibrium. This approach has the important advantage that we are not compelled to make specific functional form assumptions, allowing us to develop a unified framework in which to identify and discuss importance differences among broad classes of both supply side and preference structures.[22]

We adopt a three step approach to the theoretical exercise. We begin by outlining a simple version of a multi-product heterogeneous firm model with a make-or-source decision. We observe that a broad class of models necessarily predict a relationship between firms' core productivity and the extent of Carry-Along Trade that is in direct contradiction to the data. That is, the theory predicts that the most productive firms would do the *least* Carry-Along Trade, while the data clearly indicate the opposite. From this we conclude that that there must be something else at play, and thus proceed through a series of potential explanations. We focus first on supply-side mechanisms, before shifting attention to demand. For each modeling alternative, we outline a set of necessary conditions that would have to hold for a model to rationalize the key features of the data.

6.2 The Baseline Model

Firms. Our general framework features a continuum of atomistic firms, indexed by $j \in [0, 1]$, each of which may provide (potentially) multiple unique varieties to the market. Each firm has a 'core' variety indexed by $i = 0$; remaining varieties are indexed by their distance from the core according to $i \in (0, k_j]$, where k_j denotes the (endogenous) equilibrium mass of varieties provided to the market by firm j. Each product in the market is uniquely identified by the firm-variety pair, ji.

Firms can serve the market in three ways: by producing in-house, by sourcing from arms-length suppliers, or some combination of the two – producing some goods, and sourcing others.[23] We assume constant returns to scale in both in-house production technology and in arms-length sourcing costs so that within a given variety all goods will be either produced in-house or sourced from arms-length suppliers, but not both (except the razor's edge variety with identical in-house and sourcing costs).[24] We refer to goods produced in-house as *regular* goods, and goods sourced from arms-length suppliers as *carry-along* (or CAT) goods, just as in the earlier sections of this paper.

We denote firm j's marginal cost of producing variety i in-house by $c(j, i)$. In-house production exhibits constant returns to scale within each variety, but diseconomies of scope across varieties, so

[22] Moreover, as is well recognized in the literature and eloquently argued by Mrazova and Neary (2011), derivation of closed form general equilibrium outcomes generally requires not only specific functional form assumptions, but very *particular* functional form assumptions for tractability. The most tractable frameworks also carry a number of idiosyncratic, albeit convenient, properties that we prefer to avoid.

[23] Firms that source all goods, i.e. pure wholesalers, are not in our sample, while firms that produce only in-house, "regular firms", are relatively few in the data. See Table 5.

[24] Thus, the assumptions of the model implicitly rule out 'mixed CAT' – the potential that for the *same variety*, a firm would *simultaneously* produce in-house and source from an upstream supplier.

that $c(j,i)$ is (strictly) increasing in i.[25] We assume moreover that $c(j,i)$ is strictly increasing in j; that is, firms indexed j closest to zero are the most productive, and thus have the lowest marginal cost of production for any given scope. Finally, we assume for convenience and with little loss of generality that the cost function is continuously differentiable in each argument. To summarize our assumptions over the in-house cost structure, we have: $\frac{\partial c(j,i)}{\partial i} > 0$, $\frac{\partial c(j,i)}{\partial j} > 0$, and $c(\cdot) \in C^1$.

The technology for sourcing goods from arms-length suppliers is deliberately simple in the baseline version of the model.[26] We begin with the assumption of constant returns to both scale and scope in sourcing, so that the marginal cost to firm j of sourcing a given variety i is simply $\hat{c}(j,i) = \hat{c}$ $\forall i, j$. Together, the assumptions of constant returns to scope in sourcing and decreasing returns to scope in production ensure a simple characterization of firms' make-or-source decisions.[27] In the next section, we consider firm-level heterogeneity in sourcing technology as well as the possibly of fixed costs to engaging in Carry-Along Trade.

Finally, all firms face a variety-specific per-unit distribution cost, $\delta(i)$, which is independent of whether a good is made in-house or sourced from an arms-length supplier; constant with respect to quantity within a variety; identical across firms; and additive with the direct (constant) marginal cost of producing or sourcing the product. Most importantly, the distribution cost increases with a variety's distance from the firm's core product so that $\delta'(i) > 0$.[28] By design, $\delta(i)$ has no influence on the pattern of firms' make-or-source decisions; from a modeling perspective, the role of $\delta(\cdot)$ is simply to ensure existence of a unique interior equilibrium, so that firms do not expand scope infinitely.[29] Later, we allow $\delta(\cdot)$ to vary by firm as well as variety.

Consumers. A mass of identical consumers (or equivalently downstream assemblers), have non-degenerate preferences over differentiated goods, where goods are both firm (j) and variety (i) specific. Consumers care only about firm-variety pair, and (crucially) do not differentiate between goods produced in-house versus sourced from a supplier. For parsimony, we assume that any demand-side income effects are absorbed in total market quantity, Q, which is taken as given by atomistic firms, and that aggregate demand systems are twice continuously differentiable in relevant

[25] It is worth emphasizing that we are assuming that the unit cost of production increases for only the *marginal* variety as scope expands; our approach is thus consistent with Eckel and Neary (2010).

[26] This basic sourcing technology acts much like a wholesaling technology for the firm.

[27] Incorporating diminishing returns to scope in sourcing technology is generally straightforward as long as the implied ranking of in-house and sourcing cost functions does not change more than once over the support of possible varieties. Tractability requires only that there exists a unique make-or-source threshold below which all products will be made in-house and above which additional varieties are CAT products. Our assumption of constant returns to scope in sourcing is sufficient, but by no means necessary. At the same time, we readily acknowledge that economies of scope in sourcing are more problematic from a tractability standpoint, but we do not see sufficient value added to merit prolonged discussion of the possibility.

[28] Our assumptions over the cost structure for production and sourcing already ensure that firms will offer the goods closest to $i = 0$; thus, the sum of direct production (or sourcing) cost and distribution cost is strictly increasing in i.

[29] Note that equilibrium may exist absent such an increasing marginal cost of distribution – for instance, with the "quantity cannibalistic" preferences outlined below – but is not guaranteed.

arguments.[30]

In the baseline version of the model, we restrict attention to preference structures that generate (any) demand system in which inverse aggregate demand for product ji may be written as a function of aggregate parameters (taken as given by the atomistic firms and hereafter suppressed) and own (aggregate) quantity *only*:

$$p_{ji} \equiv p(q_{ji}, Q, ...) = p(q_{ji}) \ \forall i, j,$$

but is otherwise independent of firm or variety specific components. Later, we consider alternative preference structures that permit firm-level demand-side spillovers across goods – including the intra-firm "cannibalistic" demand developed by Eckel and Neary (2010).

7 Firm Behavior and Selection

As discussed earlier, we follow Mrazova and Neary (2011), in presupposing the existence of a unique general equilibrium, so that we may jump immediately to the key equilibrium prediction: the pattern of firm selection into regular and Carry-Along Trade activities. [31] In equilibrium, each firm makes three decisions (1) *entry:* whether to enter the market or not, (2) *product scope:* how many products, and how much of each and at what price, to sell to the market, and (3) *make-or-source:* which products to make in-house and which to source from upstream suppliers via the CAT technology. We consider each decision in turn, beginning with the last.

Make-or-Source Decision. As outlined earlier, for each variety i it sells, a given firm j decides whether to produce in-house at constant marginal cost $c(j, i)$, or to access a "fishing" technology, by which firm j is matched with a supplier from whom to source carry-along products at constant marginal cost $\hat{c}$. Recall that consumers make no distinction between in-house produced goods and CAT goods, distribution costs are similarly independent of the make-or-source decision, and (by assumption) the production and sourcing cost structures are independent of total product scope. The make-or-source decision is therefore simply that which minimizes the marginal cost of any given variety i.[32] Given that in-house production exhibits decreasing returns to scope, while the sourcing technology has constant returns to scope, it is immediate that every firm will have a unique make-or-source threshold that delineates regular goods from CAT goods. This threshold, which we denote by $\hat{k}(j)$, is defined implicitly by:

$$c(j, \hat{k}(j)) = \hat{c}. \tag{4}$$

[30] We could of course silence income effects by assuming a quasi-linear demand structure with a numeraire good, but it is not necessary to make such a functional form restriction; see Neary (2009).

[31] We address the conditions for equilibrium existence and uniqueness in the appendix.

[32] Conversely, the make-or-source decision generally would depend on the equilibrium product scope if the sourcing technology exhibits either economies or diseconomies of scope, or if there is a fixed cost to Carry-Along Trade and any form of spillovers across goods.

Lemma 1 *In equilibrium, each firm j will produce in-house all goods $i \leq \hat{k}(j)$, and will source the balance ($i > \hat{k}(j)$) from arms-length suppliers.*

For products closest to a firm j's core production competency ($i \leq \hat{k}(j)$), the firm has an in-house cost advantage relative to the pool of homogeneous arms-length suppliers; for more peripheral varieties further afield of firm j's core competency, the marginal cost of in-house production rises, eventually reaching a point at which the marginal cost of buying from an arms-length supplier is less than the cost of producing in-house.[33] The optimal cost function for each firm-product pair may then be written $\tilde{c}(j,i) \equiv \min\{c(j,i), \hat{c}\}$, and it is simply the lower envelope of the in-house and CAT-sourced cost curves over the support of varieties. Notice that this minimized cost function is strictly increasing in i until $i \geq \hat{k}(j)$ and constant thereafter as shown in Panel A of Figure 3.

Optimal Scope. From here, we can define the profit function for any given firm-product pair:

$$\tilde{\pi}(j,i) = \max_{q_{ji}} [p(q_{ji}) - \tilde{c}(j,i) - \delta(i)] q_{ji}. \tag{5}$$

Notice three important points: first, the firm-product profit function already embodies the optimal make-or-source decision, $\hat{k}(j)$, through $\tilde{c}(\cdot)$; second, in this simple baseline version of the model, a firm's profit function for each variety is independent of the total set of varieties offered by the firm; third, given the symmetric demand structure and decreasing returns to product "remoteness" (i.e. that $\tilde{c}(j,i) + \delta(i)$ is strictly increasing with i), $\frac{\partial \tilde{\pi}(j,i)}{\partial i} < 0$. Thus, we can summarize a firm's decision over the *set* of varieties to sell as the firm's optimal *scope* decision, k – the firm will sell all varieties closest to the core: $i \leq k$ – and no others.

Aggregating a firm's profit function for each variety over all offered varieties $i \in [0, k]$, firm j's total return as a function of scope and productivity is then:

$$\Pi(j,k) \equiv \int_0^k \tilde{\pi}(j,i) di. \tag{6}$$

Taking the derivative with respect to k yields the first order condition that defines implicitly the firm's optimal scope, $k(j)$. In the baseline version, this first order condition is remarkably simple because both the make-or-source decision and the demand functions for each variety are independent of the total product scope. The firm will optimally continue adding varieties until the last variety added yields zero profit.[34] The FOC is simply:

$$\frac{\partial \Pi(j,k)}{\partial k} = \underbrace{\int_0^k \frac{\partial \tilde{\pi}(j,i)}{\partial k} di}_{=0} + \tilde{\pi}(j,k) = \tilde{\pi}(j, k(j)) = 0. \tag{7}$$

[33] It is of course entirely possible to adopt functional form or distributional assumptions such that there exist firms for which even the core variety is more expensive to produce in-house than to source – we would interpret these firms as 'pure' wholesalers. This said, there are no 'pure' wholesalers in our sample (by definition, the data are for firms that have some production), and so we do not focus on them here.

[34] Note that with CES preferences, which imply an infinite choke price, one must incorporate a (potentially very small) fixed cost for adding each new variety in order to ensure existence of finite $k(j)$. See the theory appendix.

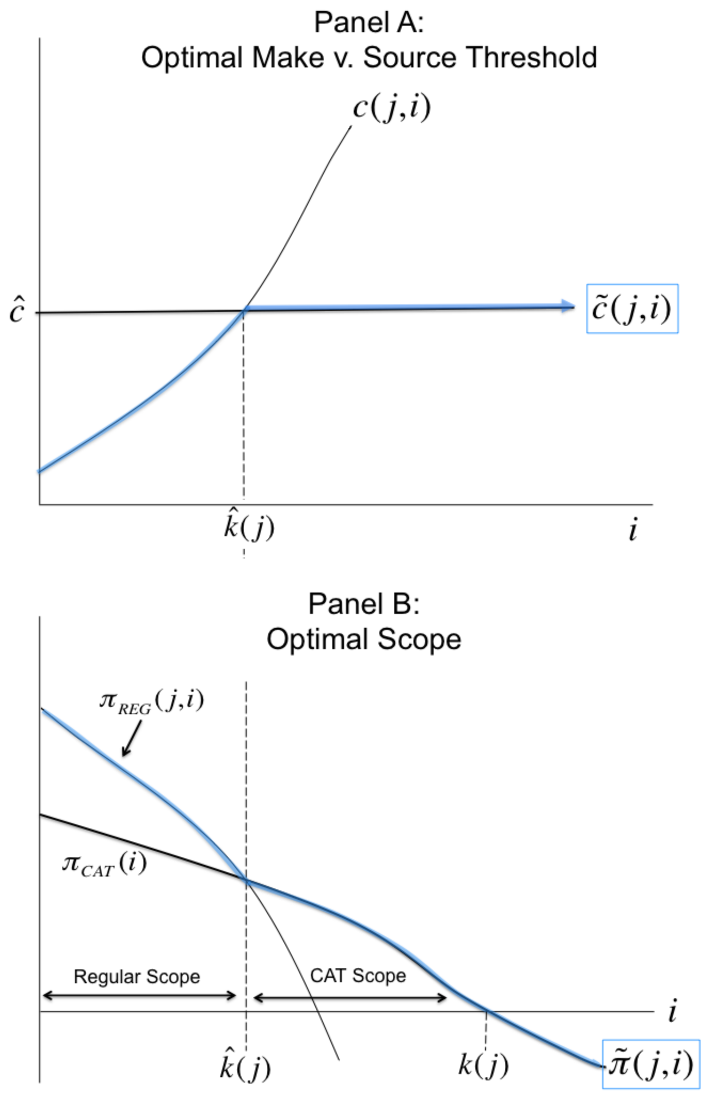


Figure 3: Firm j's Optimal Make-or-Source Decision for Each Variety i

The second order condition is then just that the profitability of the marginal (k^{th}) variety is decreasing as scope rises – i.e. that there are diseconomies of scope:

$$\frac{\partial^2 \Pi(j,k)}{\partial k^2} = \frac{\partial \tilde{\pi}(j,k)}{\partial k} = \left.\frac{\partial \tilde{\pi}(j,i)}{\partial i}\right|_{i=k} = -q^o_{ji} \left.\underbrace{\left(\frac{\partial \tilde{c}(j,i)}{\partial i} + \delta'(i) \right)}_{+}\right|_{i=k} < 0. \tag{8}$$

The importance of assuming $\delta'(i) > 0$ is immediately evident – without it, there is no reason that an interior equilibrium necessarily should exist for a firm engaged in CAT at the margin: in this baseline version of the model, demand exhibits no within-firm crowd out (e.g. brand cannibalization), and there are no other supply-side diseconomies of scope once the firm switches to CAT production (i.e. $\frac{\partial \hat{c}}{\partial i} = 0$.)

Panels A and B in Figure 3 illustrate. For any given variety i, firm j can choose between producing in-house at constant marginal cost $c(i,j)$ or sourcing a carry-along product from an upstream supplier at cost $\hat{c}$. At $\hat{k}(j)$ the two costs are equal, as shown in Panel A. Below this threshold, the cost is lower (and profit is higher) via regular production; above it, marginal cost is lower and profit is greater via Carry-Along Trade. In the figure, we label the (hypothetical) firm-variety profit function from regular production by $\pi_{REG}(i,j)$, while the CAT profit function is denoted by $\pi_{CAT}(i,j)$.[35] The firm's profit function given the optimal make-or-source decision, $\tilde{\pi}(j,i)$, is then simply the upper envelope of the two potential profit functions under either provisioning strategy, producing in-house (π_{REG}) or sourcing from an upstream supplier (π_{CAT}). In this baseline version of the model, the firm will continue to add varieties until the profit of the marginal product is zero – i.e. $\tilde{\pi}(j,i) = 0$ at $k(j)$ – as indicated by the first order condition in (7).[36]

Entry. Firms will enter a market if their realized profit is sufficient to cover an exogenous, homogeneous fixed cost of entry, F. There is no firm-level idiosyncratic component to profit apart from firm productivity, so only sufficiently productive firms will enter the market. Defining each firm's total profit to be the sum of returns to each variety given the optimal scope, $\tilde{\Pi}(j) \equiv \int_0^{k(j)} \tilde{\pi}(j,i)di$, the least productive firm to enter the market, firm $\bar{j}$, is given implicitly by $\tilde{\Pi}(\bar{j}) = F$.

Finally, a note on terminology: in the model, equilibrium product scope is equivalently the *mass* of varieties supplied to the market by a firm. In equilibrium, firm j sells a mass of regular varieties, $\hat{k}(j)$ (the range $i \in [0, \hat{k}(j)]$), to the market, with a total variety mass of $k(j)$ (the range

[35] Where $\pi_{REG}(i,j) \equiv \max_{q_{ji}}[p(q_{ji}) - c(j,i) - \delta(i)]q_{ji}$ and $\pi_{CAT}(i,j) \equiv \max_{q_{ji}}[p(q_{ji}) - \hat{c} - \delta(i)]q_{ji}$. Note that $\pi_{REG}(i,j)$ is necessarily steeper than $\pi_{CAT}(i,j)$ for all $i \leq \hat{k}(j)$ as drawn: regular production exhibits diseconomies of scope in production and distribution, whereas CAT has diseconomies only in distribution. $\frac{\partial \pi_{REG}(j,i)}{\partial i} = -q^{REG}_{ji}\left(\frac{\partial c(j,i)}{\partial i} + \delta'(i)\right) < \frac{\partial \pi_{CAT}(j,i)}{\partial i} = -q^{CAT}_{ji}\delta'(i) < 0$, given that $\forall i \leq \hat{k}(j)$, $q^{REG}_{ji} \geq q^{CAT}_{ji} > 0$.

[36] Returning briefly to the potential for diseconomies of scope in sourcing, Panels A and B demonstrate respectively that diseconomies of scope in sourcing (upward sloping $\hat{c}(\cdot)$ in Panel A) are easily embedded in our model as long as (*i*) the $\hat{c}(\cdot)$ function crosses the in-house cost function $c(\cdot)$ at most once and from above in Panel A; so that (*ii*) $\pi_{REG}(\cdot)$ crosses π_{CAT} at most once from above in Panel B.

$i \in [0, k(j)]$). The mass of varieties sold via Carry-Along Trade is then simply $\max\{0, k(j) - \hat{k}(j)\}$ (with range $i \in (\hat{k}(j), k(j))$)). This said, we typically refer to product scope – rather than mass of varieties – to avoid potential confusion with quantities of each product sold (the scale of the $q_{ji}s$). When we take our predictions to the data, we interpret product scope as the (discrete) *number* of varieties supplied to the market.

7.1 Productivity, Regular Products, and Carry-Along Trade

The baseline model's predictions for the relationship between firm productivity, regular product scope, CAT scope, and (total) product scope follow directly. In characterizing the relationship between firm productivity and the extent of regular and Carry-Along Trade across firms, we adopt the terminology in Mrazova and Neary (2011), referring to complementarity between underlying firm productivity and firm activity in a firm's payoff function as *super-modular* and negative complementarity as *sub-modular*.[37]

Productivity and Regular Product Scope. Regular product scope is increasing in firm productivity. Given that the most productive (lowest j) firms have the lowest marginal cost of in-house production for any given variety i, while the marginal cost of carry-along products is identical and constant across firms and varieties, it is immediate that the least productive firms (highest j) will be the first to switch from producing in-house to sourcing via CAT:

Lemma 2 *$\hat{k}(j)$ is strictly decreasing in j.*

Proof. From the implicit definition of $\hat{k}(j)$ in (4) and the implicit function theorem: $\hat{k}'(j) = -\frac{\frac{\partial c(j,i)}{\partial j}}{\frac{\partial c(j,i)}{\partial i}} < 0$. $\diamond$

Productivity and (total) Product Scope. Optimal (total) product scope is also increasing with firm productivity, but weakly. Among regular-only firms (meaning they produce everything in-house (i.e. $\hat{k}(j) \geq k(j)$)), the profit of the marginal product *scope* variety, $k(j)$, is strictly increasing with firm productivity (decreasing in j) as one would expect given that the marginal cost of production for any given variety scope is increasing with j. But for firms engaged in Carry-Along Trade at the margin, $\tilde{\pi}(j, i) = \tilde{\pi}_{CAT}(i)$, so that the profit of the marginal product is independent of j. For any given i, all carry-along firms of *any* productivity face the same demand and symmetric costs of bringing the good to market. That is, $\tilde{\pi}_{CAT}(i) = \max_{q_{ji}}(p(q_{ji}) - \hat{c} - \delta(i))q_{ji}$. Thus, the equilibrium (total) product scope will be the *same* for all firms engaged in Carry-Along Trade, regardless of their initial productivity. Formally:

[37] Formally, a function $f : R^n \to R$ is super-modular if $\forall \vec{x}, \vec{y} \in R^n$, $f(\vec{x} \wedge \vec{y}) + f(\vec{x} \vee \vec{y}) \geq f(\vec{x}) + f(\vec{y})$, where $\vec{x} \wedge \vec{y}$ ($\vec{x} \vee \vec{y}$) denotes the component wise minimum (maximum) of $\vec{x}$ and $\vec{y}$. When $f(\vec{z})$ is differentiable, as in our framework, super-modularity is equivalent to $\frac{\partial^2 f(\vec{z})}{\partial z_1 \partial z_2} \geq 0 \; \forall z_1 \neq z_2$, by Topkis' Characterization Theorem. (Topkis (1998))

Lemma 3 *$k(j)$ is weakly decreasing in j.*

(*i*) *For regular-only firms ($\forall j$ s.t. $\hat{k}(j) \geq k(j)$): total product scope is strictly increasing with firm productivity: $k'(j) < 0$.*

(*ii*) *For firms that engage in CAT ($\forall j$ s.t $\hat{k}(j) < k(j)$), total product scope is independent of firm productivity: $k(j) \equiv k_{CAT}$ and thus $k'(j) = 0$.*

Proof. From the implicit definition of $k(j)$ in (7) and the envelope condition for (5): $k'(j) = -\frac{\frac{\partial \tilde{\pi}(i,j)}{\partial j}}{\frac{\partial \tilde{\pi}(i,j)}{\partial j}}\Big|_{i=k} = -\frac{\frac{\partial \tilde{c}(i,j)}{\partial j}}{\frac{\partial \tilde{c}(i,j)}{\partial i}+\delta'(i)}\Big|_{i=k}$. For regular-only firms, the marginal product k is produced in-house, so that $\tilde{c}(j, i = k) = c(j, k)$, and thus $k'(j) = -\frac{\frac{\partial c(i,j)}{\partial j}}{\frac{\partial c(i,j)}{\partial i}+\delta'(i)}\Big|_{i=k} < 0$. For CAT firms, the k^{th} variety is sourced from arm-length upstream suppliers at constant marginal cost $\hat{c}$, and so $k'(j) = -\frac{0}{\delta'(i)}\Big|_{i=k} = 0$. $\diamond$

Productivity and CAT Scope. Comparing two firms with differing core productivities, the more productive (lower j) firm will produce a greater range of products in-house, and thus *necessarily* will supply fewer products via Carry-Along Trade. The fundamental mechanism is simple: if firms have the same access to an identical, constant Carry-Along Trade 'technology', then the firms with a lower opportunity cost of sourcing via CAT will use it the most. The most productive firms have the least to gain from Carry-Along Trade relative to in-house production, and thus will use it the least.[38]

Figure 4 illustrates the relationship between firm productivity and regular, CAT, and (total) product scope in equilibrium. Firm A has greater core efficiency ($j_A < j_B$) and thus greater profits for any given regular product i than Firm B. This means that Firm A will find it profitable to produce a greater range of products in-house than Firm B, so that Firm A's regular product scope is greater than Firm B's: $\hat{k}(j_A) > \hat{k}(j_B)$. However, since both firms have identical sourcing technologies, their marginal profit from any given CAT product $i > \hat{k}(j_A) > \hat{k}(j_B)$ will be the same. As such if both firms engage in any CAT activity, they will have the same optimal total product scope: $k(j_A) = k(j_B)$. CAT product scope is then necessarily smaller for the more productive firm, $k(j_A) - \hat{k}(j_A) < k(j_B) - \hat{k}(j_B)$.

Formalizing the central results of the baseline model yields the following key predictions:

Proposition 1 *For the baseline model in which firms have equal access to a constant 'sourcing' technology for acquiring carry-along products from arms-length upstream suppliers and demand is symmetric and independent across firms and varieties:*

[38] To rule out infinite entry of wholesalers, we implicitly assume that a CAT-only firm (one that produces nothing in-house) cannot cover the (homogeneous) fixed cost of entry, F; i.e. we assume $F > \int_0^{k_{CAT}} \pi_{CAT}(i)di$.

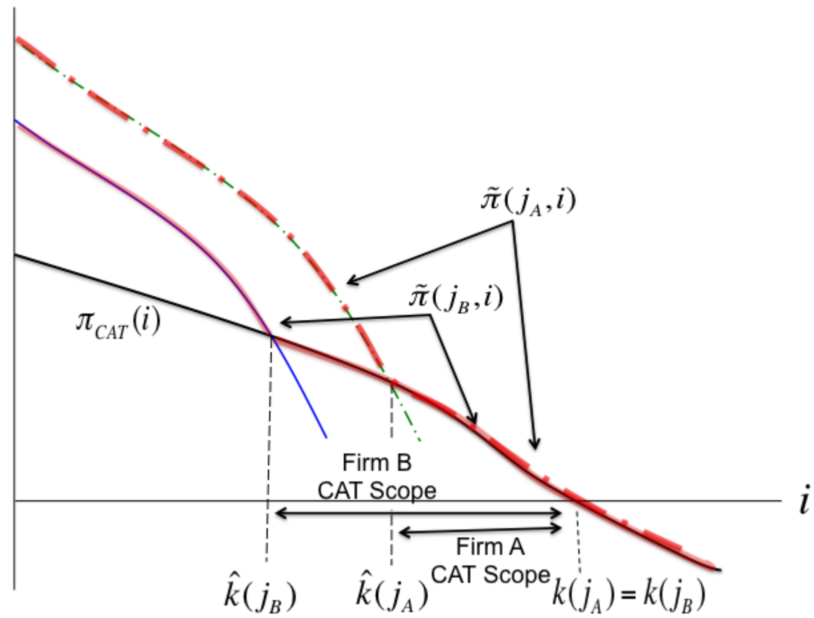


Figure 4: High (A) versus Low (B) Productivity Firms

i *Regular product scope, $\hat{k}(j)$, is increasing in productivity; i.e. firm productivity and regular scope are super-modular in firm payoffs;*

ii *Total product scope, $k(j)$, is identical for all firms engaged in carry-along-trade; i.e. firm productivity and total product scope are modular in firm payoffs for Carry-Along Traders (for whom $\hat{k}(j) \leq k(j)$).*

iii *Carry-along product scope, $k(j) - \hat{k}(j)$, is decreasing in firm productivity; i.e. firm productivity and Carry-Along Trade are sub-modular in firm payoffs.*

Proof. Parts (i) and (ii) follow directly from lemmas 2 and 3 respectively. Part (iii) follows from (i) and (ii).

Extending the results to include predictions for not just product scope – the number (technically mass, given the theory's continuum setting[39]) of varieties supplied to the market embodied in $\hat{k}$ and k – but also scale – how much of each product is sold in equilibrium (the $q^o_{ji}s$), generates the following additional predictions:

[39] As in Bernard et al. (2011), we interpret the HS6+ codes as discrete partitions of the model's continuum of products.

Corollary 1.1 *In the baseline model, sales volumes will be uniformly higher for regular products than for carry-along varieties. Within regular products, sales volumes will be highest for the most productive firms, and for products closest to a firm's core variety. Carry-along product volumes will be highest for products closest to a firms' core variety, but otherwise independent of firm productivity.*

Proof. Given symmetric demand, the within-variety scale, q^o_{ji} is inversely related to variety-specific marginal cost of provisioning, but otherwise symmetric across firms. $\tilde{c}(j,i) + \delta(i)$ is by definition lower for all regular products than for CAT products (within a given firm), and higher for less productive firms (for any given variety). Within regular products, diseconomies of scope arise in both direct production cost and distribution, whereas only the distribution cost component obtains for CAT products. $\diamond$

The predictions encompassed in Proposition 1 and Corollary 1.1 are the opposite of what we observe in the data. From Table 7 and Figure 2 presented earlier, the number of carry-along products is positively correlated with firm productivity, and it is the most productive firms, not the least, that do the most carry-along trading in both volume and scope. We do see regular product volumes and regular product scope are highest for the most productive firms, but we also observe a positive correlation between CAT product volumes and firm productivity. (We do not, of course, have a reasonable measure of a product's distance from a firm's core productivity, so we have little to say on that dimension.)

Given that the baseline version of the model is unable to rationalize the patterns in the data, we now turn to more complicated modeling structures. Before doing so, however, it is worthwhile to restate the key features of the data, and hence the central predictions that a plausible model must generate. First, regular (in-house) product scope and volumes increase with firm productivity. Second, CAT product scope and volumes *also* increase with firm productivity. Third, CAT product scope is *more* responsive to firm productivity than regular product scope. The baseline model can deliver only the first of these three patterns in the data. A variety of potential modeling structures can deliver all three of these predictions given sufficiently nuanced assumptions, but as we discuss below, they differ in plausibility and generality.

8 Alternative Modeling Frameworks

Fundamentally, any model that rationalizes the data must have sufficient super-modularity in firm payoffs between total product scope, k, and firm productivity, j. From the data, we know that more productive firms sell the broadest range of both regular *and* CAT products. And because regular (in-house) production and carry-along sourcing are substitute activities for any given variety (products that are made are not carried along, and vice versa), it therefore *must* be the case that the total number of varieties (i.e. total product scope) increases *faster* with firm productivity than does the number of regular products (regular product scope). *Total* product scope, k and firm productivity must be *more* super-modular in firm payoffs than are *regular* product scope, $\hat{k}$ and firm productivity. The remainder of this section works through a relatively broad set of scenarios, beginning with potential supply-side explanations, before turning attention to demand.

8.1 Alternative Supply Side

We consider the three plausible extensions to the supply-side set-up in the baseline model. The first allows firm-level heterogeneity in the CAT sourcing technology. The second maintains the assumption of identical CAT technology as in the baseline model, but introduces a fixed cost to Carry-Along Trade. Finally, we consider the possibility that more efficient producers also have more efficient distribution networks. We work through these extensions quickly with the expectation that the reader is now familiar with the basic framework and central mechanisms.

8.1.1 Heterogeneous CAT Technology

We maintain the assumption of constant returns to scale in CAT sourcing technology both within and across varieties, but we now let the cost of output sourced from upstream suppliers vary across firms according to $\hat{c}(j)$. It is obvious that the only way for the model to predict super-modularity between CAT scope and productivity is for the firm-level CAT cost, $\hat{c}(j)$ to be monotonically (and sufficiently) increasing in j, so that the most productive firms also have access to the lowest cost upstream suppliers. Thus, we assume that $\hat{c}'(j) > 0$.

The equilibrium make-or-source threshold, $\hat{k}(j)$, is now defined implicitly by $c(j, \hat{k}(j)) = \hat{c}(j)$, and the minimized cost function is $\tilde{c}(j,i) \equiv \min\{c(j,i), \hat{c}(j)\}$; it is still the lower envelope of the in-house and CAT-sourced cost curves. The only difference is that the "kink" at $\hat{k}(j)$ may occur earlier or later for firms with different productivity, since both the regular and CAT cost curves shift down for higher productivity firms. (Lemma 2 no longer obtains; we cannot state with any certainty the ranking of $\hat{k}(j)$ across firms.) At the same time, total product scope is now monotonically increasing with firm-level productivity, even for firms engaged in Carry-Along Trade; i.e. $k'(j) < 0$,[40] (Lemma 3 (*ii*) no longer obtains.)

The model *can* deliver predictions consistent with the data, but need not. Indeed, the key features exhibited by the data are something of a special case, or "Goldilocks" result for the model: if a firm's access to superior carry-along technology is too highly correlated with its core in-house productivity, then regular product scope $\hat{k}(j)$ will be decreasing in firm productivity. Conversely, if the carry-along technology is insufficiently correlated with in-house productivity, then carry-along scope will continue to be negatively related to productivity in equilibrium. Only if carry-along

[40]Note the super-modularity between productivity (*lower* j) and scope: $\frac{\Pi^2(j,k)}{\partial k \partial j} = \frac{\partial \pi(j,i)}{\partial j}\Big|_{i=k<\hat{k}(j)} = -\frac{\partial \tilde{c}(j,i)}{\partial j}\Big|_{i=k} = -\frac{\partial \hat{c}(j)}{\partial j} < 0$.

sourcing technology and core firm productivity are just right, sufficiently correlated *but not too correlated*, can the model generate the prediction that both regular and carry-along product scope increase with firm productivity.

The three panels in Figure 5 illustrate. Each compares a more productive Firm A with a less productive Firm B (i.e. $j_A < j_B$). In Panel A, carry-along technology is increasing too quickly with firm productivity, so that regular scope is sub-modular with firm core productivity. Panel B depicts the opposite extreme in which $\hat{c}(j)$ increases too slowly as j rises, so that CAT scope continues to be sub-modular with productivity, as in the baseline model. Panel C illustrates the intermediate scenario in which $\hat{c}(j)$ and $c(j,i)$ vary with j in such a way as to match the regularities we have identified in the data. While the introduction of heterogeneous sourcing costs that are positively correlated with production costs can reconcile the model with the three main stylized facts, the "Goldilocks" nature of the resulting equilibrium is somewhat unappealing.[41]

8.1.2 Fixed Costs to engaging in Carry-Along Trade

Another initially appealing explanation lies in fixed costs. It seems somewhat intuitive that more productive firms would earn higher profit in their regular production, and thus will be better positioned to leverage themselves into carry-along activities. To the contrary, we find that introducing a fixed cost to engaging in Carry-Along Trade offers even less traction for rationalizing the data.

Suppose we introduce a homogeneous fixed cost to Carry-Along Trade, Ω, but maintain the remaining features of the baseline model (including homogeneous, constant marginal cost of carry-along goods). Any firm that would earn sufficient profit over its CAT products, $\tilde{\Pi}_{CAT}(j) \equiv \int_{\hat{k}(j)}^{k(j)} \pi_{CAT}(i)di \geq \Omega$, would pay the fixed cost of entering the carry-along market. From Proposition 1, however, we know that among firms that engage in Carry-Along Trade, the most productive firms do the least CAT in favor of in-house production. Thus, only the lower productivity firms would do enough Carry-Along Trade to justify the fixed cost Ω; higher productivity firms with a lower cost of in-house production would instead substitute away from CAT in favor of regular products. Figure 6 illustrates. Notice that the total return to firm j from carry-along products is the area under the per-product profit function $\tilde{\pi}(j,i)$ for the set of sourced varieties, $i \in [\hat{k}(j), k(j)]$. For any pair of firms A and B where A is relatively more productive (i.e. $j_A < j_B$), we have that

$$\tilde{\Pi}_{CAT}(j_A) \equiv \int_{\hat{k}(j_A)}^{k(j_A)} \pi_{CAT}(i)di < \tilde{\Pi}_{CAT}(j_B) \equiv \int_{\hat{k}(j_B)}^{k(j_B)} \pi_{CAT}(i)di.$$

The introduction of fixed costs of CAT to the baseline model thus serves only to *increase* the disconnect with the data. Rather than rationalizing our empirical finding that the most productive

[41] Moreover, the heterogeneous sourcing cost explanation becomes even more difficult to reconcile with the data once we consider that not only is the *number* of CAT products positively related to firm productivity, but also the *share* of CAT products in total number of exported products is increasing with firm productivity; in essence, the broad knife edge result becomes yet narrower given the additional stylized fact seen in the CAT product shares.

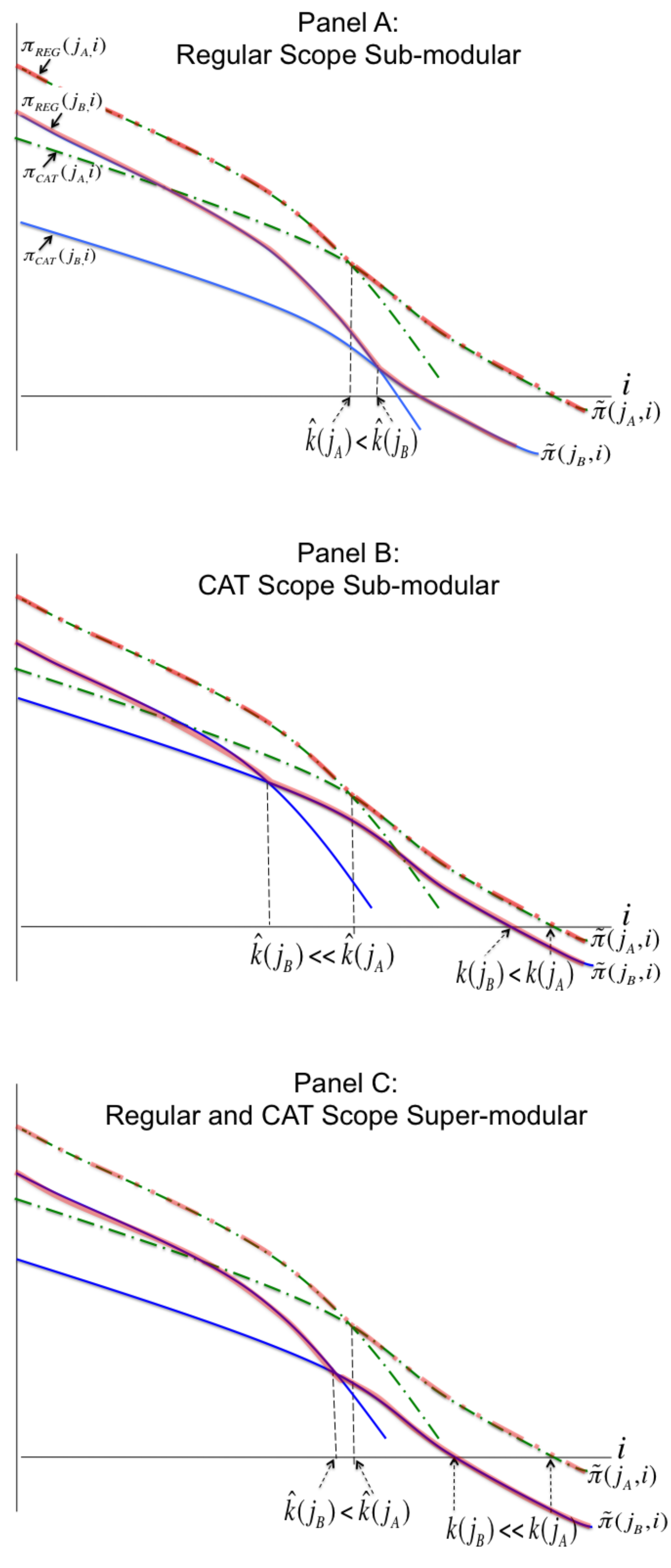


Figure 5: Heterogeneous Sourcing Productivity

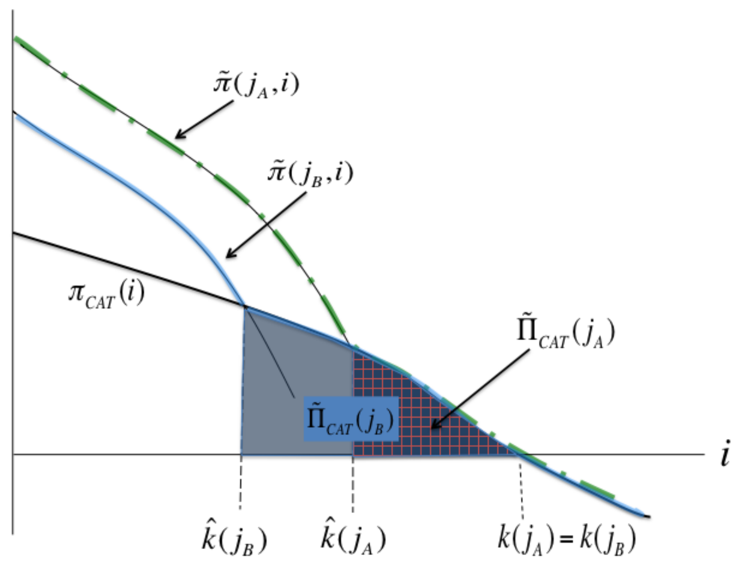


Figure 6: Fixed Costs of Carry-Along Trade

firms both producing and sourcing more products, the fixed cost extension of the model implies that the least efficient producers have an even greater incentive to source products than in the baseline model.

8.1.3 Heterogeneous Distribution Technology

Another potential explanation lies in differential distribution costs. More efficient producers may also be able to more easily create distribution networks. We maintain the assumption of constant returns to scale in CAT sourcing technology both within and across varieties, but we now let the distribution function, $\delta(j,i)$, vary across firms such that $\frac{\partial \delta(j,i)}{\partial i} > 0$, $\frac{\partial \delta(j,i)}{\partial j} > 0$.

Since the distribution cost does not depend on whether the product is produced or sourced, it will not affect the make-or-source choice of the firm. More efficient producers will make a wider range of products as in the baseline model and regular products will be super-modular in firm productivity. Total firm scope will now be increasing in firm efficiency as the most productive firms face lower distribution costs at the margin. Once again, the relationship between CAT scope and firm productivity depends on how rapidly distribution costs fall as firm efficiency increases. Distribution costs must fall sufficiently rapidly to allow the difference between regular product scope and total product scope (which are both increasing in productivity) to also increase.

We find the heterogeneous distribution cost explanation to be plausible, though it necessarily implies that there are *two* separate dimensions of firm heterogeneity, core manufacturing productivity and distribution-network acumen, and that these strengths are sufficiently and positively correlated to generate the patterns observed in the data.

8.2 Alternative Demand Side

We now turn to potential demand-side explanations for the patterns observed in the data. Throughout this section we continue to assume that preferences are symmetric both across varieties within a firm, and across firms with the same number of varieties. We could relax this assumption by introducing ex-ante exogenous firm-specific demand components or variety specific "popularity" draws (as in as in Bernard et al. 2011), but this would add more complexity at the cost of tractability.

Because preferences are central in the subsequent analysis, we take a moment to delineate three broad classifications. Each carries important differences for the predicted nature of CAT behavior across firms. The first class of preferences, *independent symmetric*, are just what we have already assumed in the baseline case: any preference structure that generates demand functions with no firm or variety specific idiosyncratic component. Namely, $p_{ji} \equiv p(q_{ji})$.

We refer to preferences as *quantity cannibalistic* if they generate demand that depends on a firm's total quantity of output supplied to the market, so that inverse demand may be written $p_{ji} = p(q_{ji}, Q_j)$, where $Q_j \equiv \int_0^{k(j)} q_{ji} di$. Generally, within-firm quantity cannibalization is assumed to be negative (as in Eckel and Neary (2010), Dhingra (2011), and Arkolakis and Muendler (2011)), so that inverse demand satisfies $\frac{\partial p(q_{ji},Q_j)}{\partial Q_j} < 0 \; \forall ji$.

Finally, we introduce a third class of preferences, which exhibit what we call *demand scope complementarity*. This new class of preferences exhibits the property that demand for a given firm's variety increases as the firm's total scope of product offerings increases. The idea is simply that *ceteris paribus* consumers prefer to buy products from firms that offer a wider range of varieties.[42] In this case, inverse demand may be written, $p_{ji} = p(q_{ji}, k(j))$ where $\frac{\partial p(q_{ji},k(j))}{\partial k} > 0 \; \forall ji$. Note that demand complementarity is perfectly compatible with quantity cannibalistic preferences – that is, we could allow $p_{ji} = p(q_{ji}, k(j), Q_j)$, where $p(\cdot)$ is increasing in the second argument and decreasing in the first and third arguments. We omit this additional complication in our discussion below for the sake of parsimony.

As mentioned earlier, we rule out preferences that generate demand structures that otherwise depend on firm or variety-specific components *other than* total firm scope or output. With this last class of preferences, we have an "anything goes" demand-side, which, while virtually infinitely flexible in its equilibrium predictions, has so little structure as to be economically uninteresting.

[42] For instance, a consumer likes all of his attire to sport a given embroidered swoosh, or a downstream assembler prefers 'one stop shopping' for her intermediate inputs.

8.2.1 Quantity Cannibalistic Preferences

With demand-side spillovers across varieties within a firm, a firm's optimal scope decision becomes somewhat more complicated. Note, however, that the make-or-source decision remains unchanged as long as demand-side spillovers remain independent of whether products are made in-house or supplied by upstream firms as assumed here. In deciding how many varieties to sell to the market, each firm now weighs the direct benefit of the k^{th} product (its own profit, $\tilde{\pi}(j,k)$) against the indirect cost of expanding firm scope (the demand-side spillover cost, $DS(j,k)$, via within-firm quantity cannibalization). The revised first order condition for optimal firm scope is:

$$\begin{aligned} \frac{\partial \Pi(j,k)}{\partial k} &= \int_0^k \frac{\partial \tilde{\pi}(j,i)}{\partial k} di + \tilde{\pi}(j,k) \\ &= \underbrace{\int_0^k \frac{\partial p(q_{ji},Q_j)}{\partial Q_j}\frac{\partial Q_j}{\partial k} q_{ji}^o di}_{\text{demand spillover} \equiv -DS(j,k) \leq 0} + \tilde{\pi}(j,k) = 0 \\ &\qquad\qquad \Longrightarrow \tilde{\pi}(j,k) = DS(j,k). \end{aligned} \tag{9}$$

Crucially, the demand-side spillover imposes a larger cost on more productive firms: more productive firms have a lower marginal cost of production for any given variety, and thus produce a greater quantity of each product (i.e. $\frac{\partial q_{ji}}{\partial j} < 0$) . For any given scope, k, the same quantity cannibalization demand shift embodied in $\frac{\partial p(q_{ji},Q_j)}{\partial Q_j}\frac{\partial Q_j}{\partial k}$ is applied to more units of production for more productive firms, resulting in a larger negative demand-side spillover.[43] Figure 7 illustrates, where again we compare a more productive firm A with a less productive counterpart B. The demand-side cost of quantity cannibalization is larger for the more productive firm – i.e. $DS(j_A,k) > DS(j_B,k)$ $\forall j_A < j_B, k$. Moreover, for any given k, the carry-along profit function, $\pi_{CAT}(i,j)$ now also depends on j via Q_j, again disciplining the productive firm relative to its less productive counterpart. It is immediate that total scope is thus decreasing in firm productivity among the set of firms engaged in any Carry-Along Trade. At the same time, regular scope and firm productivity remain super-modular, and so carry-along scope must necessarily be sub-modular in firm productivity.

8.2.2 Demand Scope Complementarity

In the final extension, we consider the potential for *positive* demand-side spillovers via demand complementarity in consumer (or downstream assembler) preferences. As noted earlier, we now adopt a demand structure so that inverse demand for every variety within the set of a firm's product offerings is increasing with its (total) product scope: $p_{ji} = p(q_{ji},k)$, where $\frac{\partial p(q_{ji},k)}{\partial k} > 0$.

[43] If demand is not linear in total quantity, Q_j, then of course an additional asymmetry may arise across j via $\frac{\partial p(q_{ji},Q_j)}{\partial Q_j}\frac{\partial Q_j}{\partial j}$. The sign of this potential second order effect is ambiguous.

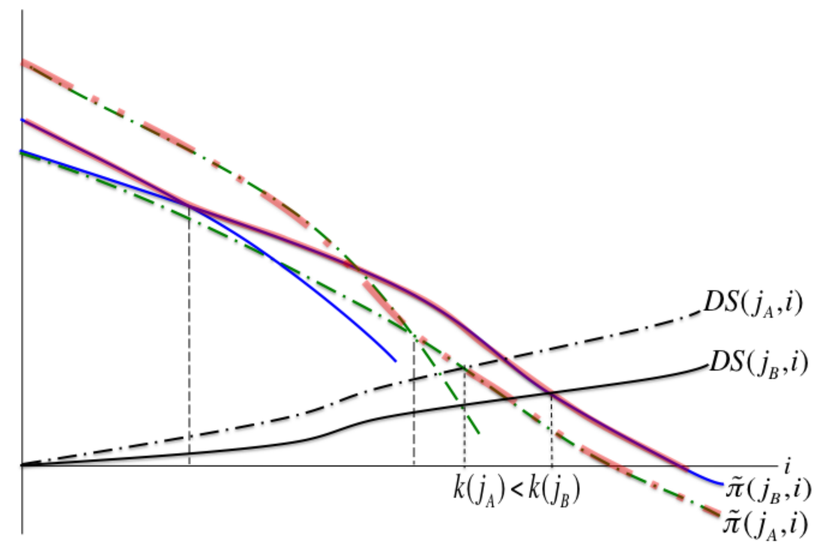


Figure 7: Intra-firm Quantity Cannibalization

As before, the make-or-source decision is independent of the total product scope or the extent of demand-side spillovers. Now, however, each firm's (total) product scope, k, depends crucially on the extent of demand complementarity. Unsurprisingly, total product scope is now increasing with firm productivity: because more productive firms sell larger quantities of each of their regular products *ceteris paribus* ($\frac{\partial q_{ji}}{\partial j} < 0$), the demand-side spillover – now positive (a shift *up* in inverse demand for all of the firm's varieties) – from adding a k^{th} product is greater for higher productivity firms. Now note that the demand side spillover *cost* is actually a benefit. Figure 8 illustrates a case in which demand complementarity is sufficient to generate super-modularity between firm productivity and CAT-scope.

One can see this super-modularity between productivity and total product scope in the firm payoff function more formally by examining the cross partial derivative:

$$\begin{aligned} \frac{\partial^2 \Pi(j,k)}{\partial k \partial j} &= \int_0^k \frac{\partial^2 \pi(j,i)}{\partial k \partial j} + \underbrace{\frac{\partial \tilde{\pi}(j,k)}{\partial j}}_{=0 \forall k \geq \hat{k}(j)} \\ &= \int_0^k \underbrace{\Big(\frac{\partial^2 p(q_{ji},k)}{\partial k \partial q_{ij}} q_{ji}^o + \frac{\partial p(q_{ji},k)}{\partial k} \Big)}_{(-)} \underbrace{\frac{\partial q_{ji}^o}{\partial j}}_{(+)} di < 0 \end{aligned} \qquad (10)$$

We now have that both regular product scope and total product scope are super-modular with productivity in firm payoffs (necessary conditions to rationalize the data, but not yet sufficient).

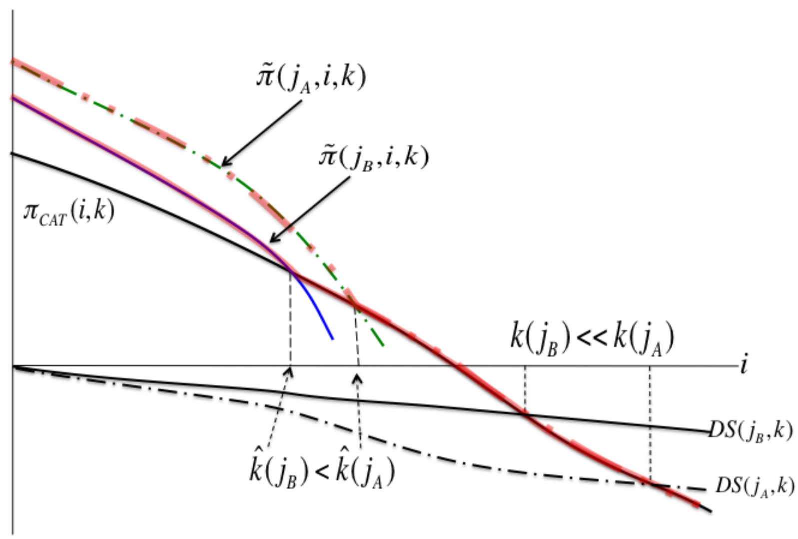


Figure 8: Demand Complementarity

The sufficient condition for CAT scope and productivity to be super-modular – and hence for realized equilibrium CAT product scope to be rising with firm productivity is of course that the total product scope is increasing *faster* with firm productivity than is regular product scope for all CAT firms: $k'(j) < \hat{k}'(j) < 0$ for all j s.t. $\hat{k}(j) < k(j)$, in essence, that (total) product scope and productivity are *more* super-modular than regular product scope and productivity.

While the baseline model of CAT fails to match the three main features of the data, we have explored relatively straight-forward supply-side and preference-based extensions that can deliver the desired predictions. If more efficient producers also have either lower sourcing costs (but not too low) or lower distribution costs then they will have greater regular product scope, CAT product scope and total product scope. On the demand side, if demand scope complementarities are sufficiently strong, then the most productive firms will supply more regular and CAT products to the market.

As with the heterogeneous distribution cost explanation, we find that demand complementarity must be sufficiently strong to rationalize the patterns observed in the data. In contrast to the supply-side explanations, however, the demand side complementarity mechanism has the appealing feature that firms continue to differ in only the single dimension of core manufacturing productivity but are in all other ways ex-ante identical and subject to the same demand structure, distribution costs, and upstream CAT-sourcing technology.

9 Back to the Data

In this section we consider additional implications of the model for the data on regular and CAT exports. We also summarize interviews conducted with exporting firms in both Belgium and the U.S. and report the findings of a specific "case" study.

We have shown that both supply-side or demand-side extensions of the basic model can match the positive relationship between firm productivity and the numbers of both sourced and produced products. In each case, the extended model predicts that the total export value of regular products will be greater than the total export value of CAT products at the firm for all firms. In addition, the export value of both regular and CAT products should be increasing in firm productivity. The top panel of Figure 9 shows that firm-level regular exports are indeed larger than CAT exports at all levels of productivity and that both are increasing as firm productivity rises for manufacturing exporters.

Both extensions also yield predictions for the average export value per product. Average firm-product exports should be greater for regular products than for CAT products within the firm. These differences should increase as firm productivity rises. The bottom panel of Figure 9 confirms that the average exports are greater for regular products than for CAT products and that the difference increases as firm productivity rises. Although these predictions from the theory are confirmed in the data, they do not help us understand whether CAT is more likely to come from supply-side or preference-based extensions to the basic model.

To both confirm the existence of CAT and to help distinguish between the supply-side and preference-based explanations, we interviewed more than 20 exporting firms in a variety of sectors. Every firm reported exporting products that it did not make (pure CAT) and several firms discussed using outside suppliers to obtain additional quantities of products that were produced in-house (mixed CAT). Firms were more likely to describe CAT products as extending the range of products produced in-house to meet customer demand. However, we also found evidence of supply-based CAT as one firm with a specialized exporting technology, e.g. frozen food, exported sourced products to fill containers, and another firm exported locally-sourced customized containers to its foreign subsidiaries.

A simple, fairly typical example of CAT exports comes from a firm we will call "Company A". Established more than 200 years ago, Company A is a manufacturing firm in the food sector which specializes in coffee roasting. Since the 1970s the company has specialized in the out-of-home (non-retail) market, supplying coffee, coffee systems and coffee service to offices, hotels, restaurants and events. Company A is a medium-sized company, but is one of the largest players in its segment in Belgium and a relatively large player at the European Union level. Coffee production is centralized in Belgium, but the firm exports its coffee to 25 countries, mainly within the European Union.

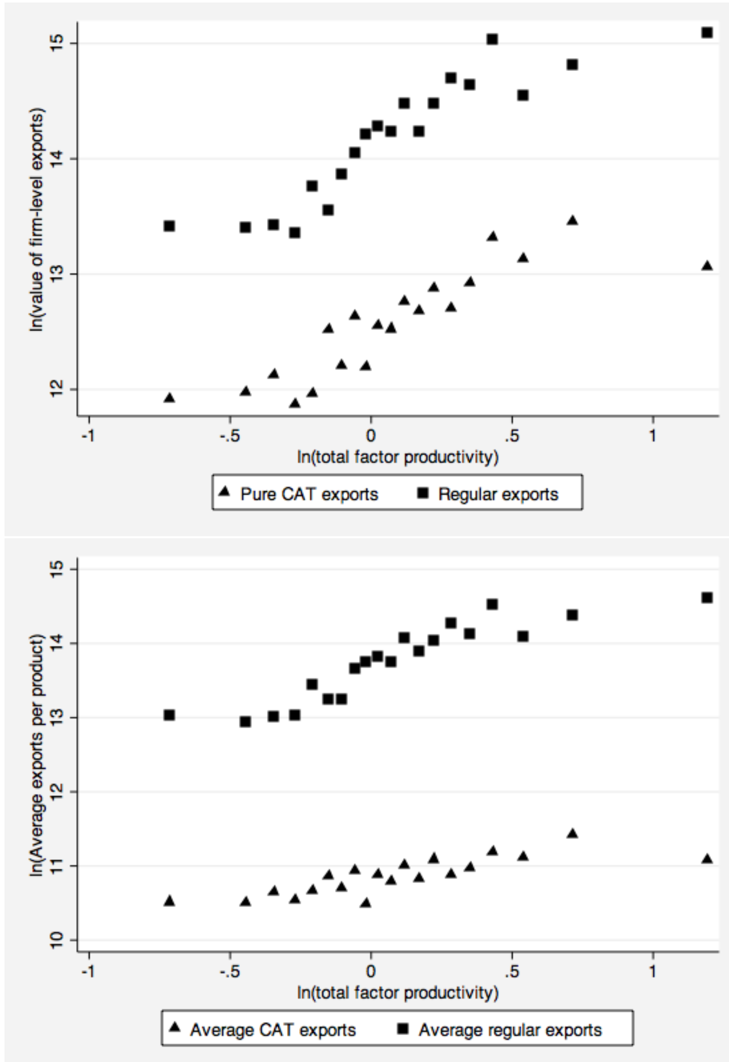


Figure 9: Productivity and Total and Average Exports, 2005

In addition to exporting its core product, coffee, Company A exports a wide variety of additional goods ranging from coffee vending machines, sugar, milk, cookies, tea, soup, plastic cups and spoons, to kitchenware (e.g. coffee cups). Company A only produces coffee in-house. The other products are sourced from external suppliers, i.e. these are Carry-Along Trade products. These Carry-Along Trade products are obtained from Belgian or foreign manufacturers, depending on expedited availability and price. The firm normally only exports Carry-Along Trade (sourced) products to destinations where they export coffee.

Company A is not selling coffee, but rather is selling a bundle of products for the service of the coffee room. A specific characteristic of the out-of-home coffee market is that it is very important to provide clients with a full service package (the complete coffee room), rather than just providing them with coffee. Carry-along products serve a double purpose for the firm: (1) they enable the firm to provide clients with a complete coffee room and (2) they are important from a commercial perspective, since the CAT products (e.g. sugar and milk) typically also carry the firm's brand name. The coffee room service package tends to be country-specific, depending on the coffee drinking habits in different countries. For instance, in some countries coffee tends to be served with cookies, while in other countries cookies are not part of the "coffee experience". This package is adapted according to the customer's and country's specific needs.

10 Conclusion

This paper introduces the concept of Carry-Along Trade (CAT) – the observed phenomenon in which firms sell more products to the market than they actually produce – in effect "carrying along" products from unaffiliated producers to a destination market. Matching trade and production data for a large sample of Belgian manufacturing firms, we show that Carry-Along Trade is pervasive across firms and products and accounts for a substantial share of exports. More than 90 percent of manufacturing exporters ship a product that they do not make and these products represent 30 percent of export value.

Across firms, we find that Carry-Along Trade plays an important role in shaping the relationship between firms' exports and firm productivity. Previous work on the extensive margins of trade has found that more productive firms export more products. This correlation is largely due to the presence of CAT. The number of exported CAT products is strongly increasing in firm productivity while the number of exported produced products is weakly increasing in firm productivity.

We develop a simple model of heterogeneous, multi-product producers and Carry-Along Trade. Producers choose whether to make or source each variety and select optimal product scope for the firm. The basic framework with heterogeneous marginal production costs but common marginal sourcing costs across firms cannot match the stylized facts about Carry-Along Trade. While the scope of produced goods rises with firm productivity matching the findings from the data, total product scope is invariant to firm productivity among firms that do any sourcing and the scope of sourced products falls as firm productivity rises.

We address both supply-side and demand-side extensions to the model and develop conditions under which we can match the stylized facts. Both supply and demand-side extensions are capable of reconciling the theory to the data.

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Theory Appendix

Here we briefly address the conditions for industry equilibrium existence and uniqueness. Industry equilibrium is characterized by (i) the set of active firms, (ii) the set of varieties produced by each firm, and (iii) the equilibrium price and quantity for each (firm-variety specific) product sold to the market – which in turn determine the (fixed point) equilibrium aggregate industry output, Q.

Beginning with (iii), the equilibrium price-quantity pair $(q^o_{ji}(Q), p^o_{ji}(Q))$ for any (firm-variety specific) product ji is simply that which maximizes firm $j's$ profit. As a function of aggregate quantity (taken as given by atomistic firms):

$$q^o_{ji}(Q) = \arg\max_{q_{ji}} p(q_{ji}, Q) - \tilde{c}(j,i), \tag{11}$$

which is unique under our assumptions that $\frac{\partial p(\cdot)}{\partial q_{ji}} < 0$ and $\frac{dc(j,i)}{dq_{ji}} = 0 \; \forall q_{ji}$. Existence requires that there exists some finite $\hat{q}_{ji}$ s.t. $p(\hat{q}_{ji}, Q) \leq \tilde{c}(j,i)$. The equilibrium price is simple given by inverse demand, s.t. $p^o_{ji}(Q) \equiv p(q^o_{ji}, Q)$.

Optimal scope (ii): Given the existence of a unique profit maximizing price-quantity pair for every firm-variety product ji given Q, the equilibrium scope of varieties $k(j;Q)$ produced by any given firm j is defined implicitly by the first order condition in (7). Uniqueness of the optimal scope decision for each firm j is ensured by the second order condition in (8), which holds with strict inequality under our assumption that $\delta' > 0$. An interior optimal scope decision $k(j)$ exists as long as there exists some finite scope $\hat{i}$ such that $\tilde{\pi}(j, \hat{i}; Q) \leq 0 \forall j$. Note that with CES preferences, then, one would need to assume some strictly positive fixed cost to producing each variety to ensure that firms do not expand scope infinitely. Such a fixed cost would complicate the analysis somewhat but otherwise would not qualitatively change the results of our general model.

Entry of firms (i): Firms will enter as long as total returns (from all produced varieties) cover the fixed cost of entry, F. The set of firms in the market is therefore $j \in [0, \bar{j}(Q)]$ where $\bar{j}(Q)$ – the least productive firm to enter the market – is given implicitly by $\tilde{\Pi}(\bar{j}(Q)) = F$ where $\tilde{\Pi}(j,Q) \equiv \int_0^{k(j)} \tilde{\pi}(j,i;Q)di$. Uniqueness of $\bar{j}(Q)$ is ensured by our assumption that $\frac{\partial c(j,i)}{\partial j} < 0$ and our assumption of sufficiently large F to exclude wholesalers. The latter assumption also ensures existence.

Aggregate equilibrium quantity Q is then simply the fixed point solution to $(i) - (iii)$ where $Q \equiv \int_0^{\bar{j}(Q)} \int_0^{k(j;Q)} q_j i^o(Q) di dj$.

Data Appendix

The data set used in this paper combines data from four different databases, made available by the National Bank of Belgium: (i) Business Registry, (ii) Foreign Direct Investment Survey, (iii) Trade Database, and (iv) Prodcom Database. The Business Registry database includes both annual accounts data and data from the Crossroads bank (data on firms' main activity). We describe the characteristics and inclusion criteria of each of these databases in turn. We also discuss how the different databases have been merged in a consistent way.

Business Registry

The Business Registry covers the population of firms required to file their (unconsolidated) accounts with the National Bank of Belgium. The data combine annual accounts figures with data from the Crossroads bank on firms' main sector of activity. Overall, most firms that are registered in Belgium (i.e. that exist as a separate legal entity) and have limited liability are required to file annual accounts. Specifically, all limited-liability firms that are incorporated in Belgium have to report unconsolidated accounts involving balance sheet items and income statements. Belgian firms that are part of a group additionally have to submit consolidated accounts where they report the joint group's activities in a consolidated way. However, Belgian affiliates that belong to a foreign group and that do not exist as a separate legal entity in Belgium are not required to report unconsolidated accounts (they are required to file a consolidated account, but these data do not allow us to obtain firm-level characteristics specifically for the Belgian affiliate). This implies that whenever these firms are exporters, they will be included in the analysis when using the full export sample, but cannot be included in the sample when we combine the trade data with firm characteristics or when we introduce a sample selection based on firms' main sector of activity (since this information is recorded in the Business Registry database, see below).

There are two types of annual accounts: full and abbreviated. Firms have to file a full annual account when they exceed at least two of the following three cutoffs: (i) employ at least 50 employees; (ii) have an annual turnover of more than €7.3million; and (iii) report total assets of more than €3.65million. An important difference between the two types of accounts is that full accounts distinguish between total turnover and total material costs, while abbreviated accounts only report value-added (although firms can report turnover and material costs on a voluntary basis if they choose to do so). Hence, whenever we calculate firm-level productivity, measured as labor productivity or total factor productivity, we will use value-added as the preferred measure of output. This implies that labor productivity will be defined as value-added per worker and total factor productivity indices are calculated using a value-added decomposition in each year.

Foreign Direct Investment Survey

The Foreign Direct Investment Survey data contain information on firms' foreign shareholders and affiliates. Since 2001, only firms with financial fixed assets of more than €5 million or total equity value of more than €10million or a balance sheet total exceeding €25million are required to report. We use the FDI survey to identify firms' foreign shareholders and affiliates.

Trade Database

The Trade Database covers the full population of firms that reported trading activities in 2005. The data include both import and export flows, at the firm-product-country level. In addition, the data distinguish between intrastat (intra-EU) and extrastat (extra-EU) trade and between different types of transactions (e.g. transactions with transfer of ownership and compensation, transactions involving repairs and return of goods, transactions before processing and repair, etc.).

Whether firms have to report their export transactions, depends on the value and destination of export flows. For intra-EU trade flows, firms have to report their trade on a monthly basis, using an electronic submission system. Firms are only required to report intrastat trade if their value of trade exceeds a particular cutoff. The participation of firms in the intrastat inquiry (pertaining to the intra-EU trade) is determined by statistical thresholds (selection is based on the VAT returns from the previous year). For 2005, firms exporting or importing for more than €250,000 a year have to report their export transactions.

Estimations performed by the National Bank of Belgium suggest that, in spite of the inclusion criteria for intrastat trade, total trade reported in the Trade Database accounts for more than 98 percent of total actual exports, i.e. the cutoff results in an average loss of about 1.5 percent of total reported trade in a particular year.

For trade flows destined for countries outside of the European Union (extrastat trade), data are collected from customs data. Usually these data are collected on a transaction basis, though a few companies are exempted from this. These companies file a monthly declaration with the NBB. The customs declarations are collected on a daily basis and aggregated by the NBB. For extrastat trade, all transactions whose value is higher than €1,000 or whose weight is bigger than 1,000Kg have to be recorded.

The Trade Database contains both intra- and extra-EU import and export transactions, recorded at the year-firm-product-country level. This implies that each observation represents an export or import flow (intrastat or extrastat) of a particular 8-digit Combined Nomenclature (CN8) product to or from a particular country. It should be noted that we exclude all trade transactions that do not involve a "transfer of ownership with compensation" from the data. This implies that we omit transaction flows such as the return, replacement and repair of goods, transactions without compensation (e.g. government support), processing or repair transactions, etc.

Prodcom Database

The Prodcom Database covers the population of firms that declared their production activities in 2005. The data contain firms' production activities at the firm-product level in each year. All firms employing at least 10 people and with primary manufacturing activity were required to report to Prodcom. Firms with primary acitivity outside the manufacturing sector were only required to report if they employed at least 20 people. Firms with less than 10 employees (or less than 20 if their primary activity is outside the manufacturing sector) are only required to report if their turnover exceeds a minimum threshold (which has increased over time). Whether or not firms have to file a Prodcom declaration is based on their social security records of the previous year. The Prodcom survey is obligatory and its underlying regulation is EU-based. All EU member states (and some EFTA countries and future accession countries) are bound by the Prodcom regulation.

In the Prodcom declaration, which has to be filed on a monthly basis, firms are required to record their production activities at an 8-digit level. Products are Prodcom products, i.e. they are part of the European Prodcom List. Eurostat has developed the Prodcom List with two prinipal goals in mind: (i) measure production in the EU member states on a comparable basis and (ii) enable a comparison between production and foreign trade statistics (Eurostat, 2006). In view of the second aim, the Prodcom List has a close relationship with the Combined Nomenclature classification, which is used to record foreign trade statistics. In addition, the Prodcom classification is closely linked to the European NACE and CPA classifications, i.e. the first six digits of the Prodcom codes are CPA codes and the first four digits are NACE codes.

Merging data

To compare firms' domestic production and trade activities at the product level, we need to merge the trade and domestic production data obtained from the Trade Database and Prodcom Database respectively. Both databases use firms' VAT number to identify firms, but a different classification system is used to record products. The Trade Database defines products using the Combined Nomenclature (CN8) classification at 8-digit level, while the Prodcom Database defines a product using the Prodcom classification at 8-digit level (PC8). Although there is a close link between the CN and PC classification by construction, the Prodcom list does not cover all goods listed in the CN classification. The Prodcom List covers Mining and Quarrying, Manufacturing and Electricity, Gas and Water Supply (Sections B, C and D of NACE Rev. 1.1), but it does not cover certain products, e.g. Recycling and Energy Products. Similarly, there are some products covered by the Prodcom List that are not recorded in the CN classification, such as certain industrial services (not all industrial services are covered by Prodcom) and waste products. Moreover, the Prodcom committee felt that some CN codes provide too much detail. As a result, the final Prodcom List is based on the CN classification, but with some modifications. Generally, Prodcom codes are less detailed than CN codes (although about half of all PC8 codes have a one-to-one correspondence with a CN8 product). Specifically for 2005, there are 4220 PC8 codes, while there are 9157 CN8 codes by both classifications. Concordances between the CN and PC classification are available on the Eurostat Ramon server. When concording the Prodcom data, it is important to take into account that certain PC8 products are recorded in the concordance using a slightly more aggregated

PC8 code, compared to the product code used in the Prodcom data. This is for instance the case for certain textile products, where there can be up to five different products in the Prodcom database, that need to be recoded into a single more aggregate code, which can be matched to a correspoding CN code.

Given the fact that there are only about half as many PC8 products compared to the number of CN8 products, we translate the trade and production data into Harmonized System 6-digit (HS6) products. Specifically for 2005, there are 4220 PC8 codes, while there are 4784 HS6 codes covered by the PC list. Out of the 4784 HS6 codes, 2140 have a one-to-one match with a particular PC8 product. The remaining 2644 HS6 codes are either one-to-many mapping from PC8 to HS6 (495 PC8 to 1750 HS6 codes), many-to-one mappings (1211 PC8 to 423 HS6 codes) or many-to-many mappings (374 PC8 to 471 HS6 codes).

Whenever PC8 codes have a one-to-many or many-to-many relationship with multiple HS6 codes, we group the corresponding HS6 codes together. Hence, products in our data are either individual HS6 codes, when there is a one-to-one or many-to-one match between PC8 and HS6 for that particular code, or groups of related HS6 codes. If a particular PC8 code maps into e.g. two HS6 (one-many) codes, we group these HS6 codes into an HS6+ code (group of two or more HS6 codes). The final HS6+ classification has 3169 products, of which 2140 have a one-to-one match with a particular PC8 product.

Firm-level data from the four databases are merged together based on a firm's VAT number, which acts as a firm's unique identifier in all four databases. In order to merge the Prodcom data (at the firm-Prodcom product level) with the Trade data (at the firm-CN product-destination level), we have relied on the Eurostat concordance between CN8 and PC8 in 2005. Since the first six digits of the CN8 classification consist of HS 6-digit codes, this file can be used to translate all CN products and Prodcom products covered by both databases into common HS6+ codes, after which both data sets can be matched using the VAT number of the firm and the HS6+ product codes. The combined Prodcom-Trade data are additionally merged with the Business Registry data and FDI survey data, using the VAT number as the firm identifier. The final data set contains data on all firms that produced at least one product in the Prodcom survey (5465 in 2005). Of these 5465 firms, 3631 are exporters.

Table 1: Summary statistics: Cross-section sample for 2005

Total exports								
	Number of firms		*Value of exports*					
Number of products exported	*N*	*% of total*	*Value (€ 1,000,000)*	*% of total*	*Average number of export destinations per firm*	*Average Exports per Firm-Product-Country (€ 1,000)*	*Average Exports at the Firm-Product Level (€1,000)*	*Average exports at the Firm-Country level (€ 1,000)*
1	7,068	33.9	4,169	2.14	1.82	324	590	324
2	2,874	13.79	5,118	2.63	3.56	397	890	500
3	1,760	8.44	4,220	2.17	5.00	326	799	480
4	1,210	5.8	4,880	2.51	6.55	386	1,008	616
5	941	4.51	6,648	3.42	7.38	517	1,413	958
6	785	3.77	6,937	3.56	9.19	497	1,473	962
7	586	2.81	7,096	3.65	10.40	551	1,730	1,164
8	496	2.38	5,281	2.71	10.94	417	1,331	973
9	443	2.12	7,655	3.93	10.66	669	1,920	1,620
10	367	1.76	2,711	1.39	11.93	251	739	619
1-5	13,853	66.45	25,035	12.86	3.37	390	906	536
6-10	2,677	12.84	29,680	15.25	10.40	481	1,452	1,066
11-15	1,321	6.34	27,387	14.07	12.87	557	1,627	1,611
16-20	777	3.73	24,323	12.50	15.78	532	1,749	1,983
21-25	488	2.34	6,913	3.55	15.90	202	622	891
25-30	362	1.74	10,225	5.25	18.17	311	1,016	1,555
1-10	16,530	79.29	54,715	28.11	4.51	434	1,138	734
11-20	2,098	10.06	51,710	26.57	13.95	545	1,682	1,767
21-30	850	4.08	17,139	8.81	16.87	255	810	1,196
31-40	406	1.95	9,835	5.05	18.63	221	690	1,300
41-50	274	1.31	8,553	4.39	21.61	185	689	1,444
>50	690	3.31	52,692	27.07	25.33	158	668	3,015
Total	*20,848*	*100.00*	*194,643*	*100.00*	*7.15*	*273*	*947*	*1,305*

Products are defined as HS6+ products. For information on sample selection and product definitions, see the Data Appendix.

Table 2: Summary statistics, Prodcom Firms: 2005

# Exported Products	*# Firms*	*# Produced Products*	*Exports (million €)*	*Average exports per firm (million €)*	*Production (million €)*	*Average production per firm (million €)*	*Average # destinations*	*ln(Total Factor Productivity)*	*ln(Value added)*	*ln(Employment)*
1	574	1.46	1,112	1.94	3,498	6.09	3.96	0.02	14.13	3.15
2	387	1.58	1,428	3.69	4,207	10.87	7.39	0.05	14.44	3.40
3	289	1.85	1,719	5.95	4,411	15.26	8.78	0.04	14.51	3.43
4	261	2.2	2,769	10.61	4,592	17.59	9.93	0.03	14.70	3.63
5	202	2.17	3,971	19.66	5,336	26.42	12.43	0.06	14.65	3.60
6	222	2.45	2,922	13.16	4,749	21.39	14.21	0.10	14.85	3.75
7	175	2.38	4,639	26.51	6,070	34.69	15.83	0.07	14.92	3.73
8	128	2.35	1,288	10.06	2,127	16.62	14.95	0.11	14.82	3.76
9	131	2.95	5,615	42.86	6,850	52.29	15.66	0.08	15.12	4.01
10	105	2.83	1,557	14.83	2,421	23.06	18.77	0.08	15.06	3.98
1-5	1,713	1.75	10,999	6.42	22,044	12.87	7.45	0.04	14.41	3.38
6-10	761	2.55	16,021	21.05	22,218	29.20	15.59	0.09	14.94	3.83
11-15	376	3.06	10,218	27.18	15,385	40.92	19.91	0.11	15.16	4.04
16-20	224	3.93	7,766	34.67	11,080	49.46	23.49	0.11	15.47	4.29
21-25	134	3.87	3,951	29.49	5,607	41.84	24.70	0.15	15.42	4.26
25-30	107	4.80	5,453	50.96	8,022	74.97	27.75	0.18	15.68	4.45
1-10	2,474	2.00	27,020	10.92	44,262	17.89	9.96	0.05	14.58	3.52
11-20	600	3.39	17,984	29.97	26,465	44.11	21.24	0.11	15.28	4.13
21-30	241	4.28	9,404	39.02	13,628	56.55	26.05	0.16	15.53	4.34
31-40	104	4.15	4,449	42.77	5,285	50.81	32.77	0.26	16.13	4.81
41-50	74	5.28	4,533	61.25	4,085	55.21	35.64	0.17	16.20	4.96
>50	138	8.76	21,624	156.70	23,818	172.59	47.98	0.35	17.01	5.59
Total	3,631.00	2.76	85,013.72	23.41	*117,544*	*32.37*	*15.51*			

Notes: This table includes all exporters in the Prodcom survey for 2005 that report positive domestic production for at least one of their products. Products are defined as HS6+ products.

Table 3: CAT Firms, Products and Exports: 2005

	CAT Firms	*Firms with at least 1 Pure CAT product*	*Total Products*	*CAT Products*	*Firm-Products*
HS+ 6-digit	3,233	3,177	2,858	2,822	45,134
HS+ 4-digit	3,081	3,030	1,012	999	34,089
HS+ 2-digit	2,745	2,669	90	90	17,643

	CAT Firm-Products	*Exports of CAT products (million €)*	*Produced Exports (million €)*	*Sourced Exports (million €)*
HS+ 6-digit	39,286	41,475	59,628	25,386
HS+ 4-digit	29,118	34,392	65,373	19,641
HS+ 2-digit	13,668	31,974	70,900	14,114

Notes: There are 3631 exporting firms. Total exports in the sample amount to €85,014 million. *CAT Firms* and *Firms with at least 1 PURE CAT product* are firms that export at least one CAT product and at least one pure CAT product respectively. *Total Products* is the number of unique products either produced and/or exported and *Firm-Products* is the total number of unique firm-product pairs either produced and/or exported. *CAT Products* is the number of products exported as a CAT product by one or more firms and *CAT Firm-Products* is the number of unique firm-product pairs exported as a CAT product. *Exports of CAT products* are the total exports of all CAT firm-products respectively. *Produced Exports* is the produced value of all exported firm-products and *Sourced Exports* is the non-produced part of all exported firm-products.

Table 4: CN and PC Codes and Descriptions for Sweet Biscuits

CN/HS Code	**Description**
1905 31	Sweet biscuits
1905 31 11	Completely or partially coated or covered with chocolate or other preparations containing cocoa in immediate packings of a net content not exceeding 85 g
1905 31 19	Completely or partially coated or covered with chocolate or other preparations containing cocoa – other
1905 31 30	Containing 8 % or more by weight of milkfats
1905 31 91	Sandwich biscuits
1905 31 99	Other

PC Code	**Description**
10.72.12	Sweet biscuits
10.72.12.53	Sweet biscuits, waffles and wafers completely or partially coated or covered with chocolate or other preparations containing cocoa
10.72.12.55	Sweet biscuits (including sandwich biscuits, excluding those completely or partially coated or covered with chocolate or other preparations containing chocolate)

Notes: The Combined Nomenclature (CN) and Prodcom (PC) classifications are available at ec.europe.eu/eurostat/ramon

Table 5: CAT Facts: Robustness

	Full data	Only manufacturing firms	Manufacturing firms excluding food (NACE 15)	Omitting domestic groups	Omitting multinational groups	Omitting multinational and domestic groups	Only one-one matches CN-PC	Subtracting imports at fp-level	Dropping fp with positive imports	Imposing 1% cut-off value
Number of exporting firms	3,631	3,110	2,635	1,922	3,114	1,769	3,485	3,534	3,164	3,631
% of Exporters with at least 1 CAT product	89.04%	89.20%	89.91%	87.88%	87.80%	86.26%	90.90%	85.71%	89.19%	88.85%
Value of Sourced exports as % of total exports	29.86%	27.61%	29.59%	29.09%	31.15%	36.20%	33.53%	24.12%	32.15%	29.86%
Exports of CAT products as % of total exports	48.79%	47.65%	50.64%	58.53%	44.27%	50.02%	45.84%	34.98%	37.64%	47.59%
% of products exported as CAT by at least 1 firm	98.74%	98.73%	98.67%	98.88%	98.83%	98.99%	98.66%	97.78%	97.80%	98.67%
% of export firm-products with CAT	87.04%	86.39%	87.63%	86.49%	85.15%	83.73%	87.76%	82.66%	88.31%	86.85%

Notes: Products are defined as HS6+ products. Manufacturing firms are firms with reported primary activity in NACE (Rev. 1.1) 15 to 37. Firms are part of a domestic groups if they are part of a Belgian group. Firms are part of a multinational group if they own foreign subsidiaries or if they are a subsidiary of a foreign firm (cut-off percentage in ownership: 20 percent). One-to-one matches between CN and PC implies that only products where a particular CN and PC code match uniquely are retained in the data. Subtracting imports at the firm-product level implies that only exports that are not covered by imports of the same product by the firm are retained in the data. Alternatively, firm-products with positive imports are dropped from the data altogether. The final column imposes a cut-off in the definitions for regular and CAT exports to account for potential rounding errors in the data, i.e. exports at the firm-product level are considered as regular exports if the ratio of domestic production to exports is higher or equal than 0.99. Similarly, firm-products are considered as pure CAT products if the ratio of domestic production to exports is lower or equal than 0.01.

Table 6: Characteristics of Regular and CAT Exporters: 2005

	All Exporters	*Regular Exporters*	*CAT exporters*
Employment (fte)	130	38	142
Value added (€ million)	12.5	2.8	13.7
Produced Sales (€ million)	32.4	9.9	35.1
All Exports (€ million)	23.4	3.1	25.9
Regular Exports (€ million)	12.0	3.1	13.1
ln(TFP)	0.09	0.05	0.10
ln(VA/worker)	0.18	0.10	0.19
Multinational	0.14	0.05	0.15
Foreign Ownership	0.13	0.05	0.14
# domestically produced products	2.76	1.81	2.88
# regular export products	1.61	1.33	1.65
# CAT export products	10.82	0.00	12.15
# export destinations	15.51	5.00	16.81
# of firms	3,631	398	3233

Notes: Regular Exporters are firms that export only regular products but no CAT products. CAT exporters export at least one CAT product. The two categories are mutually exclusive and together equal the total number of exporting firms. The number of observations differs depending on availability of the firm-level characteristics. All values reported are sample means, except in the last row, where the number of firms is reported.

Table 7: Firm Productivity (TFP), Carry-Along Trade and the Margins of Trade: 2005

Panel A: Total Factor Productivity			
All Exports			
	ln(value f)	*ln(# products f)*	*ln(average value f)*
Ln(TFP)	1.294***	0.508***	0.785***
	[0.104]	[0.051]	[0.085]
Fixed effects	Industry	Industry	Industry
Clustering	no	no	no
Observations	3,097	3,097	3,097
R-squared	0.153	0.155	0.117
Panel B: Total factor productivity			
Exports by type (regular or CAT)			
	ln(value$_f$)	*ln(# products$_f$)*	*ln(average value$_f$)*
d_{CAT}	-1.109***	1.269***	-2.378***
	[0.070]	[0.024]	[0.065]
Ln(TFP)	1.215***	0.097***	1.118***
	[0.115]	[0.033]	[0.108]
d_{CAT} * Ln(TFP)	-0.101	0.409***	-0.510***
	[0.164]	[0.060]	[0.145]
Fixed effects	Industry	Industry	Industry
Clustering	firm	firm	firm
Observations	5,219	5,219	5,219
R-squared	0.122	0.373	0.258
Panel C: Labor productivity			
Exports by type (regular or CAT)			
	ln(value$_f$)	*ln(# products$_f$)*	*ln(average value$_f$)*
d_{CAT}	-1.048***	1.243***	-2.290***
	[0.069]	[0.024]	[0.064]
Ln(VA/worker)	1.215***	0.077***	1.138***
	[0.104]	[0.022]	[0.101]
d_{CAT} * Ln(VA/worker)	-0.172	0.270***	-0.442***
	[0.124]	[0.045]	[0.117]
Fixed effects	Industry	Industry	Industry
Clustering	firm	firm	firm
Observations	5,779	5,779	5,779
R-squared	0.132	0.366	0.263

Notes: Table reports OLS regression of log export value (total - panel A, regular or CAT - Panels B and C) and its components on log firm productivity, measured as total factor productivity (Panels A and B) or labor productivity (Panel C). Panels B and C include a dummy for the type of exports (regular or CAT) and an interaction. Regular and CAT exports are aggregated at the firm level for columns 1-5 in Panels B and C (a firm with both regular and CAT products features twice). Industry dummies are defined at the two-digit NACE level. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.

Table 8: Robustness: Firm Productivity (TFP), Carry-Along Trade and the Margins of Trade: 2005

Dependent Variable: Number of products by type (regular or CAT)

	Productivity Proxies			
	log of total production value of the firm	*log of production value of largest produced product*	*log of total export value of the firm*	*log of largest export product of the firm*
d_{CAT}	-0.901***	-1.516***	-1.402***	-1.163***
	[0.251]	[0.247]	[0.123]	[0.121]
Ln(measure of productivity)	0.115***	0.052***	0.068***	0.046***
	[0.009]	[0.009]	[0.006]	[0.006]
d_{CAT} * Ln(productivity)	0.139***	0.179***	0.182***	0.170***
	[0.016]	[0.016]	[0.009]	[0.009]
Fixed effects	Industry	Industry	Industry	Industry
Clustering	firm	firm	firm	firm
Observations	5,855	5,855	5,855	5,855
R-squared	0.416	0.400	0.485	0.448

Notes: Table reports OLS regression of log number of exported products (regular or CAT) on a dummy for the type of exports (regular or CAT), a proxy for firm productivity and an interaction. Industry dummies are defined at the two-digit NACE level. Significance levels: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.10$.