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Arnarson, Björn Thor

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School of Economics and Management

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Björn Thor Arnarson

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Intra-Firm Product Complementarity in International Trade

Björn Thor Arnarson[†]

University of Copenhagen

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Abstract

This paper investigates whether firms' exports of different products within a market are systematically interconnected. Using high-quality Swedish firm-registry data from 1997-2011, I first document that the distribution of firm export sales is skewed towards their best performing products ('superstars'). I then use a novel instrumental variable approach to identify if the 'superstar' products induce more trade of non-superstar products. I find evidence that the exports of low-ranked (non-star) products of a firm are contingent on the exports of a *single* superstar product to each destination. Extending the 'superstar' concept to a 'superstar core' of products strengthens this result. Hence, I find that the exports of non-star products complements the superstar(s) while conversely, the same complementarity is not found using low-ranked products as placebo-superstars. The main contributions of this paper is identifying a new, sizeable and systematic intra-firm-destination *one-way* demand driven complementarity between products that can explain export sales variation within a market. Ignoring this pattern of between product dependency may lead to an over-emphasis on product scope as products should not be viewed in isolation.

JEL classification: F10, F14, F13, L1, L2
Keywords: Multi-product firms, product complementarity, intra-firm product dependence, within-destination export variation, Product Demand

1 Introduction

In the last decades the focus in international trade has shifted from a broad country level view towards less aggregate firm-level data. While the heterogeneity between firms is well

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acknowledged,[1] an emerging body of literature is looking within the firm. Several theoretical models on multi-product firms have been developed in the past decade to incorporate the wide product scope of multi-product exporters.[2] A central component of these models is that the export sales are granular[3] and heavily skewed towards a small number of 'core products'.[4] What these models do not consider is the possibility that firm product exports within a destination may be systematically interconnected. The importance of this dependence is highlighted by studies that found traditional measures of firm efficiency/productivity to predict better firm destination entry compared to sales variation within a destination.[5] Additionally, Munch and Nguyen (2014) find that these measures perform significantly worse for peripheral, compared to the core products of the firm. A gap therefore remains in the literature in terms of explaining the within-destination variation of firm exports, especially when it comes to non-core products.

In this paper, I suggest a new *within* firm-destination mechanism which relates the export value of a 'superstar product'[6] to the exports of more peripheral non-superstar products. The general intuition for this mechanism is that, since the trade value of firms to any particular destination is generally dominated by a single product, this superstar product may have a positive effect on the export sales of other products. Hence, the existence of a trade relationship may induce[7] other products to follow, either due to demand-side scope complementarity or supply-side (cost) advantages.

[1] Seminal theoretical contribution from Melitz (2003). Additionally, Bernard, Jensen, Redding, and Schott (2007) and Mayer and Ottaviano (2008) summarised stylised facts on firms engaging in international trade and found that they are, in general, compared to non-exporters, bigger, more productive, sell to a larger number of destinations and account for the largest share of trade value.

[2] See, for example, Bernard, Redding, and Schott (2011), Feenstra and Ma (2008), Arkolakis, Muendler, and Ganapati (2015), Eckel and Neary (2010), and Mayer, Melitz, and Ottaviano (2014). Berthou and Fontagné (2013) and Arnarson (2015) have evaluated the validity of the models of multi-product exporters.

[3] Gabaix (2011) used this term to describe how large firms are the "incompressible grains of economic activity". Because of this granularity shocks to these large grains(firms) will generate aggregate fluctuations in the economy. He finds that shocks to the 100 largest firms in the US accounted for a third of the aggregate output growth. Di Giovanni, Levchenko, and Mejean (2014) investigate this granularity and find evidence that firm-specific components contribute to aggregate sales volatility and that strong firm-to-firm linkages magnify this effect.

[4] Amador and Opromolla (2013), Görg, Kneller, and Muraközy (2012) and Fontagné, Secchi, and Tomasi (2016) have for example documented that product exports are skewed towards the most exported 'core-products' of the firm. A corresponding granular pattern is found for Swedish exporters, as documented in section 2. Goldberg, Khandelwal, Pavcnik, and Topalova (2010) found similar patterns in the production of multi-product firms.

[5] See Eaton, Kortum, and Kramarz (2011), Munch and Nguyen (2014) and Bernard, Redding, and Schott (2011).

[6] The superstar product is defined as the highest exported product, in a pre-sample period, within each firm-destination pair. The superstar product is kept constant over the time period for each firm-destination pair, but the superstar product may differ across destinations for a firm. See section 3 for further discussion. Note that the terms 'superstar' and 'star' are used interchangeably.

[7] I will mostly focus on the intensive margin, (i.e. the intensity of exports of non-star products) in response to a shock to the superstar product.

As the export sales of the superstar and non-superstar products to a destination may be jointly determined, I employ a novel instrumental variable approach to overcome the potential simultaneity bias, building on the work of Hummels, Jørgensen, Munch, and Xiang (2014). The aim is to find an instrument which is correlated with the trade flow of the superstar product but is uncorrelated with other non-superstar products. I propose using superstar product destination specific demand variation as an instrument for the trade value of the superstar product. As the demand shock is specific to the superstar product destination pair it should be uncorrelated with other product flows of the firm within the destination.

For the empirical analysis, I use detailed and high-quality Swedish firm-registry dataset (from 1997 to 2011) which is linked to export flows at the firm-HS6 product-destination level. The empirical results show strong evidence of non-superstar products being complementary to the superstar product, with an elasticity of 0.178. Hence, an 10% increase in the trade value of the superstar product increases the trade value of non-superstar products by 1.8%. A natural continuation is to investigate if this effect is limited to a single superstar product or if an analogous effect is found for other high-ranked products in the pre-sample. A similar, but weaker result is found for the product ranked second in the pre-sample, while this is not found for subsequent high ranked products. This suggests that the effect found is not limited to a single product but rather related to a 'core' of products. In the paper I extend the definition of the superstar product to a 'superstar core', which includes the products in the first decile of the pre-sample rank. The superstar core definition therefore takes the varying, and often wide product scope of firms into consideration. The results of the superstar core specification are stronger than before, with an estimated elasticity of 0.322. In order to ensure the robustness of the result I use lower-ranked product deciles as placebo-superstar cores and find no significant effects for the nine 'placebo' deciles. Hence, the complementarity is one-way, as *only* the peripheral products are dependent on the superstars.

In the paper a discussion is provided of how the proposed mechanism relates to current theoretical and empirical work on multi-product exporters. Yet, a priori it is unclear if the channel observed is driven by supply or demand factors. In an effort to disentangle these effects, some additional exercises are performed. First, I add a firm-product-year fixed effect to control for supply side factors related to the triad. This inclusion has has only a modest impact on the results indicating a large role for demand. A second exercise is to compare firms who predominantly[8] export homogeneous goods compared to those exporting differentiated products. The underlying idea here is that firms exporting homogeneous core products are engaged in price competition and therefore less able to bundle non-star products with the core products. Consistent with this explanation I find the one-way complementarity *only* for firms that are predominantly exporting differentiated products (competing more in terms of quality). These exercises suggest that the observed one-way mechanism is driven by demand-side complementaries.

Even if firm exports are granular with the sales value highly skewed towards the superstar-core products of the firm; still a third of the trade value is among the 86% of products that are defined as outside the core. Hence, bulk of the products and considerable value can be found in products that are found to be dependent on the 'star' product exported by the firm. An implication of this result is that the weight of product scope may be over-emphasised if all products are naively considered to be independent standalone entities as non-core products are exported contingent on the performance of the star-products.

This paper relates broadly to a literature on complementaries at the firm level, were early contributions include Milgrom and Roberts (1990) and Vives (1990). A more recent example is Gentzkow (2007) who found complementarity in the newspaper industry through the bundling of different platforms (online versus paper). Another example from the trade literature is by Bernard, Blanchard, Van Beveren, and Vandenbussche (2015) who document the existence of "Carry-Along-Trade" (CAT), which is the export of a product by a firm which does not produce that specific good. They suggested that CAT may be a result of demand-scope (or supply side) complementaries. Fontagné, Secchi, and Tomasi (2016) document how the product mix of firms is impacted by destination market characteristics and find suggestive evidence of either production or demand complementaries within a firm. Lastly, a recent paper by Ariu, Mayneris, and Parenti (2016) considers bi-exporters, firms that export both services and goods, and find that providing services boosts the exports of goods.

This paper is also related to several literatures, both theoretical and empirical, investigating the behaviour of exporters, specifically multi-product firms (MPFs). First, in terms of the

[8] Firms were over half of the products in the superstar core are homogeneous according to the Rauch (1999) classification.

literature on the sunk/fixed costs of exporting and the duration of trade flows. Several studies have found that a large proportion of trade flows is temporary and that such products are generally among the least traded.[9] Second, it relates to research which has found that MPFs engage in intra-firm product churning (switching) or cannibalisation which can be a source of expansion or adjustment.[10] Thirdly, it has been shown that product quality, mark-ups, and shipment frequency can be important considerations when examining trade patterns of MPFs.[11] Fourthly, it relates to research on the role of demand for exporters, especially in terms of explaining within-destination sales patterns.[12] Lastly, there are studies that have examined *between* firm geographical product level spillovers.[13]

The remainder of the paper is organized as follows. Section 2 discusses the data and documents some empirical regularities of product exports. Section 3 presents theoretical motivation for the suggested within-firm-destination mechanism, section 4, discusses the empirical strategy and section 5 the results. Section 6 concludes the paper.

2 Data and Descriptive Statistics

In this paper, I use Swedish firm-registry data provided by Statistics Sweden from 1997 to 2011. The dataset links firm-level registry data, covering the entire population of Swedish firms, with information about trade flows at the firm-product-destination level. Around 18% of the firms are exporters and the final dataset includes an unbalanced panel of 11291 manufacturing firms, 4607 HS-6 products, 26769 firm-destination combinations, and around 2.1 million firm-product-destination observations. The data is provided at the CN 8-digit level but aggregated and converted to time-consistent HS-6-digit level codes. See appendix A for information on the

[9] This has been found both for importing and exporting. See, for example, Besedeš and Prusa (2006a), Besedeš and Prusa (2006b), Görg, Kneller, and Muraközy (2012), Gullstrand and Persson (2014), Békés and Muraközy (2012), Hess and Persson (2011). The level of analysis here varies and is either at the product, firm-destination or firm-product destination level.

[10] See, for example, Iacovone and Javorcik (2010) who considered product churning and Bernard, Redding, and Schott (2010) for a theoretical model of product switching. Additionally, Timoshenko (2015b) suggested that MPFs may learn from the demand conditions they face in the export market and adjust their product portfolio accordingly.

[11] For quality and mark-ups, see, for example, Crozet, Head, and Mayer (2012), Kugler and Verhoogen (2012), Baldwin and Harrigan (2011), Khandelwal (2010), Antoniades (2015), Hummels and Klenow (2005) and Traiberman, Warzynski, and Smeets (2014). For shipments, see Eaton, Eslava, Kugler, and Tybout (2008) and Kropf and Sauré (2014).

[12] See Eaton, Kortum, and Kramarz (2011), Munch and Nguyen (2014), Foster, Haltiwanger, and Syverson (2016), and Timoshenko (2015a,b).

[13] See Mayneris and Poncet (2013) and Koenig, Mayneris, and Poncet (2010), who found evidence of product level spillovers from neighbouring firms.

sample construction, summary statistics (table A1), and definitions of variables (table A2).

2.1 Why the Lonely 'Star'?

Before proceeding to the empirical analysis it is helpful to document the within-firm and within-firm-destination patterns of export flows. Firms export many products, but a considerable proportion of them are only peripheral to the firms' aggregate export value. By only counting a single product within each firm, the top-ranked export product to all destinations, we account for around 44% of the aggregate firm trade value. The value decreases sharply as one descends the product value ladder. The second product accounts for around 21% and the third for 10%. Hence, the first three products constitute around 75% of the aggregate trade value. See table 1.

Table 1: Rank of products and percentage of trade value in each cell (2011).

	Nr. of destinations					
Product Rank	1	2	3	4-10	11+	Total
1	2.2	1.6	1.5	8.7	30.1	44.1
2	0.9	0.4	0.5	2.3	16.6	20.7
3	0.5	0.2	0.2	1.6	7.3	9.8
4-10	0.8	0.6	0.4	2.6	12.9	17.3
11+	0.4	0.3	0.1	1.1	6.1	8
Total	4.8	3.1	2.7	16.3	73.0	100

Number of firm-product observations: 50713.

Table 2: Percentage of firm-product observations in each cell (2011).

	Nr. of destinations					
Product Rank	1	2	3	4-10	11+	Total
1	7.0	0.9	0.6	1.1	1.0	10.5
2	5.4	0.7	0.3	0.9	0.6	7.9
3	4.3	0.6	0.3	0.7	0.5	6.4
4-10	15.4	2.5	1.2	2.5	1.7	23.3
11+	31.4	6.6	3.4	6.4	4.1	51.9
Total	63.5	11.3	5.7	11.6	7.9	100

Number of firm-product observations: 50713.

Noting that a single product has such a high weight within a firm also means that there are many products which only have peripheral trade value. This can be seen from table 2, where 64% of the products of a firm are only exported to a single destination and 81% to three or less. The total trade value of these observations is only around 11%. Looking more closely at tables 1 and 2 it is clear that products which are exported to three or less destinations and are ranked 2nd or lower, within the firm, account for around 72% of the firm-product observations but only 5% of the export value (marked in red). In contrast, the trade value is highly concentrated among the top-ranked products that are exported to multiple destinations. Products that are exported to four or more destinations and are among the three highest ranked within the firm make up over 67% of the trade value, but only 5% of the firm-product observations (marked in blue).

Looking *within* firm-destination pairs, a similar pattern emerges independent of the product scope at the destination. Figure 1 shows the share of each of the five most exported products of the total trade value to a destination. As the firm product scope at a destination increases, the contribution of the largest products declines, but slowly. For firms exporting over 20 products to a destination, still 50% of the firm export revenue comes from a single product. The top five products account for over 70% of the export value, regardless of the number of products exported. This shows that firm exports are granular in nature and that the trade of the 'star' product(s) could explain much of the export variation to a specific market.

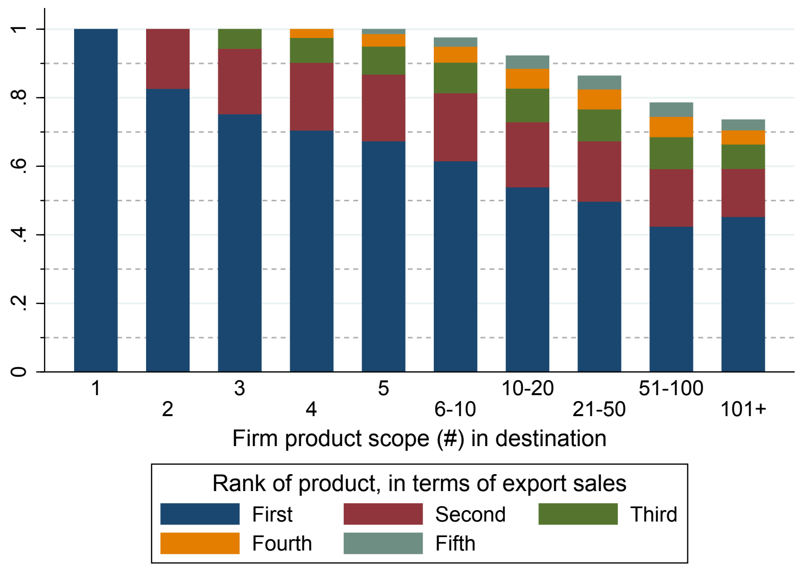

Figure 1: Share of export value of 'star' products ranked first to fifth within a firm-destination pair (2011). Calculated as the export value of the product divided by the total export value to the destination.

Another aspect of investigating multi-product exporters is the stability of the product rankings across destinations. See table 3. If we look at destinations that a specific firm trades with, then in around 42% of the cases the product with the highest export value at the firm level is also ranked first to a destination. Conditional on the product being exported to a particular destination, then in around 75% of the destinations the most exported product at the firm level is also the most exported product to a destination. Rarely is the product most exported at the firm level ranked lower than second in a destination (≈ 10% of the cases, marked blue in table 3). It is also rare for a low ranked product within the firm to be the highest ranked to a destination: in around 73% of the firm-product observations the highest ranked product in a destination is among the three highest ranked products within the firm (marked red in table 3).

Table 3: Comparison of product rankings at the firm and destination level(2011) (row/col percentages)

		Rank of product within-destination							
Rank within-firm		1	2	3	4	5	6	7+	Total
1	Row %	74.5	15.3	5.1	2.3	1.0	0.5	1.3	100
	Col %	41.8	13.1	6.0	3.5	1.9	1.1	0.2	8.8
2	Row %	48.1	31.8	9.0	4.2	2.1	1.4	3.4	100
	Col %	19.9	20.0	7.7	4.6	2.9	2.3	0.4	6.4
3	Row %	31.3	29.3	19.9	7.9	4.0	2.4	5.3	100
	Col %	10.9	15.6	14.4	7.4	4.6	3.3	0.6	5.4
4	Row %	22.5	25.0	21.9	14.7	5.7	3.4	6.8	100
	Col %	6.5	11.1	13.3	11.5	5.6	4.1	0.6	4.6
5	Row %	16.8	18.7	18.8	15.6	13.2	5.2	11.6	100
	Col %	4.4	7.4	10.1	10.9	11.4	5.5	0.9	4.0
6	Row %	12.9	16.4	17.1	15.1	11.7	12.4	14.3	100
	Col %	3.0	5.8	8.3	9.4	9.1	11.7	1.0	3.6
7+	Row %	3.1	4.1	4.5	4.6	4.5	4.1	75.0	100
	Col %	13.5	27.0	40.2	52.8	64.5	72.0	96.3	67.1
Total	Row %	15.6	10.2	7.5	5.8	4.7	3.9	52.3	100
	Col %	100	100	100	100	100	100	100	100

Note: Only firms exporting more than 6 products are used when computing this table. Interpretation of table: 41.8% of the products ranked first at the firm-level are also ranked first within a destination and in 19.9% of cases the product ranked 2 at the firm-level is ranked first in a destination. If the highest ranked product of a firm is exported to a destination, then in 74.5% of the destinations it is ranked first, and 15.3% of cases ranked second in a destination.

Relying on the preceding discussion,[14] the pattern of firm export sales can be formalised in two stylised facts:

- **Fact 1:** Both firm and firm-destination exports are granular in nature with the economic value concentrated in a few 'star' products.

[14] This paper is not unique in documenting similar within-firm descriptive statistics and the skewness towards the best performing products. See, for example, Görg, Kneller, and Muraközy (2012), Arkolakis and Muendler (2013), Amador and Opromolla (2013) and Bernard, Redding, and Schott (2010).

- **Fact 2:** A limited number of 'star' products are consistently among the highest ranked products across destinations, but need not be exported to all. Many products are exported with a peripheral trade value relative to the aggregate exports of the firm.

Based on these stylised facts I introduce the concept of superstar and non-superstar products. The superstar product of firm i in destination d is defined as the product with the highest export sales in destination d in a pre-sample period. The pre-sample period consists of the first year observed per firm-destination pair and the subsequent two years. The three-year pre-sample is used to ensure that the superstar is not endogenously determined. The identity of the superstar product is kept constant within each firm-destination pair in all consequent time periods.[15] A non-superstar product is defined as any product exported by a firm which is not ranked first in the pre-sample, regardless of the number of products the firm exports. Note that these non-star products need not be exported in the pre-sample period. All pre-sample observations are dropped in the empirical analysis. Figure A1 in appendix A illustrates the definition of the superstar and non-superstar products.

3 Theoretical Motivation and Mechanism

The aim of this paper is to investigate whether there is a systematic pattern of dependence between the products that a firm exports. To motivate the empirical analysis I suggest a mechanism in conjecture 1 which I will link to current theoretical and empirical studies on multi-product exporters. The suggested mechanism is the following:

Conjecture 1 *Each firm has a superstar product exported to a destination. I propose that an increase in the export value of the superstar product leads to increased exports of non-star products exported to that destination. The reverse mechanism, from non-superstar products to other non-star products or the superstar product, should not be found.*

Note that conjecture 1 describes a one-way complementarity or an asymmetric relationship

[15]The superstar products need not be exported or the highest exported product to a destination in any of the consequent periods. To investigate the stability of the superstar within a firm-destination pair I examine the last year in the data and compare the rankings. From figure A3 in appendix A, it can be seen, that in just under 40% of the cases, is the superstar product (as defined by the pre-sample) the highest exported product in the last period. Other products are much less likely to be the highest ranked in the last period. Products ranked second to fifth in the pre-sample are, for example, in around 14%, 7%, 4% and 3% of cases the highest ranked in the last period.

between the products, as only the non-star is dependent on the superstar product trade flows. The mechanism in conjecture 1 could be either demand- or supply-driven and a few examples of both are discussed below.

First, as the export revenue is highly skewed towards the best performing products, I argue that firms will only overcome the entry costs if the superstar product is successful. This is in line with the theoretical model of flexible manufacturing of Eckel and Neary (2010), where products close to the firms' core-competency (high ranked) are produced at a low cost and should, therefore, be more competitive and have higher mark-ups than non-core products. In line with this argument, De Loecker, Goldberg, Khandelwal, and Pavcnik (2016) demonstrated that products closer to the firms' core have higher mark-ups relative to those further away. I argue that, since the superstar product is a core-product with high mark-ups and is exported in large volume, it will generate the majority of the firm's profit. Firms will therefore base their export decisions on the superstar product while other non-star products may be exported to complement/supplement the 'main' product for that destination. This could be a result of customers demanding a bundle of superstar and complementary, non-superstar products. This relates to the findings of Bernard, Blanchard, Van Beveren, and Vandenbussche (2015) who showed that 75% of the products a firm exports, and 30% of the export value is in Carry-Along-Trade (CAT) products, which is the export of a product that the firms themselves do not produce.[16] To explain this phenomenon, they created a model emphasising sourcing of products and suggested that the demand-scope complementarity[17] of produced and non-produced products may explain the existence of CAT products. This type of demand-side product bundling may provide one explanation of conjecture 1. Hence, if superstar and non-superstar products are demanded in conjunction and are bundled, a positive demand shock to the core product will induce trade in non-star products. Conversely, a positive demand shock to non-superstar products should not induce trade of star products (or other non-star products), as these products are of minimal importance for the exporter.[18]

[16] A similar pattern is found in Sweden, see appendix E.

[17] Bernard, Blanchard, Van Beveren, and Vandenbussche (2015) provides some anecdotal evidence of the demand-scope complementaries. They interviewed Belgian and US firms on their sales strategies and reported that firms often export non-produced products with produced products as the customer demands a bundle of goods. An example they use is a coffee exporter who will bundle his produced good (coffee) with non-produced goods (coffee cups and/or cookies) which are then sold to the foreign market.

[18] In terms of the example above, a demand shock to cups (the non-superstar product) will not induce trade of coffee (the superstar product) or cookies (other non-star).

A second explanation of the mechanism in conjecture 1, is related to demand learning, product churning, and duration. Békés and Muraközy (2012) showed that over half of firm-product-destination flows last only a single year. Similarly, Timoshenko (2015b) found that, after firms enter a market, they engage in product switching (churning) as they learn about the appeal of their products. She found that continuing exporters derive around 16% of the aggregate revenue from new products and the value of products that are dropped in the next period was found to be the same. As the bulk of the trade value is in continuously exported products the learning mechanism suggested is mostly active in the lower realm of the product sales. This is consistent with an explanation that the duration of superstar and other high-selling products is longer compared to other products and firms may, as time passes, learn about the market-specific demand conditions for the non-superstar products. This learning could be in the form of how to bundle products together or learn about destination-specific demands/taste.

A third explanation for this superstar to non-superstar relationship may be related to the number of buyers in the destination and the shipment frequency.[19] As firm sales are skewed towards a limited number of products, potential buyers are more likely to have information and knowledge of the superstar product (due to, for example, marketing) rather than non-superstar products. A new buyer is, therefore, more likely to demand the superstar product than other products. This would result in the mechanism in conjecture 1 if the new buyer also demands some of the non-superstar products. A related explanation may be the ability of firms to spread costs across products by 'co-shipping' goods. Kropf and Sauré (2014) found evidence of substantial fixed costs per shipment which ranged between 0.8-5.4% of the export value. As fixed costs per shipment are independent of shipment size/value, they will have a large deterrent effect on the trade of low value peripheral products, since they make up a large share of their trade value. This could explain the response of the non-superstar products as the trade value of the superstar product increased, as an additional shipment reduces (or removes) the shipping costs for co-shipped non-superstar products.

Lastly, one could explain conjecture 1 by considering product quality and mark-ups. Eckel, Iacovone, Javorcik, and Neary (2015) found that in the flexible manufacturing framework of Eckel and Neary (2010), products close to the core-competence of the firm can be produced

[19]See Carballo, Ottaviano, and Volpe Martincus (2013), Bernard, Moxnes, and Ulltveit-Moe (2014) and Eaton, Eslava, Kugler, and Tybout (2008).

at a low cost and sold with a high margin. They argued that firms producing differentiated goods are competing in terms of quality rather than cost. There is, therefore, an incentive for firms to invest in the (perceived) quality of their core-products which have the highest mark-ups and sales. One way to achieve higher perceived quality would be to bundle the high-quality high-mark-up superstar product with complementary non-superstars. Alternatively, the firm may use marketing to increase the (perceived) quality of the firm/product which could have a positive spillover on other products exported.

4 Empirical Strategy and Specification

The aim of this paper is to identify whether there is a within-firm-destination complementarity between the 'superstar' and non-superstar products of a firm. The identification challenge, using traditional OLS, stems from the suggested within-firm dependence of export flows of the superstar and non-superstar products. Demand for different products of a firm may be jointly determined, causing a simultaneity bias in our estimates. An additional problem with using OLS is the potential for measurement error due to misclassification of the superstar product. If a non-star product is (falsely) defined from the pre-sample, as the actual superstar product the OLS results would be biased towards zero. To overcome these issues I suggest a novel instrumental variable approach. I argue that firms mainly focus on exporting *a* superstar product to a destination and that the trade flows of non-superstars products are contingent on the superstar product. By using an instrument for the export of the superstar product, I identify whether changes in the trade of the superstar product explains trade flows of non-superstars in a specific destination. The instrument, therefore, needs to be superstar product-destination specific, correlated with the trade value of the superstar and uncorrelated with other product trade flows.

The instrument used in this paper relates most closely to the instrument used by Hummels, Jørgensen, Munch, and Xiang (2014) and Autor, Dorn, and Hanson (2013). The instrument, Country-Product Import Demand (CPID), is defined based on the product-specific import demand to a destination. Formally, the CPID instrument (in logs), z_{i1dt}, is defined as:

$$z_{i1dt} = M_{1dt} \tag{1}$$

where M_{1dt} is the import of the superstar product (p=1) for firm i from the world market (except Sweden) to destination d in year t. For each superstar product, CPID is used as an instrument for the trade value of the superstar to a destination. The CPID instrument will, therefore, be firm-product-destination specific.[20] Since a single instrument is used for each firm-destination pair, a firm may have a different 'star' product in different destinations. To construct the instrument, data from UN Comtrade has been used. See appendix A for additional information on the dataset, summary statistics (table A1) and definitions (table A2).

I argue that the instrument for the superstar product is exogenous to both the firm and export flows of non-superstar products. First, as Sweden is a relatively small country it is reasonable that changes in demand for a specific product at a destination are not influenced by Swedish firms. Second, it is plausible to assume that a demand shock to the superstar product at a destination (the instrument) is exogenous to the export of other products of the firm. Hence, the instrument, z_{i1dt}, should explain the trade in the superstar product, Y_{1idt}, with destination d. However, the instrument should be uncorrelated with the export of other products, Y_{pidt}, by the firm to that destination.[21] This assumption is reasonable when considering how *dissimilar* the superstar product is to the non-superstar products of the firm. For example, one can see from the data that over 90% of the non-star products exported are *not* within the same 4-digit product category as the superstar. Even at the 2 or 1 digit product level, 67% and 44% of products are *not* within the same categories.

4.1 Empirical Specification

The idea behind the empirical strategy is that the export value of the superstar product to a destination should explain the trade of other non-superstar products there, which leads naturally to the following baseline specification:

$$ln(Y_{pidt}) = \beta ln(Y_{1idt}) + I_{pdt} + \eta_{dt} + \lambda_{ipd} + \gamma_{st} + \epsilon_{pidt} \quad (2)$$

[20] The instrument, z_{i1dt}, for firm i in destination d is constructed based *only* on the import flows of the superstar to that destination. The instrument need not be firm-product-destination-year specific as multiple firms can have the same superstar in a destination. There are cases of this in the data, but they are very uncommon. The instrument in Hummels, Jørgensen, Munch, and Xiang (2014), World Import Demand (WID), is constructed as a weighted average of the product-destination-specific shocks which are aggregated over all destinations; the WID instrument is, therefore only firm-year-specific.

[21] Note that p ranges from rank *2* to the last product, P, exported by the firm. Products not exported in the pre-sample period are included in the analysis.

Y_{pidt} is the export trade value of non-star product p by firm i to destination d, where p ranges from $p = 2$ to the last (P) within a firm-destination pair, $2 \leq p \leq P$. In equation 2, the trade in non-superstar products, Y_{pidt}, is explained with the export of the superstar product, Y_{1idt}, by the same firm. To overcome the identification challenge discussed above and causally identify the impact of the superstar product on the non-superstars, I use an instrumental variable approach, where I instrument for the export of the superstar product. Hence I perform a first stage regression where the actual exports of the superstar product, $ln(Y_{1idt})$, are regressed on $ln(z_{i1dt})$, then the fitted values, $ln(\hat{Y}_{1idt})$, are used in the second stage equation (instead of $ln(Y_{1idt})$). I include[22] a destination-year fixed effect, η_{dt}, to control for country-time specific effects, such as GDP, exchange rate fluctuations, or other country specific effects; a sector-year fixed effect, γ_{st}, which accounts for unobserved industry-year variation; a firm-product-destination fixed effect, λ_{ipd}, which accounts for time invariant effects related to the triad. This could be, for example, product-market information, product characteristics, or quality. By using firm-product-destination fixed effects, λ_{ipd}, I identify the impact of the superstar product on non-superstars only in the time dimension. The works of Eaton, Kortum, and Kramarz (2011), Bernard, Redding, and Schott (2011) and Munch and Nguyen (2014) underlined the importance of accounting for destination specific effects. Both studies found that firm-level indicators perform poorly in accounting for the distribution of sales variation within a destination. The inclusion of firm-product-destination fixed effect addresses this point as it accounts for all unobserved heterogeneity related to a specific firm-product-destination combination.

As there may have been some contemporaneous changes in the demand for the non-superstar product, p, I add a non-superstar product-specific demand control, I_{pdt}. The demand control is non-superstar product-destination-time-specific and captures the non-superstar product-specific element of the change in the export flow. The demand control is defined analogously as the instrument for the superstar product, $I_{pdt} = z_{ipdt}$ if $2 \leq p \leq P$ (in logs).

5 Results - The Superstar and the Followers

The objective of this paper is to explain variation in export sales within a market by investigating whether there is intra-firm dependence between the products that a firm exports. As there may

[22]Same fixed effects are used in both stages.

be simultaneity and measurement error problems, thereby, biasing our OLS estimates, I use an instrumental variables approach to estimate equation 2.[23] In table 4 columns 3 and 4, the first stage regression results are shown, where the log export value of the superstar product is regressed on the instrument, z_{i1dt} (in logs). The first stage results show a strong positive correlation between the superstar product's trade value and the instrument, with an F-statistic above over 20 in both regressions. Table 4 shows the results of the second stage regression, where equation 2 is estimated by using the predicted values for the superstar product exports from the first-stage. The IV results show that a 10% increase in the superstar product's trade value leads to an 1.8% increase in the non-superstar export value.[24]

The results are robust to using alternative combinations of less stringent fixed effects (available on request) and defining the superstar based on production data (see appendix E). One potential concern is that the non-star products that a firm exports may be very similar to the superstar product. In that case, the IV strategy may be less applicable as the instrument for the superstar product may be correlated with shocks to other products. As a robustness check addressing this concern, I re-run the regressions after dropping all non-superstar products belonging to the same 2- or 1-digit product category as the superstar product and the results are similar (see table B4 in appendix B). This result is not surprising, considering how dissimilar the non-star products are generally to the superstar product (see discussion in section 4). The results are also robust to excluding destinations where the superstar product exports (of a single firm) are a large part of the total import of that specific product from all destinations (see appendix C).

As a further robustness check, I experiment using different 'placebo-superstar' products. If the *one-way* mechanism in conjecture 1 is correct, then the same type of dependence of low-

[23] As there are multiple fixed effects included, I employ the Stata module, `reghdfe`. The module was developed by Correia (2015) and is able to estimate models efficiently that include high-dimensional fixed effects.

[24] The reason for using an IV estimator instead of OLS is due to simultaneity and the potential for measurement error when defining the superstar product. If (by chance) a non-star product is the most exported product in the pre-sample and is hence defined as the actual superstar there will be measurement error in the independent variable (the export value of the actual superstar) thereby, biasing the OLS results to zero. Equation 2 can be estimated with traditional OLS after substituting superstar product trade, Y_{1idt}, instead of the instrumented superstar trade, $\hat{Y}_{1idt}$. The results in column 5 of table 4 show, as expected, a minimal impact (elasticity of 0.0256). Since it is suspected that the source of the measurement error is a misclassification of the superstar product, it is possible to check if this is the case. If a non-star product (by chance) is defined as the superstar, it is likely to have considerably shorter duration than the actual superstar, and not traded in consequent periods (this argument is in line with the results of the studies of Békés and Muraközy (2012) and Timoshenko (2015b)). I test for this by dropping observations where the export value of the superstar product is zero, post pre-sample, which are cases it is suspected that the superstar may have been incorrectly defined. After having dropped these observations (under 20% of the total) the elasticities from the OLS and IV estimation are of a similar magnitude. See column 6 of table 4.

Table 4: Main results for single superstar-product specification. Dependent variable is non-superstar product trade flows (except the instrument is the dependent variable for the first stage IV results in columns 3 and 4).

	IV 2-stage		IV 1-stage		OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
Superstar-product trade value	0.178^a	0.186^a			0.0256^a	0.151^a
	(0.0642)	(0.0652)			(0.00150)	(0.00629)
Superstar-product instrument			0.206^a	0.206^a		
			(0.0454)	(0.0454)		
Product demand control	0.0654^a		0.0115		0.0681^a	0.0701^a
	(0.00428)		(0.00855)		(0.00394)	(0.00440)
Nr. obs.	1726640	1726640	1726640	1726640	1726640	1386319
R^2	0.809	0.807	0.850	0.850	0.825	0.836
# clusters	52256	52256	52256	52256	52256	33591
First stage F stat.	20.55	20.62	20.55	20.62	n.a.	n.a.
Firm-prod.-dest. FE	Yes	Yes	Yes	Yes	Yes	Yes
Dest.-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes

^{c} $p < .10$, ^{b} $p < .05$, ^{a} $p < .01$. Standard errors in parentheses are clustered on firm-destination level. Observations are at the firm-product-destination level.

ranked products within a firm-destination pair will not be found with other products. I therefore re-estimate the regressions using low-ranked products in the pre-sample as placebo-superstars. I define a placebo-superstar product for each decile of the pre-sample. The best product in each decile is the placebo-superstar product for that decile. The instrument is now based on the placebo-superstar but otherwise the identification method is unchanged. Consistent with conjecture 1, I do not find the same contingency between the placebo superstars and other products. See discussion and results in appendix B (see table B1 and B2).

5.1 Multiple Stars: The Superstar Core

One potential concern with using a single superstar per firm-destination pair is the varying and often broad product scope of firms within a destination. It may be the case that the one-way complementarity observed is present due to a group of products. Hence, instead of a single superstar per firm-destination pair, there may be multiple products which belong to a core and the one-way complementarity is from that group of products. To assess this, I re-estimate equation 2 using near-superstar products as potential superstar products. The results show that there is a similar contingency of non-star products with the product ranked second in the pre-sample (see table B3 in appendix B). Thereafter, the dependence disappears, underlining that the mechanism is concentrated among a small set of high-ranked products of the firm. This result suggests that product scope of the exporter may be important.

To address this concern I re-define the superstar as a set of one or more products that belong to a 'superstar core'. A product belongs to the superstar core, c, if it is among the top 10% of the most exported products in the pre-sample period. Formally, the superstar core is defined as, $p \in c$ if $\frac{p}{P} \leq 0.1$, where p is the product identifier (which equals the pre-sample rank of the product) and P is the total number of products exported. Both are calculated within a firm-destination pair in the pre-sample. All products not exported in the pre-sample are non-superstar core products. For this specification only firms exporting 10 or more products in the pre-sample period to a particular destination are included. See table D1 in Appendix D for descriptive statistics about the superstar core sample. A hypothetical example of the superstar core definition is shown in figure 2. Note that both the set and number of products can differ across destinations.

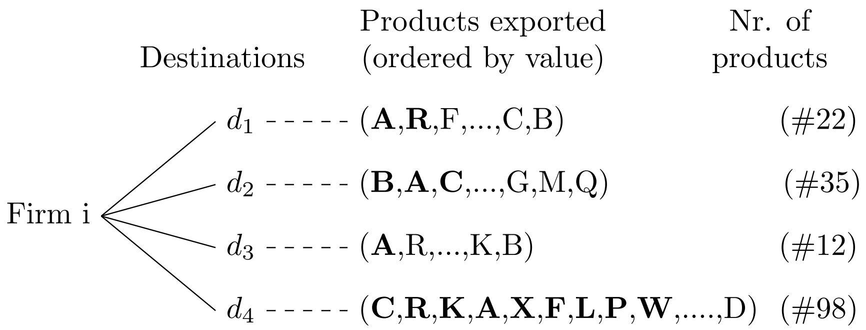

Figure 2: The definition of the superstar core. The products ranked in the top decile in the pre-sample period of firm i in a destination are in the superstar core (marked in bold). At destination d_1, products A and R are in the superstar core for firm i in *all* consequent time periods. In the superstar product definition, only product A was a star at the destination.

The data shows that around 65% of the superstar cores include only a single product, and in 89% of cases there are three or less products in the superstar core. The highest number of products in the core is 46 (see figure D1 in appendix D). The idea behind this definition is to take into account the wide and varying scope of firms. Firms may, for example, export different bundles of products to different buyers. Hence, a firm may bundle a product from the superstar core with some of the lower ranked products, while other stars in the core are bundled differently.

To construct the instrument for the superstar core, each product is weighted by a pre-sample share. The share of each product, s_{ipd}, equals the trade value of product p to destination d divided by the total trade value of all products in the core by firm i to that destination in the pre-sample period. Both the shares, s_{ipd}, and set of products included in the superstar core are kept constant over the sample period.[25] Formally, the superstar core instrument (in logs), z_{icdt}, is defined in equation 3:

$$z_{icdt} = \sum_{p \in c} s_{ipd} M_{pjdt} \tag{3}$$

The empirical specification is the same as in equation 2 after having replaced the superstar product with the superstar core. As before, the pre-sample observations are dropped, in addition the entire core of superstars is dropped post pre-sample, not just a single superstar product. The instrument, now based on the superstar core, is calculated using the same data that was used for the superstar product instrument.

5.2 Superstar Core Results

Before proceeding to the results from this superstar core specification I investigate the first stage results. From table 5, one can see that the coefficients have the expected sign, with the F-statistic around 28. The second-stage results for the superstar core specification are strong and robust, with an estimated elasticity of 0.322 for the top superstar core decile. Hence, an increase of 10% in the trade value of the superstar core (decile) results in a 3.2% increase in the non-core products to a destination. The results underline that the within-firm complementarity of the products from the top decile to the lower-ranked products.[26]

In the baseline specification, I include a product-demand control which captures the contemporaneous changes for that specific non-star product. An alternative, is to use a product-destination-year fixed effect. This inclusion is demanding on the data as it requires variation

[25] To check the stability of the superstar-core I calculate the average share of export value of the superstar-core of total trade value per destination. In the first three years in the data (1997-1999) the share of the superstar-core is on average around 68% of the total export value. The share decreases slowly over time and is around 45% in the last three years (2009-2011). The share is very similar when all pre-sample observations are excluded.

[26] As discussed in relation to the superstar product results (footnote 24), it is suspected that there may be cases of measurement error due to false definitions of a non-star product as the star. This type of measurement error will bias the OLS results towards zero. Again the OLS elasticities are low when all observations are included (see table 5 column 5). We suspect that measurement error is present when the export value of the superstar core equals zero after the pre-sample has ended. If these observations are dropped the elasticities increase substantially but are still lower than the IV estimates. As only cases in which the *entire* superstar core export value equals zero (only around 6% of the observations) are dropped, there may still be some measurement error in the superstar core definition, thereby, still biasing the OLS results downward.

Table 5: Main results for the superstar-core specification. Dependent variable is non-superstar product trade flows in columns 1-2 and 5-6. Columns 3-4 show the first stage results for col. 1-2.

	IV 2-stage		IV 1-stage		OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
Superstar-core trade value	0.322^a	0.329^a			0.0465^a	0.216^a
	(0.0806)	(0.0813)			(0.00284)	(0.00907)
Superstar-core instrument			0.221^a	0.221^a		
			(0.0419)	(0.0419)		
Product demand control	0.0681^a		0.000593		0.0692^a	0.0683^a
	(0.00529)		(0.00715)		(0.00494)	(0.00500)
Nr. obs.	1041135	1041135	1041135	1041135	1041135	976340
R^2	0.791	0.790	0.882	0.882	0.814	0.819
# clusters	8662	8662	8662	8662	8662	7497
First stage F stat.	27.90	27.91	n.a.	n.a.	27.90	27.91
Firm-prod.-dest. FE	Yes	Yes	Yes	Yes	Yes	Yes
Dest.-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes

^{c} $p < .10$, ^{b} $p < .05$, ^{a} $p < .01$. Standard errors in parentheses are clustered on firm-destination level. Observations are at the firm-product-destination level.

across firm exports of the same six-digit product-destination-year combination. The results are very similar to the main results (see column 2 in table E1). The results are also robust to *not* controlling for non-superstar specific demand variation (see column 2 in table 5).

To demonstrate that the observed mechanism is indeed one-way, I use the other nine-deciles of the pre-sample rank as 'placebo-cores'. The instrument is then based on the placebo-cores, otherwise, the calculation method is unaltered. Consistent with the suggested *one-way* mechanism in conjecture 1, I do not find any significant effects for the other nine deciles. This is clear from the coefficient plot in figure 3, where each of the 10 coefficients from the 10 regressions is shown along with 95% confidence intervals. For more detailed results, see tables D2 and D3 in appendix D. These results demonstrate that there is a strong mechanism from a set of core products in each destination towards the lower-ranked more peripheral products. I find that the superstar core in each destination has 'followers' which complement the trade of the superstar. This mechanism is asymmetric since it is only a *one-way* complementarity of non-star products to the superstar.[27]

[27] Note that as the IV elasticities are below 1 one would expect that the specialization of firms would increase over time. This need not be as new products can be added. Indeed a strong response is also found on product scope (# of products) if it is used as the dependent variable instead of non-star trade value (see column 5 in table E1).

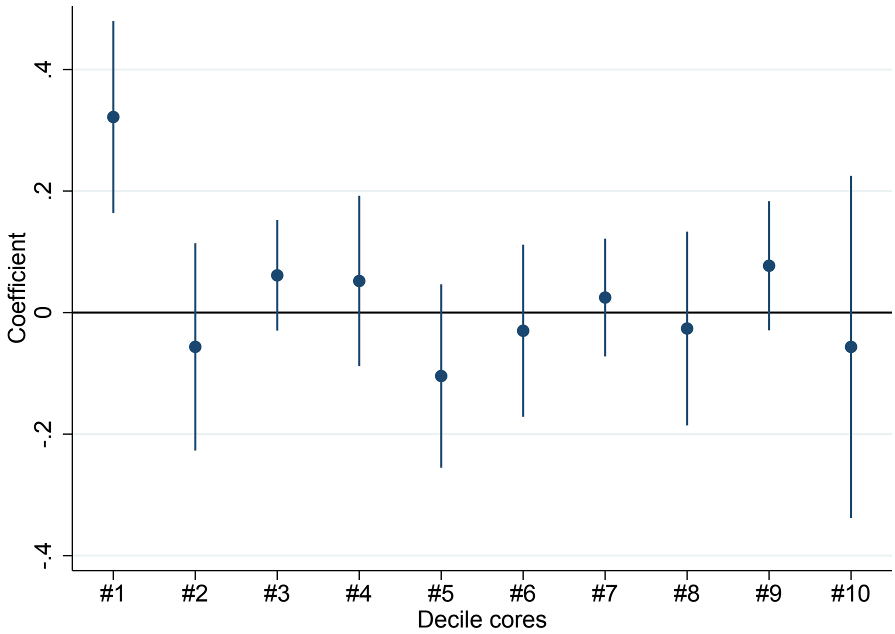

Figure 3: Coefficient plot of for each pre-sample core (decile). The plot shows the point estimate and 95% confidence interval when using each of the deciles (of the pre-sample) as superstar or placebo cores. The regression includes the baseline fixed effects. The full results underlying this figure are available in appendix D (tables D2 and D3).

5.3 Demand or Supply Channel?

A priori, it is unclear if the observed one-way complementarity is related to demand and/or supply forces. In an effort to identify which channel is driving the results a number of exercises are performed. First, we include either firm-year or firm-product-year fixed effect. These fixed effects capture most of the possible supply side variation related to the firm-year or firm-product-year combination (product production cost, efficiency etc.). For identification we therefore use variation across destination-(product)-year by the same firm. As the point estimates are only modestly impacted, and still highly significant, this indicates that the one-way complementarity mechanism is mostly driven by demand-side factors. A second test is to investigate if the mechanism is driven by Carry-Along-Trade (CAT) as discussed by Bernard, Blanchard, Van Beveren, and Vandenbussche (2015) (which is the export of a product that the firms themselves do not produce.) They suggest that CAT exists due to demand scope product complementaries between produced and non-produced products. I investigate if the one-way complementarity observed is the same for products produced by the firm, compared to those not produced, but only exported (CAT product). I find that the mechanism is found for both produced and CAT products, while the elasticity is (slightly) lower for CAT products. See appendix E for a discussion and the results.

To further analyse this demand channel, I investigate if the product type influences the mechanism. In this exercise I use the Rauch (1999) product classification to separate between homogeneous and differentiated products. The idea here being that firms exporting a homogeneous superstar-core[28] are competing in terms of price rather than quality.[29] To investigate this an interaction dummy term is added if the superstar-core is homogeneous, otherwise. I find that the interaction is negative and of similar size as the main effect. See column 1 in table E2. Hence, if a firm is predominantly selling homogeneous products (has a homogeneous core), then no causal link is found between the core and non-star products of the firm. This suggests that product characteristics matter and firms predominately exporting homogeneous goods are unable to bundle the goods in the same manner as firms selling differentiated products.

A related exercise is to investigate if product characteristics of the *non-star* products influence the mechanism. Using an interaction dummy for homogeneous non-star products an ambiguous result is found. Hence, either no specific or very small differences are found between homogeneous and differentiated *non-star* products. This is reasonable considering that there may be buyer-seller relation specific fixed costs, as in Bernard, Moxnes, and Ulltveit-Moe (2017), and therefore optimal to purchase additional products from the seller regardless of their type/characteristics. See columns 2 and 3 in table E2.

6 Conclusion

Traditional measures of firm efficiency explain to a less extent within destination sales compared to predicting firm entry to a market (as noted by Bernard, Redding, and Schott (2011), Eaton, Kortum, and Kramarz (2011) and Munch and Nguyen (2014)). This paper contributes to the literature by uncovering a new *one-way* complementarity mechanism that can enhance the

[28] A firm has a homogeneous product core if 50% or more of the products in the core are homogeneous according to the liberal Rauch (1999) classification, otherwise the firm has a differentiated core. Note that the core is destination specific and can therefore vary within a firm across destinations. In the data the most common homogeneous star products are (in size order): (1) iron and steel products, (2) plastics, (3) paper and paper-board articles, (4) Organic chemicals and (5) Pharmaceutical products.

[29] As in Rauch (1999), a buyer of homogeneous products can easily compare prices and faces therefore lower search costs to find a new seller, relative to a buyer comparing differentiated products from several sellers.

understanding of the observed intra-destination variation in exporting. As the distribution of export sales to each market is highly skewed towards a single product ('superstar product') or a small set of products (the 'superstar core'), I find that demand variation specific to these superstar products can explain variation in other more peripheral non-star products.

To investigate this mechanism, I employed detailed high-quality Swedish firm registry data which is matched with export flows at the firm-HS6 product-destination level. Using a novel instrumental variable approach, I identify that the superstar product explains the trade value of non-star products to each destination. Extending the definition of the superstar to include a 'superstar core' of products (which may include more than a single product) strengthens the results. More specifically, I find that a 10% increase in the superstar product and superstar core leads to a 1.8% and 3.2% increases in non-superstar product trade flows respectively. In the estimations, I control for unobserved heterogeneity by including firm-product-destination, sector-year and destination-year fixed effects. Furthermore, to ensure that the non-star product variation is not driven by foreign demand shocks specific to the non-superstar product, I control for the import demand of non-star products. The result can therefore be interpreted as non-star products being complementary to the superstar core (or product). As a robustness check, I use non-superstar products as placebo-superstars products (or placebo-cores) to verify if they are able to explain the trade value of other products to each destination. In line with the suggested one-way mechanism, I do not find the same type of complementarity mechanism for these placebo-superstars. The results therefore show evidence of a *one-way* complementarity from the non-superstar to the superstar products, as I only observe that the superstar has followers while the followers do not have a 'star'.

The implications of these results are threefold. First, the observed one-way mechanism implies that the weight of product scope could be overestimated. This stems from the fact that even if one acknowledges the high value share of the star, one misses the full impact of these core products due to between product synergies. This is since the star-specific variation is explaining trade in non-star products. Second, the superstar to non-superstar products mechanism established provides an explanation for observed intra-firm-destination trade that is not directly incorporated in current theoretical models of multi-product exporters. The models often incorporate the concept of core competency/products of a firm but the superstar core is an addition thereto, as it has followers. Moreover, investigating the mechanism further, by comparing firms exporting homogeneous/differentiated products and controlling for supply side explanations, we show evidence suggesting that the relationship is driven by demand side complementaries. Hence, future theoretical research on multi-product exporters should incorporate this within-destination one-way demand dependence of product exports. Third, as product exports of a firm should not be viewed in isolation, there are some direct policy implications. If a policy measure impacts products which are in the superstar core of firms, the actual impact would be underestimated as the interconnected non-superstar products are not assumed to be affected. Conversely, if the policy measure is aimed towards the periphery, the impact is overestimated. The composition of firm-sales may therefore be important for policy evaluation.

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7 APPENDICES

A About the Dataset

The datasets used in this paper are provided by Statistics Sweden (SCB) and include firm registry and trade data. The combined dataset is at the firm-(origin)-product-destination level using HS eight-digit level product codes. The data is first aggregated to the six-digit HS level and then converted to time-consistent product codes using a conversion table from UN Comtrade. All observations with zero trade values and/or missing values are dropped (e.g. missing product codes, trade partners, trade values, product demand control, or instrument values). Only firms which have an aggregate trade value above a threshold are required to report their intra-EU trade to SCB. The firm-level threshold ranges from 2.5 to 4.5 million krona depending on the year. All firms are included in the regression dataset regardless of this threshold. Deleting all firms with a minimum trade value below 4.5 million krona in any year does not change the results of the paper. Since we are interested in mostly large multi-product exporters this is not surprising.

As noted in table A2, the superstar product is defined as the highest selling product(s) to a destination in a pre-sample. Therefore, the superstar product(s) need not be exported to the destination in all years. To avoid dropping all years when the superstar is not exported all non-superstar firm-product-destination observations are merged with the data on the superstar product/core instrument regardless of whether the superstar product/core is exported that year or not. Note that the pre-sample and the superstar product/core observations are dropped in the regressions. A few negligible countries are dropped from the dataset, as they are either very small or their names were altered during the sample period (examples: Virgin Islands, Serbia/Montenegro, Myanmar/Burma).

Some descriptive statistics and variable definitions can be found in tables A1 and A2.

Table A1: Summary statistics for superstar-product dataset (logs, except # products).

	Mean	St. dev.	Min	Max	Obs.
Non-superstar trade value	10.00	2.92	0.69	22.98	2095810
Instrument	17.45	2.57	0.69	25.11	2095810
Product demand control	16.77	2.47	0.69	25.30	2095810
Superstar-product trade value	8.28	6.84	0.00	23.55	386107
# non-star products exported to dest.	5.43	16.34	1.00	487.00	386107
# firms	11291				
# products	4607				
# superstar-products	26769				

Table A2: Variable definitions and data sources

	Source	Definition
Firm and trade data	SCB	All firm registry and trade data is provided by Statistics Sweden.
Trade codes	UN comtrade	The trade values are reported as CN 8 digit codes. The codes are then transformed to time consistent 6 digit HS codes (HS 1988 classification) using a conversion table from UN Comtrade.
Superstar-product	Own def.	The product of a firm with the highest export value to a particular destination in the pre-sample period. The superstar is consistent across time for each firm-destination pair. See also figure A1.
Superstar-core	Own def.	A product ranked in the first decile in terms of export value for each destination in a pre-sample period. See figure 2 for a more detailed definition.
Homogeneous v.s. Differentiated superstar-core	Own def.	A firm has a homogeneous product core if 50% or more of the products (share of products, not export value) in the superstar-core are homogeneous according to the liberal Rauch (1999) classification, otherwise the firm has a differentiated superstar-core.
Non-superstar product	Own def.	Any product *not* ranked first (or in the superstar-core) for a firm-destination pair in the pre-sample. Includes also products not exported in the pre-sample.
Pre-sample	Own def.	The pre-sample is defined for each firm-destination pair as the first year a firm enters, t, until year t+2. This pre-sample period is then dropped in the empirical analysis.
Superstar-product trade value	SCB	Log of the export value of the product + 1, ln(export value + 1).
Superstar-core trade value	SCB	Log of the sum of the total export value of all the products in the superstar core + 1, ln(sum export value + 1).
Non-superstar trade value	SCB	Log of the export value of the product + 1, ln(export value + 1).
Instrument data	UN Comtrade	Import of HS 6 digit (HS 1988) product from all destinations aggregated to importing country-product-year level. Use logs after aggregation of the import value, ln(import value + 1).
Product demand control (I_{pdt}) data	UN Comtrade	Same as for instrument.

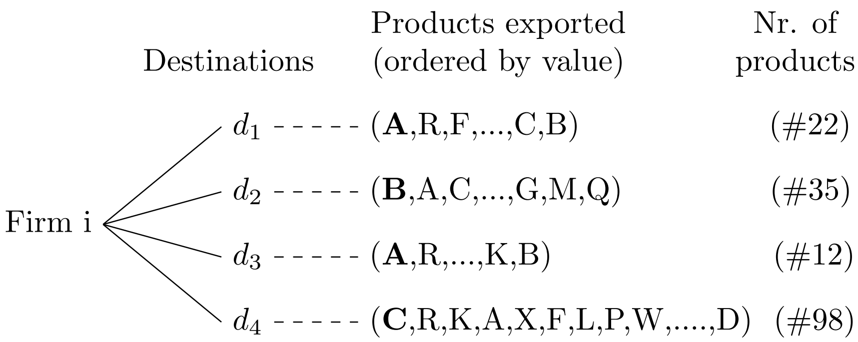

Figure A1: Defining the superstar product. Products are ranked within destination by export value in a pre-sample period. Note that the figure displays *only* the pre-sample rankings that are used to define the superstar product. Product A is the highest ranked product at destination d_1 in the pre-sample period and is therefore the superstar product for firm i in destination d_1 in all time periods. All products which are not exported in this pre-sample period are, by definition, non-star products. The superstar product for each destination is marked in bold.

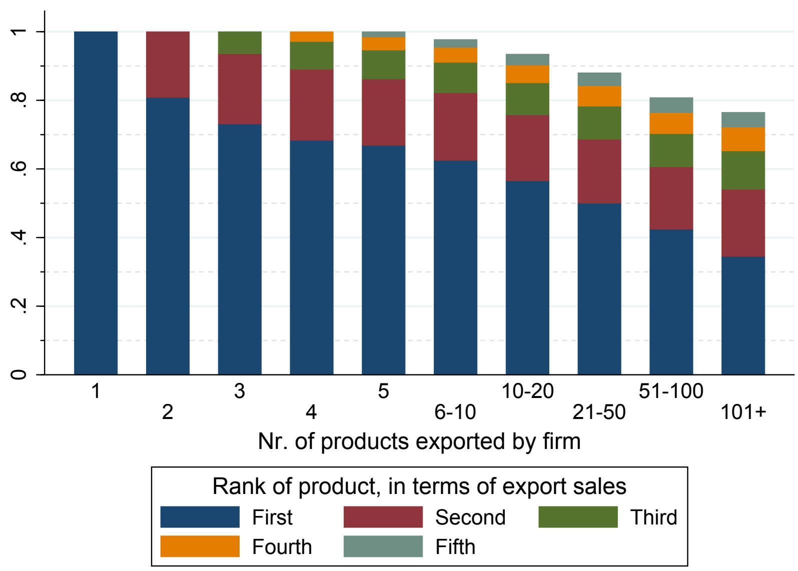

Figure A2: The export value of the top ranked products at firm level relative to the aggregate export value of firm (2011). Note: not by destination as in figure 1.

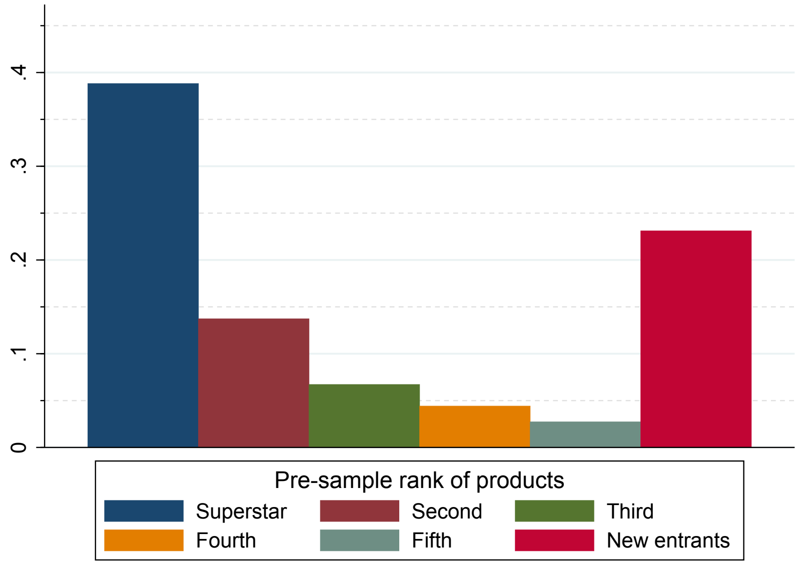

Figure A3: Stability of the superstar product. The figure shows the share of products ranked first in the last period based on initial rank. In around 40% of firm-destination pairs is the same product the most exported product to a destination in the pre-sample and the last period. Only firms exporting 10 or more products in the pre-sample.

B Alternative Placebo Superstar Products

To ensure the robustness of the results several placebo tests are performed. The products used as placebo superstar products are found using the relative rank of products in a *pre-sample* period to a destination. The specific product used is the first product that has a rank ratio strictly above each rank ratio threshold decile. The rank ratio is defined as the rank of product(p) divided by the lowest ranked product (P), $p \in c$ if $\frac{p}{P}$. Example: A firm exports 25 products in the first three years in the dataset. The product ranked third will then be used as the 10% threshold placebo product as it is the first product to have a ratio higher than 0.1 (since 3/25=0.12). The product ranked sixth is used as the 20% (6/24=0.24) placebo product. This method of choosing the placebo products is used to ensure that the placebo products have a similar relative ranking within the firm regardless of product scope to the destination. Note that, as one goes down the product ladder and looks at the lower deciles in the product rank distribution, there is a substantial increase in the number of observations that have a zero trade value for the placebo-superstar. This is expected as there is more randomness in the export of placebo-superstars and they are not expected to be consistently exported to the same destination. Note that the sample is restricted to firms exporting 10 or more products in the pre-sample.

Table B1: Robustness results comparing the actural superstar-product and placebo-superstar products from lower deciles in the pre-sample rank. Dependent variable is non-superstar product trade flows.

	Rank	Rank ratio thresholds			
	#1	10%	20%	30%	40%
Placebo-superstar product trade value	0.219^b	0.0689^a	0.0624	0.0597	0.00902
	(0.0850)	(0.0261)	(0.0392)	(0.0610)	(0.0901)
Product demand control	0.0699^a	0.0695^a	0.0739^a	0.0747^a	0.0736^a
	(0.00524)	(0.00493)	(0.00495)	(0.00496)	(0.00490)
Nr. obs.	1113667	1117484	1139750	1145417	1144834
R^2	0.812	0.845	0.847	0.848	0.848
# clusters	8669	8767	8790	8799	8799
First stage F stat.	14.35	19.03	12.55	6.380	3.218
Firm-prod.-dest. FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes
Dest.-year FE	Yes	Yes	Yes	Yes	Yes

^{c} $p < .10$, ^{b} $p < .05$, ^{a} $p < .01$. Standard errors in parentheses are clustered on firm-destination level. Limit sample to firms with at least 10 products to a destination in pre-sample. See discussion in appendix B about how the placebo cores are determined by the rank ratio thresholds.

Table B2: Robustness results using placebo-superstar products from lower deciles in the pre-sample rank. Dependent variable is non-superstar product trade flows.

	Rank ratio thresholds					
	50%	60%	70%	80%	90%	Last
Placebo-superstar product trade value	0.172^c	0.116	0.0797	0.140^c	0.0412	0.0976
	(0.0938)	(0.107)	(0.0911)	(0.0752)	(0.0851)	(0.0714)
Product demand control	0.0724^a	0.0758^a	0.0759^a	0.0740^a	0.0731^a	0.0754^a
	(0.00522)	(0.00498)	(0.00494)	(0.00496)	(0.00501)	(0.00496)
Nr. obs.	1151098	1149446	1155786	1154010	1143900	1142074
R^2	0.836	0.843	0.846	0.840	0.847	0.844
# clusters	8806	8797	8801	8790	8811	8793
First stage F stat.	12.13	3.723	3.167	8.733	5.130	14.43
Firm-prod.-dest. FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Dest.-year FE	Yes	Yes	Yes	Yes	Yes	Yes

^{c} $p < .10$, ^{b} $p < .05$, ^{a} $p < .01$. Standard errors in parentheses are clustered on firm-destination level. Limit sample to firms with at least 10 products to a destination in pre-sample. See discussion in appendix B about how the placebo cores are determined by the rank ratio thresholds.

Table B3: Robustness results using near-superstar products, ranked #2 to #6, as potential superstar-products. Dependent variable is non-superstar product trade flows.

	Rank of product within destination				
	#2	#3	#4	#5	#6
Placebo superstar-product trade value	0.107[b]	0.0360	0.0459	0.162	-0.00483
	(0.0481)	(0.0354)	(0.0391)	(0.116)	(0.0588)
Product demand control	0.0653[a]	0.0701[a]	0.0714[a]	0.0675[a]	0.0703[a]
	(0.00486)	(0.00491)	(0.00501)	(0.00578)	(0.00493)
Nr. obs.	1120164	1117282	1111639	1125345	1133881
R^2	0.839	0.846	0.846	0.836	0.847
# clusters	8757	8787	8789	8815	8807
First stage F stat.	15.65	15.31	19.75	2.407	6.851
Firm-prod.-dest. FE	Yes	Yes	Yes	Yes	Yes
Year-sector FE	Yes	Yes	Yes	Yes	Yes
Year-dest. FE	Yes	Yes	Yes	Yes	Yes

[c] $p < .10$, [b] $p < .05$, [a] $p < .01$. Standard errors in parentheses are clustered on firm-destination level. Limit sample to firms with at least 10 products to a destination in pre-sample.

Table B4: Robustness checks for the single superstar-product specification (IV) when excluding products from the same 1- or 2-digit category as the superstar product of the firm. Dependent variable is non-superstar product trade flows.

	2-dig	1-dig
	(1)	(2)
Superstar-product trade value	0.202[b]	0.259[a]
	(0.0853)	(0.0626)
Product demand control	0.0628[a]	0.0597[a]
	(0.00509)	(0.00710)
Nr. obs.	1144863	735965
R^2	0.795	0.769
# clusters	34880	28758
First stage F stat.	15.87	37.56
Firm-prod.-dest. FE	Yes	Yes
Dest.-year FE	Yes	Yes
Sector-year FE	Yes	Yes

[c] $p < .10$, [b] $p < .05$, [a] $p < .01$. Standard errors in parentheses are clustered on firm-destination level.

C Instrument Validity

A possible concern for the validity of the instrument is that the superstar product constitutes a large share of the overall import of that product to a destination. Hence, a firm may be able to influence the inflow of a product from other countries if it has a large share of the product's imports. Table C1 demonstrates the ratio of the superstar product trade value of a firm in a year relative to the destination-product-year level import of that product from all origin countries (except Sweden). In most cases, the share is small (below 0.1) which means that the trade value of the superstar product of a firm is less than 10% of the import of that same product from all other countries (excluding Sweden). A ratio above 1 will indicate that the superstar trade value of a particular firm is larger than the import trade value of that specific product from all other destinations. Excluding observations for firm-destination pairs which have a maximum ratio for any year above 0.2 does not change the result but somewhat reduces the sample size.

Table C1: Trade of superstar relative to instrument

	Single			Double		
Share	Nr. obs.	%	Cum. %	Nr. obs.	%	Cum. %
0	302948	78.46	78.46	1287394	61.43	61.43
0.1	19644	5.09	83.55	168249	8.03	69.45
0.2	17095	4.43	87.98	136470	6.51	75.97
0.4	4786	1.24	89.22	39804	1.90	77.87
0.5	13335	3.45	92.67	117660	5.61	83.48
1	10387	2.69	95.36	111393	5.32	88.79
2	8936	2.31	97.68	109379	5.22	94.01
5	3895	1.01	98.68	53471	2.55	96.57
10	4166	1.08	99.76	60625	2.89	99.46
100	692	0.18	99.94	9078	0.43	99.89
1000	223	0.06	100.00	2287	0.11	100.00
Total	386107	100	100	2095810	100	100

A share above 1 means that the trade value of the superstar is larger than the trade value of the instrument. The difference between the first three columns (single) and last (double) is that in the first each share is only counted once. Under double each share is often counted on multiple occasions. This is because the share for each firm-destination is constant and many products may be exported to each destination.

D The Superstar Core Dataset and Robustness

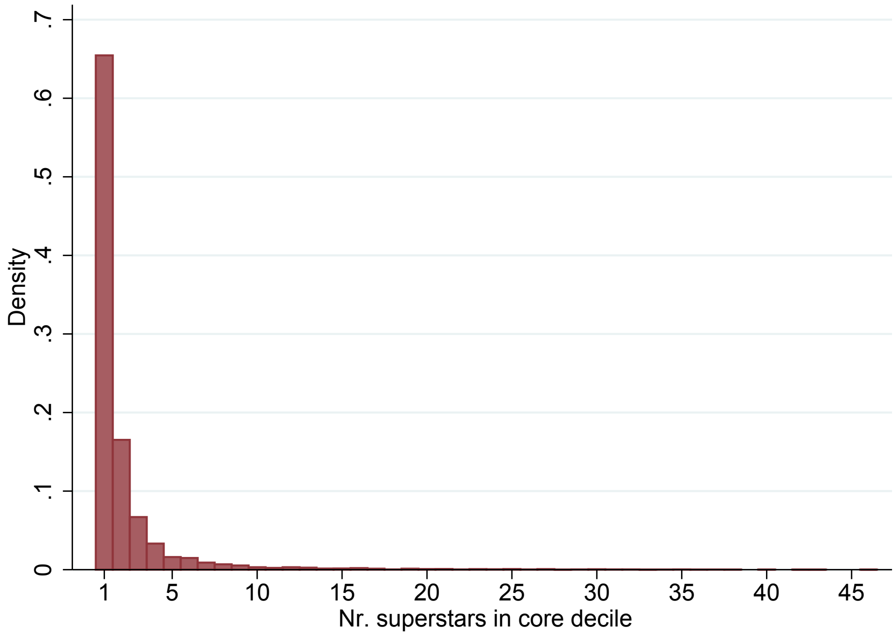

Figure D1: Density plot showing the number of products included in the superstar core (the top decile).

Table D1: Summary statistics for superstar-core dataset (logs, except # products).

	Mean	St. dev.	Min	Max	Obs.
Non-superstar trade value	9.59	2.88	0.69	22.98	1198758
Instrument	17.94	2.39	2.71	24.86	1198758
Product demand control	16.61	2.49	0.69	25.30	1198758
Superstar-core trade value	11.87	6.31	0.00	23.62	77782
# non-star products exported to dest.	15.41	30.28	1.00	442.00	77782
# firms	2584				
# products	4408				
# firm - dest. combinations	9576				

Table D2: Robustness results for superstar-core. Comparison of the superstar-core (#1) and placebo superstar-cores (based on products in the #2 to #5th deciles). Dependent variable is non-superstar product trade flows.

	Deciles				
	#1	#2	#3	#4	#5
Placebo superstar-core trade value	0.322^{a}	-0.0564	0.0613	0.0521	-0.104
	(0.0806)	(0.0870)	(0.0464)	(0.0715)	(0.0770)
Product demand control	0.0681^{a}	0.0693^{a}	0.0738^{a}	0.0736^{a}	0.0749^{a}
	(0.00529)	(0.00503)	(0.00490)	(0.00494)	(0.00511)
Nr. obs.	1041135	1057311	1081468	1093853	1105122
R^2	0.791	0.841	0.850	0.851	0.840
# clusters	8662	8781	8804	8823	8831
First stage F stat.	27.90	12.86	29.64	7.958	23.02
Firm-prod.-dest. FE	Yes	Yes	Yes	Yes	Yes
Dest.-year FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes

^{c} $p < .10$, ^{b} $p < .05$, ^{a} $p < .01$. Standard errors in parentheses are clustered on firm-destination level. Deciles are created using pre-sample rank of products. Only firms with 10 or more products in the pre-sample are included.

Table D3: Robustness results for superstar-core. Results using placebo superstar-cores (based on products in the #6 to #10th deciles). Dependent variable is non-superstar product trade flows.

	Deciles				
	#6	#7	#8	#9	#10
Placebo superstar-core trade value	-0.0299	0.0247	-0.0262	0.0771	-0.0565
	(0.0722)	(0.0494)	(0.0813)	(0.0542)	(0.144)
Product demand control	0.0751^{a}	0.0743^{a}	0.0753^{a}	0.0749^{a}	0.0755^{a}
	(0.00507)	(0.00490)	(0.00516)	(0.00487)	(0.00488)
Nr. obs.	1119419	1127383	1135851	1144634	1151162
R^2	0.847	0.848	0.844	0.845	0.840
# clusters	8833	8829	8830	8830	8856
First stage F stat.	15.29	22.04	9.497	16.86	5.169
Firm-prod.-dest. FE	Yes	Yes	Yes	Yes	Yes
Dest.-year FE	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes

^{c} $p < .10$, ^{b} $p < .05$, ^{a} $p < .01$. Standard errors in parentheses are clustered on firm-destination level. Deciles are created using pre-sample rank of products. Only firms with 10 or more products in the pre-sample are included.

E The IVP Database and Other Robustness Checks

Not all exported products are produced by the firm exporting them. This observation was highlighted by Bernard, Blanchard, Van Beveren, and Vandenbussche (2015) who call a product which is exported by the firm but produced by another, a Cary-Along-Trade (CAT) product. As a robustness check, I use data from the Industrins varuproduktion (IVP) database to identify produced and CAT products. The IVP database includes information on the production of products by manufacturing firms with more than 20 employees (10 in some cases). The production data is based on the same eight-digit[30] product nomenclature as the trade data.

We test if the observed mechanism differs for products which are produced by the firm and those that are only exported(CAT). Following Bernard, Blanchard, Van Beveren, and Vandenbussche (2015), a product which is exported by the firm but produced by another is called a Cary-Along-Trade (CAT) product. In this studys' dataset, there is a high share of (pure) CAT products. Using only firms which we have production data for we find that around 84% of the 6-digit observations (firm-product-destination) are products not produced by the firm exporting them. Notably, these observations account for only 21% of the trade value of firms.[31] To investigate if the superstar core has a different effect on CAT products compared to produced products, I include an interaction of CAT dummy and the superstar core instrument. The results show that the impact on the CAT products is statistically weaker, see column 1 (CAT) in table E1. Quantitatively, I argue that the difference is rather small compared to the size of the original effect.

An alternative robustness check is to alter the single superstar product definition (as in figure A1) to be based on production. Now, I define a 'production superstar' as the product with the highest production value at the *firm level*. In this robustness check there is only a single production-superstar product per firm for the entire period (not per firm-destination as before). By applying the same methodology as in the original superstar product case the

[30] There is one difference between the two; the IVP data uses, when applicable, an additional letter as a ninth digit in the code. As the data is aggregated to the six-digit level this has no impact.

[31] It should be stressed that firms may aggregate (group) the production of similar products to a single product code when reporting their production values in the IVP survey. This may be a result of different collection methods; the trade statistics are collected on a monthly basis while the IVP is based on a yearly survey. Additionally, the nature of international trade may limit the scope for such aggregation of exported products. The aggregation from the 8- to 6-digit level will offset this problem, at least partially. Note however that even if the data is aggregated to the 4-digit or even the very broad 2-digit level the results are similar. At the 4-digit (2-digit) level around 83% (76%) products are CAT and account for around 14% (8%) of the trade value.

results are presented in column 6 (production-star) in table E1. Now the elasticity is 0.125 compared to 0.178 before (see table 4). The difference may be due to the fact that the same 'production' superstar product is used for all destinations regardless of whether the product is ever exported to that destination. As there may be destination market-specific demand conditions (taste), this specification may be less appropriate and more noise present (introduce a similar measurement error as discussed in footnotes 24 and 26). Hence, a product may for example never be exported to a country due to specific taste or demand in that destination. See also table 3 on the comparison of firm to within firm-destination rank of products.

Table E1: Robustness results (IV) using information about production of products from IVP database and alternative more stringent fixed effects as well the extensive margin. Dependent variable is non-superstar product trade flows (except column 5 when it is the # of non-star products).

	Core-definition					Single-star
	(1)	(2)	(3)	(4)	(5)	(6)
Superstar-core trade value	0.367^a	0.341^a	0.278^a	0.249^a	1.761^a	
	(0.102)	(0.103)	(0.0878)	(0.0865)	(0.450)	
CAT ×						
Superstar-core trade value	-0.0356^a					
	(0.00264)					
Produced-Superstar						
product trade value						0.125^a
						(0.0372)
Product demand control	0.0684^a		0.0666^a	0.0259^a		0.0716^a
	(0.00560)		(0.00509)	(0.00480)		(0.00463)
Nr. obs.	934719	742136	1038298	888271	65457	1481693
R^2	0.798	0.838	0.811	0.870	0.664	0.813
# clusters	7008	8217	8450	7043	1042	27403
First stage F stat.	9.339	26.95	23.89	23.10	78.11	36.17
Firm-prod.-dest. FE	Yes	Yes	Yes	Yes	No	Yes
Year-sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-dest. FE	Yes	No	Yes	Yes	Yes	Yes
Prod-dest-year. FE	No	Yes	No	No	No	No
Firm-year FE	No	No	Yes	No	Yes	No
Firm-prod-year FE	No	No	No	Yes	No	No

^{c} $p < .10$, ^{b} $p < .05$, ^{a} $p < .01$. Standard errors in parentheses are clustered on firm-destination level. Column 1 adds an CAT interaction variable to the main core specification (as in table 5). In column columns 2-4 we use alternative fixed effects for robustness. In column 5 the dependent variable is a count variable for number of non-star products exported. In column 6 we define a single product as the superstar at the firm level based on production from the IVP database rather than exports as in the main superstar-product definition.

Table E2: Robustness results (IV) comparing firms producing homogenous and diffrentiated star products and/or followers. Dependent variable is non-superstar product trade flows.

	Superstar interaction	Non-star interaction	
	(1)	(2)	(3)
Superstar-core trade value	0.334[a]	0.322[a]	0.316[a]
	(0.0797)	(0.0805)	(0.0789)
Homogeneous Superstar-core ×			
Superstar-core trade value	-0.325[a]		
	(0.107)		
Homogeneous non-star product ×			
Superstar-core trade value		-0.00177	-0.00508[b]
		(0.00219)	(0.00208)
Product demand control	0.0662[a]	0.0681[a]	0.0674[a]
	(0.00526)	(0.00529)	(0.00551)
Nr. obs.	1041135	1041135	967755
R^2	0.795	0.791	0.786
# clusters	8662	8662	7552
First stage F stat.	11.90	13.94	15.74
Firm-prod.-dest. FE	Yes	Yes	Yes
Year-sector FE	Yes	Yes	Yes
Year-dest. FE	Yes	Yes	Yes

[c] $p < .10$, [b] $p < .05$, [a] $p < .01$. Standard errors in parentheses are clustered on firm-destination level. Products are classified as homogeneous or differentiated according to the liberal Rauch (1999) classification system. Column 1 adds an interaction equal to 1 if over 50% of products in the superstar core are homogeneous, 0 otherwise. In column columns 2-3 the interaction is defined based on the product type of the follower. The interaction equals 1 if the non-star product is homogeneous, 0 otherwise. Column 2 uses all firms and column 3 only firms that have a differentiated superstar-core.