Testing The Core Competency Model of Multi-Product Exporters

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Background

- Growing literature on multi-product firms (MPFs) in trade
- Partly based on the concept of "core competence/competency"
  - Prahalad and Hamel (1990): "Core Competencies of the Corporation"
    - Contribute to the perceived customer benefits of the end product
    - Provide potential access to a wide variety of markets
    - Difficult to imitate by competitors
  - Eckel and Neary (2010): Core competence model of MPFs
    - Costs of production differ across products
    - At the level of the firm rather than of particular markets
    - All products are differentiated from rivals' as well as from each other

Why does the core competence perspective matter?

- "Intra-firm extensive margin" an important channel of adjustment to trade shocks . . .
- . . . and a distinct source of potential gains from trade
- . . . . . because firm productivity varies with product scope

Our Contribution

- We focus on the predictions of the core competence model for firms of different productivity
- We extend model to allow for investment in market penetration
  - Arkolakis (2010), Arkolakis, Ganapati, and Muendler (2014)
- This allows us to to explain the "market-size puzzle":
  - For plausible parameter values, basic model predicts that most firms should export more of their core product than they sell at home.
- We show that our extended model is consistent with Mexican data
  - Detailed plant-product-year data for *both* home and export sales
  - ... at the *same* level of disaggregation

Digression

- A companion paper, Eckel, Iacovone, Javorcik, and Neary (2015), uses investment in quality to explain the "price-profile puzzle"
  - Basic model predicts that core products should sell at lower prices
  - But the opposite is more common, especially for differentiated products

Related Work on Multi-Product Firms

a.k.a. "testing" relative to what?

- IO: Product scope small and/or fixed, vertical product differentiation:
  - Brander and Eaton (1984), Klemperer (1992), Baldwin and Ottaviano (2001), Johnson and Myatt (2003)
- Uniform Sales Profiles:
  - Helpman (1985), Ju (2003), Allanson and Montagna (2005), Feenstra and Ma (2008), Dhingra (2013), Qiu and Zhou (2013), Nocke and Yeaple (2014)
- Demand Differs across Products:
  - Bernard, Redding, and Schott (2010), Bernard, Redding, and Schott (2011)
- Core Competence Model:
  - Prahalad and Hamel (1990), Eckel and Neary (2010)
  - Monopolistic competition: Arkolakis, Ganapati, and Muendler (2014), Mayer, Melitz, and Ottaviano (2014), Timoshenko (2015)
  - Quality: Eckel, Iacovone, Javorcik, and Neary (2015)

Outline

Outline

Preferences

- Utility function of a representative consumer:
  - $u = aQ - \frac{1}{2}b\left[(1-e)\int_{i\in\tilde{\Omega}} q(i)^2 di + eQ^2\right]$

$$\begin{aligned} \tilde{\Omega}: &\quad \text{The set of differentiated products} \\ q(i): &\quad \text{Consumption of variety } i,\ Q \equiv \int_{i\in\tilde{\Omega}} q(i)di \\ e: &\quad \text{Substitution index between goods } (0 \le e \le 1) \end{aligned}$$

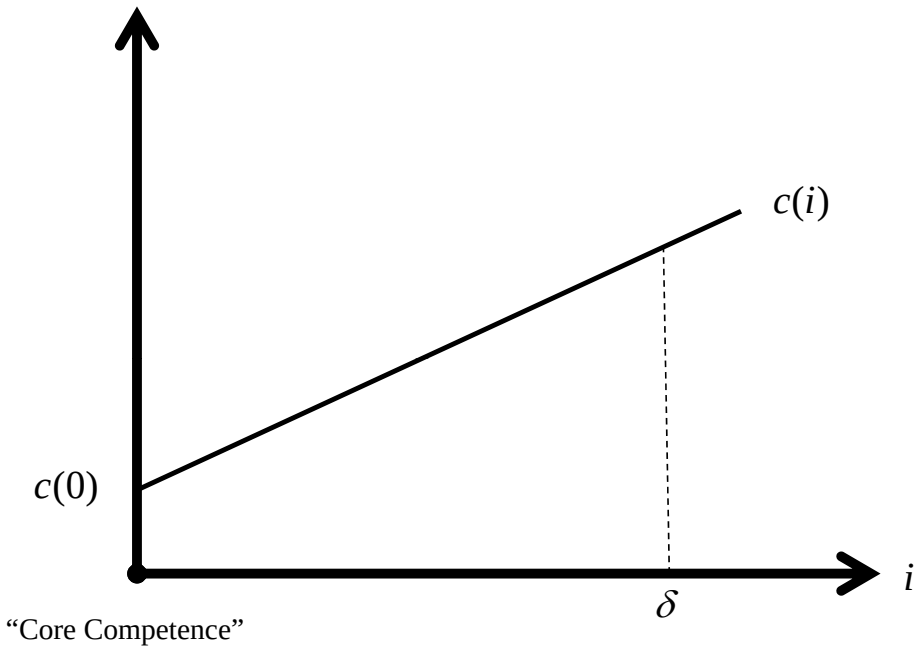
- Rationale:
  - u is a sub-utility function in an additively separable function; or
  - u is part of a quasi-linear utility function $U = u + m$
  - In either case, set marginal utility of income $= 1$
- Implied market demand functions $[x(i) = Lq(i)]$:
  - $p(i) = a - \tilde{b}\left[(1-e)x(i) + eX\right], \qquad i \in \Omega \subset \tilde{\Omega}$

$$\begin{aligned} \tilde{b}: &\quad b/L \\ X: &\quad \int_{i\in\Omega} x(i)di \end{aligned}$$

Technology

- "Flexible Manufacturing" technology, as in Eckel and Neary (2010)
  - Marginal production costs are independent of output but differ across products: $c(i)$
  - Firm has a "core competence" product which it produces at lowest cost: $c(0) = c_0$
  - Adding more products incurs adaptation costs: $c'(i) > 0$
- Industry of heterogeneous firms, differing in c_0
  - We look at cross-section only, so all firms face the same residual demand curve in each market
  - Monopolistic competition as in Mayer, Melitz, and Ottaviano (2014), Arkolakis, Ganapati, and Muendler (2014)
  - Extension to oligopoly: Eckel and Neary (2010)

Flexible Manufacturing



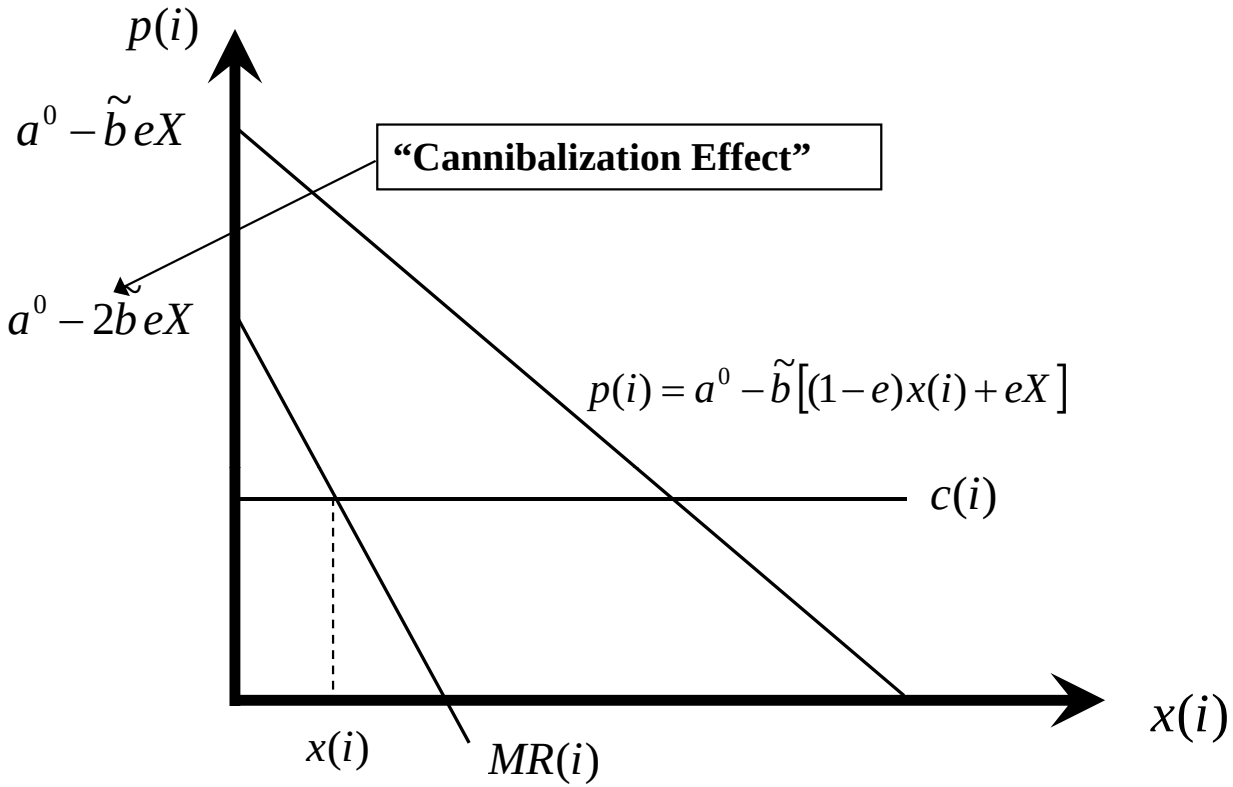
Firm wants to maximise operating profits:

$$\pi = \int_{i \in \Omega} [p(i) - c(i) - t]\, x(i) di$$

$\Rightarrow$ First-order conditions for scale $x(i)$ and scope δ: $\Omega = [0, \delta]$

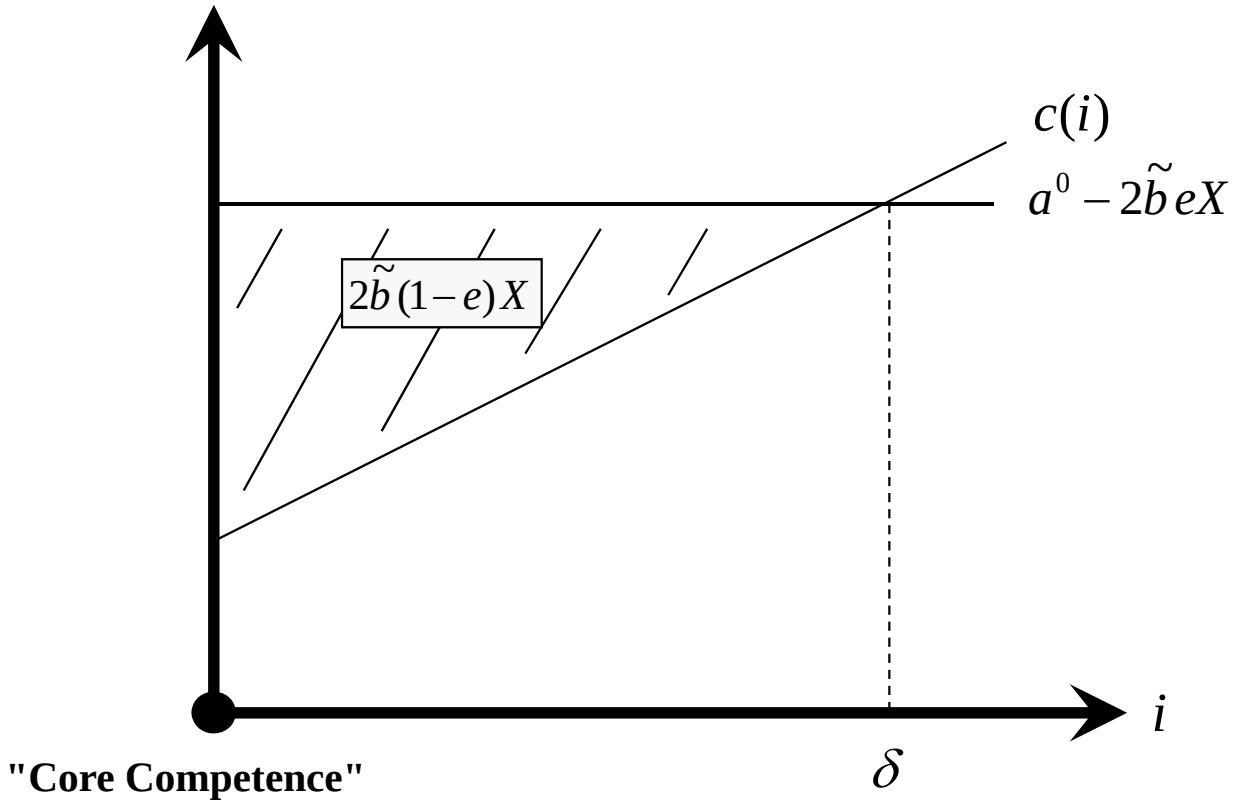
▸ Skip details

First-Order Condition for Scale



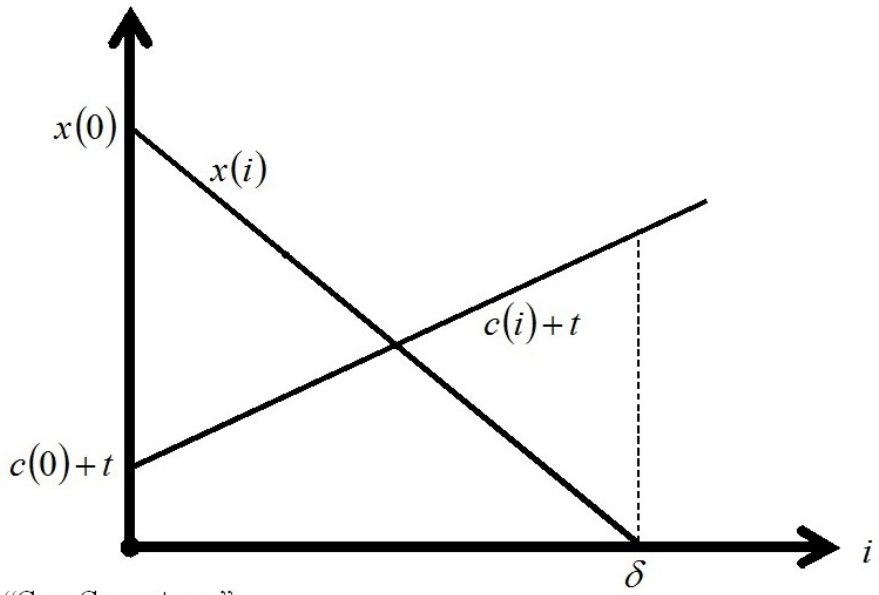
- Cannibalisation effect shifts the MR curve downwards
- Produce where MC=MR

First-Order Condition for Scope



- Produce a positive amount of a variety as long as its marginal cost ...
- ... $\leq$ the marginal revenue of the first unit consumed: $a - 2\tilde{b}eX$

Output Profile

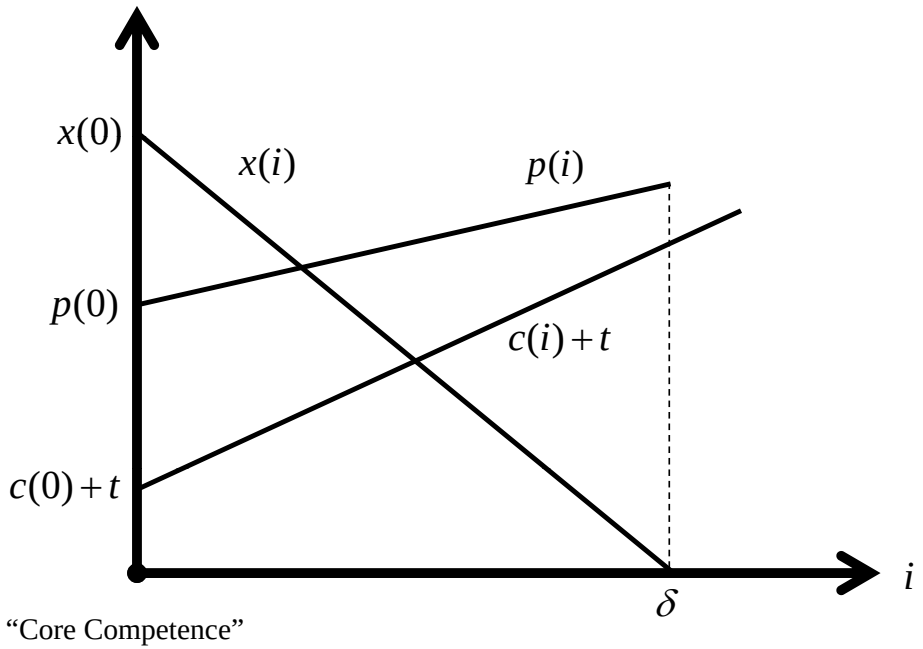


"Core Competence"

$$x(i) = \frac{a - c(i) - t - 2\tilde{b}eX}{2\tilde{b}(1-e)} \qquad i \in [0, \delta]$$

$$x(\delta) = 0 \quad \Rightarrow \quad x(i) = \frac{c(\delta) - c(i)}{2\tilde{b}(1-e)}$$

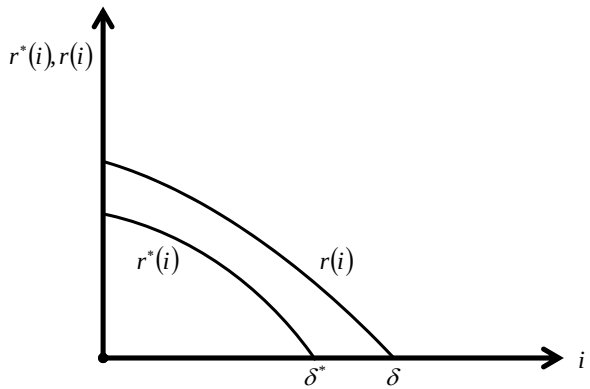
Price Profile



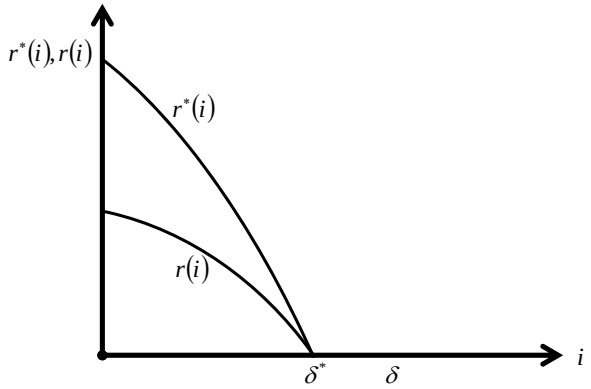
$$p(i) = \frac{1}{2}[a + c(i) + t]$$

- Prices and sales inversely related
  - Converse more plausible especially for differentiated products: Eckel, Iacovone, Javorcik, and Neary (2015)

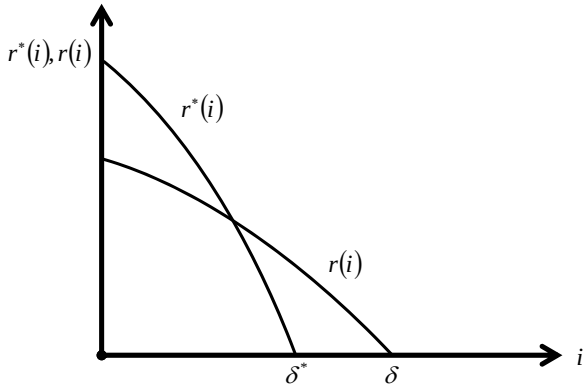
Sales Profiles at Home and Away



(a) Trade-Cost Effect



(b) Market-Size Effect



(c) Combined Effect

- Sales: $r(i) = p(i)x(i)$
- Segmented home and foreign markets: ( ) and (*)
- Predictions of model:
  - All firms export fewer products: $\delta^* \leq \delta$
  - Ratio of exports to home sales of core product ambiguous: $\frac{r^*(0)}{r(0)} \gtreqless 1$

The Market-Size Puzzle

- More Mexican firms should have higher exports of their core product:
  - $\begin{cases} \text{Large differences in market size: } L^* >> L \\ \text{Relatively low trade costs: 95\% of exports to NAFTA} \end{cases}$
- To resolve the puzzle, we introduce *market penetration costs*:
  - Let $\pi^*(i, c_0)$ be the optimal profits *per consumer* abroad given cost c_0
    - Sales profile $\{x(i)\}$ and scope δ^* chosen optimally
  - Reaching a proportion n of foreign consumers is costly:

$$\Pi^*(c_0) = \max_n \left[\int_0^{\delta^*} nL^*\pi^*(i, c_0)di - f(n) \right]$$

    - Assume $f(n)$ is convex, $f(0) = 0$, $f' > 0$, and $\lim_{n \to 1} f(n) = \infty$
- Results: ▸ Details
  - $n < 1$ for all firms;
  - n higher for more productive firms: $\frac{dn}{dc} < 0$

Resolving the Market-Size Puzzle

- Sales:

$$r^*(i) = p^*(i)x^*(i) = \frac{[a + c(i) + t][c(\delta^*) - c(i)]}{4b(1-e)} L^* n$$

- Ratio of export to home sales:

$$\frac{r^*(i)}{r(i)} = \underbrace{\frac{a + c(i) + t}{a + c(i)}}_{(1)} \underbrace{\frac{c(\delta^*) - c(i)}{c(\delta) - c(i)}}_{(2)} \underbrace{\frac{L^*}{L}}_{(3)} \underbrace{n}_{(4)}$$

		Effect	$c_0 \downarrow$
(1)	Higher gross prices abroad	> 1	$\uparrow$
(2)	Lower sales per consumer abroad	< 1	$\uparrow$
(3)	Larger market size	$>> 1$	n/a
(4)	Lower foreign market penetration: $0 \leq n \leq 1$	< 1	$\uparrow\uparrow$

Outline

The Data

Mexican survey giving plant-product-level data:

- *Encuesta Industrial Mensual* (EIM): home and foreign sales
- Monthly survey, aggregated to annual observations 1994-2004
- Coverage: c. 85% of Mexican industrial output (exc. "maquiladoras")
- From 6,291 (1994) to 4,424 (2004) plants
- ... of which, 1,579 to 2,137 engaged in exporting
- Information on 3,183 unique products, in 205 *clases*
- Detailed plant-product-year data for home and export sales
- ... consistently concorded at the same level of disaggregation

Number of Plants and Products

Year	Number of plants					Number of products	
	Total	Owned by MPFs[1]	Other	Exporters		Produced	Exported
				Total	Adjusted[2]		
1994	6,291	1,259	5,032	1,582	1,579	19,154	2,844
1995	6,011	1,245	4,766	1,844	1,842	18,568	3,406
1996	5,747	1,256	4,491	2,024	2,023	17,662	3,881
1997	5,538	1,256	4,282	2,138	2,137	16,938	4,092
1998	5,380	1,268	4,112	2,095	2,094	16,419	4,193
1999	5,230	1,279	3,951	1,951	1,950	15,885	3,889
2000	5,100	1,280	3,820	1,901	1,899	15,279	3,737
2001	4,927	1,258	3,669	1,770	1,766	14,714	3,509
2002	4,765	1,237	3,528	1,686	1,684	14,182	3,321
2003	4,603	1,193	3,410	1,678	1,675	13,507	3,282
2004	4,424	1,159	3,265	1,602	1,599	12,887	3,118
Total	58,016	13,690	44,326	20,271	20,248	175,195	39,272

(1) MPFs: Multi-plant firms; information on the number of plants owned by a single firm is available for 2003 only.
(2) The adjusted data exclude plants not reporting production in the year in question.

Outline

Predictions

Predictions:

1. The profile of sales revenue in a given market is not uniform
2. The ranking of varieties by sales revenue is the same in home and foreign markets
3. Irrespective of relative market sizes, a firm's product range is larger in its home market
4. All exported products are also sold at home
5. Sales of core products are higher in the export market for more productive firms

Prediction 1: Sales Profiles are not Uniform

	mean
Ratio of 2nd to top	0,408
Ratio of 3nd to top	0,234
Ratio of 4th to top	0,162
Ratio of 5th to top	0,125
Ratio of 6th to top	0,100
Ratio of 7th to top	0,078

- Ratio of sales of i'th product to those of top product
- Clearly, sales profile is not uniform across products

Sales Profiles in Detail

All plants							
	mean	10th pctile	25th pctile	50th pctile	75th pctile	90th pctile	No. of plants
Ratio of 2nd to top	0,408	0,041	0,14	0,365	0,649	0,857	36.059
Ratio of 3nd to top	0,234	0,015	0,053	0,166	0,36	0,569	24.119
Ratio of 4th to top	0,162	0,008	0,03	0,102	0,239	0,409	16.405
Ratio of 5th to top	0,125	0,005	0,022	0,075	0,180	0,321	11.476
Ratio of 6th to top	0,100	0,004	0,018	0,057	0,141	0,253	8.318
Ratio of 7th to top	0,078	0,003	0,014	0,042	0,106	0,198	6.192

Only plants with 5 products							
Ratio of 2nd to top	0,475	0,108	0,23	0,46	0,708	0,889	3.157
Ratio of 3nd to top	0,241	0,035	0,081	0,185	0,352	0,533	3.157
Ratio of 4th to top	0,119	0,007	0,023	0,071	0,17	0,301	3.157
Ratio of 5th to top	0,052	0,001	0,004	0,019	0,066	0,135	3.157

2: Same Product Ranking at Home and Away

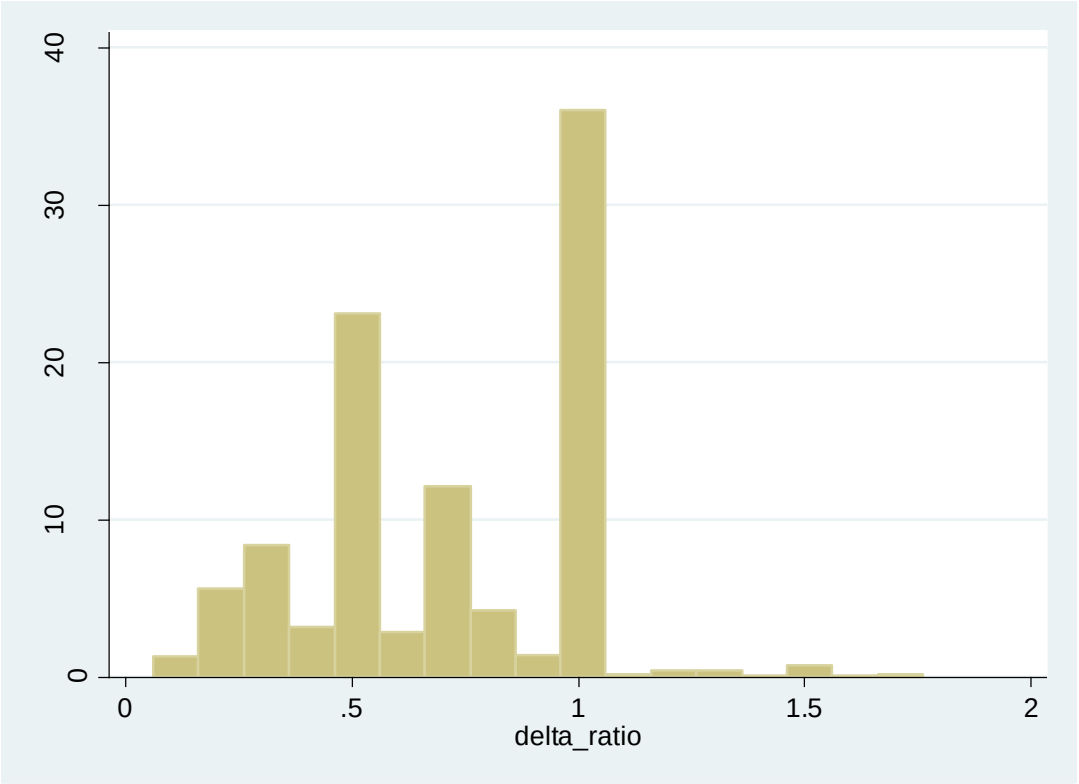
Dependent variable: Product rank in terms of domestic sales	
Product rank in terms of export sales	0.837***
	(0.004)
Intercept	0.746***
	(0.015)
No. of obs.	29486
R-squared	0.54

Note: *** denotes significance at the one percent level

Product Ranking at Home and Away in Detail

		Rank in export sales					
		1	2	3	4	5	Total
	Number of products						
Rank in domestic sales	1	7,430	1,756	459	168	139	9,952
	2	2,615	3,524	846	307	208	7,500
	3	909	1,156	1,440	434	317	4,256
	4	354	446	606	710	421	2,537
	5	357	527	675	698	2,984	5,241
	Total	11,665	7,409	4,026	2,317	4,069	29,486
	Percentage of products with a given rank in export sales						
Rank in domestic sales	1	75%	18%	5%	2%	1%	100%
	2	35%	47%	11%	4%	3%	100%
	3	21%	27%	34%	10%	7%	100%
	4	14%	18%	24%	28%	17%	100%
	5	7%	10%	13%	13%	57%	100%
	Total	40%	25%	14%	8%	14%	100%

3: Larger Product Range at Home than Away

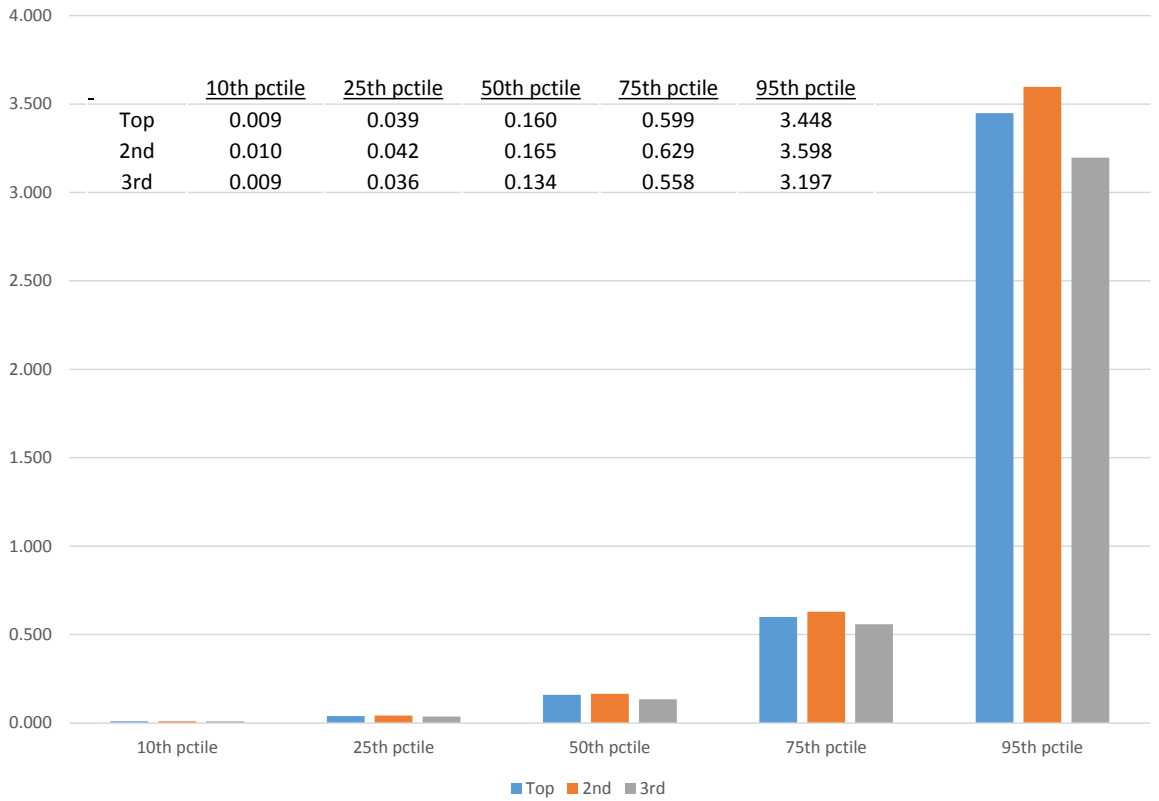


- Ratio of number of exported to home products
- Very few firms (2.3%) sell more abroad; 42% sell fewer

4: All Exported Products are Sold at Home

- Only 2.5% of exported products are not sold at home
- True for all years in the sample

Prediction 5: Sales Abroad Relative to Home



	10th pctile	25th pctile	50th pctile	75th pctile	95th pctile
Top	0.009	0.039	0.160	0.599	3.448
2nd	0.010	0.042	0.165	0.629	3.598
3rd	0.009	0.036	0.134	0.558	3.197

- Ratio of sales of top three products abroad relative to home
- Most firms sell less abroad; top firms sell much more

Sales of Core Product Abroad Relative to Home

	r*(0)/r(0)					
ln(Plant global sales)	-0.011	**0.039*** **	**0.128*** **	**-0.429*** **	**-0.243** **	**0.350** **
	(0.008)	(0.011)	(0.025)	(0.081)	(0.097)	(0.142)
ln(Plant global sales)squared				**0.018*** **	**0.012*** **	-0.01
				(0.003)	(0.004)	(0.006)
6-digit-industry year FE	no	yes	no	no	yes	no
Plant FE	no	no	yes	no	no	yes
Year FE	no	no	yes	no	no	yes
Adj R-squared	0.000	0.134	0.587	0.003	0.134	0.587
No. of obs.	9770	9770	9770	9770	9770	9770

- Ratio of sales of top product abroad relative to home
- Positively related to global sales

Outline

Conclusions

- Theory:
  - We focus on the predictions of the core competence model for firms of different productivity
  - We combine market penetration costs and multi-product firms
  - This allows us to to explain the market-size puzzle
- Empirics: We show that our model is consistent with Mexican data
- Empirical findings:
  - Profile of sales is highly non-uniform
  - Ranking of products is the same in home and export sales
  - Produce ranges are weakly larger in home market
  - Almost all exported products are sold at home
  - Export sales are much lower, except for the largest firms

Market Penetration Costs: Details

- Market Penetration Costs:

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$$\Pi^*(c_0) = \max_n \left[\int_0^{\delta^*} nL^* \pi^*(i, c_0) di - f(n) \right]$$

  - Arkolakis: CES preferences; $f(n) = \frac{1-(1-n)^{1-\beta}}{1-\beta}$, $\beta \in (0, \infty)$, $\beta \neq 1$
  - Mrázová and Neary (2011): Comparative statics hold more generally

- First-order condition: $L^* \int_0^{\delta^*} \pi^*(i, c_0) di = f'(n)$
- More productive firms spend more on market penetration:

$$\frac{dn}{dc_0} = \frac{L^* \int_0^{\delta^*} \pi^*_{c_0}(i, c_0) di}{f''(n)} < 0$$

Examples of Product Classification into Clases

- 313014: "Distilled Alcoholic Beverages" :
  - Gin
  - Vodka
  - Whisky
  - Other distilled alcoholic beverages
  - Coffee liqueurs
  - "Habanero" liqueurs
  - "Rompope"
  - Prepared cocktails
  - Hydroalcoholic extract
  - Other alcoholic beverages prepared from agave,
  - or brandy,
  - or rum,
  - or table wine

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Examples of Classification into Clases (cont.)

- 313011: "Produccion De Tequila Y Mezcal":
  - Tequila
  - Mezcal
  - Sangrita
  - Otras Bebidas Preparadas (Especificar) [Other Prepared Beverages (to be Specified)]
  - Otras Bebidas Alcoholicas (Especificar) [Other Alcoholic Beverages (to be Specified)]
  - Otros Desechos Y Subproductos [Other Subproducts and Waste]
  - Otros Productos No Genericos [Other Non-Generic Products]

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Differentiated vs. Non-Differentiated Clases

- Differentiated:
  - 311901: Produccion de chocolate y golosinas a partir de cocoa o chocolate
    - Production of chocolate and candy from cocoa or chocolate
  - 323003: Produccion de maletas, bolsas de mano y similares
    - Production of suitcases, handbags and similar
  - 322005: Confeccion de camisas
    - Ready-to-wear shirts
- Non-Differentiated:
  - 311201: Pasteurizacion de leche
    - Pasteurization of milk
  - 311404: Produccion de harina de trigo
    - Production of wheat flour
  - 341021: Produccion de papel
    - Production of paper

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References I

Arkolakis, C. (2010): "Market Penetration Costs and the New Consumers Margin in International Trade," *Journal of Political Economy*, 118(6), 1151–1199.

Arkolakis, C., S. Ganapati, and M.-A. Muendler (2014): "The Extensive Margin of Exporting Products: A Firm-level Analysis," Working paper, Yale University.

Bernard, A. B., S. J. Redding, and P. K. Schott (2010): "Multiple-Product Firms and Product Switching," *American Economic Review*, 100(1), 70–97.

——— (2011): "Multi-Product Firms and Trade Liberalization," *Quarterly Journal of Economics*, 126(3), 1271–1318.

Dhingra, S. (2013): "Trading Away Wide Brands for Cheap Brands," *American Economic Review*, 103(6), 2554–2584.

Eckel, C., L. Iacovone, B. Javorcik, and J. P. Neary (2015): "Multi-Product Firms at Home and Away: Cost- versus Quality-Based Competence," *Journal of International Economics*, 95(2), 216–232.

Eckel, C., and J. P. Neary (2010): "Multi-Product Firms and Flexible Manufacturing in the Global Economy," *Review of Economic Studies*, 77(1), 188–217.

Feenstra, R., and H. Ma (2008): "Optimal Choice of Product Scope for Multiproduct Firms," in Elhanan Helpman, Dalia Marin and Thierry Verdier (eds) : *The Organization of Firms in a Global Economy*, Harvard University Press, 173–199.

References II

Helpman, E. (1985): "Multinational Corporations and Trade Structure," *Review of Economic Studies*, 52, 443–457.

Mayer, T., M. J. Melitz, and G. I. Ottaviano (2014): "Market Size, Competition, and the Product Mix of Exporters," *American Economic Review*, 104(2), 495–536.

Mrázová, M., and J. P. Neary (2011): "Selection Effects with Heterogeneous Firms," Discussion Paper No. 588, Department of Economics, University of Oxford.

Nocke, V., and S. Yeaple (2014): "Globalization and Multiproduct Firms," *International Economic Review*, 55(4), 993–1018.

Prahalad, C., and G. Hamel (1990): "The Core Competency of the Corporation," *Harvard Business Review*, 68(3), 79–91.

Qiu, L. D., and W. Zhou (2013): "Multiproduct Firms and Scope Adjustment in Globalization," *Journal of International Economics*, 91(1), 142–153.

Timoshenko, O. A. (2015): "Product Switching in a Model of Learning," *Journal of International Economics*, 95(2), 233–249.