Testing The Core Competency Model of Multi-Product Exporters

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- MPFs dominate exports
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MPFs dominate exports

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.
Background: Multiproduct Firms in Trade

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  - 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.
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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 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.
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- We show that our extended model is consistent with Mexican data:
  - Data from Iacovone and Javorcik (2010):
    - Detailed plant-product-year data for both home and export sales
    - ... at the same level of disaggregation
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    - ... at the same level of disaggregation
- 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

1. Introduction

2. The Core Competence Model
   - Preferences
   - Technology
   - Optimal Scale and Scope

3. Sales Profiles in Home and Foreign Markets

4. Empirics

5. Summary and Conclusion
Preferences

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

- \( \tilde{\Omega} \): The set of differentiated products
- \( q(i) \): Consumption of variety \( i \), \( Q \equiv \int_{i \in \tilde{\Omega}} q(i) \, di \)
- \( e \): Substitution index between goods (\( 0 \leq e \leq 1 \))
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- Alternative rationales:
  - \( u \) 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 \([x(i) = Lq(i)]\):
  \[ p(i) = a - \tilde{b} \left[ (1 - e)x(i) + eX \right], \quad i \in \Omega \subset \tilde{\Omega} \]

  \( \tilde{b} \): \( b/L \)
  \( X \): \( \int_{i \in \Omega} x(i) di \)
“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: \( c'(i) > 0 \)
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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
- Consistent with either:
  - Monopolistic competition as in Mayer, Melitz, and Ottaviano (2014), Arkolakis, Ganapati, and Muendler (2014)
  - Oligopoly as in Eckel and Neary (2010)
Flexible Manufacturing

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

First-order conditions for scale \( x(i) \) and scope \( \delta \):

\[ \Omega = [0, \delta] \]

“Core Competence”
Firm wants to maximise operating profits:

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

⇒ First-order conditions for scale $x(i)$ and scope $\delta$: $\Omega = [0, \delta]$
First-Order Condition for Scale

\[ p(i) = a - \tilde{b}eX \]

\[ a - 2\tilde{b}eX \]

\[ p(i) = a - \tilde{b}[(1-e)x(i) + eX] \]

"Cannibalization Effect"
First-Order Condition for Scale

\[ p(i) = a - \tilde{b} eX \]

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\[ p(i) = a - \tilde{b}[(1-e)x(i) + eX] \]

\[ \text{Cannibalization Effect} \]

Cannibalisation effect shifts the MR curve downwards

Produce where \( MC = MR \)
First-Order Condition for Scope

\[ c(i) = a - 2\tilde{b}eX \]

Product Range

"Core Competence"

\[ 2\tilde{b}(1-e)X \]
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

\[ x(0) \]

\[ x(i) \]

\[ c(0) + t \]

\[ c(i) + t \]

"Core Competence"
Output Profile

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

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

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

“Core Competence”

\[ p(i) = (i + t)(p(0)) \]

Prices and sales inversely related. Converse more plausible, especially in more differentiated-good industries: Eckel, Iacovone, Javorcik, and Neary (2015).
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Outline

1. Introduction

2. The Core Competence Model

3. Sales Profiles in Home and Foreign Markets
   - Sales Profiles
   - The Market-Size Puzzle
   - Resolving the Puzzle: Export Market Penetration Costs
   - Recap: Predictions of the Model

4. Empirics

5. Summary and Conclusion
Sales Profiles at Home and Away

(a) Trade-Cost Effect

- Segmented home and foreign markets: ( ) and (*)
- Sales: \( r(i) = p(i)x(i), \quad r^*(i) = p^*(i)x^*(i) \)

(b) Market-Size Effect

(c) Combined Effect
Sales Profiles at Home and Away

(a) Trade-Cost Effect

- Segmented home and foreign markets: ( ) and (*)
- Sales: \( r(i) = p(i)x(i) \), \( r^*(i) = p^*(i)x^*(i) \)
- Predictions of model:
  - All firms export fewer products: \( \delta^* \leq \delta \)
  - Export ratio of core product ambiguous in general: \( \frac{r^*(0)}{r(0)} \geq 1 \)
  - BUT: Simple calibrations suggest it should be \( > 1 \) for most firms

(b) Market-Size Effect

(c) Combined Effect
Most Mexican firms should have higher exports of their core product:

\[
\begin{align*}
    \text{Large differences in market size: } L^* &>> L \\
    \text{Relatively low trade costs: 95% of exports to NAFTA}
\end{align*}
\]
The Market-Size Puzzle

- Most Mexican firms should have higher exports of their core product:
  - Large differences in market size: $L^* \gg L$
  - Relatively low trade costs: 95% of exports to NAFTA
- To resolve the puzzle, we introduce *market penetration costs*:
  - Reaching a proportion $n$ of foreign consumers incurs costs $f(n)$:
    - Assume: $f(0) = 0$, $f' > 0$, $f'' > 0$, and $\lim_{n \to 1} f(n) = \infty$
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  - $q^*(i)$: Sales *per consumer* abroad; exports: $x^*(i) = nL^* q^*(i)$
  - Sales profile $\{q^*(i)\}$ and scope $\delta^*$ chosen optimally:

$$\pi^*(c_0) = \max_{\{q^*(i)\}, \delta^*} \left[ \int_0^{\delta^*} \{p^*(i) - c(i) - t\} q^*(i) di \right]$$
The Market-Size Puzzle

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$$

$$
\Pi^*(c_0) = \max_n \left[ nL^* \bar{\pi}^*(c_0) - f(n) \right]
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$$\Pi^*(c_0) = \max_n \left[ nL^* \bar{\pi}^*(c_0) - f(n) \right]$$

Results:
- $n < 1$ for all firms;
- $n$ higher for more productive firms: $\frac{dn}{dc} < 0$
Resolving the Market-Size Puzzle

Sales:

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

  (1) Higher gross prices abroad
  (2) Lower sales per consumer abroad
  (3) Larger market size
  (4) Lower foreign market penetration:
  \[ 0 \leq n \leq 1 < 1 \uparrow \uparrow \]

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Resolving the Market-Size Puzzle

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Ratio of export to home sales:

\[ \frac{r^*(i)}{r(i)} = \frac{a + c(i) + t}{a + c(i)} \frac{c(\delta^*) - c(i)}{c(\delta) - c(i)} \frac{L^*}{L} n \]

| Effect | \( c_0 \downarrow \) |
|--------|------------------|
| (1) Higher gross prices abroad | \( > 1 \) ↑ |
| (2) Lower sales per consumer abroad | \( < 1 \) ↑ |
| (3) Larger market size | \( >> 1 \) n/a |
| (4) Lower foreign market penetration: \( 0 \leq n \leq 1 \) | \( < 1 \) ↑↑ |
Recap: Predictions of the Model

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 relative to the home market for more productive firms
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Data:

- As in Eckel et al. (2015)
- 58,106 Mexican plants, 1994-2004, 175,195 products, of which 39,272 exported
Outline

1 Introduction

2 The Core Competence Model

3 Sales Profiles in Home and Foreign Markets

4 Empirics
   - Is the profile of sales revenue uniform?
   - Is the ranking of varieties the same in both markets?
   - Do firms sell more products in their home market?
   - Are all exported products also sold at home?
   - Are export sales higher than home sales?

5 Summary and Conclusion
Prediction 1: Sales Profiles are not Uniform

| Ratio of i'th to top | mean   |
|----------------------|--------|
| Ratio of 2nd to top  | 0.408  |
| Ratio of 3rd 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

### Sold products (value of sales)

| Ratio of 2nd to top | mean  | 10th pctile | 25th pctile | 50th pctile | 75th pctile | 90th pctile | No. of plants |
|--------------------|-------|-------------|-------------|-------------|-------------|-------------|---------------|
|                    | 0.408 | 0.041       | 0.140       | 0.365       | 0.649       | 0.857       | 36,059        |
| Ratio of 3rd to top| 0.234 | 0.015       | 0.053       | 0.166       | 0.360       | 0.569       | 24,119        |
| Ratio of 4th to top| 0.162 | 0.008       | 0.030       | 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 | mean  | 10th pctile | 25th pctile | 50th pctile | 75th pctile | 90th pctile | No. of plants |
|--------------------|-------|-------------|-------------|-------------|-------------|-------------|---------------|
|                    | 0.475 | 0.108       | 0.230       | 0.460       | 0.708       | 0.889       | 3,157         |
| Ratio of 3rd 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       | 0.170       | 0.301       | 3,157         |
| Ratio of 5th to top| 0.052 | 0.001       | 0.004       | 0.019       | 0.066       | 0.135       | 3,157         |

*Only plants with 3 products*

| Ratio of 2nd to top | mean  | 10th pctile | 25th pctile | 50th pctile | 75th pctile | 90th pctile | No. of plants |
|--------------------|-------|-------------|-------------|-------------|-------------|-------------|---------------|
|                    | 0.392 | 0.051       | 0.142       | 0.336       | 0.616       | 0.833       | 7,697         |
| Ratio of 3rd to top| 0.132 | 0.004       | 0.016       | 0.057       | 0.182       | 0.376       | 7,697         |

Note: products which tied in terms of their rank were excluded from the bottom two panels of the table.
### 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*** | 0.663*** |
|                                                             | (0.004)  | (0.006)  |
| Intercept                                                  | 0.746*** | 1.195*** |
|                                                             | (.015)    | (0.017)  |
| Plant fixed effects                                        | no        | yes      |
| No. of obs.                                                | 29,486    | 29,486   |
| R-squared                                                  | 0.54      | 0.60     |

Note: *** denotes significance at the one percent level
## Product Ranking at Home and Away in Detail

Is the ranking of varieties the same in both markets?

| 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  |

| Rank in domestic sales |       |         |         |         |         |         |
| Percentage of products with a given rank in export 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 (2.2%) sell more abroad; 61.9% sell fewer
4: Almost 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**

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

### Empirics

Are export sales higher than home sales?

|          | 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       |
Sales of Core Product Abroad Relative to Home

|                      | r*(0)/r(0) | ln(Plant global sales) | ln(Plant global sales) squared | 6-digit-industry year FE | Plant FE | Year FE | Adj R-squared | No. of obs. |
|----------------------|------------|------------------------|-------------------------------|-------------------------|----------|---------|--------------|-------------|
|                      |            | -0.011 (0.008)         | 0.039*** (0.011)             | no                      | no       | yes     | 0.000         | 9,770       |
| ln(Plant global sales) |            | 0.128*** (0.025)      |                               | no                      | no       | yes     | 0.134         | 9,770       |
|                      |            | -0.429*** (0.081)     |                               | no                      | no       | yes     | 0.587         | 9,770       |
| ln(Plant global sales) squared |        | -0.243** (0.097)      | 0.018*** (0.003)              | yes                     | no       | yes     | 0.003         | 9,770       |
|                      |            | 0.350** (0.142)       | -0.010 (0.006)                | yes                     | no       | yes     | 0.134         | 9,770       |

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

- **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 explain the market-size puzzle

- **Empirics:**
  - We show that our model is consistent with Mexican data
    - Highly disaggregated data on both home and foreign sales

- **Empirical findings:**
  - Profile of sales is highly non-uniform
  - Ranking of products is the same in home and export sales
  - Product 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
Thank you for listening. Comments welcome!

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Market Penetration Costs: Details

- Market Penetration Costs:
  \[ \Pi^*(c_0) = \max_n \left[ nL^* \pi^*(c_0) - f(n) \right], \quad \pi^*(c_0) = \max_{\{q^*(i)\}, \delta^*} \left[ \int_0^{\delta^*} \{p^*(i) - c(i) - t\} q^*(i) di \right] \]

- Arkolakis: CES preferences; \( f(n) = \frac{1-(1-n)^{1-\beta}}{1-\beta}, \quad \beta \in (0, \infty), \quad \beta \neq 1 \)

- Mrázová and Neary (2011): Comparative statics hold more generally

- First-order condition: \( L^* \pi^*(c_0) = f'(n) \)

- More productive firms spend more on market penetration:
  \[ \frac{dn}{dc_0} = L^* \frac{d\pi^*}{dc_0} = f''(n) < 0 \]

- Envelope theorem:
  \[ \frac{d\pi^*}{dc_0} = \frac{\partial \pi^*}{\partial c_0} = -\int_0^{\delta^*} q^*(i) di = -\frac{X^*}{nL^*} < 0 \]
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*
  - Similar to 6-digit Harmonized System
- Detailed plant-product-year data for home and export sales
- ... consistently concorded at the same level of disaggregation
## Number of Plants and Products

| Year | Total Owned by | Other Exporters | Number of products |
|------|----------------|-----------------|-------------------|
|      | MPFs<sup>1</sup> | Total/Adjusted  | Produced/Exported |
| 1994 | 6,291          | 1,259/5,032     | 19,154/2,844      |
| 1995 | 6,011          | 1,245/4,766     | 18,568/3,406      |
| 1996 | 5,747          | 1,256/4,491     | 17,662/3,881      |
| 1997 | 5,538          | 1,256/4,282     | 16,938/4,092      |
| 1998 | 5,380          | 1,268/4,112     | 16,419/4,193      |
| 1999 | 5,230          | 1,279/3,951     | 15,885/3,889      |
| 2000 | 5,100          | 1,280/3,820     | 15,279/3,737      |
| 2001 | 4,927          | 1,258/3,669     | 14,714/3,509      |
| 2002 | 4,765          | 1,237/3,528     | 14,182/3,321      |
| 2003 | 4,603          | 1,193/3,410     | 13,507/3,282      |
| 2004 | 4,424          | 1,159/3,265     | 12,887/3,118      |
| Total | 58,016          | 13,690/44,326   | 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.
Examples of Product Classification into Classes

- 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
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]
Differentiated vs. Non-Differentiated Classes

**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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