Risk, Returns, and Multinational Production

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**What this Paper is About**

- Many features distinguish firms that sell only domestically from exporters and multinational firms:
  - Exporters and MN firms are larger, more productive, employ more workers, sell more products.
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- Does the international status of the firm matters for its shareholders?
  
  YES, on average, MN firms exhibit higher earnings yields ($E/P$) than exporters, and exporters exhibit higher earnings yields than firms selling only domestically.
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  - YES, on average, MN firms exhibit higher earnings yields ($E/P$) than exporters, and exporters exhibit higher earnings yields than firms selling only domestically.

- This paper presents a model that:
  1. explains differences in earnings yields depending on international status;
  2. is consistent with other facts about firm dynamics;
  3. can predict the responses of different firms to common shocks.
A firm must decide whether and how to sell in a **foreign market** where **aggregate demand is risky**:

- Exports entail high variable costs, but a small sunk cost of starting operations;
- FDI entail low variable costs, but a large sunk cost of starting operations.
Main Idea

• A firm must decide whether and how to sell in a foreign market where aggregate demand is risky:
  ○ Exports entail high variable costs, but a small sunk cost of starting operations;
  ○ FDI entail low variable costs, but a large sunk cost of starting operations.

• In a dynamic setting, the large sunk cost of FDI implies a larger hysteresis effect:
  ○ Following a negative shock, MN firms are more reluctant to exit, hence their profit flows are more exposed to risk.
Related Literature


- **On trade and FDI with uncertain demand:**
  
  Rob and Vettas (2003)

- **On trade dynamics and sunk costs:**
  

- **On risk and multinational production:**
  
  Ramondo and Rappoport (2008)

- **On cross-sectional differences in earnings yields and returns:**
  
  Fama and French (1996), Santos and Veronesi (2005)
Motivating Evidence (I)

Figure 1: Earnings-to-price ratios, portfolios of firms in each group.
## Motivating Evidence (II)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
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<tbody>
<tr>
<td>MN dummy</td>
<td>.068</td>
<td>.069</td>
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<tr>
<td></td>
<td>(.004)****</td>
<td>(.004)****</td>
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<tr>
<td>EXP dummy</td>
<td>.039</td>
<td>.039</td>
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<tr>
<td></td>
<td>(.004)****</td>
<td>(.004)****</td>
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<tr>
<td>$\beta^{MKT}$</td>
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<td>-.051</td>
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<tr>
<td></td>
<td></td>
<td>(.005)****</td>
</tr>
<tr>
<td>K/L</td>
<td>2.599</td>
<td>3.395</td>
</tr>
<tr>
<td></td>
<td>(8.312)</td>
<td>(9.308)</td>
</tr>
<tr>
<td>sales per emp.</td>
<td>32.029</td>
<td>32.840</td>
</tr>
<tr>
<td></td>
<td>(18.81)**</td>
<td>(19.54)**</td>
</tr>
<tr>
<td>total revenue</td>
<td>.0006</td>
<td>.0005</td>
</tr>
<tr>
<td></td>
<td>(.0003)**</td>
<td>(.0003)*</td>
</tr>
<tr>
<td>market cap.</td>
<td>.001</td>
<td>.001</td>
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<tr>
<td></td>
<td>(.0002)****</td>
<td>(.0002)****</td>
</tr>
<tr>
<td>No. of obs.</td>
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<td>52079</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.076</td>
<td>.082</td>
</tr>
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</table>

Table 1: Firm-level regressions of earnings-to-price ratios on multinational and exporter dummies, with year and industry fixed effects.
Motivating Evidence (III)

Table 2: Firm-level regressions of returns on multinational and exporter dummies, with year and industry fixed effects, firms switching status excluded.
Setup of the Model

- Two countries, Domestic and Foreign, with preferences:

\[ U = \int_0^\infty e^{-\rho t} \left[ H(s)^{1-\zeta} \left( \int q_i(s)^{1-1/\eta} di \right)^{\zeta \eta/(\eta-1)} \right] ds \]

where \( \rho > 0, \eta > 1, \zeta \in [0, 1] \).

- Firms from \( D \) produce differentiated goods with linear technologies, and they are heterogeneous in productivity \( 1/a \), with \( a \sim G(a) \).

- Aggregate demand in the differentiated sector in \( D - Q_D \) is deterministic, but aggregate demand in \( F - Q \) is stochastic:

\[ \frac{dQ}{Q} = \mu dt + \sigma dz \]

where \( \mu \in (0, \rho), \sigma > 0, E(dz) = 0 \) and \( E(dz^2) = dt \).
Firms from $D$ decide whether to sell also in $F$, and whether to do so through export or FDI:

- Exports entail a one-time sunk cost $F_X$, fixed operating costs $f_X$, iceberg trade cost $\tau$;
- FDI entail a one-time sunk cost $F_I > F_X$, fixed operating costs $f_I$, and no iceberg costs (à la HMY):

$$(f_I + \rho F_I) > \tau^{\eta-1}(f_X + \rho F_X).$$

Per-period profits:

$$\pi_D(a; Q_D) = B(aw)^{1-\eta} P_D^n Q_D,$$
$$\pi_X(a; Q) = B(\tau aw)^{1-\eta} P^n Q - f_X,$$
$$\pi_I(a; Q) = B(aw^*)^{1-\eta} P^n Q - f_I.$$

where $B \equiv \frac{1}{\eta-1} \left(\frac{\eta}{\eta-1}\right)^{-\eta}$. 
Bellman Equations

Let $V_S(a, Q)$ be the value of a firm with productivity $1/a$ in status $S$, net of domestic profits, when foreign aggregate demand is $Q$.

\[
V_D(a, Q) = \max \left\{ \frac{1}{1 + \rho \Delta t} E[V_D(a, Q')|Q] ; \ V_X(a, Q) - F_X ; \ V_I(a, Q) - F_I \right\}
\]

\[
V_X(a, Q) = \max \left\{ \pi_X(a, Q) \Delta t + \frac{1}{1 + \rho \Delta t} E[V_X(a, Q')|Q] ; \ V_D(a, Q) ; \ldots \ V_I(a, Q) - F_I \right\}
\]

\[
V_I(a, Q) = \max \left\{ \pi_I(a, Q) \Delta t + \frac{1}{1 + \rho \Delta t} E[V_I(a, Q')|Q] ; \ V_D(a, Q) ; \ldots \ V_X(a, Q) - F_X \right\}.
\]
Value Functions

By applying Ito’s Lemma, one can solve for the value functions in their continuation regions:

\[ V_D(a, Q) = A_D(a)Q^\alpha + B_D(a)Q^\beta \]

\[ V_X(a, Q) = A_X(a)Q^\alpha + B_X(a)Q^\beta + \frac{B(\tau a\omega)^{1-\eta}P^\eta Q}{\rho - \mu} - \frac{f_X}{\rho} \]

\[ V_I(a, Q) = A_I(a)Q^\alpha + B_I(a)Q^\beta + \frac{B(aw^*)^{1-\eta}P^\eta Q}{\rho - \mu} - \frac{f_I}{\rho} \]

where \( \alpha < 0, \beta > 1 \).
Value Functions

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where \( \alpha < 0, \beta > 1 \).

Using value matching and smooth pasting conditions, solve for the undetermined parameters \( A_S, B_S \) and the quantity thresholds \( Q_{RS} \) \((R, S = D, X, I)\) that make firms switch from a status to another.
**Properties of the Solution: Hysteresis**

For a given productivity level $1/a$, the quantity thresholds $Q_{RS}$ $(R, S = D, X, I)$ respect the following ordering:

$$Q_{IX} < Q_{ID} < Q_{XD} < Q_{DX} < Q_{DI} < Q_{XI}$$

which implies:

- **A larger positive shock is needed to induce a firm to do FDI** with respect to the quantity necessary to induce the firm to export;

- **A larger negative shock is needed to induce a multinational to exit** the foreign market with respect to the shock needed to induce an exporter to exit.
Hysteresis and Productivity

Introduction

Data

Model
- Setup
- Bellman Equations
- Value Functions
- Hysteresis
- E/P Ratios

Calibration

Next

Figure 2: Quantity thresholds as functions of firm’s productivity.
Hysteresis and Productivity (II)

- Quantity thresholds are decreasing in productivity:
  - More productive firms need smaller positive shocks to enter the foreign market;
  - More productive firms need larger negative shocks to exit the foreign market.

- For the same choice of status, more productive firms exhibit less hysteresis.

- But more productive firms self-select into the status (I) that is associated with more hysteresis.

↓

Imperfect sorting of productivities into status, which generates variation in $E/P$ ratios across groups.
Hysteresis in the Data

The ordering of the thresholds finds support in the data:

<table>
<thead>
<tr>
<th></th>
<th>D</th>
<th>X</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>1.48</td>
<td>&gt;</td>
<td>1.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>⌈</td>
</tr>
<tr>
<td>X</td>
<td>1.07</td>
<td></td>
<td>1.59</td>
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<tr>
<td></td>
<td>⌈</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>0.71</td>
<td>&gt;</td>
<td>0.47</td>
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</table>

Table 3: Average percentages of firms switching status each year (Source: Compustat).
Earnings-to-Price Ratios

For a given cost level \( a \), earnings-to-price ratios in the model are given by:

\[
\left( \frac{\pi}{V} \right)_D = \frac{\pi_D}{\pi_D/(\rho - \mu) + B_D Q^\beta}
\]

\[
\left( \frac{\pi}{V} \right)_X = \frac{\pi_D + \pi_X(Q)}{(\pi_D + \pi_X(Q))/(\rho - \mu) + A_X Q^\alpha + B_X Q^\beta}
\]

\[
\left( \frac{\pi}{V} \right)_I = \frac{\pi_D + \pi_I(Q)}{(\pi_D + \pi_I(Q))/(\rho - \mu) + A_I Q^\alpha}
\]

We need to find a parameterization able to generate the observed ranking in average earnings-to-price ratios:

\[
\int_{\Omega_D} \left( \frac{\pi}{V} \right)_D dG(a) < \int_{\Omega_X} \left( \frac{\pi}{V} \right)_X dG(a) < \int_{\Omega_I} \left( \frac{\pi}{V} \right)_I dG(a)
\]

where \( \Omega_S \) is the set of firms currently in status \( S \) (\( S = D, X, I \)).
## Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Value</th>
<th>Source</th>
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</thead>
<tbody>
<tr>
<td><strong>Brownian motion</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\mu$</td>
<td>drift</td>
<td>0</td>
<td>no productivity growth</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>variance</td>
<td>0.1</td>
<td>to match data</td>
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<td><strong>Pareto distribution</strong></td>
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<td></td>
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</tr>
<tr>
<td>$b$</td>
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<tr>
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<td>Luttmer (2007)</td>
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<td><strong>Preferences</strong></td>
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<tr>
<td>$\rho$</td>
<td>discount rate</td>
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<td>risk-free rate</td>
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<tr>
<td>$\eta$</td>
<td>el. of substitution</td>
<td>2.54</td>
<td>Broda and Weinstein (2006)</td>
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<td><strong>Trade and FDI costs</strong></td>
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<td>$w, w^*$</td>
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<td>$F_I$</td>
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<td><strong>Aggregate demand</strong></td>
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<tr>
<td>$Q_D$</td>
<td>domestic demand</td>
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</tr>
<tr>
<td>$Q(0)$</td>
<td>initial foreign demand</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
Moments  (from Compustat)

- Average export and FDI persistence:
  1. % of domestic firms that remain domestic: 89.98
  2. % of domestic firms that start exporting: 5.04
  3. % of exporters that remain exporters: 84.31
  4. % of exporters that become MN firms: 7.83
  5. % of MN firms that remain MN firms: 97.25
  6. % of MN firms that become exporters: 1.06

- Average % of firms in each status:
  7. % of exporters: 20.66
  8. % of multinationals: 44.61

- Average size (employment) differential:
  9. Between exporters and domestic firms: 1
  10. Between MN firms and exporters: 6
Preliminary Results

Data Model

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Model</th>
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<tr>
<td>( D \rightarrow D ) (%)</td>
<td>89.98</td>
<td>96.25</td>
</tr>
<tr>
<td>( D \rightarrow X ) (%)</td>
<td>5.04</td>
<td>2.98</td>
</tr>
<tr>
<td>( X \rightarrow X ) (%)</td>
<td>84.31</td>
<td>84.8</td>
</tr>
<tr>
<td>( X \rightarrow I ) (%)</td>
<td>7.83</td>
<td>3.4</td>
</tr>
<tr>
<td>( I \rightarrow I ) (%)</td>
<td>97.25</td>
<td>99.1</td>
</tr>
<tr>
<td>( I \rightarrow X ) (%)</td>
<td>1.06</td>
<td>0</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>( X ) (%)</td>
<td>20.66</td>
<td>16.06</td>
</tr>
<tr>
<td>( I ) (%)</td>
<td>44.61</td>
<td>36.52</td>
</tr>
<tr>
<td>empl. ( X/D )</td>
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<td>3.33</td>
</tr>
<tr>
<td>empl. ( I/X )</td>
<td>6</td>
<td>6.99</td>
</tr>
</tbody>
</table>

Table 4: Moments’ comparison, model versus data.

Predicted earning yields (%):

\[
\begin{align*}
\left( I \right) & > 1.33 \\
\left( X \right) & > 0.48 \\
\left( D \right) &
\end{align*}
\]
Coming Next

- More precise estimation of the parameters of the model.

- Robustness of the results to a symmetric world with shocks in both countries.

- Risk aversion and returns: adjusting for the risk associated to international exposure.

- Other testable predictions - compare exporters and multinational firms’ dynamics:
  - switchers’ behavior: what happens to E/P ratios and returns when a firm switches status?
  - hysteresis and exit: the model predicts that – following a negative shock – firms serving a foreign market through export should exit before/faster than MN firms.
Construction of the Portfolios

- For each firm $i$, determine its status $S$ ($S = D, X, I$) at the end of period $t - 1$;

- For each firm $i$, collect data on earnings ($e^i_t$) and market capitalization ($p^i_t$);

- Compute earnings yields for firm $i$ in period $t$: $e^i_t / p^i_t$;

- Aggregate earnings yields across firms weighting them by market share:

$$
\left( \frac{E}{P} \right)_t^S = \sum_{i \in S} \omega^i_t e^i_t / p^i_t
$$

where: $\omega^i_t = \frac{p^i_t}{\sum_{i \in S} p^i_t}$, and $S = D, X, I$. 

For each firm $i$, determine its status $S$ ($S = D, X, I$) at the end of period $t - 1$;
How to Solve for the Value Functions

In the continuation region, the BE of a domestic firm reduces to:

$$\rho V_D(a, Q) = \frac{E(dV_D(a, Q))}{dt}$$

By applying Ito's lemma to the RHS:

$$\rho V_D(a, Q) = V'_D(a, Q)\mu Q + \frac{1}{2}V''_D(a, Q)\sigma^2 Q^2.$$ 

The general solution takes the form $V_D(Q) = Q^\xi$, where:

$$\xi = \frac{(1 - 2\mu/\sigma^2) \pm \sqrt{(1 - 2\mu/\sigma^2)^2 + 8\rho/\sigma^2}}{2}$$

Hence the value function of a domestic firm can be written as:

$$V_D(a, Q) = A_D(a)Q^\alpha + B_D(a)Q^\beta$$

where $\alpha$ and $\beta$ are the negative and positive values of $\xi$, respectively, and $A_D(a)$ and $B_D(a)$ are parameters to be determined.
In the continuation region, the BEs of an exporters and a multinationals can be written as:

\[
\rho V_X(a, Q) = B(\tau aw)^{1-\eta} P^n Q - f_X + V'_X(a, Q)\mu Q + \frac{1}{2} V''_X(a, Q)\sigma^2 Q^2
\]

\[
\rho V_I(a, Q) = B(aw^*)^{1-\eta} P^n Q - f_I + V'_I(a, Q)\mu Q + \frac{1}{2} V''_I(a, Q)\sigma^2 Q^2.
\]

For \( S = X, I \), the value function takes the affine form:

\[
V_S(Q) = Q^\xi + c_{s0} + c_{s1} Q.
\]

By substituting it in the expressions above:

\[
V_X(a, Q) = A_X(a)Q^\alpha + B_X(a)Q^\beta + \frac{B(\tau aw)^{1-\eta} P^n Q}{\rho - \mu} - \frac{f_X}{\rho}
\]

\[
V_I(a, Q) = A_I(a)Q^\alpha + B_I(a)Q^\beta + \frac{B(aw^*)^{1-\eta} P^n Q}{\rho - \mu} - \frac{f_I}{\rho}
\]

where \( A_X(a), B_X(a), A_I(a) \) and \( B_I(a) \) are to be determined.
Value-Matching and Smooth Pasting

Solve for the six quantity thresholds $Q_{SR}$, and for the six parameters $A_S, B_S$.

**Value-Matching conditions:**

\[
\begin{align*}
V_D(a, Q_{DX}) &= V_X(a, Q_{DX}) - F_X \\
V_D(a, Q_{DI}) &= V_I(a, Q_{DI}) - F_I \\
V_X(a, Q_{XD}) &= V_D(a, Q_{XD}) \\
V_X(a, Q_{XI}) &= V_I(a, Q_{XI}) - F_I \\
V_I(a, Q_{ID}) &= V_D(a, Q_{ID}) \\
V_I(a, Q_{IX}) &= V_X(a, Q_{IX}) - F_X.
\end{align*}
\]

**Smooth-Pasting conditions:**

\[
\begin{align*}
V'_D(a, Q_{DX}) &= V'_X(a, Q_{DX}) \\
V'_D(a, Q_{DI}) &= V'_I(a, Q_{DI}) \\
V'_X(a, Q_{XD}) &= V'_D(a, Q_{XD}) \\
V'_X(a, Q_{XI}) &= V'_I(a, Q_{XI}) \\
V'_I(a, Q_{ID}) &= V'_D(a, Q_{ID}) \\
V'_I(a, Q_{IX}) &= V'_X(a, Q_{IX}).
\end{align*}
\]
Value and Productivity

Figure 3: Value function of a domestic firm.
Value and Productivity (II)

Figure 4: Value functions of an exporter and of a multinational firm.
Figure 5: Difference between the value functions of exporters and multinationals and the value function of domestic firms.
Figure 6: Difference between the value functions of an exporter and of a multinational firm.
Sets of Firms in Each Status

The sets of firms belonging to each status are defined by:

\[
\Omega_{Dt+1} = \left\{ \Omega_{Dt} \cap [a_{DX}, \infty) \right\} \cup \left\{ \Omega_{Xt} \cap [a_{XD}, \infty) \right\} \cup \left\{ \Omega_{It} \cap [a_{ID}, a_{IX}] \right\}
\]

\[
\Omega_{Xt+1} = \left\{ \Omega_{Dt} \cap [a_{DI}, a_{DX}] \right\} \cup \left\{ \Omega_{Xt} \cap [a_{XI}, a_{XD}] \right\} \cup \left\{ \Omega_{It} \cap [a_{IX}, \infty) \right\}
\]

\[
\Omega_{It+1} = \left\{ \Omega_{Dt} \cap (0, a_{DI}] \right\} \cup \left\{ \Omega_{Xt} \cap (0, a_{XI}] \right\} \cup \left\{ \Omega_{It} \cap (0, a_{ID}] \right\}.
\]