Demand learning and firm dynamics : evidence from exporters

N. Berman[1] V. Rebeyrol[2] V. Vicard[3]

[1] IHEID (Geneva) & CEPR [2] Toulouse School of Econ. [3] Banque de France

Compnet conference
'Enhancing competitiveness and fostering sustainable growth'
June, 26th 2015

Motivation

Key role of new firms in industry/aggregate dynamics

- Firms start small, few survive their first years...
- ...but the survivors grow fast.
- After a decade, new firms/markets account for more than half of French exports.

What are the determinants of firm dynamics ? - A still open question

- Consistent with several theories : stochastic productivity growth, endogenous R&D investment, demand learning...
- Hard to separate out the role of a specific channel

Motivation

Key role of new firms in industry/aggregate dynamics

- Firms start small, few survive their first years...
- ...but the survivors grow fast.
- After a decade, new firms/markets account for more than half of French exports.

What are the determinants of firm dynamics ? - A still open question

- Consistent with several theories : stochastic productivity growth, endogenous R&D investment, demand learning...
- Hard to separate out the role of a specific channel

→ **This paper : direct evidence that demand learning is an important driver of post-entry firm dynamics**

What we do

Our paper

1. Derives the following core prediction from a standard trade model with Bayesian demand learning (Jovanovic, 1982) :
   - Younger firms update more their belief following a new demand signal

What we do

Our paper

1. Derives the following core prediction from a standard trade model with Bayesian demand learning (Jovanovic, 1982) :
   - Younger firms update more their belief following a new demand signal

2. Proposes an empirical methodology which allows :
   - purging firm quantities and prices from market-specific conditions and supply-side dynamics ;
   - identifying separately the firms' belief and the demand shocks.

What we do

Our paper

1. Derives the following core prediction from a standard trade model with Bayesian demand learning (Jovanovic, 1982) :
   - Younger firms update more their belief following a new demand signal

2. Proposes an empirical methodology which allows :
   - purging firm quantities and prices from market-specific conditions and supply-side dynamics ;
   - identifying separately the firms' belief and the demand shocks.

3. Tests this prediction using detailed data from the French customs

What we do

Our paper

1. Derives the following core prediction from a standard trade model with Bayesian demand learning (Jovanovic, 1982) :
   - Younger firms update more their belief following a new demand signal
2. Proposes an empirical methodology which allows :
   - purging firm quantities and prices from market-specific conditions and supply-side dynamics ;
   - identifying separately the firms' belief and the demand shocks.
3. Tests this prediction using detailed data from the French customs
4. Considers the implications of the model for firm growth and survival

What we find

Main results

1. Strong support for the core prediction of learning model : updating is strong in the first years and declines over time.
2. Weakened learning process in more uncertain environments.
3. Our model generates the decline in growth rates with age, *conditional* on size, observed in the data.
4. (Firm survival is also consistent with our learning model.)

What we find

Main results

1. Strong support for the core prediction of learning model : updating is strong in the first years and declines over time.
2. Weakened learning process in more uncertain environments.
3. Our model generates the decline in growth rates with age, *conditional* on size, observed in the data.
4. (Firm survival is also consistent with our learning model.)

Implications for

- Models of firm and industry dynamics
- The effect of uncertainty shocks on aggregate outcomes
- Policies supporting small firms

Literature

- Empirical literature on the dynamics of
  - Firms : Evans (1987), Dunne *et al.* (1989), Cabral and Mata (2003)...
  - Exporters : Eaton *et al.* (2007), Berthou and Vicard (2014), Bernard *et al.* (2014) .

Literature

- Empirical literature on the dynamics of
  - Firms : Evans (1987), Dunne *et al.* (1989), Cabral and Mata (2003)...
  - Exporters : Eaton *et al.* (2007), Berthou and Vicard (2014), Bernard *et al.* (2014) .
- Models of firm and exporter dynamics featuring
  - Learning : Jovanovic (1982), Albornoz *et al.* (2012), Eaton *et al.* (2014), Fernandes and Tang (2014), Timoshenko (2012)
  - Stochastic productivity growth : Hopenhayn (1992), Luttmer (2007, 2011), Arkolakis (2013).
  - Endogenous productivity variations : Constantini and Melitz (2007), Klette and Kortum (2004), Rossi-Hansberg and Wright (2007).

Literature

- Empirical literature on the dynamics of
  - Firms : Evans (1987), Dunne *et al.* (1989), Cabral and Mata (2003)...
  - Exporters : Eaton *et al.* (2007), Berthou and Vicard (2014), Bernard *et al.* (2014) .
- Models of firm and exporter dynamics featuring
  - Learning : Jovanovic (1982), Albornoz *et al.* (2012), Eaton *et al.* (2014), Fernandes and Tang (2014), Timoshenko (2012)
  - Stochastic productivity growth : Hopenhayn (1992), Luttmer (2007, 2011), Arkolakis (2013).
  - Endogenous productivity variations : Constantini and Melitz (2007), Klette and Kortum (2004), Rossi-Hansberg and Wright (2007).
- Methodology : Foster *et al.* (2008, 2013), Li (2014)
- Active vs. passive learning : Pakes and Ericson (1998).

Exporter dynamics : some stylized facts

Data

Data from the French customs

- → Quasi-exhaustive coverage of French exporters
- → Values and quantities
- → Disaggregated by firm, 6 digit product, destination country and year
- → Around 100,000 firms selling more than 4,000 products to 180 destination countries
- → Period 1994-2005 (focus on 1996-2005)

Decomposition of the dynamics of French exports

TABLE : Shares in end-of-period French aggregate exports

	Average yoy 1996/2005	Overall 1996/2005
New firms	2.4%	26.2%
Initial size	-	*16.5%*
Growth since entry	-	*9.7%*
New product-destination	9.9%	27.3%
Initial size	-	*16.1%*
Growth since entry	-	*11.3%*
Incumbent firm-product-destination	87.7%	46.5%
Total	100%	100%

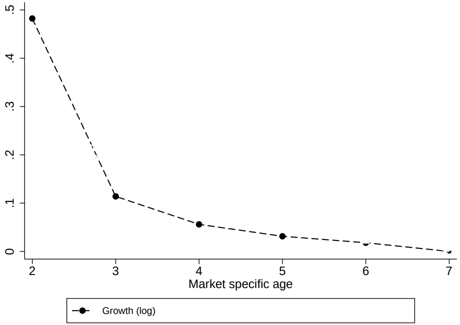
Note : sample of HS6 fixed over time. Source : French Customs.

Supply vs demand side dynamics

Post-entry sales growth is primarily due to firm-market-specific factors (i.e. firm-destination-product) :

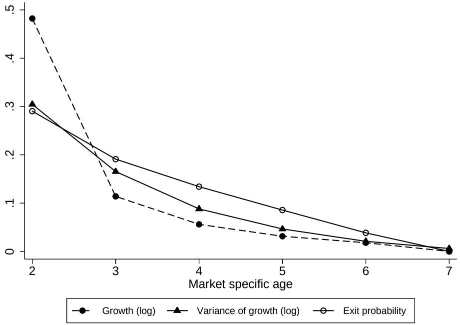
- Regressing firm-market sales growth on market-time FE, $R^2 = 0.12$
- Adding firm-product-time dummies (supply side factors), $R^2 = 0.44$
- The rest is firm-market-time specific...
- ... and largely related to firm learning : $R^2 = 0.87$ when our estimate of firms beliefs is included

Growth declines with age, conditional on size...



Coefficients obtained from of a regression of the log change of firm sales (resp. variance of firms' sales within cohorts of firms on a product-destination market and exit) on age bins, firm size and year and sector dummies (omitted category : age of seven years or more).

...as does the volatility



Coefficients obtained from of a regression of the log change of firm sales (resp. variance of firms' sales within cohorts of firms on a product-destination market and exit) on age bins, firm size and year and sector dummies (omitted category : age of seven years or more).

A simple model of firm age and growth

Demand side

Notations. Index firm by i, destination by j, product by k and time t

Firm-market specific demand. $q_{ijkt} = e^{a_{ijkt}} p_{ijkt}^{-\sigma_k} \frac{\mu_k Y_{jt}}{P_{jkt}^{1-\sigma_k}}$

σ_k is the elasticity of substitution, Y_{jt} is total expenditure, P_{jkt} the ideal price index

a_{ijkt} is a demand parameter with $a_{ijkt} = \overline{a_{ijk}} + \varepsilon_{ijkt}$, and ε_{ijkt} a white noise

Production

Production-side assumptions.

(i) Quantity decision made before demand observed in each market
(ii) Productivity is *ikt*-specific (does not vary across destination)

Per-period profits. $\pi_{ijkt} = q_{ijkt}p_{ijkt} - \frac{w_{it}}{\varphi_{ikt}}q_{ijkt} - F_{ijk}$

with F_{ijk} a per-period fixed cost, φ_{ikt} productivity, w_{it} the wage rate

Learning

Learning. $a_{ijkt} = \overline{a_{ijk}} + \varepsilon_{ijkt}$, firms uncertain about $\overline{a_{ijk}}$

Prior beliefs $\sim N(\theta_0, \sigma_0^2)$ before observing any signal a_{ijkt}, and $\varepsilon_{ijkt} \sim N(0, \sigma_\varepsilon^2)$ (known)

Bayesian learning. Posteriors' beliefs about $\overline{a_{ijk}}$ after t signals :

$$\widetilde{\theta}_t = \theta_0 \frac{\frac{1}{\sigma_0^2}}{\frac{1}{\sigma_0^2} + \frac{t}{\sigma_\epsilon^2}} + \overline{a}_t \frac{\frac{t}{\sigma_\epsilon^2}}{\frac{1}{\sigma_0^2} + \frac{t}{\sigma_\epsilon^2}} \qquad \widetilde{\sigma}_t^2 = \frac{1}{\frac{1}{\sigma_0^2} + \frac{t}{\sigma_\epsilon^2}}$$

with $\overline{a}_t = \left(\frac{1}{t} \sum_t a_{ijkt}\right)$

Learning

Learning. $a_{ijkt} = \overline{a_{ijk}} + \varepsilon_{ijkt}$, firms uncertain about $\overline{a_{ijk}}$

Prior beliefs $\sim N(\theta_0, \sigma_0^2)$ before observing any signal a_{ijkt}, and $\varepsilon_{ijkt} \sim N(0, \sigma_\varepsilon^2)$ (known)

Bayesian learning. Posteriors' beliefs about $\overline{a_{ijk}}$ after t signals :

$$\widetilde{\theta}_t = \theta_0 \frac{\frac{1}{\sigma_0^2}}{\frac{1}{\sigma_0^2} + \frac{t}{\sigma_\epsilon^2}} + \overline{a}_t \frac{\frac{t}{\sigma_\epsilon^2}}{\frac{1}{\sigma_0^2} + \frac{t}{\sigma_\epsilon^2}} \qquad \widetilde{\sigma}_t^2 = \frac{1}{\frac{1}{\sigma_0^2} + \frac{t}{\sigma_\epsilon^2}}$$

with $\overline{a}_t = \left(\frac{1}{t}\sum_t a_{ijkt}\right)$

Recursive formulation $\Delta\widetilde{\theta}_t = g_t \left(a_{ijkt} - \widetilde{\theta}_{t-1}\right)$ with $g_t = \frac{1}{\frac{\sigma_\epsilon^2}{\sigma_0^2} + t}$

$\rightarrow$ Firms revise their expectations when $a_{ijkt} \neq \widetilde{\theta}_{t-1}$, especially when they are "young"

Firm size

Optimal quantities and prices.

$$q^*_{ijkt} = \underbrace{\left(\frac{\sigma_k}{\sigma_k - 1}\frac{w_{it}}{\varphi_{ikt}}\right)^{-\sigma_k}}_{C^q_{ikt}} \underbrace{\left(\frac{\mu_k Y_{jt}}{P^{1-\sigma_k}_{jkt}}\right)}_{C^q_{jkt}} \underbrace{\mathrm{E}_{t-1}\left[e^{\frac{a_{ijkt}}{\sigma_k}}\right]^{\sigma_k}}_{Z^q_{ijkt}}$$

$$p^*_{ijkt} = \underbrace{\left(\frac{\sigma_k}{\sigma_k - 1}\frac{w_{it}}{\varphi_{ikt}}\right)}_{C^p_{ikt}} \underbrace{e^{\frac{a_{ijkt}}{\sigma_k}}\mathrm{E}_{t-1}\left[e^{\frac{a_{ijkt}}{\sigma_k}}\right]^{-1}}_{Z^p_{ijkt}}$$

Firm growth

And we can show that :

$$\Delta \ln \mathrm{E}_t \left[e^{\frac{a_{ijkt+1}}{\sigma_k}} \right] = \frac{1}{\sigma_k} \left(\Delta \widetilde{\theta}_t + \frac{\widetilde{\sigma}_t^2 - \widetilde{\sigma}_{t-1}^2}{2\sigma_k} \right)$$

Prediction # 1 (updating) : *A new signal a_{ijkt} leads to a larger updating of the belief, the younger the firm is.*

Identification strategy

Identification strategy

1/ we purge sales from supply-side and market-specific factors

2/ we separate demand shocks from beliefs

Identification strategy

1/ we purge sales from supply-side and market-specific factors

$$
\begin{aligned}
\ln q_{ijkt} &= \mathbf{FE}_{ikt} + \mathbf{FE}_{jkt} + \varepsilon^{q}_{ijkt} \\
\ln p_{ijkt} &= \mathbf{FE}_{ikt} + \varepsilon^{p}_{ijkt}
\end{aligned}
$$

Which yields :

$$
\begin{aligned}
\varepsilon^{q}_{ijkt} &= \ln Z^{q}_{ijkt} = \sigma_k \ln \mathrm{E}_{t-1}\left[e^{\frac{a_{ijkt}}{\sigma_k}}\right] \\
\varepsilon^{p}_{ijkt} &= \ln Z^{p}_{ijkt} = \frac{1}{\sigma_k} a_{ijkt} - \ln \mathrm{E}_{t-1}\left[e^{\frac{a_{ijkt}}{\sigma_k}}\right]
\end{aligned}
$$

Identification strategy

2/ we separate demand shocks from beliefs

Regress ε^{p}_{ijkt} on ε^{q}_{ijkt} for each product k :

$$\left(\frac{1}{\sigma_k}a_{ijkt} - \ln \mathrm{E}_{t-1}\left[e^{\frac{a_{ijkt}}{\sigma_k}}\right]\right) = \beta\left(\sigma_k \ln \mathrm{E}_{t-1}\left[e^{\frac{a_{ijkt}}{\sigma_k}}\right]\right) + v_{ijkt}$$

Which yields

$$\widehat{\beta} = -\frac{1}{\sigma_k} \quad \text{and} \quad \widehat{v}_{ijkt} = \frac{1}{\sigma_k}a_{ijkt}$$

Baseline results

Descriptive statistics

	Obs.	Mean	S.D.	Q1	Median	Q3
$\ln q_{ijkt}$	6472999	5.28	3.05	3.04	5.06	7.27
$\ln p_{ijkt}$	6472999	3.03	1.87	1.82	3.00	4.19
$\Delta\varepsilon^{q}_{ijkt}$	2726474	0.03	1.37	-0.74	0.02	0.80
$\Delta\varepsilon^{p}_{ijkt}$	2726474	0.00	0.68	-0.24	0.00	0.24
$\widehat{v}_{ijkt}$	2726474	0.00	0.58	-0.25	0.00	0.24
σ_k	2675182	11.15	8.07	5.81	8.10	13.94
Age^{1}_{ijkt}	2726474	3.48	1.78	2	3	4

Source : Authors computations from French Customs data.

Definitions of market-specific firm age : Age_{ijkt} is the nbr of consecutive years of export (i.e. reset after 1 year of exit)

Descriptive statistics

	Obs.	Mean	S.D.	Q1	Median	Q3
$\ln q_{ijkt}$	6472999	5.28	3.05	3.04	5.06	7.27
$\ln p_{ijkt}$	6472999	3.03	1.87	1.82	3.00	4.19
$\Delta\varepsilon^{q}_{ijkt}$	2726474	0.03	1.37	-0.74	0.02	0.80
$\Delta\varepsilon^{p}_{ijkt}$	2726474	0.00	0.68	-0.24	0.00	0.24
$\widehat{v}_{ijkt}$	2726474	0.00	0.58	-0.25	0.00	0.24
σ_k	2675182	11.15	8.07	5.81	8.10	13.94
Age^{1}_{ijkt}	2726474	3.48	1.78	2	3	4

Source : Authors computations from French Customs data.

$\rightarrow$ Estimate of σ_k in the range of existing studies (using very different methodologies and data – Broda and Weinstein, 2006, Romalis, 2007)

$\rightarrow$ σ_k smaller for differentiated goods than for referenced priced and homogeneous goods (medians : 8.6/9.9/13.9)

Prediction 1

Prediction # 1 (updating) : *A new signal a_{ijkt} leads to a larger updating of the belief, the younger the firm is.*

We want to estimate :

$$\Delta\varepsilon^{q}_{ijkt} = \sum_{g=2}^{G} \alpha_g (\widehat{v}_{ijk,t-1} \times \text{AGE}^{g}_{ijkt}) + \sum_{g=1}^{G} \beta_g \text{AGE}^{g}_{ijkt} + u_{ijkt}$$

where AGE^{g}_{ijkt} are *firm-product-destination* specific age dummies, with $g = 2, ...7+$.

We expect the $\alpha_g > 0$ and decreasing with age g.

Prediction 1 : results

TABLE : Prediction 1 : demand shocks and beliefs updating

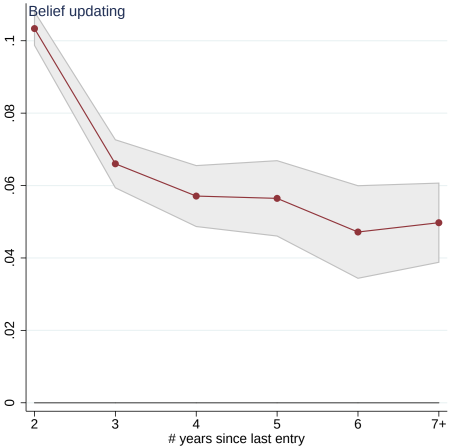
	(1)	(2)	(3)
Dep. var.		$\Delta\varepsilon^{q}_{ijkt}$	
Age definition		# years since last entry (reset after 1 year of exit)	
$\widehat{v}$	0.075[a]	0.109[a]	0.109[a]
	(0.002)	(0.004)	(0.004)
Age		-0.040[a]	-0.040[a]
		(0.000)	(0.000)
$\widehat{v}$×Age		-0.009[a]	-0.009[a]
		(0.001)	(0.001)
Observations	2726474	2726474	2726474

Robust standard errors in parentheses (bootstrapped in columns (3)).

[c] significant at 10% ; [b] significant at 5% ; [a] significant at 1%.

Prediction 1 : results

FIGURE : Firms' belief updating following a demand shock



This figure depicts the estimated coefficients of Table 2, column (4), together with 90% confidence intervals. Grey areas represent 90% confidence intervals.

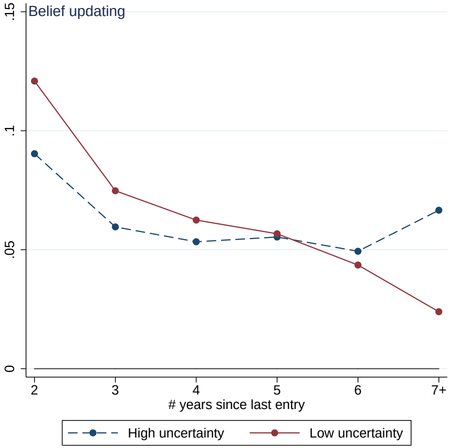
Prediction 1 : extensions

1. **Learning and market uncertainty :**
   - a signal is less informative when market uncertainty is larger.
   - market uncertainty measured by stock-market index volatility, exchange rate volatility or the s.d. of (log) imports by importer and product.

2. **Learning and forgetting :** two ways to study the learning process of exporters
   - use alternative age definitions : Go
   - directly study beliefs updating after re-entries : do firms update less their beliefs when they re-enter ?

Learning and market uncertainty

FIGURE : Uncertainty and belief updating



This figure is obtained from estimating the specification of column (4) of Table 2 on two sub-samples defined according to the sample median of the uncertainty measure. The market-specific uncertainty measure used here. The figure plots the coefficients of the $\widehat{v}_{ijkt}$ variable for each age category.

Learning and forgetting

Do firms update less their beliefs when they re-enter ?

$\rightarrow$ Compare the responsiveness to demand shocks of firms which re-enter after x years to first time entrants.

$$\Delta\varepsilon^{q}_{ijkt} = \theta_1 \widehat{v}_{ijk,t-1} + \sum_{g=2}^{6} \alpha_h (\widehat{v}_{ijk,t-1} \times \mathrm{GAP}^{h}_{ijkt}) + \sum_{g=1}^{G} \beta_h \mathrm{GAP}^{h}_{ijkt} + \mathbf{FE}_{ijk} + u_{ijkt}$$

where GAP^{h}_{ijkt} are dummies for re-entries on a market by number of years since last exit.

Learning and forgetting

Do firms update less their beliefs when they re-enter ?

$\rightarrow$ Compare the responsiveness to demand shocks of firms which re-enter after x years to first time entrants.

$$\Delta\varepsilon^{q}_{ijkt} = \theta_1 \widehat{v}_{ijk,t-1} + \sum_{g=2}^{6} \alpha_h (\widehat{v}_{ijk,t-1} \times \mathrm{GAP}^{h}_{ijkt}) + \sum_{g=1}^{G} \beta_h \mathrm{GAP}^{h}_{ijkt} + \mathbf{FE}_{ijk} + u_{ijkt}$$

where GAP^{h}_{ijkt} are dummies for re-entries on a market by number of years since last exit.

Dep. var. :			$\Delta\varepsilon^{q}_{ijkt}$			
Gap (years of exit)	1	2	3	4	5	6
$\widehat{v}\times$Gap	-0.079[a]	-0.023	0.000	-0.011	0.177	0.452
	(0.022)	(0.036)	(0.053)	(0.093)	(0.153)	(0.280)

Robust standard errors in parentheses. [c] significant at 10% ; [b] significant at 5% ; [a] significant at 1%.

Prediction1 : Robustness

We perform **three main types of robustness exercises :**

1. Modelling hypotheses
   - Constant demand parameter Go
   - Fixed quantities Go
   - CES assumption Go
2. Measurement issues
   - Definition of a product
   - Extra-EU

Firm growth and survival

Firm growth

Growth rates.

Younger firms grow faster in our model because they i) display larger *unconditional* growth rates and ii) have more volatile growth rates together with exit rates that are non increasing with age.

$$\begin{aligned}\Delta \ln Z^{q}_{ijk,t+1} &= \sigma_k \Delta \ln \mathrm{E}_t \left[e^{\frac{a_{ijkt+1}}{\sigma_k}} \right] \\ \Delta \ln Z^{p}_{ijk,t+1} &= \frac{1}{\sigma_k} \Delta a_{ijkt+1} - \Delta \ln \mathrm{E}_t \left[e^{\frac{a_{ijkt+1}}{\sigma_k}} \right]\end{aligned}$$

Firm growth

TABLE : Dynamics of quantity and prices

	(1)	(2)	(3)	(4)
Dep. var.	ε^{q}_{ijkt}		ε^{p}_{ijkt}	
Age definition	# years since last entry (reset after 1 year of exit)			
Age_{ijkt}	0.103[a]		-0.008[a]	
	(0.001)		(0.001)	
$\text{Age}_{ijkt} = 3$		0.264[a]		-0.022[a]
		(0.003)		(0.001)
$\text{Age}_{ijkt} = 4$		0.348[a]		-0.030[a]
		(0.005)		(0.002)
$\text{Age}_{ijkt} = 5$		0.410[a]		-0.032[a]
		(0.006)		(0.002)
$\text{Age}_{ijkt} = 6$		0.460[a]		-0.035[a]
		(0.008)		(0.003)
$\text{Age}_{ijkt} = 7+$		0.546[a]		-0.040[a]
		(0.009)		(0.004)
Observations	6472999	6472999	6472999	6472999

Standard errors clustered by firm in parentheses. [c] significant at 10% ; [b] significant at 5% ; [a] significant at 1%.

Firm growth

Prediction # 2a (growth rate) : *The expected absolute value of growth rates of* Z^{q}_{ijkt} *and* Z^{p}_{ijkt} *decrease with firm age.*

We estimate :

$$\left|\Delta\varepsilon^{X}_{ijkt}\right| = \alpha^{X} + \beta^{X} \times \text{AGE}_{ijkt} + u_{ijkt} \qquad \forall X = \{q, p\}$$

and we expect $\beta^{X} < 0$, and $|\beta^{q}| > |\beta^{p}|$.

Prediction 2a : results

	(1)	(2)	(3)	(4)
Dep. var.	$\Delta\varepsilon^{q}_{ijkt}$		$\Delta\varepsilon^{p}_{ijkt}$	
Age definition	# years since last entry (reset after 1 year of exit)			
Age	-0.040[a]		-0.024[a]	
	(0.000)		(0.000)	
Age		-0.076[a]		-0.053[a]
		(0.001)		(0.001)
Age= 4		-0.119[a]		-0.079[a]
		(0.002)		(0.001)
Age= 5		-0.152[a]		-0.096[a]
		(0.002)		(0.001)
Age= 6		-0.184[a]		-0.109[a]
		(0.002)		(0.001)
Age= 7+		-0.216[a]		-0.129[a]
		(0.002)		(0.001)
Observations	2795979	2795979	2795979	2795979

Robust standard errors in parentheses. [c] significant at 10% ; [b] significant at 5% ; [a] significant at 1%.

Firm growth

Prediction # 2b (variance of growth rate) : *The within cohort variance of growth rates of* Z^q_{ijkt} *and* Z^p_{ijkt} *decrease with cohort age.*

We estimate :

$$\text{Var}\left(\Delta\varepsilon^X_{ijkt}\right) = \delta^X \times \text{AGE}_{cjkt} + \mathbf{FE}_{cjk} + u_{ijkt} \qquad \forall X = \{q, p\}$$

where $\mathbf{FE}_{cjk}$ represent cohort fixed effects ; we expect $\delta^X < 0$

Prediction 2b : results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. var.	$Var(\Delta\varepsilon^{q}_{ijkt})$				$Var(\Delta\varepsilon^{p}_{ijkt})$			
Age definition	# years since last entry (reset after 1 year of exit)				# years since last entry (reset after 1 year of exit)			
Sample	All			Permanent exporters[1]	All			Permanent exporters[1]
Age_{cjkt}	-0.067^{a}		-0.060^{a}	-0.043^{a}	-0.033^{a}		-0.029^{a}	-0.014^{a}
	(0.001)		(0.001)	(0.001)	(0.001)		(0.001)	(0.001)
$Age_{cjkt} = 3$		-0.130^{a}				-0.072^{a}		
		(0.003)				(0.002)		
$Age_{cjkt} = 4$		-0.208^{a}				-0.108^{a}		
		(0.004)				(0.002)		
$Age_{cjkt} = 5$		-0.271^{a}				-0.134^{a}		
		(0.005)				(0.003)		
$Age_{cjkt} = 6$		-0.314^{a}				-0.153^{a}		
		(0.006)				(0.003)		
$Age_{cjkt} = 7+$		-0.375^{a}				-0.184^{a}		
		(0.006)				(0.003)		
# observations			0.007^{a}	0.015^{a}			0.003^{a}	0.003^{c}
			(0.001)	(0.004)			(0.000)	(0.002)
Observations	598821	598821	598821	262849	598821	598821	598821	262849
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered by cohort in parentheses. Cohort FE included in all estimations. ^{c} significant at 10% ; ^{b} significant at 5% ; ^{a}

Firm survival : predictions

We have :

$$\mathrm{E}_{t-1}\left[\pi_{ijkt}\right] = \frac{C^S_{ikt} C^S_{jkt}}{\sigma_k} e^{\left(\widetilde{\theta}_{t-1} + \frac{\widetilde{\sigma}^2_{t-1} + \sigma^2_{\varepsilon}}{2\sigma_k}\right)} - F_{ijk}$$

Note $A_{ijkt} = C^S_{ikt} C^S_{jkt}$

Firm survival : predictions

We have :

$$E_{t-1}\left[\pi_{ijkt}\right] = \frac{C^S_{ikt} C^S_{jkt}}{\sigma_k} e^{\left(\widetilde{\theta}_{t-1} + \frac{\widetilde{\sigma}^2_{t-1} + \sigma^2_{\varepsilon}}{2\sigma_k}\right)} - F_{ijk}$$

Note $A_{ijkt} = C^S_{ikt} C^S_{jkt}$

Assuming that A_{ijkt} follows a Markov process we can show that :

Prediction # 3 (firm exit) : *Given A_{ijkt} and t (firm age) (i) the probability to exit decreases with $\widetilde{\theta}_{t-1}$ (ii) negative demand shocks should trigger less exit for older firms.*

Intuition :

$$\widetilde{\theta}_{t-1} = \left(\frac{\widetilde{\sigma}^2_{t-1}}{\sigma^2_{\epsilon}}\right) a_{ijkt-1} + \left(1 - \frac{\widetilde{\sigma}^2_{t-1}}{\sigma^2_{\epsilon}}\right) \widetilde{\theta}_{t-2}$$

Results

Estimate the following probabilistic model :

$$\begin{aligned}
\Pr(S_{ijkt} > 0 | S_{ijk,t-1} = 1) &= 1 \text{ if } \alpha_1 \text{AGE}_{ijkt-1} + \alpha_2 \widehat{v}_{ijk,t} + \alpha_3 \varepsilon^{q}_{ijkt-1} + \textbf{FE} + u_{ijkt} > 0 \\
&= 0 \text{ otherwise.}
\end{aligned}$$

Results

Estimate the following probabilistic model :

$$\Pr(S_{ijkt} > 0 | S_{ijk,t-1} = 1) = 1 \text{ if } \alpha_1 \text{AGE}_{ijkt-1} + \alpha_2 \widehat{v}_{ijk,t} + \alpha_3 \varepsilon^q_{ijkt-1} + \textbf{FE} + u_{ijkt} > 0$$
$$= 0 \text{ otherwise.}$$

	(1)	(2)	(3)	(4)	(5)
Dep. var.			$\Pr(S_{ijkt} > 0 \| S_{ijk,t-1} = 1)$		
Age definition			# years since last entry (reset after 1 year of exit)		
Belief$_{t-1}$	-0.041^a		-0.041^a		-0.041^a
	(0.000)		(0.000)		(0.000)
Age$_{t-1}$	-0.034^a	-0.045^a	-0.033^a	-0.045^a	-0.033^a
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\widehat{v}_{t-1}$		-0.028^a	-0.031^a	-0.030^a	-0.042^a
		(0.000)	(0.000)	(0.000)	(0.000)
$\widehat{v}_{t-1} \times$Age$_{t-1}$				0.001^a	0.004^a
				(0.000)	(0.000)
Observations	8786242	8786242	8786242	8786242	8786242

Robust standard errors in parentheses. ^{c} significant at 10% ; ^{b} significant at 5% ; ^{a} significant at 1%.

Conclusion

Conclusion

- Strong support for a simple model of passive demand learning in the spirit of Jovanovic (1982)
- The model generate the well documented age dependance of firms' growth (and variance) conditional on size.
- Implications for the modelling of firm dynamics and for firms' responses to shocks
- Current work : quantification
- Future work : entry decisions and informational spillovers

Appendix

Alternative age definitions : results

Back

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.		$\Delta\varepsilon^q_{ijkt}$			$\Delta\varepsilon^q_{ijkt}$	
Age definition		# years since last entry (reset after 2 years exit)			# years exporting since first entry	
$\widehat{v}$	0.075^a	0.106^a	0.106^a	0.075^a	0.101^a	0.101^a
	(0.002)	(0.004)	(0.004)	(0.002)	(0.004)	(0.004)
Age		-0.036^a	-0.036^a		-0.034^a	-0.034^a
		(0.000)	(0.000)		(0.000)	(0.000)
Observations	2726474	2726474	2726474	2726474	2726474	2726474

Robust standard errors in parentheses (bootstrapped in columns (3) and (7)). ^{c} significant at 10% ; ^{b} significant at 5% ; ^{a} significant at 1%.

Robustness : CES assumption

Relaxing the CES assumption generate variables mark-ups which has two implications :

1. Prices depend on market-specific conditions : easy to solve
2. Optimal quantities depend on beliefs about demand and markups : ε^{q}_{ijkt} and ε^{p}_{ijkt} confound demand factors and firms markups.
   - Could bias the results either way...
   - But most likely against us : can be checked by controlling for (market-specific) firm size in estimations

Robustness : CES assumption

Back

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.			$\Delta\varepsilon^{q}_{ijkt}$			
Age definition			# years since last entry (reset after 1 year of exit)			
Robustness	Controlling for FE_{jkt} in prices		Controlling for FE_{jkt} in prices and size			
			$Size_{ijk,t-1}$		$\overline{Size}_{ijk,t/t-1}$	
$\widehat{v}$	0.159^a		0.095^a		0.075^a	
	(0.005)		(0.005)		(0.005)	
Age	-0.041^a		-0.013^a		-0.044^a	
	(0.000)		(0.000)		(0.000)	
$\widehat{v}\times$Age	-0.008^a		-0.009^a		-0.013^a	
	(0.001)		(0.001)		(0.001)	
$\widehat{v}\times$Age$=2$		0.160^a		0.088^a		0.065^a
		(0.003)		(0.004)		(0.004)
$\widehat{v}\times$Age$=3$		0.118^a		0.048^a		0.013^b
		(0.004)		(0.006)		(0.006)
...						
$\widehat{v}\times$Age$=7+$		0.108^a		0.033^a		-0.014^c
		(0.007)		(0.008)		(0.008)
$Size_{t-1}$			-0.082^a	-0.081^a	0.010^a	0.011^a
			(0.000)	(0.000)	(0.000)	(0.000)
$\widehat{v}\times Size_{t-1}$			0.014^a	0.015^a	0.018^a	0.019^a
			(0.001)	(0.001)	(0.001)	(0.001)
Observations	2739927	2739927	2739927	2739927	2739927	2739927

Robust standard errors in parentheses. $Size_{t-1}$ is the log of the total quantity exported by firm i in product k, destination j in year $t-1$, and $\overline{Size}_{ijk,t/t-1}$ is the average quantity exported by firm i in market jk between t and $t-1$.

Robustness : Fixed quantities

We assumed that quantities are fixed ex-ante. Now focus on destinations and sectors with **high adjustment costs** (i.e. for which the assumption is more likely to be satisfied)

1. Complex goods (Nunn, 2007)
2. Large time-to-ship (Berman *et al.*, 2013)

Robustness : High adjustment costs

Back

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. var.		$\Delta\varepsilon^q_{ijkt}$				$\Delta\varepsilon^q_{ijkt}$		
Sample		Complex goods				Large time-to-ship		
$\widehat{v}$	0.091[a]	0.138[a]	0.138[a]		0.162[a]	0.231[a]	0.231[a]	
	(0.004)	(0.008)	(0.008)		(0.004)	(0.008)	(0.008)	
Age		-0.038[a]	-0.038[a]			-0.035[a]	-0.035[a]	
		(0.001)	(0.001)			(0.001)	(0.001)	
$\widehat{v}\times$Age		-0.013[a]	-0.013[a]			-0.022[a]	-0.022[a]	
		(0.002)	(0.002)			(0.002)	(0.002)	
$\widehat{v}\times$Age= 2				0.126[a]				0.198[a]
				(0.006)				(0.005)
$\widehat{v}\times$Age= 3				0.079[a]				0.145[a]
				(0.008)				(0.008)
$\widehat{v}\times$Age= 4				0.066[a]				0.134[a]
				(0.011)				(0.010)
$\widehat{v}\times$Age= 5				0.072[a]				0.096[a]
				(0.013)				(0.013)
$\widehat{v}\times$Age= 6				0.044[a]				0.097[a]
				(0.016)				(0.017)
$\widehat{v}\times$Age= 7+				0.050[a]				0.093[a]
				(0.014)				(0.016)
Observations	582450	582450	582450	582450	546586	546586	546586	546586

Robust standard errors in parentheses (bootstrapped in columns (3) and (7)).

Robustness : Active vs passive learning

Can we ensure that our results can be interpreted as *passive* learning ?

1. Active learning unlikely given fixed effects included
2. Price behavior not in line with consumer accumulation models (Foster *et al.*, 2013)
3. Perform a test proposed by Eriscon and Pakes (1998)
   - Regress current belief on immediate past beliefs and initial beliefs
   - Passive learning : initial beliefs should matter throughout the firm's life

Robustness : Active vs passive learning

Back

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.	Belief_{ijkt}					
Age definition	# years since last entry (reset after 1 year of exit)					
Age	3	4	5	6	7	8
$\text{Belief}_{ijk,t-1}$	0.511^a	0.559^a	0.601^a	0.618^a	0.633^a	0.648^a
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
$\text{Belief}_{ijk,0}$	0.150^a	0.131^a	0.105^a	0.091^a	0.083^a	0.072^a
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Observations	59425	59425	59425	59425	59425	59425

Robust standard errors in parentheses. ^{c} significant at 10% ; ^{b} significant at 5% ; ^{a} significant at 1%.