Firms, Destinations, and Aggregate Fluctuations

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Motivation

- What are the microeconomic underpinnings of aggregate fluctuations?
  - Long-standing question in business cycle research, going back at least to Long and Plosser (1983)
- How large a role do firms play in generating or amplifying aggregate volatility?
  1. Firm entry and exit: Bilbiie et al. (2007), Ghironi and Melitz (2005)
  2. Firm shocks: Gabaix (2011) emphasizes large firms
- To date, the empirical evidence of the impact of firms on aggregate fluctuations is scarce

This Paper

Measures the role of individual firms in generating aggregate fluctuations of French manufacturing sales growth over 1990–2007:

1. Derives a decomposition of aggregate sales growth into its *extensive* and *intensive* components
2. Presents a simple multi-sector model of heterogeneous firms selling to multiple markets to motivate a further decomposition of a *firm's* annual sales growth into several components ("shocks"):
   i. Firm and firm-destination
   ii. Sector and sector-destination
   iii. Country ("macroeconomic")
3. Uses estimates to measure each margin's and component's contribution to *aggregate* fluctuations (measured by variance of aggregate sales growth)

Preview of Results

1. The *extensive margin* contributes approximately 46% of year-to-year variation of total sales growth, while the *intensive margin* has a greater contribution to aggregate fluctuations: 72%
2. The relative variance of the estimated components to that of total sales growth are:
   i. "Idiosyncratic": 0.40
   ii. Sectoral: 0.40
   iii. Macroeconomic: 0.20
3. The breakdown for *domestic* and *export* sales is similar, though idiosyncratic is the largest component for exports

Related Literature

- The extensive margin:
  - Empirical: Dunne et al. (1988), Bernard et al. (2010)
  - DSGE: Bilbiie et al. (2007), Ghironi and Melitz (2005) (constant death rate); Lee and Mukoyama (2008) (exit decisions), Clementi and Palazzo (2010) (entry and exit)
- The importance of firms and sectors:
  - Sectors: Long and Plosser (1983), Stockman (1988), Horvath (1998, 2000), Dupor (1999). More recently, importance of I-O linkages in Carvalho (2009) and Foerster et al. (2011)
  - Firms: "granular" or "fundamental" volatility of Gabaix (2011) and Carvalho and Gabaix (2010); Castro et al. (2010)
- Open economy context:
  - Sectors: di Giovanni and Levchenko (2009, 2012)
  - Firms: granularity examined by Canals et al. (2007) and di Giovanni and Levchenko (2011)

Aggregation Exercise Roadmap

1. Decompose *aggregate* growth into intensive and extensive margins

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2. Decompose *firm* growth into (i) firm-level idiosyncratic, (ii) sectoral, and (iii) country ("macroeconomic") component

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1. Decompose *aggregate* growth into intensive and extensive margins
2. Decompose *firm* growth into (i) firm-level idiosyncratic, (ii) sectoral, and (iii) country ("macroeconomic") component
3. Implications of 1 and 2 for aggregate fluctuations (volatility)

Aggregate Sales

- Total aggregate sales by all French firms:

$$X_t = \sum_{f,n \in I_t} x_{fnt},$$

where x_{fnt} is firm f's sales to destination n at time t

- The growth rate of aggregate sales:

$$\gamma_{At} = \ln X_t - \ln X_{t-1}$$

- The aggregate growth rate, γ_{At}, can then be broken down into contributions from the intensive and extensive margins

Intensive and Extensive Margins

- Aggregate growth can be decomposed into the two margins:

$$\gamma_{At} \equiv \ln \sum_{f,n\in I_t} x_{fnt} - \ln \sum_{f,n\in I_{t-1}} x_{fnt-1}$$

$$= \ln \frac{\sum_{f,n\in I_{t/t-1}} x_{fnt}}{\sum_{f,n\in I_{t/t-1}} x_{fnt-1}} - \left(\ln \frac{\sum_{f,n\in I_{t/t-1}} x_{fnt}}{\sum_{f,n\in I_t} x_{fnt}} - \ln \frac{\sum_{f,n\in I_{t/t-1}} x_{fnt-1}}{\sum_{f,n\in I_{t-1}} x_{fnt-1}} \right)$$

$$= \underbrace{\tilde{\gamma}_{At}}_{\text{Intensive margin}} \underbrace{- \ln \frac{\lambda_{t,t}}{\lambda_{t,t-1}}}_{\text{Extensive margin}},$$

where $I_{t/t-1}$ is the set of firm$\times$destination pairs active in both t and $t-1$ and $\lambda_{t,t}$ ($\lambda_{t,t-1}$) is the share of output produced by this intensive sub-sample of firms in period t ($t-1$)

A Motivating Model of Firm Sales Growth

- We wish to decompose firm's sales growth between $t-1$ and t into (i) firm-specific idiosyncratic, (ii) sectoral, and (iii) country ("macroeconomic") components. To motivate the exercise, we set up a multi-sector heterogeneous firms model in the spirit of Melitz (2003) and Eaton et al. (2011)
- Preferences:

$$U_{nt} = \prod_{j=1}^{J} \left(C_{nt}^{j} \right)^{\alpha_{nt}^{j}},$$

where C_{nt}^{j} is consumption of sector j in country n at time t, and α_{nt}^{j} is a time-varying demand shock for sector j in country n

A Motivating Model of Firm Sales Growth

- Each sector j is a CES aggregate of Ω_{nt}^{j} varieties available in country n at time t, indexed by f:

$$C_{nt}^{j} = \left[\sum_{\Omega_{nt}^{j}} \left(\omega_{fnt}\right)^{\frac{1}{\sigma}} C_{nt}^{j}\left(f\right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}},$$

where ω_{fnt} is a time-varying demand shock for variety f in market n

A Motivating Model of Firm Sales Growth

- The firm:
  - Sells a unique CES variety $\Longrightarrow$ has market power
  - Is characterized by a time-varying marginal cost a_{fnt} (the inverse of productivity)
  - Uses an input bundle, specific to a sector, with cost c^j_{nt}

$\Longrightarrow$ Sales by French firm f (residing in country d) to market n in period t:

$$x_{fnt} = \omega_{fnt} \frac{\alpha^j_{nt} Y_{nt}}{\left(P^j_{nt}\right)^{1-\sigma}} \left(\frac{\sigma}{\sigma - 1} \tau^j_{nd} c^j_{dt} a_{fdt} \right)^{1-\sigma}, \qquad (1)$$

where τ^j_{nd} is the iceberg cost of selling from France to country n in sector j, and we normalize $\tau^j_{dd} = 1$

Sales Decomposition/Estimating Equations

- Take log differences/growth rates of (1) to arrive at the estimating equation:

$$\gamma_{fnt} = \delta_{nt} + \delta_{jnt} + \varepsilon_{fnt}, \tag{2}$$

where γ_{fnt} is the growth rate of sales of firm f to some market n and

$$\delta_{nt} = \Delta \log Y_{nt} \quad \text{(macro shock)}$$

$$\delta_{jnt} = \Delta \log \alpha^{j}_{nt} + (1-\sigma)(\Delta \log c^{j}_{dt} - \Delta \log P^{j}_{nt}) \quad \text{(sector shock)}$$

$$\varepsilon_{fnt} = \Delta \log \omega_{fnt} + (1-\sigma)\Delta \log a_{fdt} \quad \text{(idio shock)}$$

Sales Decomposition/Estimating Equations

- Equation (2) can be stacked for each year, allowing us to estimated a panel regression where

$\hat{\delta}_{nt}$: Country-time fixed effect (macro shock)

$\hat{\delta}_{jnt}$: Country-sector-time fixed effect (sector shock)

$\hat{\varepsilon}_{fnt}$: Residual for firm-destination-time (idio shock)

- Estimated each year using OLS

Sales Decomposition/Estimating Equations

- We further break down the sectoral and idiosyncratic shocks into a common (France) and destination-specific components:

$$\delta_{jnt} = \delta^1_{jt} + \delta^2_{jnt}$$

$$\delta^1_{jt} = (1-\sigma)\Delta \log c^j_{dt} \qquad \text{(cost shock)}$$

$$\delta^2_{jnt} = \Delta \log \alpha^j_{nt} - (1-\sigma)\Delta \log P^j_{nt} \qquad \text{(demand shock)}$$

and

$$\varepsilon_{fnt} = \varepsilon^1_{ft} + \varepsilon^2_{fnt}$$

$$\varepsilon^1_{ft} = (1-\sigma)\Delta \log a_{fdt} \qquad \text{(cost shock)}$$

$$\varepsilon^2_{fnt} = \Delta \log \omega_{fnt} \qquad \text{(demand shock)}$$

Aggregate Volatility

- Define aggregate volatility as

$$\sigma_A = \sqrt{\frac{1}{T-1}\sum_{t=1991}^{2007}(\gamma_{At} - \bar{\gamma}_A)^2},$$

where γ_{At} is the growth rate of total sales between $t-1$ and t and $\bar{\gamma}_A \equiv \frac{1}{T}\sum_{t=1991}^{2007}\gamma_{At}$ is the mean growth rate over the sample period

Intensive and Extensive Margins

- We decompose volatility between the two margins as

$$\sigma_A^2 = \tilde{\sigma}_A^2 + \sigma_\lambda^2 - 2\text{Cov}(\tilde{\gamma}_{At}, g_{\lambda t}),$$

where σ_λ^2 is the variance of the extensive margin growth rate, $\tilde{\sigma}_A^2$ is the variance of the intensive margin growth rate $\tilde{\gamma}_{At}$, and $\text{Cov}(\tilde{\gamma}_{At}, g_{\lambda t})$ is the covariance between the two

Intensive Margin and Macroeconomic, Sectoral, and Firm-Specific Idiosyncratic Shocks

- Given the estimated firm-level regressions, we further break down the aggregate variance of the intensive margin. Write the annual sales growth as

$$\tilde{\gamma}_{At} \equiv \sum_{f,n} w_{fnt-1}\gamma_{fnt}$$
$$= \sum_{n} w_{nt-1}\delta_{nt} + \sum_{j,n} w_{jnt-1}\delta_{jnt} + \sum_{f,n} w_{fnt-1}\varepsilon_{fnt},$$

where w's are weights of sales in market n; sector-market jn; and firm-market fn to total sales

Intensive Margin and Macroeconomic, Sectoral, and Firm-Specific Idiosyncratic Shocks

- Then, the variance of the intensive margin is

$$\tilde{\sigma}_{At}^2 \equiv \sum_{g,m}\sum_{f,n} w_{gmt-1} w_{fnt-1} \text{Cov}\left(\gamma_{gmt}, \gamma_{fnt}\right)$$

$$= \underbrace{\sum_{m}\sum_{n} w_{mt-1} w_{nt-1} \text{Cov}\left(\delta_{mt}, \delta_{nt}\right)}_{\textit{Macroeconomic Volatility}}$$

$$+ \underbrace{\sum_{j,m}\sum_{k,n} w_{jmt-1} w_{knt-1} \text{Cov}\left(\delta_{jmt}, \delta_{knt}\right)}_{\textit{Sectoral Volatility}}$$

$$+ \underbrace{\sum_{g,m}\sum_{f,n} w_{gmt-1} w_{fnt-1} \text{Cov}\left(\varepsilon_{gmt}, \varepsilon_{fnt}\right)}_{\textit{Idiosyncratic Volatility}} + COV_t$$

- Note: there is time variation because weights vary over time

Data Description

- Firm-level domestic and export sales data for the French manufacturing sector over 1990-2007
- Merge two large datasets:
  - Fiscal administration: firm tax forms from BRN and RSI (small firms). BRN covers 1.6 million firms and 52 NAF sectors. Manufacturing has 209 thousand firms and 22 NAF industries, representing 30% of total sales
  - Customs: firm-destination exports
- Resulting dataset is at the firm-destination level, which allows us to better identify different factors driving sales growth

Data Description

- Trimming procedure to clean outlier growth rates and possible mergers/synthetic exits
  - Extreme growth rates: half or double previous years sales
  - Trimming by upper and lower percentiles
- 18% of firms exported at some point in whole economy, and 42% in manufacturing sector
- The mean net entry rate is 1.2%, which when converted to a five-year rate (5.9%), lines up well with Dunne et al. (1988)

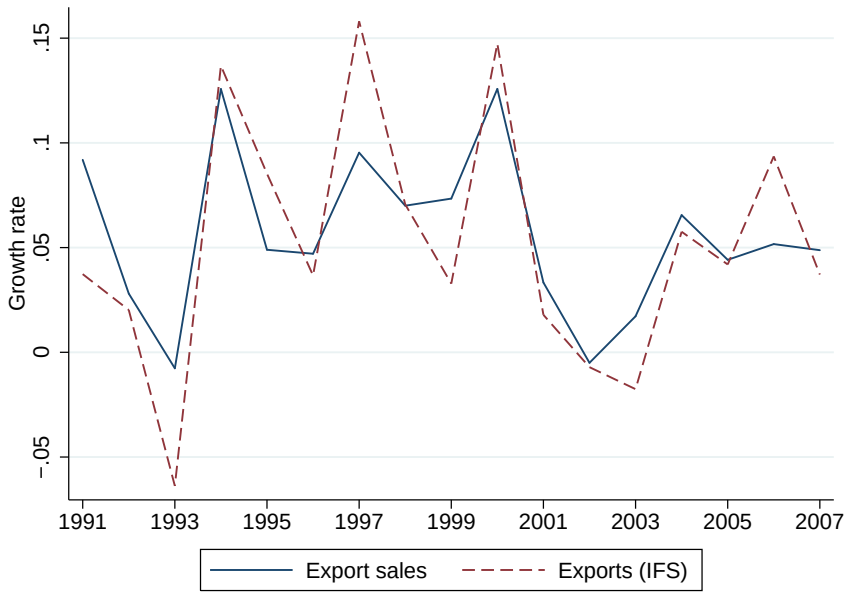
Aggregate Growth of Total Sales, Value Added and GDP

Manufacturing

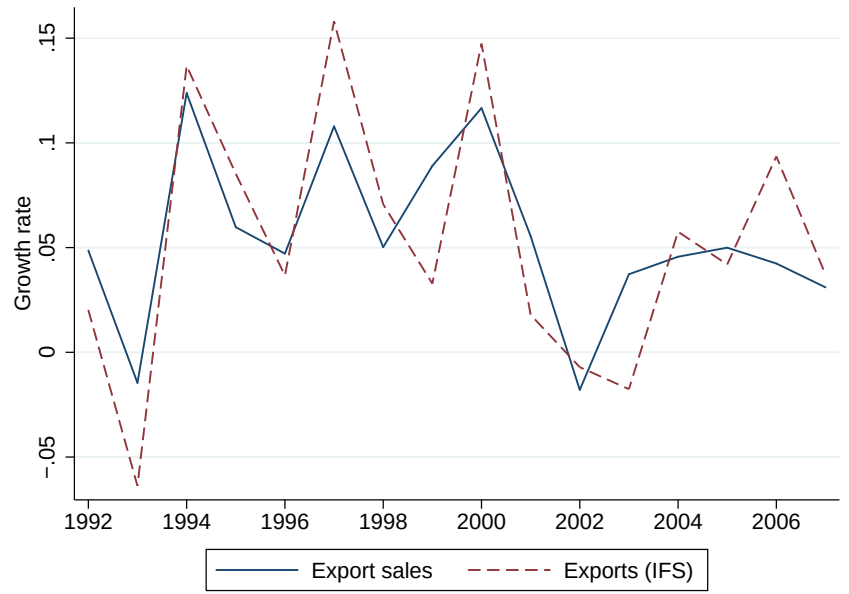
All sectors

Aggregate Growth of Exports

Manufacturing



All sectors



Results Summary for Whole Sample Period

- Margin breakdown:

	Aggregate	Intensive	Extensive	Extensive Domestic	Extensive Exports
			Manufacturing Sector		
Mean	0.0441	0.0282	0.0159	0.0104	0.0055
St. Dev.	0.0305	0.0258	0.0207	0.0159	0.0053
Corr. w/Agg.		0.7426	0.5483	0.5099	0.6088

Results Summary for Whole Sample Period: Manufacturing

	Total Sales		
	(1)	(2)	(3)
	St. Dev.	Contribution	Correlation
Actual	0.0241	1.0000	1.0000
Idiosyncratic	0.0165	0.6826	0.7074
Sectoral	0.0159	0.6577	0.6461
Macroeconomic	0.0113	0.4700	0.3035

Results Summary for Whole Sample Period: Manufacturing

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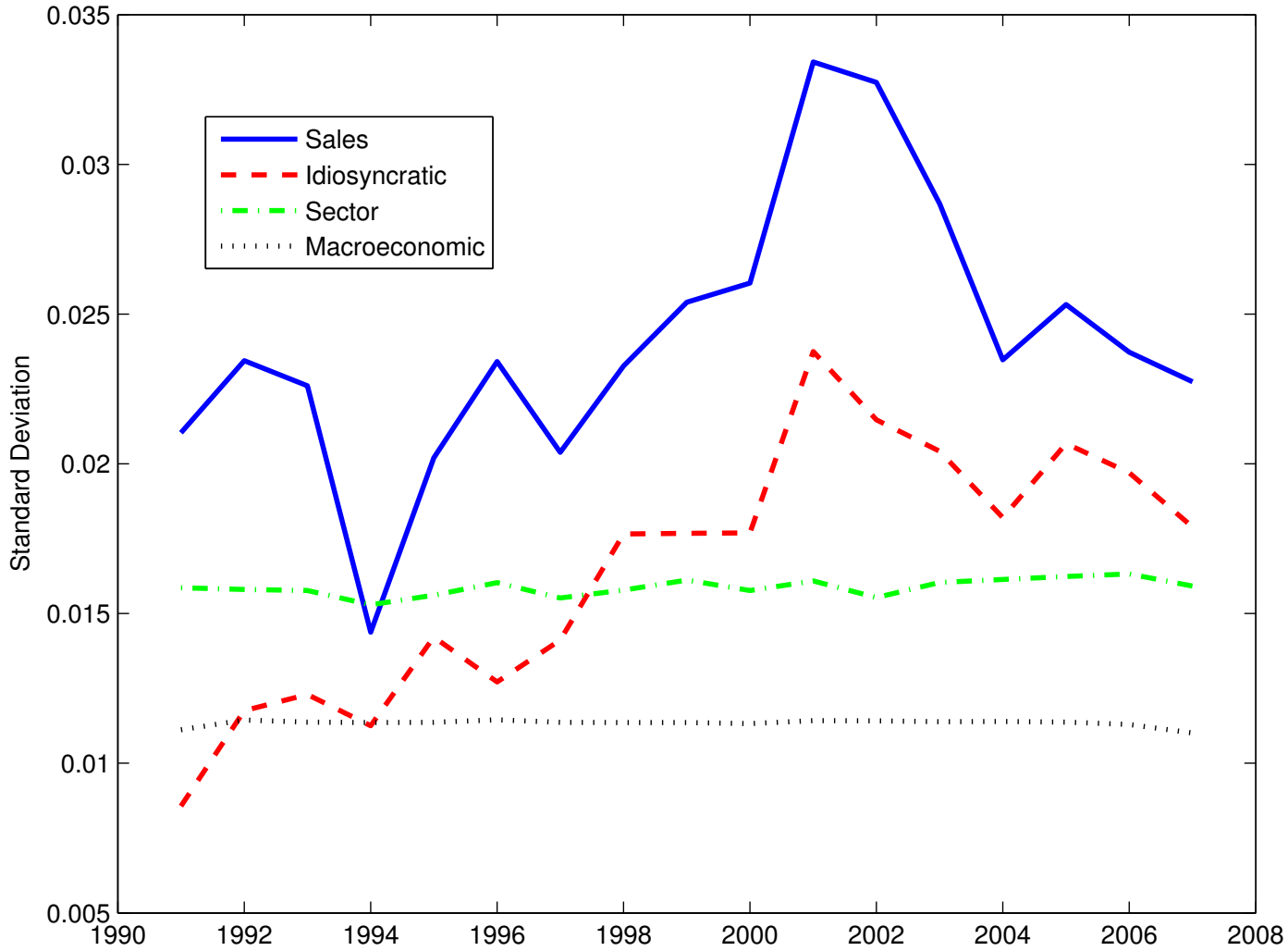
Macroeconomic	0.0113	0.4700	0.3035
	Domestic Sales		
	(1) St. Dev.	(2) Contribution	(3) Correlation
Actual	0.0174	1.0000	1.0000
Idiosyncratic	0.0106	0.6100	0.5850
Sectoral	0.0134	0.7711	0.6670
Macroeconomic	0.0095	0.5434	0.3416

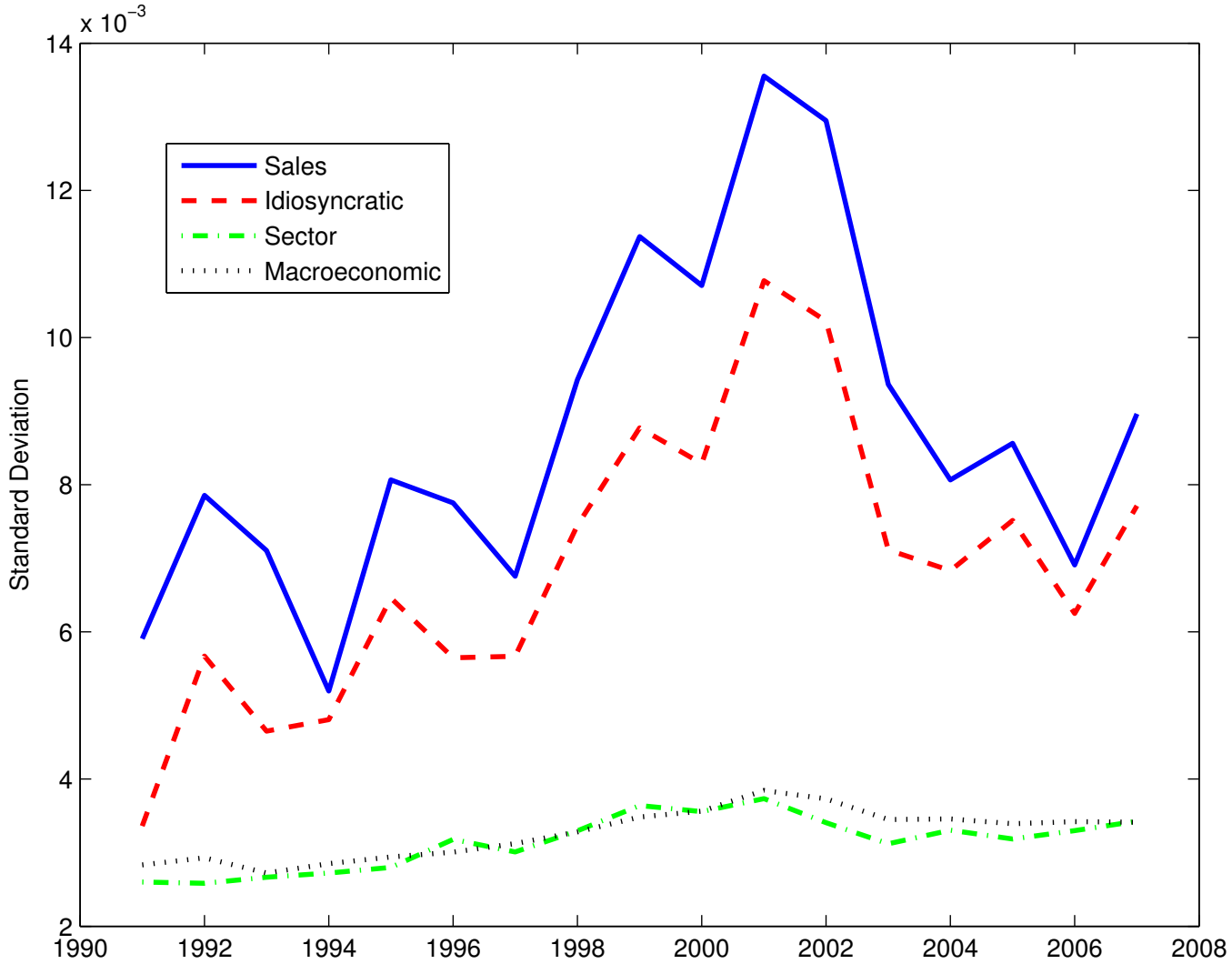
Intensive Volatilty Results Summary for Whole Sample Period: Manufacturing

	(1) St. Dev.	(2) Contribution	(3) Correlation
Total Sales			
Actual	0.0241	1.0000	1.0000
Idiosyncratic	0.0165	0.6826	0.7074
Sectoral	0.0159	0.6577	0.6461
Macroeconomic	0.0113	0.4700	0.3035
Domestic Sales			
Actual	0.0174	1.0000	1.0000
Idiosyncratic	0.0106	0.6100	0.5850
Sectoral	0.0134	0.7711	0.6670
Macroeconomic	0.0095	0.5434	0.3416
Export Sales			
Actual	0.0087	1.0000	1.0000
Idiosyncratic	0.0069	0.7892	0.9218
Sectoral	0.0031	0.3604	0.5352
Macroeconomic	0.0033	0.3734	0.3269

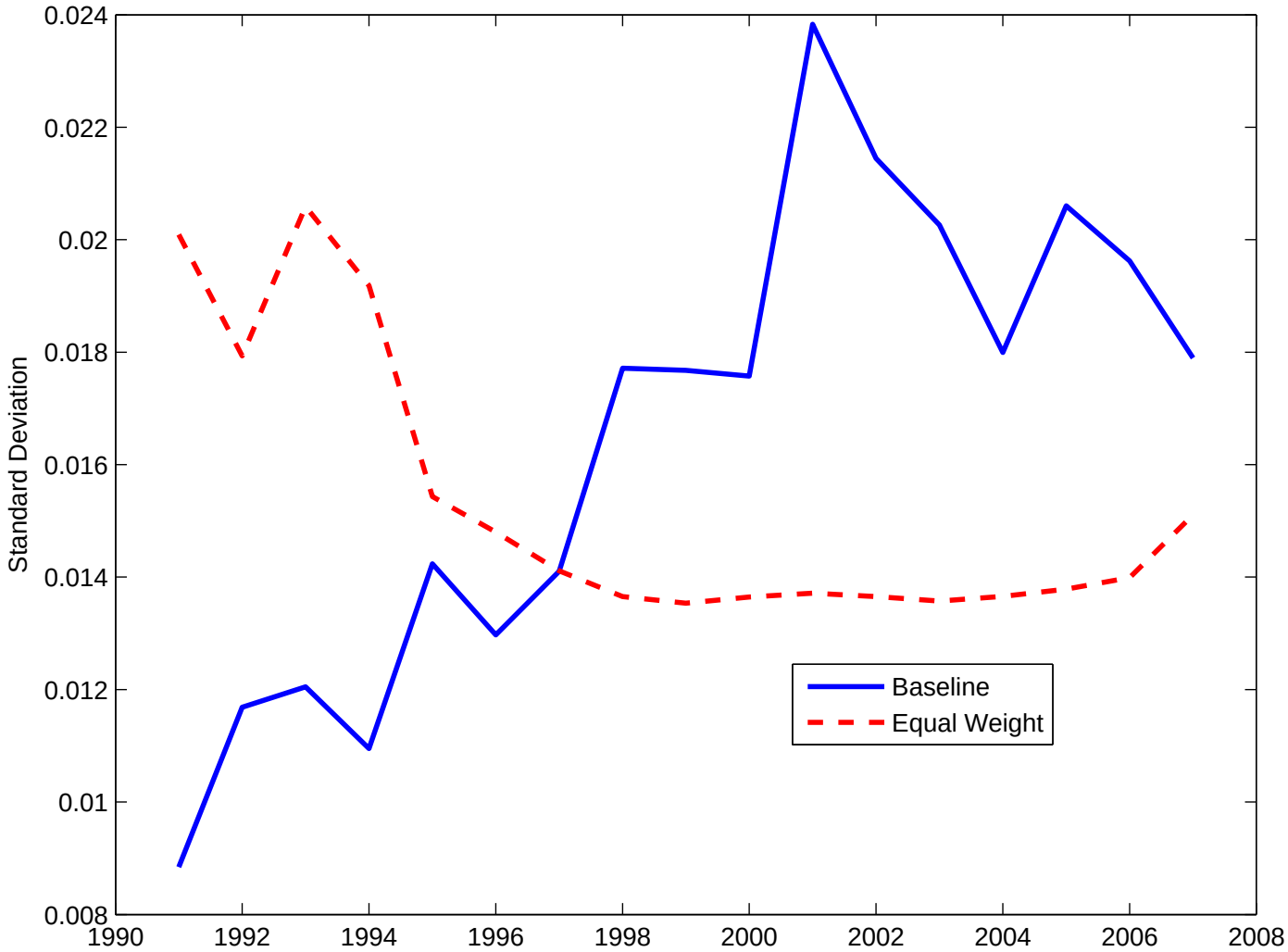
Volatility of Intensive Sales Growth and Components: Manufacturing



Volatility of Intensive Sales Growth and Components for Export Sales: Manufacturing



Idiosyncratic Component and Firm-Size Distribution



Robustness Checks

- Temporal Aggregation
  - Look at sales growth over 3 year period
  - Intensive and extensive variance contributions are similar to annual estimates
  - Variance contributions across idiosyncratic, sectoral and macroeconomic similar as baseline
- Potential firm-level heterogeneity in reaction to sector and/or country shocks:

$$\gamma_{fnt} = \delta_{nt} + \delta_{jnt} + \beta_1 Size_{fnt} + \beta_2 Size_{fnt} \times \delta_{jnt} + \varepsilon_{fnt},$$

where *Size* is either share w_{fnt} or quintile dummy of distribution of sales

  - Results are robust

Conclusion

- Empirical evidence on role of firms in aggregate fluctuations is still relatively scarce
- The extensive margin is an important contributor to annual sales growth on average, but more of year-to-year variation is explained by the intensive margin
- Further disaggregation shows that both firm-level idiosyncratic and sectoral shocks explain a bulk of aggregate sales volatility

Next Steps

- Currently extending the analysis to the whole economy
- Adding more structure to the analysis
  - Linkages across firms and sectors (e.g., I-O)
  - Mapping the estimated shocks to economic variables (e.g., exchange rate fluctuations)
- Exploiting other firm-level characteristics to better understand what drives firm dynamics and the implications for the aggregate economy