

# Finance or Demand: What drives the Responses of Young and of Small Firms to Financial Crises

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# Motivation

- The cyclical behavior of small and large firms has received considerable attention in the literature on firm dynamics and in macroeconomics.
- However, the results are mixed:
  - Some find that small firms' sales are more sensitive than large to recessions ([Crouzet and Mehrotra, 2021](#)), but other that they are equally responsive to recessions ([Chari et al., 2013](#); [Kudlyak and Sanchez, 2017](#)).
  - Some find that small employers are more responsive than large to recessions ([Fort et al., 2013](#); [Chodorow-Reich, 2014](#); [Siemer, 2019](#)), but other studies provide evidence for the opposite ([Moscarini and Postel-Vinay, 2012](#); [Mian and Sufi, 2014](#)).



## Motivation III

- There is an extensive literature asserting that financing constraints (FCs hereafter) may be responsible for the greater sensitivity of small (and of young) firms to recessions ([Chaney et al., 2012](#); [Mian and Sufi, 2014](#); [Chodorow-Reich, 2014](#); [Duygan-Bump et al., 2015](#); [Zwick and Mahon, 2017](#); and [Siemer, 2019](#)).
- This idea is motivated by the “financial accelerator” theory of [Gertler and Gilchrist \(1994\)](#), asserting that financial frictions can amplify the response of the economy to aggregate shocks, and from the fact that credit constraints are closely connected with the size and the age of a firm ([Gertler and Gilchrist, 1994](#); [Cloyne et al. 2019](#); and [Dinlersoz et al., 2018](#)).
- [Crouzet and Mehrotra \(2021\)](#) documents that the differential responses of US firms to the business cycle by size are not driven by financial frictions.

# Research Questions

Three research questions:

- 1 Are financial crises particularly disruptive to small (versus large) and to young (versus mature) firms' sales growth and if so, to what extent?
- 2 What drives the excess sensitivity of small and of young firms: Credit, Demand or maybe both factors?
- 3 What is the impact of the excess sensitivity of small and of young firms on an economy undergoing a financial crisis?

# Greek Depression

We answer these questions by studying the *Greek Depression*

- one of the deepest and longest economic downturns experienced in a developed economy post WWII.
- Suitable economic laboratory to examine the role of:

## 1. Demand

- sovereign debt crisis leading to a sovereign default in 2012 → fiscal austerity and structural reform programs adopted by Greece
- deep and persistent economic slowdown that was dramatically amplified by the austerity measures (Ioannides and Pissarides, 2015; Gourinchas et al., 2016)

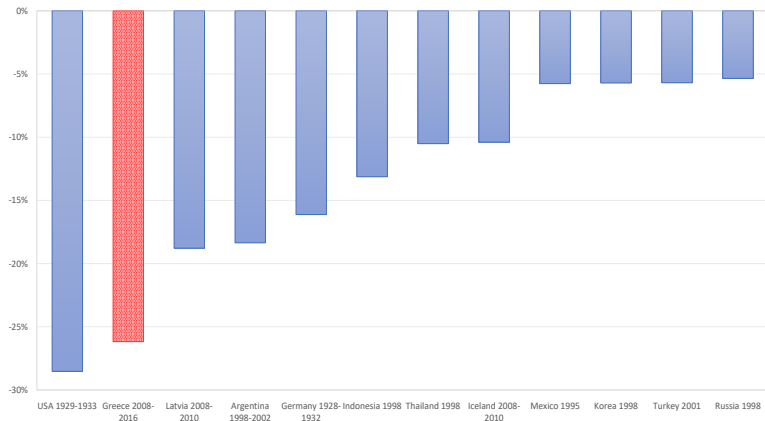
# Greek Depression II

## 2. Credit Supply

- systemic banking crisis: almost-collapse of the entire banking system requiring a bailout to survive → aggregate credit supply shock
- credit boom before the crisis → Greek firms became more vulnerable during the crisis

# Greek Depression III

Figure: Real GDP Growth in Crisis (from peak to first recovery year)



Source: Leounakis and Sakellaris (2019)



# Greek Depression IV

Figure: Greek Crisis vs US Crises

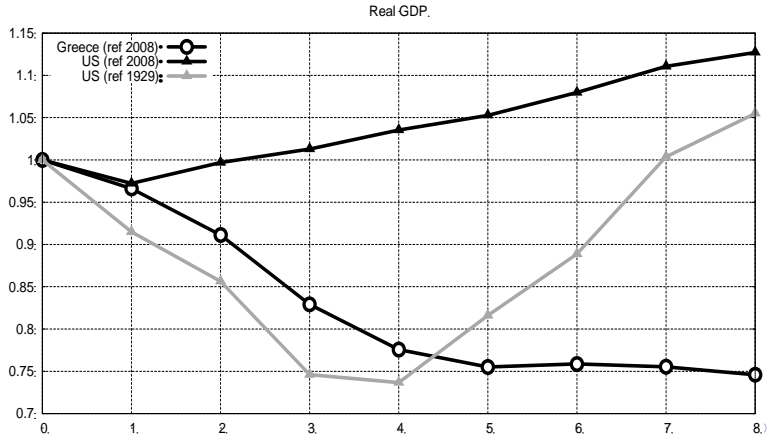
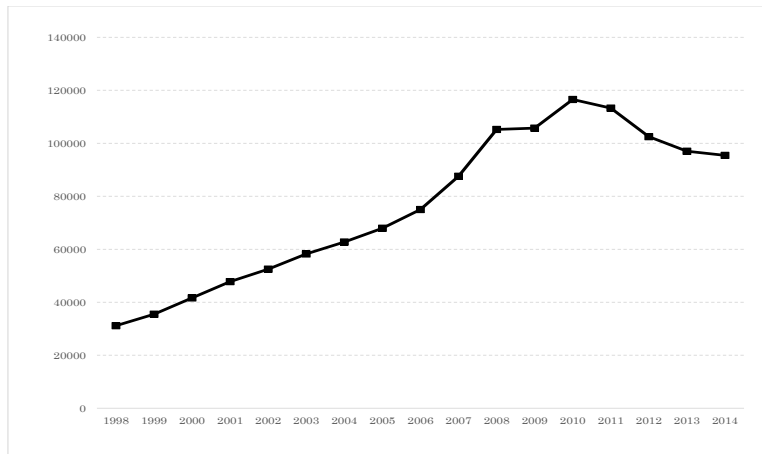


Figure: Evolution of Loan Supply over the period 1998-2014



Sources: Bank of Greece.

# Main Findings

**Are financial crises particularly disruptive to small (versus large) and to young (versus mature) firms' sales growth and if so, to what extent? → Yes**

- Controlling for age effects, we estimate that the Greek Depression reduced firm sales growth by 9.8 percentage points in small relative to large firms
- Controlling for size effects, we estimate that the Greek Depression reduced firm sales growth by 6.6 in young relative to mature firms.

# Main Findings II

## What drives the excess sensitivity of small and of young firms: Credit, Demand or maybe both factors?

- The excess decline in small firms' sales growth rates is driven by both credit constraints and unexpected demand shocks.
- The excess decline in young firms' sales growth rates is driven by financing constraints but not by short-term demand shocks.

## Main Findings III

### What is the impact of the excess sensitivity of small and of young firms on an economy undergoing a financial crisis?

- The excess sensitivity of small firms accounts for about 13% of the reduction of the total output of the Greek economy due to the crisis, with credit constraints and firm-level demand shocks contributing almost equally to this percentage (21% and 21.5% respectively).
- The excess sensitivity of young firms accounts for about 13.7% of this reduction, with about the 54.5% of this effect stemming from financing constraints.

## Contribution to the Literature

- Our findings revisit the literature on the differential responses of firms to aggregate shocks by size and age focusing not just on a business cycle downturn but to a uniquely severe and unprecedentedly prolonged financial crisis, the ***Greek Depression***.
- It is the first study that explores the differential responses of firms to an aggregate shock by age (and size) focusing on ***sales dynamics*** rather than employment.
- Our findings support the view of a ***“financial amplification mechanism”*** and are in contrast with those of [Crouzet and Mehrotra \(2021\)](#).

## Contribution to the Literature II

- Our paper expands the literature by introducing the role of ***firm-level unexpected demand shocks***, beyond the role of credit.
- Another strand of this literature has focused on the role of young or small firms in the reduction of aggregate employment in response to credit contractions, especially during the US Great Financial Crisis ([Mian and Sufi, 2014](#); [Chodorow-Reich, 2014](#)). We explore the role of young or small firms in the reduction of ***gross output***, in response to a credit supply shock, during the Greek Financial Crisis.

# Implications for Academics

- There is a large class of theoretical models and empirical applications that attribute the excess sensitivity of small firms to the credit constraints that these firms face ([Chodorow-Reich, 2014](#); [Duygan-Bump et al., 2015](#); [Gilchrist et al., 2018](#); and [Siemer, 2019](#)) → for a deeper insight, there is a need for theoretical models that incorporate idiosyncratic demand shocks as a mechanism of the greater sensitivity of small relative to large firms.
- There is an important and growing theoretical literature on the link between firm life-cycle dynamics and aggregate fluctuations ([Clementi and Palazzo \(2016\)](#); [Sedlacek Sterk \(2017\)](#); [Sedlacek \(2019\)](#); [Pugsley and Sahin \(2019\)](#)). A common feature of these theoretical frameworks in the above papers is that finance does not matter. Our empirical results suggest that it is important to introduce financing constraints on young and on small firms in such equilibrium models.



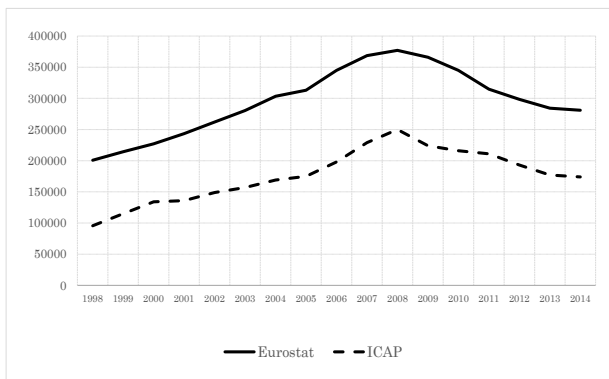
# Policy Implications

- Our findings also inform the policy debate on appropriate public policy for the support of enterprises during recessions.
- Governmental policies that attempt to alleviate credit constraints faced by enterprises are widely adopted across countries. These policies focus on SMEs ignoring the role of age → young firms are more important for the aggregate economy.
- Unexpected demand faced by small firms has also important aggregate implications. → public policies aimed at supporting SMEs should also focus on demand-driven interventions.

# Data

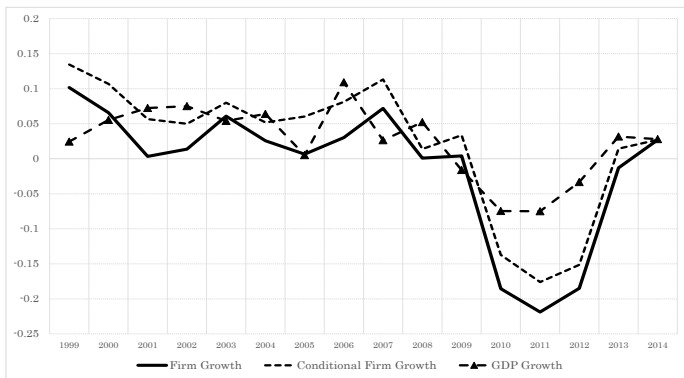
- Detailed proprietary firm-level financial accounts data obtained from the ICAP Group, SA. Wide coverage of small and young firms
- Firm-level information for approximately 83,000 Greek firms operating in all sectors, except for banks and insurance companies, for the time period 1998 - 2014. Largest available dataset for Greece
- The coverage in our sample found to be consistently high. The ratio of aggregate gross output recorded in our sample (i.e. aggregate sales) relative to the national level averages 60 percent.
- Variables include: gross sales, gross output/revenue, total balance-sheet assets, long-term liabilities, short-term liabilities, year of establishment, NACE2 codes, firm location and accounting depreciation flow.

Figure: Aggregate Gross Output in ICAP and Eurostat databases



**Notes:** In this Figure, we compare the evolution of the aggregate gross output in our ICAP dataset with the same aggregate as it recorded by Eurostat. Gross output is defined by the Bureau of Economic Analysis (BEA) as: "a measure of an industry's sales or receipts, which can include sales to final users in the economy (GDP) or sales to other industries (intermediate inputs)". In firm-level, gross output was measured by aggregate gross sales.

Figure: Dynamic Patterns of Firm Growth



**Notes:** This figure presents the dynamic patterns of average annual firm growth rates of Greek firms for the time period 1998-2014. In addition, in order to investigate whether the growth rates of the firm-level data resemble the growth path of the Greek economy we include in the same graph the growth of the Gross Domestic Product (GDP hereafter) annual time series, collected from OECD Database. Both the firm-level and the macro-level series are on 2003 base.

## Firm Growth, Size and Age

- We define firm size as the logarithm of gross sales in period  $t-1$ , deflated by the Producer Price Index (PPI).
- Davis, Haltiwanger and Schuh's (1996) bounded growth rates:

$$g_{i,t} = \frac{(S_{i,t} - S_{i,t-1})}{0.5(S_{i,t} + S_{i,t-1})}$$

- 3 size groups based on the percentiles of the firm size distribution: "small" for percentiles 1-50, "medium" for percentiles 51-90 and "large" for the percentiles 91-100.
- 2 age groups: "young" (less than 6 years old) and "mature". ICAP's information for the year of establishment comes from administrative records.

# Identification of Financing Constraints (FCs)

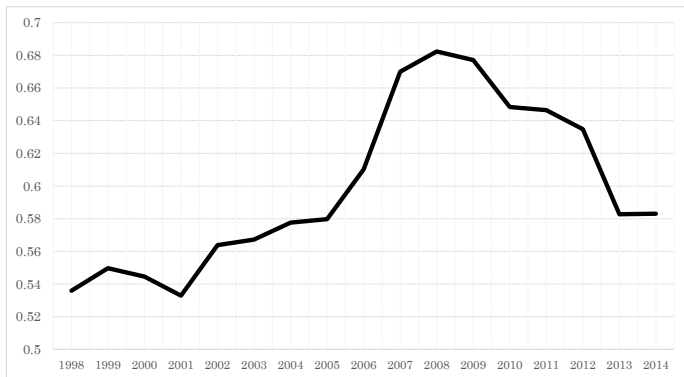
- Domestic banks are the overwhelmingly predominant source of external financing for Greek firms.
- During the Greek Depression, the economy was confronted with a severe banking crisis: the entire banking system almost collapsed.
- Thus, the banking crisis can be best described as an aggregate shock to credit supply, affecting all firms in the economy regardless of which bank they used.
- To identify which firms were more affected by this aggregate credit-supply shock we use firm- or industry-specific characteristics.

# Identification of Financing Constraints (FCs) II

- Baseline Measure (at the firm-level): We consider firms entering the crisis with high financial leverage (debt-to-assets ratio) as financially constrained ([Giroud and Mueller, 2016](#); and [Fakos et al., 2019](#)).
- Alternative Measure (at the industry-level): [Rajan and Zingales' \(1998\)](#) measure of external financial dependence.

# Identification of Financing Constraints (FCs) III

Figure: Dynamic Patterns of Financial Leverage



**Notes:** This figure presents the dynamic patterns of average financial leverage of Greek firms for the time period 1998-2014. We define financial leverage as the debt-to-assets ratio.



# Identification of Unexpected Demand Shocks (UDSs)

- During the Greek Depression, the economy was confronted with a deep and persistent contraction in demand that was dramatically amplified by austerity measures ([Ioannides and Pissarides, 2015](#); [Gourinchas et al., 2016](#)).
- [Giannoulakis and Sakellaris \(2021a\)](#) showed that a large part of the Greek Depression can be attributed to firm-specific shocks.
- We measure “demand contraction” as a series of less favourable firm-specific unexpected demand shocks.
- To identify the UDSs we adopt a novel identification strategy based on the recent work of [Kumar and Zhang \(2019\)](#).
- They proposed a method to identify unexpected demand shocks at the firm level, using the inventories.

## Identification of Unexpected Demand Shocks (UDSs) II

- The main idea behind this approach is that the within-firm deviation of inventory stock over time from the targeted level of inventory each period contains important information about (unexpected) demand shocks.
- Following [Kumar and Zhang \(2019\)](#), we can identify a short-term unexpected demand shock at the firm-level through the following equation:

$$\log\left(\frac{S_{i,t}}{S_{i,t} + VInv_{i,t}}\right) = -\log(1 + \lambda_i) + \zeta_{i,t}$$

where  $S_{i,t}$  denotes the gross sales of firm  $i$  at period  $t$ , and  $VInv_{i,t}$  the value of end-of-period inventories of finished goods and work-in-progress of firm  $i$  at period  $t$ .

## Identification of Unexpected Demand Shocks (UDSs) III

- We recover the unexpected demand shocks  $\zeta_{i,t}$  by estimating the above equation, considering the inventory share,  $-\log(1 + \lambda_i)$ , as a firm-specific fixed effect.
- The transitory demand shock is the residual from the estimation of the above equation,  $\hat{\zeta}_{i,t}$ . Following [Kumar and Zhang \(2019\)](#), we replace the estimated demand shock by the conditional lower bound (i.e.  $\log(1 + \hat{\lambda}_i)$ ) when inventory is zero.
- We identify firms that experienced less favourable unexpected demand shocks as those firms with  $\Delta\hat{\zeta}_{i,t} < 0$ .
- Greek firms faced ten times less favorable transitory demand shocks on average during the Greek Depression (relative to the pre-crisis period).

# 1. Excess Sensitivity of young and of small firms

## *Hypothesis H1:*

- ① *The Greek Financial Crisis was more disruptive to young than to mature firms.*
- ② *The Greek Financial Crisis was more disruptive to small than to large firms.*

## First Step:

$$g_{i,t} = \beta_0 + f(\text{young}_{i,t}, \text{small}_{i,t}, \text{large}_{i,t}, \text{crisis}_t; \beta) + \sum_{s=1}^S \gamma_s I_s + \sum_{c=1}^C \zeta_c L_c + \xi_{i,t} \quad (1)$$

The function  $f(\cdot)$  is linear with complete interactions in its arguments.  $I_s$  and  $L_c$  stand for sectoral FEs (85 industries at the two-digit NACE Rev. 2 level) and prefecture FEs (51 prefectures).

# 1. Excess Sensitivity of young and of small firms II

**Second Step:** Double growth differentials:

$$\hat{\theta}_{age}^{Cr} = (\hat{\theta}_{yng} - \hat{\theta}_{mtr})^{Cr} - (\hat{\theta}_{yng} - \hat{\theta}_{mtr})^{Bm} \quad (1a)$$

$$\hat{\theta}_{size}^{Cr} = (\hat{\theta}_{sml} - \hat{\theta}_{lrg})^{Cr} - (\hat{\theta}_{sml} - \hat{\theta}_{lrg})^{Bm} \quad (1b)$$

- The term  $\hat{\theta}_j^T$  denotes the predicted mean growth rate (i.e. the marginal effects at the mean - MEM) of firms that belong in group  $j \in \{\text{young, mature, small, large}\}$  during the period  $T \in \{\text{pre-crisis, crisis}\}$  as estimated by model (1).
- Age-size Dependence: results for firm size may be driven by age, and vice versa ([Haltiwanger et al., 2013](#); [Siemer, 2019](#)).

## 2. Drivers of the Excess Sensitivity

### Hypothesis H2:

- 1 The Greek Financial Crisis was more disruptive to young (relative to mature) firms that were highly financially constrained during the crisis.
- 2 The Greek Financial Crisis was more disruptive to small (relative to large) firms that were highly financially constrained during the crisis.

### Hypothesis H3:

- 1 The Greek Financial Crisis was more disruptive to young (relative to mature) firms that were facing less favourable firm-level unexpected demand shocks.
- 2 The Greek Financial Crisis was more disruptive to small (relative to large) firms that that were facing less favourable firm-level unexpected demand shocks.

## 2. Drivers of the Excess Sensitivity II

**First Step:** Augmented Version of model (1)

$$g_{i,t} = \alpha_0 + g(\text{young}_{i,t}, \text{small}_{i,t}, \text{large}_{i,t}, FC_{i,t}, LUD_{i,t}, \text{crisis}_t; \alpha) + \sum_{s=1}^S \gamma_s I_s + \sum_{c=1}^C \zeta_c L_c + \varepsilon_{i,t} \quad (2)$$

**Second Step:** Triple Growth Differentials

$$\hat{\theta}_{age}^{Cr,F} = [(\hat{\theta}_{yng} - \hat{\theta}_{mtr})^{Cr} - (\hat{\theta}_{yng} - \hat{\theta}_{mtr})^{Bm}]^1 - [(\hat{\theta}_{yng} - \hat{\theta}_{mtr})^{Cr} - (\hat{\theta}_{yng} - \hat{\theta}_{mtr})^{Bm}]^0 \quad (2a)$$

$$\hat{\theta}_{size}^{Cr,F} = [(\hat{\theta}_{sml} - \hat{\theta}_{lrg})^{Cr} - (\hat{\theta}_{sml} - \hat{\theta}_{lrg})^{Bm}]^1 - [(\hat{\theta}_{sml} - \hat{\theta}_{lrg})^{Cr} - (\hat{\theta}_{sml} - \hat{\theta}_{lrg})^{Bm}]^0 \quad (2b)$$

- $F \in \{\text{financing constraints, less favourable unexpected demand shocks}\}$ , “1” and “0” correspond to the two groups of firms as classified by factor “F”.
- Dependence between credit supply shocks and unexpected demand shocks.

# Estimation Strategy

**Endogenous firm selection due to exit and sampling bias** → use as an additional term in the conditional expectation of firm growth the predicted probability of a firm remaining in the sample estimated from a first-stage sample selection model, like in [Olley and Pakes \(1996\)](#)

$$Pr(y_{i,t} = 1) = \Phi \left( \delta_0 + g(\text{young}_{i,t}, \text{small}_{i,t}, \text{large}_{i,t}, FC_{i,t}, LUD_{i,t}, \text{crisis}_t; \delta) + \sum_{s=1}^S \gamma_s I_s + \sum_{c=1}^C \zeta_c L_c + \mu_{i,t} \right), \mu_{i,t} \sim N(0, \sigma_\mu^2) \quad (3)$$

OLS with corrected standard errors for heteroskedasticity and autocorrelation).



# Baseline Results

**Table:** Quantifying the Excess Sensitivity of Young and Small Firms to the Greek Depression

|                | Estimated Expression                           | Young VS Mature      | Small VS Large       |
|----------------|--|----------------------|----------------------|
| <b>Panel A</b> | $\theta^{Cr}$<br>(1a for age, 1b for size)     | -0.066***<br>(0.007) | -0.098***<br>(0.006) |
| <b>Panel B</b> | $\theta^{Cr,FCs}$<br>(2a for age, 2b for size) | -0.078***<br>(0.018) | -0.050***<br>(0.010) |
| <b>Panel C</b> | $\theta^{Cr,LUD}$<br>(2a for age, 2b for size) | -0.016<br>(0.019)    | -0.084***<br>(0.010) |

# Sensitivity Analysis

- ① Rajan and Zingales' (1998) measure of external financial dependence as a proxy for FCs (instead of financial leverage).
- ② Alternative Measurement for changes in UDSs:

$$\Delta \ln S_{i,t} = \Delta \ln(S_{i,t} + VInv_{i,t}) + \Delta \zeta_{i,t} \quad (4)$$

- ③ Heckman's (1979) correction for selection and sampling bias.
- ④ Logarithmic instead of DHS measure for firms growth rates.

# Sensitivity Analysis II

| Estimated Expression                        | Baseline Results     | Robustness Check I   | Robustness Check II  | Robustness Check III | Robustness Check IV  |
|---|----------------------|----------------------|----------------------|----------------------|----------------------|
| $\theta_{age}^{Cr}$<br>(expression 1a)      | -0.066***<br>(0.007) | same as baseline     | same as baseline     | -0.070***<br>(0.006) | -0.085***<br>(0.010) |
| $\theta_{size}^{Cr}$<br>(expression 1b)     | -0.098***<br>(0.006) | same as baseline     | same as baseline     | -0.109***<br>(0.006) | -0.161***<br>(0.008) |
| $\theta_{age}^{Cr,FCs}$<br>(expression 2a)  | -0.078***<br>(0.018) | -0.047***<br>(0.015) | -0.079***<br>(0.019) | -0.047***<br>(0.015) | 0.103***<br>(0.026)  |
| $\theta_{size}^{Cr,FCs}$<br>(expression 2b) | -0.050***<br>(0.010) | -0.034***<br>(0.010) | -0.049***<br>(0.010) | -0.066***<br>(0.013) | -0.060***<br>(0.015) |
| $\theta_{age}^{Cr,LUD}$<br>(expression 2a)  | -0.016<br>(0.019)    | -0.004<br>(0.015)    | -0.011<br>(0.017)    | -0.030<br>(0.026)    | -0.038<br>(0.024)    |
| $\theta_{size}^{Cr,LUD}$<br>(expression 2b) | -0.084***<br>(0.010) | -0.095***<br>(0.011) | -0.086***<br>(0.010) | -0.076***<br>(0.013) | -0.110***<br>(0.015) |

# Aggregate Implications

- Following the approach of [Chodorow-Reich \(2014\)](#) and [Siemer \(2019\)](#), we do two [counterfactual exercises](#) to obtain the aggregate implications of the financial crisis and financing constraints. In the first exercise, we assume that the crisis affected equally young and mature firms (small and large firms). In the second exercise we assume that FCs (UDSs) affected young (small) firms in the same way as mature (large) firms during the crisis.
- To do this exercises the following assumption is necessary:

**Assumption** (Partial equilibrium): The overall effect of the crisis (or FCs during the crisis) on gross output is the sum of the direct sales effects on each firm.

- The above assumption ignores any general equilibrium effects through price adjustments. Taking such effects into account would require a general equilibrium model.

# Aggregate Implications II

|  | <b>Gross Output Losses: 2009-2014</b>                        |   |
|--|--|---|
| Economy  | 23%  |   |
| <b>A. The Role of the Excess Sensitivity of Young and Small Firms</b>                          | <b>Total Contribution to the Decline in Gross Output (%)</b> |   |
| Fall in Gross Output explained by the excess decline in Young Firms                            | 13.70%   |   |
| Fall in Gross Output explained by the excess decline in Small Firms                            | 13.04%   |   |
| <b>B. The Drivers</b>  | <b>Total Contribution (%)</b>                                | <b>Contribution to the Age or Size Effect</b> |
| Fall in Gross Output explained by the financing constraints (FCs) of Young Firms               | 7.44%  | 54.31%  |
| Fall in Gross Output explained by the financing constraints (FCs) of Small Firms               | 2.72%  | 20.86%  |
| Fall in Gross Output explained by less favorable unexpected demand shocks (LUD) of Small Firms | 2.80%  | 21.47%  |

# Aggregate Implications

- The total (gross) output of the Greek economy was reduced by 23% during the Greek Depression (from 2009 to 2014).
- The excess sensitivity of young (relative to mature) firms to the crisis accounts for about 13.7% of this reduction with about the 54.5% of this effect stemming from financing constraints.
- The excess decline in small (relative to large) firms accounts for about 13% of this reduction, with credit constraints and firm-level demand shocks contributing almost equally to this percentage (21% and 21.5% respectively).

# Conclusions

- Young and small firms were disproportionately hit by the Greek Depression.
- Although the excess sensitivity of small firms to the Greek Depression is driven by both credit supply and demand shocks, that of young firms is credit- but not demand-driven,
- The excess sensitivity of small and of young firms have an important impact on the observed loss of aggregate gross output of the Greek economy during the crisis.

- Although, EU and national policies aiming to alleviate credit constraints that weak enterprises may face were widely adopted in the wake of the 2008 global financial crisis, most of them have targeted businesses of a certain size, underestimating or even ignoring the role of age.
- **Examples:** a) EU: European Investment Fund, Horizon 2020 Program, Enterprise European Network. b) Greece: Roots Program.
- We find that young firms are more important than small firms for aggregate fluctuations. Therefore, we need policies to alleviate access to finance by startups and young firms, esp. during crises.
- Unexpected demand shocks faced by small firms have also important aggregate implications. Public policies aimed at supporting SMEs should also focus on demand-driven interventions.
- **Example:** “Innovation in SMEs” initiative of the Horizon 2020 Programme,



## Appendix A: Functional form $f(\cdot)$ from equation (1)

$$\begin{aligned}
 f(\text{young}_{i,t}, \text{small}_{i,t}, \text{large}_{i,t}, \text{crisis}_t; \beta) = & \beta_1 \text{young}_{i,t} + \beta_2 \text{small}_{i,t} \\
 & + \beta_3 \text{large}_{i,t} + \beta_4 (\text{young} \times \text{small})_{i,t} + \beta_5 (\text{young} \times \text{large})_{i,t} \\
 & + \beta_6 \text{crisis}_{i,t} + \beta_7 (\text{young} \times \text{crisis})_{i,t} + \beta_8 (\text{small} \times \text{crisis})_{i,t} \quad (\text{A.1}) \\
 & + \beta_9 (\text{large} \times \text{crisis})_{i,t} + \beta_{10} (\text{young} \times \text{small} \times \text{crisis})_{i,t} \\
 & + \beta_{11} (\text{young} \times \text{large} \times \text{crisis})_{i,t}
 \end{aligned}$$

return

## Appendix B: Estimation Strategy (1)

- Sampling and selection bias is an important statistical concern.
- Bias may arise from endogenous firm selection due to starting or closing a business, or from the sampling design and procedure of our dataset, which is not a census.
- To address this issue we employ the methodology of [Olley and Pakes \(1996\)](#).
- Selection into the sample introduces a bias term in equations (1) as follows:

$$E[g_{i,t} | X_{i,t}^{(1)}, y_{i,t} = 1] = \beta_0 + f(\text{young}_{i,t}, \text{small}_{i,t}, \text{large}_{i,t}, \text{crisis}_t; \beta) + \sum_{s=1}^S \gamma_s I_s + \sum_{c=1}^C \zeta_c L_c + E[\xi_{i,t} | X_{i,t}^{(1)}, y_{i,t} = 1] \quad (\text{B.1})$$

where  $X_{i,t}^{(1)}$  denote the sets of explanatory variables of econometric specification (1), and  $y_{i,t}$  is an indicator function that takes the value 1 if firm  $i$  is active and included in our ICAP sample in period  $t$  and 0 otherwise.

## Appendix B: Estimation Strategy (2)

The last term in equation (1) is the *bias term* due to endogenous selection and sampling. Following [Olley and Pakes \(1996\)](#), we consider this *bias term* as function of the probability of being in the dataset at period  $t$ . Specifically, for specification (1):

$$E[\xi_{i,t} | X_{i,t}^{(1)}, y_{i,t} = 1] \approx h^{(1)}(\hat{P}_{i,t}). \quad (\text{B.2})$$

We use a first-order polynomial expansion in  $\hat{P}_{i,t}$  of function  $h^{(1)}(.)$ . We obtain the probability of being in the dataset at period  $t$  by estimating a binary choice model. We augment the set of regressors of model (1) with the predicted probability of a firm observation being included in the sample. return

## Appendix C: Aggregate Implications (1)

- Following the approach of [Chodorow-Reich \(2014\)](#) and [Siemer \(2019\)](#), the aggregate implications of the financial crisis can be calculated by comparing the sales evolution in the (fitted) data with the sales evolution in a counterfactual in which we assume that the crisis affected small firms in the same way as large firms, i.e. the differential crisis effect is zero (and similar for young and mature).
- Define the counterfactual growth rate of a firm  $i$  of group  $j$ ,  $j \in \{\text{small during the crisis, young during the crisis}\}$ , as:

$$\tilde{g}_{i,t}^j = \hat{g}_{i,t}^j + \left| \hat{\theta}_j^{Cr} \right|$$

$\hat{g}_{i,t}^j$  denotes the predicted value of firm growth of firm  $i$  at year  $t$  from the regression of firm type  $j$ , and  $\hat{\theta}_j$  is the corresponding point estimate of the differential crisis effect. During the pre-crisis (1998-2009) period the counterfactual growth rate equals the fitted growth rate.

## Appendix C: Aggregate Implications (2)

- After the construction of the counterfactual growth rate, we can create the counterfactual series for firm sales as follows:

$$\tilde{s}_{i,t} = M(\tilde{g}_{i,t}, \tilde{s}_{i,t-1})$$

where, as in [Chodorow-Reich \(2014\)](#),  $M(\cdot)$  denotes the mapping from symmetric annual growth rates to the end-period  $t$  level of sales:

$$M[x, y] = \frac{1 + 0.5x}{1 - 0.5x}y$$

- In order to calculate the counterfactual sales series for the years of the Greek financial crisis (2010-2014), we use as initial value the real value of sales in the year before the eruption of the crisis:

$$\tilde{s}_{i,t_0}^{(1)} = s_{i,2009}.$$

## Appendix C: Aggregate Implications (3)

- In the same spirit, the fitted value end-period sales level can be computed as:  $\hat{s}_{i,t} = M(\hat{g}_{i,t}, \hat{s}_{i,t-1})$ .
- The aggregate crisis effect can be calculated as follows:

$$\frac{\sum_{i \in j} (\tilde{s}_{i,2014} - \hat{s}_{i,2014})}{\sum_i (s_{i,2009} - s_{i,2014})}$$

return