# Monetary Policy and the Firm: Some Empirical Evidence[1]

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January 2018

[1]The views expressed are those of the presenter and not necessarily those of the Bank of England, the MPC, the FPC or PRC.

# Motivation

- Limits to what we can learn about the transmission of monetary policy from aggregate data
- Heterogeneous responses at the firm level can distinguish channels
  - Size and age
  - Leverage and credit scores
- **This paper:**
  - Impact of monetary policy in a panel of UK non-financial firms
    - Includes small and large firms
    - Private and listed firms
  - "Off-the-shelf" high frequency identified monetary policy shocks
  - Focus on employment

# What we find

1. **Aggregate and (weighted) average firm level responses align**
   - Helpful to focus on employment
2. **Small firms respond more (different dynamics)**
   - So do young firms
3. **Heterogeneity consistent with financial frictions narrative**

# The Literature

- **Which types of firms are more sensitive to aggregate shocks?**
  - Monetary policy: Gertler and Gilchrist [1994]
  - Size and Business Cycle: Moscarini and Postel-Vinay [2012], Chari et al. [2013], Kudlyak and Sanchez [2017], Crouzet and Mehrotra [2017]
  - Age & size: Fort et al. [2013]
- **Macro literature on household heterogeneity and monetary policy**
  - Auclert [2015], Cloyne et al. [2016], Kaplan et al. [2016]
- **Recent work on firms using Compustat**
  - Ippolito et al. [2017], Ottonello and Winberry [2017], Jeenas [2017]

# Firm Data

## Overview

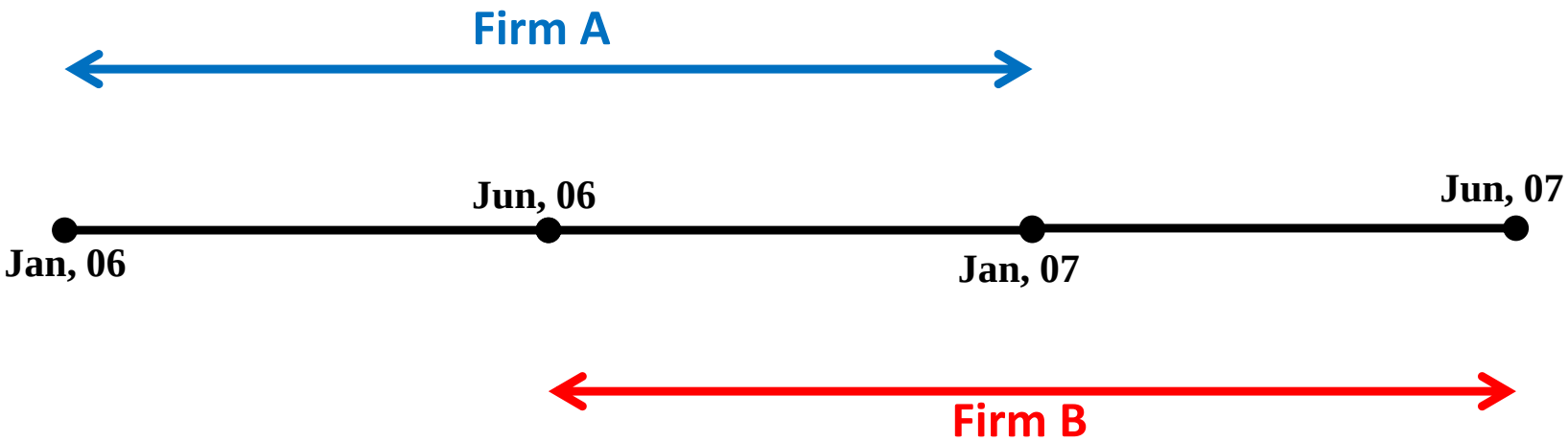
Accounting Data: Bureau van Dijk (BVD) based on filings at Companies House (UK registrar)

- Annual data covering ~1.5 million UK firms annual Companies House filings
- BVD is a live database, which leads to several limitations, most importantly: **selection issue, firms that die leave the database after ~ 5years**
- To circumvent this issue, archived data sampled at a six monthly frequency to capture information when it was first published (similar to Kalemli-Ozcan et al. 2015)
  - Illustrating the Selection Effect

# Data

## Treatment of Firms

- Sample selection:
  - Exclude companies that have a parent with an ownership stake greater than 50%
  - Operate in finance, utilities or public sectors
  - Firms must be active, have operated for at least three years and report variables of interest
- Sample period is 1990-2015 (95% obs in 1998-2014).
- Annual data but firms have different accounting periods.



# Two Samples

## Sample I: Firms who report Number of Employees

| Variable | Mean | Median | 25%tile | 75%tile | N | Histogram |
|---|---|---|---|---|---|---|
| **Firms that report *Number of Employees* (105,610 unique firms)** | | | | | | |
| Total Assets (£'000s) | 61,718 | 2,326 | 157 | 6909 | 465,444 | chart |
| Number of Employees | 303 | 28 | 4 | 91 | 467,816 | chart |
| Age (years) | 20 | 13 | 6.6 | 25 | 460,230 | chart |
| Leverage | 1.20 | 0.65 | 0.41 | 0.86 | 414,839 | chart |
| Credit Score (0-100) | 67 | 75 | 46 | 91 | 388,998 | chart |
| *Employment Growth Rates (conditional on survival)* | | | | | | |
| 1-year | 0.011 | 0.000 | -0.026 | 0.065 | 467,816 | chart |
| 3-year | 0.027 | 0.000 | -0.100 | 0.190 | 282,028 | chart |
| 5-year | 0.074 | 0.013 | -0.160 | 0.340 | 143,259 | chart |

Note: Firms are counted as reporting total assets/number of employees if they report either for three consecutive years or two consecutive years non-consecutively. Growth rates are calculated for firms who file all accounts in a regular annual pattern (observations for which there is an accounting period that is not annual are excluded). Nominal asset growth is converted into real terms using the UK CPI at the month of filing.

# Two Samples

## Sample II: Firms who report Total Assets

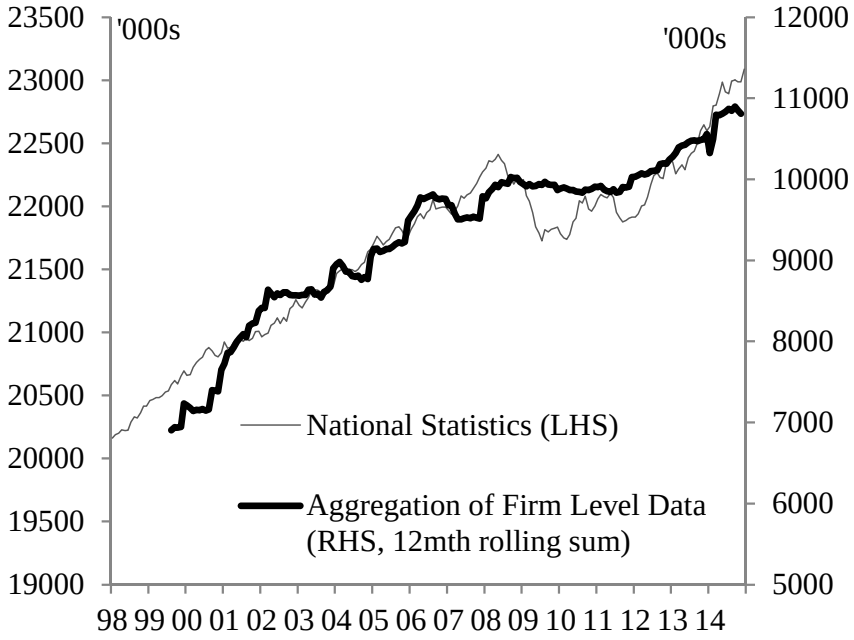
| Variable | Mean | Median | 25%tile | 75%tile | N | Histogram |
|---|---|---|---|---|---|---|
| **Firms that report *Total Assets* (3,744,718 unique firms)** | | | | | | |
| Total Assets (£'000s) | 2,779 | 55 | 15 | 225 | 12,050,499 | chart |
| Age (years) | 11 | 7 | 3.9 | 13 | 12,050,480 | chart |
| *Real Asset Growth (conditional on survival)* | | | | | | |
| 1-year | 0.022 | 0.000 | -0.160 | 0.220 | 12,050,499 | chart |
| 3-year | 0.068 | 0.031 | -0.260 | 0.430 | 8,072,643 | chart |
| 5-year | 0.160 | 0.120 | -0.310 | 0.670 | 4,462,878 | chart |

Note: Firms are counted as reporting total assets/number of employees if they report either for three consecutive years or two consecutive years non-consecutively. Growth rates are calculated for firms who file all accounts in a regular annual pattern (observations for which there is an accounting period that is not annual are excluded). Nominal asset growth is converted into real terms using the UK CPI at the month of filing.

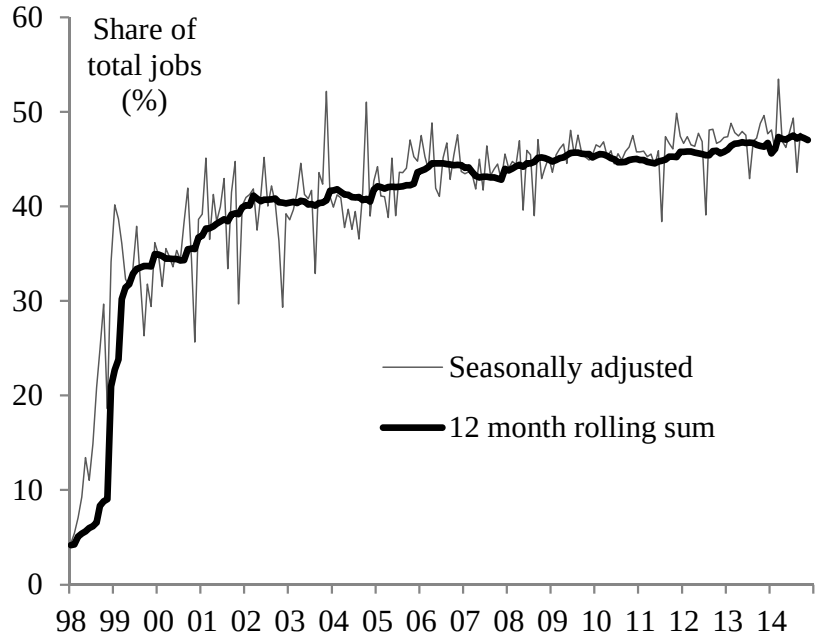
# Descriptive Statistics

## Firm vs Aggregate Employment

### Total Employment (Relevant Industries)



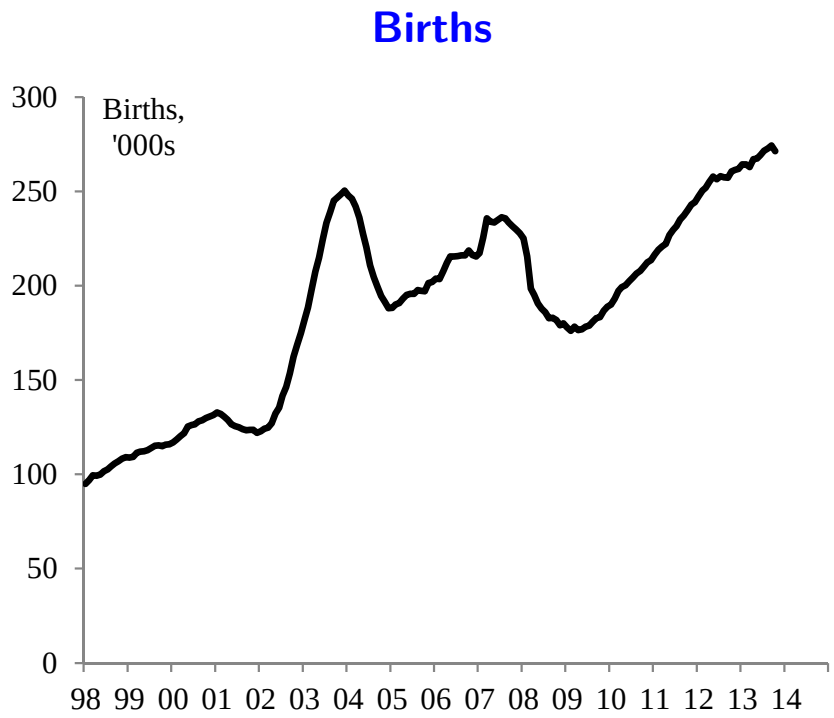

### Labour market coverage

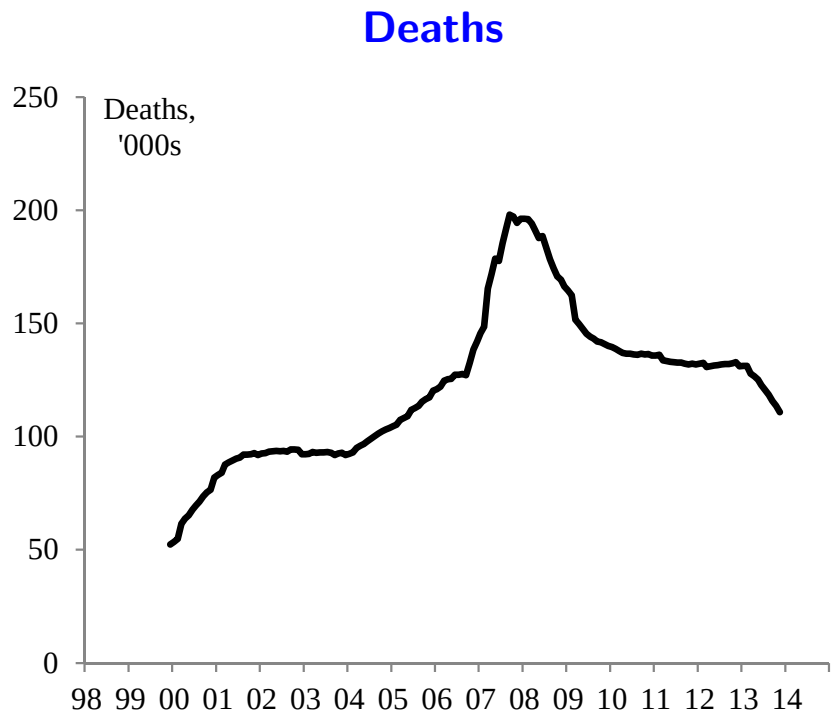



Notes: (i) *left panel:* Thick black line (aggregation of firm level data) is the sum of the employment of all companies that file in particular month expressed as a 12 month moving sum. Thin black line (national statistics) is employment in the relevant industries as sourced from the UK ONS. (ii) *right panel:* thick black line (12 month rolling sum) is the ratio between the two lines in the top left panel. Thin black line (seasonally adjusted) is the constructed by taking the sum of all firms that file in a particular month, seasonally adjusting the time series and multiplying it by 12 dividing by the thin black line in the left panel.

# Descriptive Statistics

## Birth and Death




Notes: (i) *left panel:* number of firms with *incorporation date* in a rolling 12 month window. (ii) *right panel:* number of firms with a *statement date* where the *company status* was first listed as dissolved in a rolling 12 month window.

# Microdata Validation

1. **Representativeness**
   - Replicate the aggregate response for employment

2. **Selection**
   - Compare total asset response for firms that do and don't report employment

3. **Administrative data**
   - Interdepartmental Business Register (IDBR): the complete universe of firm level employment
   - Similar to Census Bureau's Longitudinal Business Database (LBD)
   - No balance sheet info/within year timing: $\Longrightarrow$ in future work merge to BvD data

# General Methodology

1. **Proxy SVAR** (Mertens and Ravn 2013)
   - Feed in monetary policy shock instrument
   - Get aggregate response

2. **Extract shock from VAR**
   - Advantage: not limited by instrument sample

3. **Use extracted shock in firm level local projections**

Robustness: using proxy directly - similar results

# Monetary Policy VAR

Gerko and Rey (2017)

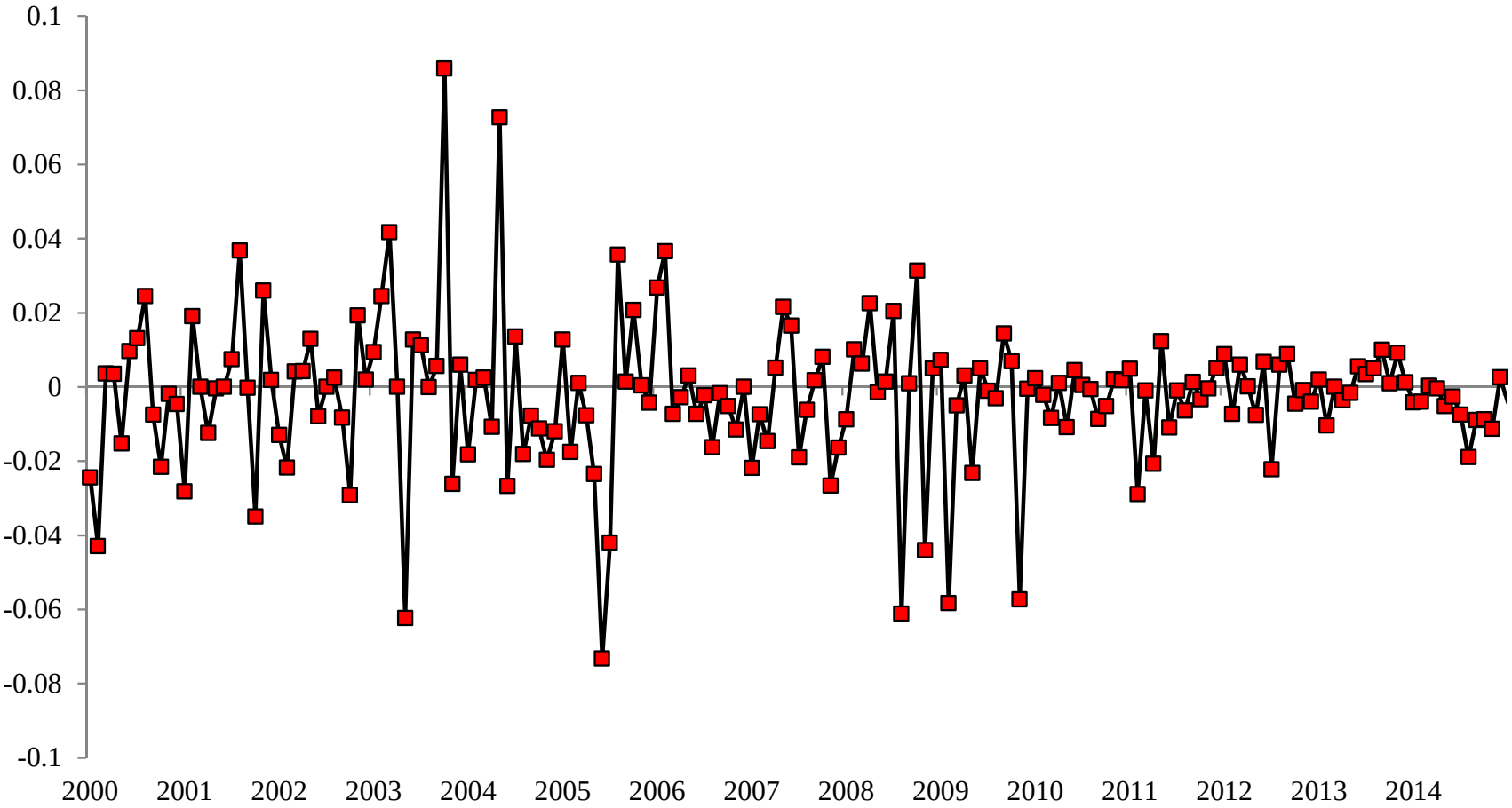
**Off-the-shelf approach**

- Shock instrument from Gerko and Rey [2017], covering 2000m1-2015m1
- High frequency market reaction to monetary policy announcements
  - Using Bank of England's MPC Minutes, Inflation Report
  - Interpretation is a monetary policy news shock

- Specification as in Gerko and Rey [2017] (augmented to include labour variables). Proxy SVAR, estimated over 1982-2015.
  - VAR series: 5-year gilts, IP, Prices, £/$, corporate bond spread, unemployment rate, employment of firms in our industries
  - F-stat for relevance of instrument is above 10
  - The estimated shock goes into our firm level regression

# Monetary Policy VAR

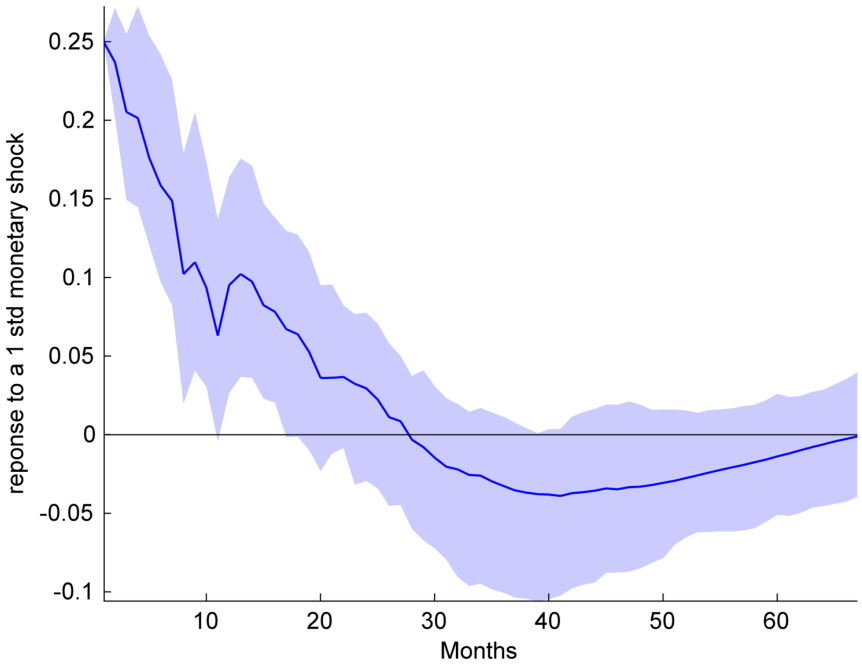
## Gerko Rey (2017) Policy Surprises



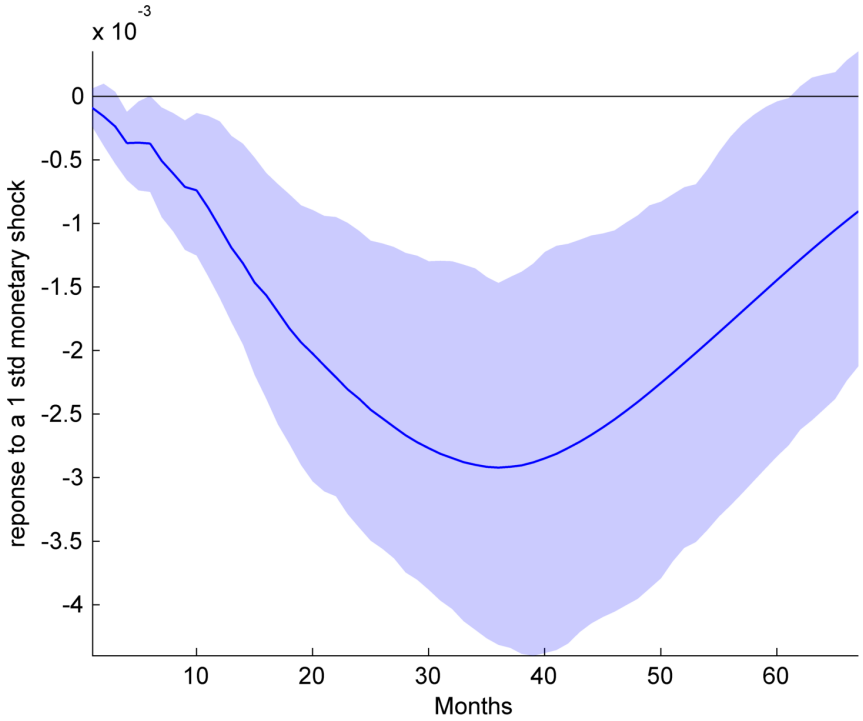
# Aggregate Responses to Monetary Policy Shock

## 1sd monthly contractionary shock

**Interest Rate**



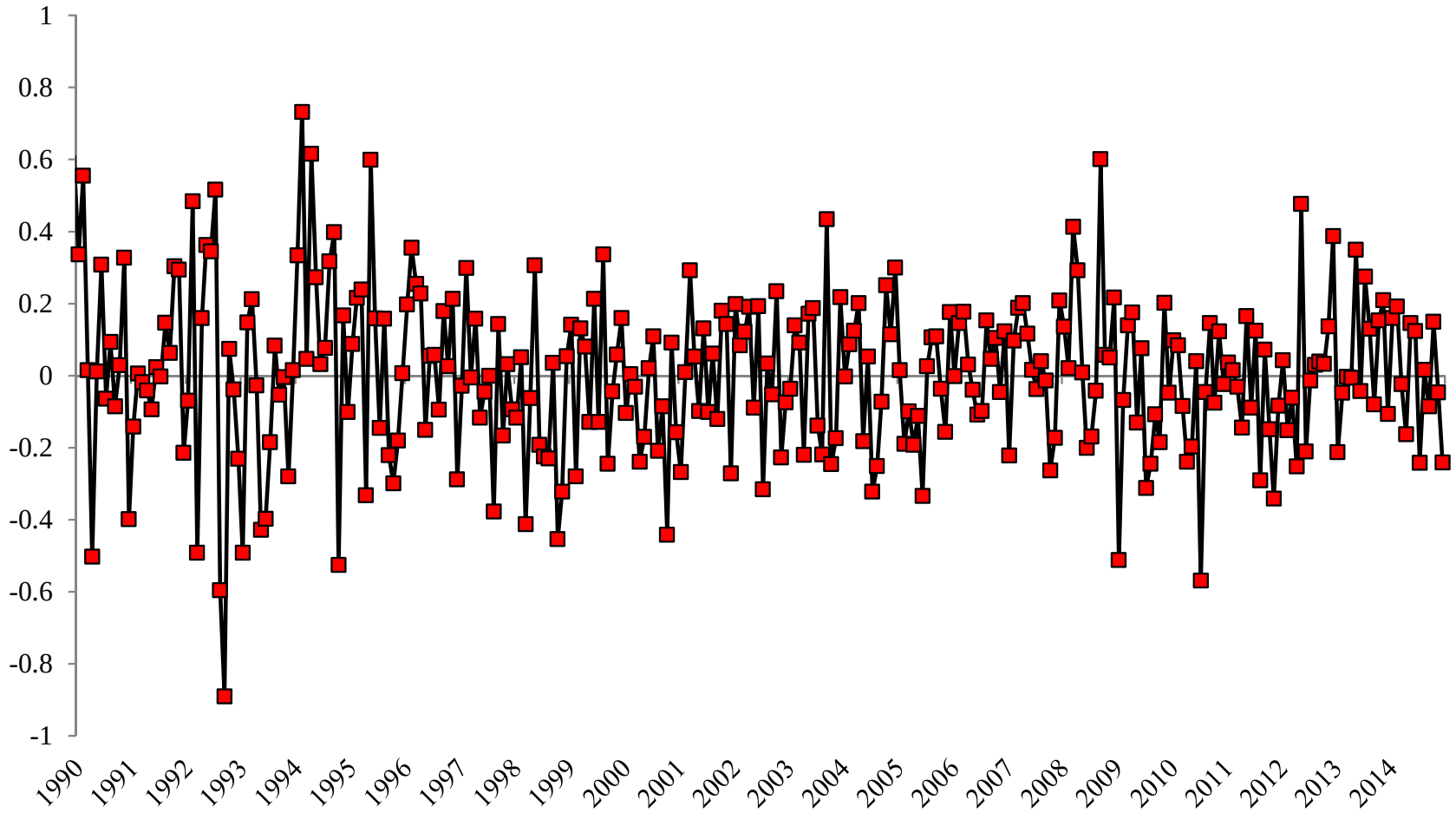

**Employment**




Notes: Estimates are from a proxy SVAR estimated on UK monthly data over the period 1982-2012. Monetary policy shocks are identified using the Gerko and Rey [2017] series. The blue solid lines are the point estimates, and the shaded areas are the 90% confidence intervals constructed from a wild recursive bootstrap.

Output and Prices

# Monetary Policy Shock Series Extracted From the VAR




**1 standard deviation = 24bps**

Rolling sum

# Firm Level Responses

## Linear effects

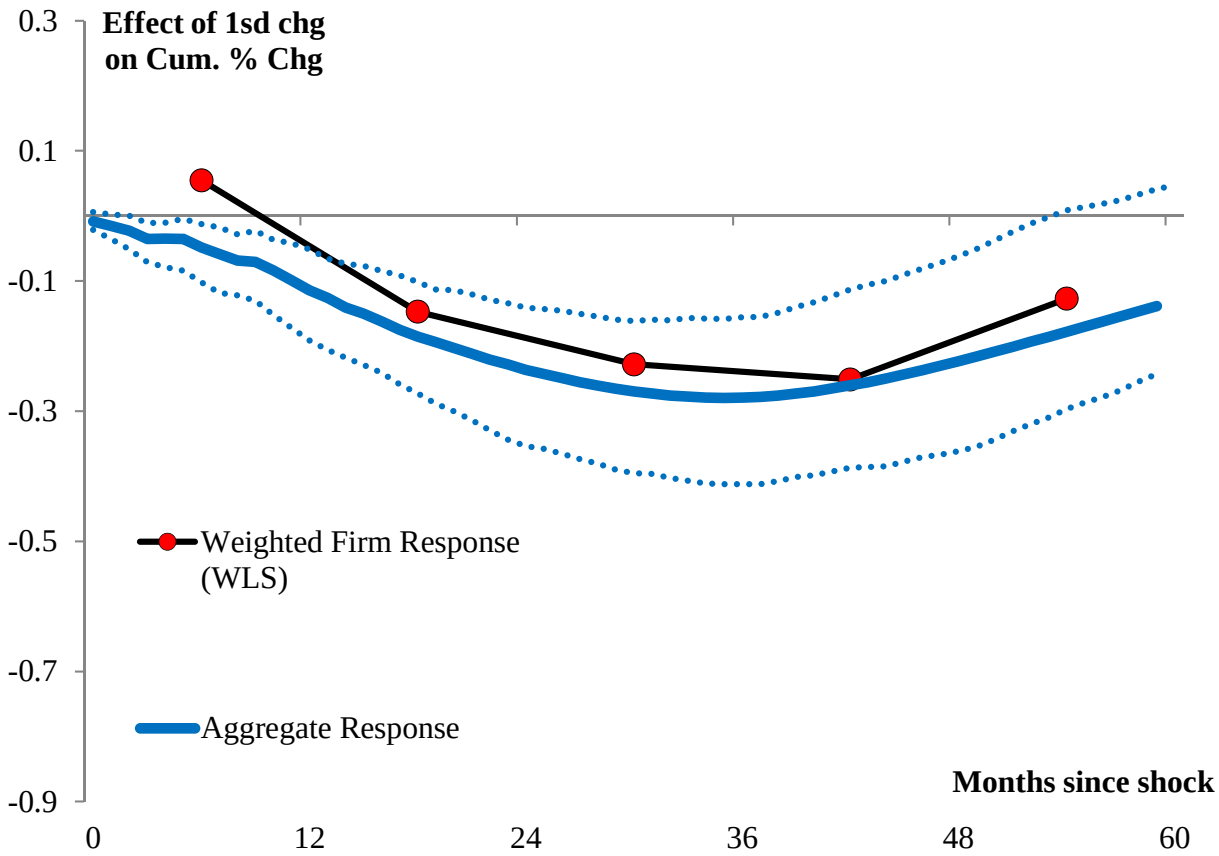
Specification follows local projection method of Jorda [2005]:

$$log(EMP_{t+h,i}) - log(EMP_{t-1,i}) = \alpha_i^h + \beta^h \times \sum_{m=1}^{12} w_m e_{m,t} + \gamma^h \times controls_{i,t-1} + \sum_{j=1}^{6} \phi^h \times \sum_{m=1}^{12} \tilde{u}_{m,j,t} + \varepsilon_{i,t}^h$$

- $t$ is an index of time denoting firm accounting year
- $m$ denotes months over a firm's account year
  - $\sum_{m=1}^{12} w_m e_{m,t}$ is the weighted sum of monetary shocks over the accounting year
  - We show $w_m = 1$, results robust to other weights
- **Inference:**
  - Multiway clustering to account for overlapping time windows
  - Also cluster at the industry level

# Comparison to the Aggregate

## Employment Responses: 1sd Contractionary Shock

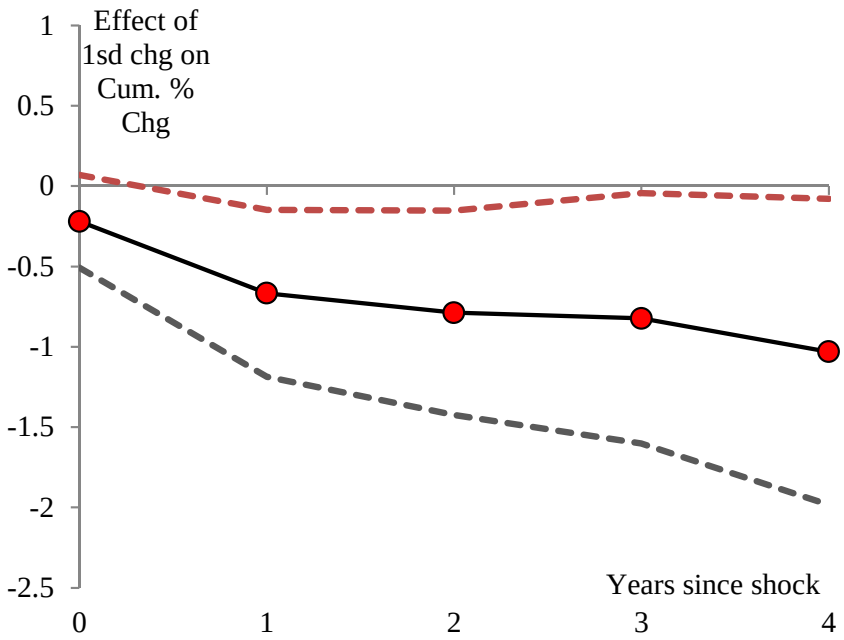



Notes: Responses to a 1 standard deviation contractionary monetary policy shock. Black dotted lines are point estimates at the firm level, WLS estimates weighted by firm level employment. Blue Line is the aggregate response from the VAR, dashed blue lines denote 90% confidence intervals.

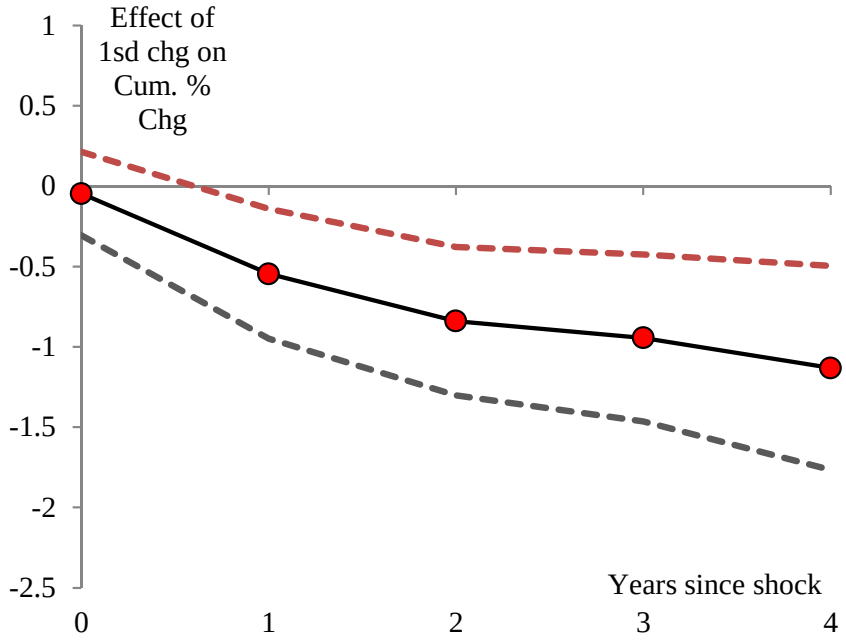
Firm Level with errors

# Selection: Comparison of Total Asset Responses

## Sample I - Firms that report Employment




## Sample II - All firms




Notes: Firm level responses to a 1 standard deviation contractionary monetary policy shock. Black dotted lines are point estimates. Dashed lines are +/- two stand errors. The dependent variable is the cumulative growth rate in log points of total assets from $t - 1$ to $t + h$ where $t$ is the date of the monetary policy shock and $h$ is the x-axis.

# Firm Level Responses

## Assessing Heterogeneity

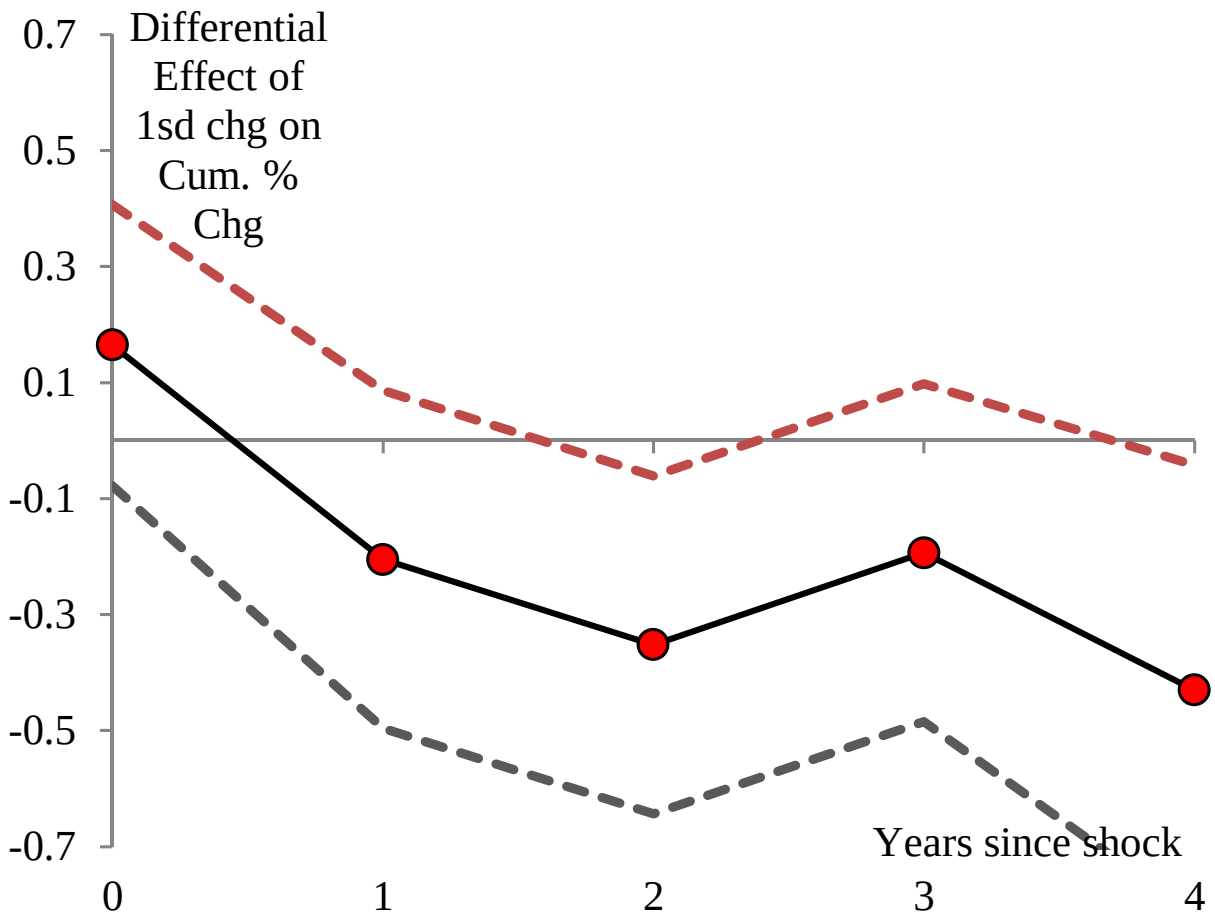
Specification:

$$log(EMP_{t+h,i}) - log(EMP_{t-1,i}) = \alpha_i^h + \delta_{j,t}^h + \beta^h \times dum_{i,t-1} \times \sum_{m=1}^{12} w_m e_{m,t} + \gamma^h \times controls_{i,t} + \varepsilon_{i,t}^h$$

- Industry-time fixed effect, $\delta_{j,t}^h$
- $dum_{i,t-1}$: binary dummy if firm $i$ is in a particular group (small, levered, etc)
- $\beta^h$ is then the relative impulse response at horizon $h$

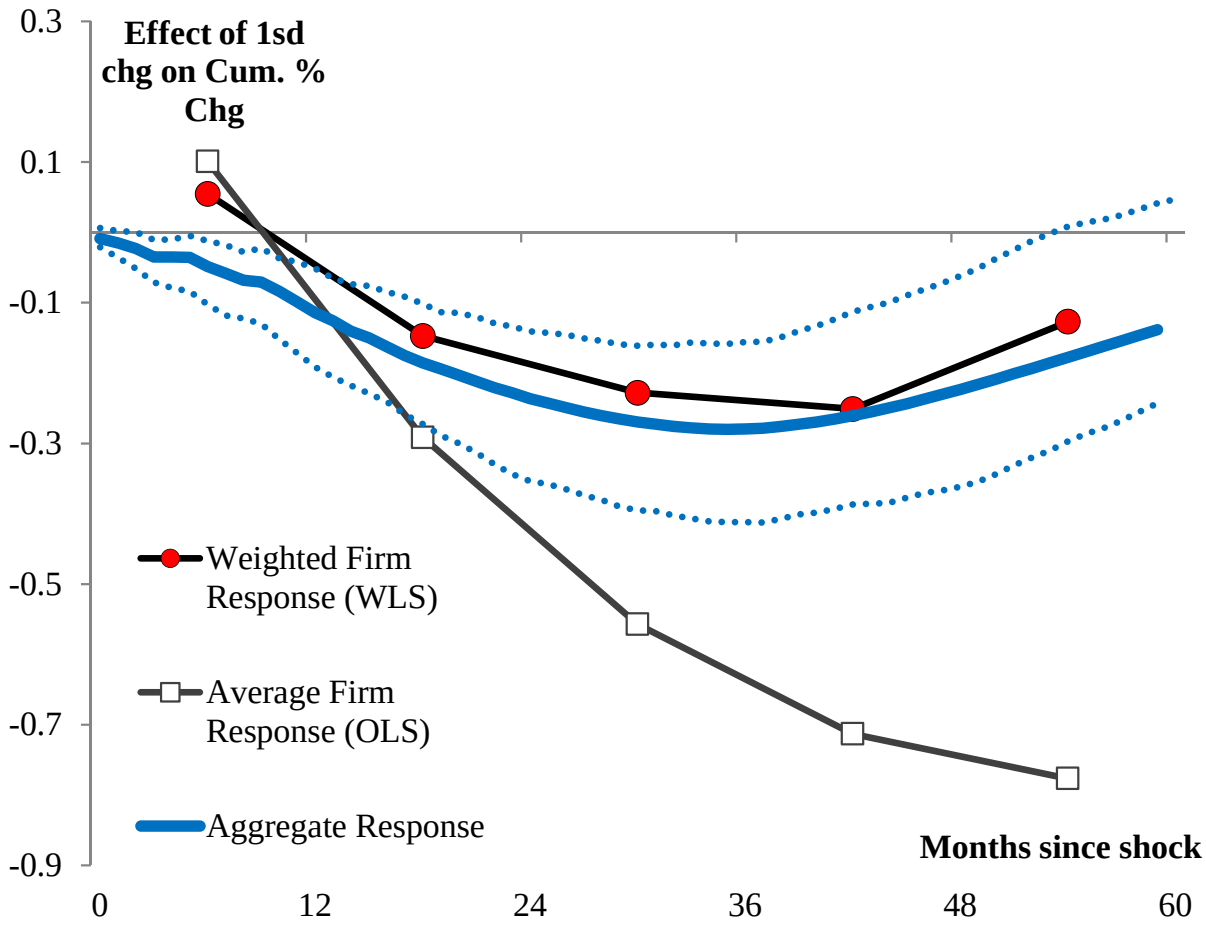
# Relative Effect of Being a Small Firm

## Firms with Fewer than 1000 Employees




Notes: Additional firm level response to a 1 standard deviation contractionary monetary policy shock when the firm is small. Black dotted lines are point estimates. Dashed lines are +/- two stand errors. The dependent variable is the cumulative growth rate in log points of employment from $t-1$ to $t+h$ where $t$ is the date of the monetary policy shock and $h$ is the x-axis.

# The Response of the Average Firm Revisited




Notes: Responses to a 1 standard deviation contractionary monetary policy shock. Grey lines with squares and black dotted lines are point estimates at the firm level, OLS and WLS estimates weighted by firm level employment respectively. Blue Line is the aggregate response in from the VAR, dashed blue lines denote 90% confidence intervals.

# Comparison of Characteristics

## Size

| | Age (years) | Employees | Leverage (Share of Assets) | Credit Score (0-100) |
|---|---|---|---|---|
| <1000 Employees | | | | |
| p25 | 7 | 4 | 0.41 | 46 |
| mean | 19 | 76 | 0.80 | 67 |
| p50 | 13 | 28 | 0.65 | 74 |
| p75 | 25 | 87 | 0.86 | 91 |
| ≥1000 Employees | | | | |
| p25 | 8 | 1413 | 0.50 | 58 |
| mean | 30 | 2001 | 0.68 | 75 |
| p50 | 19 | 2328 | 0.65 | 86 |
| p75 | 47 | 2515 | 0.82 | 92 |

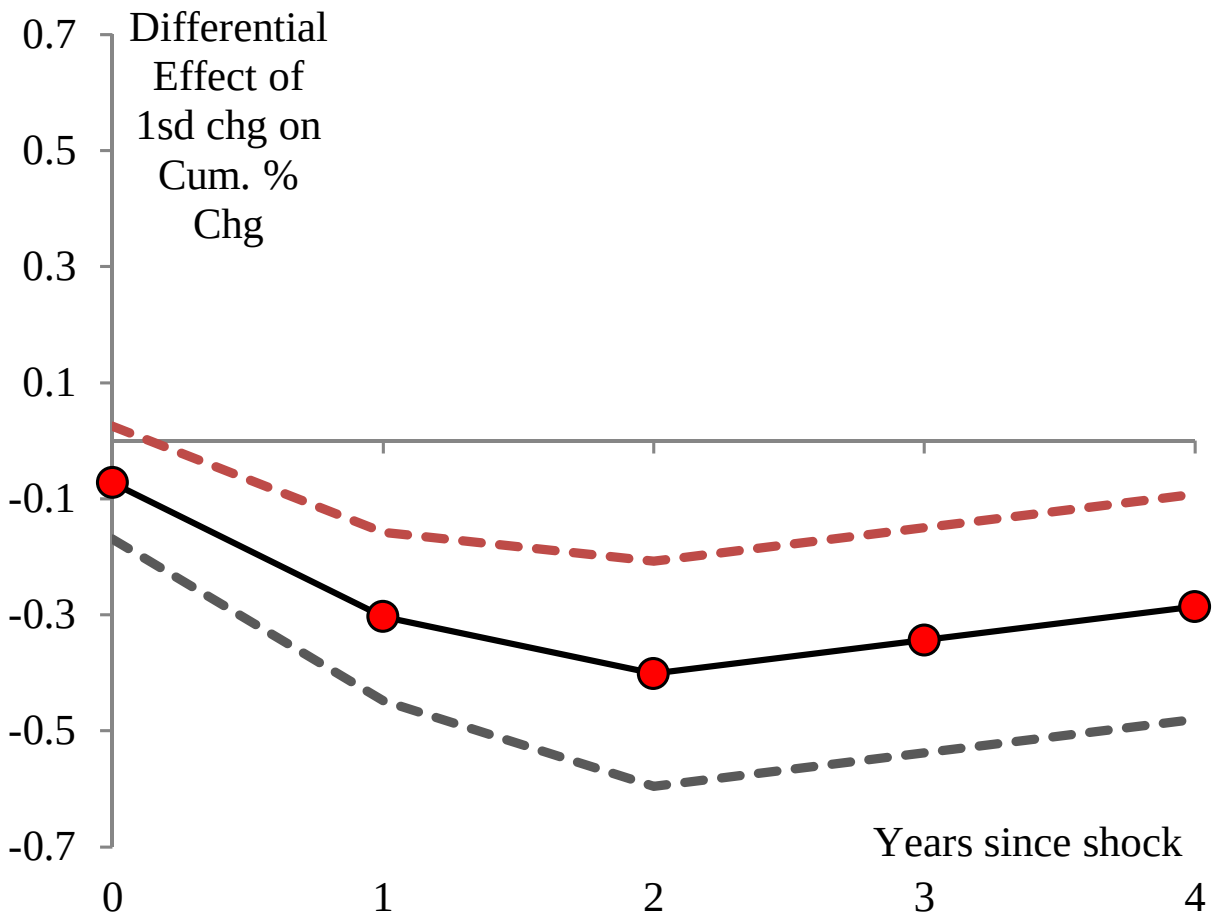
# Comparison of Characteristics

## Age

| | Age (years) | Employees | Leverage (Share of Assets) | Credit Score (0-100) |
|---|---|---|---|---|
| Less than 10 years old | | | | |
| p25 | 3 | 2 | 0.49 | 37 |
| mean | 5 | 96 | 0.96 | 59 |
| p50 | 5 | 7 | 0.76 | 59 |
| p75 | 7 | 63 | 0.97 | 89 |
| Greater than 10 years old | | | | |
| p25 | 15 | 9 | 0.38 | 54 |
| mean | 28 | 142 | 0.70 | 72 |
| p50 | 22 | 47 | 0.59 | 83 |
| p75 | 35 | 109 | 0.79 | 92 |

# Relative Effect of Being a Young Firm

## Less than 10 years old




Notes: Additional firm level response to a 1 standard deviation contractionary monetary policy shock when the firm is less than 10 years old. Black dotted lines are point estimates. Grey dashed lines are +/- two stand errors. The dependent variable is the cumulative growth rate in log points of employment from $t - 1$ to $t + h$ where $t$ is the date of the monetary policy shock and $h$ is the x-axis.

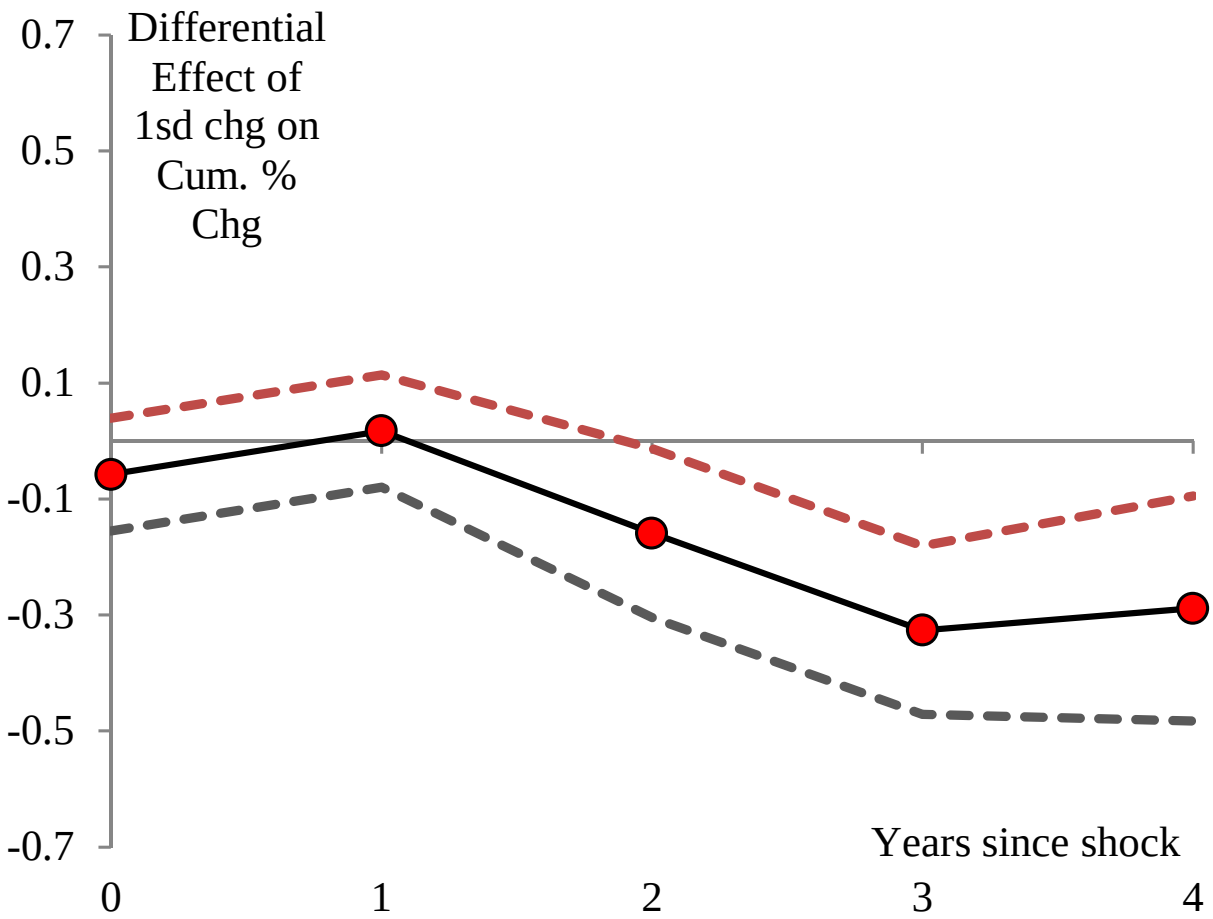
# Comparison of Characteristics

## Leverage

| | Age (years) | Employees | Leverage (Share of Assets) | Credit Score (0-100) |
|---|---|---|---|---|
| Below median leverage | | | | |
| p25 | 9 | 5 | 0.27 | 62 |
| mean | 23 | 131 | 0.42 | 77 |
| p50 | 17 | 39 | 0.45 | 87 |
| p75 | 32 | 101 | 0.58 | 93 |
| Above median leverage | | | | |
| p25 | 5 | 3 | 0.80 | 33 |
| mean | 14 | 120 | 1.30 | 55 |
| p50 | 10 | 21 | 0.90 | 53 |
| p75 | 19 | 88 | 1.01 | 86 |

# Relative Effect of Being a Highly Levered Firm

## Leverage above the Median




Notes: Additional firm level response to a 1 standard deviation contractionary monetary policy shock when the firm is highly levered. Black dotted lines are point estimates. Grey dashed lines are +/- two stand errors. The dependent variable is the cumulative growth rate in log points of employment from $t-1$ to $t+h$ where $t$ is the date of the monetary policy shock and $h$ is the x-axis.

# Credit Score

- Credit Score: QuiScore is a propriety measure of creditworthiness developed by UK credit rating agency CIRF; primarily used to rate small firms.
- The QuiScore is calculated from a number of financial variables including fixed assets and shareholder funds.
- The QuiScore runs from 0-100 and indicates the probability of the company failing within the next year
- Companies with a QuiScore of 61-100 are stable/secure and are very unlikely to fail.
- Companies with a QuiScore of 0-60 are far more likely to fail.

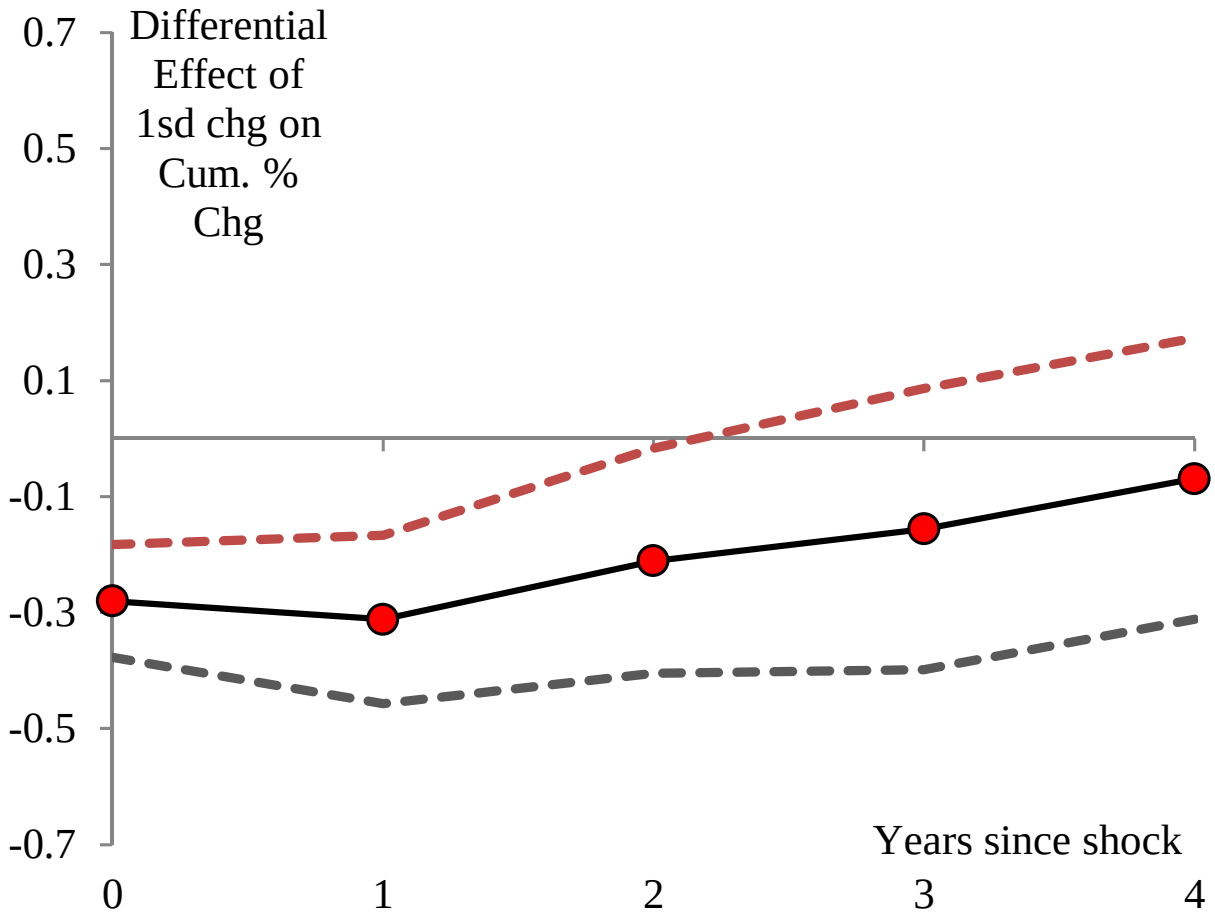
# Comparison of Characteristics

## Credit Score

| | Age (years) | Employees | Leverage (Share of Assets) | Credit Score (0-100) |
|---|---|---|---|---|
| QuiScore<60 | | | | |
| p25 | 5 | 2 | 0.61 | 28 |
| mean | 15 | 89 | 1.12 | 37 |
| p50 | 10 | 8 | 0.80 | 40 |
| p75 | 19 | 59 | 0.99 | 50 |
| QuiScore≥60 | | | | |
| p25 | 8.25 | 8 | 0.33 | 79 |
| mean | 22 | 152 | 0.57 | 85 |
| p50 | 16 | 51 | 0.53 | 90 |
| p75 | 29 | 118 | 0.75 | 93 |

# Relative Effect of Being a Firm with a Bad Credit Score

## Score less than "Stable" (60)




Notes: Additional firm level response to a 1 standard deviation contractionary monetary policy shock when the firm has a low credit score. Black dotted lines are point estimates. Grey dashed lines are +/- two stand errors. The dependent variable is the cumulative growth rate in log points of employment from $t - 1$ to $t + h$ where $t$ is the date of the monetary policy shock and $h$ is the x-axis.

# Conclusions

- Empirical evidence on the impact of monetary policy shocks at the firm level
- Near representative sample: consistent with the aggregate
- Small firms respond more
- Consistent with financial frictions

**Future Work**:

- Double-sorts of firm characteristics
- Merge balance sheet data with administrative employment data

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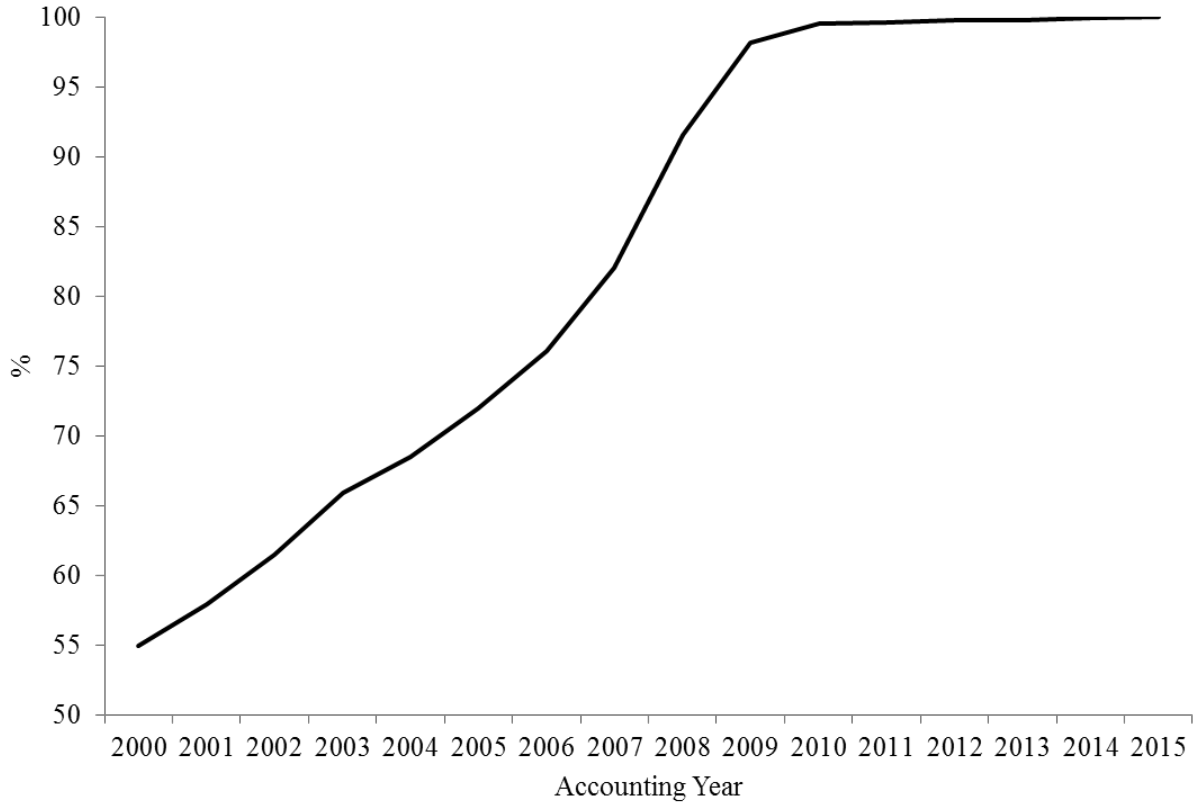
# Appendix Material

# Illustrating the Selection Effect

## Fraction of Companies Present in August 2015 Vintage




Notes: the figure displays the proportion of companies in each statement year, as derived from the full panel of 21 discs, that are present in the August 2015 disc.

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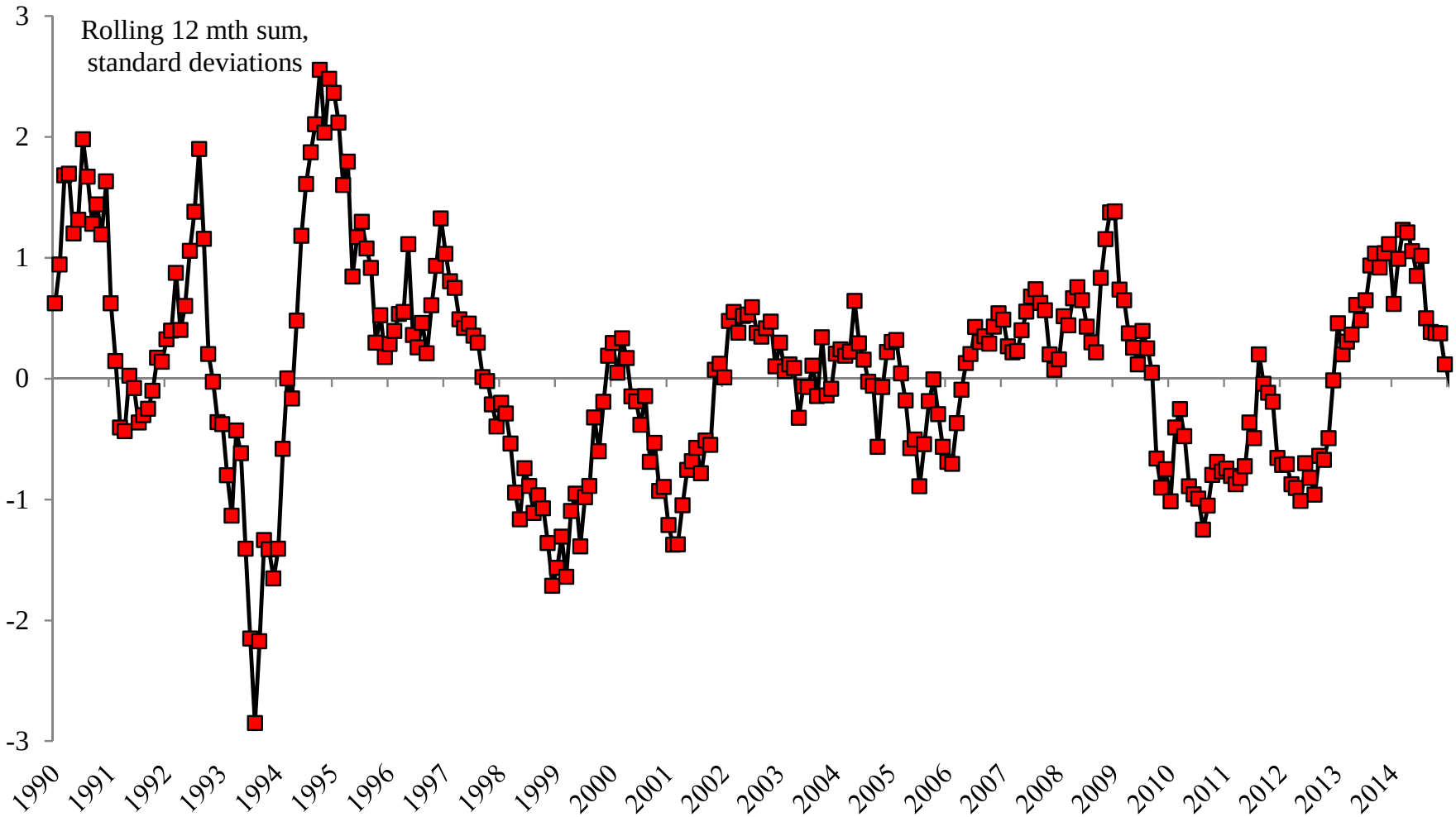
# Shock Series Extracted from the VAR

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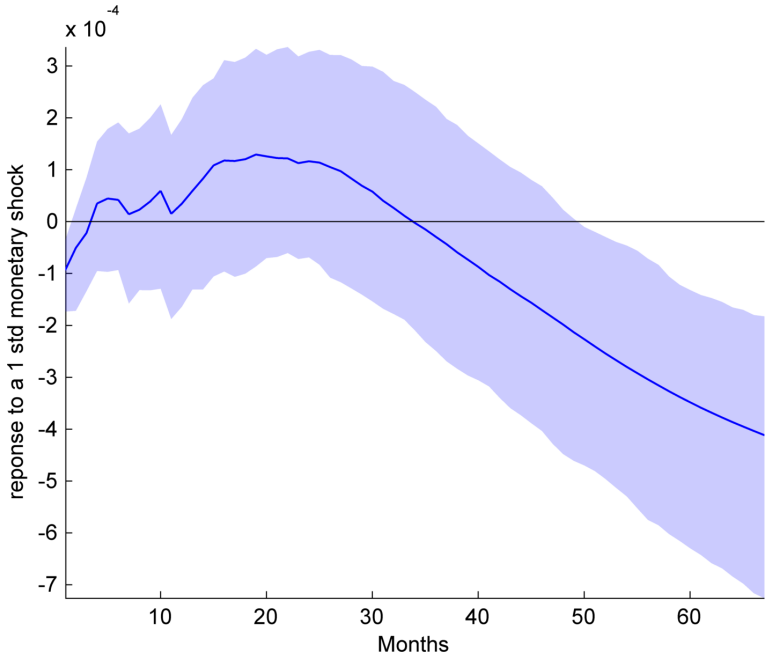
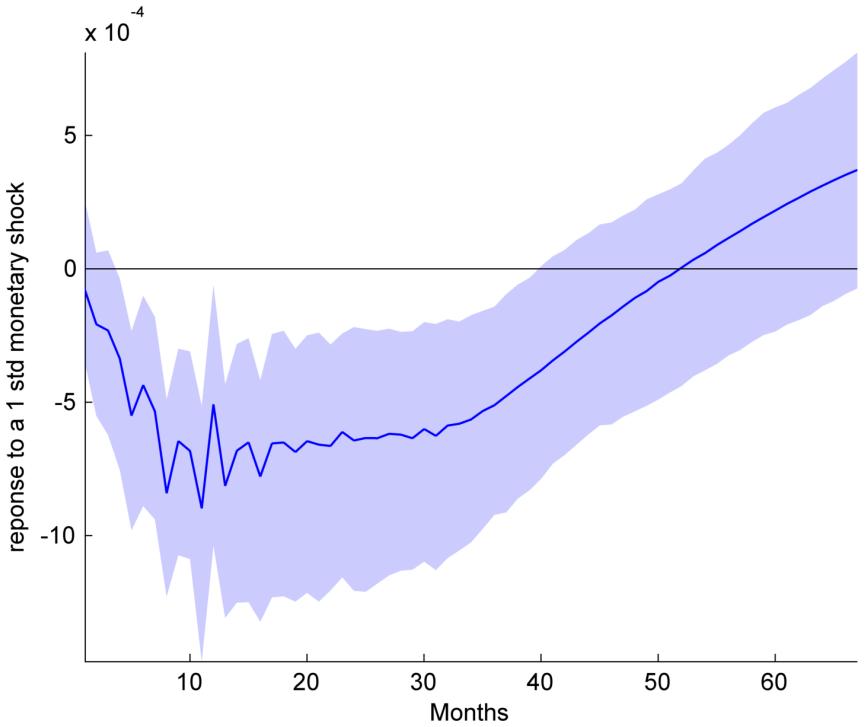
# Aggregate Responses to Monetary Policy Shock

## 1sd monthly contractionary shock

### Retail Prices (ex Mortgages)




### Industrial Production




Notes: Estimates are from a proxy SVAR estimated on UK monthly data over the period 1982-2012. Monetary policy shocks are identified using the Gerko and Rey [2017] series. The blue solid lines are the point estimates, and the shaded areas are the 90% confidence intervals constructed from a wild recursive bootstrap.

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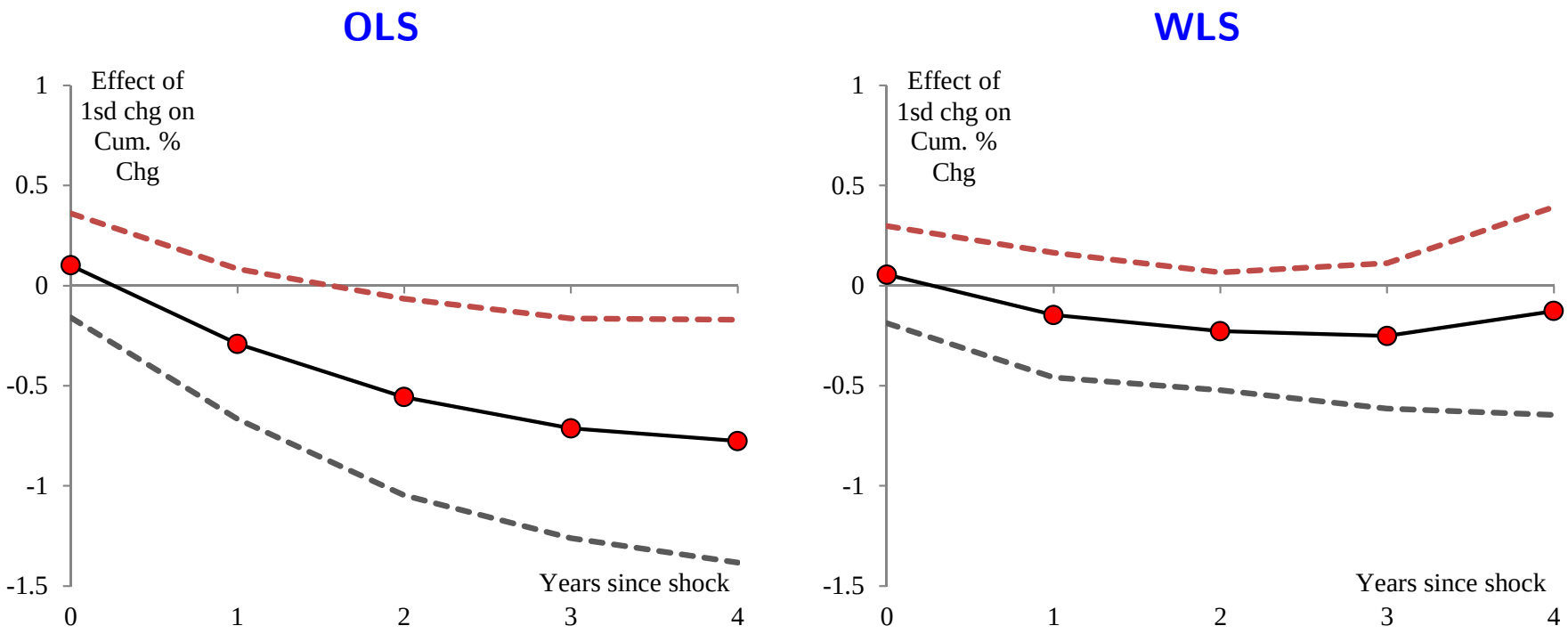
# Employment Responses: 1sd Annual Contractionary Shock

## With Standard Errors




Notes: Firm level responses to a 1 standard deviation contractionary monetary policy shock. Black dotted lines are point estimates. Grey dashed lines are +/- two stand errors. The dependent variable is the cumulative growth rate in log points of employment from $t - 1$ to $t + h$ where $t$ is the date of the monetary policy shock and $h$ is the x-axis.

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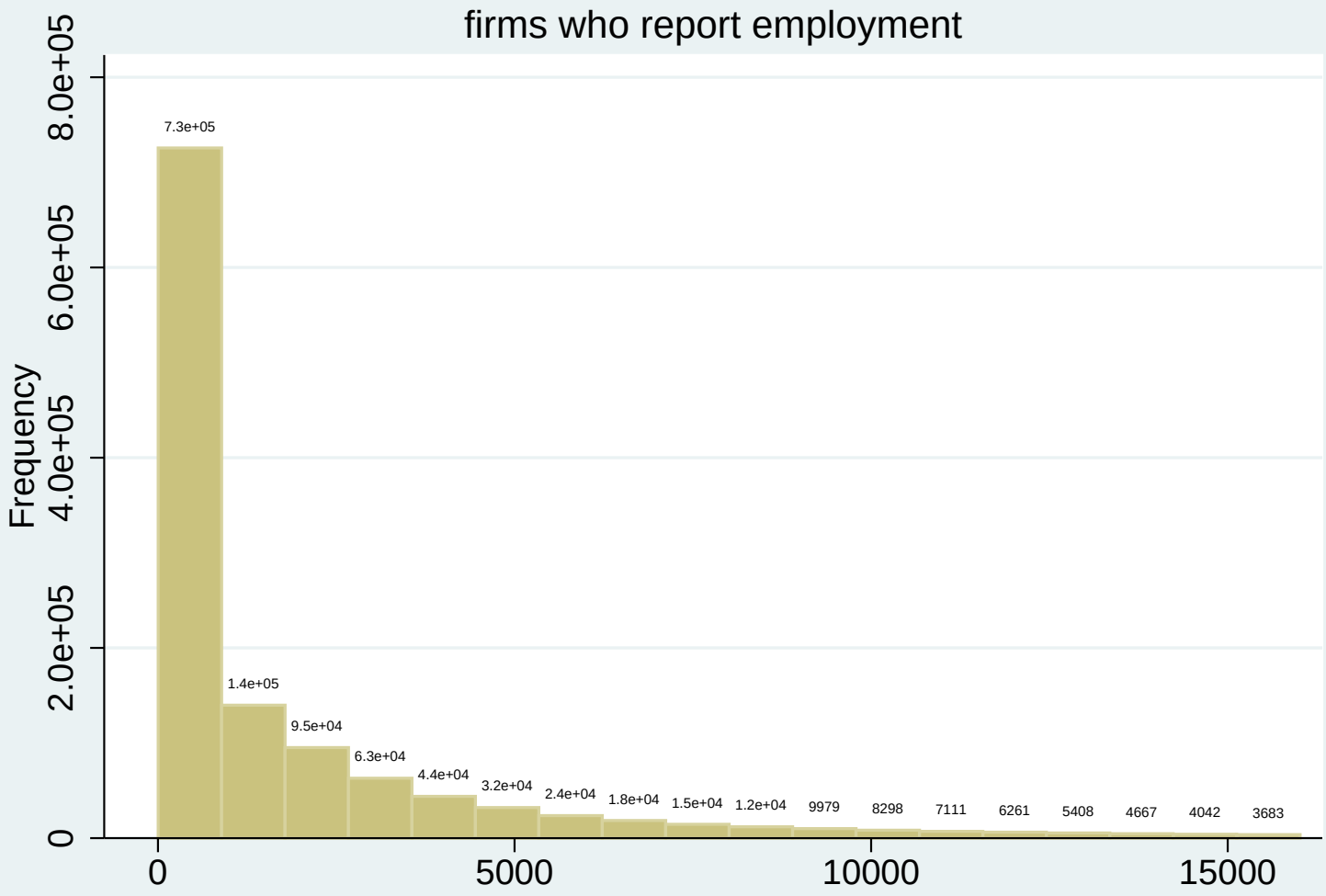
# Histogram: Total Assets

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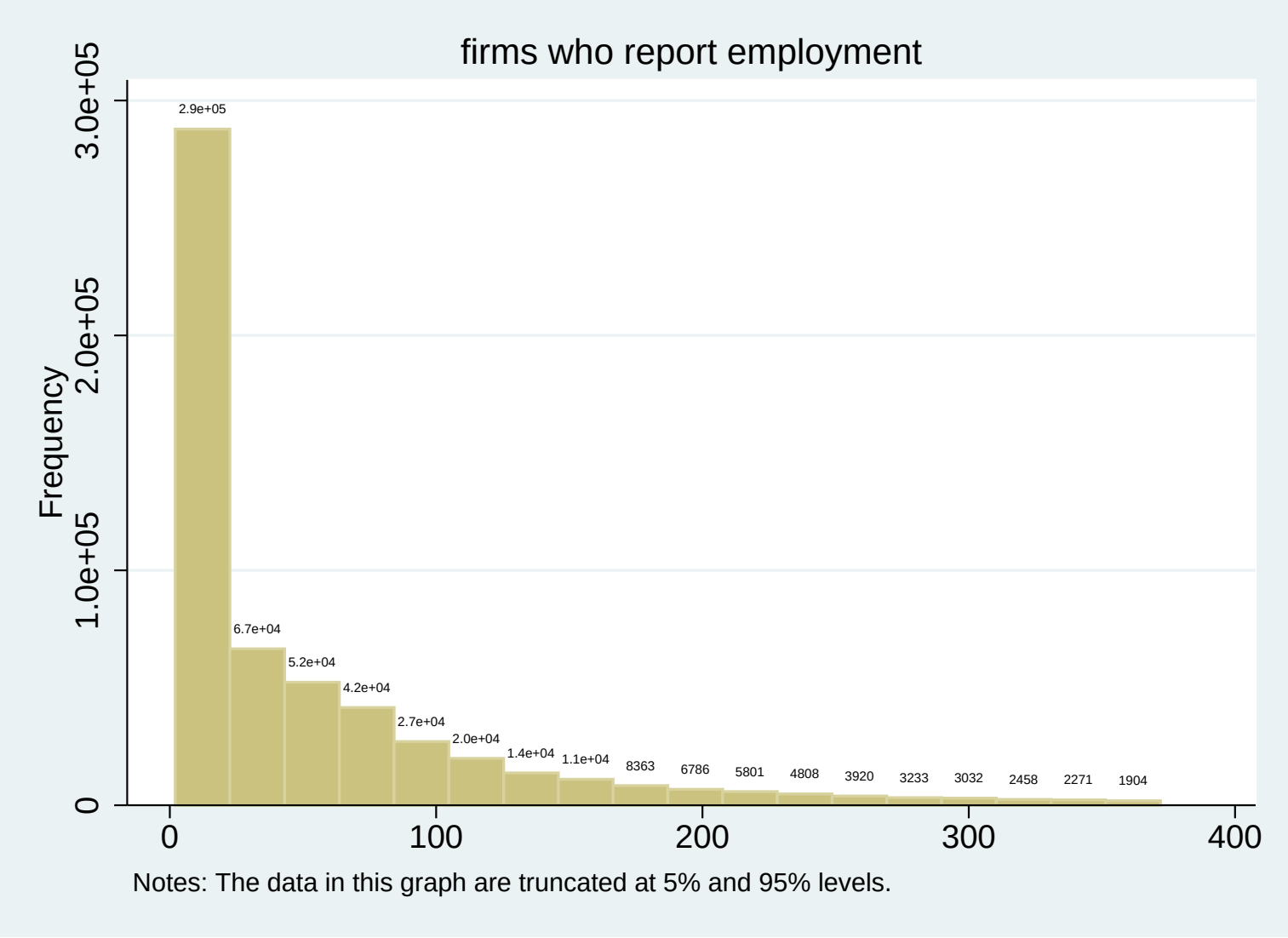
# Histogram: Number of Employees

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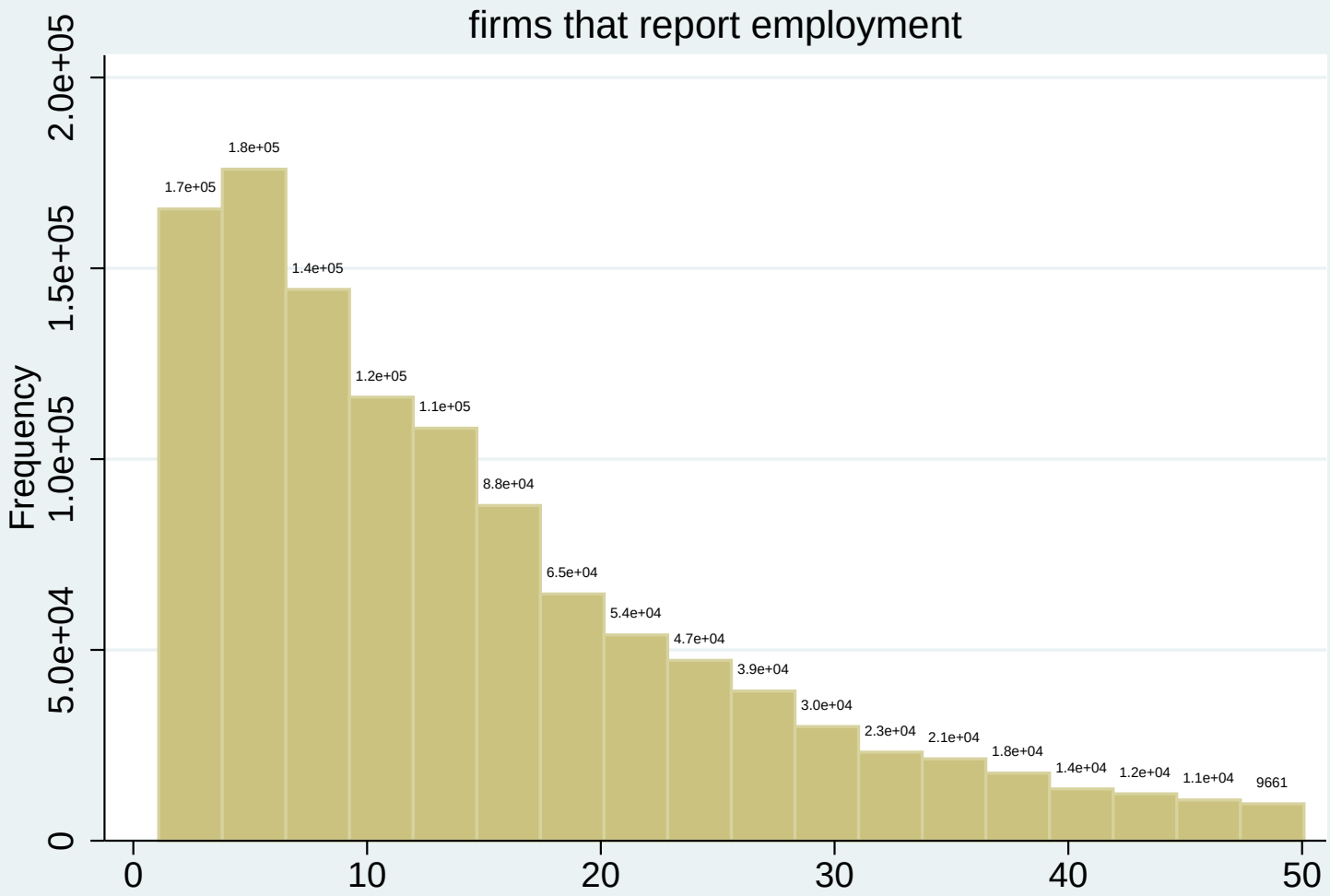
# Histogram: Age

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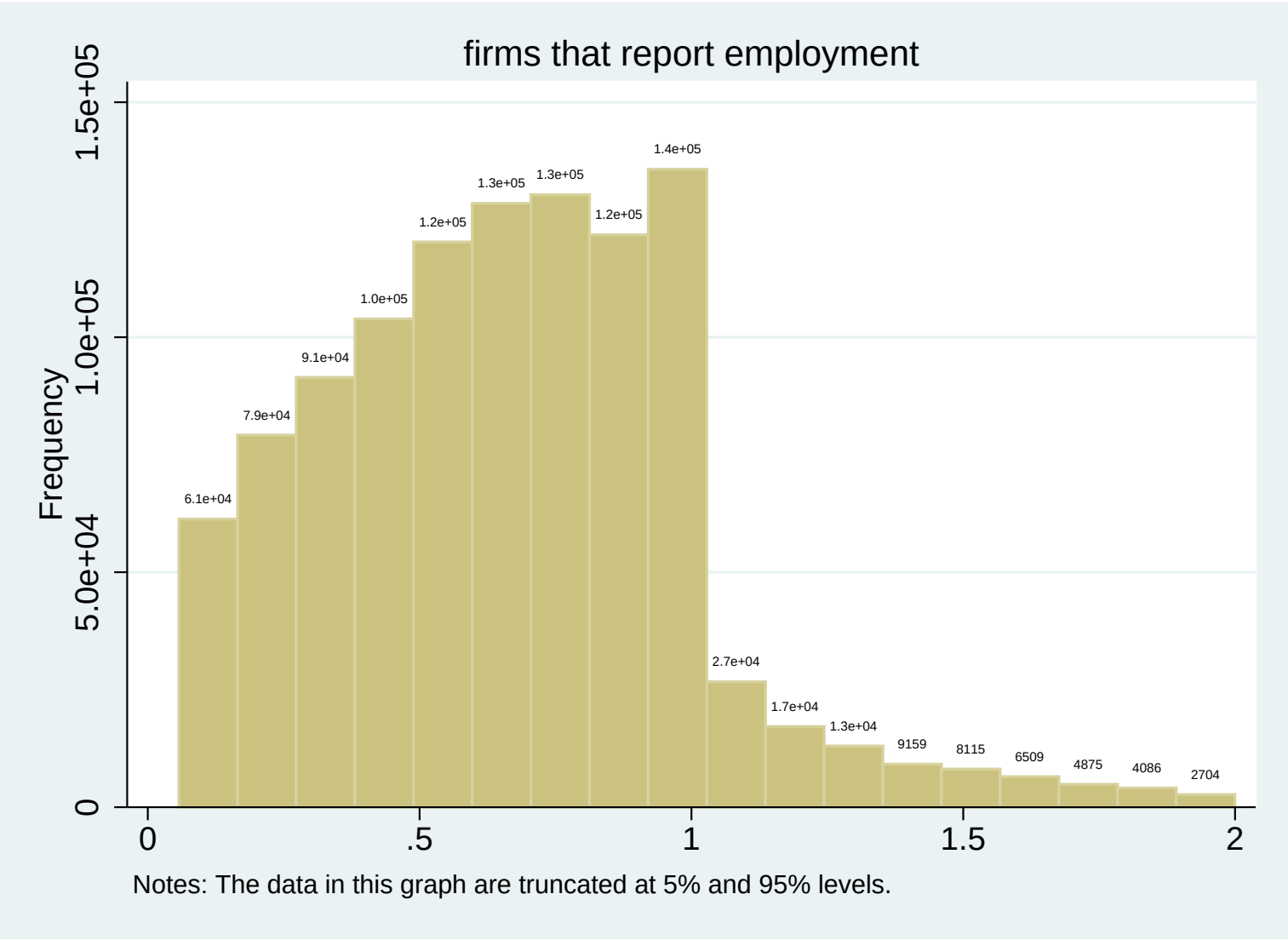
# Histogram: Debt to Assets

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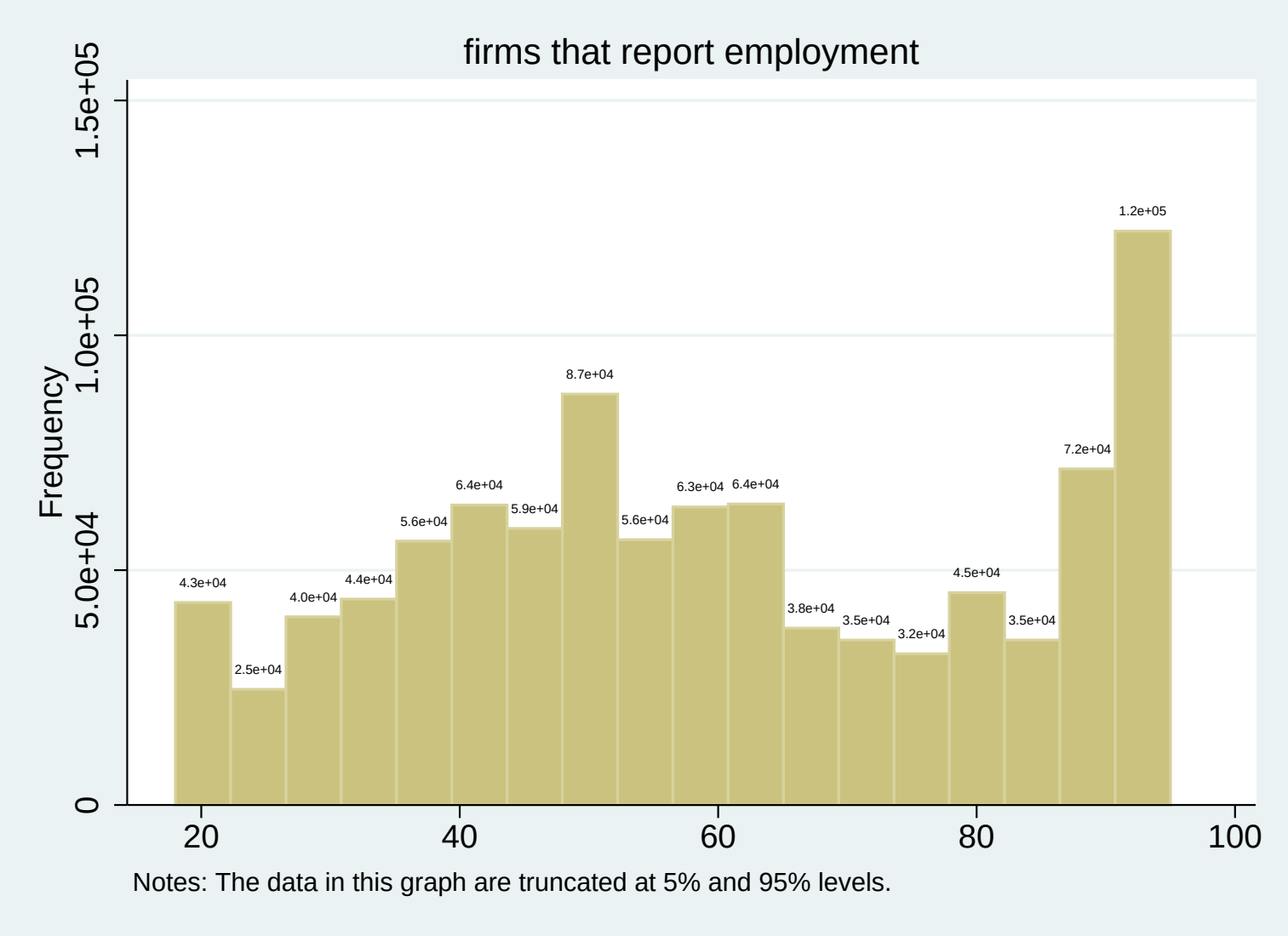
# Histogram: Credit Score

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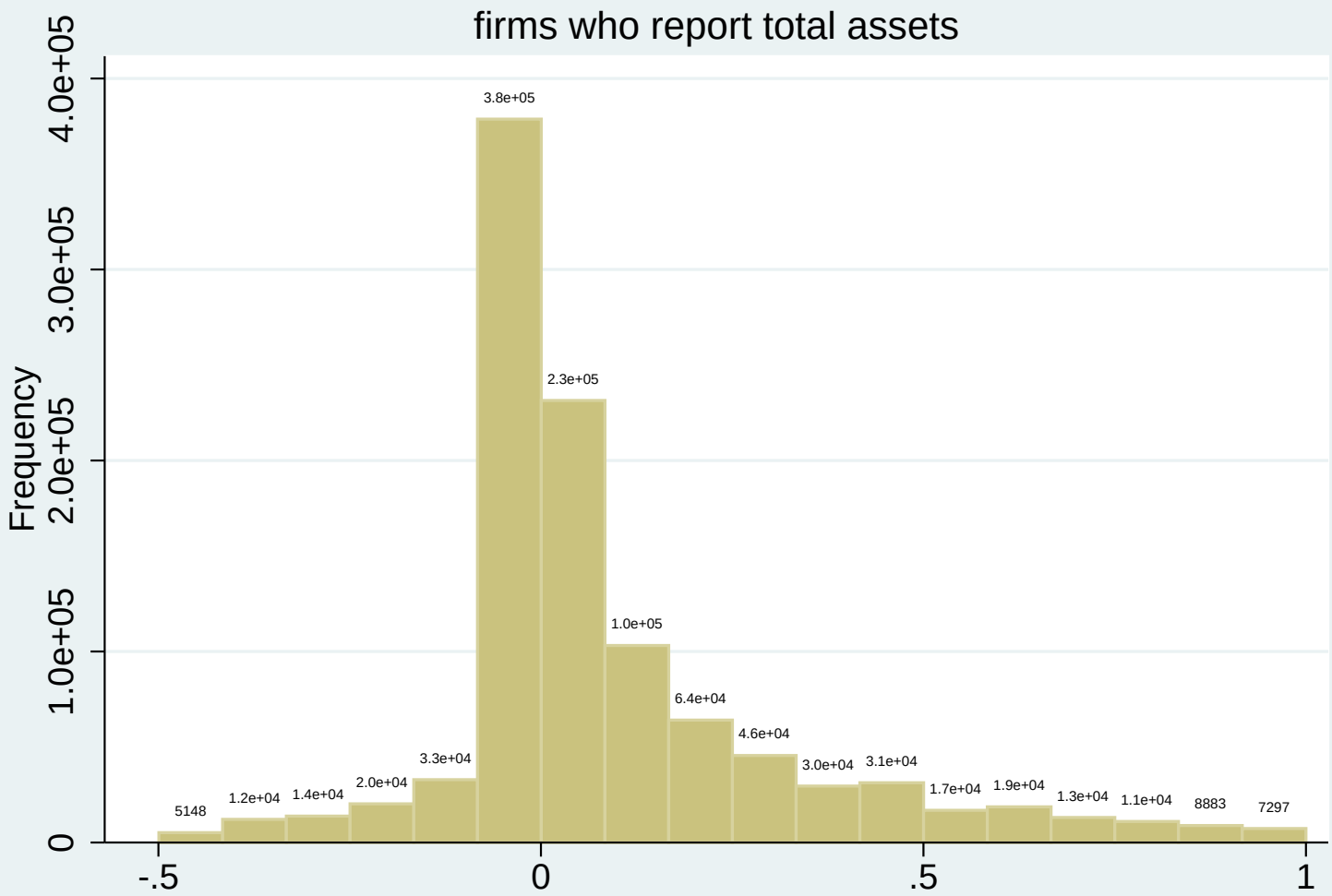
# Histogram: Interest Coverage Ratio

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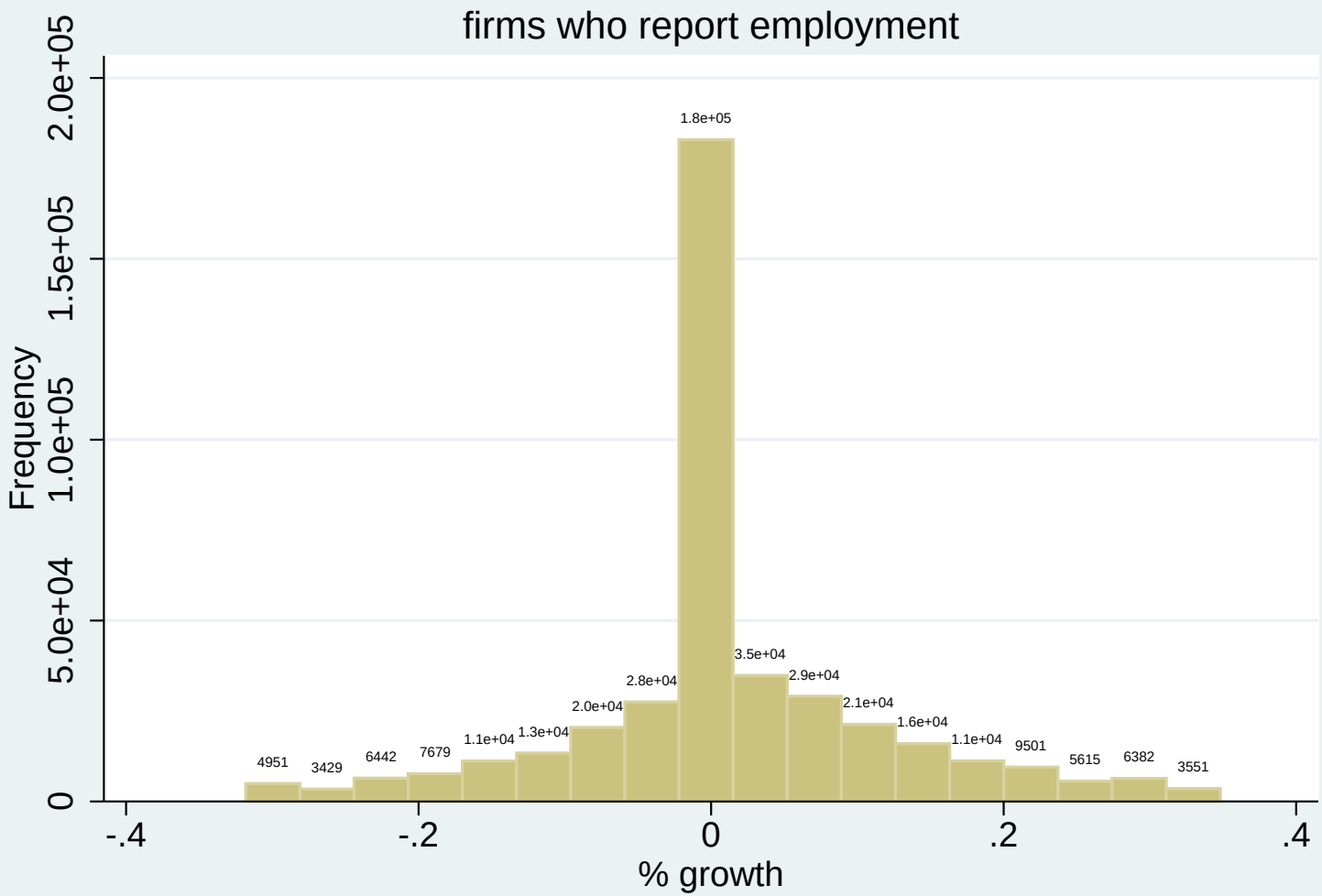
# Histogram: Employment Growth 1-year




Notes: The data in this graph are truncated at 5% and 95% levels.

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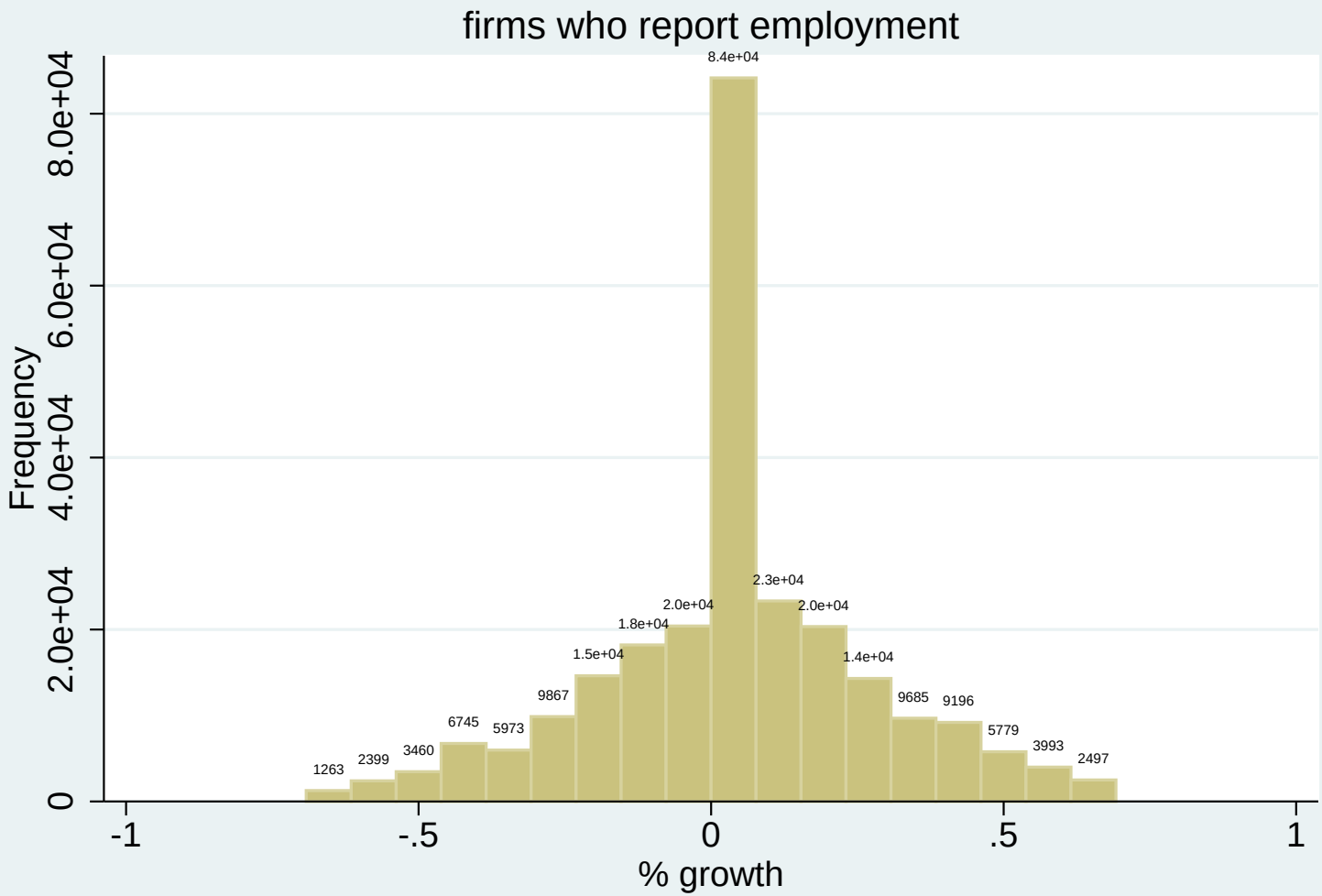
# Histogram: Employment Growth 3-year




Notes: The data in this graph are truncated at 5% and 95% levels.

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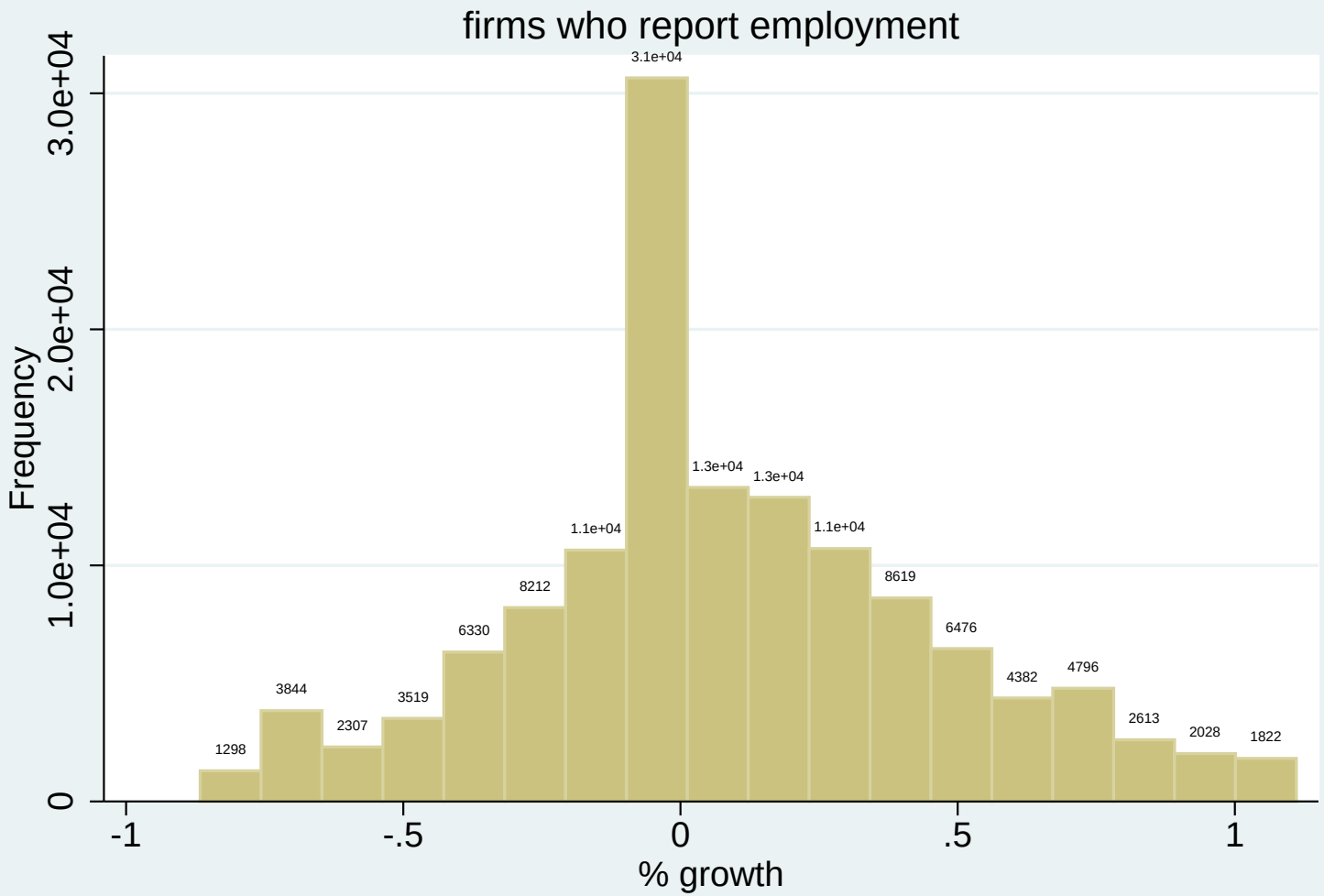
# Histogram: Employment Growth 5-year




Notes: The data in this graph are truncated at 5% and 95% levels.

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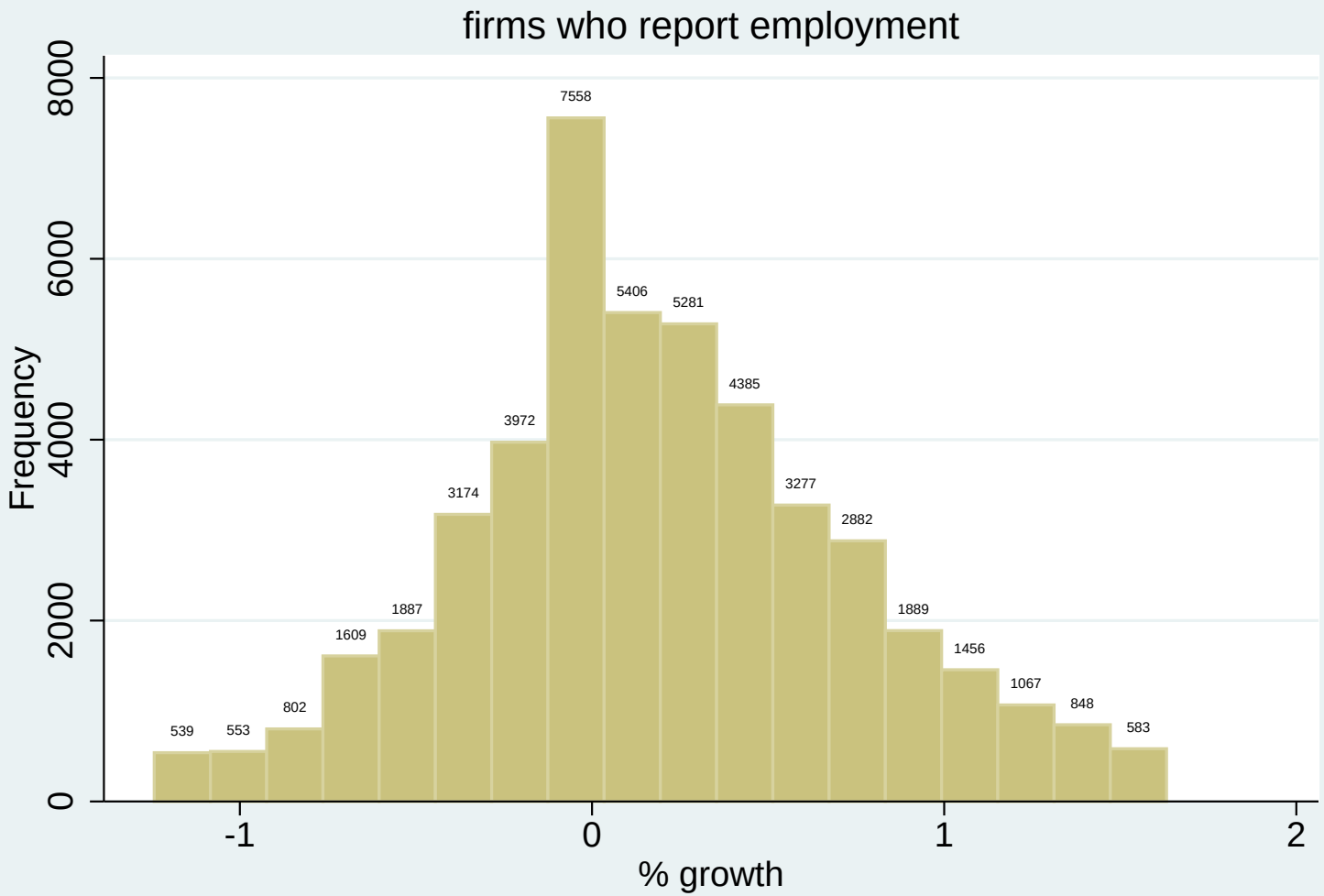
# Histogram: Employment Growth 10-year




Notes: The data in this graph are truncated at 5% and 95% levels.

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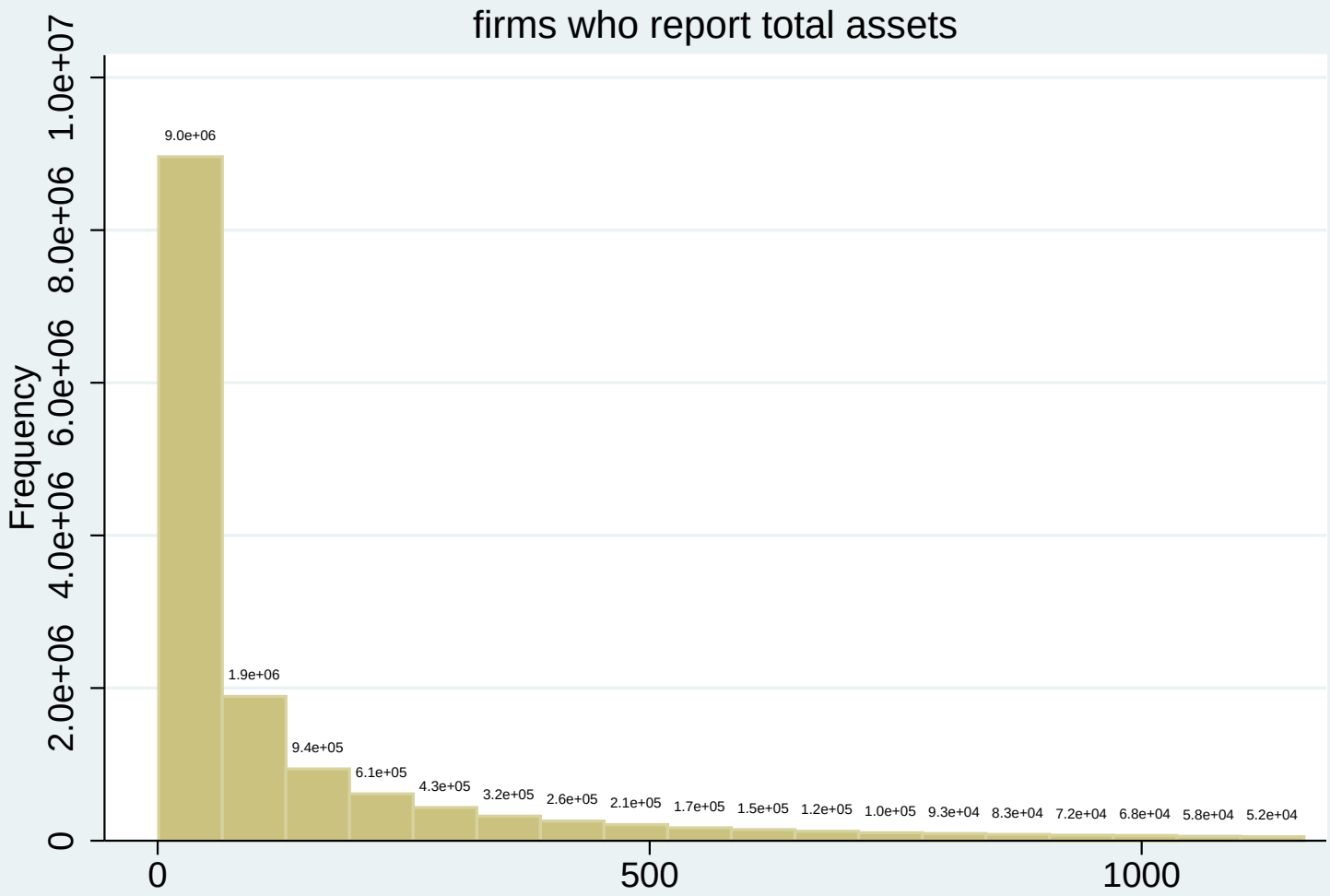
# Histogram: Total Assets




Notes: The data in this graph are truncated at 5% and 95% levels.

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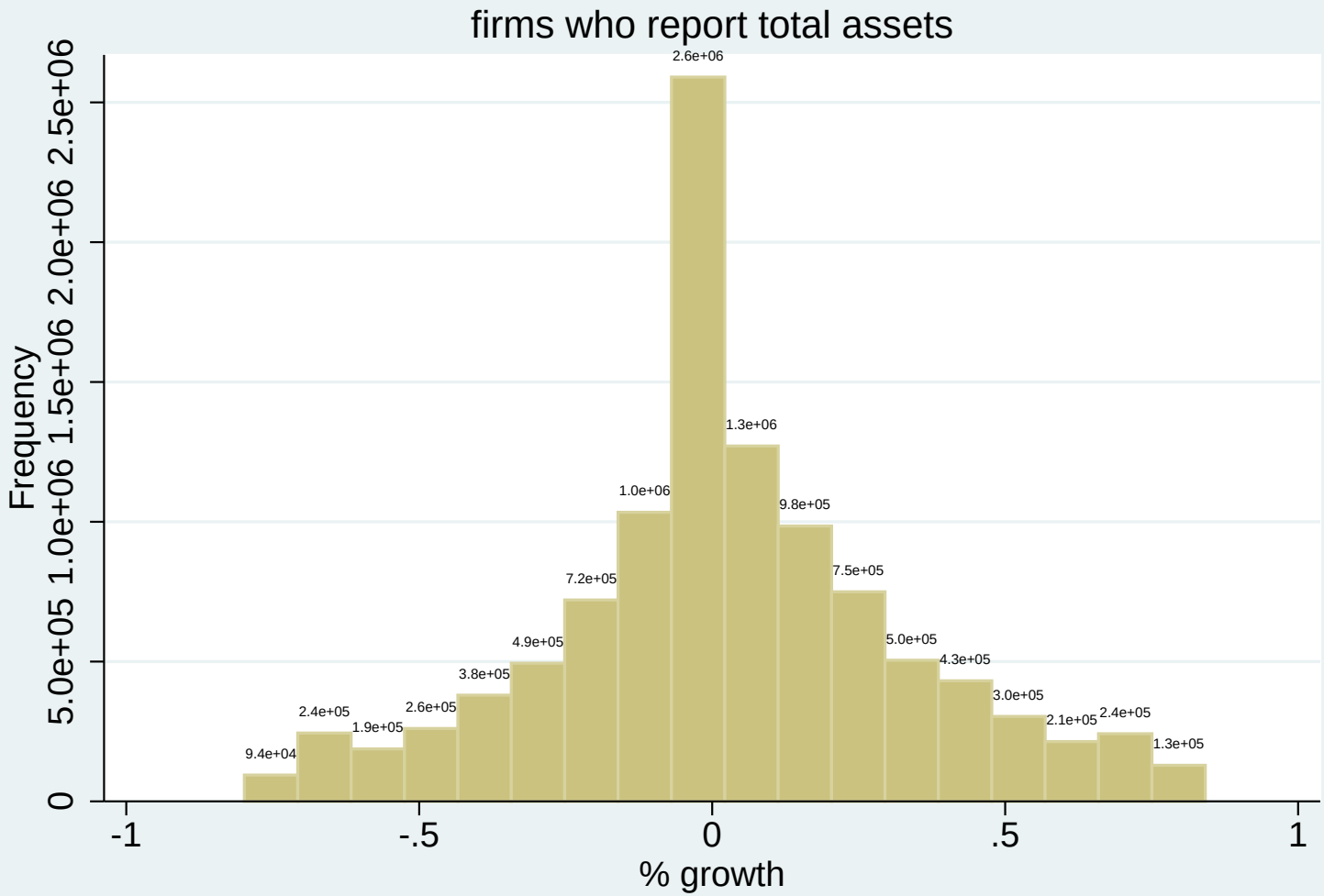
# Histogram: Asset Growth 1-year




Notes: The data in this graph are truncated at 5% and 95% levels.

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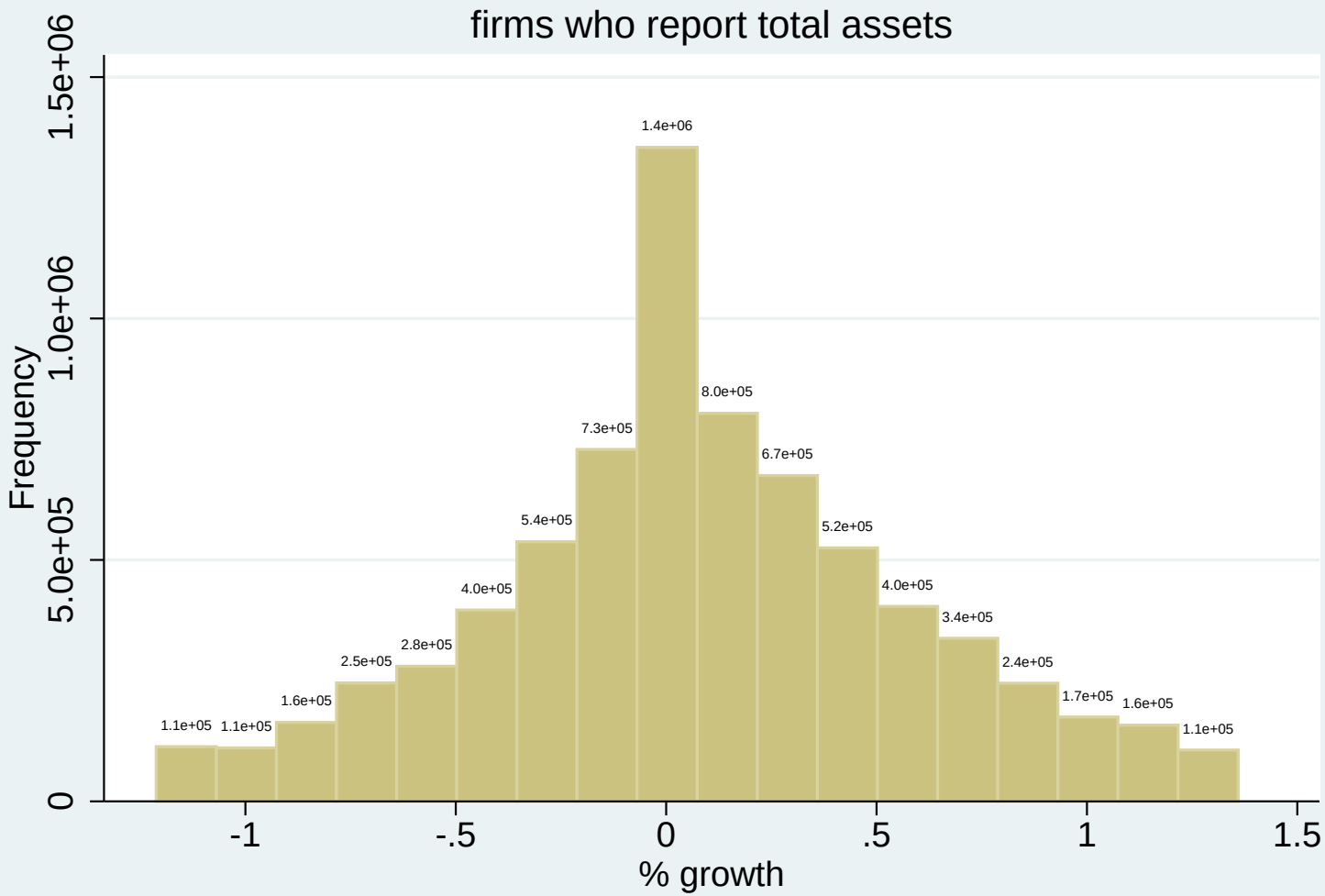
# Histogram: Asset Growth 3-year




Notes: The data in this graph are truncated at 5% and 95% levels.

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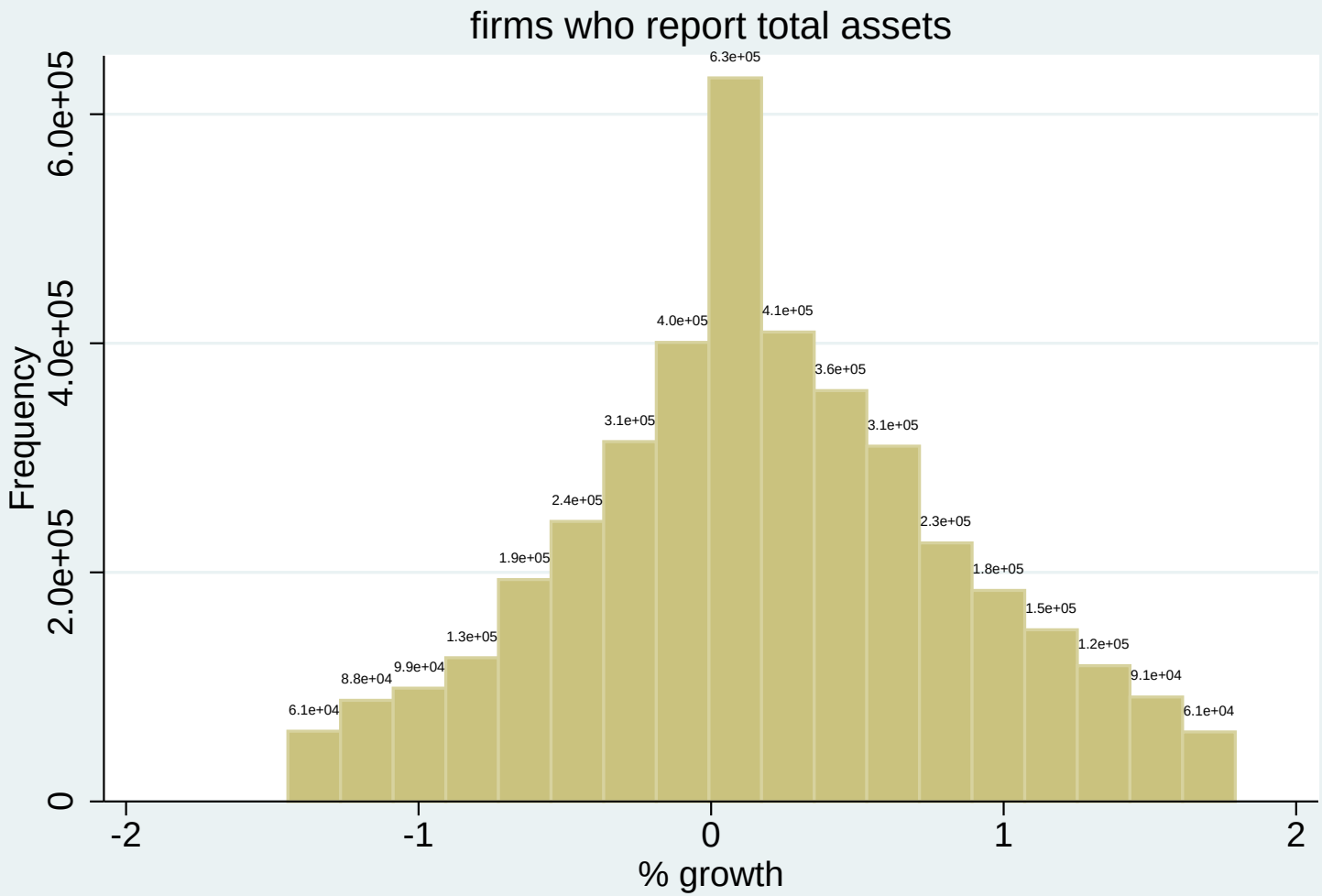
# Histogram: Asset Growth 5-year




Notes: The data in this graph are truncated at 5% and 95% levels.

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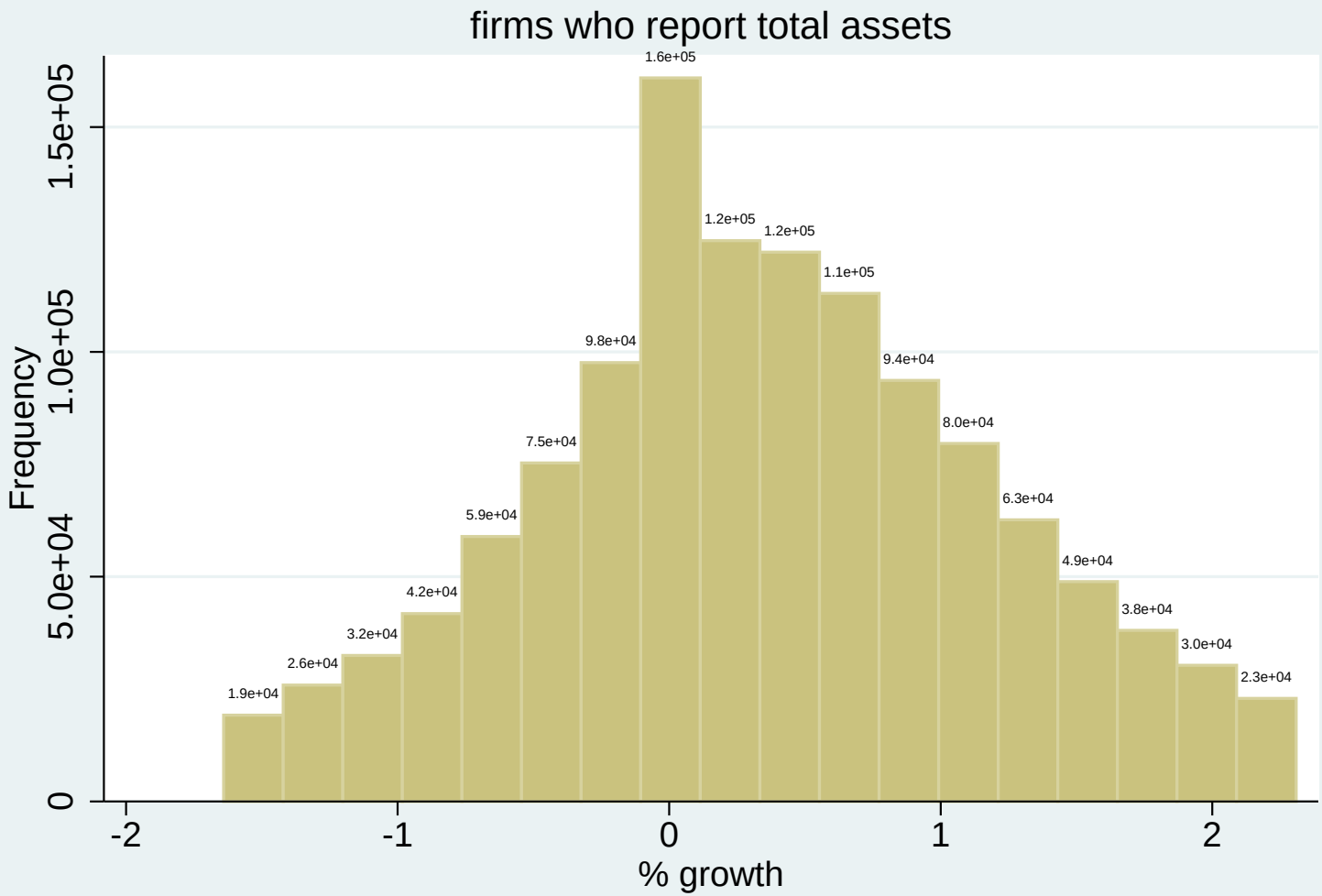
# Histogram: Asset Growth 10-year




Notes: The data in this graph are truncated at 5% and 95% levels.

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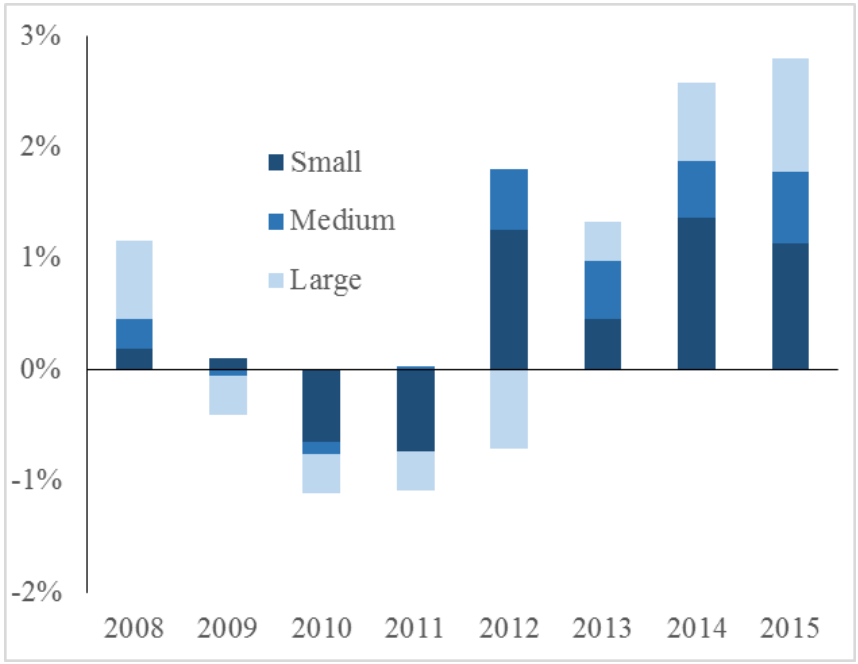
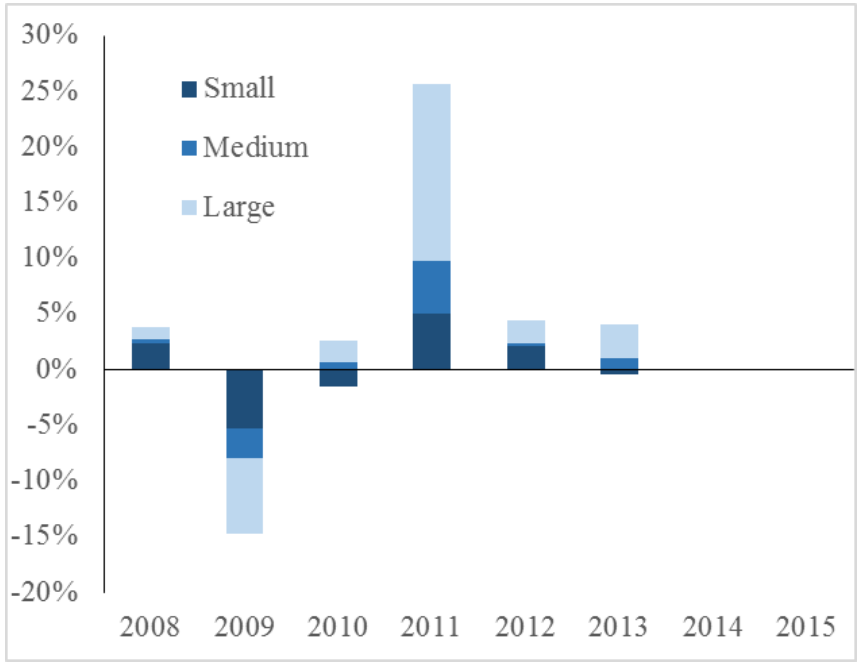
# Are Small Firms Important?

## Contributions to Macro Dynamics by Firm Size

Employment




Investment Growth




Source: ONS, BSD and ABS, Note: microdata do not perfectly correspond to national accounts, small: <50 employees, medium: >50 & <250; large: >250.