Survey on Total Factor Productivity: Evidence from Iran

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Outline

1. Motivation
   - Motivation
2. Data
   - Data
3. Questions
   - TFP over Time
   - Dust and Sand

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Motivation

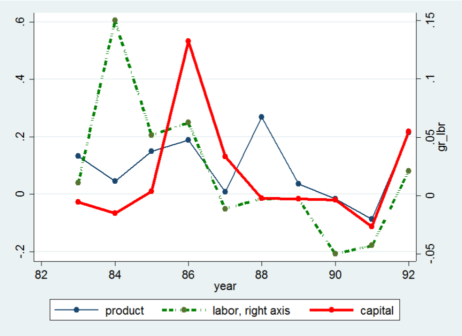

Figure: Growth rates of aggregate production, labor and capital

- Iran's industry encounters growth issues over the last years
- productivity(tfp) is ... *level of our ignorance*
- need to know its determinants
- previous studies needs to be updated

Potential Questions about TFP

- Qualitative Research
  - changes of TFP over time, trends and components (today, joint with Professor Salehi Esfahani)
  - missing middle? (Rahmati, Pilevari, 2017; Tybout, 2000; Banerjee and Duflo, 2005, 2011; McKinsey, 2001)

- Policy Evaluation
  - impact of weather quality (today, joint with Malihe Birjandi)
  - impact of entry into export market (Yousefi, Sobhani, Madanizadeh, 2017)
  - impact of trade liberalization on productivity (Heidari, Madanizadeh, Yousefi, 2017)

Outline

Dataset

- Panel of industrial plants, 2003 to 2013
- more than 32000 distinct plant, more than 161000 observations
- data is collected yearly by CSI, surveyed if $labor > 50$; surveyed if $10 < labor < 50$

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Question: TFP over Time

- Nili et al (2012) report negative trend (pp. 29 & 233)
  - using pooled cross sectional data, 1998 to 2005
  - results show decreasing aggregate tfp in all sectors, except for textile, garment, food, leather;
  - they assume non-competitive market structure
- Rahmati & Pilevari (2017) : negative trend for average TFP and aggregate TFP
  - panel of 91,088 observations (23,144 firms), 2005-2011
  - calculating tfp using Levinsohn-Petrin method
  - simple average of tfp is reported as the *average tfp*
  - tfp of a representative firm is reported as *aggregate tfp*

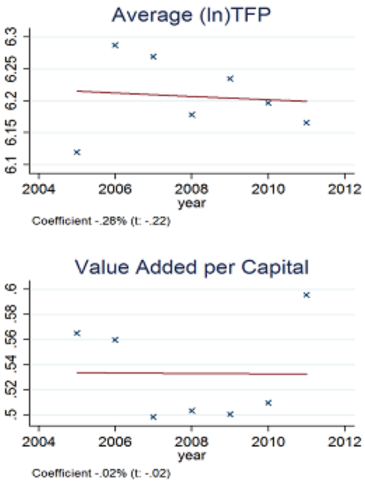


Figure: Negative Trend in Average TFP and Aggregate TFP; by Rahmati & Pilevari, 2017

What we do...

1- Data Cleaning
   - impute if missing capital or output
   - exclude duplicates (zarib=0, labor=0) and exiters
2- Calculate TFP for each firm, using method of Levinsohn-Petrin (2003)
   - we use gross output; mainly because many observations with negative value added
3- Calculate *aggregate* TFP for the industry and *decompose* it into components
   - following aggregation method used by Olley and Pakes (1996), Levinsohn and Petrin (2005; 2012), Polanec and Melitz (2012)

Empirical Model

- Assume a Cobb-Douglas production function

$$y_t = \beta_0 + \beta_l l_t + \beta_k k_t + \beta_m m_t + \omega_t + \eta_t$$

- ω is a state variable, observed by manager, unobservant by econometrician
- Simultaneity problem: ω is correlated with inputs
- Solution: take *material* a proxy to identify ω
  - Levinsohn and Petrin, 2003
  - Olleyad and Pakes, 1996

Distribution of tfp and size

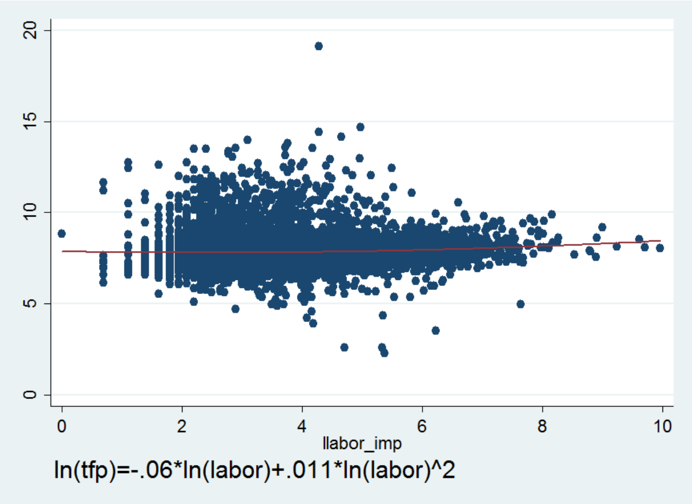


Figure: productivity vs. size is U shaped, 2013

Histogram of TFP

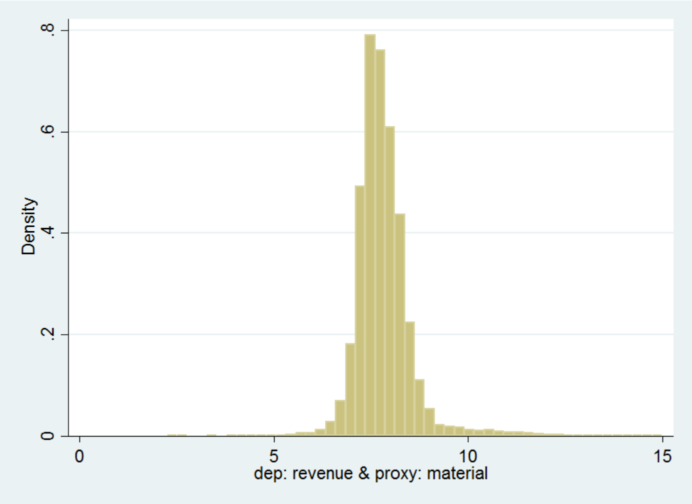
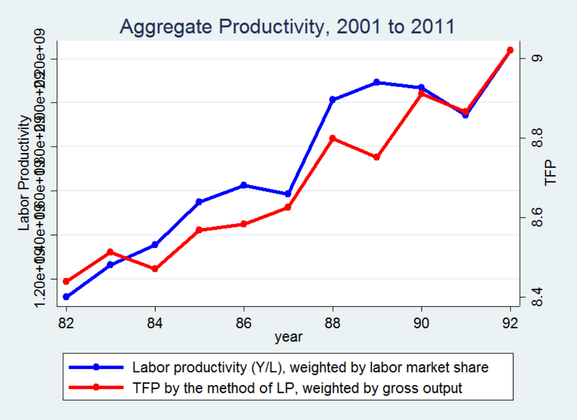


Figure: Hisotgram of TFP in 2013, no evidence of missing middle

Aggregate TFP

- Aggregate productivity is measured as the weighted summation of individual tfp: $\Sigma s_{it}\phi_{it}$
  s is market share
  ϕ is a measure of productivity



What is the Share of Small and Large firms?

- Interested to obtain the impact of exit and entry
- However, the data is sampled for $labor < 10$ and exits are not identified from sampling
- Among large firms, entry and exit are observable
- Let's first look into the share of large firms out of aggregate productivity:

$$
\begin{aligned}
\Phi &= \Sigma s_{it}\phi_{it} \\
&= \Sigma_{i \in small} s_{it}\phi_{it} + \Sigma_{i \in large} s_{it}\phi_{it} \\
&= mktshr_{small} \times \Sigma_{small} \frac{s_{it}}{mktshr_{small}} \phi_{it} \\
&+ mktshr_{large} \times \Sigma_{large} \frac{s_{it}}{mktshr_{large}} \phi_{it} \\
&= mktshr_{small} \times \Phi_{small} + mktshr_{large} \times \Phi_{large}
\end{aligned}
$$

Share of Larges and Smalls...

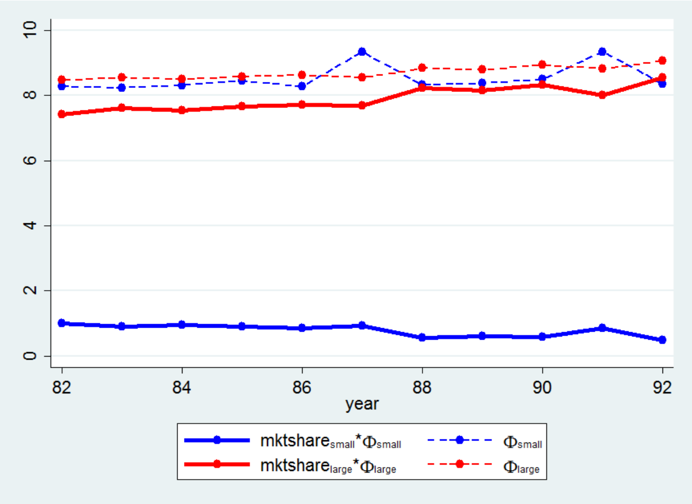


Figure: Share of large and small firms in aggregate TFP

Share of Larges and Smalls...

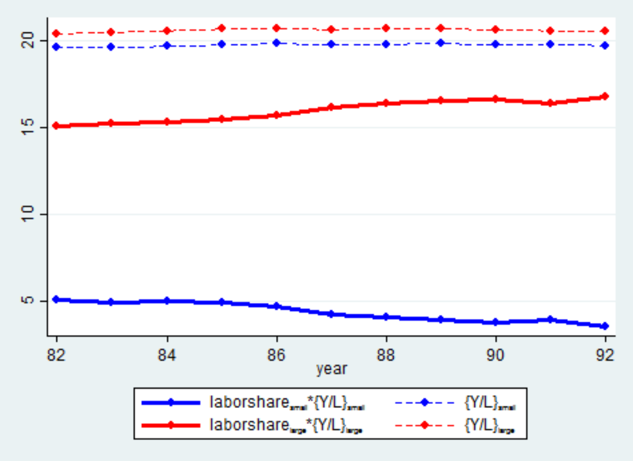


Figure: Share of large and small firms in aggregate labor market productivity

Exit and Entry

- Usually, entrants are high productive firms,
  exitings are low productive firms
- Do entry and exit makes a downward bias in measuring aggregate TFP?
- Melitz and Polanec (RAND, 2015) decompose aggregate productivity to three parts:

$$\Phi_1 = s_{S1}\Phi_{S1} + s_{X1}\Phi_{X1} = \Phi_{S1} + s_{X1}(\Phi_{X1} - \Phi_{S1})$$
$$\Phi_2 = s_{S2}\Phi_{S2} + s_{E2}\Phi_{E2} = \Phi_{S2} + s_{E2}(\Phi_{E2} - \Phi_{S2})$$

$$\Delta\Phi = (\Phi_{S2} - \Phi_{S1}) + s_{E2}(\Phi_{E2} - \Phi_{S2}) + s_{X2}(\Phi_{X1} - \Phi_{S1})$$

- Entrants adds to the aggregate $\Delta\Phi$ (if high productive)
- Exiters lower aggregate $\Delta\Phi$ (if low productive)

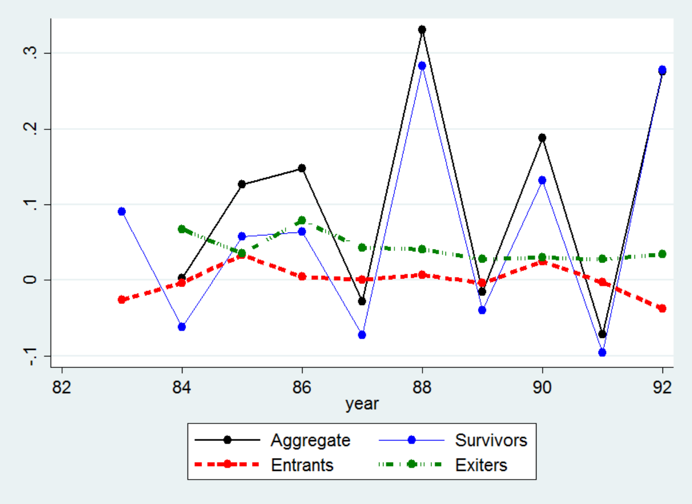


Figure: Share of entry and exit in aggregate productivity, labor> 50

Share of Entry and Exit in Aggregate Productivity Growth

Table: Aggregate Productivity Change Relative to $\Phi_{S,2004}$, labor¿50

	ΔTFP			Δlabor Productivity		
	Survivors	Entrants	Exitings	Survivors	Entrants	Exitings
2010	-0.44	-0.04	0.30	0.26	-0.18	0.08
2011	1.46	0.28	0.34	-0.21	-0.11	0.11
2012	-1.06	-0.03	0.30	-0.60	-0.09	0.07
2013	3.08	-0.41	0.38	1.63	-0.50	0.05

- Compared to incumbents, exiters are low productive both in terms of TFP and $\frac{Y}{L}$
- Entrants' *Phi* is usually worse than incumbents
- There is sharp decline in $\Delta\Phi$ and $\Delta\frac{Y}{L}$ in 2012 (sanctions)

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Question

- Does productivity affected by dust and sand?

- The effect on productivity is not explored in the literature
- The right-hand-side variable of interest (weather condition) is completely exogenous
  - remind that endogeneity is a big issue in policy evaluations
- We use Irans' recent weather quality change

Data

- Weather data is from the National Centers for Environmental Information
    - original data is on hourly basis
    - aggregated to yearly, province, county level
    - different codes are reported; we are interested in aerosoles
    - code 6: non-local dust
    - code 7: locally raised dust
- Merged with industrial plants
- observations: 88,346.
- years: 2001-2011

How firms are distributed?

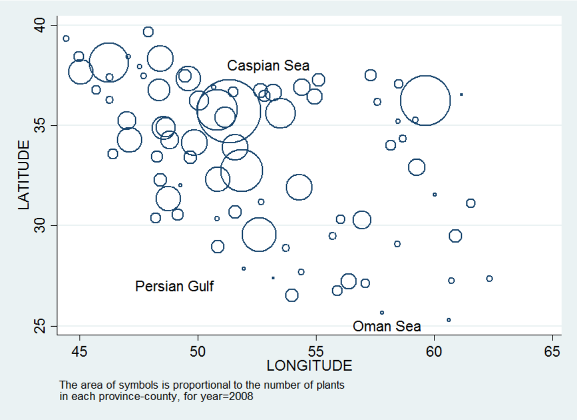

Figure: Distribution of # of plants over the county

- Size of circles is proportional to number of plants in each county, for which there exist a land-based weather station

How non-local dust is documented?

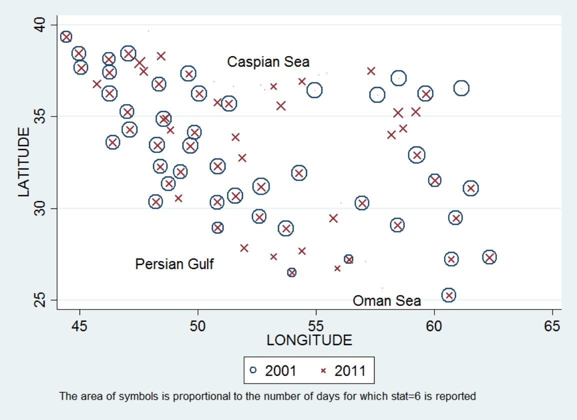

Figure: The pattern of # of days for which non local dust is reported is changing from 2001 to 2011

Model

- The coefficients of dust (α & β) show the impact of aerosoles on productivity.
- OLS model:

$$ln(productivity_{it}) = \alpha \ dust_{ct} + i.year_t + i.isic_i + i.province_c + \varepsilon_{it}$$

- Fixed Effect model:

$$ln(productivity_{it}) = \beta \ dust_{ct} + i.year_t + i.isic_i + f_i + \varepsilon_{it}$$

- productivity:
  1. TFP calculated by Levinsohn-Petrin method
  2. Labor productivity
- i: firm
- c: county

Results: Non-Local Dust

	OLS		FE	
	ln(labor productivity)	ln(TFP) LP	ln(Labor Productivity)	ln(TFP) LP
Non-local dust	-0.0029 (2.8)***	-0.0014 (3.1)***	-0.00081 (2.7)***	-0.00043 (1.9)*
Observations	88,337	88,425	88,337	88,425
R-squared	0.12	0.03	0.01	0.003
# of firms			17,192	17,192

- Labor is included, robust S.E. is reported
- In OLS regressions:
  - sampling weights imposed
  - Distinct dummies for industry, year and province are included
  - S.Es are clustered in each isic-2dgts

Results: Locally Raised Dust

	OLS		FE	
	ln(labor productivity)	ln(TFP) LP	ln(Labor Productivity)	ln(TFP) LP
Locally raised dust	-0.0023	-0.0005	-0.0007	0.00004
	-1.43	-0.83	-1.62	-0.12
Observations	88,337	88,425	88,337	88,425
R-squared	0.11	0.01	0.01	0.003
# of firms			17,192	17,192

- Labor is included, robust S.E. is reported
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What About Windy Areas?

- We are able to measure the impact of aerosoles in windy areas

$$ln(productivity_{it}) = \alpha \; dust_{ct} + \beta \; wind_{ct} \\ + \gamma \; wind_{ct} \times dust_{ct} + i.year_t + i.isic_i + i.province_c + \varepsilon_{it}$$

	OLS		FE	
	ln(labor productivity)	ln(TFP) LP	ln(Labor Productivity)	ln(TFP) LP
Non-local	-0.007	-0.002	0.0002	-0.0007
dust	(1.9)*	-1.2	-0.2	-1.1
wind×dust	0.0008	0.0002	-0.0001	0.00007
	-1.4	-0.7	-1.2	-0.6
wind speed	-0.01	-0.002	0.006	0.01
	-1.1	-0.3	-1.3	(2.6)***
labor	0.0003	0.00008	-0.0002	-0.00003
	(2.9)***	(3.2)***	(3.1)***	-0.7
Observations	87905	87993	87905	87993
R-squared	0.1175	0.0322	0.0119	0.0037

Conclusion

- Aerosol, or dust, causes a significant reduction in productivity
  - Non-local dusts ranges from 0 to 161, median 6, average 17.
  - Each 1 unit more dust causes 0.2% less labor productivity
  - Average labor productivity is $8 * 10^8$
  - Labor productivity decreases by $0.002 * 8 * 10^8$ which is 1600000.
  - Each labor's production reduces by 160,000.
  - Production of an average firm (with 77 labor) reduces by 12,000,000 per year.
- Wind decreases the impact of aerosoles
- However, the negative effect doesn't disappear
  - average wind speed is 6
  - effect of aerosol remains negative: $-0.007 + 0.0048 < 0$