Offshoring and Reorganization

A. Bernard[1] T. Fort [1] V. Smeets[2] F. Warzynski[2]

[1]Tuck School at Dartmouth

[2]Aarhus University

Stat DK meeting

June 20, 2017

Motivation

- Well documented increase in offshoring (fragmentation of tasks; entry of China in WTO;...)
- Huge literature on offshoring and employment (see HMX, 2016 for a recent review)
- Fear that it generates important losses for low skilled workers
- What is offshoring? How do we measure it?
- Little is know about how firms adapt their domestic workforce after offshoring and reallocate resources across activities
- Shift towards higher-value activities? Core competence?

Our paper

- Use very detailed offshoring survey data matched with rich Danish LEED, R&D surveys, production surveys, raw material surveys and international trade transactions
- Show what offshoring implies in terms of imports (final vs. intermediate goods)
- Show that offshoring leads firms to reallocate labor away from production activities and towards more innovative activities

Results

- around 10% of Danish firms relocated their core activity abroad over the period 2001-2006 (around one third to China)
- offshorers import more final goods than intermediate products - and the trend increases over time
- share of technology workers increases from 15% in 1999 to more than 25% in 2009 for offshorers
- the share remains stable around 15% for non offshorers
- document a causal relationship from offshoring to reallocation towards more innovative tasks using an IV strategy (work in progress):
  - offshorers increase their share of tech workers by 22%
  - offshorers increase their share of R&D expenditures by 6.5%

Theoretical motivation

- Comparative advantage and gains to specialization
  - Fragmentation allows for specialization in tasks
  - Deardorff (2001); Jones and Kierzkowski (2001); Kohler (2004); Grossman and Rossi-Hansberg (2008, 2010)
- Change in opportunity cost to innovation
  - Decrease in returns to production work affect innovation
  - Rodriguez-Clare (2010)
- Trade, technology adoption, and innovation

  Constantini and Melitz (2007); Atkeson and Burstein (2010); Lileeva and Trefler (2010); Bustos (2010); Aw, Roberts, and Xu (2011); Autor et al. (2016); Harrigan et al. (2016)

Related literature (I): offshoring and labor outcomes

- employment and wage effects of offshoring: Feenstra and Hanson, 1996, 1999; HJMX2014
- typically measures offshoring as imported intermediates
- Bloom, Draca and Van Reenen (REStud 2016); Bloom et al. (2015 WP), trapped factors
- their channel: increased competition from China
- Bøler et al. (2015 AER): cheaper R&D increases innovation and sourcing (complementary)
- More recent: Bøler (2015 WP), innovation and demand for skill; Andersen (2015 WP), importing and innovation; see also Kasahara et al. (2013 WP), importing and demand for skill
- offshoring defined as sourcing

Data

- 2007 offshoring survey run by Statistics Denmark (part of a larger effort coordinated by Eurostat)
- surveys firms with more than 20 employees in the private sector (4,161 firms responded; 98% response rate)
- questions about the **type of business function** offshored (core activity; distribution and logistics; marketing; sales and after sales services; ICT services; administrative and management functions; engineering work and other technical services; R&D; facility management; other functions); **location**; within the boundaries of the firm or not.

Offshoring definition

- the offshoring definition includes only those functions that were previously performed domestically, either by the firm itself or by another domestic firm.
- does not include offshoring of newly undertaken activities, which are asked about in another part of the survey.
- provides a direct measure of a firm's decision *to begin* offshoring in the period from 2001 to 2006
- we focus on the core activity; and on offshoring to the South, with special emphasis on China

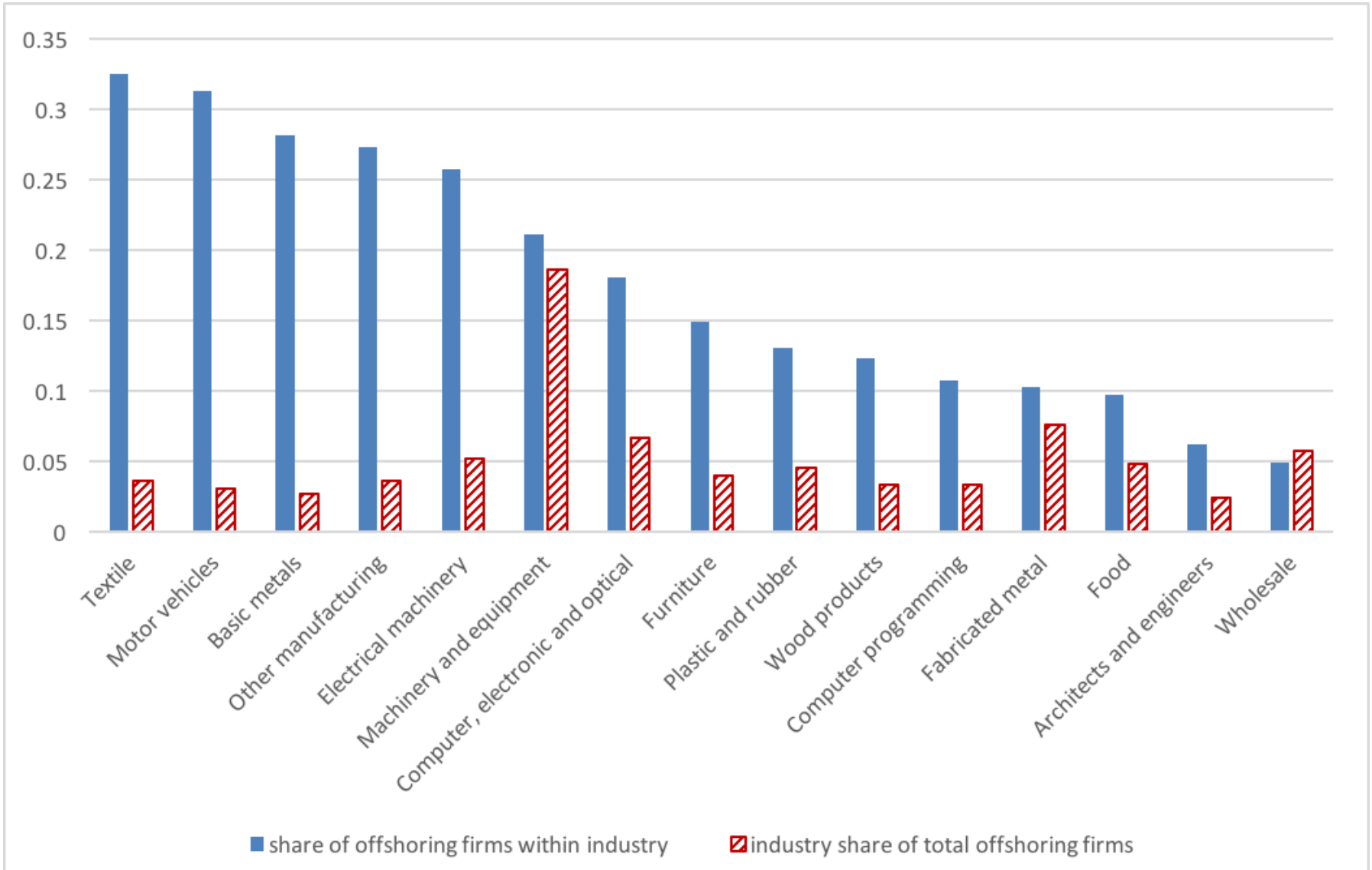
Other datasets

- accounting information from value added statistics
- population of workers from 1993 to 2011 (LEED): includes occupational code information (extension to 2013?)
- international trade transactions at the CN8 level (1993-2013)
- production survey (1995-2013) at the CN8 level
- raw material survey (2000-2013) at the CN8 level
- R&D survey (1999-2013)
- use and adoption of IT (1999-2013)

Defining tech workers

- allocate workers in 5 occupational groups based on the detailed occupational code: managers, tech workers, support workers, sales and marketing workers; production workers
- tech workers are mostly from the one-digit ISCO code 2 (professionals) and 3 (technicians and associate professionals)

Distribution of firms across industries by offshore status



Summary statistics: offshoring destinations and import

- most popular offshoring destinations are new EU members (EU-12) and China (table 1)
- many firms offshore to more than one region (table 2)
- firms that offshore to a region also import predominantly from that region (table 3)

Table 1: Offshoring of core activity by region

Region	Firm count	Share
EU-15	109	0.29
EU-12	205	0.54
Other European countries	46	0.12
China	126	0.33
India	30	0.08
Other Asian countries and Oceania	60	0.16
US and Canada	25	0.07
Total offshoring firms	380	0.091

Notes: Locations to which firms relocated their core activity.

Table 2

Table 2: Number of locations to which firms offshore core activity

No. of regions	Count	Percent
1	229	60.26
2	97	25.53
3	36	9.47
4+	18	4.74

Questions and Facts

- using our rich collection of datasets, we ask three main questions about the nature of offshoring and its consequence:
  1. what happens in terms of import behavior when firms start offshoring? what kind of goods do firms import (intermediate vs. final good; CAT) before an after (compared to non offshorers)
  2. do we observe a **relationship** between offshoring, innovation & internal reorganization?
  3. can we identify a **causal effect** of offshoring on internal reorganization? (work in progress)
- Accumulate set of facts

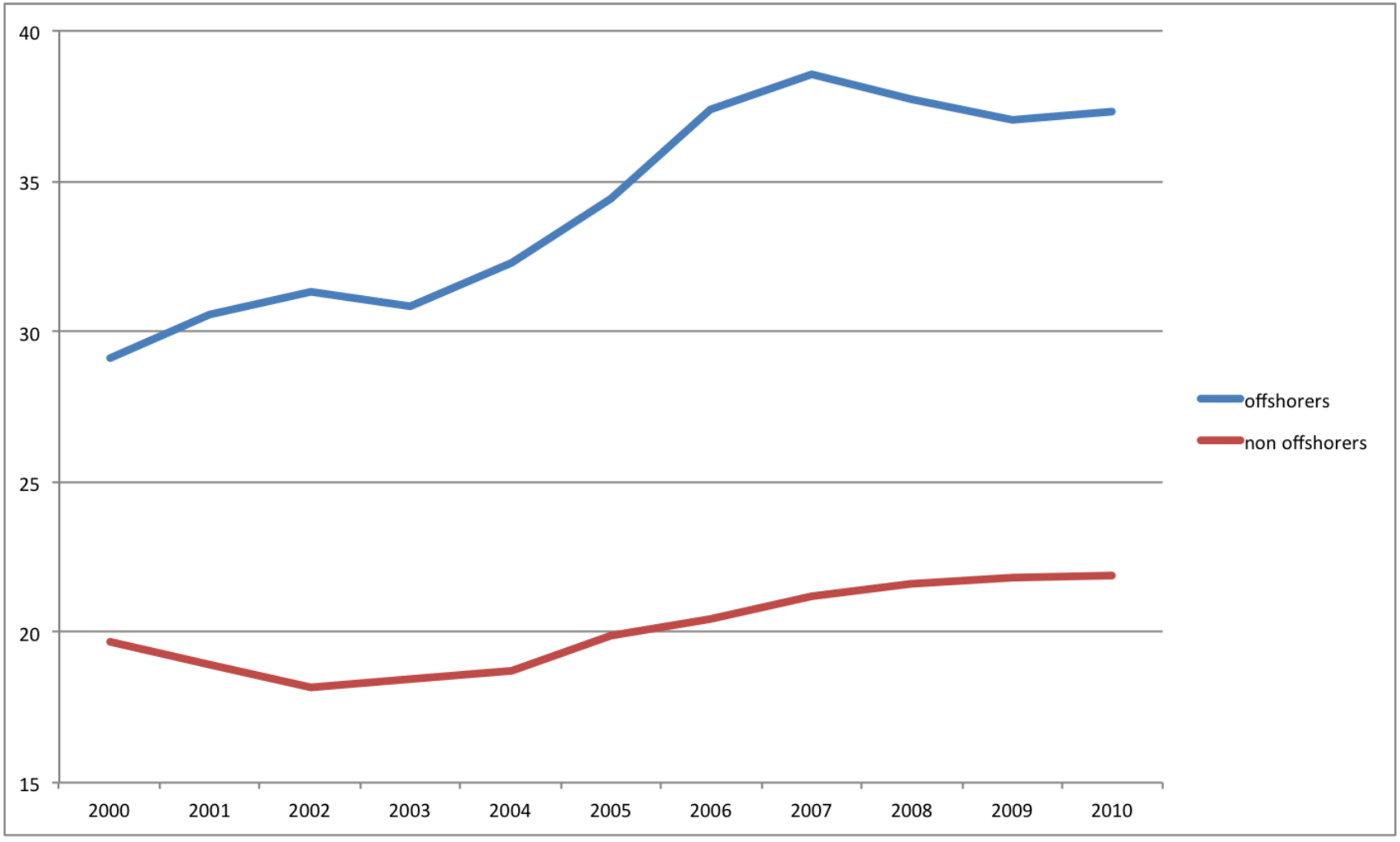
Question #1: what happens in terms of import behavior when firms start offshoring?

- Many studies proxy offshoring with imports of raw materials (task fragmentation)
- Intuition is that assembly still takes place in the domestic country
- Not necessarily the case (very unlikely?) in Danish case
- What kind of goods do firms import by offshoring status?
- Distinguish between final goods and intermediates (and "other" goods: CAT)

Defining imported final goods

- Combine the production survey with trade data
- If same HS6 (for the same year), the good is reported to be produced in Denmark and also imported
- Look at how the evolution differs by offshoring status

Average share of final goods in total imports by offshore status



Defining the share of materials imported by firms

- Combine the raw material survey with trade data
- same HS6(/HS4), the good is reported to be used as raw material and also imported
- Look at how the evolution differs by offshoring status

Average share of materials in total imports by offshore status

“Other goods”: CAT

- A significant share of imports consist of goods exported but not produced by the firm (here use HS4): declining from around 35% for offshorers to 30%, and stable around 28% for non offshorers
- The share of firms doing CAT stable for both groups (around 98% for offshorers; around 80% for non offshorers)
- For firms doing CAT, the share of imports of goods exported but not produced is stable for non offshorers (around 35%), declining for offshorers from 35% to 30%

Mean share of exported goods not produced by the firm in total imports by offshoring status

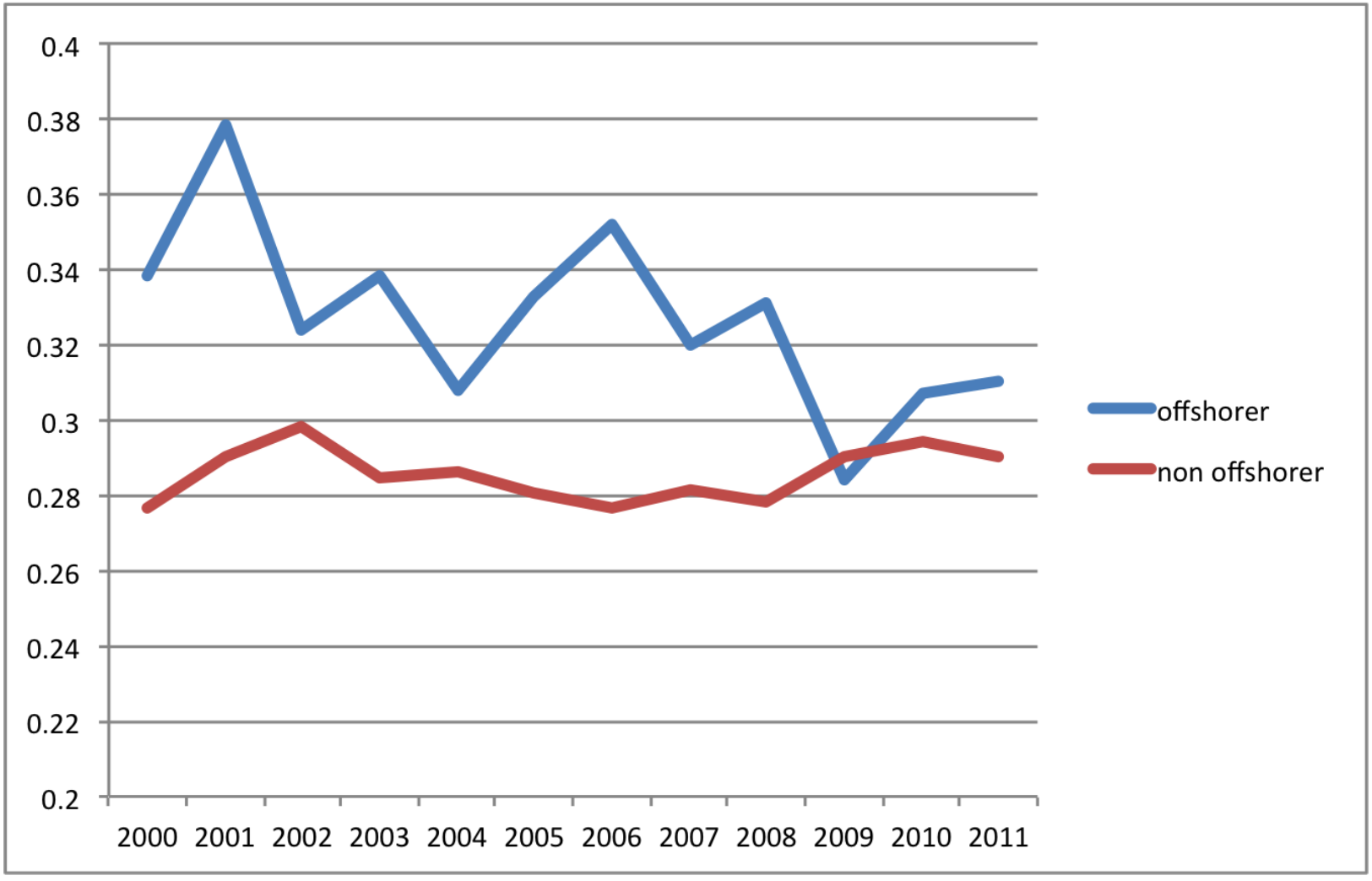


Table 3

Table 3: Share of firms that import from the region to which they offshore

EU-15	0.89
EU-12	0.93
Other European countries	0.95
China	0.96
India	0.82
Other Asian countries and Oceania	0.93
US and Canada	1.00
All offshoring firms	0.95
All non-offshoring firms	0.70

Notes: Offshoring firms are defined as those that relocated their core activity to a foreign region between 2001 and 2006. Inputs and final production based on the firm's values in 2000. A firm is considered to import from a region if we observe any positive imports between 2001 and 2006.

Share of offshoring firms' that import by region and good type

	Any Imports	Share that imports Inputs	Final Goods
Panel A: 2000			
Offshore to EU12			
No	0.48	0.01	0.13
Yes	0.75	0.06	0.39
Offshore to China			
No	0.48	0.02	0.14
Yes	0.82	0.14	0.32
Panel B: 2007			
Offshore to EU12			
No	0.64	0.09	0.19
Yes	0.95	0.24	0.59
Offshore to China			
No	0.64	0.08	0.17
Yes	0.99	0.36	0.72

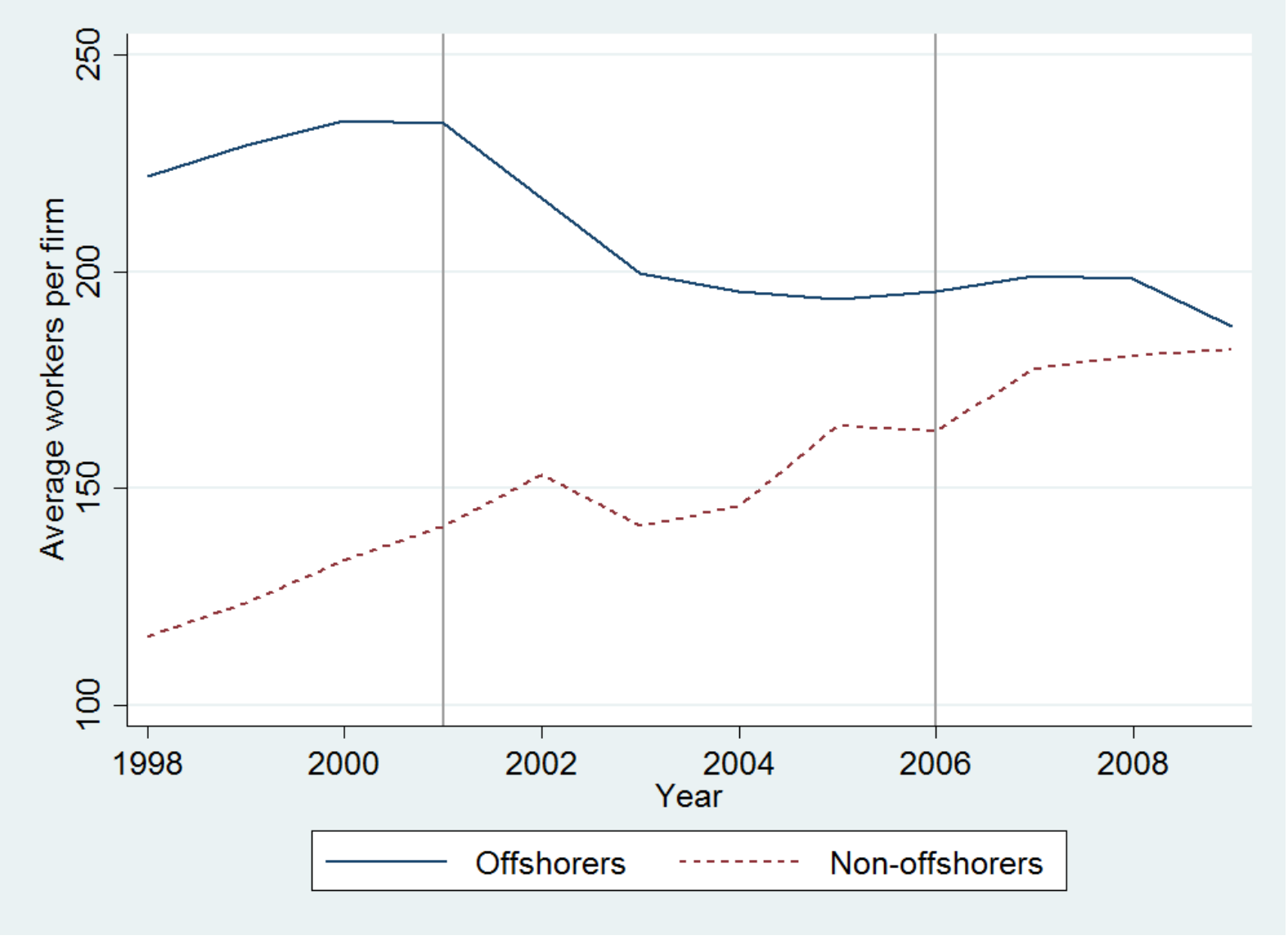
Facts about the nature of imports

- Fact #1: offshorers import more final goods and the difference increases over time; final goods constitute the bulk of imports, reaching around 39% at the end of the sampling period
- Fact #2: offshorers import more materials from 2004 onwards but they only constitute around 10% of total imports
- Same is true when we look at more detailed geographical areas (China and EU12)

Question #2: do we observe a **relationship** between offshoring, innovation & internal reorganization?

- Fact #3: offshorers have on average a higher share of tech workers and the difference increases over time
- Fact #4: offshorers in manufacturing make more products than non offshorers and the difference increases over time
- Fact #5: offshorers introduce a lot more products and drop a little bit more products too
- Stronger pattern when controlling for industry

Average firm employment by firm's offshoring status



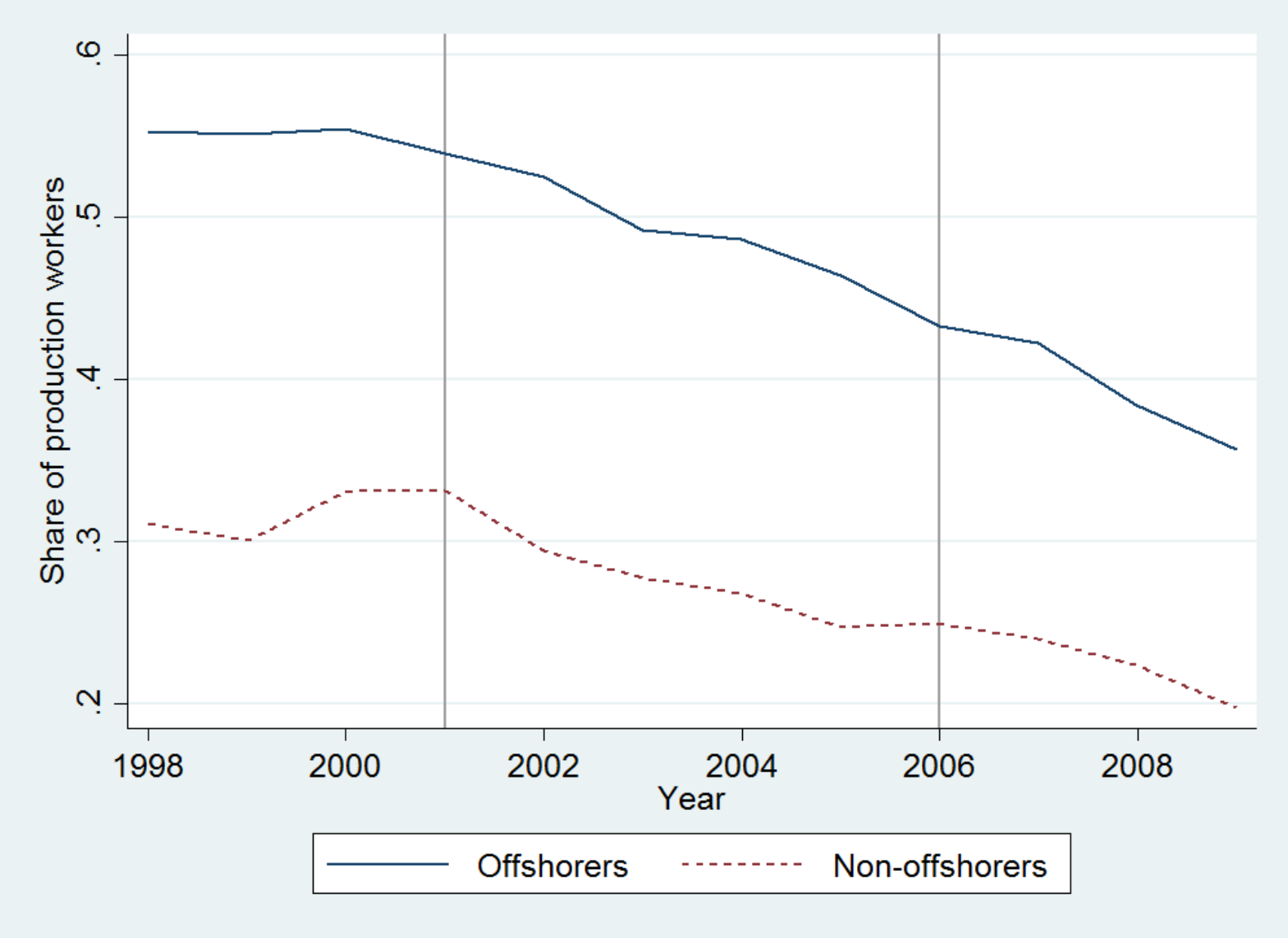
Worker skill levels by offshore status

Panel A: Offshoring firms	1998	2001	2006	2008
Skill level				
Education - low	**0.40**	**0.37**	**0.32**	**0.30**
Education - middle	0.55	0.57	0.58	0.59
Education - high	0.05	0.06	0.10	0.11
Panel B: Non offshoring firms				
Skill level				
Education - low	**0.39**	**0.38**	**0.39**	**0.38**
Education - middle	0.54	0.55	0.53	0.52
Education - high	0.06	0.07	0.08	0.09

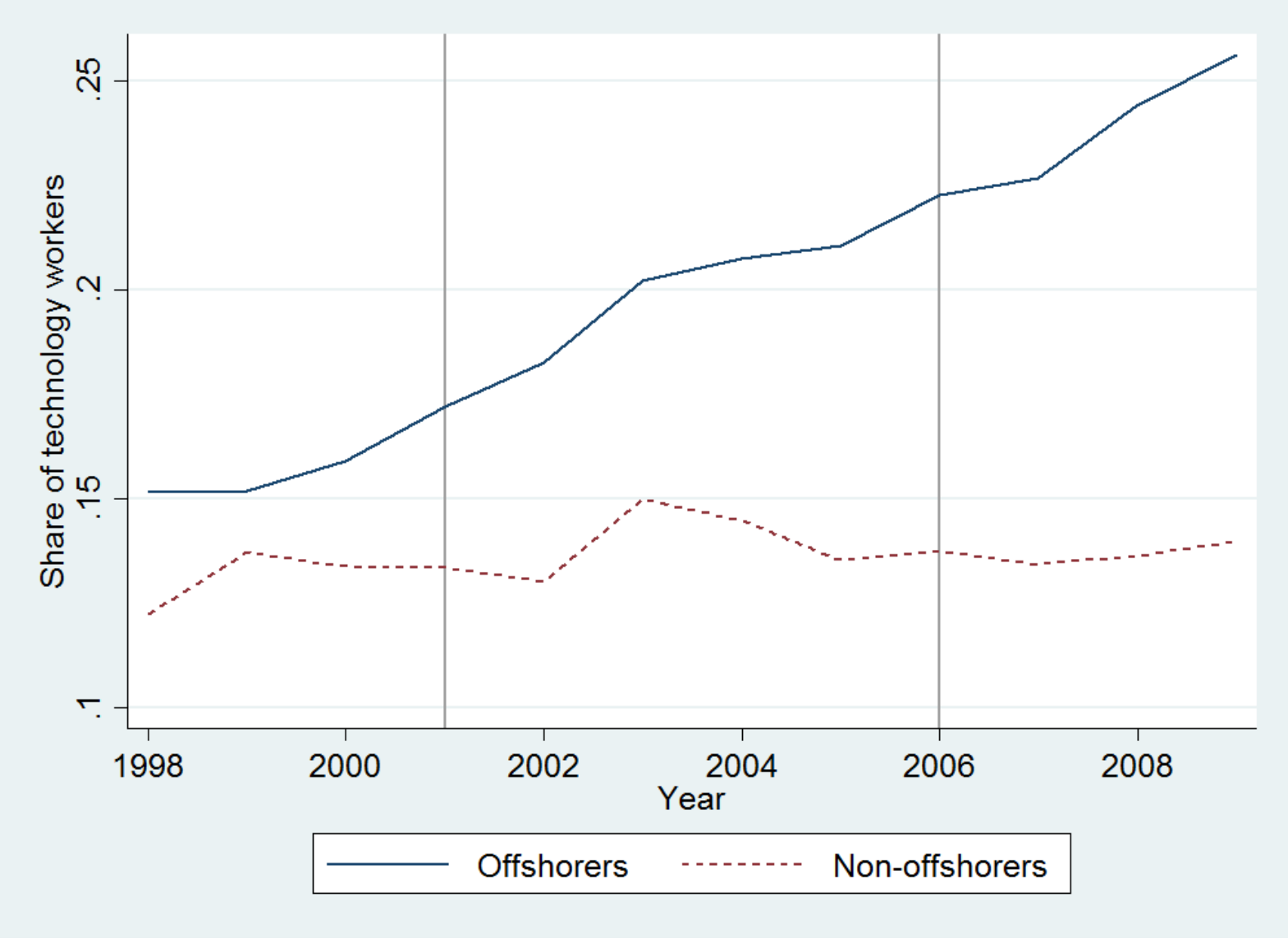
Worker occupations by offshore status

Panel A: Offshoring firms	1998	2001	2006	2008
Occupations				
Managers	0.04	0.03	0.04	0.04
Production workers	0.55	0.54	0.43	0.38
Blue non production workers	0.07	0.07	0.06	0.06
Tech workers	**0.15**	**0.17**	**0.22**	**0.24**
Support workers	0.14	0.13	0.17	0.18
Sales workers	0.05	0.05	0.07	0.08
NEC	0.01	0.01	0.01	0.01
Panel B: Non offshoring firms				
Occupations				
Managers	0.04	0.04	0.04	0.04
Production workers	0.31	0.32	0.25	0.22
Blue non production workers	0.09	0.09	0.11	0.10
Tech workers	**0.12**	**0.13**	**0.14**	**0.14**
Support workers	0.30	0.27	0.28	0.28
Sales workers	0.12	0.13	0.18	0.21
NEC	0.02	0.02	0.01	0.01

Share of production workers by firm's offshoring status



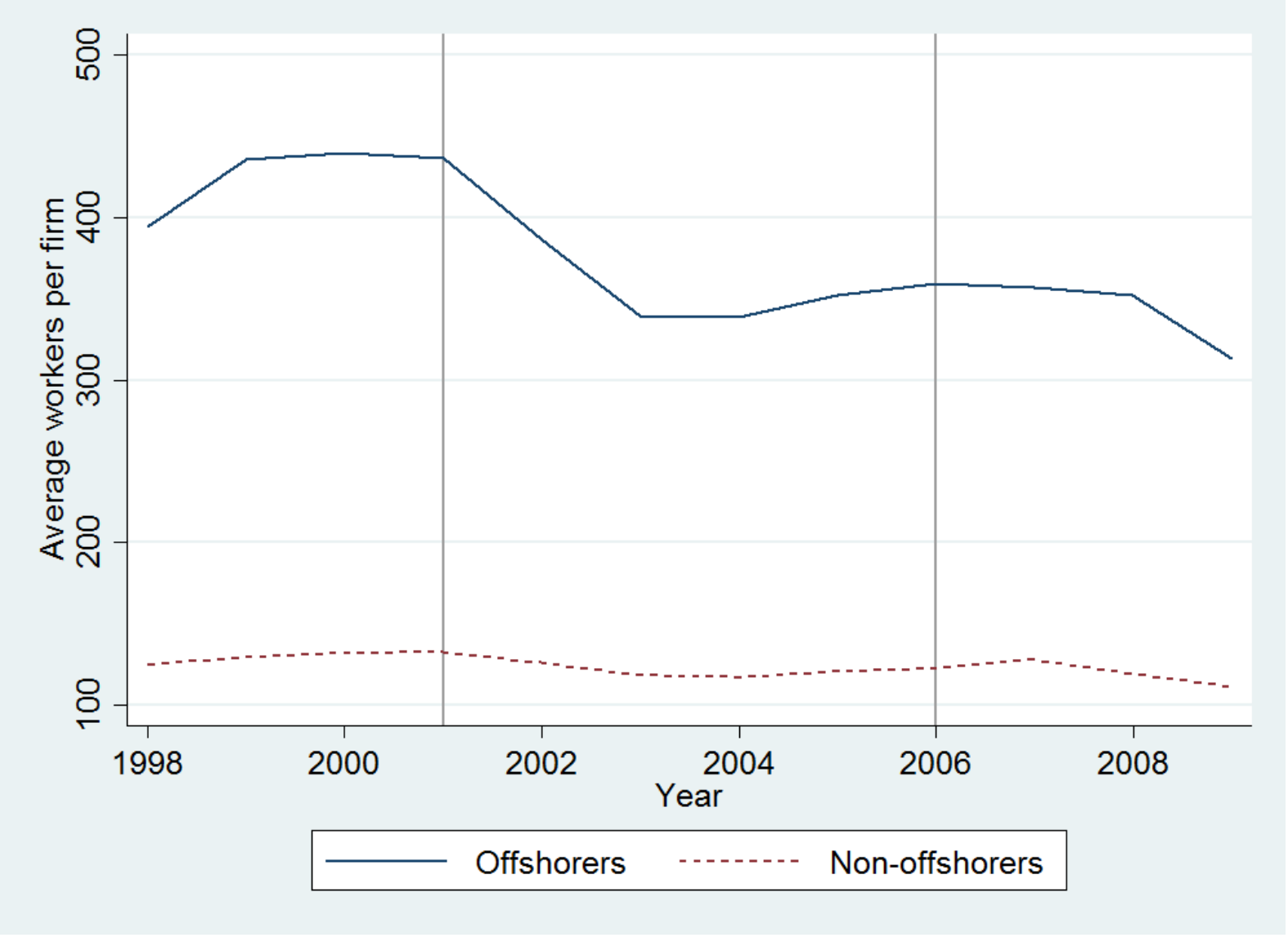
Share of technology workers by firm's offshoring status



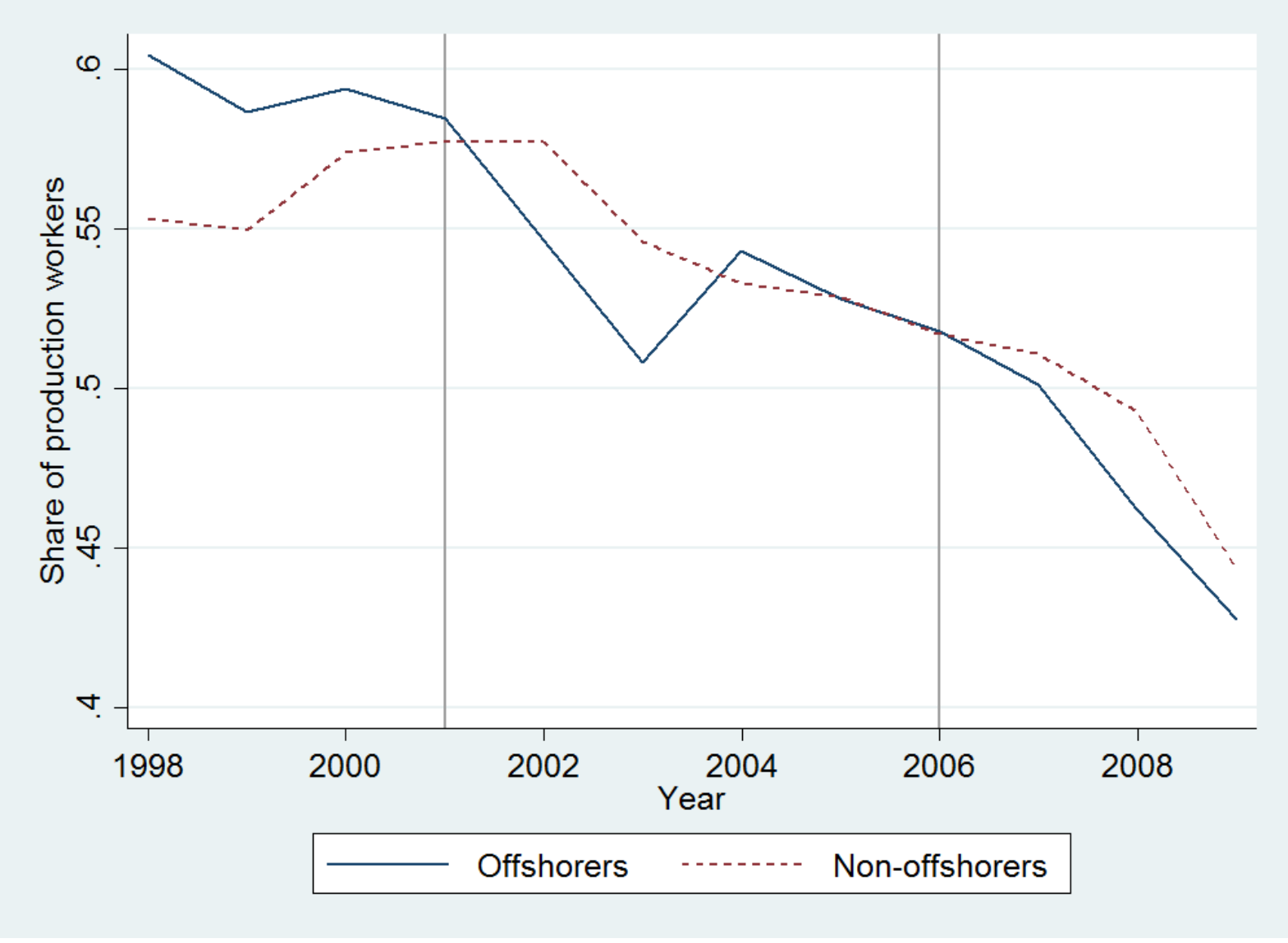
Sample composition

- Firms surveyed from manufacturing and services
- Many of the stories we have in mind are about manufacturing
- Some of our IV strategies rely on identifying product shares from the production survey
- Same graphs for manufacturing only

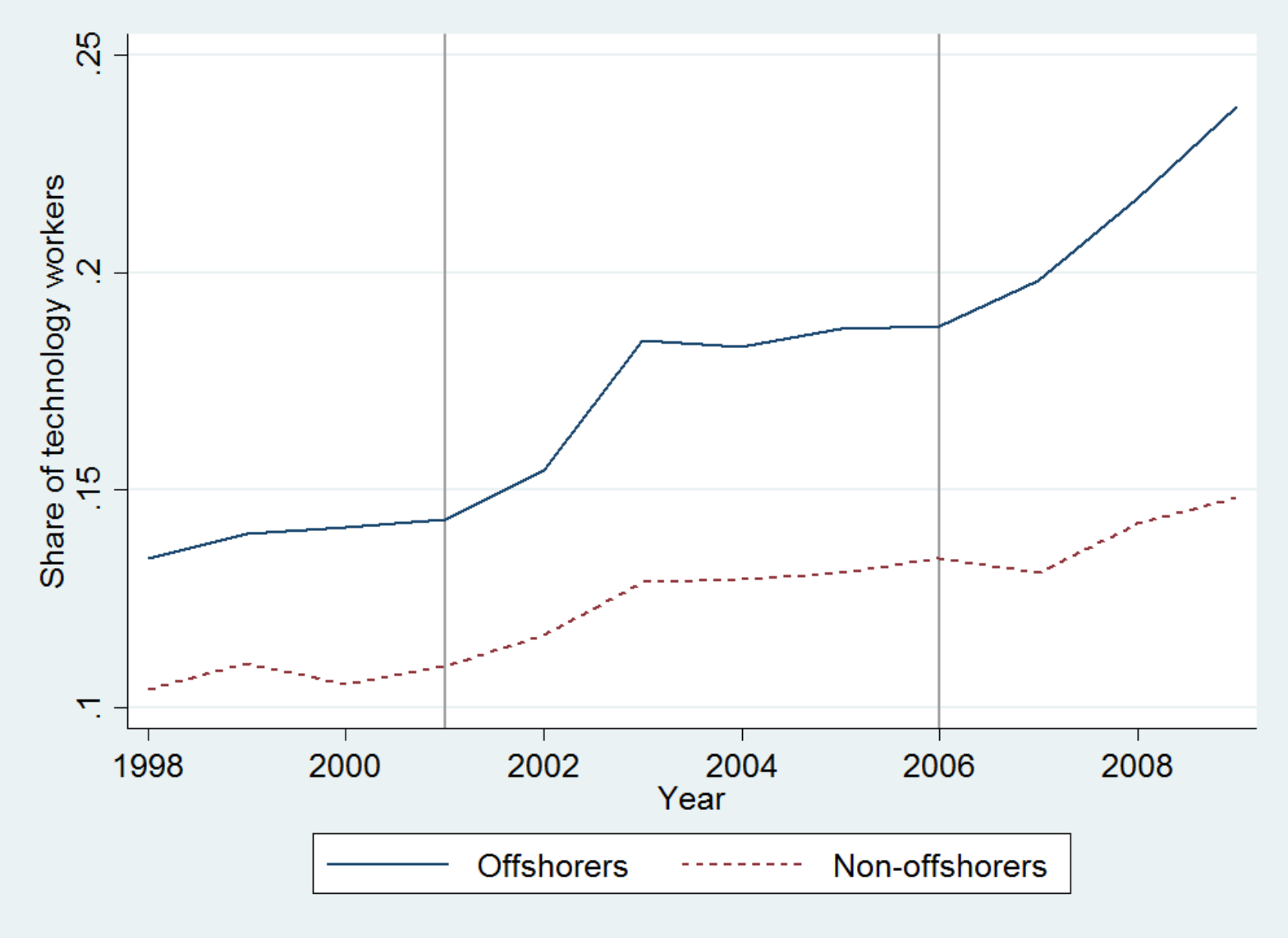
Average firm employment by firm's offshoring status



Share of production workers by firm's offshoring status



Share of technology workers by firm's offshoring status



Dynamics of share of technology workers

- firm size is decreasing for offshorers
- but the absolute number of tech workers is increasing due to several factors:
  - higher retention rate
  - higher gross and net hiring rate (note: higher separation rate too but less important difference)
  - positive net transformation rate of non tech workers to tech workers (within firm reallocation)

Product switching by offshore status

	No. of Products		Product changes from 2000-2007		
	2000	2007	Continued	Dropped	Introduced
Offshorers	4.76	6.13	3.35	1.41	2.78
(percent)			*(70.38)*	*(29.62)*	*(45.35)*
Non-offshorers	2.94	3.06	2.14	0.8	0.92
(percent)			*(72.79)*	*(27.21)*	*(30.07)*
Total	3.25	3.58	2.35	0.9	1.23
(percent)			*(72.31)*	*(27.69)*	*(34.36)*

Notes: There are 1261 firms (214 offshorers) with production data.

Product switching by offshore status, relative to firm's industry average

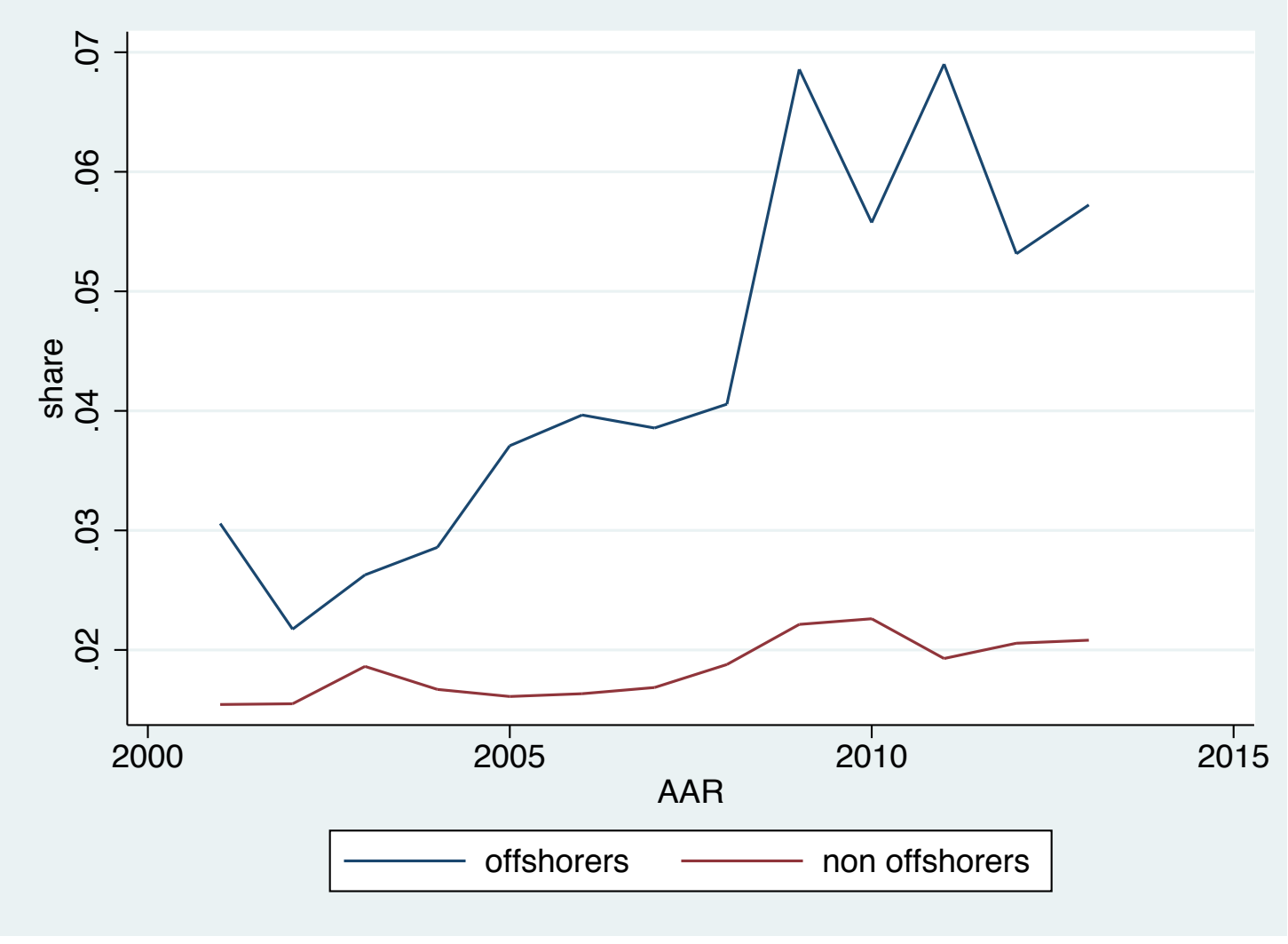
	No. of Products		Product changes from 2000-2007		
	2000	2007	Continued	Dropped	Introduced
Non-offshorers	0.94	0.90	0.95	0.91	0.81
Offshorers	1.28	1.46	1.22	1.46	1.94
Total	1.00	1.00	1.00	1.00	1.00

Notes: There are 1,220 firms (207 offshorers) with production data.

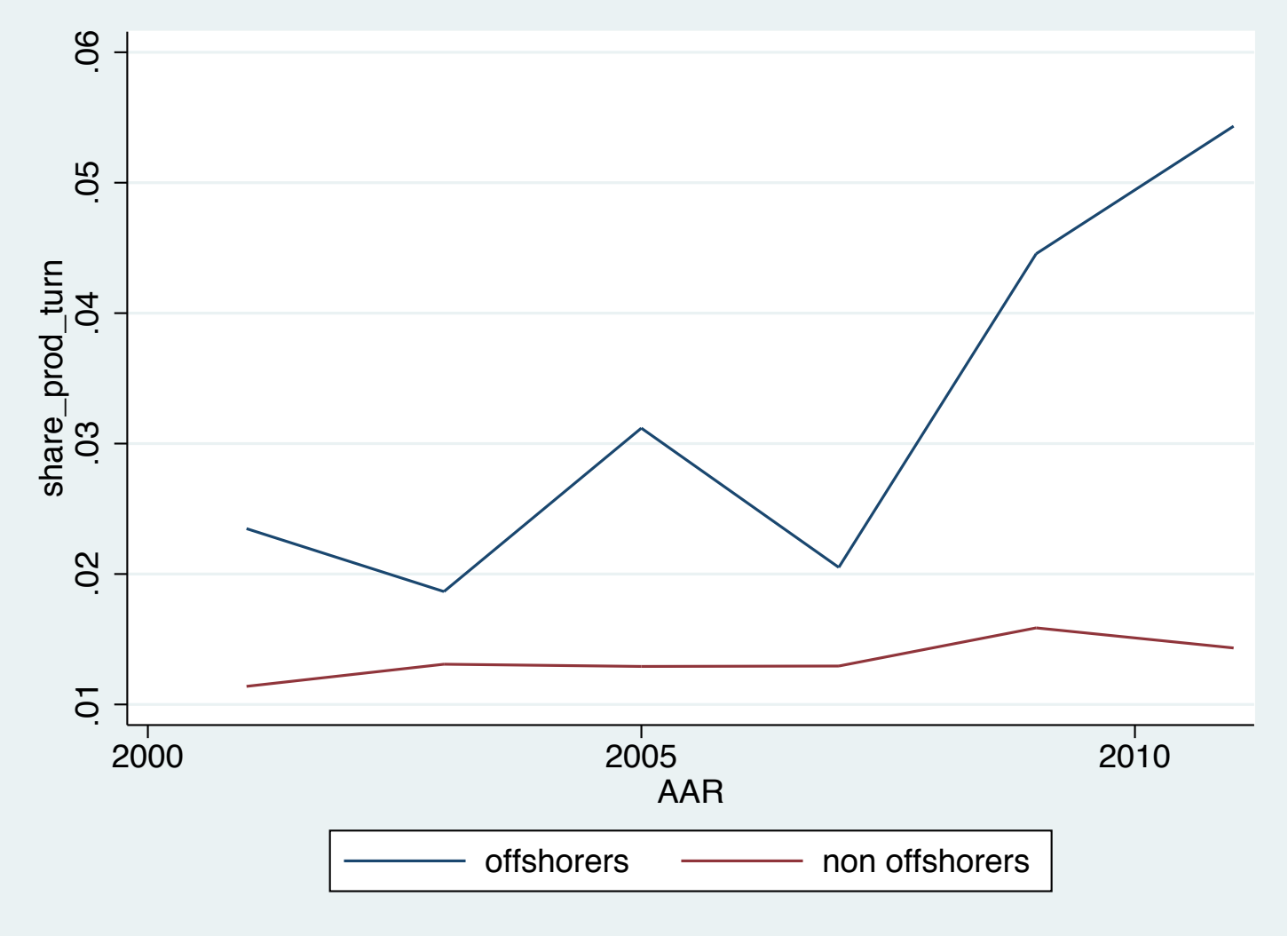
Facts about R&D

- Fact #6: offshorers have higher R&D intensity and that difference dramatically increases over time
- Fact #7: mostly driven by an increase in product R&D
- Big jump in process R&D in 2007 but still lower than product R&D

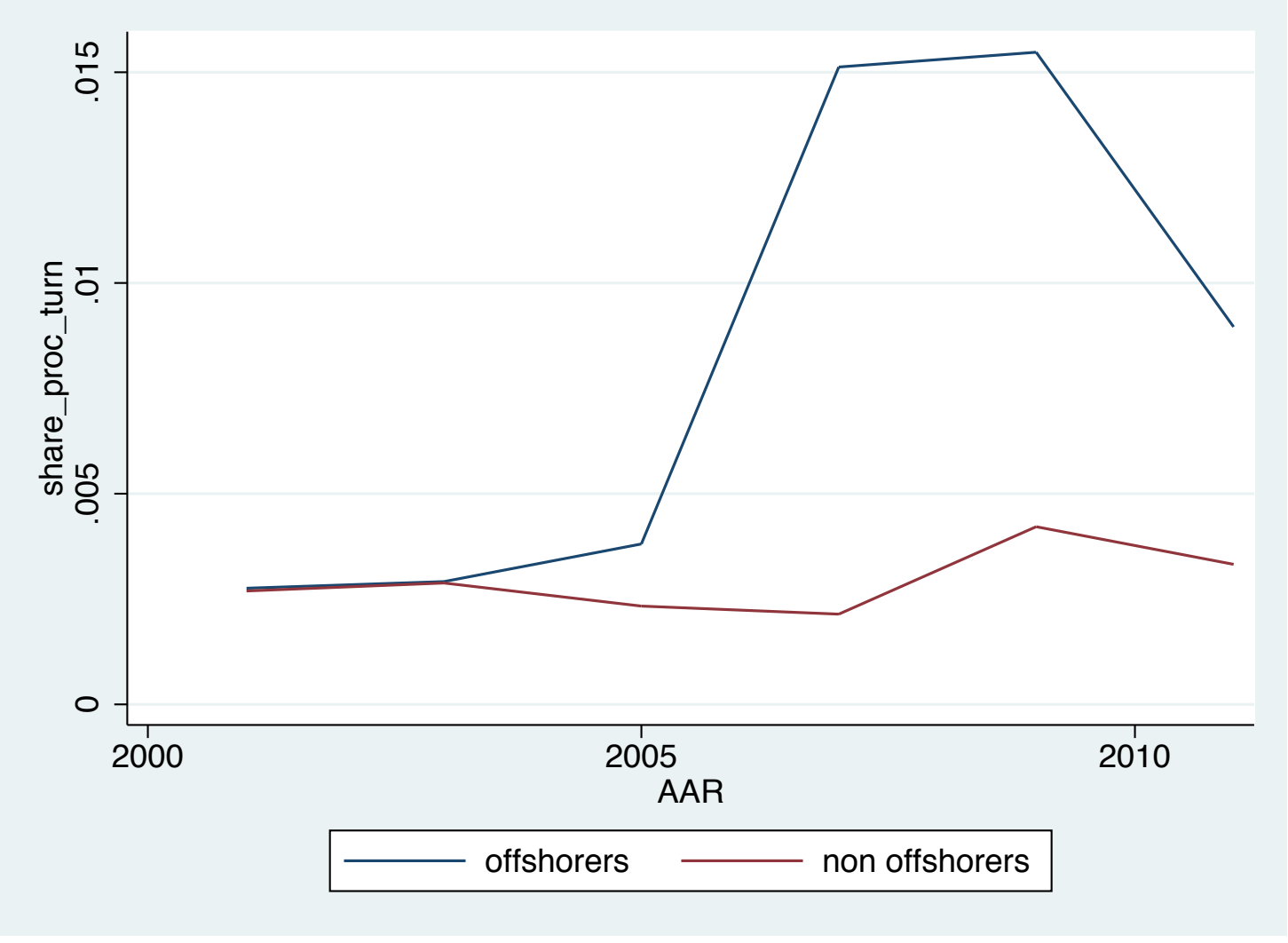
Evolution of the average weighted share of R&D spending over turnover by offshoring status



Evolution of the average weighted share of product R&D spending over turnover by offshoring status



Evolution of the average weighted share of process R&D spending over turnover by offshoring status



Offshoring and IT adoption

- look at early adoption of IT and link with offshoring decision
- measured by adoption of IT in production in 2003 and 2004 (several questions)
- positive and significant effect

Question #3: can we identify a **causal effect** of offshoring on internal reorganization?

- Work in progress
- Tried several IV strategies, working on improving it
- All indicate downward bias in OLS estimates and sizable causal effect of offshoring on R&D and labor reallocation towards innovative activities:
  - increase in share of tech workers in the order of 20%
  - increase in share of R&D expenditures around 6%
- replace offshoring dummy by trade flows associated with it? change in share of final goods

Conclusion

- Offshoring and importing intermediates are not synonymous
- Clear differences in technology worker employment by offshore status
- Remaining agenda
  - Use trade flows to identify offshoring
  - Document differences between EU12 and China offshoring
  - Identify changes in occupations within the firm
  - Assess longer-term impacts on innovative output
- Implications for comparative advantage, specialization, and growth