

# The Value of AI Innovations in Non-IT Firms

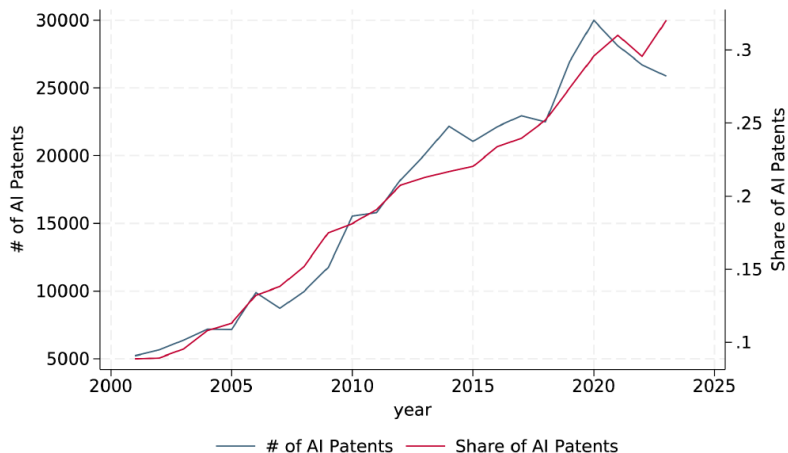
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# AI as a General Purpose Technology

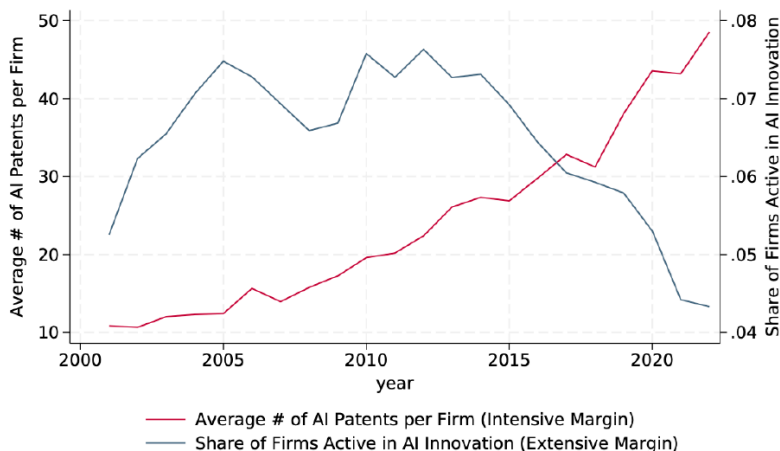
- ▶ As a GPT, AI is getting adopted in “non-IT” sectors - not only applied but non-IT sectors also innovate in AI as evidenced by rise in AI patents granted to these non-IT firms
- ▶ Compared to non-AI patents, non-IT AI patents are more valuable as measured by stock price reaction upon their grants
- ▶ They are also associated with more forward citations
- ▶ Firms that are granted these patents have higher market share
- ▶ Firms that innovate in AI also innovate in non-AI

# Trends



► 30% of patents are AI patents

# Trends



► But only 4-8% of firms innovate in AI

# Broader Takeaways

- ▶ AI is GPT
- ▶ Non-IT firms adopting AI are different from adopters even within the same sector
- ▶ High heterogeneity in AI innovation across sectors
  - ▶ So is AI GPT then?
  - ▶ Do other firms/sectors still adopt AI even if they do not patent themselves?

# Questions

- ▶ Which non-IT sectors innovate?
- ▶ Which non-IT firms innovate?
- ▶ Measuring AI innovation
- ▶ Measuring value effects
- ▶ Measuring real effects

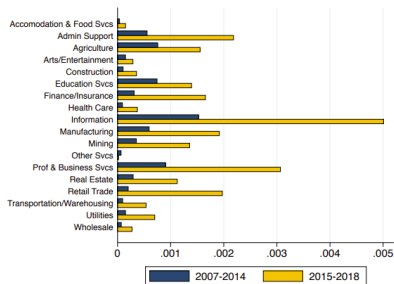
# Innovating Sectors

| Sector                                                                                     | AI Patents | % of Firms That Innovate in AI |
|--------------------------------------------------------------------------------------------|------------|--------------------------------|
| Electronic And Other Electrical Equipment And Components, Except Computer Equipment        | 80331      | 30%                            |
| Flexible Electric Cable                                                                    | 45655      | 29%                            |
| Transportation Equipment                                                                   | 20130      | 25%                            |
| Communications                                                                             | 18184      | 11%                            |
| Measuring, Analyzing, And Controlling Instruments; Photographic, Medical And Optical Goods |            |                                |
| Watches And Clocks                                                                         | 14666      | 26%                            |
| Depository Institutions                                                                    | 12235      | 5%                             |
| Non-depository Credit Institutions                                                         | 7513       | 1%                             |
| Security And Commodity Brokers, Dealers, Exchanges, And Services                           | 3565       | 5%                             |
| Engineering, Accounting, Research, Management, And Related Services                        | 3223       | 13%                            |

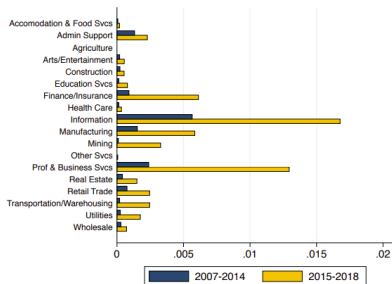
# Which Sectors?

- ▶ Primarily hardware (still tech?), transportation equipment, communications, and financial services?
- ▶ Very little in other services
- ▶ What defines which sectors innovate in AI patents?
- ▶ Do other sectors innovate in AI but AI innovation is more valuable there, so it is kept as secret?
- ▶ Or is this measurement? Is USPTO ML algorithm capturing AI patents in some sectors better than in others?

# Babina, Fedyk, He, Hodson (2024)



(a) Resume data (Cognism)



(b) Job posting data (Burning Glass)

- ▶ AI investment based on resume / job posting data
  - ▶ Likely capturing a different aspect?
  - ▶ Different measurement issues
- ▶ More discussion on how to reconcile the sectors?

# Which Firms?

- ▶ Babina et al. (2024): firms investing in AI are more likely to be larger and have higher sales, markups, cash reserves, faster sales and employment growth than other firms
  - ▶ This paper finds that AI innovators have lower sales (lower market share)
- ▶ Alderucci et al. (2020): employment growth is 25% higher and revenue growth is 40% higher for firms with AI patents
  - ▶ Also includes privately-held firms. This paper excludes them
  - ▶ How much bias does that create? Aren't non-listed startups more likely to adopt new technologies compared to the incumbent firms with higher adjustment costs?

# Which Firms?

- ▶ This paper's main contribution on firm cross-section: high complementarity with being innovator in non-AI technologies
- ▶ Does it just say that innovators are innovators across technologies? Would we expect differently?
- ▶ Or is non-AI innovation a byproduct of AI innovation?
- ▶ Causality is difficult

# What Are AI Patents?

- ▶ Defined by USPTO Office of the Chief Economist that uses machine learning to identify AI in patent documents
  - ▶ Does ML algorithm capture more AI innovation in later years?
- ▶ Eight fields: knowledge processing, speech, AI hardware, evolutionary computation, natural language processing, machine learning, computer vision, and planning/control
- ▶ Rather broad definitions - why should we expect that AI innovation should be limited to IT firms?
  - ▶ AI hardware is likely innovated by the hardware sector
  - ▶ Financial services likely to innovate in knowledge processing and planning/controls

# Very Broad Definition?

## Knowledge processing

The field of knowledge processing contains methods to represent facts about the world and to derive new facts (or knowledge) from a knowledge base. For example, *expert systems* generally contain a knowledge base and an inference method to obtain new facts from that knowledge base.

## Planning/control

The field of planning and control contains methods to identify and execute plans to achieve specified goals. Key aspects of planning include representing actions and states of the world, reasoning about the effects of actions, and efficiently searching over potential plans. Modern control theory includes methods to maximize objectives over time (Russell et al. 2009). For example, *stochastic optimal control* considers dynamic optimization in uncertain environments. Additionally, planning and control includes data systems for administration/management (e.g., managing an organization and its employees, including inventory, workflow, forecasting, and time management), adaptive control systems, and models or simulators of systems.

# Very Broad Definition?

## Natural language processing

Natural language processing contains methods for understanding and using data encoded in human natural language. For example, *language models* represent probability distributions of language expressions (Russell et al. 2009).

## Machine learning

The field of machine learning contains a broad class of computational learning models. For example, *supervised learning classification models* are algorithms that learn to classify observations based on pre-labeled training data. Machine learning includes, among other techniques, neural networks, fuzzy logic, adaptive systems, probabilistic networks, regression and intelligent searching.

- Examples for non-IT firms?

# How Interpret Value Effects?

- ▶ Positive returns, both at announcement and also longer term
- ▶ Market does not expect this innovation? Undervalues it before (Cohen et al., 2013)?
  - ▶ Controlling for R&D does not help address market undervaluing innovation
  - ▶ Is AI R&D measured as well as non-AI R&D?
- ▶ Or is there indeed valuation premium for AI patents? Overvaluation of the innovation?
- ▶ Interesting that AI value is increasing over time
  - ▶ Market recognizes it earlier?
  - ▶ Or is it again influenced by the time variation in the classification of AI patents?

# Consider Innovation Vintages?

- ▶ Is it a general statement for new GPTs/new innovation: new innovation like AI patents is misvalued more?
- ▶ Or is there a higher variance in the innovation?
- ▶ Wouldn't the right comparison be to look at the returns for similar innovation vintages?
  - ▶ Same for the forward citations - earlier patents (same as earlier papers in the literature) are cite more

# Broader Real Implications?

- ▶ AI innovating firms end up having higher market share even if they start from the lower market share = higher sales growth
  - ▶ Consistent with Alderucci et al. (2020) and Babina et al. (2024)
  - ▶ Babina et al. (2024) attempt to make a causal statement (and do it across IT and non-IT sectors), not this paper
  - ▶ Can you tell more where the sales growth effects are coming from? Any other benefits?
- ▶ The paper also talks about follow up innovation. Does AI help innovation, new product introduction?
  - ▶ See the current discussion around “Artificial Intelligence, Scientific Discovery, and Product Innovation”
- ▶ Big topic on AI and labor - is there a difference in the AI effect on employment for tech and non-tech firms?

# Final Takeaways

- ▶ Non-IT (non-software?) firms are granted patents in AI
  - ▶ Large heterogeneity across firms and sectors; firms that innovate in other technologies also innovate in AI
  - ▶ These patents have higher values than non-AI patents and are associated with larger sales growth
- 
- ▶ So is this GPT? What are the real implications?