Data-intensive Innovation and the State: Evidence from AI Firms in China

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Motivation: government data as input in AI innovation

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$\Longrightarrow$ **Government data** can exceed privately-collected data in magnitude/scope; or lack good substitutes altogether

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- A common way in which AI firms **gain access** to valuable government data is by **providing services** to the state
- Think about **facial recognition AI firms in China**...
  - Train algorithms with, e.g., video streams of faces from many angles
  - The state's public security units collect this form of data through their surveillance apparatus, and contract AI firms for services
  - AI firms gaining access to surveillance data can use it to train algorithms and develop software

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2. Firms may **learn** to manage and utilize large datasets too

$\Longrightarrow$ a procurement contract with access to gov't data can fuel commercial innovation, overcoming **crowd-out** from the contract

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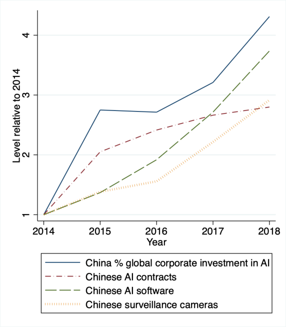
Evidence of this in China's facial recognition AI sector

Two implications

1. Access to gov't data contributed to Chinese firms' emergence as leading innovators in facial recognition AI
   - Indeed, this has coincided with the expansion of the government's procurement of AI and surveillance capacity



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1. Access to gov't data contributed to Chinese firms' emergence as leading innovators in facial recognition AI
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2. Novel role for the state in data-intensive economies
   - So far, emphasis on the regulation of privately-collected data due to antitrust or privacy concerns (Tirole, 2020; Aridor et al., 2020)
   - AI procurement and policies of gov't data collection and provision could, **whether intentionally or not**, stimulate and shape the direction of innovation in a range of sectors

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Would like to compare software output changes after receipt of gov't procurement contracts giving access to more v. less data

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1. Dataset linking AI firms to govt. contracts did not exist
2. Dataset on AI firms' software did not exist (our measure of *product innovation*). Also, critical for us to classify by use (commercial or not)
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Identification challenges

1. Non-random assignment of gov't contracts
2. Contracts work through other mechanisms unrelated to data

Data 1: linking AI firms to govt. contracts

1. Identify all facial recognition AI **firms**
   - 7,837 firms
   - Two sources: Tianyancha (People's Bank of China) and PitchBook (Morningstar)
   - Include: *(i)* firms specialized in facial recognition AI (e.g., Yitu); *(ii)* hardware firms that devote substantial resources to develop AI software (e.g., Hik-Vision); *(iii)* facial recognition AI units of large tech conglomerates (e.g., Baidu AI)

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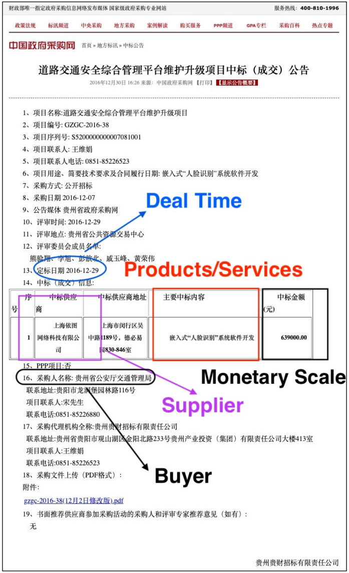
3. Link government **buyers** to AI **suppliers**



财政部唯一指定政府采购信息网络发布媒体 国家级政府采购专业网站　服务热线：400-810-1996

政策法规　标讯频道　中央采购　地方采购　案例解读　购买服务　PPP频道　GPA专栏　采购百科　热点专题

中国政府采购网　首页 » 地方标讯 » 中标公告

道路交通安全综合管理平台维护升级项目中标（成交）公告

2016年12月30日 16:26 来源：中国政府采购网 【打印】 【显示公告概要】

1、项目名称:道路交通安全综合管理平台维护升级项目

2、项目编号: GZGC-2016-38

3、项目序列号: S5200000000007081001

4、项目联系人: 王维娟

5、项目联系人电话: 0851-85226523

6、项目用途、简要技术要求及合同履行日期: 嵌入式“人脸识别”系统软件开发

7、采购方式: 公开招标

8、采购日期 2016-12-07

9、公告媒体 贵州省政府采购网

10、评审时间: 2016-12-29

11、评审地点: 贵州省公共资源交易中心

12、评审委员会成员名单:
熊验翔、李旭、彭歆北、戚玉峰、黄荣伟

13、定标日期 2016-12-29

14、中标（成交）信息:

序号	中标供应商	中标供应商地址	主要中标内容	中标金额(元)
1	上海依图网络科技有限公司	上海市闵行区吴中路1189号，德必易园830-846室	嵌入式“人脸识别”系统软件开发	639000.00

15、PPP项目:否

16、采购人名称: 贵州省公安厅交通管理局
联系地址:贵阳市龙洞堡园林路116号
项目联系人:宋先生
联系电话:0851-85226880

17、采购代理机构全称:贵州贵财招标有限责任公司
联系地址:贵州省贵阳市观山湖区金阳北路233号贵州产业投资（集团）有限责任公司大楼413室
项目联系人:王维娟
联系电话:0851-85226523

18、采购文件上传（PDF格式）：
附件:
gzgc-2016-38(12月2日修改版).pdf

19、书面推荐供应商参加采购活动的采购人和评审专家推荐意见（如有）：
无

贵州贵财招标有限责任公司

Data 2: AI firms' software production

Registered with Min. of Industry and Information Technology

- Validation exercise: check against IPO Prospectus of MegVii

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Categorize by intended customers:

1. **Commercial:** e.g., *visual recognition system for smart retail*;
2. **Government:** e.g., *smart city — real time monitoring system on main traffic routes*;
3. General: e.g., *a synchronization method for multi-view cameras based on FPGA chips.*

Categorization: analyze text using machine learning

- Recurrent Neural Network (RNN) model using tensorflow
  - Corpus: 13,000 manually labeled software programs
  - Word-embedding: converted sentences to vectors based on word frequencies and used the words from full datasets as dictionary
  - Long Short-Term Memory (LSTM) algorithm: 2 layers of 32 nodes
  - 90% of corpus for training, 10% for validating
  - 10,000 training cycles are run for gradient descent on loss function
- Results robust to perturbing parameters of learning model

Data 3: measuring access to government data

Within AI public security contracts: variation in the data collection capacity of the public security agency's local surveillance network

1. Identify non-AI contracts: police department purchases of street cameras
2. Measure quantity of advanced cameras in a prefecture at a given time
3. Categorize public security contracts as coming from "high" or "low" camera capacity prefectures

Baseline empirical strategy

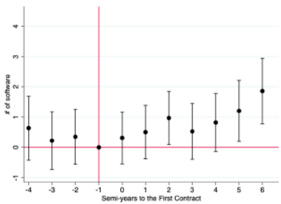
- **Triple diffs:** compare cumulative software releases before and after firms received 1st data-rich contracts, relative to the data-scarce ones

$$y_{it} = \sum_{T} \beta_{1T} T_{it} Data_i + \sum_{T} \beta_{2T} T_{it} + \alpha_t + \gamma_i + \sum_{T} \beta_{3T} T_{it} X_i + \epsilon_{it}$$

  - T_{it}: 1 if, at time t, T semi-years have passed before/since firm i received 1st contract
  - $Data_i$: 1 if firm i receives "data rich" contract (i.e., from "high" camera capacity prefecture at time of contract receipt)
  - X_i controls for pre-contract firm characteristics: age, size (cap), and software production

Public security contract “richer in data” & firm innovation

Commercial use cumulative software releases



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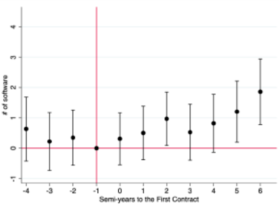

Magnitude: 2 new software products over 3 years
(20% of pre-contract software)

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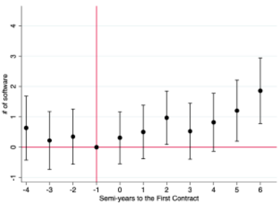
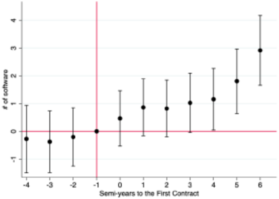


Government use cumulative software releases



Commercial innovation overcomes crowd-out of inputs by gov't

Evaluating alternative hypotheses

1. **Selection** at a given time differs by contract
   - No differential pre-contract levels/trends of software
   - Control for time-varying effects of proxies for firms' underlying productivity: index constructed from establishment year, pre-contract capitalization, pre-contract rounds of external financing, pre-contract software production

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2. **Productive benefits other than data** differ by contract
   - Value of contract; tasks of contract; market access: we control for time-varying effects of an index of non-data contract characteristics (dollar value; prefecture income; tasks coded using NLP)
   - Signaling value: examine second contracts within parent firms
   - Political value: drop Beijing/Shanghai contracts; drop firms receiving contracts in home province

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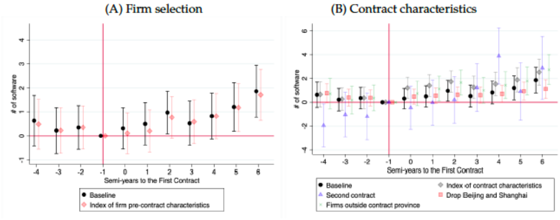
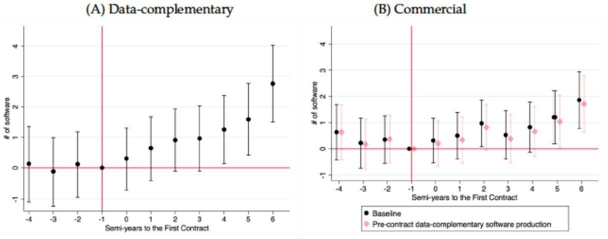

(A) Firm selection

(B) Contract characteristics

Additional evidence for our mechanism(s)

Data-complementary software (e.g., storage/transmission) differentially increases after data-rich contract (learning); but, accounting for pre-contract data-complementary software does not greatly affect our findings (sharable data and algorithms)



Contributions to literature

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    - Government data provision to firms can act as an innovation policy, **whether intentionally or not**
    - Mechanisms **similar** to other government policies (e.g., learning spillovers from space exploration) but **distinct** too (direct effect of sharability)

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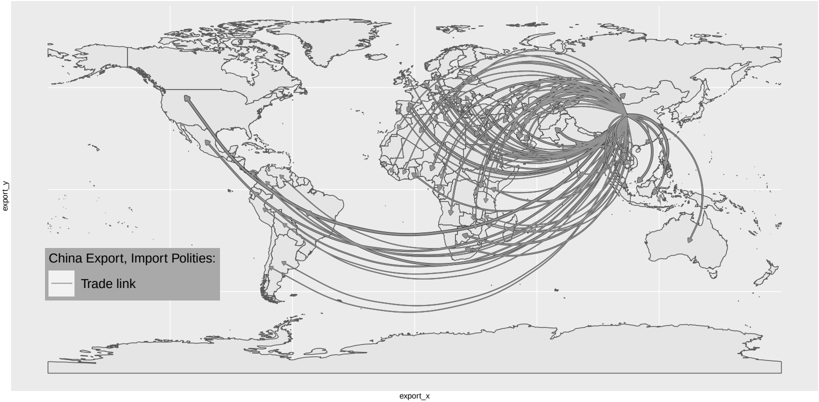
3. To the literature on the rise of China emphasizing the role of the state (e.g., Lau et al., 2000; Brandt and Rawski, 2008; Song et al., 2011)
    - Highlight the role of the **surveillance apparatus** in commercial innovation
    - *Next project:* **AI-tocracy**. Alignment between innovation and autocracy? Contrasts with e.g., North (1991); Acemoglu and Robinson (2006, 2012)

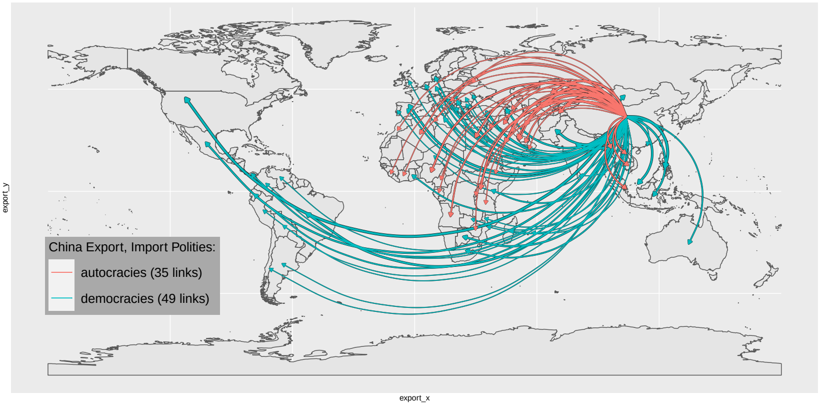
China's export of AI

Dominate global trade ($> 50\%$), different from other frontier tech



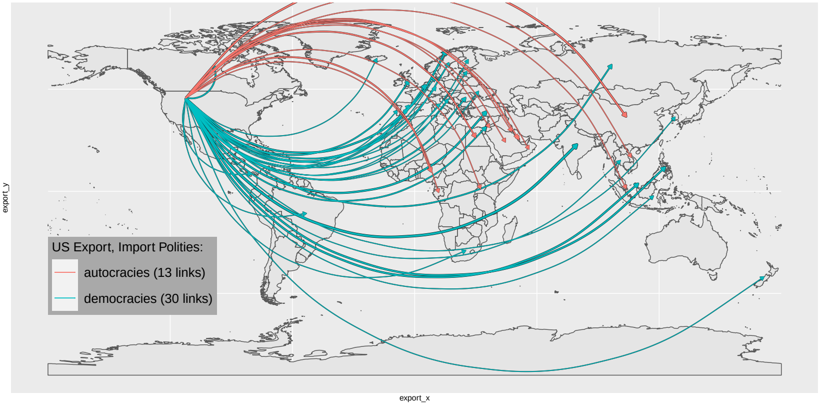
China's export of AI

High number of autocratic destinations



US's export of AI

Much fewer links, higher share of democratic destinations


US Export, Import Polities:
autocracies (13 links)
democracies (30 links)
export_y
export_x