# Big Data, Machine Learning, and Quantum Computing at the Riksbank

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# Big Data

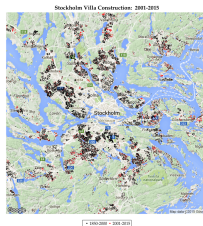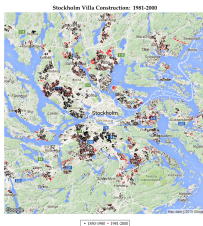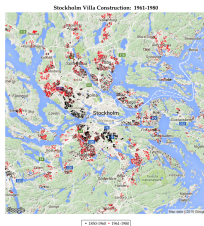**Traditional Big Data**
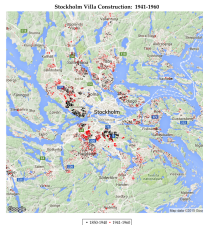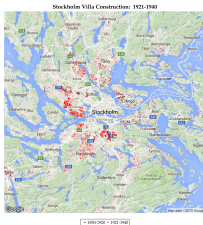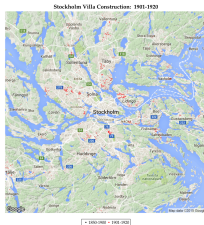
▶ **Trade credit.**

    ▶ Jacobson and von Schedvin (2015); Amberg et al. (2016); Amberg, Jacobson, von Schedvin (2018).

▶ **Household finance.**

    ▶ Jansson et al. (2012); Jansson, Haliassos, and Karabulut (2012); Jansson (2017); and Jansson, Haliassos, and Karabulut (2017).

# Big Data

## **Nontraditional Big Data: Housing**

# Big Data

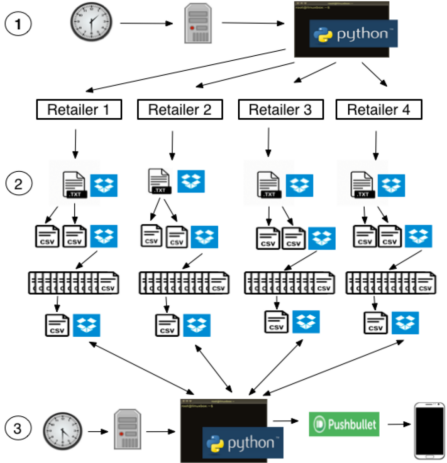## Nontraditional Big Data: Grocery Prices



Figure: Figure taken from Hull, Löf, and Tibblin (2017).

# Big Data

**Nontraditional Big Data: Grocery Prices**



Figure: Figure taken from Hull, Löf, and Tibblin (2017).

# Big Data

## **Nontraditional Big Data**

- Housing transactions

- Rental contracts

- Satellite images

- Financial filings

- Local public services

- Online loan funding

- Fruit and vegetable prices

- Foreign travel package prices

- Central bank speeches

- Newspaper archive

- EPU index

- Fraud complaints

# Big Data

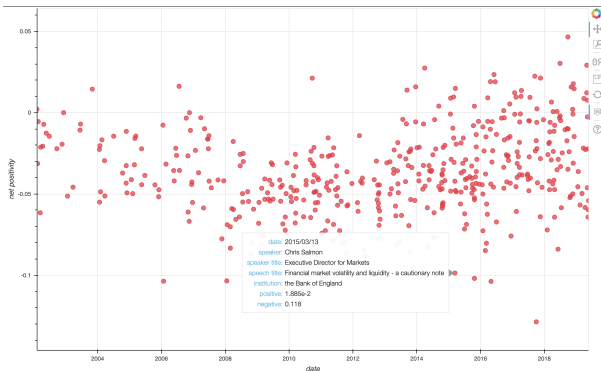## **Nontraditional Big Data: Central Bank Communication**



Figure: Dynamic plot of Bank of England net sentiment.

# Big Data

**Nontraditional Big Data: Central Bank Communication**
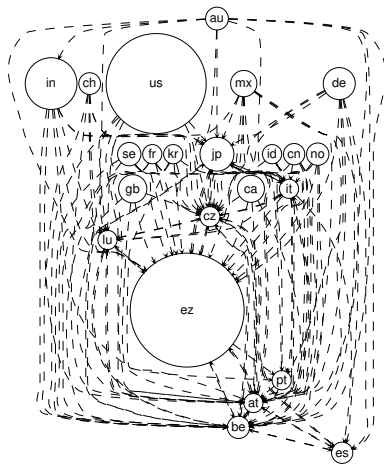


Figure: Figure taken from Armelius, Bertsch, Hull, and Zhang (2018)
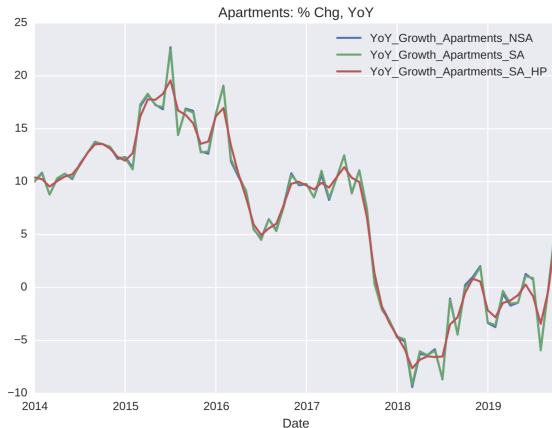
# Big Data

## Nontraditional Big Data: Housing Transactions



Figure: Daily approximation of monthly apartment price index.
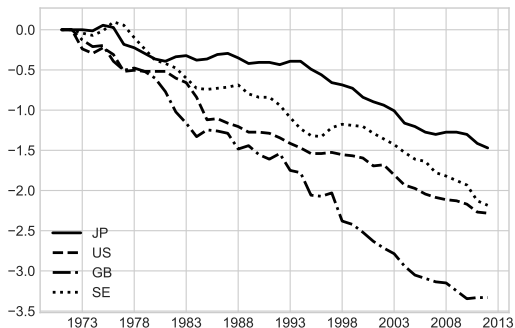
# Big Data

## **Nontraditional Big Data: Housing Transactions**



Figure: Impact of manufacturing's decline on house price volatility
(Hull, Olovsson, Walentin, and Westermark, 2017)

# Big Data

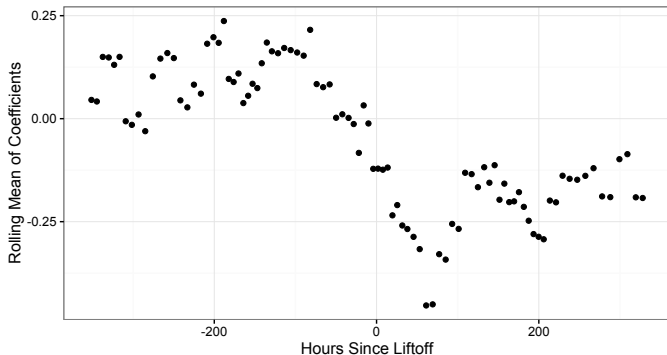## Nontraditional Big Data: Online Lending



Figure: Figure taken from Bertsch, Hull, Zhang (2016).

# Machine Learning

**<u>Machine Learning</u>**

- ▶ Tax capitalization measurement

- ▶ Fraud classification

- ▶ Real estate bubble prediction

- ▶ Central bank communication

- ▶ Corporate default prediction

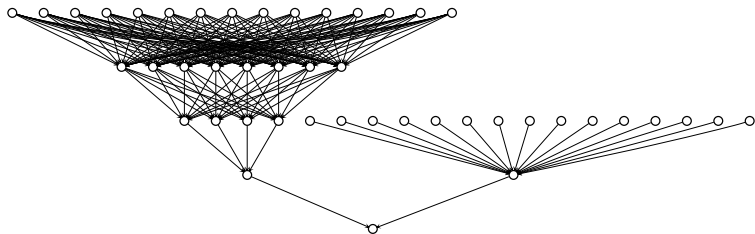**Machine Learning: Debiased Machine Learning**



Figure: Figure taken from Grodecka and Hull (2019).
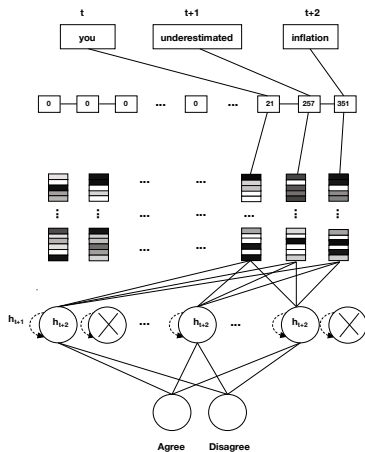
# Machine Learning

**Machine Learning: Transfer Learning**



Figure: Figure taken from Apel, Blix Grimaldi, and Hull (2019).

# Quantum Computing

**Diamanti, Hull, Sattath, Wendin (2019)**

▶ Quantum supremacy achievable within a few years (Wendin, 2017).

▶ Speed-ups will enable advancement of econometrics and computational economics.

▶ Attacks will render classically-secured financial system vulnerable.

# Quantum Computing

**<u>Diamanti, Hull, Sattath, Wendin (2019)</u>**

- Mathematical Preliminaries

- Notational Preliminaries

- Quantum Circuits

- Quantum States

- Quantum Dynamics

- Quantum Algorithms

- True Random Number Generation
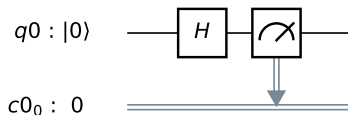
- Quantum Money

- Pseudocode

# Quantum Computing

**True Random Number Generation**



Figure: Figure taken from Diamanti, Hull, Sattath, Wendin (2019).

# Quantum Computing

**Diamanti, Hull, Sattath, Wendin (2019)**

▶ Working paper available 2019:Q4.

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