News and Consumer card payments

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Harnessing Big Data & Machine Learning for Central Banks

Motivation and Research question

- Policy makers and academics are increasingly interested about the macroeconomic impact of shocks related to:
  - **Uncertainty,** especially due to institutional and global factors;
  - **Cyber-Security** and the safety of the electronic money.

- **This paper** investigates for Italy the **reaction of Italian households to news** about:
  - **Economic Policy Uncertainty** (see Visco 2017)**;**
  - Payment system frauds and **Cyber-risks** (see Draghi 2017)**.**

- We use a unique **daily** data set on **debit card expenditures,** tracking private **consumption.**
- We apply **Big-Data techniques** on **Bloomberg** and **Twitter** to build daily indexes of news.

Literature

Economic policy uncertainty

Baker, Bloom and Davis (2016); Bachmann and Bayer (2013); Bachmann, Elstner and Sims (2013); Bloom, Bond and Van Reenen (2007); Bloom (2009).

Payment system and Macro applications

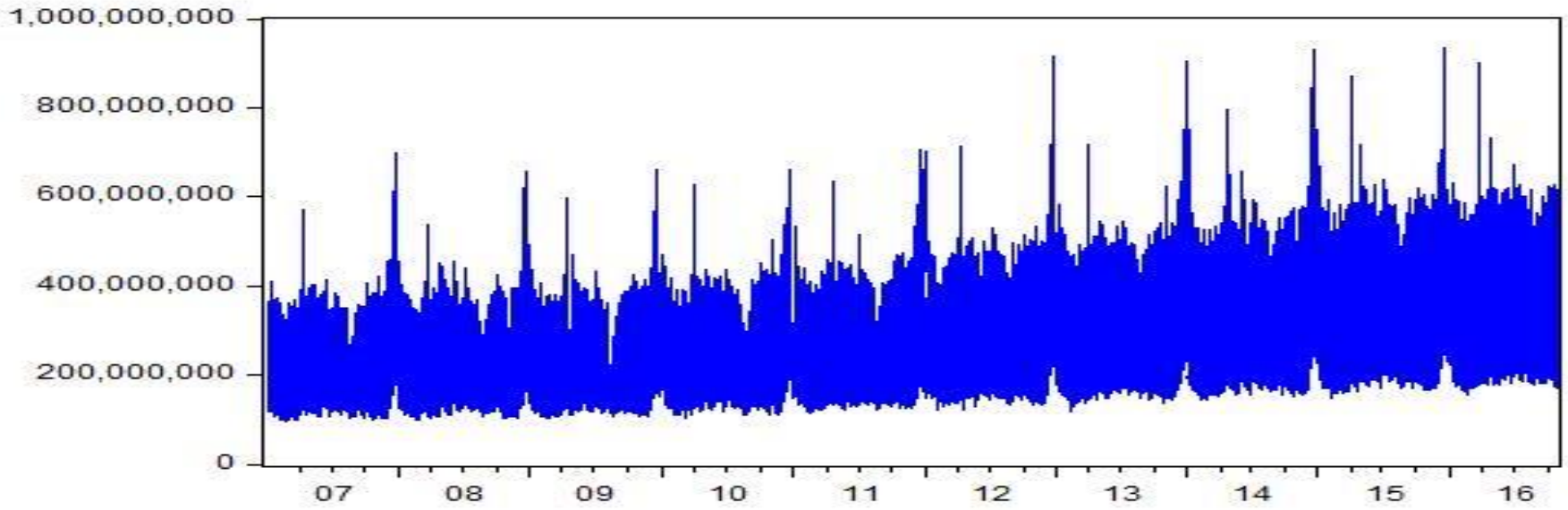
Aprigliano, Ardizzi and Monteforte (2017); Carlsen and Storgaard (2010); Duarte, Rodrigues and Rua (2017); Esteves (2009); Galbraith and Tkacz (2013); Rodrigues and Esteves (2010).

Credit/Debit card frauds news, Cyber-security

Biancotti (2017); Khan and Linares-Zegarra (2012); Kosse (2013).

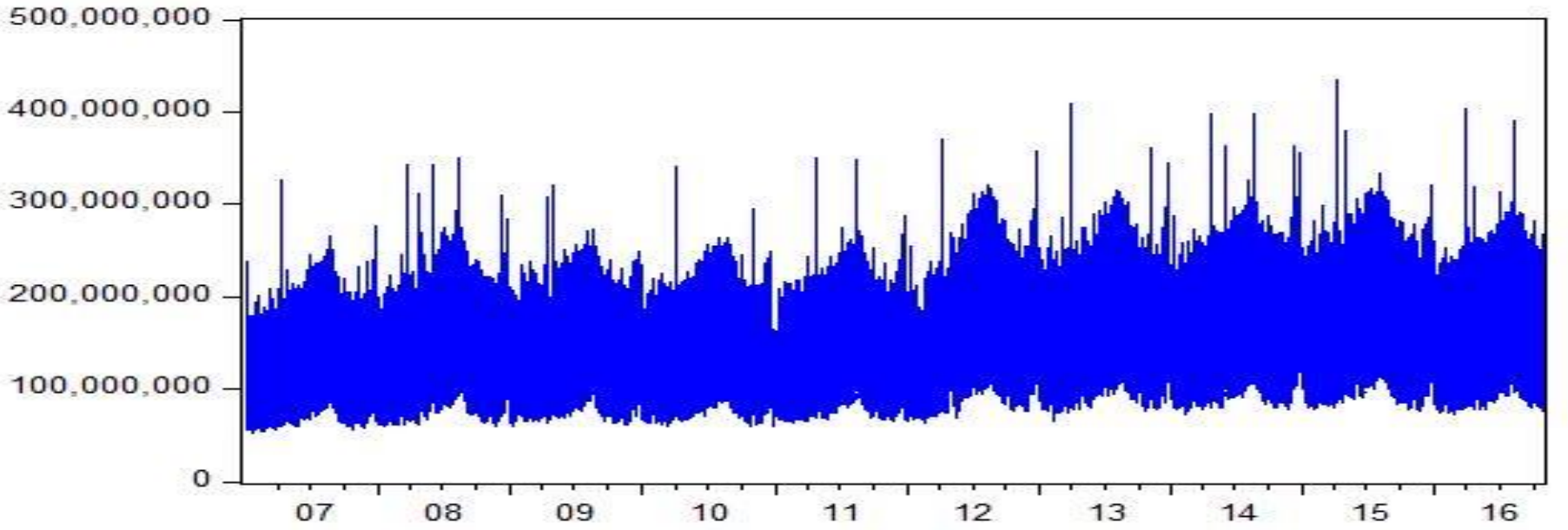
Our data set

Payment System Data: POS



- **Daily POS purchases** extracted from the **Italian payment system BI-comp** (2007-2016); no revisions and observation errors.
- The dynamics is **in line with consumption**, as in Duarte et al. (2017) C&P:
  - 75% of Italian households own a card, according to the SHIW survey;
  - 1.8 Billions transactions in 2016 (approx. 70 Billions of euros).
- **Caveat:** strong **seasonal patterns** and **calendar effects.** Bplot

Payment System Data: ATM



- **ATM** withdrawals extracted **BI-comp**.
- Comparison with POS: similar seasonality; around half of the amounts.
- The **ratio ATM/POS** is considered a proxy for the **preference for cash** (see Ardizzi et al. 2014). Chart ATM&IP
- **Caveat:** We only refer to the withdrawals charged by a fee, as made by customers of other banks (so called “not on us operations”).

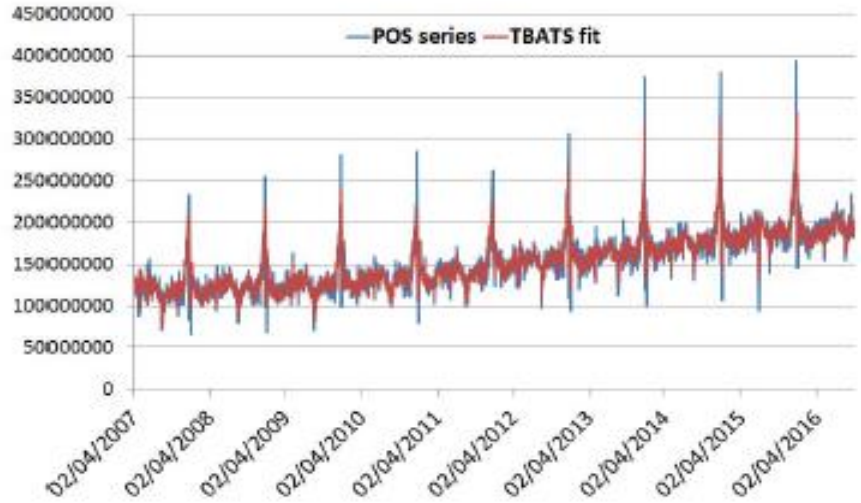
Seasonality of Payment Data (2)

Seasonality is **a salient feature** of our daily data on payments**:**

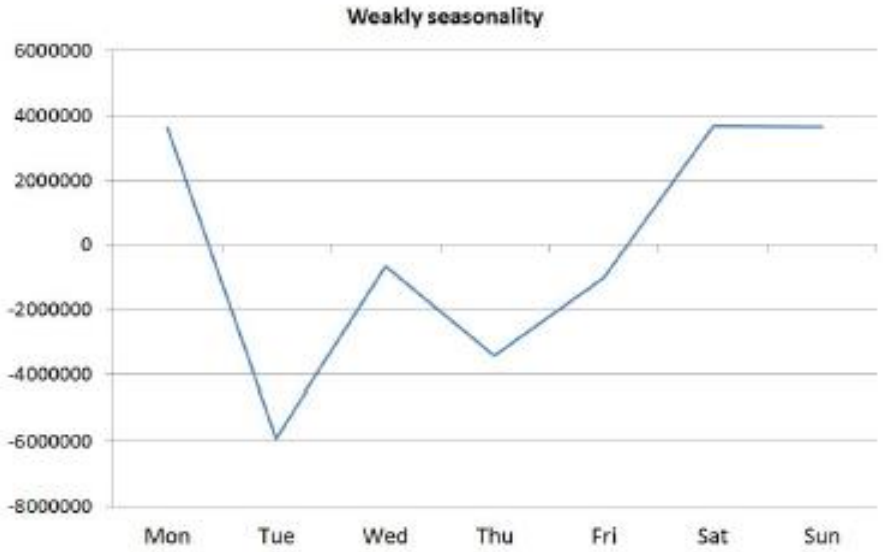
- Day-of-the-week;
- Day-of-the-month;
- Day-of-the-year;
- Fixed Holidays (eg. Christmas, June the 1°, May the 1°);
- Moving Holidays (eg. Easter).

- **We investigate the seasonal components with two approaches**:
  - **TBATS**, by De Livera, Hyndman and Snyder (JASA 2011) is based on state space models, as in Harvey, Koopman and Riani (1997) but allows for a larger parameter space; TBcycles
  - **Prophet**, by Taylor and Lethman (2017), is a flexible bayesian model that decomposes the time series with complex seasonal patterns in a) trend, b) seasonal components and c) calendar effects.

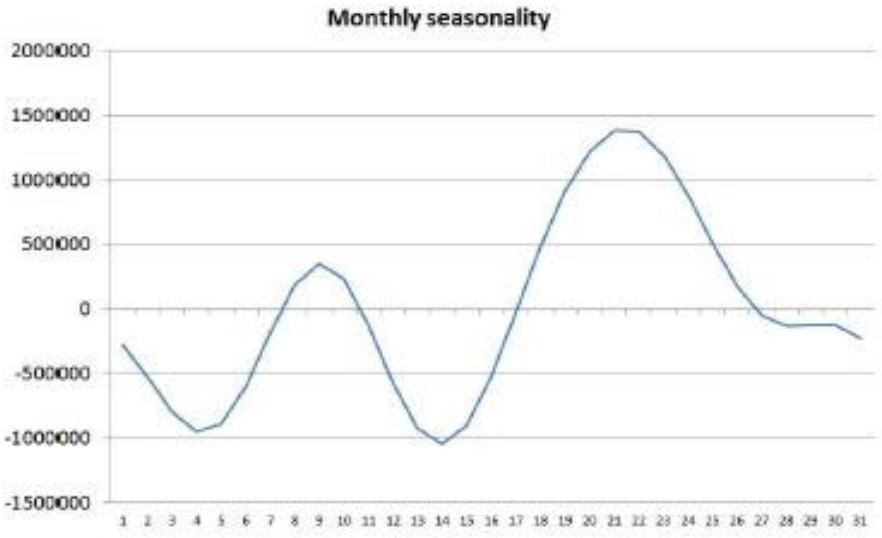
Seasonality of POS in TBATS



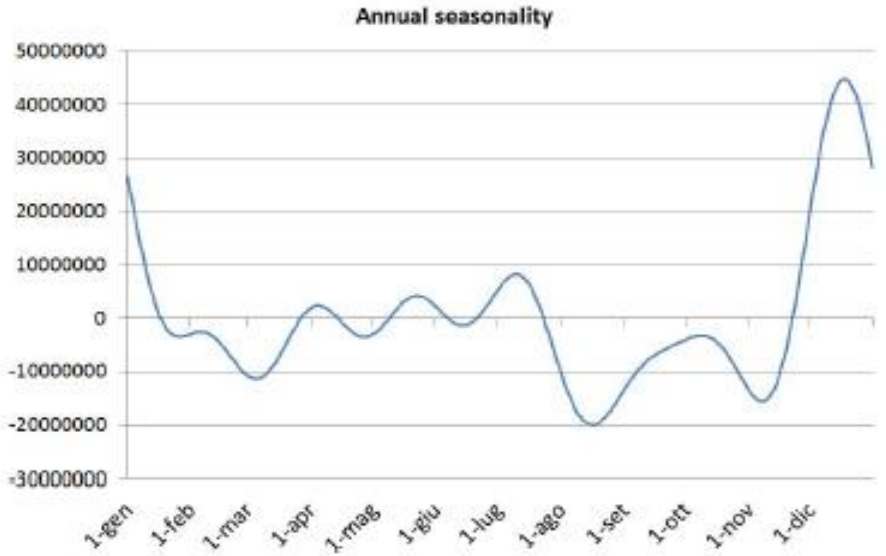
(a) POS daily series fitted with *TBATS*



(b) POS daily series - weekly seasonality

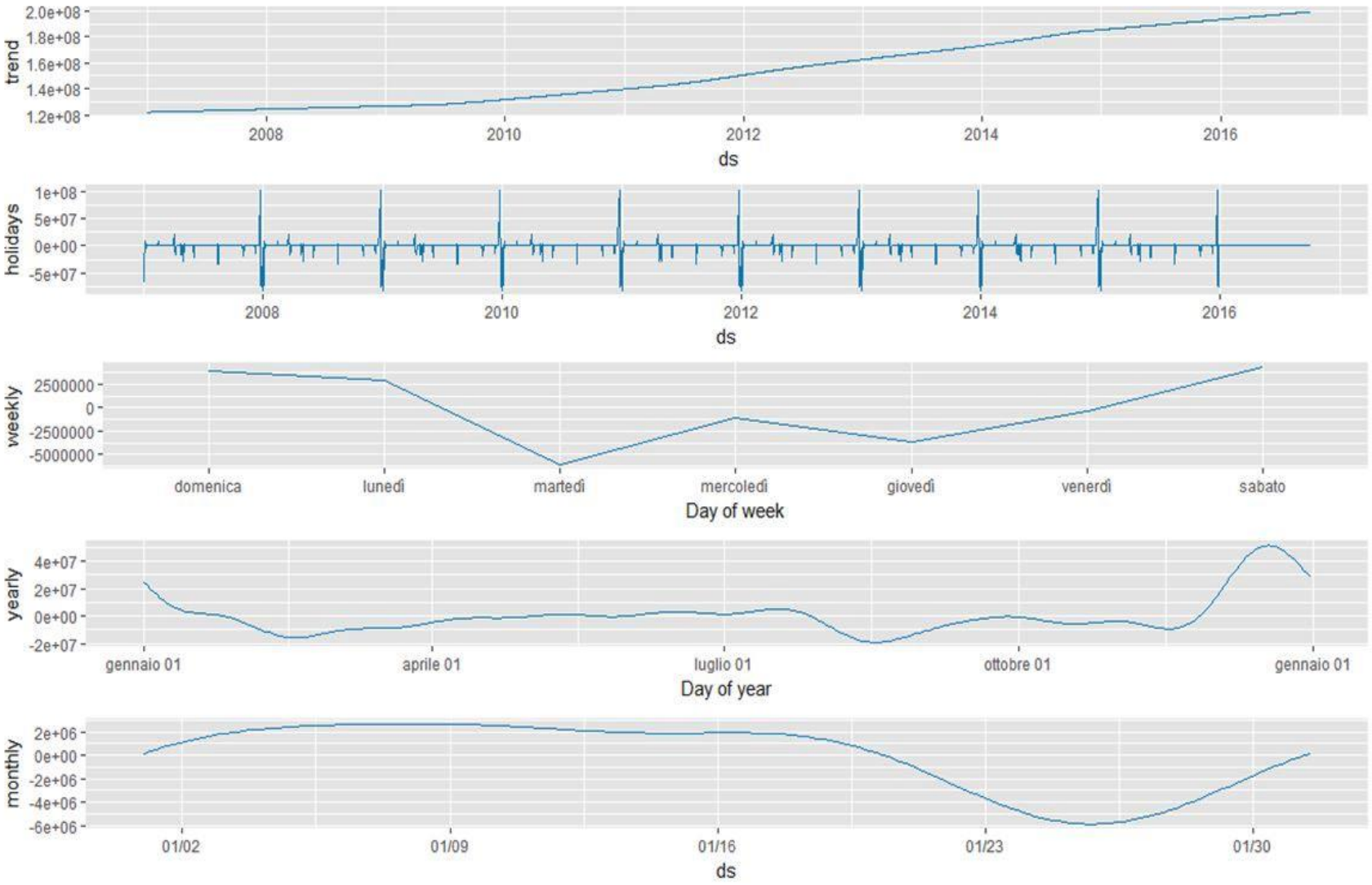


(c) POS daily series - monthly seasonality



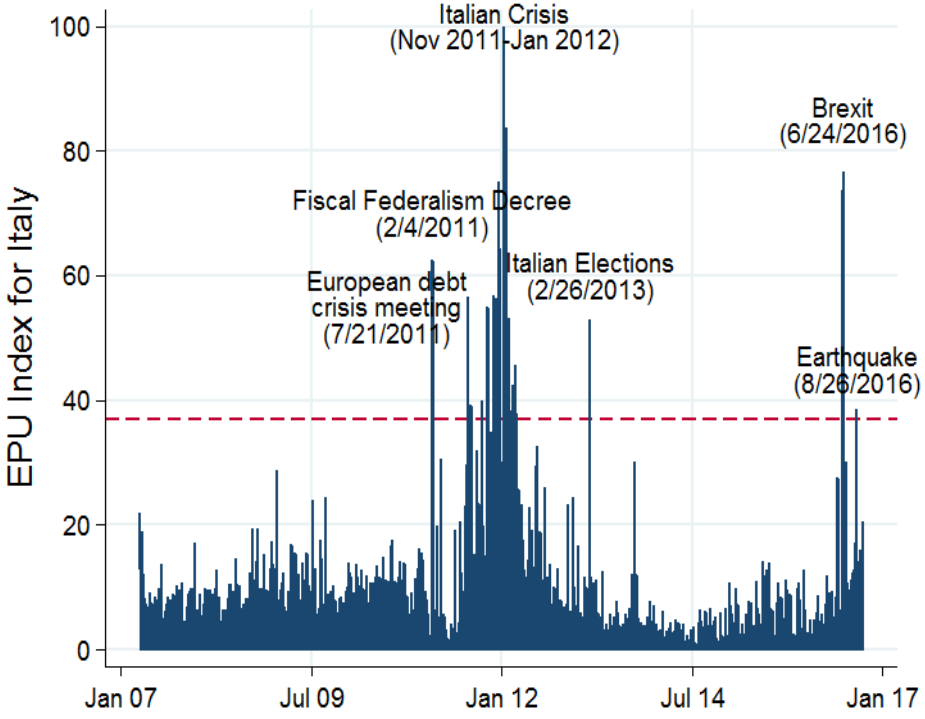
(d) POS daily series - annual seasonality

Seasonality of POS in Prophet

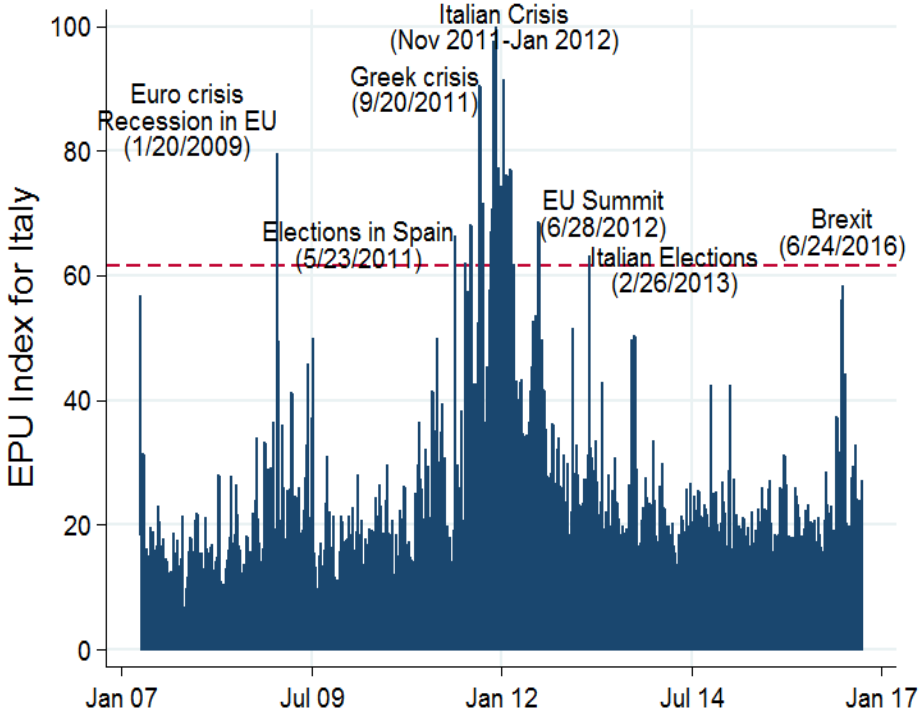


Daily E(P)U indexes for Italy

EPU Italy

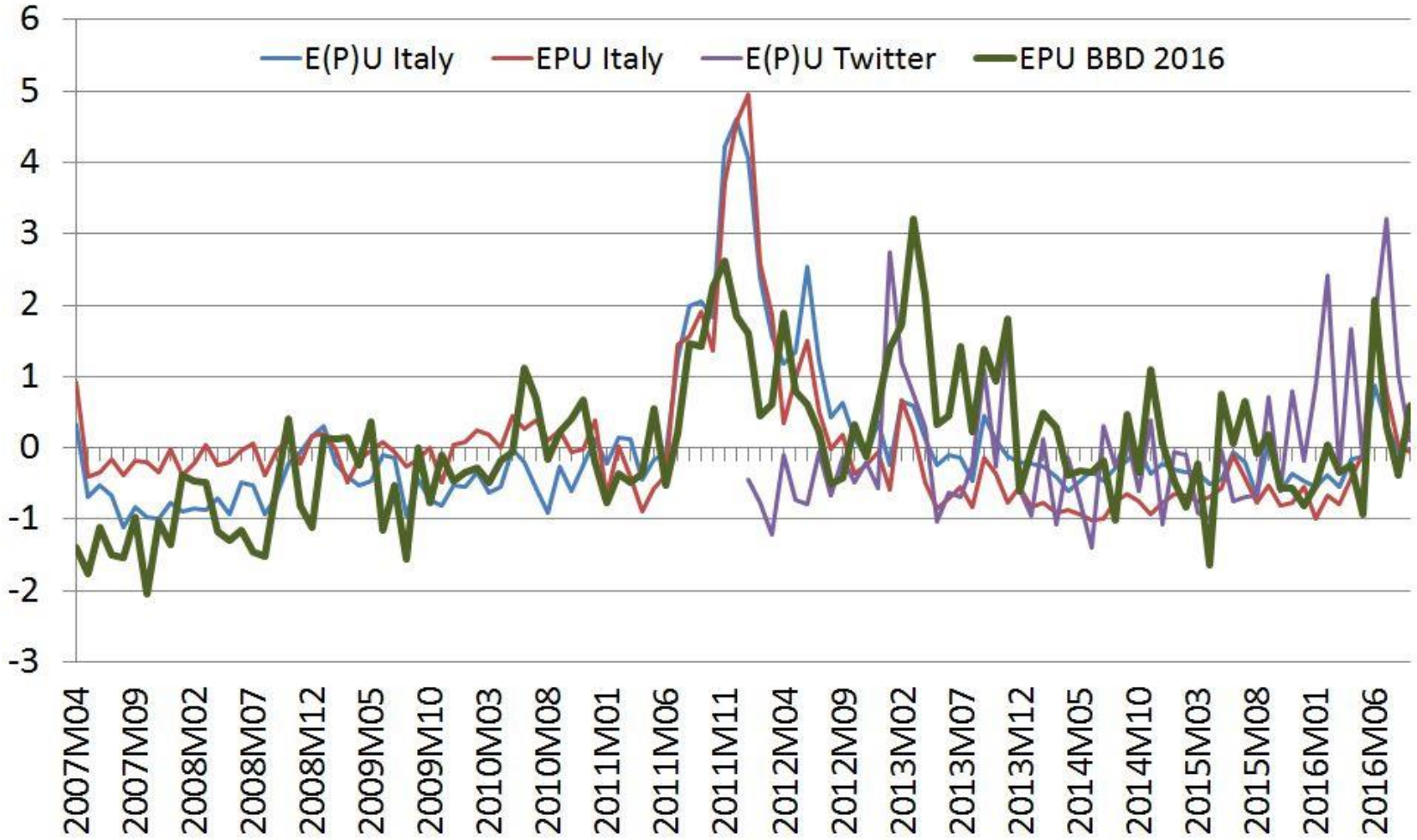


E(P)U Italy



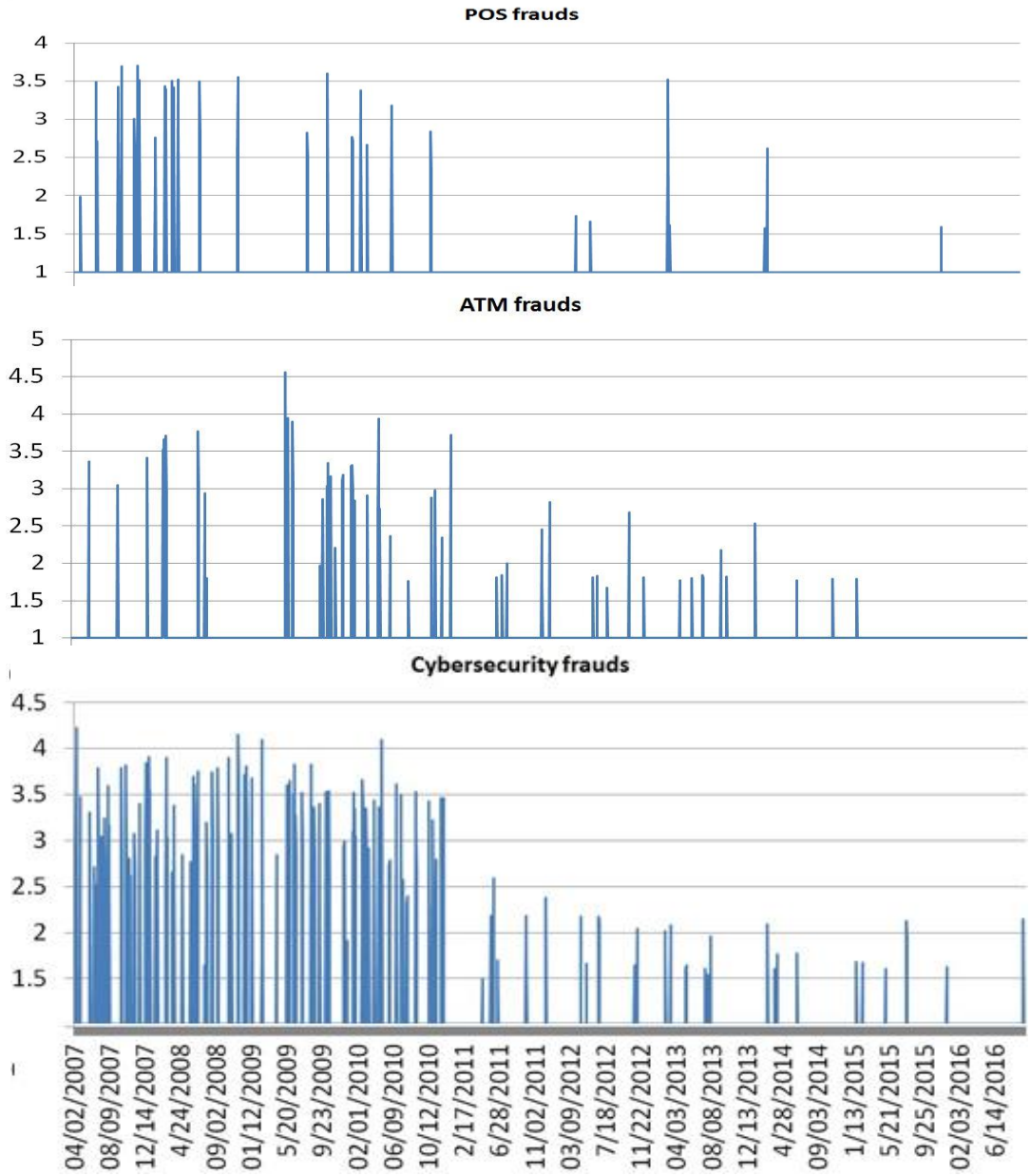
Notes: indexes computed with Bloomberg. E(P)U contains at least the keywords (E) and (U). The dotted red line shows the 99 percentile. **Keywords**

Monthly EPU indexes



Our indexes are consistent with the series of Baker et al. (2016); The Twitter based index excludes the P keywords.

News on Card Frauds/Cybersecurity



- **Index focused on POS.** Keywords: `FRAUD' AND `PAYMENT' AND `POS' AND `ITAL*'.
- **Index focused on ATM.** Keywords: `FRAUD' AND `ATM' AND `ITAL*'
- **Index focused on Cybersecurity.** Keywords: `CYBER*' AND `FRAUD' AND `PAYMENT' AND`ITAL*‘.

The econometric analysis

Econometric framework

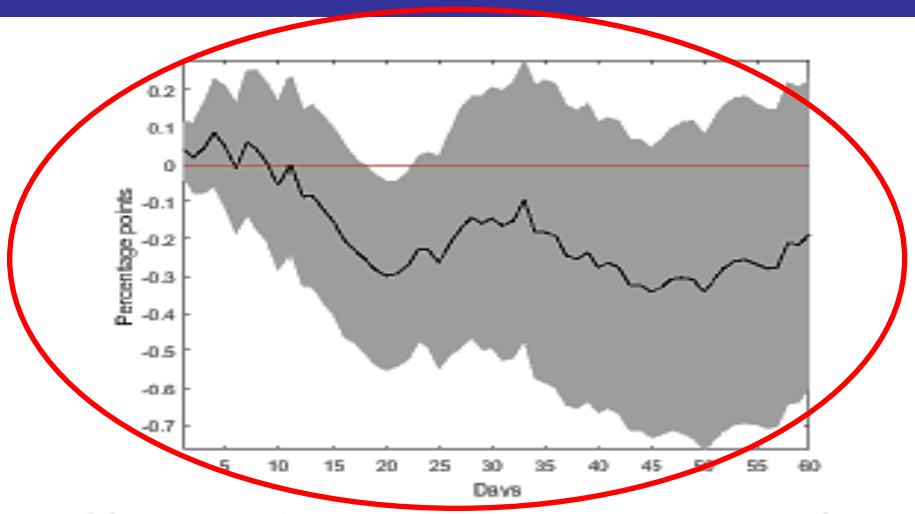
- We build daily impulse response functions with **Local projections** (LP, by Jordà, AER 2005), with the following specification:

$$y_{t+h} - y_t = \alpha_h Index_t^v + \sum_{i=0}^{I} \beta_i y_{t-i} + \sum_{j=1}^{J} \gamma_i Index_{t-j} + \dots$$

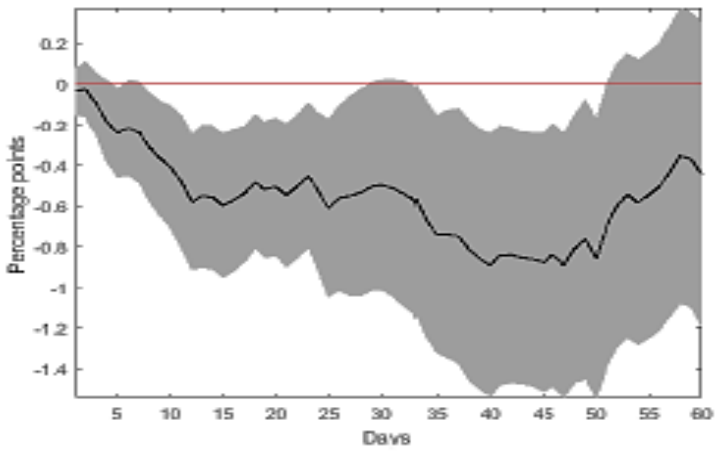
$$\dots + det_t + \varepsilon_t, \quad h = 1, \dots, H, \quad v = \{EPU, Frauds\}.$$

  - We fully exploit our data set, using **daily data** =>
    - Around 2400 observations (02/04/2007 – 30/09/2016);
    - No need of mixed frequency models; no time aggregation issues; negligible concerns for endogeneity.
  - LP are more **robust** than VAR **to misspecification**, the more for large horizons of the IRFs => given the lack of macroeconomic daily observables.

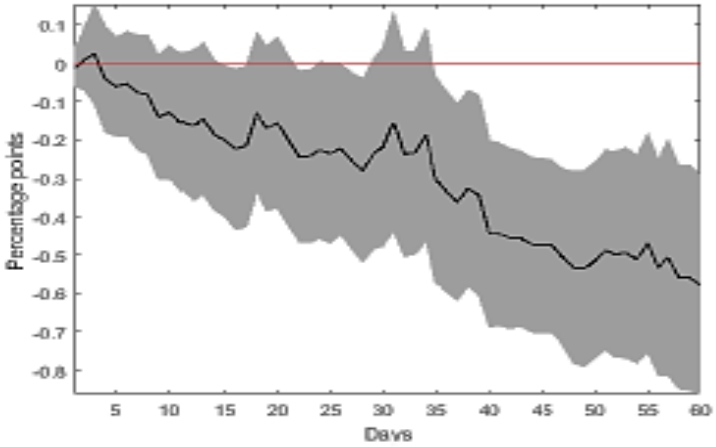
POS and EPU: whole sample



(a) Impulse of payments to a shock in uncertainty (EPU with words in English).



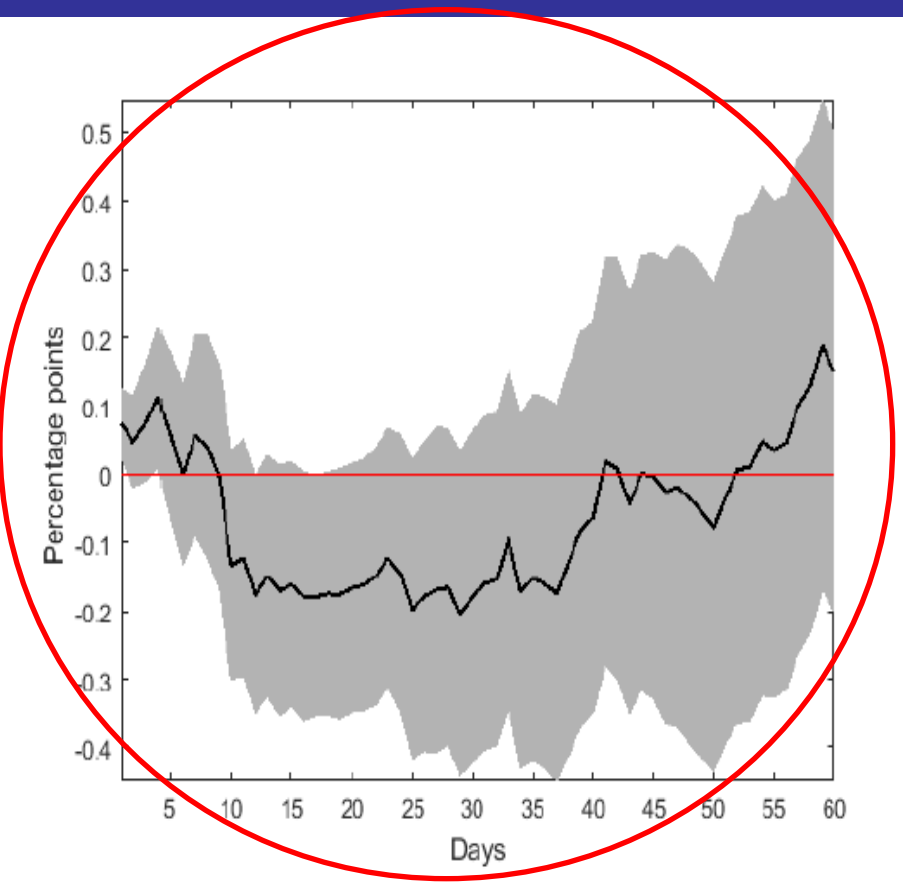
(b) Impulse of payments to a shock in uncertainty (EU with words in English).



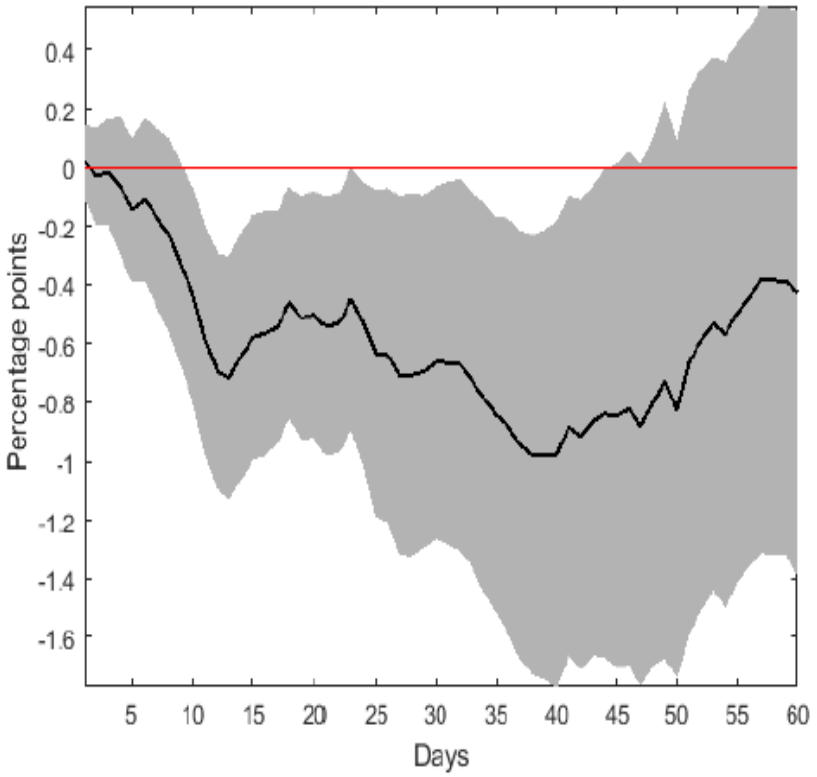
(c) Impulse of payments to a shock in uncertainty (Twitter). Sample January 2012- September 2016.

- EPU generates a **non negligible reduction in purchases**.
- The effects **tend to vanish after 1-2 months** (except for the Twitter measure).
- Baker et al. (2016) find a contraction on production and employment.

POS and EPU: 2007-2012



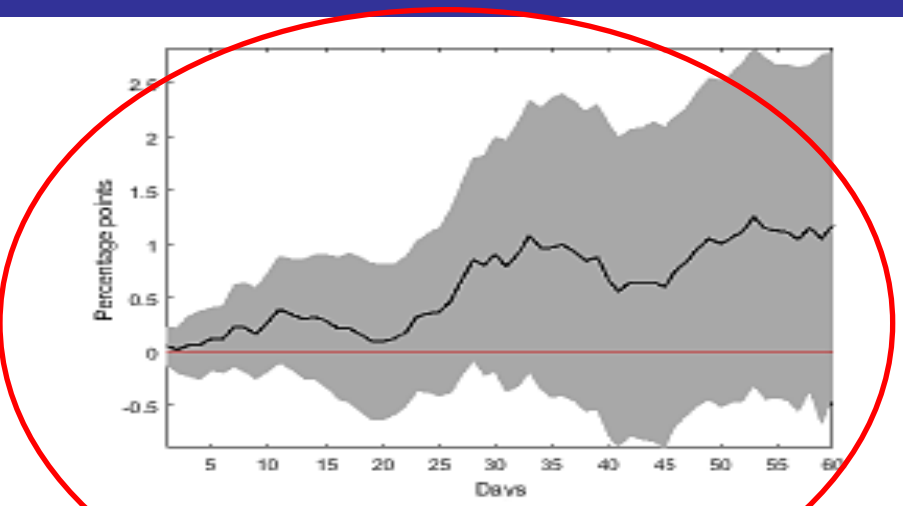
(a) Impulse of payments to a shock in uncertainty (EPU with words in English).



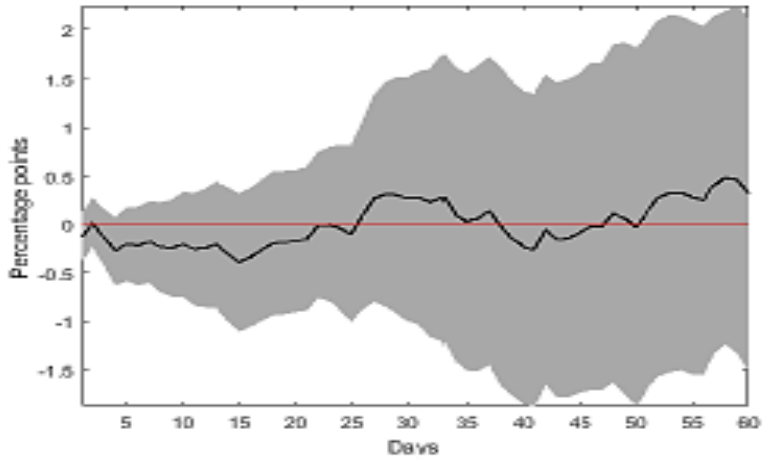
(b) Impulse of payments to a shock in uncertainty (EU with words in English).

In the **first half of the sample** of the whole sample the contractionary effect is **confirmed**

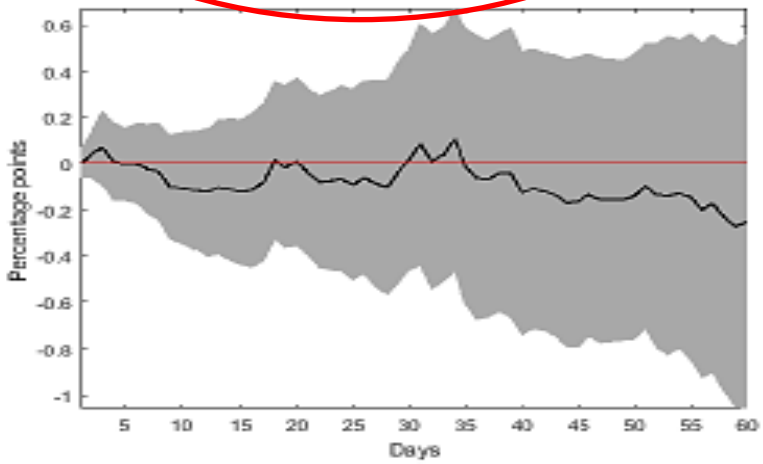
POS and EPU: 2012-2016



a) Impulse of payments to a shock in uncertainty (EPU with words in English).



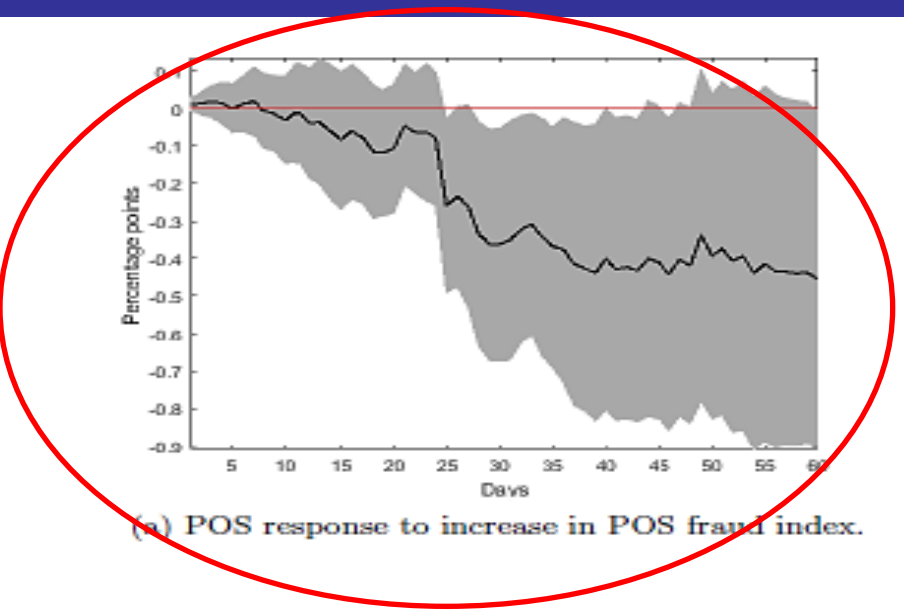
(b) Impulse of payments to a shock in uncertainty (EU with words in English).



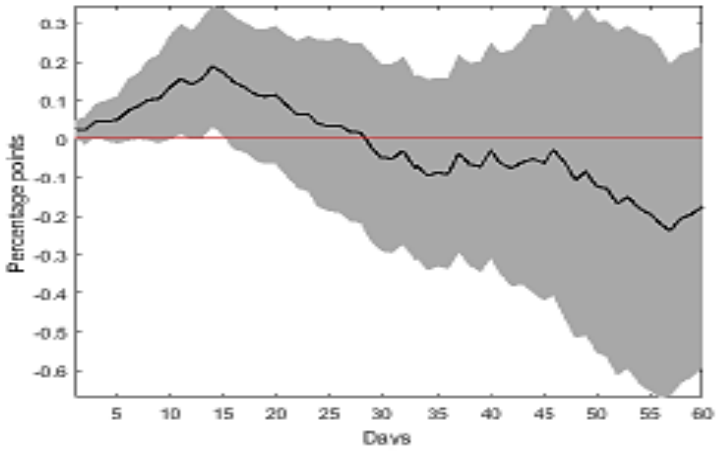
c) Impulse of payments to a shock in uncertainty (Twitter).

- In the **second half of the sample** an increase of the EPU index has **not statistically significant effects** on purchases.

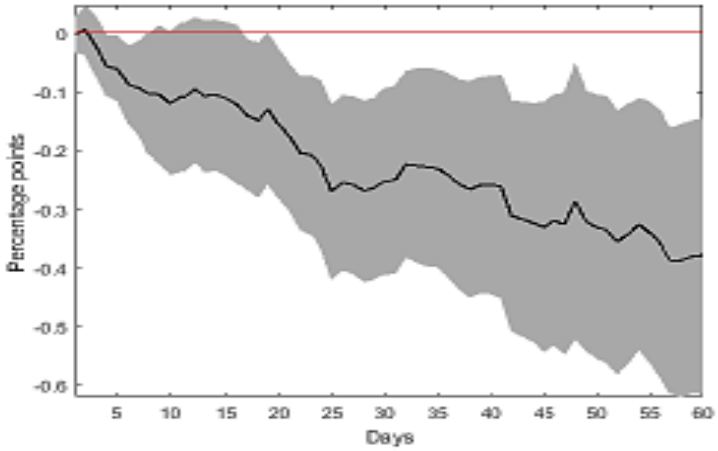
POS and news about frauds/cyber-risks



(a) POS response to increase in POS fraud index.



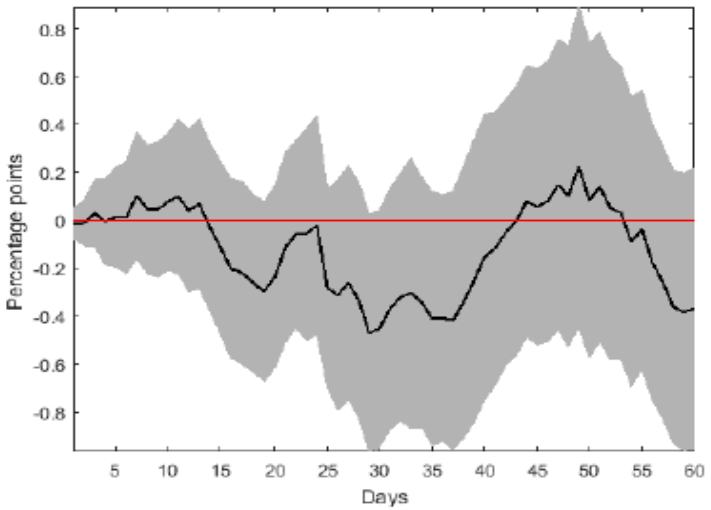
(b) POS response to a temporary increase in the ATM fraud index.



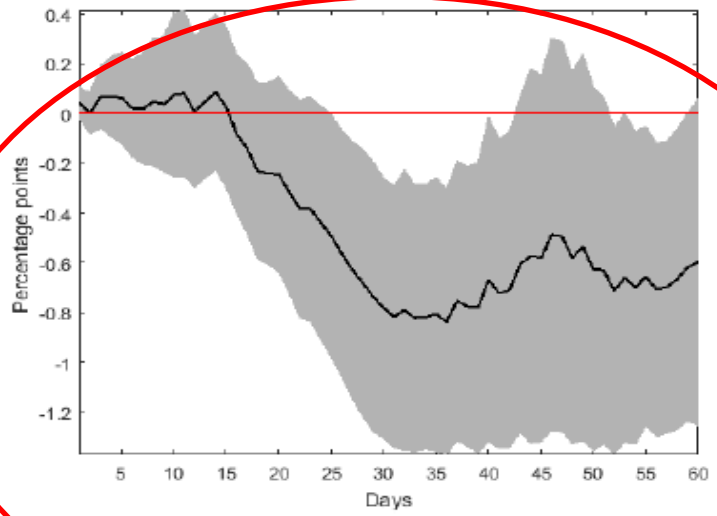
(c) POS response to a temporary increase in the Cyber-security fraud index.

- An increase of the news about **frauds related to POS or Cyber-attacks** has a **persistent impact on expenditures**.
- Kosse (2013) finds similar effects, on the number of transactions for Netherland.

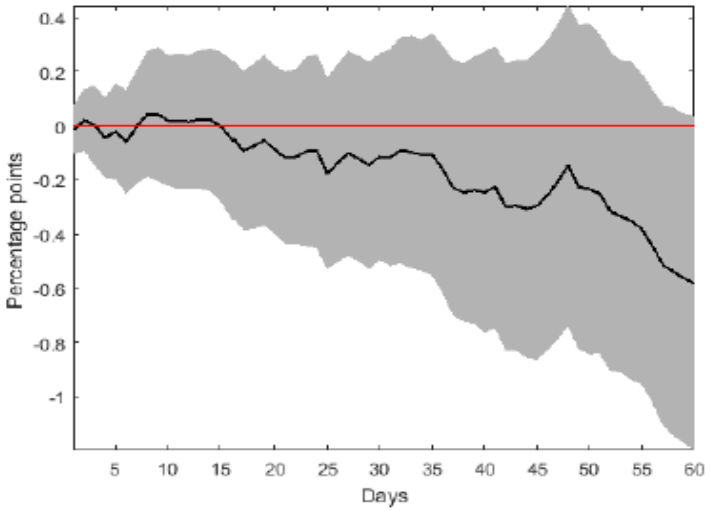
ATM and news about frauds/cyber-risks



(a) ATM response to increase in POS fraud index.



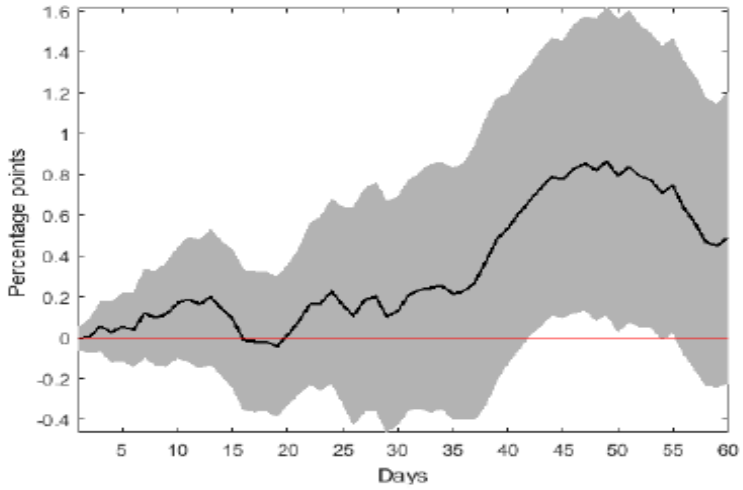
(b) ATM response to a temporary increase in the ATM fraud index.



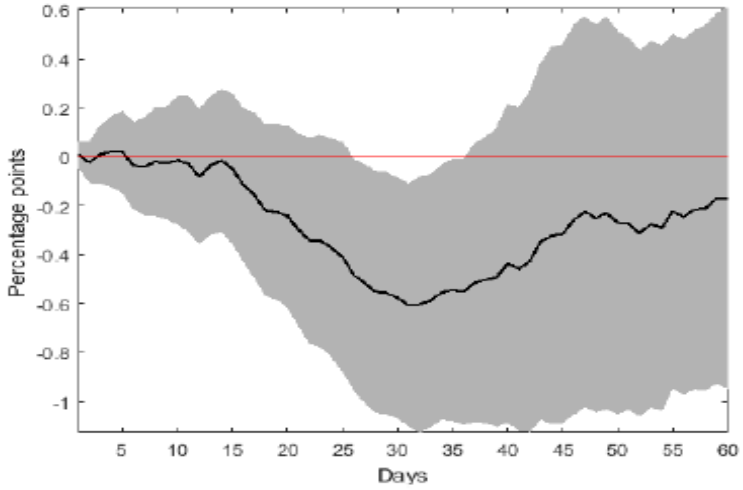
(c) ATM response to a temporary increase in the Cyber-security fraud index.

- An increase of the news about **frauds related to ATM** has a **persistent impact on withdrawals**.
- **News on Cyber-attacks** (and POS frauds) are basically irrelevant.

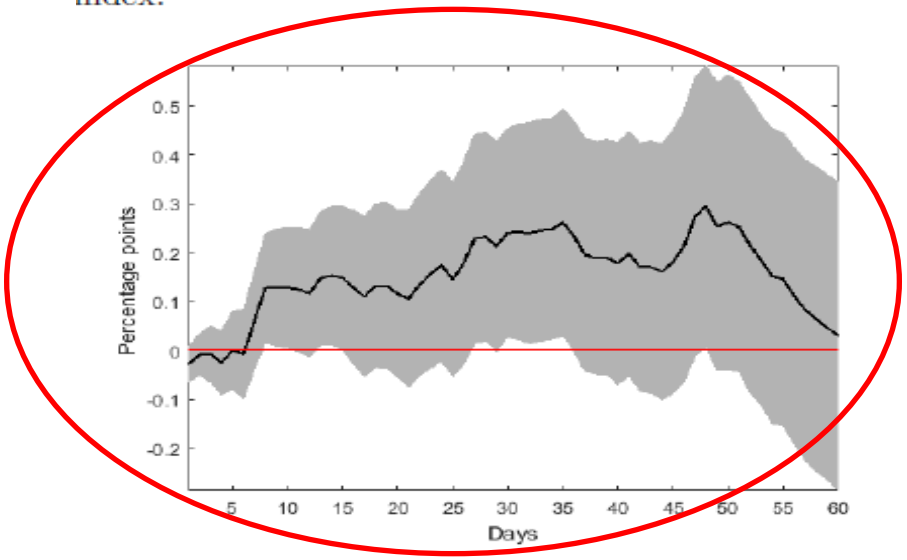
Preference for cash and cyber-risks



(a) ATM/POS ratio response to increase in POS fraud index.



(b) ATM/POS ratio response to a temporary increase in the ATM fraud index.



(c) ATM/POS ratio response to a temporary increase in the Cybersecurity fraud index.

- **News about frauds and cybersecurity increase the ratio ATM/POS.**
- This is consistent with the finding (see Alvarez and Lippi, ECA, 2009) that consumers increase the cash withdrawals when the probability of theft increases**.**

Robustness check: monthly estimates

- **Monthly Local Projections**
  - We claim that the daily frequency, is crucial as it rules out problems of endogeneity and is suited to identify effects within the quarter.
  - In order to check the relevance of the frequency we also estimate local projections of **EPU on POS** with data.
  - Whatever the index or the horizon, there are **no effects on purchases** monthly_LP.

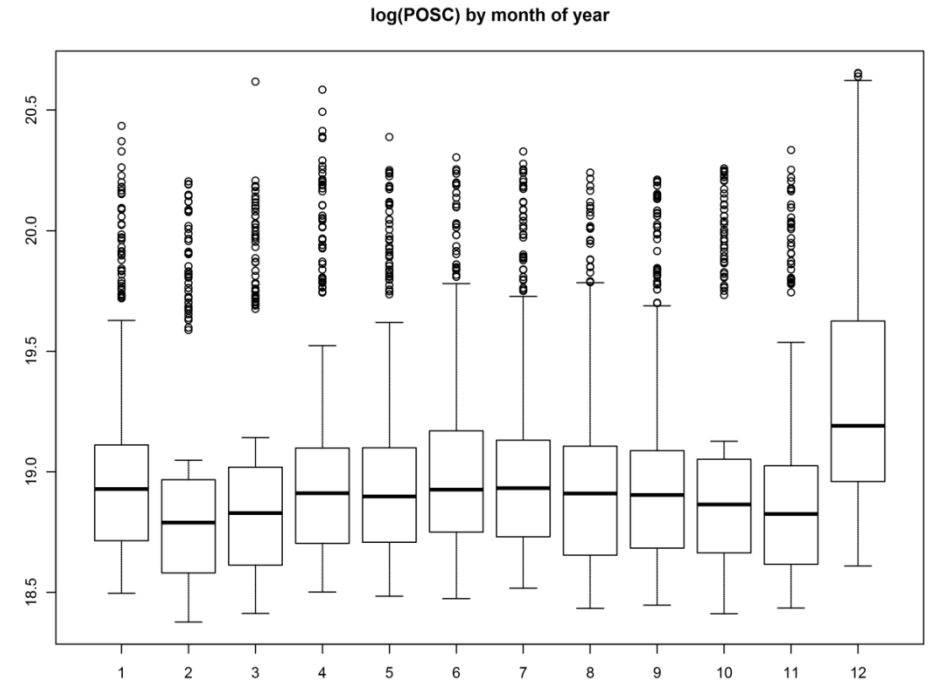
- **Monthly VAR** with **Cholesky identification**.
  - **Variables:** EPU, industrial production, HICP and POS purchases.
  - Both **payments** and **industrial production do not to respond** to **EPU** at monthly frequency IRFs.
  - **Not claim** that **EPU shocks** are not relevant => At **monthly frequency** the macro effects can be **masked** by the profile of the response within the month.

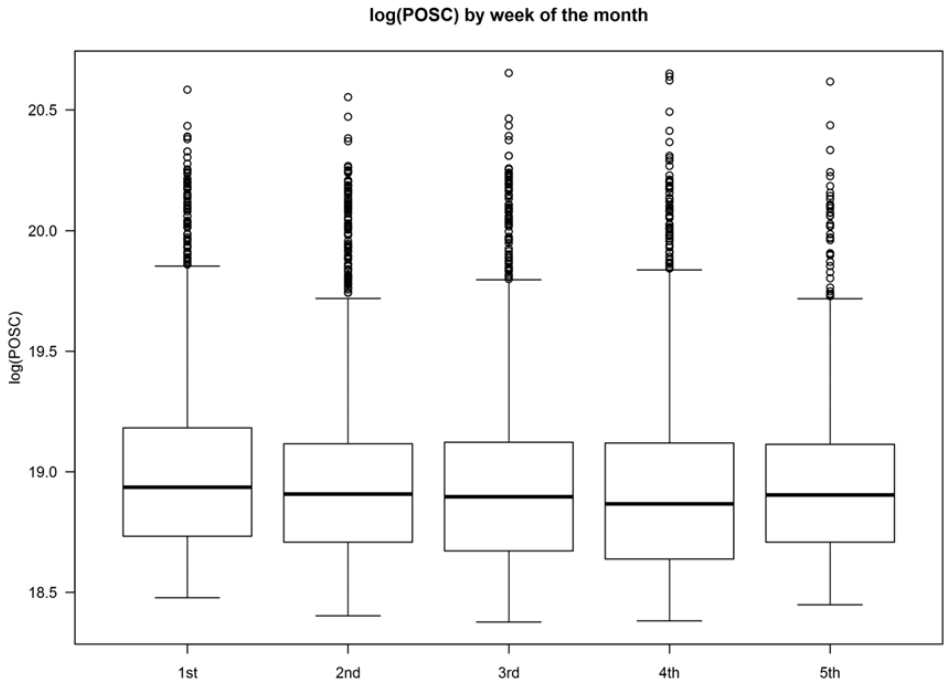
Conclusion: main results

- The series of **payments with cards** are correlated with quarterly consumption; at daily frequency have strongly **seasonal components**.
- Our indexes on **news on EPU** are consistent with those of Baker, Bloom and Davis (2016).
- **EPU shocks** have **temporary but not negligible contractionary effects on purchases**, mainly during the crisis => "Protracted (political) instability may undermine confidence".
- The fears about **the security of the payments have a clear negative impact both on POS and ATM**=> the safety of the payment system is key to sustain the use of debit cards.
- The **preference for cash increases following cyber-attacks** => In the age of cryptocurrencies cash remains the safe haven.

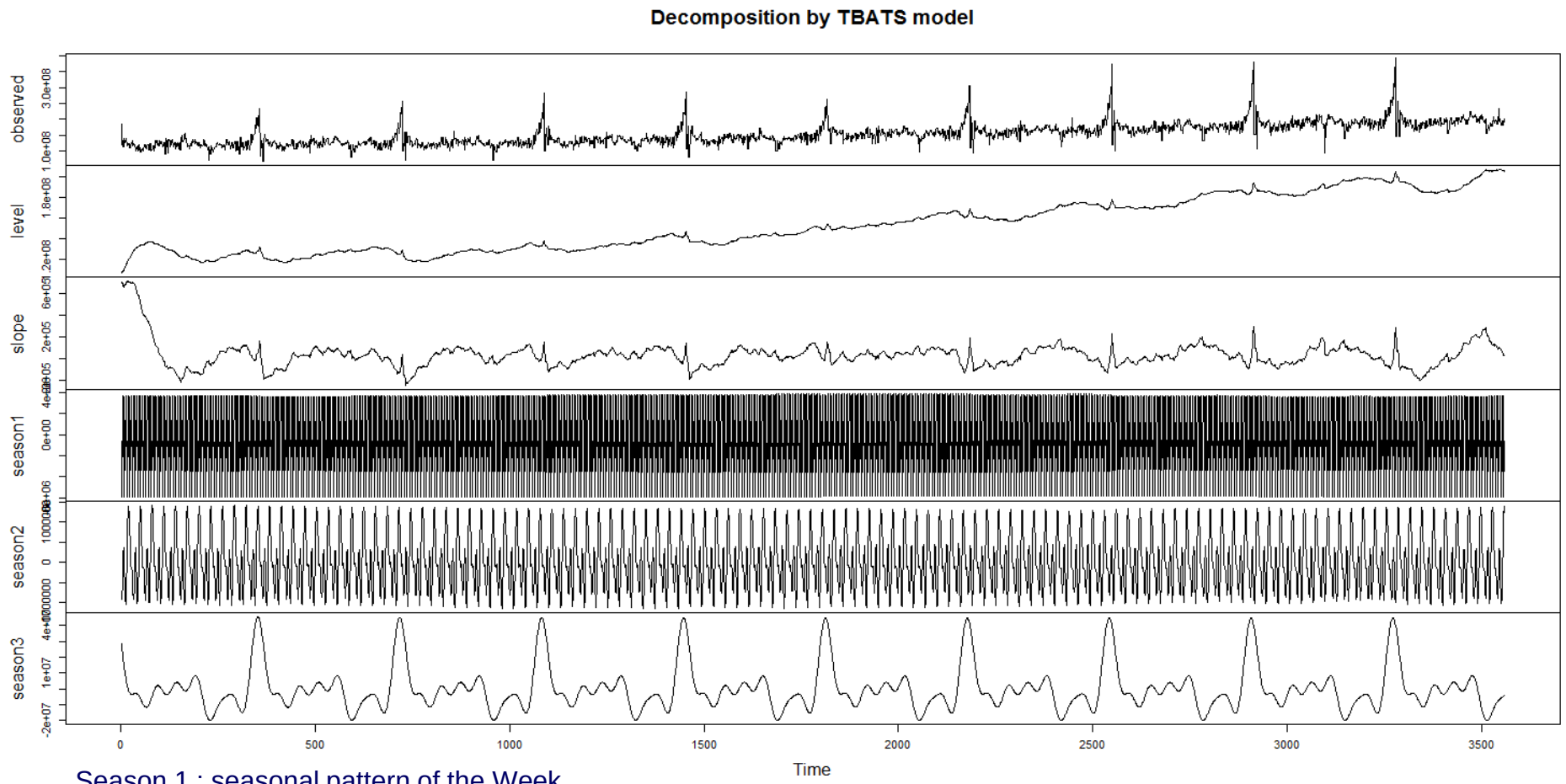
Thanks!

Seasonality of Payment Data (1)





Seasonality of Payments in TBATS (1)



Season 1 : seasonal pattern of the Week
Season 2 : seasonal pattern of the Month
Season 3 : seasonal pattern of the Year

E(P)U Index in Italian

- **Computed from Bloomberg (EPU - story counts normalized by the # of all news a la Google Trends) containing**

Keywords:

- **(E): «Economia» or «Economico» or «Economica» or «Economici» or «Economiche»**
- **(P): «Tassa» or «Tasse» or «Politica» or «Regolamento» or «Regolamenti» or «Spesa» or «Spese» or «Deficit» or «Banca Centrale» or «Banca d'Italia» or «Budget» or «Bilancio»**
- **(U): «Incerto» or «Incerta» or «Incerti» or «Incerte» or «Incertezza»**

As in **Baker, Bloom and Davis (2016)**

- **If E(P)U, policy keywords not included to match Twitter**

E(P)U Index in English with country Identifier

- **Computed from Bloomberg (EPU - story counts normalized by the # of all news a la Google Trends) containing**

Keywords:

- **(E): «Economic» or «Economy»**
- **(P): «Congress» or «Bank of Italy» or «Legislation» or «Regulation» or «Parliament» or «Government» or «Deficit» or «Central Bank» or «Budget»**
- **(U): «Uncertain» or «Uncertainty»**
- **(IT): AND «Ital*»**

As in **Baker, Bloom and Davis (2016)** but adapted to Italian case

E(P)U Index in Italian from Twitter

- **Computed from Twitter (EPU - Tweet counts normalized by the max à la Google Trends) containing**

Keywords:

- **(E): «Economia» or «Economico» or «Economica» or «Economici» or «Economiche»**
- **(U): «Incerto» or «Incerta» or «Incerti» or «Incerte» or «Incertezza»**

As in **Baker, Bloom and Davis (2016)**

- **(P) part excluded for limited number of tweets. Remember: a tweet has max 140 characters (around 12/13 words)**

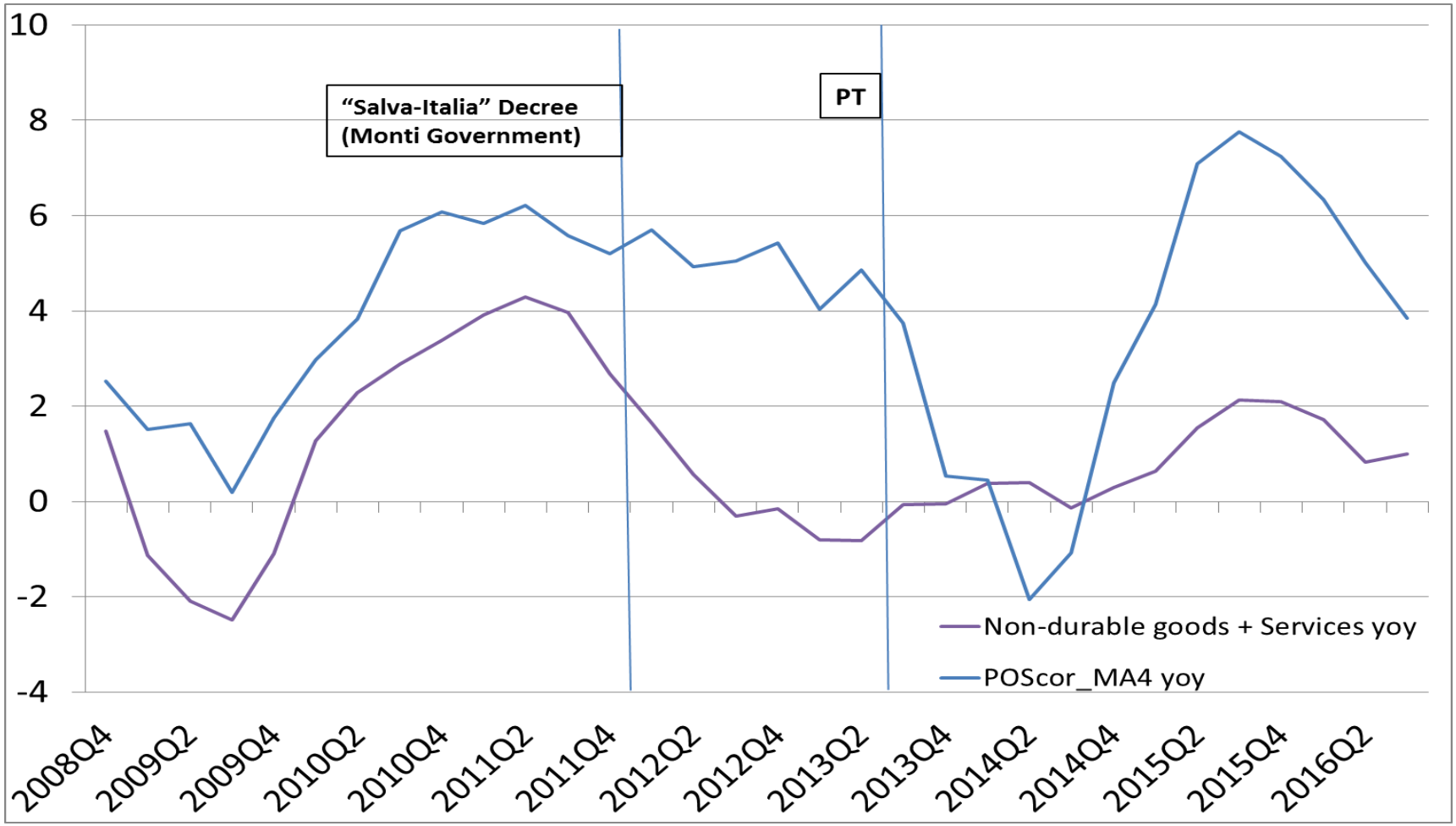
Card Fraud/Cyber-security Index in Italian and English with country identifier

- **Computed from Bloomberg (story counts normalized by the # of all news a la Google Trends) containing**

Keywords:

1. **("debit card" OR "skimming fraud" OR "credit card" OR "skimming fraud" OR "ATM fraud" OR "debit card fraud") AND ITAL***
2. **("skimming fraud" OR "credit card fraud" OR "ATM fraud" OR "debit card fraud") AND ITAL***
3. **(("PIN code" OR "debit card" OR "credit card" OR "magnetic stripe") AND ("crime" OR "copy" OR "victim" OR "hacking" OR "violation")) AND ITAL***
4. **("Bancomat" OR "carta di credito" OR "carta di debito" OR "POS" OR "ATM" OR "codice PIN" OR "striscia magnetica") AND ("frode" OR "frodi" OR "crimine" OR "crimini" OR "clonata" OR "clonate" OR "vittima" OR "truffa" OR "copia" or "duplica*")**
5. **"FRAUD" AND "PAYMENT" AND "ITAL*"**
6. **"FRAUD" AND "CARD" AND "ITAL*"**
7. **("BANCOMAT" OR "CARTA") AND ("FROD*" OR "FRAUD*" OR "CRIMIN*" OR "CLON*" OR "TRUFF*")**

POS and Consumption

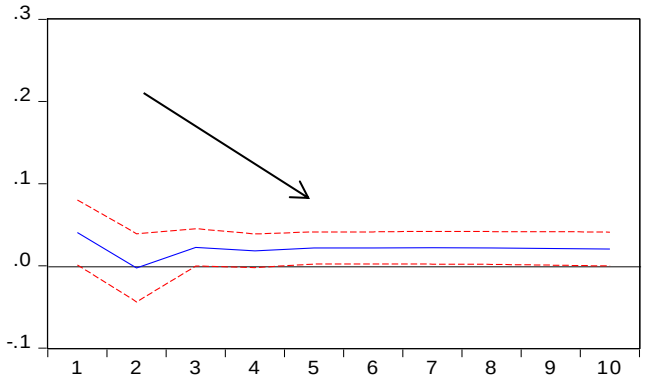


The correlation is close to 2/3

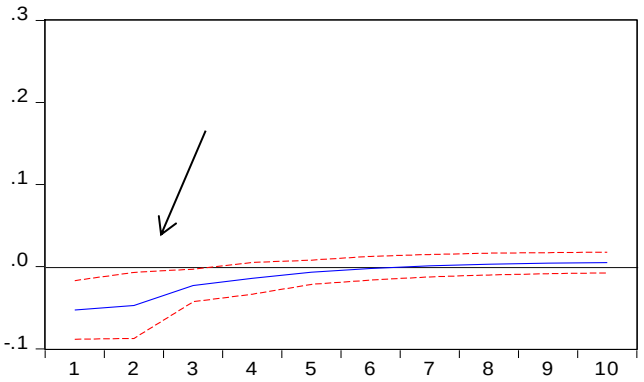
Effects of EPU on POS payment data, Monthly data

Response to Cholesky One S.D. Innovations ± 2 S.E.

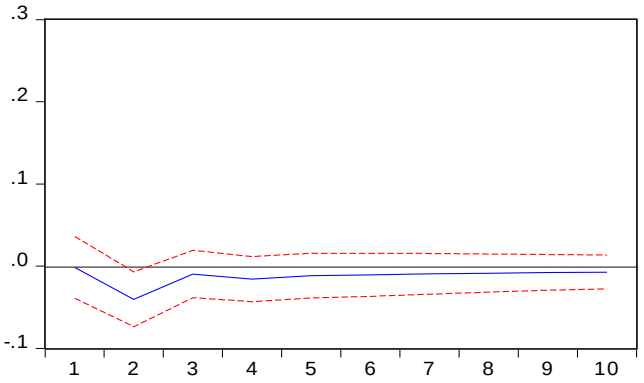
Response of POS payment to Industrial production



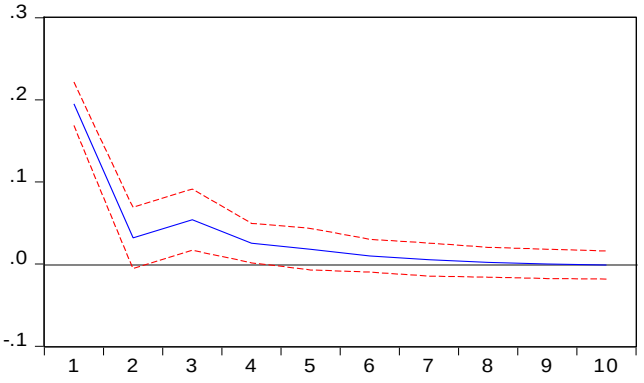
Response of POS payments to HICP index



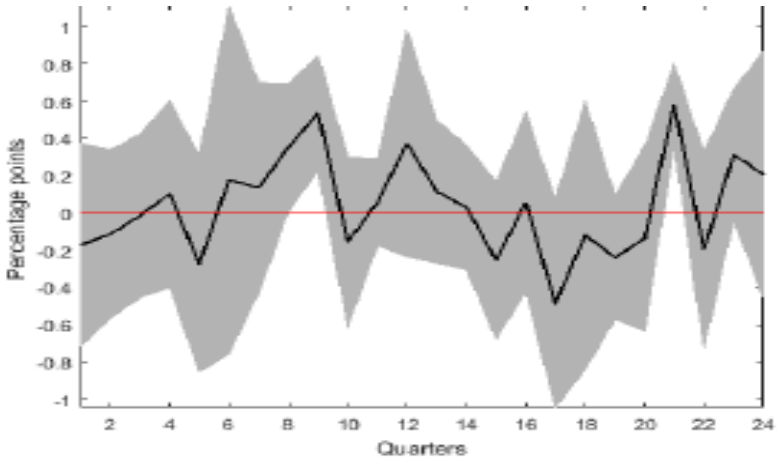
Response of POS Payments to Uncertanty index (EPU Italy)



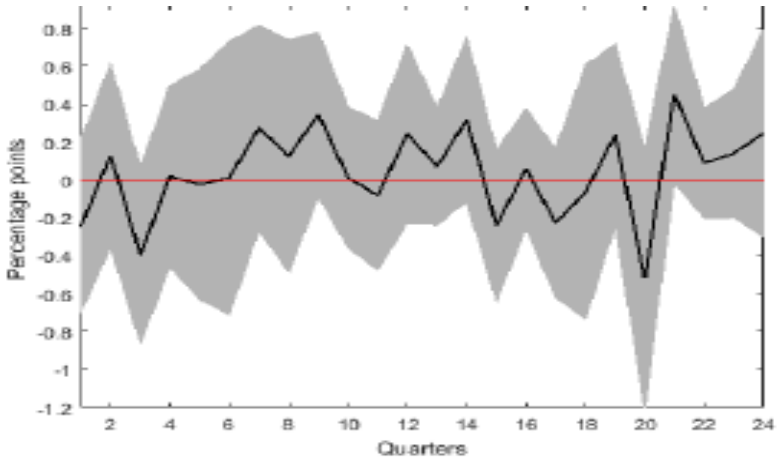
Response of POS payment to POS payment



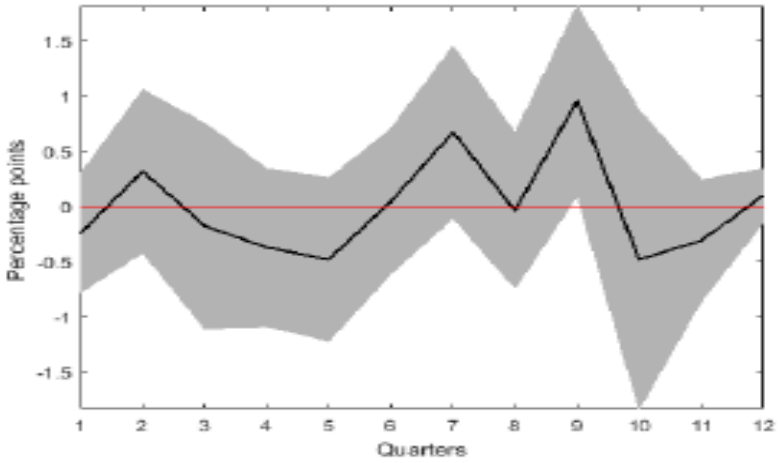
Monthly LP of EPU on POS



(a) Impulse of payments to a shock in uncertainty (EPU with words in English).



(b) Impulse of payments to a shock in uncertainty (EU with words in English) - monthly frequency.



(c) Impulse of payments to a shock in uncertainty (Twitter) - monthly frequency.

POS, univariate results with daily data

(1)

Impact of an increase in EPU index on POS purchases fig. PDL

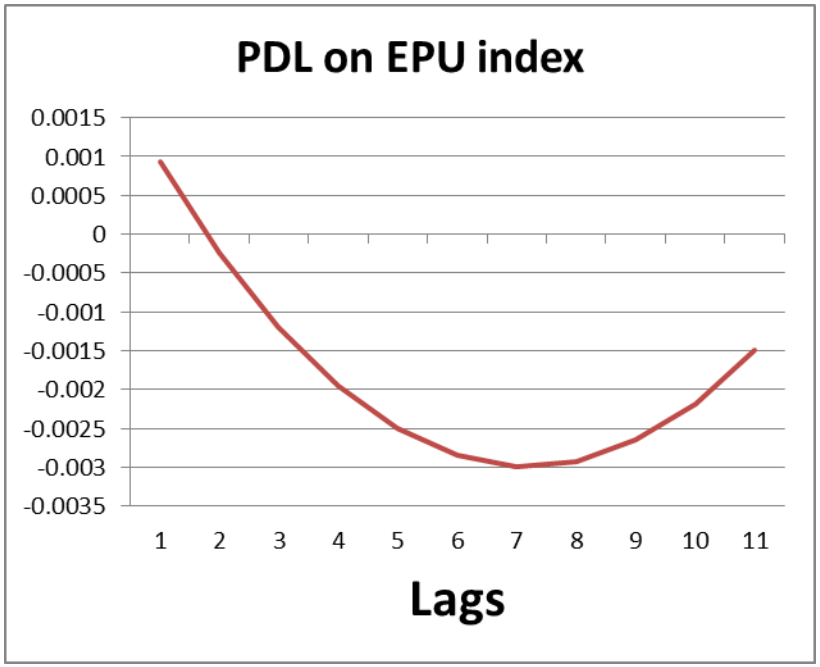
- Strong and lasting effects (2/3 weeks)➔ POS purchases are -2% lower
- Economic activity increases POS transactions

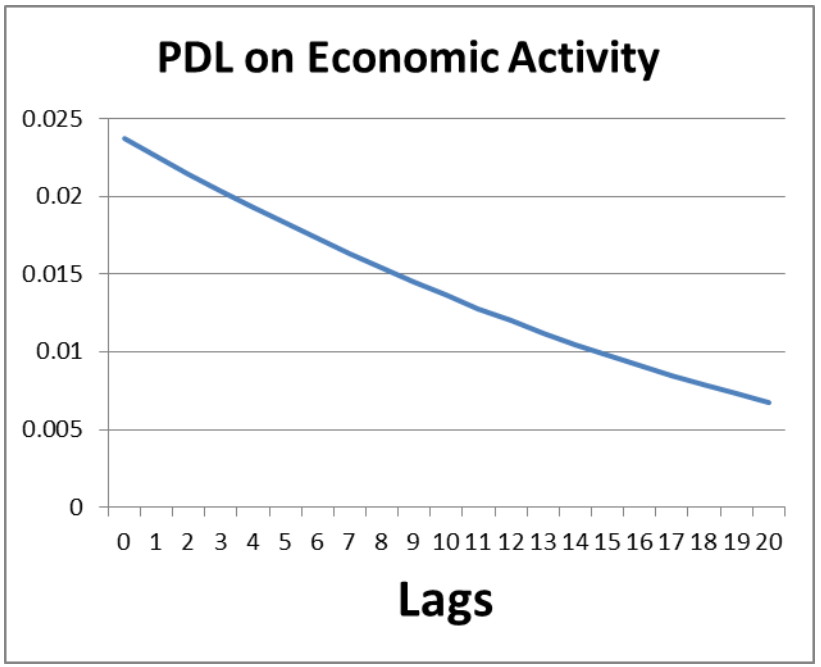
Shocks to Card Fraud/Cyber security index have a minor impact on POS purchases than shocks to EPU index

- Temporary effects showing up 2/3 days after a **positive innovation** of our **fraud news indicator**
- POS purchases go down by -0,7%, value in line with Kosse (2013)

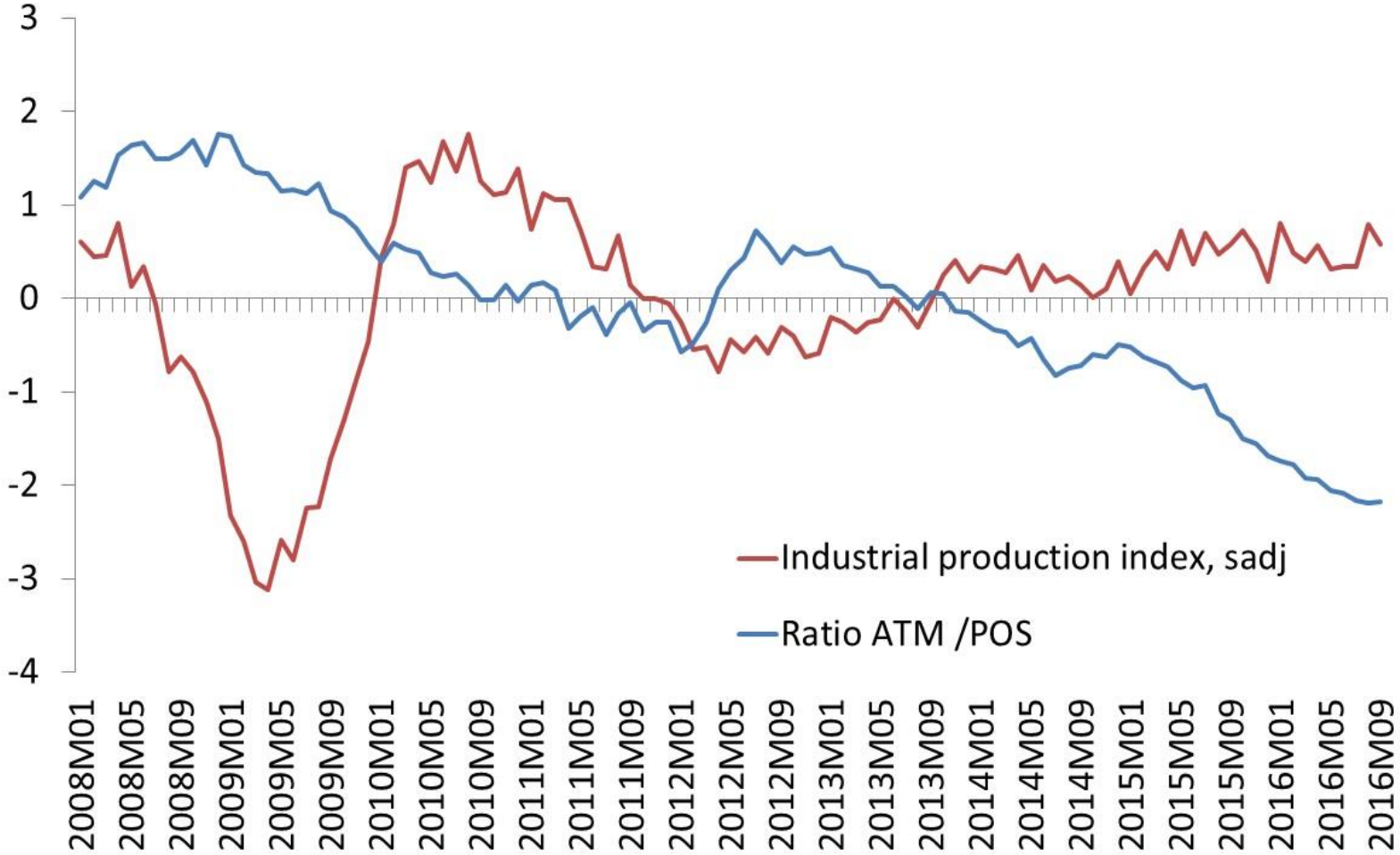
Calendar

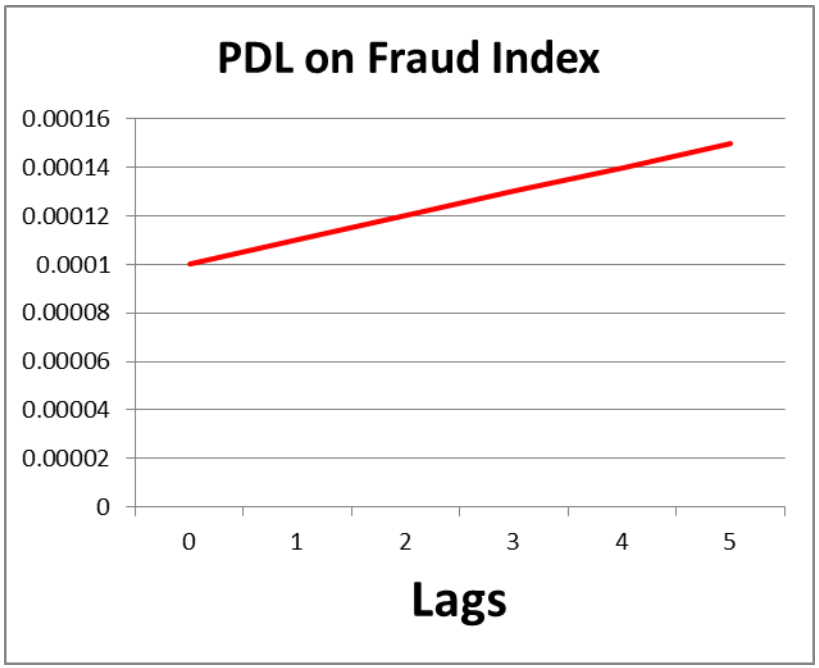
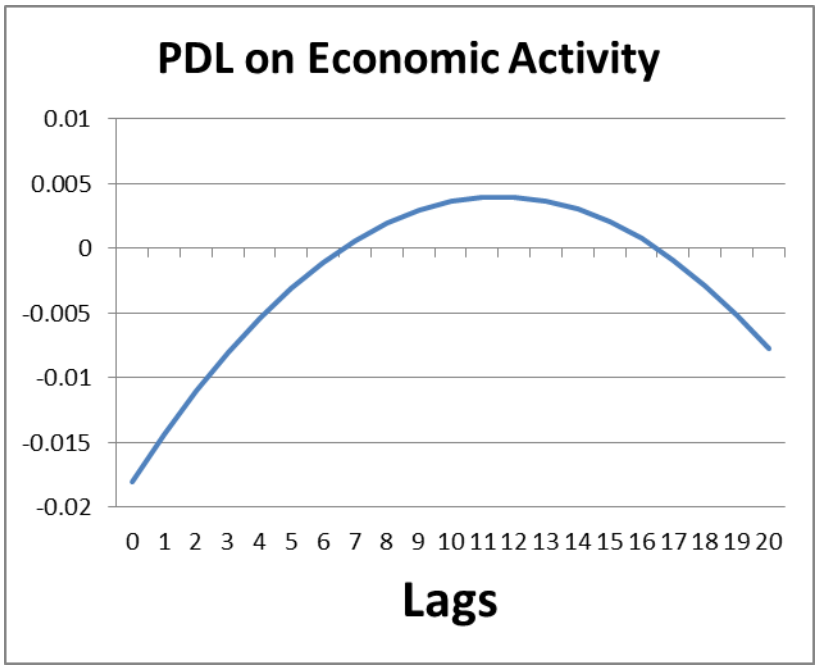
POS, PDL on EPU and Econ Activity





ATM/POS is counter-cyclical



The correlation is about -0.50%

ATM/POS, PDL on EPU and Econ Activity