WARSAW econometric CHALLENGE Third edition

WELCOME EVERYONE

ON WEC 2023 !

HIGH TECH FOUNDATION

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Agenda for today

- 10:00 – general introduction by **Piotr Wójcik**
- 10:10 – warm welcome by **Gabriela Grotkowska**, Dean of our Faculty
- 10:20 – description of the contest rules by **Jacek Lewkowicz**
- 10:30 – Econometric Hackathon 101 by **Marcin Chlebus**
- 10:50 – description of the contest problem by **Marcin Chlebus**
- 11:10 – presentation of the data by **Piotr Wójcik**
- 11:20 – mini-lecture about quantitative easing by **Gabriela Grotkowska**
- 11:40 – the 24-hour **competition begins**!
- – 13:00 – time for potential **confidential** questions sent via email to wec@wne.uw.edu.pl

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GENERAL INTRODUCTION

by Piotr Wójcik

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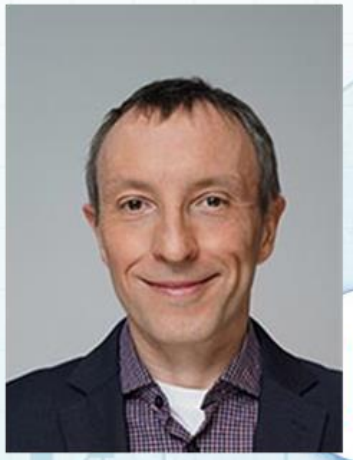
Organizing Commitee

- **Marcin Chlebus, PhD**
- Department of Quantitative Finance

- **Jacek Lewkowicz, PhD mult.**
- Department of Political Economy

- **Rafał Woźniak, PhD**
- Department of Statistics and Econometrics



- **prof. Piotr Wójcik**
- Department of Quantitative Finance

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High Tech Foundation

- The HTF discovers Young Scientific Talents and helps them develop through the **Explory Program**, which is now the largest science talent program in Poland for people under 20 years old.

- Later this year, **in September** the Foundation starts **Talent Open** a fully **online** and **remote Business Accelerator** for scientific innovators under 25 years old. **Stay tuned!**

https://www.fzt.org.pl

https://www.explory.pl

Office of Communication and IT support

Dominika Huczek

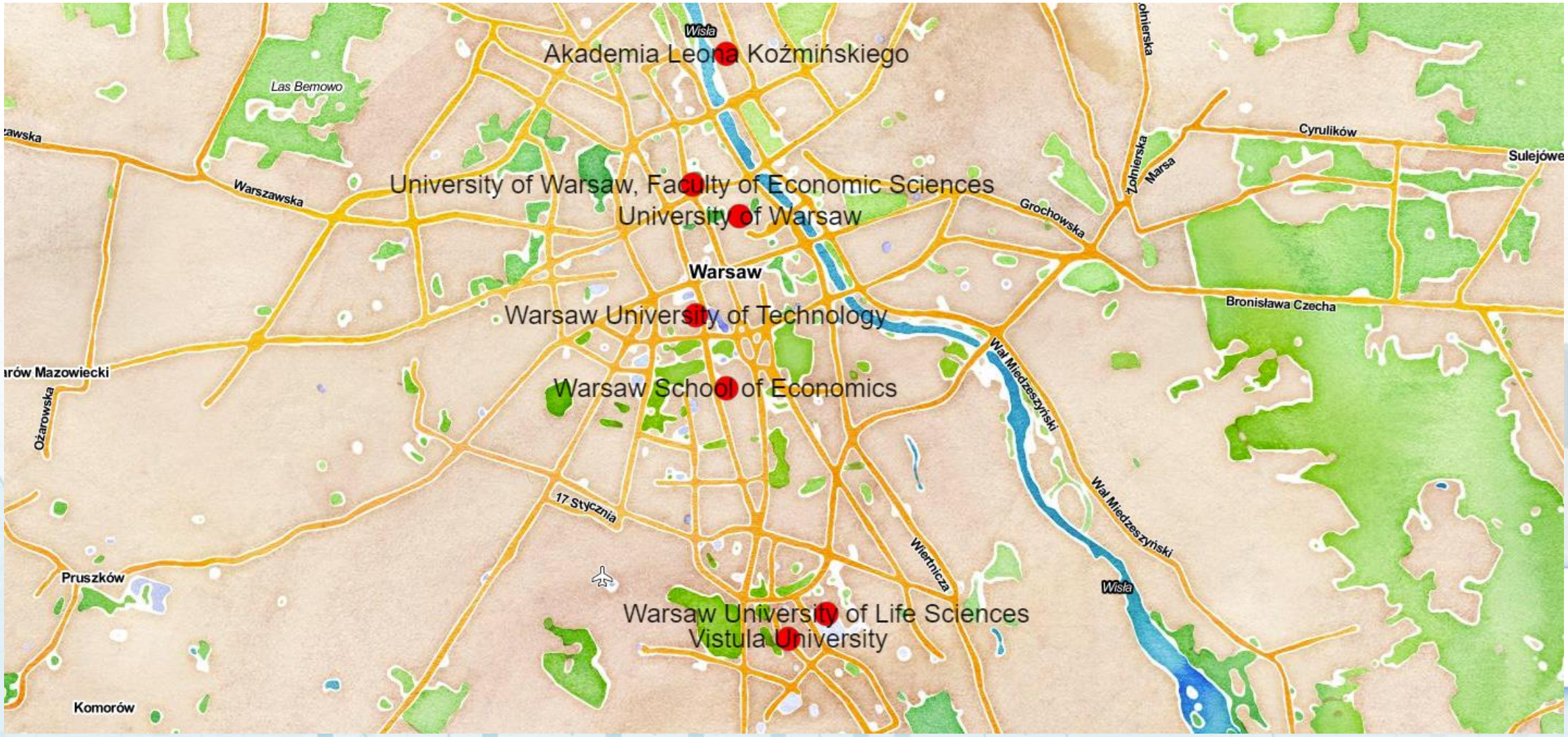
Magdalena Dominiak

Marcin Bąba

Participants

- 1st edition (2021)
  - local at the Faculty of Economic Sciences
  - 5 teams
  - 16 participants
- 2nd edition (2022) - co-organized by LOT Polish Airlines
  - students from 6 Polish universities
  - 28 teams
  - 93 participants
- **3rd edition (2023) - co-organized by the High Tech Foundation**
  - **students from 23 countries representing 21 European universities**
  - **46 teams**
  - **134 participants**

Participants 2023 – universities from Warsaw



Participants 2023 – all participating universities

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WARM WELCOME

by Gabriela Grotkowska, Dean of the Faculty of Economic Sciences, University of Warsaw

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DESCRIPTION OF THE CONTEST RULES

by Jacek Lewkowicz

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What we expect from you?

- Your **core goal** is to prepare a **research paper** in which you describe your solution to the task
  - Present some background and brief literature review
  - Define research questions/hypotheses
  - Describe the data
  - Comment on the methodology
  - Present your results
  - Draw conclusions and provide discussion

How to submit your works?

- Send them via **email** to wec@wne.uw.edu.pl
- Do it before **16:00** CET on Sunday, April 23rd 2023
- Submit the **article**, full **codes** and all the **additional data** used, so that we can **reproduce** your analyses

Criteria for evaluation

adequacy

comprehensivity

interpretability

predictive power

Prizes

- Satisfaction and glory – priceless ☺
- One-off scholarships
  - 1st place: PLN 4500 for each team member
  - 2nd place: PLN 3000 for each team member
  - 3rd place: PLN 2000 for each team member
  - Honourable mention: PLN 1000 for each team member

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ECONOMETRIC HACKATHON 101

by Marcin Chlebus

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A few words about the competition strategy (1/3)

TEAMS OF 4 MEMBERS:

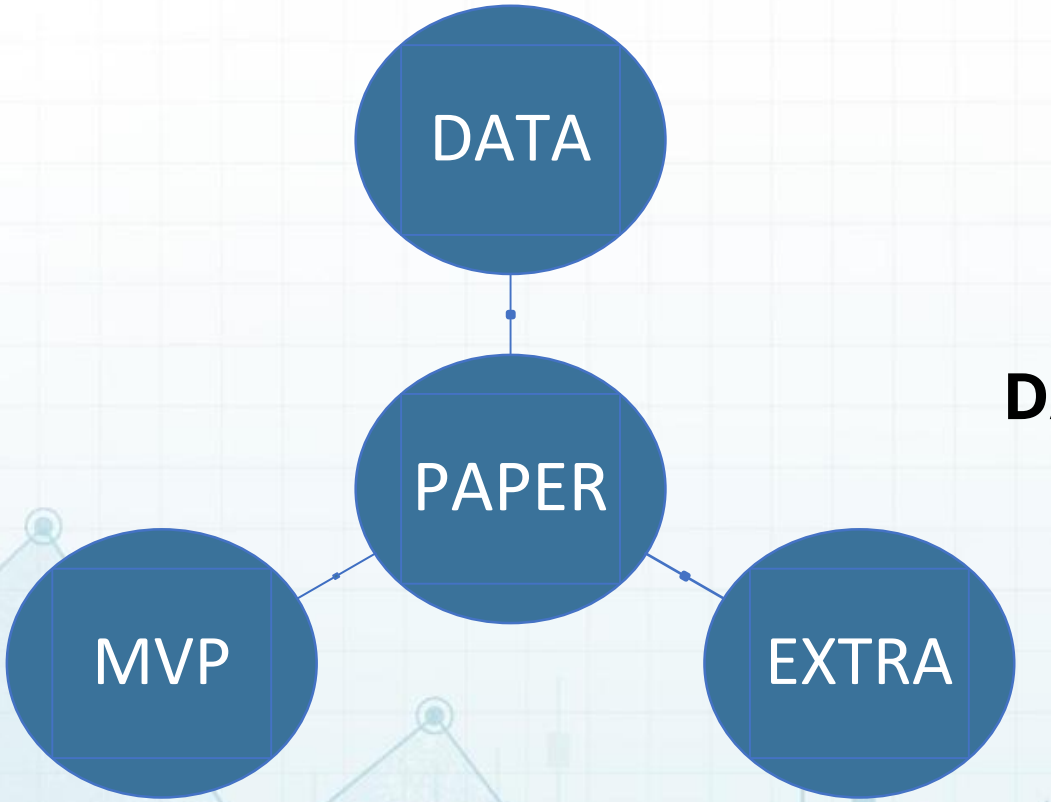
- DATA PREPARATION
- MVP SOLUTION
- EXTRA SOLUTION
- PAPER WRITING

TEAMS OF 3 MEMBERS:

- DATA PREPARATION
- MVP SOLUTION
- PAPER WRITING

TASKS LEADERS ARE NOT DEDICATED TO JUST ONE TASK

A few words about the competition strategy (2/3)



PAPER:

1. USE ONLINE TOOLS, WHERE ALL TEAM MEMBERS MAY JOINTLY UPDATE THEIR PARTS
2. ALL TEAM MEMBERS SUPPORT PAPER WRITING
3. KEEP ALL PARTS OF THE ARTICLE AND THE ABSTRACT IN MIND

DATA:

1. START WITH PREPARING DATA
2. TRY TO BE FAST AND PRECISE (DO NOT FORGET ABOUT DATA PREPROCESSING)
3. PREPARE THE DATA IN A TRANSFERABLE FORMAT

A few words about the competition strategy (3/3)

MVP – MOST VIABLE PRODUCT

1. DO NOT START WITH THE MOST SOPHISTICATED SOLUTION, TRY TO DELIVER A WORKING SOLUTION
2. ADDRESS ALL MAIN RESEARCH QUESTIONS, CONSIDER THE ADDITIONAL ONES, AND AFTER THAT EXTEND YOUR APPROACH

EXTRA SOLUTIONS

1. LOOK FOR SOLUTIONS WHICH COULD BE POTENTIALLY UNEXPECTED, SURPRISING BUT APPROPRIATE
2. TRY TO APPLY A FEW OF SUCH SOLUTIONS
3. CONCENTRATE ON THEIR ADDED VALUE

MOST IMPORTANTLY:

NEVER GIVE UP & ALWAYS ENJOY ☺

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DESCRIPTION OF THE CONTEST PROBLEM

by Marcin Chlebus

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MONEY SUPPLY AND STOCK PRICES – FRIENDS OR FOES?

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Money Supply > Stock Price #1

Price evaluation of **stocks**:

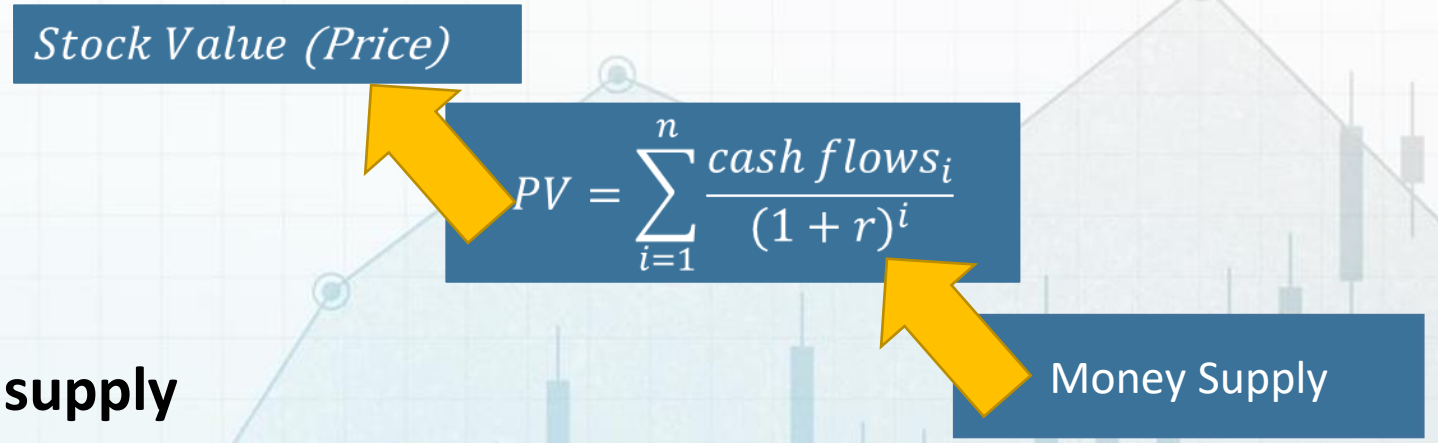
1. speculations: short-term
2. **real value of expected future gains** from owning a given stock: mid-/long-term

In the context of the **mid- and long-term** stock value (price) = present value of the future cash flows.

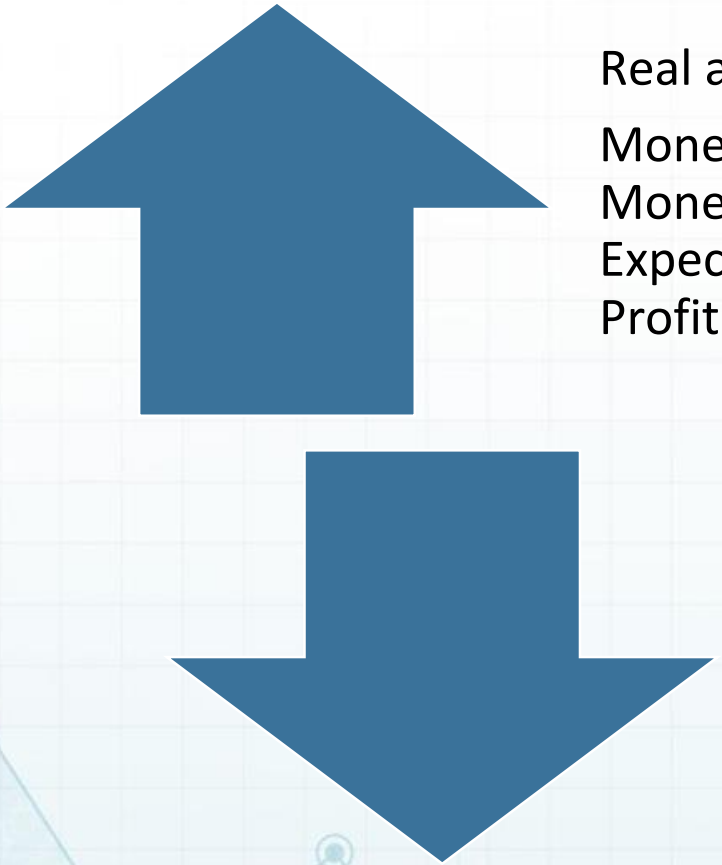
Present value depends on:

1. the future cash flows
2. the discount rate

Discount rate is affected by **money supply**



Money Supply > Stock Price #2



Real activity theorists: **Money Supply ↑ → Stock prices↑**

Money Supply ↑ ←
Money Demand ↑ ←
Expectation of higher Economic Activity ↑ → Expected
Profitability ↑ → Stock Value ↑

Money Supply → Stock Prices

Keynesian economists Money Supply ↑ → Stock prices↓.

Expectation that current increase of MS would lead to restriction of future monetary policy

Research Questions #1

Main question:

Is it true that **money (supply) makes money (increase of S&P500 index)?**

In other words:

Are we able to predict **the value of the stock** index by taking into **consideration changes of money supply**?

$$StockValue_t = f(\boldsymbol{Money\ Supply}, StockValue_{t-1}, Technical\ Indicators, Macro\ Data, Quantitative\ Easing\ \dots)$$

Research Questions #2

Main questions (**obligatory**):

1. Is M2 money supply a useful predictor of stock prices (USA **M2 supply vs S&P500**)?
2. At **which frequency** (weekly or monthly) the relationship is **stronger**?
3. Which **other predictors**, except M2, play an important role in a **predictive model**?

Additional questions (nice to consider):

4. How to predict **not only the expected value of S&P500**, but also the **distribution/interval of the expected S&P500**?
5. Did **announced quantitative easing programmes** affect S&P500 prices? Quantitative easing in the USA (but not only) – **aggressive policy** intended to pump liquidity into a fragile economy.
6. Are **daily prices/returns of S&P500 index** influenced by M2 supply changes?
7. What effect would have a **money supply shock (USD 20 billion) on the S&P index**?

References

- Maskay, B. (2007). Analyzing the Effect of Change in Money Supply on Stock Prices. *The Park Place Economist*, 15, 72-97.
- Sellin, P. (2001). Monetary Policy and the Stock Market: Theory and Empirical Evidence. *Journal of Economic Surveys*, 15, 491-541. http://dx.doi.org/10.1111/1467-6419.00147
- Olsen, J. L. (2014). The Impact of Quantitative Easing on Equity Prices. *Journal of Financial Planning,* 27(5), 52–60.

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DATA DESCRIPTION

by Piotr Wójcik

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Data files

- M2NS.csv - monthly M2 (Jan 1959 to Feb 2023), Billions of Dollars, Not Seasonally Adjusted, source: https://fred.stlouisfed.org/series/M2NS
- M2SL.csv - monthly M2 (Jan 1959 to Feb 2023), Billions of Dollars, Seasonally Adjusted, source: https://fred.stlouisfed.org/series/M2SL
- WM2NS.csv - Weekly M2 (1980-11-03 to 2023-03-06, Ending Monday), Billions of Dollars, Not Seasonally Adjusted, source: https://fred.stlouisfed.org/series/WM2NS
- Sp500_daily.csv, daily quotations of S&P 500 index (2000-01-03 to 2023-04-06, OHLCV), source: https://finance.yahoo.com/quote/%5EGSPC/history
- Sp500_monthly.csv, monthly quotations of S&P 500 index (Jan 2000 to April 2023, OHLCV), source: https://finance.yahoo.com/quote/%5EGSPC/history

Suggested additional data sources

- Yahoo finance: https://finance.yahoo.com
- FRED Economic Data: https://fred.stlouisfed.org

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MINI-LECTURE ON QUANTITATIVE EASING

by Gabriela Grotkowska

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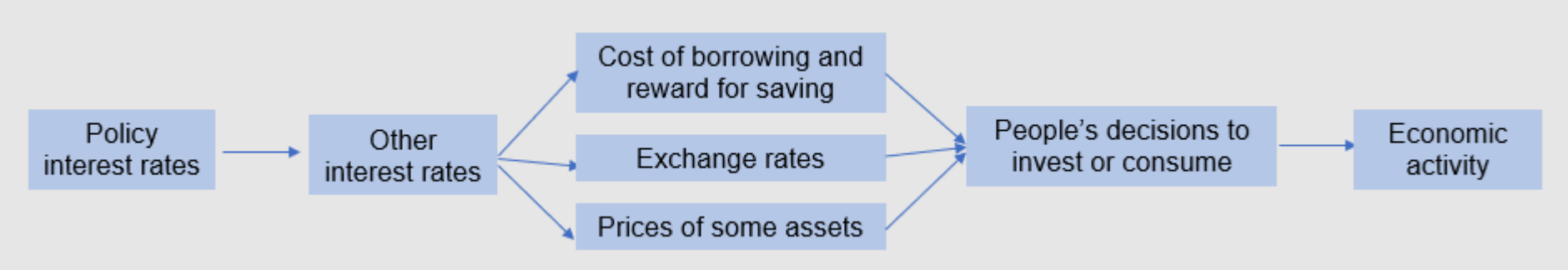
Conventional and unconventional monetary policies

- For several decades, central banks in advanced economies typically used a **policy interest rate as their tool for conducting monetary policy**.
- In reaction to the global financial crisis (2007–2009) and the deep recession it caused in some countries, central banks in many advanced economies **lowered their policy interest rates to near-zero levels**.
- As economic growth remained weak, interest rates persisted at near-zero levels and some central banks used **'unconventional' monetary policy** to stimulate economic activity.
- These measures have again become prominent as central banks around the world have responded to economic consequences of the COVID-19 global pandemic.

Conventional monetary policies

- Conventional monetary policy: **central banks changing a target for a short-term interest rate**



- By changing interest rates, conventional monetary policy helps a central bank achieve its goals for such things as inflation, aggregate demand and employment.
- Raising interest rates dampens growth in aggregate demand and employment and puts downward pressure on inflation.
- In contrast, lowering interest rates stimulates growth in aggregate demand and employment and puts upward pressure on inflation.

Unconventional monetary policies

- **Unconventional monetary policy** occurs when tools **other than changing a policy interest rate** are used. These tools include:
  - forward guidance
  - asset purchases
  - term funding facilities
  - adjustments to market operations
  - negative interest rates.
- With the exception of negative interest rates, these tools have always been in the ‘toolkit’ of central banks and have been used in some way by most central banks in the past, particularly to support the functioning of financial markets.
- What has been unconventional in recent years is the use of these tools as the principal mechanism for achieving monetary policy goals.

Unconventional monetary policies: forward guidance

- Forward guidance relates to the central bank's communication of the 'stance' of monetary policy.
- It lets market participants and the general public know what the future path of the policy interest rate, and potentially other aspects of monetary policy, is likely to be. Forward guidance can be:
  - time-based; or
  - based on the state of the economy.
- A primary motivation for their forward guidance was to reinforce the central bank's commitment to low interest rates, which helps **reduce the interest rates people can expect** in the future.
- Forward guidance has been helpful in **reducing uncertainty** about the economic and financial outlook.

Unconventional monetary policies: term funding facilities

- Term funding facilities involve central banks providing **low-cost, long-term funding to financial institutions at rates below the cost of most of their existing funding sources**.
- Term funding facilities help to reduce interest rates for borrowers and support the supply of credit to the economy.
- Term funding facilities can also provide extra incentives to encourage financial institutions to lend to firms and households.

Unconventional monetary policies: adjustments to market operations

- In response to the GFC and later to COVID-19, many central banks made significant changes to their existing market operations **to deal with strains in financial markets** that had become 'illiquid'
- The changes to operations have included central banks:
  - providing much larger amounts of liquidity to the financial system than before the crises
  - expanding the range of collateral that they accept from financial institutions
  - increasing the range of 'eligible counterparties' that they allow to engage in domestic market operations.
- The purpose of these changes to market operations was to address the fact that in periods of financial stress, financial institutions were „very nervous" about their access to liquidity.
- This, in turn, made them nervous about investing and lending, increasing the likelihood of a severe 'credit crunch' and economic contraction.

Unconventional monetary policies: adjustments to market operations

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Unconventional monetary policies: negative interest rates

- Truly unconventional tool.
- Instead of earning interest on money deposited in a bank, people would be charged by their bank to deposit money.
- Earlier, it was widely thought that there was a ‘zero lower bound’ for the policy interest rate, meaning that it was thought interest rates could never be negative.
- This was because if interest rates were negative, people would simply choose to hold their savings as banknotes outside the banking system (‘cash under the mattress’) so that deposits would be unavailable to banks for lending or other purposes.
- As it turned out, a zero lower bound did not prove to be a constraint.
- **Policy interest rates became negative in several countries**. However, commercial banks generally did not pass on negative policy interest rates and implement negative rates for all their customers.

Unconventional monetary policies: asset purchases

- Asset purchases involve the **outright purchase of assets** by the central bank from the private sector with the central bank paying for these assets **by creating 'central bank reserves'**
- Some people have referred to this as **'printing money',** but the central bank does not actually print any banknotes to pay for the asset purchases.
- Some central banks have bought a wide range of assets (whereas in the past, they bought only government bonds), though **the main asset type has remained government bonds**.
- Typically, when a central bank undertakes asset purchases, it can either set a target for the quantity of assets it will purchase (at any price) or a target for the price of an asset (purchasing whatever quantity of assets will achieve that price); for a bond, the relevant price is its interest rate. A quantity target for asset purchases is also known as **quantitative easing** (QE).

Unconventional monetary policies: asset purchases

- There were differences as for precise goals across countries, but a common objective has been **the desire to lower interest rates on risk-free assets** (such as government bonds) across different terms to maturity of those assets (across the yield curve).
- Central bank asset purchases also reinforce the central bank's forward guidance that policy interest rates will remain low, **adding to downward pressure on bond yields**.
- In addition, investors can use the proceeds they receive from selling their assets to the central bank to purchase other assets. These **portfolio adjustments** by investors can affect the price of these other assets and the exchange rate.
- **Until July 2019, the US Federal Reserve, the European Central Bank, the Bank of Japan and the Bank of England bought over $13 trillion worth of financial assets over the past decade, representing between 18% and 102% of their respective total GDP.**

Potential positive consequences of quantitative easing policy

1.**Low-risk lending for banks**. Quantitative easing will typically only be introduced to an economic landscape where interest rates have dropped to zero percent. Adding money to a bank's reserves in the face of these lower interest rates means that economic risk for banks lending money to civilians can remain low.

2.**Encourages people to spend**. The purpose of QE is to level out markets to make spending and investing money more appealing and accessible to consumers. Lower interest rates can increase the likelihood that business and civilian borrowers will take out loans to make purchases, thereby boosting economic activity.

3.**Boosts the prices of assets**. When the government participates in bond-buying during a QE measure, they replace the bonds with money that the previous bond-holder can reinvest in other assets in different financial markets, increasing their value.

Why low rates could boost equity prices in the longer term?

- **Lower discount rate** → increase in the present value of future cash flows (simple dividend pricing model)
- **Portfolio rebalancing** → increase demand for assets of higher yields
- **Direct effect for corporate profits** (stronger economic growth)

However there are some reservations as well

- A “rational expectations” investor who takes a longer-term view should regard today’s ultra-low rates as temporary
- An investor may assign a higher risk premium in today’s environment
- The discount-rate argument assumes that lower government-bond rates translate into a lower cost of equity. In reality, investors may not view the government-bond rate as the “risk-free rate.”
- The portfolio-rebalancing effect works only if investors see equity investment as a true substitute for fixed-income investment

Consequences for financial markets?

Figure 1. The Fed's balance sheet ($ billion).

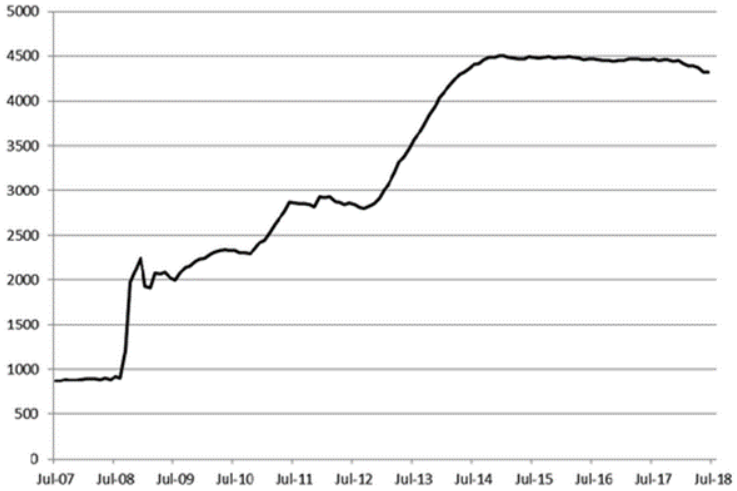

Figure 2. The Federal funds rate.

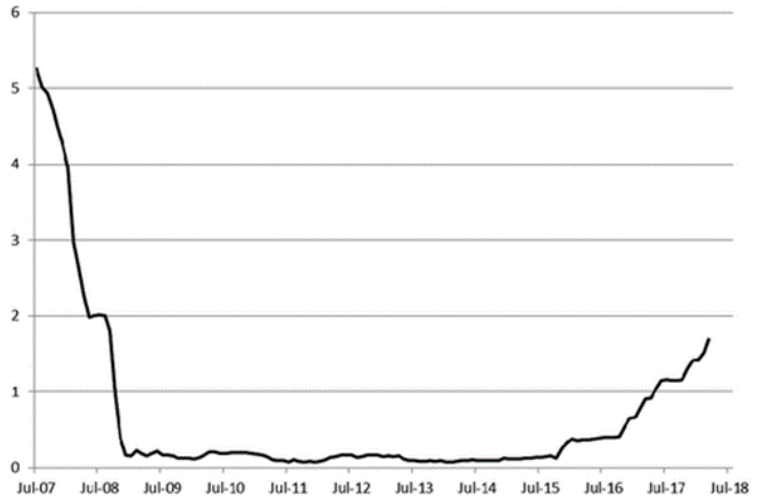

Figure 3. US stock prices (S&P 500).

Source: Sulaiman A. Al-Jassar & Imad A. Moosa (2019) The effect of quantitative easing on stock prices: a structural time series approach, Applied Economics, 51:17, 1817-1827, DOI: 10.1080/00036846.2018.1529396

Potential negative consequences of quantitative easing policy

1.**Can cause inflation**. Adding currency into circulation can be tantamount to creating money out of thin air, which can contribute to inflation and lower bond yields. It results in consequences like a higher cost of living.

2.**Can cause stagflation**. When the central bank purchases financial assets, they are doing so to make it easier for others to make investments. However, during a great recession or global financial crisis, people are less likely to spend money, so there is no guarantee that the method will work.

3.**Impacts the value of a nation's currency**. Unless other countries are also taking quantitative easing measures, QE can drastically reduce the value of a country's national currency.

4. Can lead to asset pricing bubble, pushing investors to more risky assets.

Does QE contribute to exuberance in stock markets?

- Since QE involves direct intervention in financial markets, these purchases fuel a search for yield, pushing investors into other riskier asset classes with a higher expected return. This phenomenon is well described in the academic literature and is known as **the portfolio rebalancing channel of QE**
- Although a lower price of risk is one of the intended outcomes of QE, it also increases the probability of overheating and **inflating asset price bubbles in riskier assets**, i.e. causing asset prices to increase to levels that are out of line with their fundamental value.

Does QE contribute to exuberance in stock markets?

- The **root cause of the GFC was a misalignment between asset valuations and the true risks of the asset**.
- Monitoring the build-up of new asset bubbles is key to maintaining a healthy financial system.
- Leading studies primarily focus on the effect of UMP measures by analysing the response of financial market assets to policy announcements: **UMP measures are effective in lowering yields on targeted assets, such as US bonds, and lead to higher stock prices in the US, the euro area and emerging markets.**

Does QE contribute to exuberance in stock markets?

- **Does QE coincide with the formation of asset bubbles, i.e. valuations that deviate from their fundamental value, in the euro area stock markets?**
- The paper by Tom Hudepohl, Ryan van Lamoen, Nander de Vette, *Quantitative easing and exuberance in stock markets: Evidence from the euro area*, Journal of International Money and Finance, Volume 118, 2021, 102471.
  - Authors use recent advances in **bubble detecting techniques** to test whether periods of active QE programmes coincide with exuberant behaviour on stock markets
  - In an environment with QE, risky assets become an attractive investment in comparison with the alternative of low, or even negative, yielding safe assets. This mechanism drives investors into riskier assets, thereby artificially suppressing risk premia. In turn this mechanism might lead to valuations exceeding their fundamental value.

Does QE contribute to exuberance in stock markets?

Hypotheses & results

- **There are periods of exuberant behaviour in euro area stock markets** → The results illustrate significant exuberance in the stock markets of Belgium, Finland, Ireland, Italy and the Netherlands during the implementation of QE, indicating that periods of QE coincide with exuberance.
- **QE increases the probability of exuberant investor behaviour in the euro area** → The results suggest that QE significantly contributes to exuberant behaviour in the euro area, especially around the announcement of QE (January 2015) and the start of the Expanded Asset Purchase Programme (EAPP, March 2015). However, the time response function also shows that the effect of QE is temporary.
- **Periods of exuberance have a tendency to persist** → The results indicate that there is a high probability of exuberant price behaviour in future periods when exuberance exists in the current period. This finding is in line with literature describing persistence in equity returns

Summary

- A QE policy is intended to **increase economic activity** by injecting **more cash** into the system.
- The central bank effectively creates new monetary reserves as it **purchases bonds and other securities** from commercial banks in the open market.
- Based on theory we may expect **a positive impact of QE for asset prices** (several channels), however there are also some counter arguments
- It seems that the problem of a link between QE and stock prices dynamics is an **empirical one**, and cannot be settled only on theoretical grounds.

References

- Al-Jassar, S. A., & Moosa, I. A. (2019). The effect of quantitative easing on stock prices: a structural time series approach. Applied Economics, 51(17), 1817-1827.
- Bedikanli, M. (2020). Quantitative easing and US stock prices: A study on unconventional monetary policy and its long-term effects on stocks.
- Dobbs, R., Koller, T., & Lund, S. (2014). What effect has quantitative easing had on your share price. McKinsey on Finance, 49, 15-18.
- Haitsma, R., Unalmis, D., & De Haan, J. (2016). The impact of the ECB's conventional and unconventional monetary policies on stock markets. Journal of Macroeconomics, 48, 101-116.
- Hudepohl, T., van Lamoen, R., & de Vette, N. (2021). Quantitative easing and exuberance in stock markets: Evidence from the euro area. Journal of International Money and Finance, 118, 102471.

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All solutions have to be sent to wec@wne.uw.edu.pl

Before 16:00 Sunday 23rd of April 2023

GOOD LUCK!!!

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LET THE COMPETITION BEGIN!