Possible topics for the Master/Specialist/PhD dissertation

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Overview of the Presentation

Introduction

First of all, I strongly encourage students to consider the topics discussed below not only for a potential master/specialist diploma, but also as potential topics to be developed further during a future PhD in economics.

Note that at the MSE you can attend either an *academic PhD* (where you get a monthly salary, but you have to be at the faculty every week), or a *paid PhD* for private workers, where you do not need to be a full-time university worker (you only have to pass a certain number of courses and the final defense), but you have to pay the yearly tuition yourself.

Possible Topics for Joint research: An Overview

My recent research work focuses on two fields:

- **Bitcoin and crypto-currencies financial modelling**

- **Forecasting**

Possible topics for master diploma

▶ Development and comparison of pricing models for crypto-coins.

▶ Modelling and forecasting cryptocurrency pump-and-dump schemes.

▶ Estimate the carbon footprint of Bitcoin using a dynamic model for the Bitcoin network energy efficiency.

▶ What is the real population of Ukraine? Nowcasting population numbers using proxy variables.

Some More Details about Each Topic

Development and comparison of pricing models for crypto-coins

Several pricing models have been recently proposed to find the fundamental value of crypto-coins:

- ▶ the Network-Value-to-Transactions (NVT) Ratio,
- ▶ the Network-Value-to-Realized-Value (NVRV) Ratio,
- ▶ the Network-Value-to-Hash-Rate (NVHR) Ratio,
- ▶ the Active Addresses metrics: the Network-Value-to-Metcalfe's-Law (NVML) Ratio and the Network-Value-to-Odlyzko's-Law (NVOL) Ratio
- ▶ the Cost of Mining method.
- ▶ the Equation of Exchange method

See these reports for a review:

- ▶ Lanre and Gotimer (2019), *Valuing Bitcoin AN ANALYSIS OF METHODOLOGIES FOR VALUING BITCOIN* (pages 13-35), available at https://21shares.com/img/uploads/21shares-valuing-bitcoin-report.pdf
- ▶ *Cryptoasset valuation techniques* by Lanre Ige (2018): https://s3.us-east-2.amazonaws.com/lanreige/Cryptoasset+Valuation+Techniques.pdf
- ▶ Part 1 (current state of token Valuation, page 12-28) in *CRYPTOASSET VALUATION Identifying the variables of analysis*, Working Report v1.0 October 2018, available at https://www.louisbachelier.org/wp-content/uploads/2018/10/cryptovaluationreport-v20181016-vf.pdf

Development and comparison of pricing models for crypto-coins

Moreover, models closer to traditional corporate finance have also been proposed:

- ▶ *INET valuation model* for cryptoassets developed by Chris Burniske and available at:
  https://medium.com/@cburniske/cryptoasset-valuations-ac83479ffca7
- ▶ the *modified INET valuation model* for cryptoassets developed by Alex Woodard and available at: https://medium.com/@alexwoodard17/a-new-way-to-find-discount-rates-in-crypto-models-58201facb1fd
- ▶ the *Rational Network Value model* for cryptoassets developed by Rustam Botashev and available at: https://medium.com/@HASHCIB/the-next-step-in-cryptoasset-valuation-34bade0386de
- ▶ the *VOLT Valuation Model* for cryptoassets developed by Alex Evans and available at:
  https://medium.com/blockchannel/on-value-velocity-and-monetary-theory-a-new-approach-to-cryptoasset-valuations-32c9b22e3b6f

See also the analysis performed in Caccia (2019), *A Review Of Cryptoasset Valuation Frameworks*, available at https://blog.coinfabrik.com/a-review-on-cryptoasset-valuation-frameworks, for a general review.

Development and comparison of pricing models for crypto-coins

Idea: Extend the previous models.

Idea 2: Do these models explain the dynamics of crypto-coins prices? →
Perform (linear and nonlinear) Granger causality tests, (linear and nonlinear)
cointegration tests.

Idea 3: Implement trading strategies based on these models and verify whether
they are profitable.

Literature:

- ▶ The previous cited professional literature.
- ▶ Fantazzini, D. (2019). *Quantitative finance with R and cryptocurrencie*s.
  Amazon KDP, ISBN-13, 978-1090685315.
- ▶ Burniske, C., & Tatar, J. (2017). *Cryptoassets: The innovative investor's
  guide to Bitcoin and beyond*. McGraw Hill Professional.

Mandatory Requirements:

- ▶ Good knowledge of (traditional) stock valuation methods.
- ▶ Good knowledge of R programming.

Modelling and forecasting cryptocurrency pump-and-dump schemes

There is a small but increasing literature that has proposed several methods to detect pump-and-dump schemes.

Moreover, some of these works even proposed trading strategies to benefit from these early detection of pump-and-dump schemes.

Idea 1: Compare these detection methods and verify if they are really able to detect pump-and-dump schemes in cryptocurrency markets at the early stages.

Idea 2: Verify that successful trading strategies can be implemented based on these methods, once transaction costs and slippage are taken into account.

Modelling and forecasting cryptocurrency pump-and-dump schemes

Literature:

▶ Xu, J., Livshits, B. (2019). The anatomy of a cryptocurrency pump-and-dump scheme. In *28th USENIX Security Symposium (USENIX Security 19)*, pp. 1609-1625.

▶ Li, T., Shin, D., Wang, B. (2020). Cryptocurrency pump-and-dump schemes. Available at SSRN 3267041.

▶ La Morgia, M., Mei, A., Sassi, F., Stefa, J. (2020). Pump and Dumps in the Bitcoin Era: Real Time Detection of Cryptocurrency Market Manipulations. *In 2020 29th International Conference on Computer Communications and Networks (ICCCN)*, pp. 1-9. .

▶ Hamrick, J. T., Rouhi, F., Mukherjee, A., Feder, A., Gandal, N., Moore, T., Vasek, M. (2021). An examination of the cryptocurrency pump-and-dump ecosystem. *Information Processing and Management*, 58(4), 102506.

▶ Kamps, J., Kleinberg, B. (2018). To the moon: defining and detecting cryptocurrency pump-and-dumps. *Crime Science*, 7(1), 1-18.

Modelling and forecasting cryptocurrency pump-and-dump schemes

Literature:

- Nizzoli, L., Tardelli, S., Avvenuti, M., Cresci, S., Tesconi, M., Ferrara, E. (2020). Charting the landscape of online cryptocurrency manipulation. *IEEE Access*, 8, 113230-113245.

- Chen, W., Xu, Y., Zheng, Z., Zhou, Y., Yang, J. E., Bian, J. (2019). Detecting pump and dump schemes on cryptocurrency market using an improved apriori algorithm. In *2019 IEEE International Conference on Service-Oriented System Engineering (SOSE)*, pp. 293-2935.

- Victor, F., Hagemann, T. (2019). Cryptocurrency pump and dump schemes: Quantification and detection. In *2019 International Conference on Data Mining Workshops (ICDMW)*, pp. 244-251.

- Mirtaheri, M., Abu-El-Haija, S., Morstatter, F., Ver Steeg, G., Galstyan, A. (2021). Identifying and analyzing cryptocurrency manipulations in social media. *IEEE Transactions on Computational Social Systems*, 8(3), 607-617.

Modelling and forecasting cryptocurrency pump-and-dump schemes

Mandatory Requirements:

- ▶ Very good knowledge of web scraping methods (for Telegram, Discord, etc.)

- ▶ Good knowledge of classification methods (machine learning, credit scoring, etc).

- ▶ Good knowledge of R programming.

Estimate the carbon footprint of Bitcoin using a dynamic model for the Bitcoin network energy efficiency

There is an increasing interest in estimating the carbon footprint of Bitcoin (I was contacted several times by one founder of a top cryptocurrency exchange to do some research in this regard!) .

This should not come as a surprise given the global efforts to mitigate the effects of climate change and reach carbon neutrality.

Idea: Integrate the model proposed by Stoll et al. (2019) to estimate the carbon footprint of Bitcoin with the model proposed by Fantazzini and Kolodin (2020) to estimate the dynamics of the Bitcoin network energy efficiency.

Estimate the carbon footprint of Bitcoin using a dynamic model for the Bitcoin network energy efficiency

Literature:

- Stoll, C., Klaaßen, L., Gallersdörfer, U. (2019). The carbon footprint of bitcoin. *Joule*, 3(7), 1647-1661.

- Rauchs, M., Blandin, A., Dek, A. (2019). Cambridge Bitcoin Electricity Consumption Index (Methodology). Available at https://cbeci.org/cbeci/methodology.

- Koomey, Jonathan (2019). Estimating Bitcoin Electricity Use: A Beginner's Guide. Coin Center Report, May. Available at https://www.coincenter.org/estimating-bitcoin-electricity-use-a-beginners-guide/

- Corbet, S., Yarovaya, L. (2020). The environmental effects of cryptocurrencies. In *Cryptocurrency and Blockchain Technology*, pp. 149-184. De Gruyter.

- Krause, M. J., Tolaymat, T. (2018). Quantification of energy and carbon costs for mining cryptocurrencies. *Nature Sustainability*, 1(11), 711-718.

- McCook, H. (2018). The cost and sustainability of bitcoin. Available at https://www.academia.edu/37178295/The_Cost_and_Sustainability_of_Bitcoin_August_2018_

Estimate the carbon footprint of Bitcoin using a dynamic model for the Bitcoin network energy efficiency

Literature:

- O'Dwyer, K., Malone, D. (2014). Bitcoin mining and its energy footprint. In *25th IET Irish Signals and Systems Conference 2014 and 2014 China-Ireland International Conference on Information and Communications Technologies*, pp. 280-285.

- Vranken, H. (2017). Sustainability of bitcoin and blockchains. *Current opinion in environmental sustainability*, 28, 1-9.

- Bevand, M. (2017). Electricity consumption of Bitcoin: a market-based and technical analysis. Available at https://blog.zorinaq.com/bitcoin-electricity-consumption/

- Hayes, A. S. (2017). Cryptocurrency value formation: An empirical study leading to a cost of production model for valuing bitcoin. *Telematics and Informatics*, 34(7), 1308-1321.

- De Vries, A. (2018). Bitcoin's growing energy problem. *Joule*, 2(5), 801-805.

- Fantazzini, D., Kolodin, N. (2020). Does the hashrate affect the bitcoin price?. *TJournal of Risk and Financial Management*, 13(11), 263.

Estimate the carbon footprint of Bitcoin using a dynamic model for the Bitcoin network energy efficiency

Mandatory Requirements:

▶ Good knowledge of web scraping methods: you will need to scrap the bitcoin mining equipment data from websites that catalog these data and cross-checked it with vendor websites and online marketplaces to find any possible discrepancies.

▶ Good knowledge of time series methods.

▶ Good knowledge of R programming.

What is the real population of Ukraine? Nowcasting population numbers using proxy variables

The first (and last) national census of Ukraine took place in 2001. After it, the next one was originally planned for 2010, but it has been continuously postponed since then.

In 2019 an "electronic census" estimated that Ukraine's population, excluding Crimea and parts of the Donbas, to be 37.3 million.

$\rightarrow$ However, this estimate was strongly criticized because it was based on the number of cell phones, taxpayer records, and the pensions/social registry: needless to say, people can have multiple SIM cards, and they do not automatically cancel from taxpayer and pensions registries when they emigrate.

Moreover, there is a large problem of "dead souls", that is dead people who are not officially registered as dead after death, because close relatives want to keep receiving the social benefits of their dead relatives.

What is the real population of Ukraine? Nowcasting population numbers using proxy variables

Since 2018, I found out that a simple regression of the population levels in central/Eastern European countries vs the yearly number of births and the total fertility rates (TFRs) can give estimates that are not far off from the real population numbers (the errors are close to 3-7% of the real numbers).

→ Therefore, I used this simple method to estimate Ukraine population levels since then (see below all the estimates):

https://twitter.com/DeanFantazzini/status/1420862455203385344

Idea: extend this approach using additional regressors and more complex functional forms for the regression used to nowcast Ukraine population levels.

For example, I found that the annual "Municipal water withdrawal" data (= annual quantity of water withdrawn primarily for the direct use by the population) published by FAO at,
http://www.fao.org/aquastat/statistics/query/index.html

helps considerably the estimation of population levels for the same year. Unfortunately, FAO data are unbalanced and published every 3-4 years. Maybe, Bloomberg/Reuters have these data for each year using national databases.

What is the real population of Ukraine? Nowcasting population numbers using proxy variables

Idea 2: another possibility is to use the data of the 2001 census and reconstruct the population levels recursively using the number of births, deaths and emigration to the EU and Russia, employing classical demographic methods and Russian and EU emigration data because Ukraine emigration data are unrealistic, given that very few people canceled their registration in Ukraine when they emigrated abroad.

$\rightarrow$ Such an estimate may well represent an "upper bound" for Ukraine population estimates because,

- the number of deaths in Ukraine is under reported due to the problem of "dead souls";

- the number of Ukrainians who emigrated to the EU and Russia is under reported (by the EU and Russia) because not all emigrants who spend more than 180 days a year in the EU and in Russia get the local resident permits or the citizenship.

What is the real population of Ukraine? Nowcasting population numbers using proxy variables

Literature:

- ▶ United Nations (1952), *Methods of estimating total populations for current dates - Manual 1*, Population Studies n. 10.
- ▶ Raymondo, J. C. (1992). *Population Estimation and Projection*. New York: Quorum.
- ▶ Seigel, J. S., Swanson, D. A. (2004). *The methods and materials of demography*. Emerald Publishing, London.
- ▶ Dennis, R., Howick, R., Stewart, N. (2007). *Methods of estimating population and household projections*. UK Environment Agency, Science report n. SC030238.
- ▶ Smith, S. K., Tayman, J., Swanson, D. A. (2013). *A practitioner's guide to state and local population projections*. Springer Netherlands.
- ▶ Carmichael, G. A. (2016). *Fundamentals of demographic analysis: Concepts, measures and methods*. Cham, Switzerland: Springer.

Mandatory Requirements:

- ▶ Good knowledge of statistics, econometrics and demography;
- ▶ Good knowledge of R programming;