GRA4159 Trends, Cycles, and Signal Extraction from a Macroeconomic Perspective

General information and introduction to National Account Statistics and other important macroeconomic data

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Agenda

- Motivation and preliminaries
- About the course, goals and learning outcomes

- Introduction to National Account Statistics
- Other important series in macro
- Some log considerations

Why this course?

Imagine you are working for a large consultancy firm

- In one of your projects you consult a firm selling consumer goods. They ask you to provide an analysis of how the recent increase in borrowing costs (interest rates) might affect the demand for their products going forward. What would you do?

- In another project you are asked to infer the value of a latent time series variable, such as the output gap. How would you do that?

- Moreover, in both projects you are asked to provide a well grounded narrative explaining in more structural terms the rational for your analysis

Why this course?

After taking this course you would be able to address these tasks and:

- Use time series data and time series algorithms for estimation/inference of latent variables and trend/cycle decompositions
- Use aggregate macro data to predict future interest rates, aggregate income, etc.
- Use economic theory to formulate hypothesis, discipline the analysis, and choose the relevant variables
  - For business cycle analysis
  - For more long-run analysis

Why this course?

In general

- You will learn about macroeconomic data and business cycle theory - economic part
- And, you will learn about time series tools and algorithms that can be used in this context - data science part

But

- The time series tools and algorithms are general, and can be applied within any business field

The formal course description

How we will do it

Focus on the big picture and practical applications. Understand the purpose and intuition rather than making proofs

- 12 lectures
  - 2 hours
  - Lecture slides posted on Itslearning in separate folders
- 4 seminar groups and assignments
  - Presentation and feedback on assignments
  - Assignments will be posted on Itslearning, require that you do programming, download data etc.
- 1-2 extra lectures (TBA)
- Forgot about Python and Github?
  - Github: Read this the tutorial at w3schools.com
  - Python refresher: Check out *Tutorial 0* here: https://github.com/BI-DS/EBA-3530

Relation to other courses in your program

- The theoretical part builds on:
  - GRA 4155 Microeconomics, Business Strategy and Management
  - GRA 4156 Accounting, Valuation and Financial Economics
- The empirical part builds on:
  - GRA 4152 Object Oriented Programming with Python
  - GRA 4157 (Big) Data Curation, Pipelines, and Management
  - GRA 4153 Advanced Statistics and Alternative Data Types

Thus, I expect that you know Python programming, regression analysis, and basic economics prior to taking this course

Evaluation and the road to success

Evaluation:

- Individual assignments - 40% of final grade
  - Will be posted on Itslearning. Deliver written report at the end of the semester (Wiseflow)
  - You get feedback etc. in the seminar groups during the semester
  - Requires coding
- Written (school) exam - 60% of final grade
  - No coding

I will test you in what we train on. No surprises. Will be easy if you follow the road to success...

Evaluation and the road to success

The road to success:

- Read the course description on the Portal!
- Prepare for class and be active. Ask questions!
- Get your hands dirty. To become good at working with data you have to work with data!
- Work hard and actively with the assignments
- Read the curriculum
  - Lecture slides provide a summary and intuition
  - Advice: Print the slides prior to class, and add your own reflections to the slides rather than taking a full transcript during class!

Core curriculum

See talis for details: Talis

- Applied time series for macroeconomics by Hilde Christiane Bjørnland; Leif Anders Thorsrud, Gyldendal, 2015: Abbr. **BT**
- Monetary policy under inflation targeting by Øistein Røisland; Tommy Sveen, Occasional Papers, 2018: Abbr. **RS**
- Understanding National Account Statistics OECD: Abbr. **UNAS**

Contact and drop-in sessions

Contact:

- Professor Leif Anders Thorsrud (course responsible), leif.a.thorsrud@bi.no
- Professor Tommy Sveen, tommy.sveen@bi.no

Drop-in sessions and organization:

- Post questions in this spreadsheet: QAspreadsheet
- Questions and answers will accumulate
- If needed we will also set up dedicated Zoom sessions for Q&A

Introduction to National Account Statistics (NAS)
(Chapter 1 and 2 in UNAS)

Why do we need NAS

National accounts are at the core of the modern system of economic statistics

- Delivers timely, reliable, and comprehensive monitoring of economic activity
- Essential to guide policymaking
- Essential to guide businesses about general market developments
- Coherent and internationally agreed upon accounting system

GDP

Gross Domestic Product

- Most frequently used indicator in the national accounts
- Available at (monthly), quarterly and annual frequency
- Combines in a single figure, and with no double counting, all the output (or production) carried out by all the firms, non-profit institutions, government bodies and households in a given country during a given period, regardless of the type of goods and services produced, provided that the production takes place within the country's economic territory

Defining GDP

Three ways to measure GDP

- Output approach
- Final demand approach
- Income approach

Output approach

Let Y be GDP, then:

Y = Value added = output - intermediate consumption (the stuff used in producing goods and services)

Makes it clear that there is no double counting
(pancake example)

Final demand approach

Let Y be GDP, then:

$$Y = C + I + G + X + \text{changes in inventories} \tag{1}$$

- C is consumption
- I is investment, or more precisely "Gross Fixed Capital Formation" (GFCF)
- G is government spending
- X is net exports, i.e., exports minus imports $X = (Exp - Imp)$

The income approach

Let Y be GDP, then:

$$Y = \text{Income} = \text{employees' salaries} + \text{company profits}$$

Thus

$$\text{Value added} = \text{Final demand} = \text{Income}$$

Contributions to growth

Contributions to growth from final demand approach:

$$\frac{\Delta Y_t}{Y_{t-1}} = \frac{\Delta C_t}{Y_{t-1}} + \frac{\Delta I_t}{Y_{t-1}} + \frac{\Delta G_t}{Y_{t-1}} + \frac{\Delta X_t}{Y_{t-1}} \tag{2}$$

To get it all in growth rates:

$$\frac{\Delta Y_t}{Y_t} = \frac{\Delta C_t}{C_{t-1}}\frac{C_{t-1}}{Y_{t-1}} + \frac{\Delta I_t}{I_{t-1}}\frac{I_{t-1}}{Y_{t-1}} + \frac{\Delta G_t}{G_{t-1}}\frac{G_{t-1}}{Y_{t-1}} + \frac{\Delta X_t}{X_{t-1}}\frac{X_{t-1}}{Y_{t-1}} \tag{3}$$

Thus, growth in GDP is equal to the growth in it's components weighted by their size relative to GDP

A note on accounting versus how the economy works

- It is important to understand that the NAS relationships are just accounting identities
- They tell us nothing about how GDP is actually determined and how the economy works. E.g.:
  - An increase in governmental consumption will per NAS definition, and all else given, increase GDP. But, in reality, an increase in governmental consumption might crowd-out other types of consumption and investments such that overall GDP remains unaffected or fall!
  - An increase in income might lead to more consumption or more saving and investment. I.e., no causal relationships can be inferred from accounting identities

Real versus nominal value

- It is important to be aware of the distinction between nominal and real values, often also denoted as measuring in current prices (nominal) or volume (real)
- Generally, we are more interested in the volume, i.e., what the value added of production is after “controlling" for price increases
- Adjusting for price increases is simple:

  [1 + the growth rate (divided by 100) of GDP in volume] = [1 + the growth rate (divided by 100) of GDP at current prices] / [1 + the growth rate (divided by 100) of the GDP deflator

- We can do the same for many other NAS entities, such as consumption and investment
- This also applies to absolute levels, e.g., $GDP_r = GDP_n / (deflator / 100)$

Deflator and base-year

- The GDP deflator, also called “the implicit GDP price index" or, simply “implicit GDP deflator"
- It is a measure of the money price of all new, domestically produced, final goods and services in an economy in a year relative to the real value of them
- The deflator is an index, with a value set to 100 in a so-called base-year
- The deflator can also be interpreted as a measure of inflation, i.e., changes in the deflator is inflation

Quantities versus volume

It is essential to understand the difference between an increase in quantities and an increase in volume in order to grasp the measurement of growth as recorded in the national accounts. In particular, volume takes into account all kinds of differences in quality and price changes

- To aggregate value added (utility we get from production) of many products and services they need to be measured in the same units. In NSA, their price structure is used to do so
- Summation of physical units are weighted by the prices of these units
- But, both quantities and prices change! It is therefore necessary to “freeze" the variation in prices. I.e., the base-year

Laspeyre and Paasche indexes

Formally, when constructing aggregate NAS statistics, statisticians use Laspeyre and Paasche indexes

- The Laspeyres volume index is the most widely used formula for calculating aggregated volume indices for national accounts
    - A Laspeyres volume index is a weighted average of changes in quantities, weighted by the values at current prices in the base year.
- The Paasche price index is the most widely used formula for calculating aggregated price indices in the national accounts
    - The product of the Laspeyres volume index and the Paasche price index is equal to the index of current prices

Read about them in Ch2 of UNAS

Important issues with the NAS

- Constant prices versus “chain linking"
- Reporting lags
- Revisions
- Welfare

Issues with “normalization"

Deflating is similar to normalizing the measurement to a fixed year price level

- But, the choice of a fixed year (base-year) means that one is using price structures that become more and more remote from the current structure, the further one moves away from the base year
- This can create important issues. E.g.:
  - Price of computers have fallen dramatically over time (and increased a lot in quality)
  - Using “old" prices to infer new volume results in over-estimation because prices now are much lower than before
- For this reason, most NAS use so-called “chain-linking methods", where the price structures used in aggregation are always the previous period’s prices
- But, “chain-linking methods" make the NSA statistics non-additive. Thus, statistics derived from them cannot be used in accounting identities, and they cannot be used to compile shares. They can only be used to derive growth rates

Reporting lags

- Gathering and compiling all the data need to produce the NAS is complicated. For this reason, publication of NAS are delayed. Typically 1-2 months
  - E.g., the NSA for Q4 2022 in Norway is realized in February 2023
- This has important implications in practice. E.g., for policymakers or investors that need to monitor the markets on a day-to-day basis, reporting lags mean that they have less information than what they otherwise could have had.
- For this reason, people, banks, and institutions, have constructed a number of so-called leading indicators. E.g.:
  - Norway
  - U.S.

Revisions

- Gathering and compiling all the data need to produce the NAS is complicated. For this reason, publication of NAS are subject to revisions. E.g.:
  - When the NSA for Q4 2022 in Norway is realized in February 2023, the numbers for Q3 2022 will likely not be the same as those published in November 2022.
- In economic jargon, using the economic data that was available at the relevant time period (i.e., realistically in the information set of the economic agents) is called using real-time data. In this setting, each update of the NSA is called a vintage
- When modeling economic behavior and fluctuations, evaluating policy, etc., it is often very important to take the real-time data issue into account (but often this is not done...). Why? Because close to all economic decisions are based on what we expect will happen in the future given what we know today

Welfare

The national accounts focus on measuring economic activity rather than welfare per se.
E.g.:

- Activities that are not priced are not in NAS. Still, we might value these activities
- NAS makes no distributional considerations, but the welfare concept does
- Prices might not be “correct". E.g., there might be externalities that are not in the prices
- Sustainability issues are not included but have an effect on welfare

Still, GDP is commonly regarded as being a good partial measure of welfare

Other important macro data

Price indexes

The GDP deflator is one type of price index. Many more exist. The most important (at least in this course), is the consumer price index (CPI)

- The CPI measures prices of a wide variety of goods and services households typically consume. Changes in the CPI are called inflation
- Often we want to focus on so-called core inflation. That is, inflation adjusted for (excluding) changes in, e.g., taxes and energy. Why? Because these latter changes are typically either very volatile or assumed to be infrequent changes not having persistent (long-lasting) effects on overall inflation

Interest rates

The interest rate is often referred (somewhat imprecisely) as the price of money

- Many interest rates exist in the money market. The most important is that set by the central bank: “The lender of last resort" /the bank for the banks
- Why? Because money is only worth something when their value is trusted. The central bank has monopoly on producing money, and their interest rate determines the price
- Let’s look at Norges Bank
- Detour: what about digital money and crypto...

Real and nominal interest rates

The central bank sets the nominal policy rate. In turn, this rate affects all other interest rates in the market. But, what really matters for the macro economy is the real interest rate. I.e., the rate adjusted for inflation

Let i_t denote the nominal rate and π_t inflation (in percent). Then, the real rate is simply $r_t = i_t - \pi_t$ (note: this is just another identity - says nothing about how these entities are actually determined in the market)

E.g.: If you save 1000NOK in your savings account to an interest rate of 5%, your will have earned 50NOK at the end of the first year. But, if the general price level (inflation) has been 10% during that year, your purchasing power has actually decreased. That is, it would have been better to buy the goods and services you need at the beginning of the year (before their prices increased) rather than saving the money to an interest rate lower than inflation.

Good sources for NAS and other macroeconomic indicators

- IMF
- OECD
- FRED
- National statistical agencies, e.g., Norway's SSB

Data transformations and interpretation

Some important data transformation typically used

In economics and macro we often prefer working with logs (natural logarithm)

- Makes relationships additive and linear
- Often helps in terms of interpreting regression output

Percent change calculations

First, the percent change is a linear approximation of the log difference!

$$log(Y_2) - log(Y_1) = log(\frac{Y_2}{Y_1}) \approx \frac{Y_2}{Y_1} - 1 = \frac{Y_2 - Y_1}{Y_1} \tag{4}$$

Why? Take the first-order Taylor approximation of log(X) around 1:

$$log(X) \approx log(1) + \frac{d}{dX} log(X)|_{X=1}(X-1) = 0 + \frac{1}{1}(X-1) \tag{5}$$

Thus, the approximation hold for changes that are not far away from 1

Cumulative growth

Working with logs also makes computing cumulative effects easier

Let $\Delta x_t = log(X_t) - log(X_{t-1})$, then the cumulative growth effect of X_t from t to $t+h$ is:

$$\sum_{i=t+1}^{i=t+h} \Delta x_i = (x_{t+1} - x_t) + (x_{t+2} - x_{t+1}) + \ldots + (x_{t+h} - x_{t+h-1}) = (x_{t+h} - x_t) \tag{6}$$

E.g., if we specify a model in **log growth**, which we often do (more on this on next slides), and make a prediction for log growth, the **cumulative effect** of the prediction would be the predicted percent change in the **level** of the variable at each point in time between t and $t+h$

Interpreting regression coefficients

Case 1: The linear-log model:

$$y = \alpha + \beta log(x) + \varepsilon \Rightarrow E(y|x) = \alpha + \beta log(x) \tag{7}$$

What is the effect of one unit increase in x on y, i.e., dy/dx?

$$dy/dx = \beta/x \Rightarrow \beta = dy/(dx/x) \tag{8}$$

Interpretation β: A change in x by one percent is associated with a $0.01 \times \beta$ change in y

Interpreting regression coefficients cont'd

Case 2: The log-linear model:

$$log(y) = \alpha + \beta x + \varepsilon \Rightarrow E(log(y)|x) = \alpha + \beta x \tag{9}$$

What is the effect of one unit increase in x on y, i.e., dy/dx?

$$y = e^{\alpha+\beta x} \quad dy/dx = y\beta \Rightarrow dy/y = \beta dx \Rightarrow \beta = (dy/y)/dx \tag{10}$$

Interpretation β: A change in x by one unit is associated with a $100 \times \beta$ percent change in y

Interpreting regression coefficients cont'd

Case 3: The log-log model:

$$log(y) = \alpha + \beta log(x) + \varepsilon \Rightarrow E(log(y)|log(x)) = \alpha + \beta log(x) \qquad (11)$$

What is the effect of one unit increase in x on y, i.e., dy/dx?

$$y = e^{\alpha + \beta log(x)} \quad dy/dx = y\beta/x \Rightarrow \beta = (dy/y)/(dx/x) \qquad (12)$$

Interpretation β: A change in x by one percent is associated with a β percent change in y, i.e, the elasticity of y with respect to x

What to use? Case 1, 2, or 3? The data and the interpretation you want determines. But, remember, can not take log of negative values!