EC1B1 CourseworkMock — Does Money Matter?

EC1B1 Teaching Team

EC1B1 CourseworkMock | 2026

Final Python Session — Replicating a Research Paper

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0 Overview of the Project

- In this final Python session, you will replicate the main findings of a real research article published in a top economics journal.
- The paper is **"The Real Effects of Monetary Expansions: Evidence from a Large-scale Historical Experiment"** by **Nuno Palma**, published in the *Review of Economic Studies* (2022), Vol. 89(3), pp. 1593–1627.
- Palma uses the discovery of massive deposits of precious metals (gold and silver) in the Americas during the 16th–18th centuries as a **natural experiment** to identify the causal effects of changes in money supply on real economic activity in Europe.
- This parallels what you studied in Lecture 2 (The Medieval Economy): the early modern commodity money system, in which precious metals were a required input for the production of coinage.
- **The central question is: "Does money matter?"** — specifically, do exogenous monetary expansions have real effects on GDP and prices, and if so, how large and how persistent are these effects?
- Using a panel of six European countries (England, Holland, Italy, Spain, Portugal, and Germany) over the period 1531–1790, Palma finds that a 10% increase in precious metals production led to a **hump-shaped increase in real GDP** of up to 0.9% after 6–9 years, while prices responded with **considerable lags**.
- You will use the paper's own replication data to reproduce the key figures and statistical results, and then explore open-ended extensions.

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1 Guidance

1.1 Group Work

- You should work in groups of 2 students for this exercise.
- All group members should contribute to both the coding and the written analysis.
- Free riding will not be tolerated — all submissions include a coversheet describing task allocation.

1.2 Submission Materials

One member from each group should submit the following:

1. **A Jupyter Notebook** (`.ipynb` file) containing all code and outputs
   - The notebook must be clean, well-commented, and executable from top to bottom
   - Ensure another user can run your code by using relative file paths
2. **A PDF document** containing answers to all questions in Sections 5 and 6
   - Include relevant graphs where appropriate
   - Markers reward **precision and clarity**, not length
3. **A 2–3 minute video presentation** (Section 7)
   - Upload as `.mp4` or provide a link to a cloud-hosted video
4. **The completed coversheet**, signed by all group members

1.3 Grading

This exercise is formative (practice), but if it had to be marked, here is the mock rubric:

Component	Weight
1. Code quality: documentation, clarity, and executability	10%
2. Data cleaning and preparation (Section 3)	10%
3. Replication of figures (Section 4.1–4.2)	15%
4. Summary statistics and comparisons (Section 4.3)	10%
5. Local projections and interpretation (Section 4.4–4.5)	15%
6. Comprehension questions (Section 5)	15%
7. Extensions (Section 6)	15%
8. Video presentation (Section 7)	10%

NOTE: THIS RUBRIC IS JUST AN EXAMPLE AND DOES NOT CORRESPOND TO THE ACTUAL MARKING RUBRIC.

1.4 AI Usage Policy

- You are **actively encouraged** to use AI tools to assist with coding and debugging.
- However, it is very likely thatAI-generated text will **not** score highly on the comprehension and extension questions. Your written analysis must reflect your own understanding of the economics.
- The final written responses should demonstrate genuine engagement with the material. AI is not a replacement for your own understanding, it's just a tool to help you.

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2 Preparation

2.1 Required Reading

- Read the **Introduction** and **Section 2** of Palma (2022): "The Real Effects of Monetary Expansions."
  - Available at: https://academic.oup.com/restud/article/89/3/1593/6375454
  - Or via the course Moodle page under Lecture 2 readings.
- Briefly revise the content from **Lecture 2: The Medieval Economy**.

2.2 Setting Up Your Environment

Install the required Python packages:

```
pip install -r requirements.txt
```

The key packages are: `pandas`, `numpy`, `matplotlib`, `statsmodels`, `scipy`, and `jupyter`. If you use Colab, or Anaconda on your machine, these will already be installed. If you use Cursor, you can install them by running the above command on the terminal, or by asking Cursor to install them for you.

2.3 Obtaining the Data

The data comes from Palma's **replication package**, deposited at Zenodo:

> **DOI:** https://doi.org/10.5281/zenodo.4727681

We have converted the original Stata `.dta` files to CSV format and placed them in the `data/` folder:

- `palma2022_panel.csv` — the main panel dataset (from `liquidity.dta`): 6 countries × 260 years = 1,560 observations. Contains GDP, prices, and the precious metals shock variable used in the regressions.
- `palma2022_descriptive.csv` — additional descriptive data (from `datadescriptive.dta`): precious metals production in tonnes, mint output data. Used for Figures 2, 3, and related plots.

- `README_data.md` — complete variable definitions, original Stata column names, units, and source citations.

The original Zenodo package contains Stata `.dta` files and `.do` scripts. If you prefer, you can download the raw files from Zenodo and work with them directly, either in the original Stata format, or by converting them in csv files. And by you, I mean ask AI to help, and learn how to do it yourself.

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3 Data Cleaning and Variable Construction

(Marks: ~20%)

3.1 Load and Inspect the Data

- Load the panel dataset and the precious metals production data into pandas DataFrames.
- Report: the dimensions of the data, column names, data types, and the number of observations per country.
- Use `.head()`, `.info()`, and `.describe()` to inspect the data.

3.2 Handle Missing Values

- Identify any missing values in the dataset. Are there patterns to the missingness?
- Decide on an appropriate treatment (e.g. linear interpolation, exclusion of specific years) and **justify your choice** in a markdown cell.

3.3 Understand and Extend the Variables

The panel dataset already contains pre-computed variables from Palma's Stata replication. Key variables:

Column in CSV	Description	Unit
`nominal_gdp_index`	Nominal GDP	Index (1700 = 100)
`price_level_index`	GDP deflator / price level	Index (1700 = 100)
`real_gdp_index`	Real GDP	Index (1700 = 100)
`ln_real_gdp`	Log of real GDP index	Natural log
`ln_price`	Log of price level index	Natural log
`ln_nominal_gdp`	Log of nominal GDP index	Natural log
`metals_prod_ship`	**Main shock variable** (log precious metals / EU stock, adjusted for shipping)	Log ratio

Column in CSV	Description	Unit
`metals_nologs`	Same shock variable, not in logs	Ratio
`temperature`	European temperature anomaly	°C deviation
`war_with_spain`	Country at war with Spain	0/1 dummy

Construct the following **additional** derived variables using pandas:

Variable to Create	Description	Formula
`nominal_gdp_growth`	Annual growth rate of nominal GDP	`nominal_gdp_index.pct_change()` within each country
`real_gdp_growth`	Annual growth rate of real GDP	`real_gdp_index.pct_change()` within each country
`price_growth`	Inflation (annual price growth)	`price_level_index.pct_change()` within each country

- In your code comments, explain what each variable measures and why it is useful.
- Note: the log variables (`ln_real_gdp`, `ln_price`, `ln_nominal_gdp`) are used directly in the local projections.

3.4 Display the Dataset

- Display a summary of the merged panel dataset in your notebook.
- Show the full set of columns and a sample of rows for at least two countries.

Hint: Use `pd.options.display.max_rows` to temporarily display more rows, then reset it.

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4 Questions and Analysis

(Marks: ~40%)

4.1 Precious Metals Production Over Time

Replicate **Figure 2** from Palma (2022): the time series of gold and silver production in the Americas.

- Plot the annual production of precious metals from 1531 to 1790.

- Annotate key events on the graph:
  - The discovery of Potosí silver mines (~1545)
  - The introduction of mercury amalgamation process (~1571–76)
  - The discovery of Brazilian gold (~late 1690s)
- Give the plot an informative title and include a source note.

4.2 GDP and Price Level Time Series

Replicate **Figures 4–6** from Palma (2022): nominal GDP, real GDP, and the price level for each country.

Plot the following, presenting them as a panel of subplots (one per country, or one per variable):

- **(a)** Log of nominal GDP over time for all 6 countries
- **(b)** Log of real GDP over time for all 6 countries
- **(c)** Log of the price level over time for all 6 countries

For each set of graphs:

- Use a consistent y-axis scale across countries where appropriate
- Include a clear legend, axis labels, and title
- Consider using colours to distinguish countries or sub-periods

4.3 Summary Statistics and Cross-Country Comparisons

Replicate **Tables 1–2** from Palma (2022):

- Calculate and report in a well-formatted table:
  - Mean and standard deviation of real GDP growth by country
  - Mean and standard deviation of inflation (price level growth) by country
  - The correlation between precious metals production growth and GDP growth
- **Sub-period analysis:** Split the sample into two sub-periods:
  - (a) 1531–1650: The Silver Age (dominated by Potosí and Mexican silver)
  - (b) 1651–1790: The Gold Age (dominated by Brazilian gold)
  - Report the same statistics for each sub-period.

Question: Are there notable differences between the two sub-periods? What might explain them?

4.4 Local Projections — Impulse Response Functions (Figure 9)

This is the paper's key empirical contribution. You will implement **local projections** following Jordà (2005) to estimate how GDP and prices respond to precious metals shocks.

The actual Stata specification (from `projections_main_1700.do`):

For each horizon $h = 0, 1, 2, \ldots, 12$ years, estimate:

$$y_{i,t+h} - y_{i,t-1} = \alpha_i^h + \beta^h \cdot \text{metals\_prod\_ship}_{i,t} + \gamma^h \cdot X_{i,t-1} + \varepsilon_{i,t+h}$$

Where:

- y = `ln_real_gdp`, `ln_price`, or `ln_nominal_gdp` (already in the data)
- `metals_prod_ship` = log precious metals production as share of European stock, adjusted for shipping disruptions (already in the data — this is the `$shock` variable in the Stata code)
- X = control variables: 4 lags of the dependent variable, year, year^2, country-specific trends, `war_with_spain`, `temperature` (lags 0–4)
- α_i = country fixed effects (dummies for `cnumber`)
- Sample restricted to years ≤ 1700
- Standard errors: clustered by country

Simplified version for this exercise: You may use a simplified specification with:

- 2 lags of the dependent variable (instead of 4)
- Country fixed effects
- No additional controls (temperature, war_with_spain, trends)
- Clustered standard errors by country

For each horizon:

1. Construct the dependent variable: `y(t+h) - y(t-1)` (the cumulative change)
2. Estimate OLS with country dummies
3. Use **clustered standard errors** by country
4. Store the coefficient β^h and its 95% confidence interval

Then **plot the impulse response functions** (replicating Figure 9):

- **(a)** Response of real GDP to a precious metals shock
- **(b)** Response of prices to a precious metals shock
- **(c)** Response of nominal GDP to a precious metals shock

Each plot should show:

- The point estimates (β^h) connected as a line
- 95% confidence bands as shaded areas
- A horizontal line at zero for reference
- Horizon (years) on the x-axis, from 0 to 12

Hint: You will need to run a separate regression for each horizon h. A loop is the natural approach. See the scaffolded code in the notebook.

4.5 Interpret the Results

Using your impulse response function plots from Q4.4:

- Describe the dynamic response of real GDP, prices, and nominal GDP to a monetary shock.
- Is the response of real GDP hump-shaped? When does the peak effect occur?
- Do prices respond immediately or with a lag? What does this imply about price stickiness?
- How do your results compare to the findings reported in Palma (2022)?

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5 Comprehension Questions

(Marks: ~15%)

Q5.1 The Natural Experiment

- How does the discovery of precious metals in America serve as a natural experiment for identifying the causal effects of money supply on the economy?
- What is the key identification assumption, and why is it plausible? (Refer to the discussion in Palma, 2022, Section 2.2)
- Can you think of another natural experiment that could be used to study the effects of monetary policy? How would it compare to Palma's approach?

Q5.2 Commodity Money and the Modern Economy

- Explain how the early modern commodity money system worked. How is it different from the modern fiat money system?
- Why did the availability of precious metals matter for the money supply?
- Connect your answer to the concepts from Lecture 2 on the medieval economy.

Q5.3 Long and Variable Lags

- Milton Friedman famously stated that monetary policy operates with "long and variable lags." Do Palma's findings support this view?
- Why might the lags be particularly long in the early modern period? Consider the role of:
  - Transportation of precious metals from the Americas
  - The minting process
  - The speed of economic transactions
- What implications does this have for modern monetary policy?

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6 Extensions

(Marks: ~15%)

6.1 The Price Revolution

One of the most debated questions in economic history is the cause of the **"Price Revolution"** — the sustained rise in European prices during the 16th and 17th centuries.

Two competing hypotheses have been proposed:

1. **The Monetary Hypothesis:** Prices rose because of the influx of precious metals from the Americas, which increased the money supply (Hamilton, 1934).
2. **The Real Hypothesis:** Prices rose because of population growth, urbanization, and changes in agricultural productivity (Goldstone, 1991).

Using the data from this exercise:

- Present evidence for and against the monetary hypothesis.
- Consider: does the timing of price increases match the timing of precious metals inflows?
- Do all countries experience similar price increases, or are there heterogeneities that the monetary hypothesis cannot explain?
- You should include relevant graphs and statistics in your response.

6.2 The Spanish Paradox — A Resource Curse?

Spain received the most precious metals from the Americas, yet by the 17th century it was in economic decline, while England and Holland were thriving.

- Use the data to compare the trajectories of Spain, England, and Holland in terms of real GDP and prices.
- Is there evidence of a **"resource curse"** — where abundance of natural resources leads to worse economic outcomes?
- What mechanisms might explain why Spain's monetary windfall did not translate into sustained economic growth? Consider:
  - Dutch disease / real exchange rate appreciation
  - Institutional quality
  - The structure of the Spanish economy

Present your analysis with appropriate data visualizations and discuss the limitations of drawing conclusions from this data alone.

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7 Video Presentation

(Marks: ~10%)

Brief

Prepare a **2–3 minute video** in which your group explains the key findings from this exercise to a **non-technical audience** (e.g., a friend or family member who has never studied economics).

Requirements

- **Topic:** Answer the question "Does money matter?" using the evidence from Palma (2022) and your replication.
- **Format:** Screen recording with narration, recorded presentation, or face-to-camera — your choice.
- **Audience:** Assume your audience has no knowledge of economics. Avoid jargon; use analogies and clear examples.
- **Duration:** Strictly 2–3 minutes. We will stop watching at 3:00.

Tips for a Good Presentation

1. **Start with a hook:** Why should a non-economist care about whether money matters?
2. **Tell a story:** The discovery of silver in Potosí, the flood of precious metals to Europe — this is intrinsically interesting!
3. **Show one key graph:** Pick the single most compelling visualization from your analysis.
4. **Explain the punchline:** What did the data show? Was the effect big or small? Fast or slow?
5. **End with a connection to today:** Does this have any relevance for modern monetary policy?

Rubric

Criterion	Excellent	Good	Satisfactory	Needs Work
Clarity (40%)	Crystal clear, no jargon, excellent structure	Mostly clear, minor jargon	Understandable but disorganized	Confusing or overly technical
Accuracy (30%)	All claims accurate and well-supported	Mostly accurate, minor imprecisions	Core message correct, some errors	Significant factual errors

Criterion	Excellent	Good	Satisfactory	Needs Work
Audience fit (30%)	Perfectly pitched for non-experts	Mostly appropriate, occasional lapses	Somewhat too technical	Not adapted for audience

Grade bands: Excellent 90–100%, Good 70–89%, Satisfactory 50–69%, Needs Work under 50%.

References

- Palma, N. (2022). "The Real Effects of Monetary Expansions: Evidence from a Large-scale Historical Experiment." *Review of Economic Studies*, 89(3), 1593–1627. DOI: 10.1093/restud/rdab042
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- Hamilton, E.J. (1934). *American Treasure and the Price Revolution in Spain, 1501–1650.* Harvard University Press.
- Goldstone, J.A. (1991). "Monetary versus Velocity Interpretations of the 'Price Revolution': A Comment." *Journal of Economic History*, 51(1), 176–181.
- Schwabish, J.A. (2014). "An Economist's Guide to Visualizing Data." *Journal of Economic Perspectives*, 28(1), 209–234.