MTP Assignment 1

**1 Kiyotaki-Wright with cost for holding money ξ**

Consider the simplified version of the Kiyotaki-Wright model you saw in class. There is a large number of infinitely-lived individuals, a large number of indivisible consumption goods and one indivisible good with no intrinsic value, fiat money. Initially, a fraction M ∈ (0, 1) of individuals is endowed with one unit of money, and 1 − M with one good. Let x ∈ (0, 1) denote both the proportion of goods that any individual can consume, and the proportion of individuals that consume any given good. Utility from consumption is U > 0. Consumption yields production of a unit of good. Those who do not consume, cannot produce. Money cannot be produced. Last, individuals cannot consume their output and/or their endowment. Traders meet at random, one meeting per period each. Let π be the probability that an agent accepts money, and Π denote the expected probability that the other agents accept money. Let ξ ∈ (0,∞) de note the utility cost that agents must pay whenever they end a period holding money. This is the only modification relative to the model you studied in class.

**Question 1**

Derive the expression for the expected utility of holding money and of holding a good at the beginning of time t. Denote them with VM,t and VC,t respectively.

Note: all computations are reported in APPENDIX A, at the end of the paper

First, we define the probability trees

A diagram of mathematical equations

Description automatically generated with medium confidence



Second, after having defined the probability tree as in the baseline model, I am subtracting the value of the disutility ξ from the scenario of holding money in t1. This leads to the following equations that define the expected utility of holding money and of holding a good at the beginning of time t:

VC, t =

VM, t =

**Question 2**

Explain how an agent decides whether to accept money in exchanges and derive his optimal strategy. In doing that, clearly state the properties of the equilibrium that you use in deriving the results. Hint Derive a threshold value of Π, call it Π∗ , below which commodity traders never accept money in exchange, and above which they always do.

In this scenario we can assume symmetry (π = Π) and stationarity (VM, t = VM, t+1, VC, t = VC, t+1). Agents will accept money whenever the expected utility of holding money is greater than the expected utility of holding cash. Thus, we first compute this difference (VC – VM) and then we set it to 0 in order to find the cutoff condition (a threshold Π\*). If the actual Π will be greater than the threshold agents will always accept money (monetary equilibrium), if it will be smaller they will never accept money (non-monetary equilibrium)

rVC = (1 - M) x2 U + MxΠ(VM - ξ - VC)

rVM = (1 – M) xΠU + (1 - M)xΠ(VC - VM + ξ) – ξ

🡪 r(Vc – Vm) = (1 – M) xU(x - ) + xΠ(VM - VC - ξ) + ξ 🡪 VC – VM = \* (x - Π ) +

The cutoff will be at:

0 = \* (x - Π ) + 🡪

**Question 3**

Explain and discuss how the optimal strategy differs from the baseline case where ξ = 0.

The difference with respect to the baseline model is that now the choice is affected not only by the values of Π and x but also from the Utility costs of holding money in t1 (ex. due to capital erosion due to inflation). An higher threshold Π\* will need to be met as agents are less induced to hold money.

If 🡪 commodity traders will always accept money (π = 0). It is more valuablw to hold money rather than commodities

If 🡪 commodity traders will never accept money (π = 1)

If Π = Π\* 🡪 traders are indifferent

**A diagram of a line with red lines and numbers

Description automatically generated with medium confidenceQuestion 4**

Derive the possible equilibria and represent them graphically as we did in class.

If Π < Π \* 🡪 Vm< Vl, which 🡪 best response π = 0 (agent will always refuse money)

If Π > Π \* 🡪 Vm> Vl, which 🡪 response π = 1 (agent will always cacapt money)

Given choices are symmetric symmetry we will have three possible equilibria (note also that in this model expectations are self-fulfilling)

🡪 3 possible Equilibria

1. Nonmonetary equilibrium (Π=0): Agents expect that money will not be accepted, so they never accept it. Money is not used (Point A)
2. Pure monetary equilibrium (Π=1): Agents expect that money will be accepted, so they always accept it. Money is universally used (Point C)
3. Mixed monetary equilibrium (Π= Π\* ): Agents are indifferent between accepting and not accepting money as long as other agents accept it with probability Π= Π\*. Money is only partially acceptable (Point B)



**Question 5**

Now assume U = 5, M = 0.4, x = 0.5 and ξ = 0.5. Derive the value of the threshold value Π∗ which determines whether the commodity trader accepts money or no, and write the optimal decision rule of the agent.

Putting the required values into 🡪 = 0.7143

If 🡪 commodity traders will always accept money (π = 1) 🡪 we will end up in the monetary equilibrium

If 🡪 commodity traders will never accept money (π = 0) 🡪 we will end up in the non-monetary equilibrium

If 🡪 traders are indifferent 🡪 we will end up in the mixed monetary equilibrium

As we can see, with ξ = 0.5 the required threshold increases significantly to = 0.7143 from the baseline model threshold of = 0.5.

**Question 6**

Assume the same values for the parameters as in the previous question, but now let ξ = 2. Compute the new threshold Π∗ . What does the value for the new threshold imply for the existence of the three equilibria? In light of your findings, discuss which equilibrium always exists independently of the value of ξ. Derive the condition such that the pure monetary equilibrium exists

In case ξ = 2 🡪 Π∗ = 1.1 🡪 this means that no possible Π will allow for the existence of monetary or mixed equilibria.

Being any ξ > 0 a penalizing factor for the Utility of holding money, we can say that the cutoff condition is a function of ξ. The higher ξ the higher the threshold. Over a certain level of ξ it will never be optimal, regardless of Π to hold money.

For a pure monetary equilibrium to exists, < 1\* 🡪 🡪 < 1.5

In fact, putting 1.5 in we get = 1

\*note smaller or equal would imply only the potential existence of a mixed equilibrium

**2 Inflation and Labor Market Slackness**

In the first part of this exercise you will analyze the recent inflation dynamics in the US and the Euro Area. For the US, you will need to download the following series, at a monthly frequency, from the FRED website starting from 2000M1 up to the last available date:

Warning For the FRED data series remember to select the specific unit of measurement that you want to download (indicated in parenthesis below). For the ECB data series, the unit of measurement is already the correct one.

• Personal Consumption Expenditures: Chain-type Price Index (Unit: Percent Change from Year Ago)

• Personal Consumption Expenditures Excluding Food and Energy: Chain-type Price Index (Unit: Percent Change from Year Ago)

For the Euro Area, download the following series from the ECB Data Portal (link):

HICP - Overall index, Euro area (changing composition) (Unit: Annual rate of change)

HICP - All-items excluding energy and food, Euro area (changing composition) (Unit: Annual rate of change)

**Question 1**

Produce two graphs:

In the first graph, plot “Personal Consumption Expenditures: Chain-type Price Index, Per- cent Change from Year Ago” along with “Personal Consumption Expenditures Excluding Food and Energy: Chain-type Price Index, Percent Change from Year Ago” over time;

Using python

A screenshot of a computer code

Description automatically generatedA graph of a graph showing the price of a company

Description automatically generated with medium confidence

In the second graph, plot “HICP - Overall index, Euro area (changing composition), Monthly" along with “HICP - All-items excluding energy and food, Euro area (changing composition), Monthly”, over time.

Using excel

A table of numbers and numbers

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**Question 2**

The first series in each graph is the headline inflation rate, while the second is the core inflation rate. Comment on the co-movement of the two series and their relative volatility within the two geographical areas. Then, briefly compare their dynamics between the US and the Euro Area. What could explain the difference in inflation dynamics between the US and the Euro Area after the Covid recession? Explain.

The headline inflation rate reflects the total increase in prices of (almost) all goods and services in an economy. This includes volatile components like food and energy prices. Core inflation, on the other hand, excludes these volatile components.

By excluding spikes related to food and energy components (which often have nothing to do with the sphere of authority of the CB, ex. a sudden war), core inflation provides a clearer picture of the inflation trend and provides central banks with a more stable reference point.

A blue screen with white text

Description automatically generatedObservationally, while both series frequently move in tandem, headline inflation demonstrates greater volatility, and this is evidenced by its higher St. dev in both the US and the Euro Area over a 25-year span.

In fact, we can see that St. dev of overall inflation is higher, both in US and Eu, than core inflation across a 25 year period.

A graph of red and blue lines

Description automatically generatedPost the Covid recession a number of factors could have contributed to differing inflation dynamics between the US and the Euro Area, let’s delve into data:

After the pandemic, but before War in Ukraine, both regions witnessed inflationary pressures, likely driven by expansive monetary and fiscal policies combined with supply chain disruptions. However, the US, possibly due to a larger fiscal stimulus, experienced a more pronounced inflationary uptick. As of the 24th of February 2022, before the Ukrainian conflict began, both core and headline inflation rates in the Euro Area were below those in the US. However, once the conflict started, Europe's significant reliance on Russian oil and gas imports magnified its overall inflationary outlook. This led to a marked divergence between Europe's core and headline inflation, highlighting the economic vulnerabilities tied to the european energy sources.

**US labor market**

Let’s now focus on the US labor market. Alternative labor market measures of slackness have been used by economists to produce inflation forecasts. The most used measure is the unemployment rate. For example, conventional formulations of the Phillips Curve assert that when the unemployment rate is below its natural level, inflation should raise above target. So when the labor market is slack, i.e., the unemployment rate is high, then we expect inflation to slow, and vice-versa when the labor market is tight, i.e., the unemployment rate is low, we expect inflation to increase. More recently, there has been resurgent interest in looking at measures of slackness that include information from the employer side, such as the ratio of the level of unemployment to job openings. The ratio is calculated by dividing the number of unemployed people by the number of job openings in a given period. This number is informative of the relative size of labor supply (unemployed people) and labor demand (job openings). Another useful measure to gauge the state of the labor market is the quit rate, defined as the share of quits (i.e., separations due to voluntary departures by workers) in a given period relative to total employment. Most workers who quit their jobs do so to move directly to a new job elsewhere. Quits, therefore, serve as a proxy for workers’ willingness or confidence in their ability to find better opportunities in the labor market. Hence, 1− quit rate can be used as measure of labor market slackness. In the following questions, you are asked to analyze and compare these different measures of slack ness for the US labor market. Download the following time series for the labor market in the US, at quarterly frequency, from the FRED website from 2001Q1 until 2023Q2:

Unemployment Level, Thousands of Persons, Seasonally Adjusted (Unit: Thousands of Persons. Aggregation Method: Average)

Job Openings: Total Nonfarm, Seasonally Adjusted (Unit: Level in Thousands. Aggregation Method: Average)

Unemployment Rate, Seasonally Adjusted (Unit: Percent. Aggregation Method: Average)

Quits: Total Nonfarm, Seasonally Adjusted (Unit: Rate. Aggregation Method: Average)

**Question 1**

Calculate the Unemployment/Job Openings ratio. Elaborate on what it represents and what additional information it conveys compared to the unemployment rate.

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Description automatically generatedObtained through py:

f = Fred(api\_key=’-’)

# List of series IDs

columns = ['UNEMPLOY','JTSJOL', 'UNRATE', 'JTSQUR']

# Initialize an empty DataFrame

combined\_df = pd.DataFrame()

# Retrieve each series and add it to the DataFrame

for i in columns:

series = f.get\_series(i, observation\_start='2001-1-1')

combined\_df[i] = series

# Compute the ratio of 'UNEMPLOY' to 'JTSJOL' and store it in a new column

combined\_df['Unemployment\_over\_Job\_Openings\_Ratio'] = combined\_df['UNEMPLOY'] / combined\_df['JTSJOL']

# Display the DataFrame with the new ratio column

print(combined\_df.tail(40))

Unemployment/Job Openings ratio:

This ratio is derived by dividing the total number of unemployed individual by the Total number of job openings

With a ratio greater than 1: there are more unemployed people than there are job openings 🡪 labor market is slack and it is difficult for a worker to find a job (ex. during a recession firms may be reluctant to hire new workers)

With a ratio less than 1: there are more job openings than there are unemployed people 🡪 labor market is tight. Employers find it relatively difficult to find workers, thus could be forced to offer higher than normal wages.

The unemployment/job openings provides a more nuanced view of the labor market than the unemployment rate. The unemployment rate simply provides a snapshot of the proportion of unemployed individual (demand for jobs), while the unemployment/job openings ratio offers insight into how tight or loose the labor market is providing a comprehensive estimate of Demand and Supply forces.

**Question 2**

Finally, plot the following three series in the same graph and briefly comment their behavior:

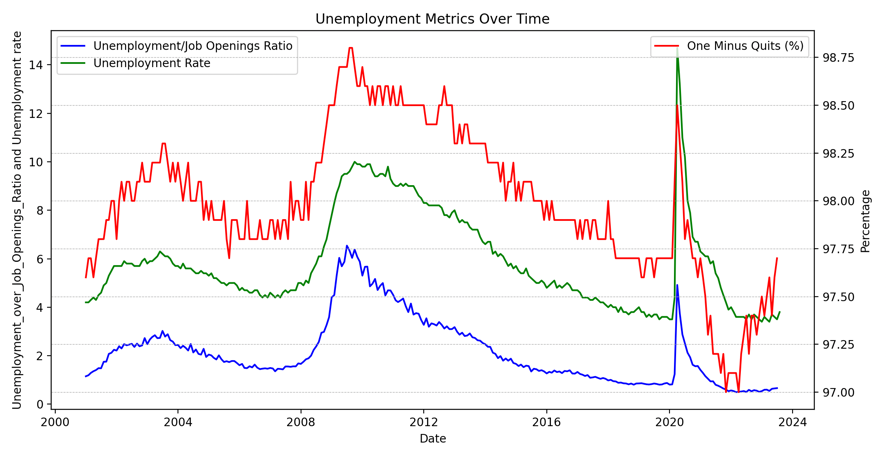
Unemployment/Job Openings ratio;

Unemployment Rate;

1 - Quits (Rate);

Hint As mentioned above, to use Quits as a measure of market tightness, you should use 1 - Quits (Rate) so that higher values correspond with a greater degree of slack consistently with the other measures of slack considered here.

A screenshot of a computer program

Description automatically generated

A low unemployment rate is associated with a low unemployment/Job opening markets, and to an high quit rate (lower 1-quit rate).

When the economy is strong the market is tight. Employers looks for employees, but since employment is high they are forced to offer higher wages. High job opportunities and wages foster people to quit their job, thus reducing the 1-quits rate.

**Question 3**

To have a clearer interpretation of how these measures co-move over time, it is appropriate to scale them by the characteristics of their relative distributions. Calculate the mean and the standard deviation for each time series using only data points until 2018 (included). Standardize each time series for the whole sample period (until 2023 Q2) using the just calculated values and plot the obtained series. How have these measures of slackness co-moved before Covid? Now focus on the period immediately after the Covid recession. Would these measures tell the same story about the state of the economy? Comment.

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A graph of a graph

Description automatically generated with medium confidencePrior to the advent of the COVID-19 pandemic, key indicators of labor market slackness—namely, the quit rate, the ratio of unemployment to job openings, and the overall unemployment rate—exhibited significant co-movement. At the onset of the pandemic, all ratios surged sharply.

However, the post-pandemic period, spanning from 2020 to 2023, shows a significant divergence in these metrics. Following the downturn induced by the virus, the quit rate saw a sudden decline, reaching historically low values. In contrast, both the unemployment-to-job-opening ratio and the aggregate unemployment rate persisted at elevated levels for a relatively longer period. This created a remarkable divergence in these slackness measures. While the unemployment rate and the Unemployment/Job Openings ratio indicated a weak labor market, the quit rate seemed to suggest the market was tight.

Under conventional economic wisdom, these observations appear contradictory; heightened economic uncertainty (caused by a recession) typically dissuades workers from voluntarily exiting their jobs.

However, it seems some plausible factors could explain the surge in quit rates (‘The great resignation”):

1. Health Imperatives: the pandemic may have created a tradeoff between remuneration and health concerns. In line with this trade off, many workers may have decided to quit their jobs to avoid the contagion. This reasoning more probably applies to workers engaged in frontline services such as accommodation, food services, and retail, which rely on in-person customers and can’t be done remotely or to workers that were close to retirement.

2. Shift in Work Values: The pandemic, by enforcing prolonged home stays, inadvertently instigated a re-evaluation of work-life equilibrium. Extended familial engagements might have catalyzed a broader shift in occupational aspirations, favoring roles that promote a balanced work-life equilibrium.

3. Family Care Obligations: The pandemic posed unique challenges for workers with familial obligations—especially those catering to elderly relatives or young children. This demographic might have felt the necessity to exit the labor force, at least temporarily.

4. Preference for Flexibility: The enforced work-from-home regime during the lockdowns highlighted the feasibility and benefits of remote work. Consequently, a segment of the workforce, cherishing this newfound flexibility, might have sought roles that allowed them to work on remote even after the end of the pandemic.

code

# Define the columns to be standardized

columns\_to\_standardize = ['Unemployment\_over\_Job\_Openings\_Ratio', 'UNRATE', 'one\_minus\_quits']

# Calculate mean and standard deviation for each series until 2018

mean\_std\_dict = {}

for col in columns\_to\_standardize:

mean = combined\_df.loc[:'2018-12-31', col].mean()

std = combined\_df.loc[:'2018-12-31', col].std()

mean\_std\_dict[col] = (mean, std)

# Print the mean and standard deviation for each column

print(f"Column: {col}")

print(f"Mean (until 2018): {mean}")

print(f"Standard Deviation (until 2018): {std}")

print("-----")

# Standardize each series for the whole sample period using the calculated mean and standard deviation

for col in columns\_to\_standardize:

mean, std = mean\_std\_dict[col]

combined\_df[col] = (combined\_df[col] - mean) / std

print(combined\_df[col])

# Plot the standardized series

plt.figure(figsize=(14,8))

for col in columns\_to\_standardize:

plt.plot(combined\_df.index, combined\_df[col], label=col)

plt.axvline(pd.Timestamp('2020-02-01'), color='red', linestyle='--', lw=2) # Add a vertical line at the start of Covid

plt.title('Standardized Job Market Indicators')

plt.xlabel('Date')

plt.ylabel('Standardized Value')

plt.legend()

plt.show()

A piece of paper with math equations

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