**1. Household Heterogeneity and the Transmission Mechanism of Monetary Policy**

Note: all intermediate mathematical passages are reported in Appendix A

**Question 1:**

*Combine the two period budget constraints of E-households to obtain a single intertemporal budget constraint. Then, solve the problem of Entrepreneurs. In particular, derive the consumption Euler equation relating C2E to C1E, i1, Π1 ≡ P2/P1, and β.*

**A. Lifetime Utility**

Utility in ti: U(CtE) = log(CtE)

Lifetime Utility: U(C1E) + βU(C2E)

🡪 Hence, lifetime utility can be rewritten as: U(C1E, C2E) = log(C1E) + βlog(C2E)

**B. Lifetime Budget Constraint**

BCt1: P1 C1E + B1 = Y1

BCt2: P2 C2E = Y2 + (Y1 – P1 C1E) (1 + i1 )

🡪 derive lifetime BC, merging by B: P2 C2E = Y2 + (Y1 - P1 C1E) (1 + i1), rearranging: P1 C1E + = Y1 +

Where the left term is the PV of total consumption, the right term is PV of total resources

**C. Unconstrained optimization: deriving the Euler equation**

rearranging (computation in Appendix A.1) the lifetime Bc: C2E =

where we can call the exogenous component d =

we now substitute C2E in U(C1E, C2E) = log(C1E) + βlog(C2E) 🡪 U(C1E, C2E) = log(C1E) + βlog()

taking FOC wrt C1: 🡪 rewriting (Euler equation):

FOC equates marginal cost and benefit of postponing cons. by 1u from today to tomorrow

MC: give up consumption by 1u at t1 🡪 U at t1 will decrease by 1/C1

MB: saving 1u in t1 will give you +1 in consumption 🡪 marginal Utility (MB) in t2 is the of U (1u \* real rate / discount factor )

**D. The equation for C2**

Then, C2 will be:

C1 = 🡪

**Question 2**

*Entrepreneurs take income Y1,Y2, prices P1,P2 and the nominal interest rate i1 as given. The optimal consumption schedule expresses consumption in both periods as a function of these exogenous variables and the parameters of the model. Use the consumption Euler equation and the intertemporal budget constraint to derive the optimal consumption schedule of E-households.*

Substituting C2 from the Euler equation into the Bc we get (Appendix A.2):

we have:

🡪

*🡪*

*🡪*

*🡪*

Substituting C1 into the Bc we get:

C2E =

🡪 C2E =

🡪 C2E =

🡪 C2E\* =

**Question 3**

*Solve now the problem of hand-to-mouth households. First, derive the optimal labor supply condition relating the marginal cost and marginal benefit of labor supply. Second, derive the consumption path (C2H and C1H ) for the hand-to-mouth agents using the period budget constraints. Explain why hand-to-mouth households do not have a consumption Euler equation. Finally, compute the household labor supply given the consumption path.*

**A. Household utility:** U(CtH, Nt) = log(CtH) -

**B. Household budget constraint:** CtH = WtNt 🡪 CtH =

**C. Optimizing U s.t BC holds:**

a. Substitute Ct from BC into U: log() -

b. Take FOC wrt N to maximize: = 0 🡪 = 0

c. Optimal choice of labor:

left term: marginal benefit of labor supply (extra U from additional wage), right term: marginal cost of labor supply

Household do not have the possibility to maximize jointly their lifetime Utility, as their budget constraints in t1 and t2 are not linked. Clearly, there will be no Euler equation, there is no tradeoff between marginal benefit of consuming today or saving for consuming tomorrow, as there is no possibility to smooth consumption through lending and borrowing.

In each period they will consume exactly what they dispose (can’t save): CtH\* =

Moreover, if we now put their optional level of consumption into the optimal choice of labor: (

we get:  *🡪 🡪*  *🡪 ,* since sqroot(1) is always 1 🡪 N\* = 1

This result seems to be consistent with a broader intuition on real wages and consumption. In fact, If we Insert N\* = 1 into we get = 1 🡪 and so that the ratio of real wage and consumption is equal to 1. This seems to be reasonable as households have no access to financial markets.

Sidenote: It could be argued that if (Nt)φ>1🡪 > Ct, hence the agent would be saving part of its income for the future, whereas if (Nt)φ<1 🡪 < Ct hence the agent would be currently borrowing in t to consume more than what he earns.

**Question 4**

*Discuss how an increase in the nominal interest rate affect the optimal consumption plan of the two household categories, taking their incomes - Yt and Wt - as given. Now, assume that while Yt is given exogenously, the nominal wage Wt is a decreasing function of the nominal interest rate. First, explain why this may be the case. Then, discuss how this affects your answer about the effects of an increase in the nominal interest rate on the optimal consumption plan of the two agents.*

**A. Basics**

Entrepreneurs opt. consumption

*,*

Households:

CtH\* =

**B. Effects of an increase in i, given Y,W exogenous**

a. Effect on entrepreneurs:

Higher implies that will decrease, thus this would mean that consumption in t1 will decrease, and consumption in t2 will increase.

In fact, if we look at the derivative wrt i of C1E\* = it is negative:

and at the derivative wrt i of CwE = it is positive:

b. effects on households:

With respect to household, being them outside the credit market, a change in r, given W and P exogenous, would not affect consumption. Mathematically, we can see their equation for optimal consumption does not comprehend the term r.

**C. Effects of an increase in i, given Y exogenous, W endogenous**

Many reasons could lead us to expect the nominal wage (w) to be a decreasing function of i. The key idea is that higher rates could slow down the economy, leading to higher unemployment, hence downward pressure on wages.

a. Investment channel: Higher interest rates make borrowing more expensive for firms. This lead many firms to reduce investment, hence causing lower demand for labor and downward pressure on wages.

b. Consumption channel: Higher i increases the cost of borrowing for consumers. If this forces consumers to consume less, consumer demand will decrease. This in turn should have a negative effect in production and, subsequently, less demand for labor, putting downward pressure on wages.

c. Asset prices channel, two possible effects:

I. contractionary monetary policy 🡪 r on bonds increases 🡪 equities or housing less attractive relative to bonds 🡪 stocks or housing demand decreases 🡪 prices of stocks decreases

II. expansionary monetary policy aggregate demand increases 🡪 dividends decrease, r increases 🡪 stock prices decrease

A math equations with numbers

Description automatically generated with medium confidence

If we consider the Tobin’s Q = (market value of firms) / (replacement cost of capital), lower stock prices (lower market value) would imply a lower Q. This would mean that new plant and equipment capital is expensive relative to the market value of firms. Firms will reduce investment. Note: lower asset prices have also an effect on consumers, whose stock of wealth is reduced as stock prices go down (this increase the problem related to asymmetric information and moral hazard in the credit market).

d. Deflationary Pressures: In some cases, a significant increase in I can tip the economy into a deflationary spiral. If prices start to fall, firms might experience reduced revenue and, in turn, might cut wages or delay wage increases. However, due to downward rigidities in the job market, it is quite uncommon to see firms reducing nominal wages, rather we would probably assist to an increase in layoffs. Nevertheless, in the long run, layoffs would lead to higher supply of labor, hence downward pressures on wages.

e. Exchange Rate Appreciation: Higher interest rates can lead to an appreciation of the domestic currency. While this can make imports cheaper, it can also hurt export competitiveness. Firms that rely heavily on exports might need to reduce costs.

If nominal wage a decreasing function of i:

Since entrepreneurs earn no wage they will not be affected by this channel, and our previous conclusion will not be touched.

Instead, household would see their wage Wt decrease, hence also their consumption in the period with higher i will decreases, however, obviously, this will give then no advantage in the following period.

**Question 5**

*We can write total consumption Ct as the between-group average consumption, i.e. Ct = λCtE + (1 − λ)CtH . Use the optimal consumption schedules for E and H households to derive the asso- ciated aggregate optimal consumption schedule. To answer this question, assume that the wage for the Hand-to-Mouth households is equal to the income of the Entrepreneurs, that is Wt = Yt, and both are exogenously given. How does an increase in the nominal interest rate affect the aggregate optimal consumption schedule? How does λ influence the real effectiveness of monetary policy?*

Entrepreneurs opt. consumption

,

Households:

CtH\* =

Aggregate consumption t1 (Wt = Yt): = λ

FOC with respect to r1:

Aggregate consumption t2:

FOC with respect to r1:

An increase in r1 will lead C1 to decrease and C2 to increase. The variable has a crucial effect. the higher the higher the decrease in aggregate consumption in t1, and the increase in t2. This is perfectly reasonable: the higher the fraction of entrepreneurs (the only ones affected by the interest arte change) the higher the effect of the interest rate change (hence of monetary policy).

***2 The Beveridge Curve and the Role of Labor Reallocation***

*Over the last year, the Federal Reserve has raised the Fed Funds target rate to curb the significant surge in inflation observed after the strong recovery of the US economy since the Covid recession. An open debate is about the possibility for the FED to slow inflation without causing a recession and a higher unemployment rate, i.e., the possibility of a "soft landing". Economists are currently debating about the likelihood of a "soft landing" by looking at an empirical relation: the Beveridge curve. The Bev- eridge curve describes the cyclical dynamics of the labor market, but also captures structural aspects. Hence, understanding its current features may provide relevant information to assess the likelihood of a soft landing.*

*In the first part of this exercise you are going to uncover the fundamental relationship between job vacancies and unemployment: the standard Beveridge curve. In the second part, you are going to see how modifications to the standard specification may provide additional information to assess whether the US economy is heading to a soft or a hard landing.*

*In order to solve this exercise, you will need to download, the following series from the FRED dataset:*

*• Job Openings: Total non-farm (Unit: Level in Thousands, Seasonally Adjusted);*

*• Unemployment level (Unit: Thousands of Persons, Seasonally Adjusted);*

*• Working Age Population: Aged 15-64: All Persons for the United States (henceforth, simply popu- lation), divided by 1000 (Unit: Persons, Seasonally Adjusted).*

*Download all the series at monthly frequency, over the period 2001M1 up to the latest available observation.*

**Questions 6-10: all graphs have been developed on py through the FRED API**

**Question 6**  
*Draw a scatter plot where you have the unemployment-population ratio on the x-axis, and the job openings-population ratio on the y-axis, for the following periods:*

*• Pre-GreatRecession(2001M1-2007M12)  
• GreatRecession(2008M1-2009M6)  
• PostGreatRecession(2009M7-2020M3)*

*• PandemicRecession(2020M2-2022M4)*

*• PostPandemicRecession(2022M5-2023M8)*

*Plot them in the same graph and, to make the reading of the graph easier, use different colors for each period.*

A graph of a graph with colored dots

Description automatically generated with medium confidence

\*note: smoothing is realized through LOWESS

Why is the relationship downward-sloped? Using this empirical regularity, describe the labor market dynamics over the business cycle.

In a strong (tight) labor market high job openings and low unemployment are expected to be observed, while in a loose labor market high unemployment and low job openings should be recorded. When the economy is performing well, there are typically more job vacancies and fewer unemployed workers, which means a point on the top left of the curve. Conversely, in a recession, there may be fewer vacancies and more unemployed people, leading to a point on the bottom right of the curve. Let’s consider two examples: as we can see in the graph, during the great recession there was mainly a movement along the curve, progressively to the left, so towards lower levels of job openings and higher levels of unemployment. During the recovery after the pandemic, instead, we experienced the exact opposite movement: the economy moved from the bottom right (light grey) to the top left (yellow), hence job openings increased and job openings decreased. Movements along the curve represents cyclical employment, hence the effects of business cycles.

sidenote:

We can see that after the great recession, and especially during the pandemic the Beveridge curve progressively shifted outward. These shifts are caused by fundamental changes in the structure of the economy. This is extremely interesting: in fact, currently, at the same level of unemployment (so at the same level of demand for labor (say 5% ) )there is a systematically higher supply (ex. before the great recession <2%, after 2.5%, during the pandemic almost 4%). It looks like the market has become structurally more inefficient in matching demand and supply, workers and firms. This graph, from <https://cepr.org/voxeu/columns/sliding-safely-down-beveridge-curve>, shows how the jib matching efficiency of the market evolved in the last decade.

A graph showing a graph of a graph

Description automatically generated with medium confidence

This could be the effect of many structural factors: skills mismatches, geographical mismatch (unemployment is concentrated in some zones), lower degree of job requalification etc. Trade has strongly fostered the development of certain areas (whose production facilities where characterized by competitive advantages, hence the growing exporting sectors), while harming some other areas (which experienced import competition): being labor not perfectly mobile, it could be reasonable the thesis of a geographical mismatch. Furthermore, the rising skill requirements of modern jobs (consider for example the challenge caused by the rise of ICT in the last 20 yrs) could hinder worker reallocation. It could be interesting to analyze, across countries, if higher degrees of import competition / development of ICT have led to outward shifts in the Beveridge curve. Moreover, some key aspects, that will be discussed in the next question, may have played a strong role in the post pandemic economy: the efficiency of the labor market is affected in itself also by factors that weaken an employer’s efforts to hire potential candidates or job searchers’ efforts to secure employment shift the curve outward.

**Question 7**

*Focus now on the last two periods, the Pandemic Recession (2020M2-2022M4) and the Post Pan- demic Recession (2022M5-2023M8). Comment on the dynamics of the labor market during and after the Pandemic recession.*

*A graph with colored dots and lines

Description automatically generated*

As it was previously reported during the pandemic the economy experienced very high levels of unemployment and low levels of job openings (deep blue dots). However, at the end of 2020 the economy started recovering steadly. As we discussed previously, the beveridge curve, during the pandemic, shifted outward (it was estimated a 25% loss in efficency). Some key reasons, beyond the ones we discussed previously may have shifted the curve during the pandemic. The Pandemic may have changed workers’ willingness and efforts to look for new jobs: pandemic relief, the necessity to take care of beloved ones health, fear of contagion, and the mental health effects of the pandemic may have played a role.

The ‘pandemic’ Beveridge curve experienced three kinks: the first one (September 2020) ended a period in which workers quickly returned to their jobs (movement along the curve), those who wanted to come back to work did it very quickly . In the second period (Oct 2020 - June 2021) unemployment started being be very insensitive to job openings: to decrease unemployment by a small % a huge increase in job openings was needed. This could be explained by the reluctance of many to come back to their jobs (maybe due to the factors discussed previously). With high demand for labor, but low supply, firms had to increase compensations to attract new workers.

Then, in the summer of 2021, workers started again to apply to available jobs, maybe thanks to the high wages, the pullback of enhanced state unemployment insurance benefits, vaccination, safer workplaces and school openings.

One key factor encompasses the slope of the curve: in the post pandemic the curve illustrates a very steep slope (relatively speaking, full prospect on the slope in the last question). A flat slope means that a strong decraese in job openings would mean strong incraese in unemployemnt. The pandemic slope was relatively flat, in fact, ‘relative to the May 2022 value of 3.6%, unemployment would be estimated to rise to 6.4% if the vacancy rate falls from its May level of 7.2% to its pre-pandemic peak of 4.6% ‘(<https://cepr.org/voxeu/columns/sliding-safely-down-beveridge-curve>). The post pandemic slope, as we said, is very steep, a large decrease in job openings would not create a large decraese in unemployement: ‘a decline in the vacancy rate to its pre-pandemic peak of 4.6% would be associated with the unemployment rate rising only to 4.4%’. This is 2 percentage points less than implied by the red curve shown in Figure 1. As we can see, the recent steep decrease in job openings is not being matched by an incraese in unemployemnt rates.

*What you are asked to do now is to modify the standard Beveridge curve to take into account dif- ferent measures of labor reallocation. You will plot two additional Beveridge curves: one taking into account employer-to-employer switches; and one adjusted by the number of employed job seekers, also corrected by the time input that employed job seekers put into job search. We will guide you in the construction of the two curves step by step.*

*An important flaw of the Beveridge curve is that employer-to-employer (EE) transitions are not taken into account when constructing the curve. As you have seen already in your first take-home assign- ment, the quits rate measure of market slackness was telling a slightly different story with respect to the unemployment-vacancy ratio and the unemployment rate. In the recovery after the Covid outbreak, unemployed individuals were competing not only with their unemployed peers for each vacancy but also with employed workers looking to change their jobs (Great Resignation). In the next question, you will plot a modified Beveridge curve that accounts for the realized EE transitions.*

**Question 8**

*First, click go the the following link (https://campuspress.yale.edu/moscarini/data/) and down- load the file under Dataset on the same webpage. It will automatically download a file named EE-FMP-August2023.xlsx. This file contains different monthly time series for EE transition rates, you just need to use the one named FMP (standing for Fujita, Moscarini, Postel-Vinay - the au- thors of a related paper). Consistently with the time series you have downloaded before, you should use only observations starting from 2001-M1. Construct a measure for unemployed and realized employer-to-employer job switches as a share of the population following the next steps:*

1. *calculatetheemploymentlevelaspopulation×(1−unemployment-populationratio);*
2. *calculate the realized EE transitions as the employment level time the transitioning probability (the FMP series you have just downloaded);*
3. *construct the measure of unemployed and realized employer-to-employer job switches as a share of the population by summing the level of unemployed individuals with the realized EE transitions, divided by the population level.*

*Finally, draw a scatter plot where you have this new measure on the x-axis, and the job openings- population on the y-axis (same as the initial Beveridge curve), for the same periods as before. Always plot the different periods in the same graph differentiating by colors.*

***Hint*** *The transition rates are calculated between time t and time t + 1 which are indicated as year0−month0 and year1−month1 in the Moscarini Excel file. You have to use year0−month0 to match the time series downloaded from FRED with the EE time series. In this way we are going to interpret the number in the EE series as the average probability of transitioning to a new employer in the next month for U.S. workers.*

A graph with colored lines and numbers

Description automatically generated

*Not all workers who are employed and searching for a new job end up in one, however. To account for all searching employed workers not just those who end up switching jobs, we assume that about 22% of employed workers in any given month are searching for new employment. This assumption is motivated by the empirical findings of Faberman et al. (2022), who used data from the New York Fed’s Survey of Consumer Expectations and documented that around 22% of employed workers search for a new job.*

*Moreover unemployed and employed individuals may not exert the same effort to find a job. So we fur- ther assume that those employed only spend half as much time on job searching as those unemployed, and divide the number of employed searchers to be used in the third figure by two. This assumption is also motivated by the empirical findings of Faberman et al. (2022), who show that the average number of job applications among employed job seekers is around half of that for the unemployed and that the former group spends around half as much time searching for a job as the latter.*

**Question 9**  
*Given these considerations, calculate a new measure for unemployed and employed job seekers adjusted for time input as a share of the population through the following steps:*

*1. Calculate the number of job seekers as the employment level × 0.22;*

*2. Calculate the effective employed job seekers by dividing the job seekers by 2 (adjustment for time input);*

*3. Construct a measure of unemployed and employed job seekers adjusted for time input as a share of the population by summing the level of unemployed individuals with the measure of effective employed job seekers, divided by the population level.*

*Draw a scatter plot where you have on the x-axis, and the job openings-population on the y-axis (same as the initial Beveridge curve), for the same periods as before.*

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final data frame

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**Question 10**

*Compare the three different Beveridge curves that you plotted in the questions before. Focus in particular on the slope that these curves display. Do their slope changes once we adjust for measures of labor market reallocation? Would a steeper Beveridge curve suggests a “soft landing” scenario or a “hard landing” scenario? Why?*

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This graph is fuzzy: subperiods belonging to the same version of the Beveridge curve have the same marker. The same subperiods, in the different curves, have the same color. Aggregating wrt metrics (to make graph more clear):

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*Slopes:*

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here I computed the slopes for each subperiod of each Beveridge curve. I am now plotting the rolling evolution of the slopes.

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As we can clearly see the different curves exhibited similar slopes in the last 20 years, except for the post pandemic period. While the first and the third curve present significant negative coefficients (hence very steep slopes) the second one actually flattened in the post pandemic period. This is consistent with last week’s analysis on quit rates: the post pandemic period was characterized by a general reallocation of human capital, known as the ‘great resignation’. Many companies opted to employer-to-employer switches; hence, if we add to the unemployment level the number of workers switching their jobs we have an higher aggregate value for the x variable, therefore a flatter curve.

With respect to the ‘soft lending scenario’: the steeper the curve the lower the effect of a decrease in job openings on unemployment. Accordingly, if the Beveridge curve is, in fact, steep, and will remain steep in the future, it seems to be possible to cool down the economy (tighter condition will lead firms to reduce job offerings ) without creating excessive levels of unemployment.