Labor Mobility and and the Level of Unemployment in a Currency Union

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Abstract

Unemployment rates are substantially higher and more volatile in the euro area relative to the United States. We ask to what extent the lack of cross-country labor mobility can account for unemployment dynamics in Europe. Our analytical model incorporates frictions in the labor market as well as an endogenous migration decision. Firms are unable to freely adjust wages during economic contractions, generating an asymmetric distribution of unemployment over the business cycle. The model is calibrated to the dynamics of unemployment and net migration in a typical euro area country. An increase in labor mobility to that observed in the United States and holding all other parameters fixed would reduce both the level and the volatility of euro area unemployment. The welfare cost to a typical euro area country of the currency union is 5 percent of permanent consumption; increasing labor mobility reduces this cost to just under 4 percent.

Keywords: labor mobility, unemployment, currency union

JEL Codes:

1 Introduction

Unemployment rates are persistently higher in Europe than they are in the United States. Figure 1 plots harmonized unemployment rates for the European union, the euro area and the United States for the period 1990 – 2022. With the exceptions of the sharp unemployment spikes in the United States during the Great Recession and the pandemic, European unemployment rates are uniformly higher than the U.S. rate. The average unemployment rates over the 1990:01 to 2023:01 period for the European union and the euro area are 9.4 and 8.7 respectively. Average unemployment for the United States over the 1990:01 to 2020:01 period is 5.8 percent.[1] There are many possible reasons for the generally high unemployment rates in Europe (termed "Eurosclerosis" by Giersch, 1985). Most often, the cause is attributed to European labor market rigidities caused by regulation and unionization. Such rigidities could hinder the ability of workers to relocate in response to changes in economic conditions.

In previous work, House, Proebsting and Tesar (2023), and Foschi et al. (2023) document the relatively higher rates of labor mobility in the United States compared to the euro area. In both currency areas, labor flows are correlated with local business cycles, with workers moving from regions with temporarily higher unemployment to regions with temporarily lower unemployment. However, the responsiveness of migration flows to local economic conditions is three times stronger in the United States than in the euro area. House, Proebsting and Tesar (2023) show that a higher level of labor mobility in the euro area would help stabilize unemployment and therefore serve as a substitute for independent monetary policy.

We return to the issue of migration in this paper, but shift the focus towards its effect on the *level* of unemployment observed in Europe rather than the effect on the cyclical variability of unemployment. While labor mobility can reduce the variance of unemployment differentials across regions, it is not clear that greater labor mobility would reduce the average unemployment rate. There are settings in which this happens – in particular, models that feature asymmetric business cycles with frequent shortfalls in production and employment but relatively infrequent instances of overproduction, have the property that business cycle stabilization implies an increase in average employment.

To quantify the extent to which low labor mobility in Europe results in higher average

[1] We exclude the COVID-19 period for the United States because the unprecedented, short-lived spike in the U.S. unemployment rate during the pandemic is due to lockdowns. The stable unemployment rate in the euro area during the pandemic was by design – governments implemented job retention policies that kept workers connected to firms. For a discussion, see Klitgaard (2022).

unemployment, we utilize a "plucking" model of the business cycle. The plucking model was initially suggested by Friedman (1964) and more recently advocated by Dupraz, Nakamura and Steinsson (2023). Importantly, plucking models feature asymmetric cyclical variations in unemployment. In the standard business cycle framework, macroeconomic variables are assumed to fluctuate around a given trend. Friedman (1964) suggested an alternative perspective in which cycles are caused by random negative shocks that pull the economy below full employment but never cause overemployment. One might imagine a helium balloon bouncing along a ceiling. Every now and then, a negative shock pulls down on the balloon's string (i.e., a recession) after which the balloon gradually floats back to the ceiling (full employment). In this setting, anything that reduces the variance of the balloon's distance from the ceiling (e.g. labor mobility) will cause its average distance to the ceiling diminish (in the limit with zero variance, the balloon simply comes to rest at the ceiling with a distance of zero).

Our analytical framework incorporates frictions in the labor market as well as an endogenous migration decision in a small open economy. We follow Schmitt-Grohé and Uribe (2016) (SGU) in modelling labor market frictions as an inability of firms to freely reduce nominal wages during economic contractions[2]. In our setup, workers consider the risk of unemployment and the anticipated wage rate in alternative locations and, subject to relocation costs, can move in response to local shocks (Caliendo, Dvorkin and Parro, 2019). The model is calibrated to match broad business cycle properties and the degree of labor mobility for a typical country in the euro area.

The model is successful in reproducing the dynamics of unemployment over the business cycle in some dimensions and less successful in other dimensions. The model generates a relationship between the mean level of unemployment and the variance of unemployment. The model also matches the correlation between net migration in a typical euro area country with the unemployment rate. The model generates some asymmetry in unemployment rates over the cycle, but does not generate the significant gap between the duration of expansions and contractions highlighted by Dupraz, Nakamura and Steinsson (2023).

We use the model to examine the effect of increasing labor mobility in Europe. In the counterfactual, the extent of labor mobility is expanded to match that of the United States. Increasing labor mobility reduces both the volatility and the level of unemployment. The

[2] For recent empirical evidence on the prevalence of downward nominal wage rigidity, see e.g., Babecky et al. (n.d.), Caju, Fuss and Wintr (2007), Elsby and Solon (2019), Grigsby, Hurst and Yildirmaz (2021), Jo (2021), Schaefer and Singleton (2022).

volatility of aggregate output increases while the duration of expansions and contractions both decrease. In effect, the additional margin of adjustment that comes with the option to migrate eases the constraint on wage adjustment, weakening the features of the model that generate significant asymmetries. For realistic calibrations, average unemployment rates for euro area economies falls by at most one half of one percent with greater labor mobility.

In the final section of the paper, we solve for the welfare costs of being in the currency union, under the conditions of downward wage rigidity and limited labor mobility. The cost of being in the currency union in the baseline case is approximate 5 percent of permanent consumption. Increased labor mobility reduces the cost to just under 4 percent of permanence consumption.

The idea that downward nominal wage rigidity in combination with suboptimal monetary policy (such as a fixed exchange rate) can generate higher average levels of unemployment has gained traction among macroeconomists and trade economists (Schmitt-Grohé and Uribe, 2016; Dupraz, Nakamura and Steinsson, 2023; Rodríguez-Clare, Ulate and Vasquez, 2022). Rodríguez-Clare, Ulate and Vasquez (2022) show that DNWR can rationalize the increase in unemployment in U.S. states that were particularly exposed to stronger import competition from China. Similar to House, Proebsting and Tesar (2023), their discussion of labor mobility is limited to its effect on the dispersion in unemployment. In contrast, we focus on its effects on the average level of unemployment and ask how labor mobility can mitigate the costs of suboptimal monetary policy. This complements the discussion in Schmitt-Grohé and Uribe (2016) who show that capital controls also reduce the average level of unemployment by preventing overborrowing and strong nominal wage increases during booms.

2 Empirical Patterns

In this section, we present evidence on unemployment dynamics across the euro area and the United States. Unemployment dynamics in both regions are characterized by asymmetries consistent with the plucking narrative. On average, countries in the euro area have both more volatile and higher unemployment rates compared to U.S. states. In both regions, countries or states with more volatile unemployment rates also have higher mean unemployment rates, and this mean-variance relationship is similar across the two regions.

2.1 Data Sources

European unemployment data for individual countries are taken from the short-term labor force statistics reported by the International Labor Organization. The data are collected through the European labor force survey and are based on standard international definitions of unemployment. Unemployment rates are monthly, seasonally adjusted and cover the years 1990 to 2023, with some countries having shorter samples.

Data for aggregate and state-level unemployment in the United States are taken from the local area unemployment statistics reported by the Bureau of Labor Statistics. All data are monthly and seasonally adjusted. The series start in 1976 and we end the series at the onset of COVID in February 2020.

Data on migration in the euro area are drawn from Eurostat and are cross-checked against national sources. U.S. migration flows at the state level are based on publicly available data from the Internal Revenue Service (IRS). For detailed information on the definition and calculation of migration rates, see the discussion in House, Proebsting and Tesar (2023), and Foschi et al. (2023).

2.2 Unemployment Asymmetries

Figure 2 shows the time series of unemployment rates for individual European countries. Dark lines mark the peak of the business cycle expansion (the local minimum of the unemployment rate) and dotted lines show the onset of the recession (the local maximum of unemployment). To fix the dates of expansions and recessions we follow the algorithm developed by Dupraz, Nakamura and Steinsson (2023). The basic idea is to find local minima and maxima of the unemployment rates based on substantial swings in the unemployment rate (see the Appendix for details). As a reference point, we also repeat the exercise for each U.S. state. The U.S. figures are provided in the appendix.

The time series on unemployment rates in Figure 2 indicate that fluctuations in unemployment are not tightly sychronized across the euro area. The average of bilateral correlations between euro area countries is 0.49, in contrast with the cross-state correlation of 0.69. The figures are also suggestive of the asymmetry in unemployment dynamics, with smaller gaps between the end of an expansion and the next recession (i.e. the sudden increase in unemployment in the recession) compared with the longer duration of the subsequent expansion.

These features of the data are more evident in Table 1. The first two columns provide

U.S. data as a point of reference, with the first column providing statistics for the United States as a whole, and the second column showing the moments found by averaging the 50 U.S. states. Similarly, column 3 provides data for the euro area aggregate, and the fourth column the average of the moments of the euro area member countries. Focusing on the state and country averages (columns 2 and 4), which are the relevant statistics of comparison with our model, we see that both the mean and the standard deviation of unemployment are about fifty percent higher in the euro area relative to the United States.

In both regions, unemployment rates are positively skewed, meaning that most of the time, the unemployment rate is below its mean. This characteristic is somewhat more pronounced for the United States (0.69 vs. 0.25). Expansions are longer than contractions. On average, expansions in both regions take about 6.5 years, whereas contractions are only half as long. Consequently, the unemployment rate takes longer to fall during expansions than it takes time to rise during contractions. In both regions, unemployment rates rise twice as quickly during contractions as they fall during expansions. On the other hand, changes in the unemployment rate in the euro area are substantially faster, as already suggested by the higher standard deviation. For instance, during contractions unemployment rates rise by 1.4 percentage points per year in the average U.S. state, whereas they rise by 2.7 percentage points in the average euro area country.

The final asymmetry reported in Table 1 tests more directly the plucking property of the unemployment rate. Following the image of a helium balloon being randomly pulled down and then gradually drifting back, the size of a contraction should be predictive about the size of the following expansion. The stronger the balloon is pulled down, the stronger the subsequent drift up. To test this, we follow Dupraz, Nakamura and Steinsson (2023) and regress the amplitude (in percentage points) of an expansion on its preceeding contraction. For both regions, the size of a contraction is a strong predictor for the size of the subsequent expansion with R^2's above 0.5. In the United States, the relationship is close to one-for-one: for every percentage point increase in the amplitude of a contraction, the amplitude of the subsequent expansion increases by 0.82 percentage points. In the euro area, this coefficient is somewhat smaller (0.62). More importantly, running an analogous regression of the size of a contraction on its preceding expansion has no predictive power: its R^2 is 0.05 in both regions. Hence, the size of an expansion is not predictive of the size of the following contraction.

Together, these statistics indicate a strong asymmetry in unemployment rate dynamics that motivates our model with downward nominal wage rigidity. We later evaluate our model against these moments.

2.3 Relation between the volatility of unemployment and its mean

An important correlate of the plucking view is that there should be a positive relationship between the volatility of unemployment and its average level. The stronger and more often the helium balloon gets pulled down, the more time it spends far below the ceiling. That is, countries with more volatile unemployment rates should have, on average, higher levels of unemployment rates. This prediction is borne out by the data: Figure 3 illustrates the relationship between mean unemployment and the variation in unemployment for U.S. states (in red) and euro area countries (in blue). The slopes are in the 1.6 to 1.8 range and are statistically significantly different from zero. While the slopes are similar in the two regions, the red dots of the U.S. states are bunched in the bottom left corner characterized by stable and low unemployment rates, whereas the blue dots euro area countries are equally spread across the regression line.

One interpretation of this figure is that stabilizing unemployment rates in the euro area could bring down their average level as well. In terms of the figure, the idea would be to move down along the regression line towards the bottom left corner. There are obviously many possible reasons why unemployment rates are more stable across U.S. states, ranging from smaller business cycle shocks to various risk-sharing mechanisms such as fiscal transfers and income diversification. In this paper, we study to what extent the lack of labor mobility in the euro area could help explain the higher volatility of unemployment rates and, consequently, their higher level.

3 Model

The world economy consists of two countries that form a currency union. The focus is on a limiting case where the size of the foreign economy goes towards infinity and the home economy becomes a small open economy. Consequently, the exposition concentrates on the home economy, but equivalent equations hold for the foreign economy as well. Variables pertaining to the foreign economy are denoted by an asterisk.

3.1 Households

The small open economy is populated by capital owners and workers. Capital owners are immobile. Their number is given by $\mathbb{N}^k$. Workers are mobile and can move between the small open economy and the rest of the world if they find it optimal to do so. The number of workers in the small open economy at time t is given by $\mathbb{N}_t^w$ and the total population is

$$\mathbb{N}_t = \mathbb{N}^k + \mathbb{N}_t^w.$$

Variables are indicated in per capita terms. For instance, c_t^w is consumption of a single worker while total consumption for workers is $\mathbb{N}_t^w c_t^w$.

3.1.1 Capital owners

Capital owners receive utility from consumption. At any point in time t, they maximize the expected discounted sum of utility

$$\mathbb{E}_t \sum_{j=0}^{\infty} \beta^j \frac{\left(c_{t+j}^k\right)^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}},$$

subject to the nominal budget constraint

$$P_t c_t^k + \frac{B_t}{E_t(1+i)} = R_t K + \frac{B_{t-1}}{E_t}.$$

Here, σ is the intertemporal elasticity of substitution and β is the discount factor. Nominal expenditure on consumption is $P_t c_t^k$, where P_t is the nominal price of the final good. Capital owners own the fixed capital stock K and rent it out to firms in return for rental payments $R_t K$. The face value of nominal bonds is denoted by B_t. Bonds pay a constant nominal interest rate i and mature in one period. The nominal exchange rate E_t is the price of the home currency in euros, such that an increase in E_t implies an appreciation of the home currency. In our baseline specification, we assume that the country is part of the euro currency area and thus $E_t = 1$. The optimal demand for bonds satisfies a standard Euler equation

$$\left(c_t^k\right)^{-\frac{1}{\sigma}} = \beta(1+i)\mathbb{E}_t \left(\frac{E_t P_t}{E_{t+1} P_{t+1}} \left(c_{t+1}^k\right)^{-\frac{1}{\sigma}} \right).$$

3.1.2 Workers

Workers are mobile and earn only labor income. Each worker has an inelastic supply of labor given by L^S. Following the specification in SGU, because of downward nominal wage rigidity, households may not be able to sell all of the hours they supply. While there is no constraint on the amount of wage increases, wages can only fall by a fraction of their previous value. Specifically, we require

$$W_t \geq \eta W_{t-1},$$

where W_t is the nominal wage and $\eta \in [0,1]$ is a parameter that governs the degree of downward nominal wage rigidity. If $\eta = 0$ then wages are fully flexible. If $\eta = 1$ then nominal wages can never fall. The presence of wage rigidity implies that the labor market will in general not clear and some workers will be unemployed. As in Hansen (1985) and Rogerson (1988), workers agree to a risk-sharing contract that guarantees each worker has the same income at date t though in equilibrium not all workers are employed. The equilibrium level of employment is

$$L_t \leq L^S,$$

and the unemployment rate is given by $ur_t = 1 - \frac{L_t}{L_t^S}$. As in SGU, the labor market either clears (in which case $L_t = L^S$) or the wage constraint binds (in which case $W_t = \eta W_{t-1}$). This can be captured by the slackness condition

$$\left(L^S - L_t\right)\left(W_t - \eta W_{t-1}\right) = 0.$$

When residing in the small open economy, workers earn nominal labor income $W_t L_t$. Workers are assumed to be hand-to-mouth, so their consumption satisfies

$$P_t c_t^w = W_t L_t.$$

When living abroad, workers' consumption is fixed and given by $c^{w,*}$.

At the beginning of each period, workers choose to migrate or remain in their current country. Migration takes place within a period and migrants immediately work and consume in their new location. Here, we focus on the location decision faced by workers currently living in the home country, but equivalent conditions hold for workers living in the foreign country.

A worker moving from Home to Foreign incurs a migration cost τ. Each period, workers receive idiosyncratic (i.e. worker-specific) shocks for each of the two countries, denoted by ϵ_t and ϵ_t^*. Define $v_t\left(\epsilon_t, \epsilon_t^*\right)$ as the value of a worker currently living in Home conditional on the aggregate state and the worker's vector of idiosyncratic shocks. The value of living in Home at time t is

$$v_t(\epsilon_t, \epsilon_t^*) = \max\left\{U\left(c_t^w\right) + \frac{1}{\gamma}\epsilon_t + \beta\mathbb{E}_t\left(V_{t+1}\right), U\left(c^{w,*}\right) + \frac{1}{\gamma}\epsilon_t^* - \tau + \beta\mathbb{E}_t\left(V^*\right)\right\}$$

The flow utility function $U\left(c\right)$ is $\frac{c^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}$. The value V_t is the expected value of $v_t\left(\epsilon_t, \epsilon_t^*\right)$ prior to the realization of the idiosyncratic shocks and thus, V_t is the average expected utility of any worker in Home at the start of time t. The parameter γ governs how strongly idiosyncratic location shocks affect migration decisions.

We follow Artuç, Chaudhuri and McLaren (2010) and assume that the idiosyncratic shocks are i.i.d. over time and across individuals and are distributed according to a Type-I extreme value distribution with zero mean. Given these assumptions, the expected value V_t – the average utility of a worker in Home at time t – is

$$V_t = \frac{1}{\gamma}\ln\left(\exp\left\{\gamma\left(U\left(c_t^w\right) + \beta\mathbb{E}_t\left(V_{t+1}\right)\right)\right\} + \exp\left\{\gamma\left(U\left(c^{w,*}\right) - \tau + \beta\mathbb{E}_t\left(V^*\right)\right)\right\}\right). \tag{3.1}$$

Migration decisions depend on this average utility. The share of workers that relocate from Home to Foreign, denoted by n_t, is

$$n_t = \frac{\exp\left\{\gamma\left(U\left(c^{w,*}\right) - \tau + \beta\mathbb{E}_t\left(V^*\right)\right)\right\}}{\exp\left\{\gamma\left(U\left(c_t^w\right) + \beta\mathbb{E}_t\left(V_{t+1}\right)\right)\right\} + \exp\left\{\gamma\left(U\left(c^{w,*}\right) - \tau + \beta\mathbb{E}_t\left(V^*\right)\right)\right\}}. \tag{3.2}$$

Naturally, a decrease in utility in Home, $U(c_t^w)$, leads to outmigration. The larger the value of γ, the stronger the migration response. The share of workers that stay in Home is $1 - n_t$.

In the limiting case of a small open economy with $\mathbb{N}^w \to 0$, the utility terms in Foreign, $U(c^{w,*})$ and V^*, do not respond to business cycle fluctuations in the small open economy.

Combining expressions (3.1) and (3.2), the number of emigrants is[3]

$$n_t \mathbb{N}^w_{t-1} = \exp\left\{-\gamma \Delta V_t\right\} n \mathbb{N}^w_{t-1}.$$

where $\Delta V_t = V_t - V$. In the Appendix, we derive a corresponding expression describing the number of migrants from Foreign to Home,

$$n^*_t \mathbb{N}^{w,*}_{t-1} = \exp\left\{\gamma\left(\Delta U_t + \beta \mathbb{E}_t \Delta V_{t+1}\right)\right\} n^* \mathbb{N}^{w,*},$$

where $\Delta U_t = U(c^w_t) - U(c^w) = \frac{(c^w_t)^{1-\frac{1}{\sigma}} - (c^w)^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}$. Then, the number of workers living in Home at time t consists of the number of workers last period, plus net immigration:

$$\mathbb{N}^w_t = \mathbb{N}^w_{t-1} + \exp\left\{\gamma\left(\Delta U_t + \beta \mathbb{E}_t \Delta V_{t+1}\right)\right\} n^* \mathbb{N}^{w,*} - \exp\left\{-\gamma \Delta V_t\right\} n \mathbb{N}^w_{t-1}. \tag{3.3}$$

It is convenient to rewrite (3.1) in terms of changes from the steady state:[4]

$$\exp\left(\gamma \Delta V_t\right) = (1-n) \exp\left\{\gamma(\Delta U_t + \beta \mathbb{E}_t \Delta V_{t+1})\right\} + n. \tag{3.4}$$

Equations (3.4)and (3.3) fully characterize the dynamics of the workers' population.

[3]First, combine (3.1) and (3.2) to get

$$n_t = \frac{\exp\left\{\gamma\left(U\left(c^{w,*}\right) - \tau + \beta \mathbb{E}_t\left(V^*_{t+1}\right)\right)\right\}}{\exp\left\{\gamma V_t\right\}}.$$

In steady state, this implies

$$\tau = U(c^w) + \beta V^* - V - \frac{1}{\gamma} \ln n$$

Inserting that expression into the expression for n_t yields

$$n_t \mathbb{N}^w_t = \exp\left\{-\gamma \Delta V_t\right\} n \mathbb{N}^w_t.$$

[4]Rewriting yields

$$\exp\left(\gamma V_t\right) = \exp\left\{\gamma\left(U\left(c^w_t\right) + \beta \mathbb{E}_t\left(V_{t+1}\right)\right)\right\} + \exp\left\{\gamma\left(U\left(c^{w,*}\right) - \tau + \beta \mathbb{E}_t\left(V^*\right)\right)\right\}.$$

Using the expression for τ this can be rewritten as

$$\exp\left(\gamma V_t\right) = \exp\left\{\gamma\left(U\left(c^w_t\right) + \beta \mathbb{E}_t\left(V_{t+1}\right)\right)\right\} + \exp\left\{\gamma V\right\} n.$$

Further, note that

$$(1-n)\exp(\gamma V) = \exp\left\{\gamma\left(U + \beta V\right)\right\}.$$

3.2 Firms

Production takes place in a two-stage process. A first set of competitive firms produce intermediate goods that are sold at price P_t^Q either domestically to final-good firms or to firms abroad. They choose capital and labor inputs to maximize profits

$$\max\left\{P_t^Q \mathbb{N}_t Q_t - W_t \mathbb{N}_t^w L_t - R_t \mathbb{N}^k K\right\}$$

subject to the production function

$$\mathbb{N}_t Q_t = Z_t \left(\mathbb{N}^k K\right)^{\alpha} \left(\mathbb{N}_t^w L_t\right)^{1-\alpha}.$$

The optimal choice of labor and capital imply standard expressions for the demand curves for labor and capital. Namely,

$$W_t \mathbb{N}_t^w L_t = (1-\alpha) P_t^Q \mathbb{N}_t Q_t$$

and

$$R_t \mathbb{N}^k K = \alpha P_t^Q \mathbb{N}_t Q_t.$$

A second set of producers combine domestically produced intermediates, D_t, and foreign produced (imported) intermediates, M_t, to produce a final consumption good C_t. We assume that the nominal price of imported intermediate goods is constant and normalized to 1. Final goods producers choose intermediate inputs, D_t and M_t, to maximize profits:

$$\max\left\{P_t C_t - P_t^Q D_t - \frac{1}{E_t} M_t\right\}$$

subject to the CES production function

$$C_t = \left(\omega^{\frac{1}{\psi}} D_t^{\frac{\psi-1}{\psi}} + (1-\omega)^{\frac{1}{\psi}} M_t^{\frac{\psi-1}{\psi}}\right)^{\frac{\psi}{\psi-1}}.$$

The parameter ψ describes the elasticity of substitution between domestic goods and imports, and the parameter ω describes the home bias. The optimal demand for domestic intermediate goods and imported intermediate goods is given by

$$D_t = \omega C_t \left(\frac{P_t}{P_t^Q}\right)^{\psi}$$

and

$$M_t = (1-\omega)C_t \left(E_t P_t\right)^{\psi}. \tag{3.5}$$

In a similar fashion, the Foreign country demands some of the Home country's intermediate goods. We assume the foreign demand curve takes the same form as (3.5). Adjusting for fluctuations in the home country's population, this demand schedule is

$$\mathbb{N}_t X_t = \mathbb{N} X \left(\frac{P_t^Q}{E_t}\right)^{-\psi}$$

where X (without the time subscript) denotes the per capita amount of exported intermediate goods in the non-stochastic steady state equilibrium.

3.3 Market clearing

Market clearing requires that the total production of tradable intermediates equal total demand,

$$Q_t = X_t + D_t.$$

Total production of the final consumption good must be purchased by the capital owners and the current workers so,

$$\mathbb{N}_t C_t = \mathbb{N}^k c_t^k + \mathbb{N}_t^w c_t^w.$$

Finally, we define GDP as the sum of total labor and captial income. This implies that nominal GDP is simply $P_t^Q Q_t$ and thus we have the following expression for real GDP:

$$GDP_t = P^Q Q_t.$$

3.4 Calibration and Model Solution

Calibration The model is expressed at a monthly frequency and is calibrated to match an average euro area country. Table 2 lists the parameter values for the benchmark case.

We set the discount factor to match an annual real interest rate of 2 percent. The intertemporal elasticity of substitution is set to $\sigma = \frac{2}{3}$. The curvature parameter on the production function is $\alpha = \frac{1}{3}$.

The trade block is governed by two parameters: the home bias parameter ω and the

Armington elasticity ψ. We set the first to $\omega = 0.7$ to match an import share of 30 percent in the non-stochastic steady state and set the Armington elasticity to $\psi = 10$.

Similarly, the migration block is described by two parameters: the migration cost parameter τ and the volatility of the idiosyncratic shocks γ. The migration cost parameter τ pins down the share of migrants in the non-stochastic steady state, $\frac{n\mathbb{N}^w}{\mathbb{N}}$, and we choose it so that about 0.75 percent of the population migrates per year, as reported by House, Proebsting and Tesar (2023).[5] The parameter γ governs the sensitivity of migration rates to utility differentials. Higher values of γ make migration more responsive to fluctuations in workers' expected labor income. House, Proebsting and Tesar (2023) report that for the sample of euro area countries, an increase in a country's unemployment rate by one percentage point is associated with a net outflow of 0.08 people. We set γ to match this coefficient in our simulated data. House, Proebsting and Tesar (2023) find that the responsiveness of migration to unemployment differentials is about three times larger in the United States relative to the euro area. Our counterfactuals will consider the impact of increasing labor mobility in Europe to match that of the United States.

We set η to 0.999 for our baseline specification, implying that nominal wages can fall by about 1.2% per year. This is a slightly higher value for η than what is used in Schmitt-Grohé and Uribe (2016) and Born and Pfeifer (2020), who let nominal wages fall by a maximum of 2% a year. Because there is substantial uncertainty around this parameter, and because it plays a central role in the model, we report results for alternative values below.

Model solution Because the model embodies non-linear, asymmetric equilibrium dynamics, we numerically solve the model using a global solution method. Specifically, we adapt the FiPIt algorithm for solving models with occasionally binding constraints in Mendoza and Villalvazo (2020) to our setting. We obtain a solution for a finite number of grid points in the model state space. For us, the state space includes 5 productivity levels, 30 wage levels, 15 population levels and 20 debt levels. Once we have computed equilibrium reactions on this grid mesh, we compute reactions for intermediate points by linear interpolation. Details of our solution method are included in the appendix.

We use the method given by Tauchen (1986) to construct a Markov transition matrix corresponding to an AR(1) process with an autoregressive root of 0.98 and a 5-point produc-

[5] We set the share of workers to match the labor share, $\frac{\mathbb{N}^w}{\mathbb{N}} = 1 - \alpha$, which implies that per-capita consumption is the same across workers and capital owners. Then, we adjust n to match the annual migration rate.

tivity grid given by the points $\{0.929, 0.966, 1.000, 1.033, 1.071\}$. The standard deviation of the shock is 0.05. The model is simulated for 1,300 periods and the first 500 observations are dropped to minimize the effect of initial conditions. We repeat the simulation 18 times and take the average of the moments across the 18 series.

4 Results

4.1 Effects of labor mobility on macroeconomic aggregates

Table 3 shows key moments of the euro area data (column 1), the simulation results for the baseline case (column 2) and the case with increased labor mobility (column 3). The average unemployment rate in the baseline model is 4.88 percent. This is much lower than the 9.23 percent unemployment observed in the euro area reported in Table 1 but this is to be expected. The model does not include frictional unemployment caused by inevitable search frictions in finding employment and filling vacancies present in real-world data even when an economy is close to full employment. The simulated unemployment from the model should thus be interpreted as purely cyclical unemployment. The time series standard deviation of unemployment in the baseline simulation is roughly 5 percentage points, higher than the 3 percentage points observed in data. Since the model would predict zero unemployment in the absence of any productivity shocks, the model generates a roughly one-to-one relationship between the standard deviation and the mean of unemployment. This is somewhat lower than in the data where a one percentage point higher standard deviation is associated with a more than 1.5 higher percentage point average unemployment rate (see the slope coefficient β_1 in Figure 3).

The model generates some skewness due to the downward rigidity of wages: Expansions are longer than contractions, although this feature is more pronounced in the data than in the baseline model. The baseline model reproduces the finding that contractions predict the magnitude of subsequent expansions with a coefficient of 0.78. Expansions only weakly explain subsequent recessions with a coefficient of 0.20. Both values line up well with the data.

A central focus of our paper is the impact of labor mobility on the average unemployment rate. The baseline specification features $\gamma = 0.2$ which implies a fairly low amount of labor mobility. Notice that the model-implied slope coefficient for a regression of net migration on unemployment is -0.09. The corresponding regression coefficient for the euro area is -0.08.

Labor mobility increases as we increase γ. For the model variation reported in column (3), we raise γ to produce a slope coefficient of -0.17 which is closer to the responsiveness of labor mobility observed across U.S. states (see Foschi et al., 2023, for more discussion of this estimate). We see that increased labor mobility dampens the variation in unemployment and increases the sensitivity of net migration to the unemployment rate. Both the average rate of unemployment and the standard deviation of unemployment fall by about half a percentage point, which is a modest, but economically significant decrease.

Intuitively, the extra margin of adjustment through relocation helps to relax the constraint on downward wage adjustment and reduces the amount of unemployment needed to clear the labor market during economic contractions. Note that the additional movement of workers in and out of the country in response to productivity shocks increases the volatility of GDP but decreases the volatility of per capita GDP. To understand this result, consider a positive productivity shock. This attracts an inflow of workers, pushing up aggregate GDP. Due to diminishing returns, the percent increase in total GDP caused by in-migration is less than the percent increase in labor. As a result, per capita GDP rises by less than the increase in aggregate GDP.

Figure 5 shows impulse response functions for the baseline case (solid lines) for both positive and negative TFP shocks.[6] The plots show reactions to increases and decreases in productivity of 7 percent. As expected, the figures clearly display a pronounced asymmetric reaction to positive and negative shocks. The leftmost panel shows the reaction of the wage. Because of the downward rigidity in wages, wages rise sharply following a positive productivity shock but decline only slightly after a negative shock. On impact, wages increase by 3 percent after an increase in productivity. In contrast, wages fall by only half a percent (this is dictated by the constraint on wage adjustment implied by the η parameter). The middle panel shows the reaction of unemployment. While there is a large, sudden increase in unemployment following a negative shock (unemployment rises by more than 6 percent), the decrease in unemployment is much smaller. Finally, the rightmost panel shows the change in the total working population. The dotted lines in the figure show corresponding reactions in a high-labor-mobility environment. Unlike the wage and the unemployment rate, the population takes time to adjust and economically significant changes only become apparent after

[6] Impulse response functions are calculated by averaging the responses to positive (negative) innovations in productivity from the simulated time series. Note, while the non-stochastic steady state features zero unemployment, the average unemployment rate in the stochastic equilibrium is positive. This means that the impulse responses do not all start from the same initial value.

roughly 2 periods. As one would expect, when labor is more mobile, the change in wages and unemployment are more muted while the cumulative change in the working population is more pronounced.

Table 4 shows how our results depend on different parameter values. First, we consider an increase in η from 0.999 to 0.9995. This increases the role of downward wage rigidity by further limiting the rate at which the wage can fall from one month to the next. In our baseline specification, wages could fall by at most 1.2 percent per year; with $\eta = 0.9995$, wages can fall by at most 0.6 percent anually. This has three implications: First, the increased downward wage rigidity makes cyclical fluctuations even more asymmetric. This increases volatility of GDP and unemployment, but particularly the average unemployment rate. Second, holding γ fixed, the tighter wage constraint generates more mobility. In the face of bad shocks and very little wage adjustment, the option value of relocating increases, generating higher average labor mobility and a higher sensitivity of net migration to the unemployment rate. Because labor mobility increases (again, holding γ constant), the duration of expansions and contractions slightly decreases relative to the baseline case. Third, the increased downward wage rigidity increases the average level of unemployment.

The third column shows the effects of reducing the magnitude of the shocks. For this illustration, we reduce the shock volatility by reducing the spread of the points in the productivity grid while keeping the transition matrix between the shocks fixed. With the lower shock volatility, average unemployment falls. Again, this outcome relies heavily on the asymmetric nature of the frictions in the model. In a symmetric model (e.g., a Calvo setting) the shock variance would not affect the mean level of unemployment. Surprisingly, the migration elasticity (the coefficient from a regression of migration on unemployment) actually increases in absolute value. This suggests that migration flows are somewhat more responsive to unemployment compared to our baseline case.

The last column shows how changes in the trade elasticity affects the model outcomes. Variations in the trade elasticity have a surprisingly strong effect on the equilibrium. Going to a lower elasticity of 5 compared to our baseline elasticity of 10 reduces both the mean and standard deviation of unemployment.

One of the key motivations in using a plucking model is the relationship between the level of unemployment and the variability of unemployment that we saw in the data, and that cannot be generated by a standard business cycle model. Figure 3 showed the relationship between the mean and standard deviation in unemployment in US states and euro area countries. The slope based on data is in the range of 1.6 to 1.8, with the U.S. observations shifted toward the origin and the euro area observations tending to fall further from the origin. Panel (a) of Figure 4 provides a corresponding figure based on our simulated data from the baseline specification. The slope of the fitted line based the simulated data is a bit flatter, closer to 1, again biased downward because mean unemployment in the model misses frictional unemployment in the steady state due to job mismatch. Higher labor mobility shifts the points toward the origin.

Panel (b) of Figure4 illustrates the impact of labor mobility in an alternative space. Here, we plot mean unemployment against the standard deviation of productivity shocks. Now, increased labor mobility implies a downward tilt in the fitted line. In words, labor mobility helps to moderate the business cycle, which in turn reduces mean unemployment. The impact on unemployment is larger the greater is the volatility of TFP.

4.2 Welfare effects

The combination of downward nominal wage rigidity and a fixed exchange rate result in a higher mean unemployment rate. If the economy could implement an optimal exchange rate policy, the economy would be at full employment rate at all times. Hence, being part of a currency union entails welfare costs that are reflected in lower average consumption levels due to inefficiencies in the labor market. The last section showed, however, that labor mobility helps to moderate both fluctuations in unemployment and can reduce mean unemployment, thereby reducing the welfare costs of a fixed exchange rate.

In this section, we quantify by how much labor mobility reduces the welfare costs of a fixed exchange rate. We define the welfare cost of the peg, λ_t conditional on state $s_t \equiv \left\{Z_t, W_{t-1}, \mathbb{N}^w_{t-1}\right\}$, , as the percentage increase in the lifetime consumption stream experienced by a household living in the baseline economy with a currency peg at time t to be as well off as a household living in an economy with the optimal exchange rate. We calculate $\lambda(s_t)$ separately for both capital owners and workers. For capital owners, $\lambda^k(s_t)$ is calculated as

$$\mathbb{E}_t \left\{ \sum_{j=0}^{\infty} \beta^j U\left(c^k_{t+j}(1+\lambda^k(s_t))\right) \middle| s_t \right\} = \mathbb{E}_t \left\{ \sum_{j=0}^{\infty} \beta^j U\left(c^{k,opt}_{t+j}\right) \middle| s_t \right\},$$

where $c^{k,opt}$ is consumption in an economy where the central bank follows an exchange rate policy that ensures full employment, $L_t = L^S$. The measure $\lambda^k(s_t)$ depends on the state of the economy and is therefore stochastic. Following SGU, we report the mean of $\lambda^k(s_t)$ over the distribution of s_t in the baseline economy, that is, we report $\lambda^k = \sum_{s_t} \pi(s_t)\lambda^k(s_t)$, where $\pi(s_t)$ is the unconditional probability of s_t in the benchmark economy.

To calculate an equivalent expression for the workers, we need to take into account that workers are mobile and have the option of moving across countries. From (3.1) and (3.2), we have that workers' lifetime utility as of period t equals:

$$V_t = U(c_t^w) - \frac{1}{\gamma}\ln(1-n_t) + \beta\mathbb{E}_t V_{t+1}.$$

Then, the welfare cost $\lambda^w(s_t)$ for a worker that lives in the SOE at state s_t is calculated as

$$\mathbb{E}_t\left\{\sum_{j=0}^{\infty}\beta^j\left[U\left(c_{t+j}^w(1+\lambda^w(s_t))\right) - \frac{1}{\gamma}\ln(1-n_t)\right]\middle| s_t\right\} = \mathbb{E}_t\left\{\sum_{j=0}^{\infty}\beta^j\left[U\left(c_{t+j}^{w,opt}\right) - \frac{1}{\gamma}\ln(1-n_t^{opt})\right]\middle| s_t\right\}.$$

As before, we then calculate λ^w as the average across $\lambda^w(s^t)$. Notice that in these calculations, we keep the migration rates, $1-n_t$, fixed at their baseline values and do not recalculate them based on the adjusted consumption values $c_t^w(1+\lambda_t^w)$.

In Table 5, we report the welfare measures λ^k and λ^w for both the baseline economy and the economy with higher labor mobility. The bottom of the table reports welfare gains for the economy as a whole, using the population weights of 0.33 and 0.67 for capital owners and workers, respectively. The cost of the currency peg (the inability to pursue a full employment policy by adjusting prices) is substantial; in the baseline economy the welfare cost is 5 percent of permanent consumption. Higher labor mobility helps reduce the cost to roughly 4 percent of permanent consumption.

[In a final experiment, we evaluate the gains from increasing labor mobility within a currency union. The welfare gains from labor mobility are significant at 1 percent of permanent consumption. The gains are large than those found in a typically business cycle framework because labor mobility helps offset the costs of wage rigidity and increases the levels of output, employment and consumption.

5 Conclusion

Unemployment rates tend to be higher and more volatile in the euro area than in the United States. While there are a number of differences between the two regions, one key difference is the greater degree of labor mobility in United States. For a given increase in the unemployment rate, workers are about three times more likely to relocate another state (country) in the United States than in the euro area (House, Proebsting and Tesar, 2023; Foschi et al., 2023). This paper deploys a plucking model of unemployment to study the impact of labor mobility on unemployment. Our analytical model incorporates frictions in the labor market as well as an endogenous migration decision. Firms are unable to freely adjust wages during economic contractions. This rigidity amplifies the costs of negative shocks and generates asymmetries in the dynamics of macroeconomic variables including unemployment. Workers make forward-looking decisions regarding where to work, subject to costs of relocating. This additional margin of adjustment –one that we think realistically captures a feature of labor markets in advanced economies – cuts against the friction of downward wage rigidity.

The model is calibrated to the dynamics of unemployment and net migration in a typical euro area country. The resulting model mimics the asymmetry in unemployment dynamics and the responsiveness of net migration to fluctuations in unemployment. A counterfactual of increasing the degree of labor mobility to that observed in the United States – holding all other parameters of the model fixed – would decrease both the level and the variability of unemployment in the euro area.

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Table 1: Statistics on unemployment dynamics

	United States		Euro area	
	Aggregate	Ave state	Aggregate	Ave country
Moments				
Average unemployment rate (in %)	6.23	5.89	9.39	9.23
Std. deviation (monthly)	1.63	1.75	1.40	2.96
Skewness (monthly)	0.61	0.69	0.05	0.25
Speed				
Speed of expansions (pp/year)	0.61	0.79	0.54	1.19
Speed of contractions (pp/year)	1.18	1.37	1.39	2.70
Duration				
Duration of expansion (months)	83	82	71	75
Duration of contraction (months)	39	41	37	38
Regression				
Expansion on preceding contraction				
β	1.12	0.82	0.74	0.62
R^2	0.89	0.52	0.76	0.54
Contraction on preceding expansion				
β	-0.80	-0.21	-0.71	0.26
R^2	0.69	0.05	0.30	0.05
Time period	1976 - 2020.2		1990 - 2023.2	

Notes: Each column corresponds to a separate sample. Column 1 refers to statistics for the national U.S. unemployment rate series, column 2 refers to average statistics across U.S. state-level unemployment rate series. Column 3 and 4 report the statistics for the euro aggregate and the average across euro area countries. **Moments**: Reports first, second and third moment of monthly unemployment rates. **Speed**: Reports the average decrease in the unemployment rate during expansions, measured in percentage points per year, and the average increase in the unemployment rate during contractions. **Duration**: Reports the duration of expansions and contractions in months. **Regressions**: The first specification ("expansion on preceding contraction") reports the coefficient in an OLS regression of the size of the subsequent expansion (percentage point fall in unemployment rate) on the size of a contraction (percentage points increase in unemployment). The second specification ("contraction on preceding expansion") reports the coefficient in an analogous regression of the size of the subsequent contraction on the size of an expansion. Regressions are pooled across U.S. states (column 2) or euro area countries (column 4).

Table 2: Calibration

Parameter	Value
Discount rate	0.9983
Capital owner share	1/3
Coefficient of risk aversion	1.5
Import share	0.3
Trade elasticity	10
Share of migrants p.a.	0.75%
Migration elasticity	0.2
Downward wage rigidity	0.999
Shock persistence	0.98
Shock volatility	0.05

Table 3: Unemployment and labor mobility

	Euro area	Model	
	Ave country	$\gamma = 0.2$	$\gamma = 0.8$
Migration & Unemployment			
Average unempl. (%)	9.23	4.88	4.35
Std. deviation unempl. (monthly, %)	2.96	5.33	4.77
Std. deviation net migr. (%)	0.38	0.56	0.89
Reg. net migr. on unempl.: β	-0.08	-0.09	-0.17
Business Cycle moments			
Std. deviation GDP (%)	4.25	4.11	4.27
Corr(unempl.,GDP)	-0.56	-0.47	-0.38
Corr(net migr., GDP)	0.38	0.51	0.37
Corr(NX,GDP)	-0.42	0.78	0.83
Plucking statistics			
Duration of expansion (months)	75	38	34
Duration of contraction (months)	38	23	23
Reg. expansion of prev. contraction: β	0.62	0.78	0.52
Reg. contraction of prev. expansion: β	0.26	0.20	0.05

Table 4: Alternative calibrations

	Baseline	Increased wage rigidity $\eta = 0.9995$	Lower shock volatility $\sigma_\varepsilon = 0.03$	Lower trade elasticity $\psi = 5$
Average unempl. (%)	4.88	7.59	1.94	3.45
Std. deviation unempl. (monthly, %)	5.33	6.51	1.99	3.88
Reg. net migr. on unempl.: β	-0.09	-0.10	-0.14	-0.11
Std. deviation GDP (%)	4.11	4.75	1.63	3.80

Table 5: Welfare results

	Capitalist Consumption		Worker Consumption				Welfare	
	mean c_k	sd(c_k)	mean c_w	sd(c_w)	mean n	sd(n)	λ_k	λ_w
Optimal (full employment) policy: eta=0								
Low mobility	0.527	1.973	0.528	2.718	0.001	0.006	0.094	0.029
High mobility	0.527	1.824	0.528	2.713	0.001	0.006	0.081	0.019
Wage rigidity: eta=0.999								
Low mobility	0.495	3.168	0.522	3.637	0.001	0.042	0.015	0.009
High mobility	0.498	2.788	0.523	3.331	0.001	0.074		
Welfare gain from optimal full employment policy								
Low mobility	0.050							
High mobility	0.040							
Welfare gain in currency union from increased labor mobility								
	0.011							

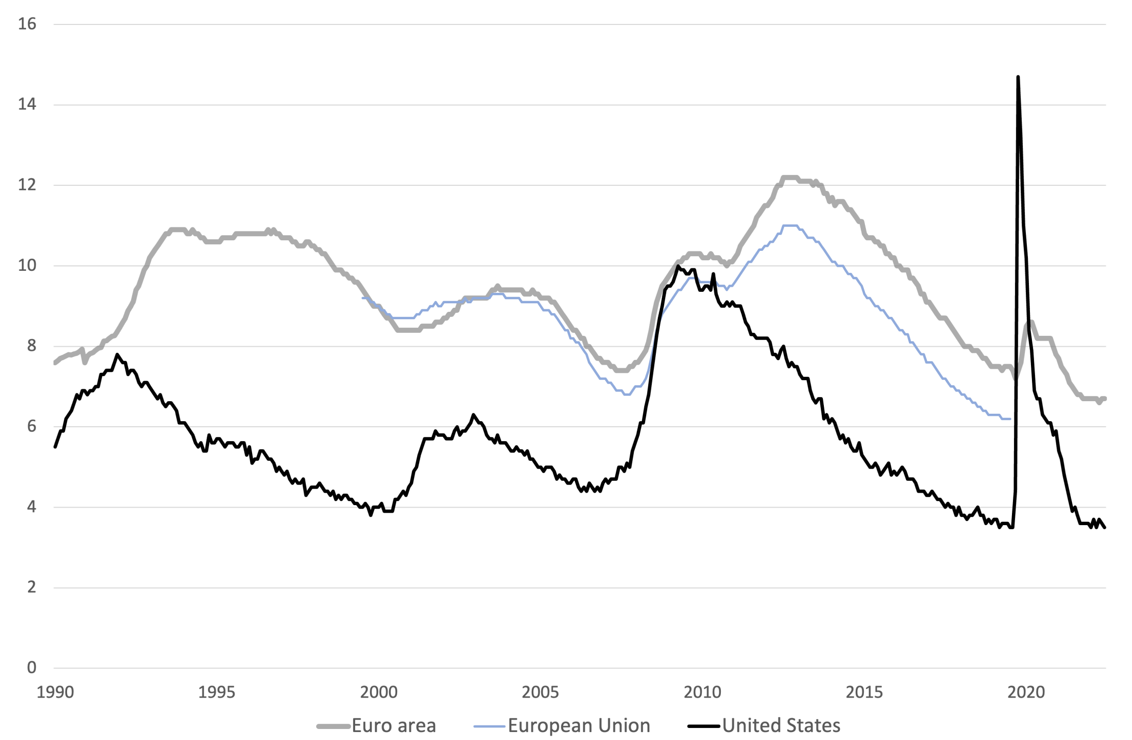


Figure 1: Unemployment: Europe vs. United States

Note: The figure plots aggregate unemployment rates for the United States, the euro area and the European Union.

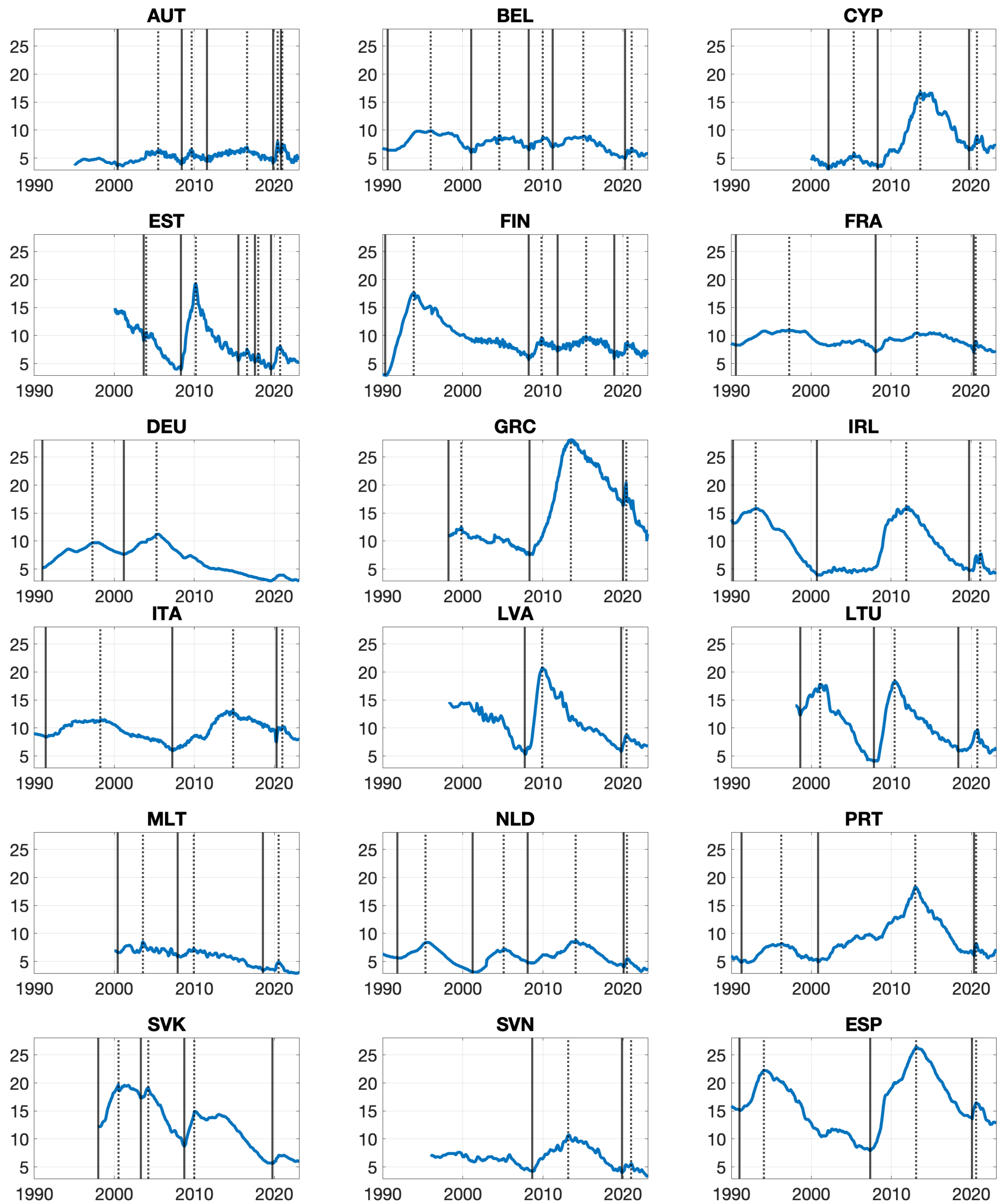


Figure 2: Peaks and Troughs in Unemployment Rates across the Euro Area

Notes: Figure displays unemployment rates for euro area countries. Business cycle peaks are denoted by dashed vertical lines, while business cycle troughs are denoted by solid vertical lines.

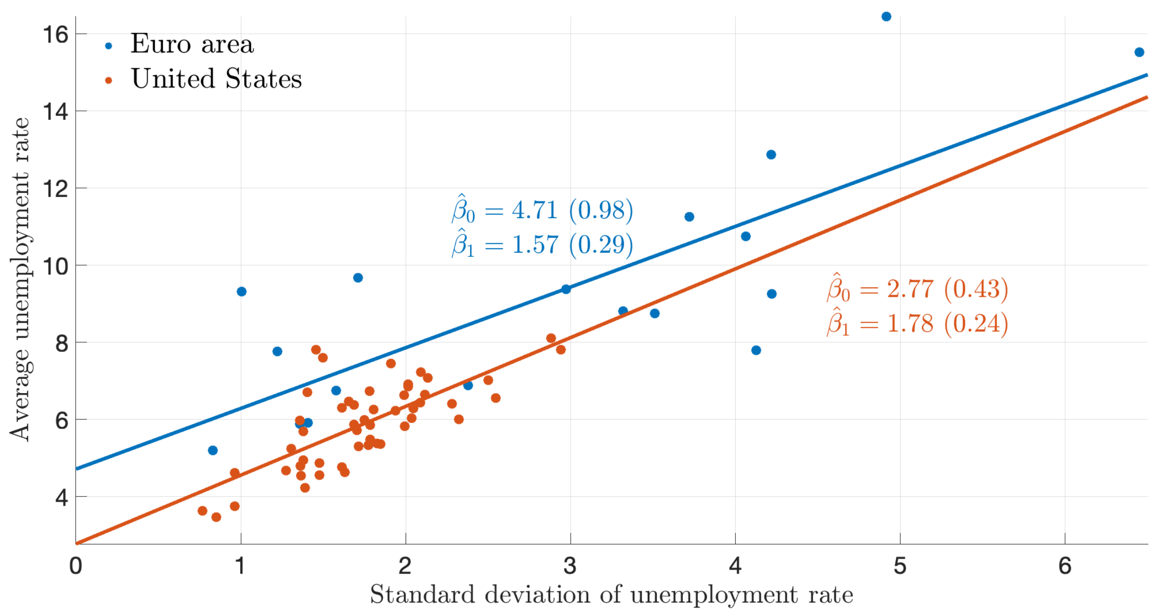
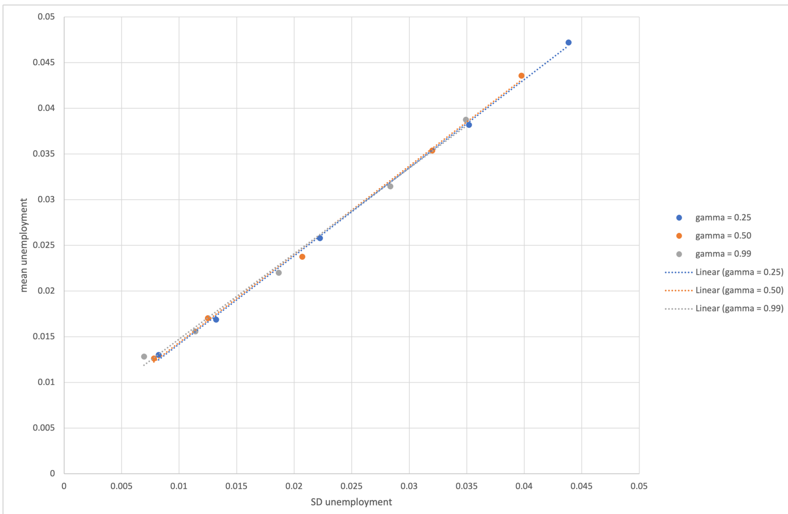
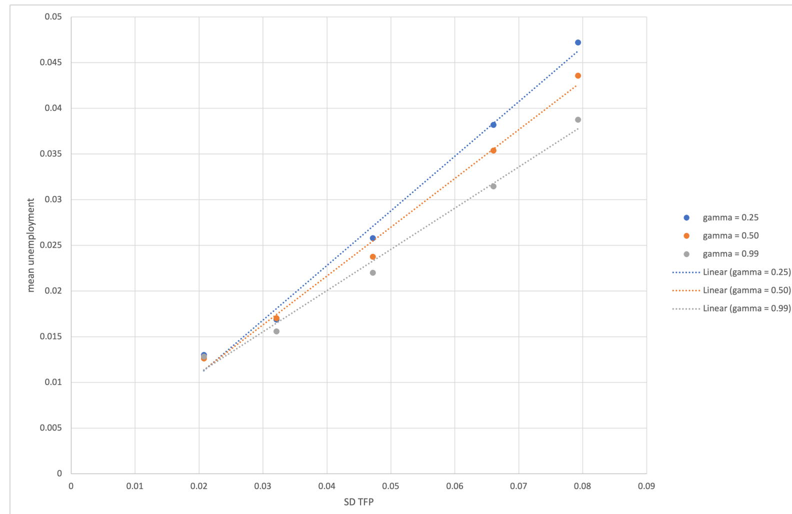


Figure 3: VOLATILITY AND AVERAGE UNEMPLOYMENT

Note: The figure plots the time-series standard deviation for each euro area country / U.S. state against its time-series mean. The coefficients indicate the estimated intercept (β_0) and slope (β_1) of a regression of the standard deviaton on the mean. Simple standard errors are in parentheses.



(a) Volatility of unemployment



(b) Volatility of TFP

Figure 4: Labor mobility, volatility and the average level of unemployment

Note: The figure plots average levels of unemployment vs. the standard deviation of unemployment (panel (a)) and the standard deviation of TFP (panel (b)) from simulated data assuming different values for the migration elasticity γ. A higher value of γ corresponds to a more mobile labor force in the sense that migration decisions are more sensitive to fluctuations in labor income.

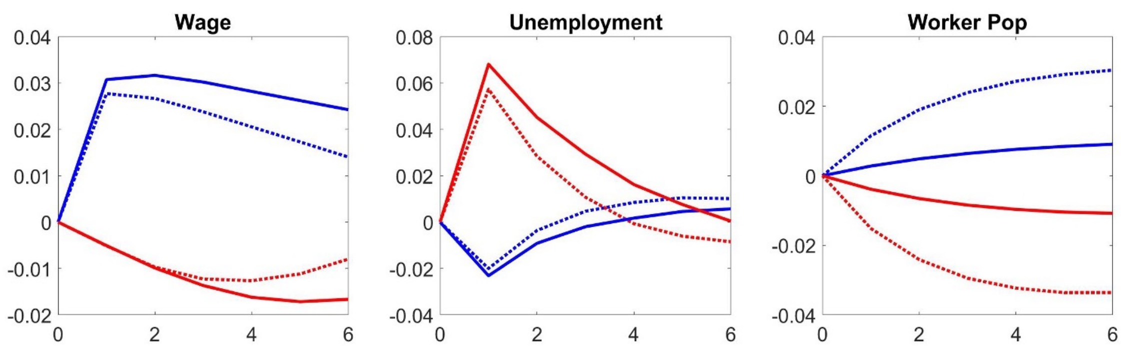


Figure 5: Impulse response to TFP shock

Note: The figure plots the impulse response to a positive (blue) and a negative (red) TFP shock. The dotted line assumes a higher value of the migration elasticity γ.