

Moving closer? Comparing regional adjustments to shocks in EMU and the United States¹

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Abstract

This paper analyzes alternative channels of adjustment to nominal exchange rate flexibility in response to shocks faced by countries and regions that are part of a monetary union. Over our full sample period of analysis (1977-2018), the results suggest a dominant role of interstate migration as an adjustment channel to labor demand shocks for the United States. In contrast, European countries tend to adjust to negative labor demand shocks mainly through changes in labor force participation and unemployment. Labor mobility is lower in the euro area, regardless of whether one is looking at cross-country migration or within-country mobility. Price flexibility is more important as a shock absorber to labor demand shocks in the EMU compared to the United States. We also document that risk-sharing mechanisms have been, on average, more effective in smoothing income fluctuations in the United States than in the EMU. The strength of these channels, however, has changed over time both for the EMU and in the United States. In particular, the results suggest that the pattern of regional adjustments to shocks in EMU and the United States is moving closer, partly because of strengthening of adjustment channels in the EMU and partly because of weakening of these channels in the United States.

JEL Classification Numbers: E32, E42, F41, F42.

Keywords: Euro, Currency Unions, Regional adjustments; Risk-sharing.

An updated version of this article has been published in Papers in Regional Science:

Furceri, D., Loungani, P., & Pizzuto, P. (2022). Moving closer? Comparing regional adjustments to shocks in EMU and the United States. *Journal of International Money and Finance*, 120, 102282. <https://doi.org/10.1016/j.jimonfin.2020.102282>

¹ We would like to thank two anonymous referees, Nauro Campos, Jacopo Cimadomo, Jakob de Haan, Jan-Egbert Sturm, Cecilio Tamarit, Bořek Vašíček and other participants to the conference “The Euro Area at 20: Evaluating the Real Side of the Economic and Monetary Union” for useful comments and suggestions. The views expressed in this paper are those of the author(s) and do not necessarily represent those of the IMF.

I. Introduction

Since the outbreak of the Great Recession in 2008, there has been a proliferation of studies trying to understand differences in how economies adjust to shocks. Growing attention has been paid to countries of the European Monetary Union (EMU) given the constraints posed on their adjustment by the loss of monetary independence. As discussed in the classic contribution by Mundell (1961), several mechanisms must be in place to mitigate the negative effects of an asymmetric shock in cases when currency depreciation is not an option, as in the case of a monetary union.

In this context, the paper analyzes the alternative channels of adjustment to nominal exchange rate flexibility and compares the strength of these channels between EMU countries (and regions) and US states. Specifically, the first contribution of the paper is to extend the influential empirical approaches of Blanchard and Katz (1992), Obstfeld and Peri (1998) and Asdrubali, Sorensen and Yosha (1996) to analyze regional adjustment in these two currency areas. By using these frameworks, we discuss and provide evidence on three main channels of adjustment, namely labor mobility, price adjustments and (public and private) risk-sharing mechanisms.

Over our full sample period of analysis (1977-2018), the results suggest a dominant role of interstate migration as an adjustment channel to labor demand shocks for the United States. In contrast, the contribution of labor mobility is lower in the euro area, regardless of whether one is looking at cross-country migration or within-country mobility. European countries tend to adjust to negative labor demand shocks mainly through changes in labor force participation and unemployment. In contrast, price flexibility is more important as a shock absorber to labor demand shocks in the EMU compared to the United States. When we consider the role of risk-sharing mechanisms, a greater stabilizing effect of income flows and fiscal transfers is observed in the United States compared to the EMU, contributing to greater smoothing of asymmetric shocks in the former than in the latter.

The second contribution of the paper is to document how these adjustment mechanisms have changed over time, in particular after the creation of the EMU. Interestingly, we find that regional adjustment to shocks in the EMU is getting more similar

to that of the United States. In other words, the channels of adjustment in the EMU are changing over time in a direction that supports the monetary union. In particular, although the role of migration as shock absorber remains more limited in the EMU than in the United States, it has increased over time in the euro area while it has declined in the United States, as documented by Dao et al. (2017). Similarly, the degree of risk-sharing has improved over time in EMU countries, but it has declined in the United States. In particular, the results based on the post-EMU period (1998-2017) suggest that the amount of shock not smoothed in the EMU11 is almost identical to that of the United States. Looking at each risk-sharing channel, it seems that the major factor contributing to the increase in risk-sharing in the EMU11 is factor income flows.

The remainder of the paper is organized as follows. The next section provides a theoretical discussion of the channels mentioned above and reviews the existing empirical literature on these channels. Section III documents business synchronization patterns in the EMU and in the United States. Section IV describes the empirical methodology used to assess the role of migration as shock absorber and how it has changed over time. Section V analyzes the adjustment through relative prices since the creation of the common currency. Section VI evaluates the importance of risk-sharing channels (factor income flows, private and government saving and fiscal transfers) in smoothing asymmetric shocks. Section VII summarizes the findings.

II. Business cycle synchronization and channels of adjustment: a review

The standard Optimal Currency Area theory, based on the pioneering contribution of Mundell (1961), stresses that there should be a high degree of homogeneity, in terms of business cycle synchronization, among the countries that want to establish a currency area. This is because the more synchronized the business cycles among the member countries, the lower the probability of asymmetric shocks, and thus the less painful the loss of independent monetary policy and of a flexible exchange rate for the member country. Moreover, in the case of a high degree of business cycle synchronization, it becomes more plausible to expect a single monetary authority to respond to aggregate shocks and to implement these interventions with greater ease.

The literature on business cycle synchronization in Europe (and how it compares to the United States) is vast. Bayoumi and Eichengreen (1993) find that demand and supply shocks are more correlated between states in the United States than in Europe, and that the US states adjust more quickly to economic fluctuations than European countries. Wynne and Koo (2000) also find that business cycles are more aligned in the United States than in the Eurozone (of 11 members). Other authors, such as Clark and Shin (1998) and Clark and Van Wincoop (2001), focused on both within-country and cross-country synchronization. They find that average within-country cyclical output correlations are larger than cross-country correlations, for both the United States and European countries (and again that business cycles are more synchronized in the United States than in Europe). Angeloni and Dedola (1998) find that the output correlation between Germany and other European countries has clearly increased during 1993–1997. Furceri and Karras (2006), analyzing cyclical output for the EU-15 countries find that business-cycle synchronization has also increased for many countries from 1980–1991 to 1992–2003. In contrast, Giannone et al. (2010) find that EMU has not affected historical characteristics of member countries' business cycles and their cross-correlations.

If shocks are predominantly asymmetric, alternative channels of adjustment to nominal exchange rate flexibility should be in place. A first channel of adjustment is through migration. People from depressed economies can move to lower unemployment regions, until the former regain competitiveness. Higher migration flows could help avoid a sharp rise in unemployment or a strong decrease in activity rates in the economy affected by the adverse shock. A second channel of adjustment is through changes in relative prices—that is, real exchange rates. When an economy is hit by a negative demand shock, a reduction in relative prices compared to other countries in the union would lead to a depreciation in the real exchange rate and a consequent boost in export and external demand. Finally, a third category of adjustment pertains to private (income flows and private saving) and public (net transfers and government saving) risk-sharing mechanisms. In the face of a negative shock, these mechanisms can allow a smoothing of consumption. For example, in the case of interregional transfers, the government may provide insurance by transferring resources from economies with stronger cyclical positions to countries or regions affected by a negative shock.

Much of the empirical literature has focused on the role played by migration flows. Starting from the seminal contribution of Blanchard and Katz (1992) several papers have analyzed labor force migration as a channel of adjustment to shocks. Decressin and Fatás (1995), Obstfeld and Peri (1998), Dao et al. (2014), Arpaia et al. (2016), Beyer and Smets (2015) and Arpaia et al. (2018) are some examples. The evidence of these studies suggests that migration plays a stronger stabilization role among US states than among European countries or regions.

In the case of price adjustments, evidence suggests that real prices within EU countries have been relatively less flexible, in the short and medium term, than among US states. As discussed by Obstfeld and Peri (1998) previous research documents this finding adding that, in general, relative regional prices tend to fluctuate less than international prices (Vaubel, 1976, 1978; Eichengreen, 1991; De Grauwe and Vanhaverbeke, 1993). In addition, the relative insufficient degree of prices and wages flexibility in Europe is suggested by recent studies, such as Arpaia and Pichelmann (2007) and Heinz and Rusinova (2011). Arpaia and Pichelmann (2007) suggest that long-lasting cross-country differences in labor cost and wage dynamics in the euro area reflect weak wage flexibility, rather than a mechanism of adjustment between countries. Heinz and Rusinova (2011) find that the degree of real wage flexibility tends to be larger in the central and eastern European countries than in the euro area—probably due to the more limited role played by trade unions and collective bargaining coverage in the EU peripheral economies. Indeed, Biroli et al. (2013) point to labor (and product) market regulations as natural candidates for explaining the changing behavior of price dynamics in response to shocks.

Risk-sharing mechanisms among the residents of different regions/countries exposed to idiosyncratic shocks received considerable interest in the start-up phase of the EMU. Notably, Asdrubali et al. (1996) find that in the United States, 75 percent of the shock to per capita gross state product is smoothed by: (i) federal tax-transfer and grant system (13 percent); (ii) capital markets (39 percent); and (iii) credit markets (23 percent). These results for the United States are broadly confirmed by Melitz and Zumer (1999, 2002) and Athanasoulis and van Wincoop (2001). Some studies have extended the analysis to international risk-sharing mechanisms. Afonso and Furceri (2008), analyzing a panel of 25 European countries, find that only 43 percent of the shock to GDP is smoothed (almost uniquely by private and public saving) and this share has decreased to 37 percent after the

creation of the EMU, suggesting that euro area members have not benefited from additional risk-sharing. Furceri and Zdzienicka (2015), using an unbalanced panel of 15-euro area countries over the period 1979-2010, find the effectiveness of risk-sharing mechanisms in the euro area is significantly lower than in existing federations and it falls sharply in severe downturns. Recently, Cimadomo et al. (2018) find an increased shock absorption capacity in EMU countries due to a higher financial integration, but also to the activation of the European Financial Stability Facility (EFSF) and the European Stability Mechanism (ESM) channeling official loans to distressed euro zone economies.

III. Business cycle synchronization

We use three complementary approaches to investigate business cycle synchronization in the EMU and in the United States and how have evolved over time. The first consists of computing the correlation between the country's (state) cyclical GDP (GSP) and the corresponding component for the EMU (United States) as a whole. The cyclical component is obtained using the Hodrick-Prescott (HP) filter proposed by Hodrick and Prescott (1980), with a smoothness parameter equal to 6.25 (see Ravn and Uhlig 2002 for a discussion).²

The second approach follows the methodology proposed by Giannone et al. (2010). They define synchronicity among countries (states) as the negative of the absolute divergence in GDP (GSP) growth:

$$\varphi_{ij,t} = -|(\ln Y_{i,t} - \ln Y_{i,t-1}) - (\ln Y_{j,t} - \ln Y_{j,t-1})| \quad (1)$$

where $Y_{i,t}$ and $Y_{j,t}$ are the GDPs (GSPs) of countries (states) i and j in year t , respectively. A more negative value indicates that the business cycles between the two states are less synchronized, while a zero value indicates a complete synchronization. The average business cycle synchronization for the monetary union of n countries (states) is measured as the cross-sectional average of pairwise synchronizations:

² Similar results are obtained using alternative filtering techniques, such as the Band-Pass filter of Baxter and King (1995) and the recent filter proposed by Hamilton (2018). See Table A1 in the Appendix.

$$Syn_t = 1/n \sum_{ij} \varphi_{ij,t} \quad (2)$$

The third approach follows Mink et al. (2012) who propose two alternative measures of business cycle coherence. The first is a measure of business cycle synchronicity, defined as:

$$\varphi(t) = \frac{1}{n} \sum_1^n \frac{g_i(t)g_r(t)}{|g_i(t)g_r(t)|} \quad (3)$$

where $g_i(t)$ denotes the output gap of countries (states) i at time t ; $g_r(t)$ is the reference output gap (as in Mink et al. (2012) we use the median of all individual countries' (states') output gaps at time t); n is the number of countries (states) in the monetary union. This measure is defined on a $[0,1]$ scale, with a value of 1 indicating that all countries (state) output gaps have the same sign as the euro area (United States) as whole. The second measure takes into account amplitude differences between countries' (states') output gaps within the monetary union and is defined as:

$$\gamma(t) = 1 - \frac{\sum_1^n |g_i(t) - g_r(t)|}{\sum_1^n |g_i(t)|} \quad (4)$$

The measure ranges within a $[0,1]$ interval, with a value of 1 indicating that all countries (state) have identical output gap.

In order to maximize the time-dimension of the analysis before the creation of the EMU , in this section and in the rest of the paper, we use annual data and focus on the EMU 11—the signatories of the Maastricht Treaty except Luxembourg. The Data Appendix provides details on the source of real GDP for EMU countries and GSP for US states.³

We start by reporting in Figure 1 the average and the median of the correlation coefficient of each country's (state's) cyclical component of real GDP with that of the EMU (United States) as a whole, using the HP filter with smoothness parameter equal to 6.25. The results are reported for three different periods of analysis: 1977-1997 (pre-EMU), 1998-2018 (post-EMU), and the entire period of analysis 1977-2018. Two key facts emerge from this

³ The results obtained using quarterly data for the more restricted sample are extremely close to those obtained for annual observations (Table A2, Figure A1-2 in the Appendix).

analysis. First, and in contrast with some of the previous literature of the 2000s based on earlier periods, we do not find significant differences in business cycle synchronization between the EMU and the United States. If anything, business cycles appear to be slightly more synchronized, on average, in the EMU than in the United States. Interestingly, this pattern also holds when comparing the median EMU country with the median US state, suggesting that it is not driven by some influential observations. Second, for EMU11 we observe a slight increase in business cycle synchronization after the creation of the monetary union.

(INSERT FIGURE 1 NEAR HERE)

The finding that business cycles of EMU countries are synchronized as well as those of US states is also confirmed when using the measure of business cycle divergence proposed by Giannone et al. (2010). In particular, the results presented in Figure 2 show that average divergences in output growth have been, on average, smaller in the EMU11 than in the United States. In contrast, based on this measure, and in line with Giannone et al. (2010), we do not observe an increase in GDP growth convergence across EMU countries since the Euro adoption, while for the United States we observe an increasing trend. Moreover, the chart also shows that synchronization tends to decline during periods of major recessions such as the Global Financial Crisis (for both EMU and the United States) and the European debt crisis.

(INSERT FIGURE 2 NEAR HERE)

Finally, we report in Figure 3 the two measures of business cycles coherence proposed by Mink et al. (2012). The chart confirms that business cycles appear to be slightly more synchronized, on average, in the EMU than in the United States. In addition, they also suggest that business cycle coherence has increased over time in the EMU11, while it has declined in the United States.

(INSERT FIGURE 3 NEAR HERE)

IV. Adjustment through labor mobility

This section uses the Blanchard-Katz (1992, henceforth referred to as ‘BK’) methodology to analyze labor adjustments for the EMU and the United States economies (see the Data Annex for the source used for the labor market variables).

Before turning to the analysis of how shocks to regional labor demand in Europe are absorbed, it is useful to look at the dispersion and persistence of unemployment rates. Figure 4 and 5 plot, respectively, the standard deviations and coefficients of variation (standard deviations divided by means) of unemployment rates. Dispersion in unemployment rates turns out to be at least twice as large (depending on the measure used) between EMU11 countries than between US states. The chart also reveals two important facts: (i) up to the Global Financial Crisis, dispersion in unemployment rates decreased in EMU, particularly since the mid-90s, while it has remained broadly stable in the United States; (ii) in the aftermath of the GFC, dispersion has sky-rocketed in EMU11 and it still remains significantly above pre-crisis level, while in the United States the GFC did not have a significant and persistent effect on unemployment rates dispersion. This result speaks loudly to the lower flexibility of EMU labor markets to adjust to aggregate shocks compared to US states.

(INSERT FIGURES 4 AND 5 NEAR HERE)

Patterns of unemployment appear to have been more persistent in the EMU11 than in the United States, in the sense that countries with relatively high unemployment have tended to remain broadly the same over time. This is shown in Figure 6 which reports the scatter plot of unemployment rates in 1988 against 2008 rates for both the EMU11 and the United States.

(INSERT FIGURE 6 NEAR HERE)

To summarize, the evidence presented in Figures 4-6 seems to suggest a slower adjustment of migration (or labor force participation) to “regional” shocks in the EMU11 than in the United States. We now turn to a formal empirical investigation of this issue. In particular, we make use of the BK framework to formally analyze the joint behavior of regional relative employment, relative unemployment rate and relative participation in

response to labor demand shocks and compare the results between the EMU11 and the United States.

Specifically, we estimate a system of panel VAR equations as follows:

$$\Delta e_{it} = \alpha_{i10} + \gamma_{t1} + b_{11}(L)\Delta e_{it-1} + b_{12}(L)le_{it-1} + b_{13}(L)lp_{it-1} + \epsilon_{1,it} \quad (5)$$

$$le_{it} = \alpha_{i20} + \gamma_{t2} + b_{21}(L)\Delta e_{it} + b_{22}(L)le_{it-1} + b_{23}(L)lp_{it-1} + \epsilon_{2,it} \quad (6)$$

$$lp_{it} = \alpha_{i30} + \gamma_{t3} + b_{31}(L)\Delta e_{it} + b_{32}(L)le_{it-1} + b_{33}(L)lp_{it-1} + \epsilon_{3,it} \quad (7)$$

where: Δe_{it} represents the employment change in country (state) i , le_i denotes the logarithm of employment rate (equal to 1 minus unemployment rate), and lp_i is the logarithm of the participation rate. The three variables are stationary. Consistently with BK, two lags for each variable are included.⁴ We include time and regional—that is country or state—fixed effects in our estimations.⁵

As in BK, the identification relies on the assumption that unexpected movements in employment within the year—that is, innovations in employment orthogonal to past changes in employment and employment and participation rates, the residual in equation (5)—primarily reflect exogenous labor demand shocks. The specification allows for current changes in employment Δe_{it} to affect current values of the employment (le_{it}) and the participation rates (lp_{it}), but not viceversa.

The top left panel of Figure 7 shows the impulse response of employment, employment rates and labor force participation to a 1 percent shock in relative employment in

⁴ In line with Dao et al. (2017), we estimate the system by OLS equation-by-equation. This is identical to transforming the system to a reduced-form VAR and ordering employment growth first. As a robustness check, we re-estimate the model using alternative lag structures finding similar results (see Figure A3 in the Appendix).

⁵ To estimate impulse responses, the baseline analysis relies on the VAR approach instead of the Jordà (2005) local projection method for three reasons. First, this makes it easier to compare our results to the previous literature, which has exclusively focused on the VAR approach. Second, we want to capture the feedback dynamic effects of each variable in the system (which is not possible using the local projection method). Third, we are also interested in long-term effects, which are typically less precisely estimated with the local projection method. That said, to check the robustness of our results we estimate the model also using the local projections approach by Jordà (2005). The results presented in Figure A4 in the Appendix show very similar results to those presented in the main text.

the EMU11. In the first year, a 1 percent adverse shock to labor demand lowers the relative employment rate by 0.2 percentage point and the participation rate by 0.5 percentage point. Over the long run (15 years after the shock), an initial shock of 1 percent leads to an impact of about 0.6 percent on the employment level, while employment *growth*, as well as unemployment and participation rates revert to the pre-shock average eventually. That is, migration following the regional shock drives permanent changes in relative employment levels.

(INSERT FIGURE 7 NEAR HERE)

By looking at changes in terms of number of workers instead of rates, the bottom left panel of Figure 7 decomposes the employment response following a 1 percent negative labor demand shock into the different margins of adjustments: increase in unemployment, decrease in participation and increase in net migration (all measured in number of workers). Of every 10 workers that lose employment, about 6 drop out of the labor force (shown in blue in the figure) about 3 workers become unemployed (shown in orange) and 1 worker migrates out of the region within the first year following the shock (shown in gray). The role of migration increases in subsequent years and the other two margins shrink in importance.

Comparing the results for the EMU11 to those from the United States, shown in the right charts of Figure 7, the main difference arises from the roles played by employment (unemployment) rate and migration.⁶ In particular, compared to the results for the United States, the role of the employment rate is significantly larger in EMU11 than in the United States (34 percent of shock absorbed in the EMU compared to 24 percent in the United States), while the role of net out-migration as shock absorber is significantly smaller (12 percent of shock absorbed in the EMU compared to 28 percent in the United States).

An important contribution of our paper is to see whether the adjustment mechanisms through which regional labor demand shocks are absorbed have changed over time. To examine this, we perform two exercises. In the first exercise, we replicate the previous analysis splitting the sample in two periods: 1977-1997 and 1998-2018. In the second, we perform rolling-windows estimates based on a 20-year window. We present the short-term (after 2 years) response of net migration obtained with these exercises in Figure 8 and Figure

⁶ Charts with 90 percent confidence bands are shown in the Appendix (Figure A5).

A6 (of the Appendix), respectively. The results show that the response of migration has become closer between the two areas in the most recent years: while the role of migration as shock absorber has increased over time in the EMU11, it has declined in the United States as documented by Dao et al. (2017).

(INSERT FIGURE 8 NEAR HERE)

We have also investigated whether the relative weak response of regional migration to labor demand shock in the EMU11 is the result of the reluctance of people to migrate across countries or the reluctance to migrate even within countries. For this purpose, we have analyzed the response to regional labor demand shocks within countries and separately re-estimated the BK framework for each country in the sample. The results for the overall EMU11 area are presented Figure 9 and show that the relatively weak response of regional migration to labor demand shocks in the EMU11 is evident not only for international migration but also for intranational migration. However, these averages mask significant differences across EMU11 countries. The results reported in Table A3-4 suggest that while migration acts as the main shock absorber for some countries (such as Italy and Finland), adjustment to regional demand shocks mostly occur through participation and unemployment rates in countries such as Germany and Belgium, respectively.

(INSERT FIGURE 9 NEAR HERE)

V. Price flexibility

As discussed earlier, numerous papers have tried to evaluate price flexibility within and between countries. Research on developed currency unions shows that relative regional prices tend to fluctuate less than international prices, and this is one of the claimed advantages of monetary unification. At the same time, there have been several investigations of the role played by price adjustments after shocks. In this section, we compare the different behavior of relative price flexibility between the United States and the EMU11 following the approach proposed by Obstfeld and Peri (1988). Specifically, we first analyze intranational price variability (both in level and in changes) and then we estimate a bivariate panel VAR of relative regional employment growth and of relative regional price changes.

We start by reporting in Figure 10 the standard deviations of the log of GDP (GSP) deflator since the creation of the common currency—we focus on this period to strictly examine the role of the real exchange rate. Figure 11 presents an analogous calculation of the standard deviation of annual first differences in such real exchange rates. As such Figure 10 illustrates the long-run variation in real exchange rates, while Figure 11 short-run variations in real exchange rates around their trend. Looking at Figure 10, we can observe that price variability is not significantly different between EMU11 and the United States. Interestingly, in both currency unions we can observe a decline in price dispersion up to the Global Financial Crisis, and a significant increase afterwards. In contrast, looking at changes in relative prices we can observe that, on average, real exchange flexibility has been larger in the United States than in the EMU11 (Figure 11). In addition, the results not reported here suggest that real exchange variation between EMU countries is also typically larger than within countries, confirming the previous finding that relative regional prices tend to fluctuate less than international prices.

(INSERT FIGURES 10 AND 11 NEAR HERE)

For the United States, Blanchard and Katz (1992) find that regional price movements play a small role in the adjustment to permanent labor demand shocks. They attribute this finding to the larger role of migration. Given the less important role of migration in the EMU11, we might expect to find that regional prices play a larger role. To examine this issue, we estimate the following bivariate VAR specification:

$$\Delta e_{it} = \alpha_i + \gamma_{t1} + b_{11}(L)\Delta e_{it-1} + b_{12}(L)DEFL_{it-1} + \epsilon_{1,it} \quad (8)$$

$$DEFL_{it} = \beta_i + \gamma_{t2} + \partial\Delta e_{it} + b_{21}(L)\Delta e_{it-1} + b_{22}(L)DEFL_{it-1} + \epsilon_{2,it} \quad (9)$$

where Δe_{it} and $DEFL_{it}$ are respectively, the employment change and the (log) relative GDP deflator of region (country or state) i . As before, we include time fixed effects. In addition, we control for the unconditional average of these variables by controlling for regional fixed effects α_i and β_i , and we consider two lags for each variable (Δe_{it} and $DEFL_{it}$). As before, the identification relies on the assumption that unexpected

movements in employment within the year—the residual in equation (8)—primarily reflect exogenous labor demand shocks. The specification allows for current changes in employment to affect current values of the GDP deflator, but not viceversa.

Figure 12 presents the response of the regional price level to a 1 percent negative labor demand shock in the EMU11 (left panel) and in the United States (right panel) for the post-EMU period (1998-2018). The results show that the short-term response of prices is larger (by almost 5 times) in the EMU11 than in the United States, suggesting the price flexibility is an important shock absorber in the EMU compared to the United States.

(INSERT FIGURE 12 NEAR HERE)

VI. Risk-sharing mechanisms

The effectiveness of risk-sharing mechanisms is estimated applying the approach proposed by Asdrubali et al. (1996). The approach consists in disaggregating per capita Gross Domestic Product (GDP) into different national aggregates: Gross National Product (GNP), Net National Income (NI), Disposable National Income (DNI), and the sum of Government Consumption and Private Consumption (G+C).⁷ In particular:

$GDP - GNP = \text{international income transfers (factor income flows)},$

$NI - DNI = \text{net international taxes and transfers},$

$DNI - (C + G) = \text{total saving}.$

Using these identities, the following chain equation can be considered:

$$GDP_i = \frac{GDP_i}{NI_i} \frac{NI_i}{DNI_i} \frac{DNI_i}{(C+G)_i} (C + G)_i \quad (10)$$

GDP shocks propagate through the economic system and affect the other income variables in the identity, unless they are smoothed by some counter-cyclical factor. Full stabilization is obtained if only (per capita) GDP varies while (per capita) consumption remains unchanged. In particular, smoothing is provided by capital markets, through the international net transfers of income factors, if after the shock, GDP changes while GNP remains constant. Successively, if NI is modified and DNI stays constant, smoothing takes

⁷ See the data annex for detailed sources.

place via net transfers from abroad. If DNI moves while C+G remains unchanged, stabilization is obtained by credit markets through private and public saving. Finally, if total consumption also co-moves with GDP, a share of the shock remains unsmoothed.

In principle, all these factors may provide smoothing. The first factor is the international transfers of income earned by foreign entities in each country. Risk-sharing through this channel consists in income insurance through an internationally diversified portfolio. The second channel is the system of net taxes and transfers to/from a supranational government. In the case of the euro area this incorporates insurance provided by transfers via the EC budget, such as the structural funds. Finally, the third channel represents consumption smoothing through saving behavior, which is determined by inter-temporal considerations, and represents the ability of credit markets to smooth consumption relative to income.

To measure the contribution of each factor in smoothing shocks to GDP, Asdrubali et al. (1996) derive the following system of independent equations⁸:

$$\Delta \log GDP_{i,t} - \Delta \log NI_{i,t} = \alpha_t^m + \beta^m \Delta \log GDP_{i,t} + \varepsilon_{i,t}^m \quad (11)$$

$$\Delta \log NI_{i,t} - \Delta \log DNI_{i,t} = \alpha_t^g + \beta^g \Delta \log GDP_{i,t} + \varepsilon_{i,t}^g \quad (12)$$

$$\Delta \log DNI_{i,t} - \Delta \log (C + G)_{i,t} = \alpha_t^p + \beta^p \Delta \log GDP_{i,t} + \varepsilon_{i,t}^p \quad (13)$$

$$\Delta \log (C + G)_{i,t} = \alpha_t^u + \beta^u \Delta \log GDP_{i,t} + \varepsilon_{i,t}^u \quad (14)$$

where the α_t are time fixed effects. β measures the incremental percentage of smoothing achieved by each channel of the GDP per capita decomposition. In particular, β^m indicates the percentage of shock smoothed by capital markets, β^g indicates smoothing from net transfers, and β^p the percentages of shock smoothed by the credit market via private and public saving. If $\beta^u=0$ then full stabilization is achieved; if not, a part of a shock remains unsmoothed. Additionally, since no constraints are imposed on each β coefficient, it could be the case that some of these factors could amplify the shock ($\beta > 1$), or dis-smooth it ($\beta < 0$). By construction, $\sum \beta = 1$.

⁸ See Asdrubali et al. (1996) for details.

Table 1 presents the estimated percentage of shocks to per capita GDP smoothed through each of the channels in the GDP chain decomposition for the EMU11 and the United States over the entire period 1977-2017. Looking at the table, it is immediately apparent that a large portion of shocks to GDP (about 40 percent) is not smoothed in the EMU11 compared to the United States (about 20 percent). This result reflects the greater effectiveness of risk-sharing mechanisms in the US related to factor income flows, and to a lesser extent, net transfers. In contrast, EMU11 countries are characterized by a larger amount of shock smoothed through domestic saving. The results are in line with those obtained by Furceri and Zdzienicka (2015) and reflect on the one hand the greater financial integration and “home bias” in the United States compared to the EMU (as documented by French and Poterba (1991) and Tesar and Werner (1995)), and on the hand, the greater reliance of EMU countries on domestic saving.

(INSERT TABLE 1 NEAR HERE)

In order to assess whether the ability of risk-sharing mechanisms to smooth income fluctuations has changed over time, equations (11)-(14) have been estimated during the two periods, pre- (1977-1997) and post-EMU (1998-2017). The results presented in Table 2 and 3 suggest that while the degree of risk-sharing has improved over time in EMU countries, it has declined in the United States. In particular, the results based on the last 20 years of data suggest that the amount of shock not smoothed in the EMU11 is not statistically significantly different from that of the United States.

Looking in detail at each risk-sharing channel, it seems that the major factor contributing to the increase (decrease) in risk-sharing in the EMU11 (United States) is factor income flows, which have increased (decreased) from about zero (68) percent in the period 1977-1997 to about 46 (45) percent in the period 1998-2017. For the EMU11, and in line with Cimadomo et al. (2018), rolling-windows estimates based on a 20-year window suggest that the bulk of the increase started in 2013 following the activation of the European Financial Stability Facility (EFSF) and the European Stability Mechanism (ESM) channeling official loans to distressed euro zone economies (Figure 13).

(INSERT FIGURE 13, TABLE 2-3 NEAR HERE)

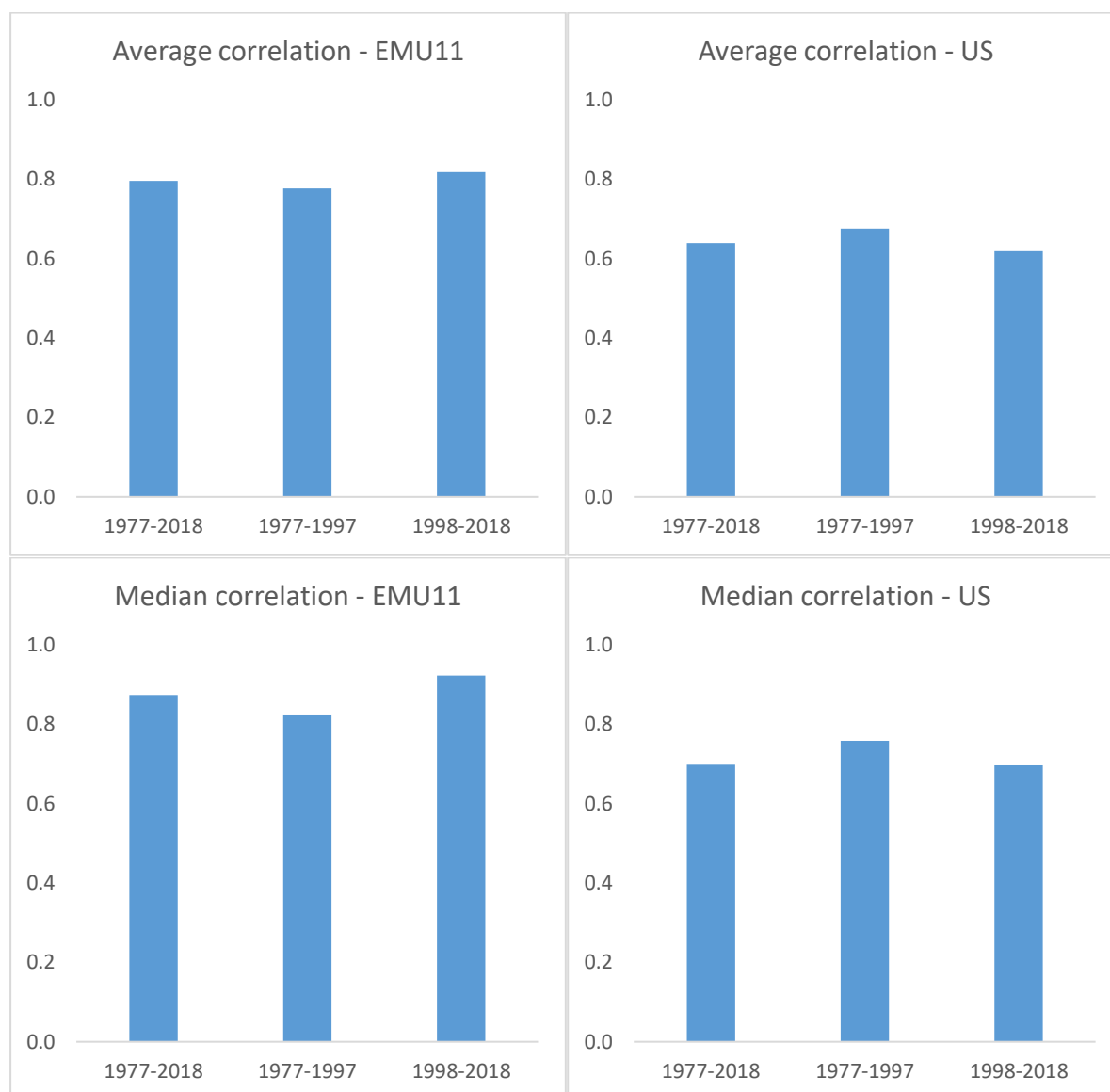
VII. Conclusions

Our paper analyzes alternative channels of adjustment to nominal exchange rate flexibility in response to shocks faced by countries and regions that are part of a monetary union. Over the full sample, the dominant means of adjustment in the United States is through interstate migration. In contrast, labor mobility, both cross-country and within-country, is lower in the euro area; euro area economies adjust to an adverse labor demand shock mainly through a rise in unemployment rates or fall in participation rates. In contrast, we find a noticeable effect on changes in relative prices after a negative labor demand shock in EMU countries. We also document that risk-sharing mechanisms—in particular, factor income flows and to a lesser extent, net transfers—have been, on average, more effective in smoothing GDP per capita fluctuations in the United States than in the EMU.

The strength of these channels, however, has changed over time both for the EMU and in the United States. In the case of EMU countries, we observe that the role of migration as shock absorber has increased, though it remains more limited than in the United States. Similarly, the degree of risk-sharing has significantly increased over time and mostly following the activation of the European Financial Stability Facility (EFSF) and the European Stability Mechanism (ESM). In contrast, both channels of adjustment (migration and risk-sharing mechanisms) have deteriorated in the United States. In other words, our results suggest that patterns of regional adjustments to shocks in EMU and the United States are moving closer, partly because of strengthening of channels of adjustment in the EMU and partly because of worsening of the channels in the United States.

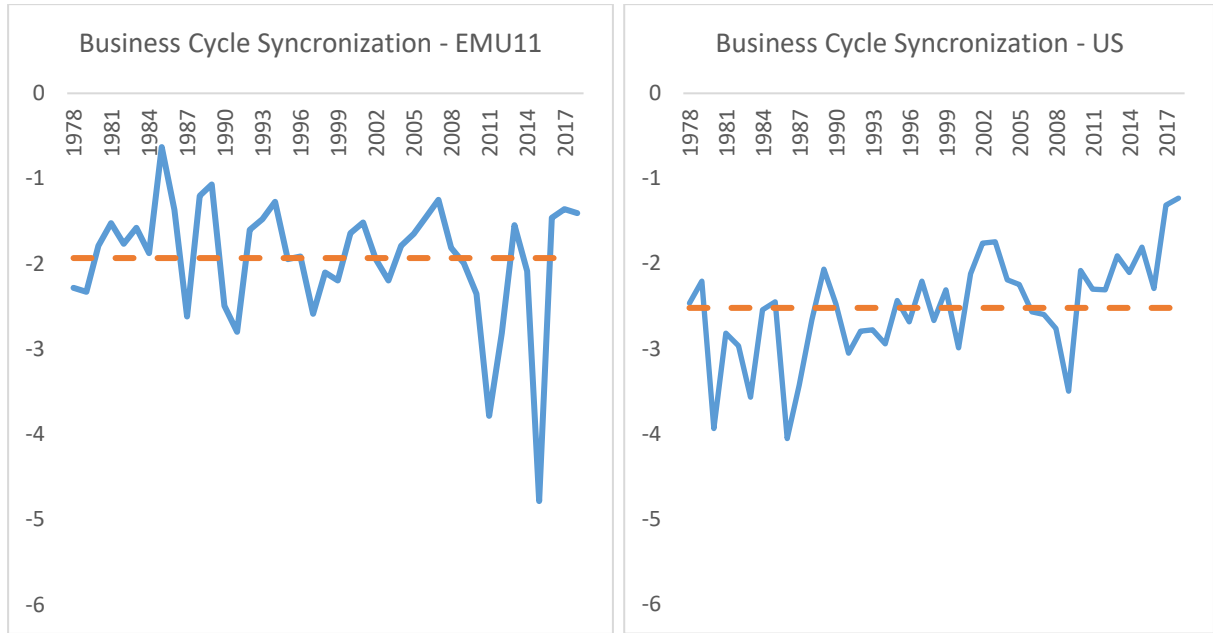
These results may have important implications for the current crisis. While the COVID-19 pandemic is affecting all countries and territories around the world, the course of the pandemic as well as its short-term economic effects appear to be quite heterogeneous both within US states and EMU countries. This implies that the ability of each region to insure against asymmetric shock will be key. While our results suggest that EMU and US are now more similar along this dimension, empirically addressing how each region will perform is an important issue for future research.

Figure 1. Business Cycles Correlation



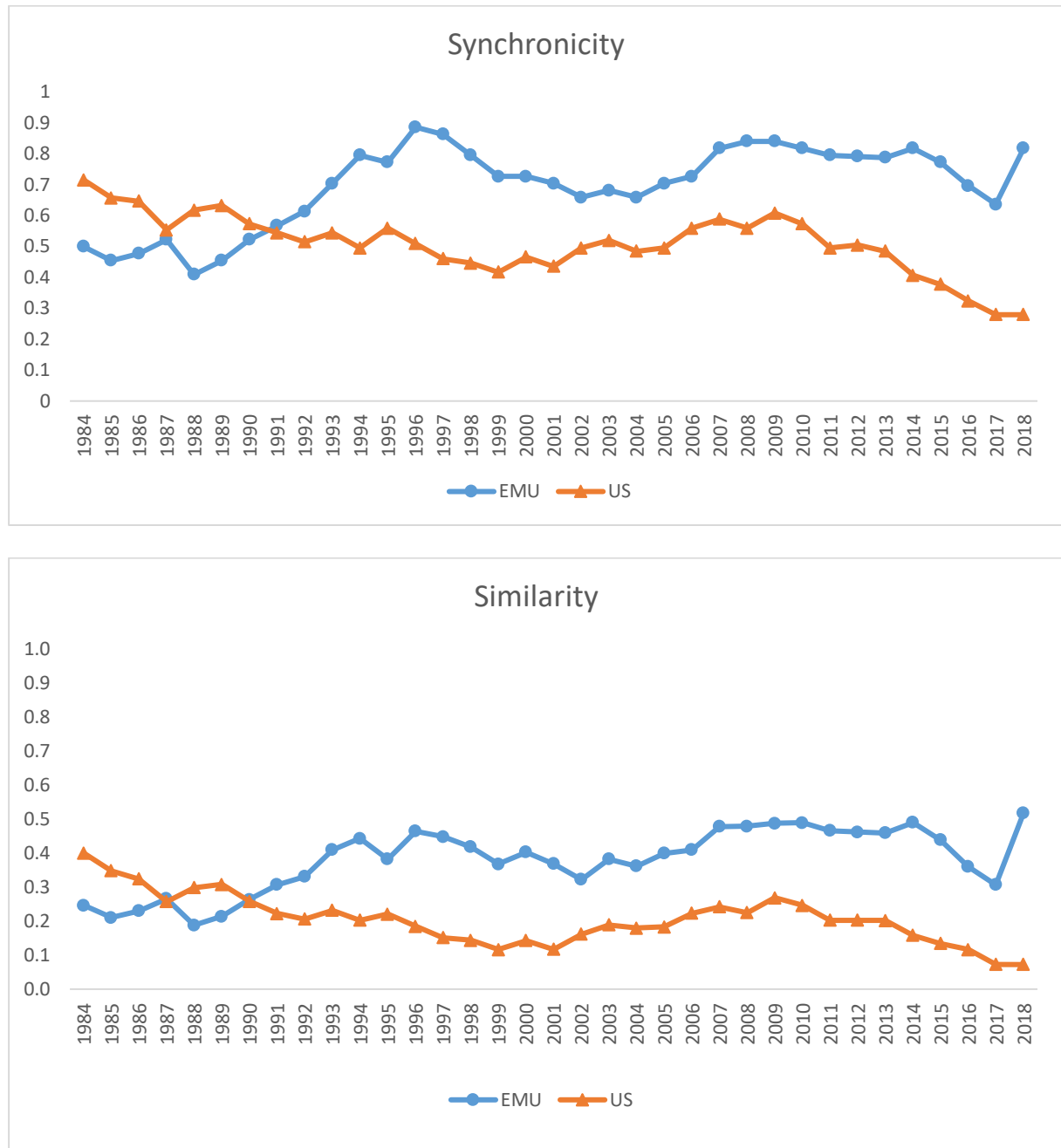
Note: the figure reports the average and the median of the correlation coefficient of each country's (state's) cyclical component of real GDP with that of EMU (US) as a whole, using the HP filter with smoothness parameter equal to 6.25.

Figure 2. Business Cycles Divergence



Note: The figure reports the average business cycle synchronization for the monetary union (blue line), measured as the cross-sectional average of pairwise synchronizations: $Syn_t = 1/n \sum_{ij} \varphi_{ij,t}$, where synchronicity among countries (states) is computed as the negative of the absolute divergence in GDP (GSP) growth: $\varphi_{ij,t} = -|(\ln Y_{i,t} - \ln Y_{i,t-1}) - (\ln Y_{j,t} - \ln Y_{j,t-1})|$. A more negative value indicates that the business cycles between the two states are less synchronized, while a zero value indicates a complete synchronization. The red dashed line indicates the average value of the period.

Figure 3. Business Cycles Coherence



Note: business cycles synchronicity is defined as: $\varphi(t) = \frac{1}{n} \sum_{i=1}^n \frac{g_i(t)g_r(t)}{|g_i(t)g_r(t)|}$; business cycles similarity is defined as $\gamma(t) = 1 - \frac{\sum_{i=1}^n |g_i(t) - g_r(t)|}{\sum_{i=1}^n |g_i(t)|}$; where $g_i(t)$ denotes the output gap of countries (states) i at time t ; $g_r(t)$ is the reference output gap (i.e. the median of all individual countries' (states') output gaps observed at time t); n is the number of countries (states) in the monetary union. As in Mink et al. (2012), the charts show 8-years rolling windows estimates.

Figure 4. Standard deviations of regional (country/states) unemployment rates in EMU11 and US, 1977-2018

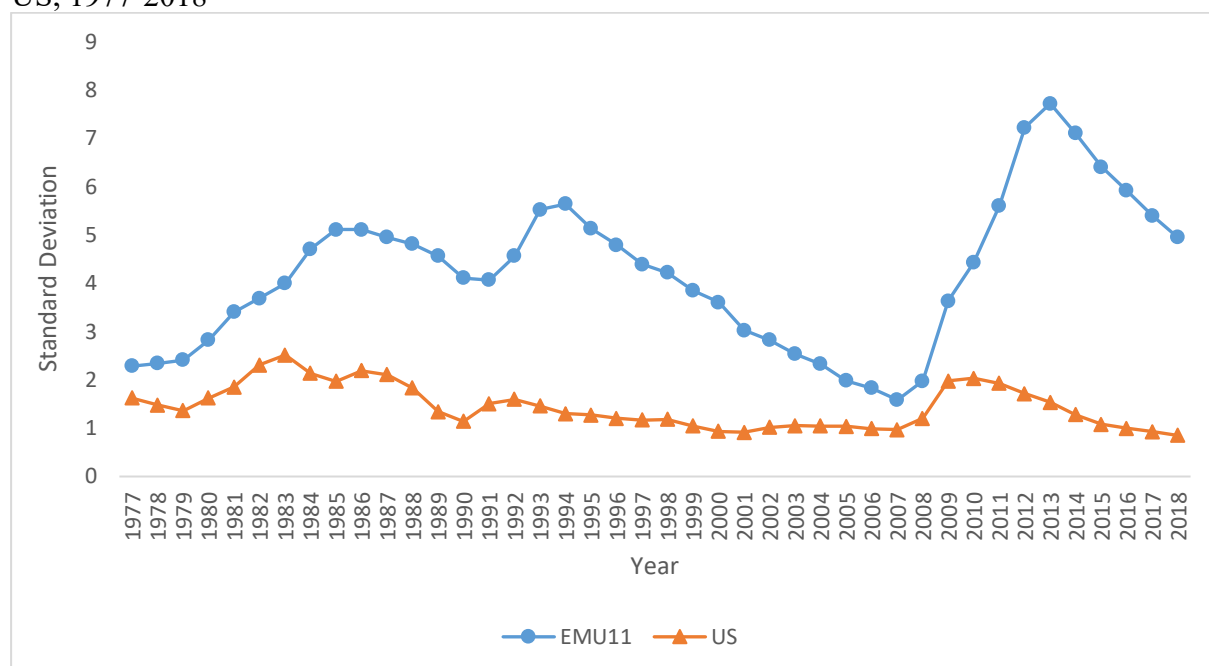


Figure 5. Coefficients of variation of regional (country/states) unemployment rates in EMU11 and US, 1977-2018

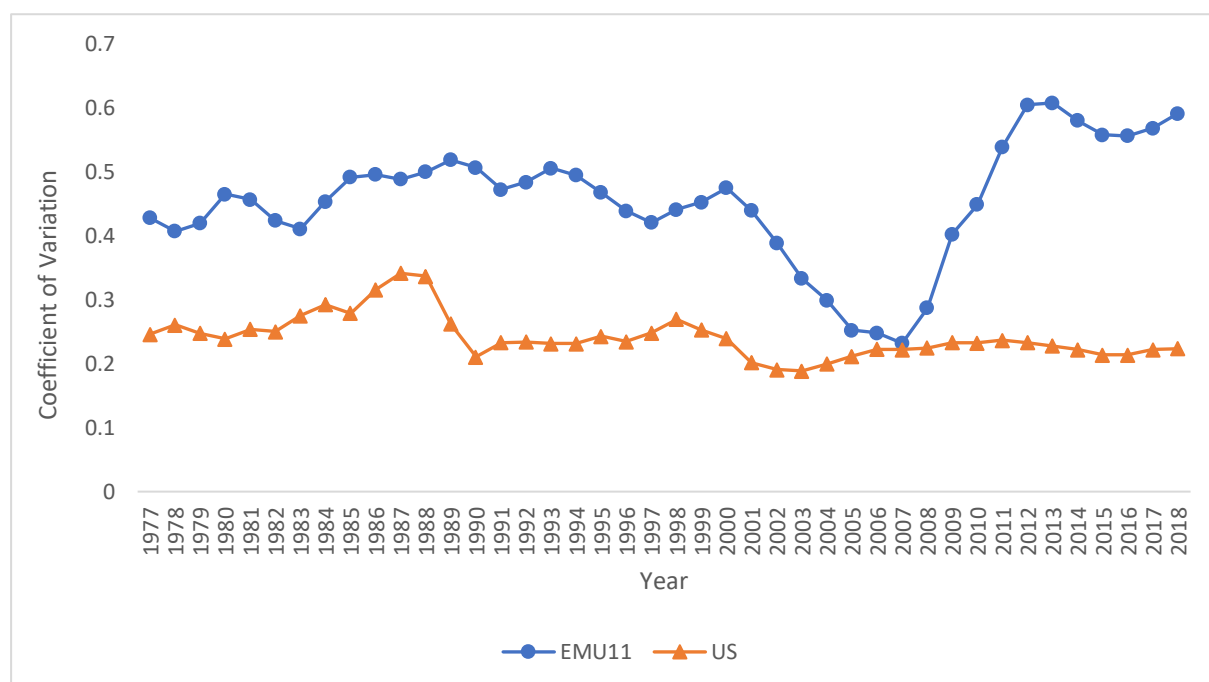


Figure 6. Persistence of regional (country) unemployment in the EMU11 (left panel) and US (right panel) – 1988-2008

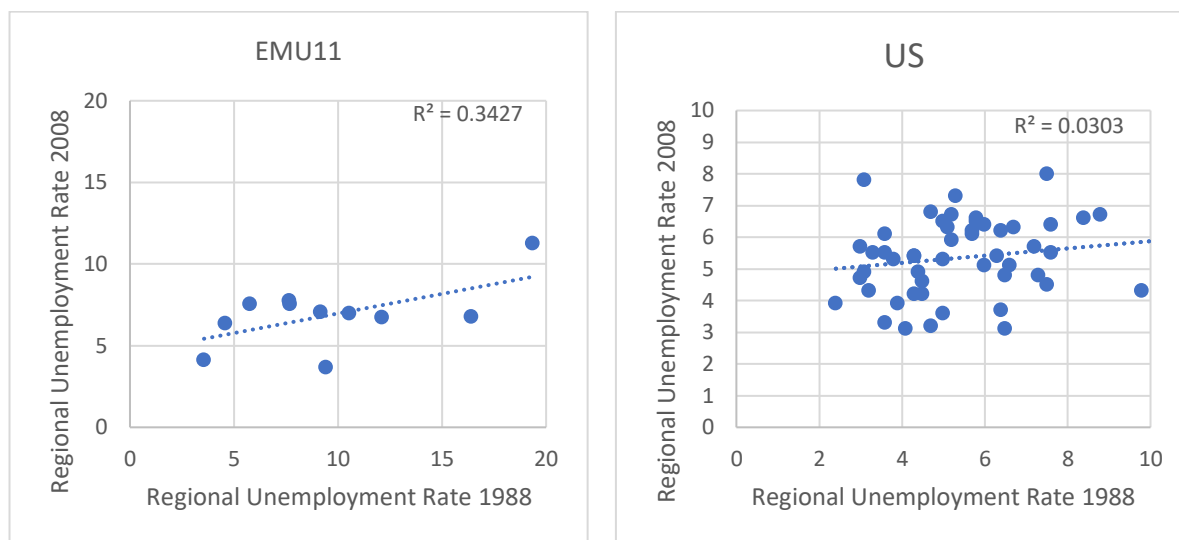
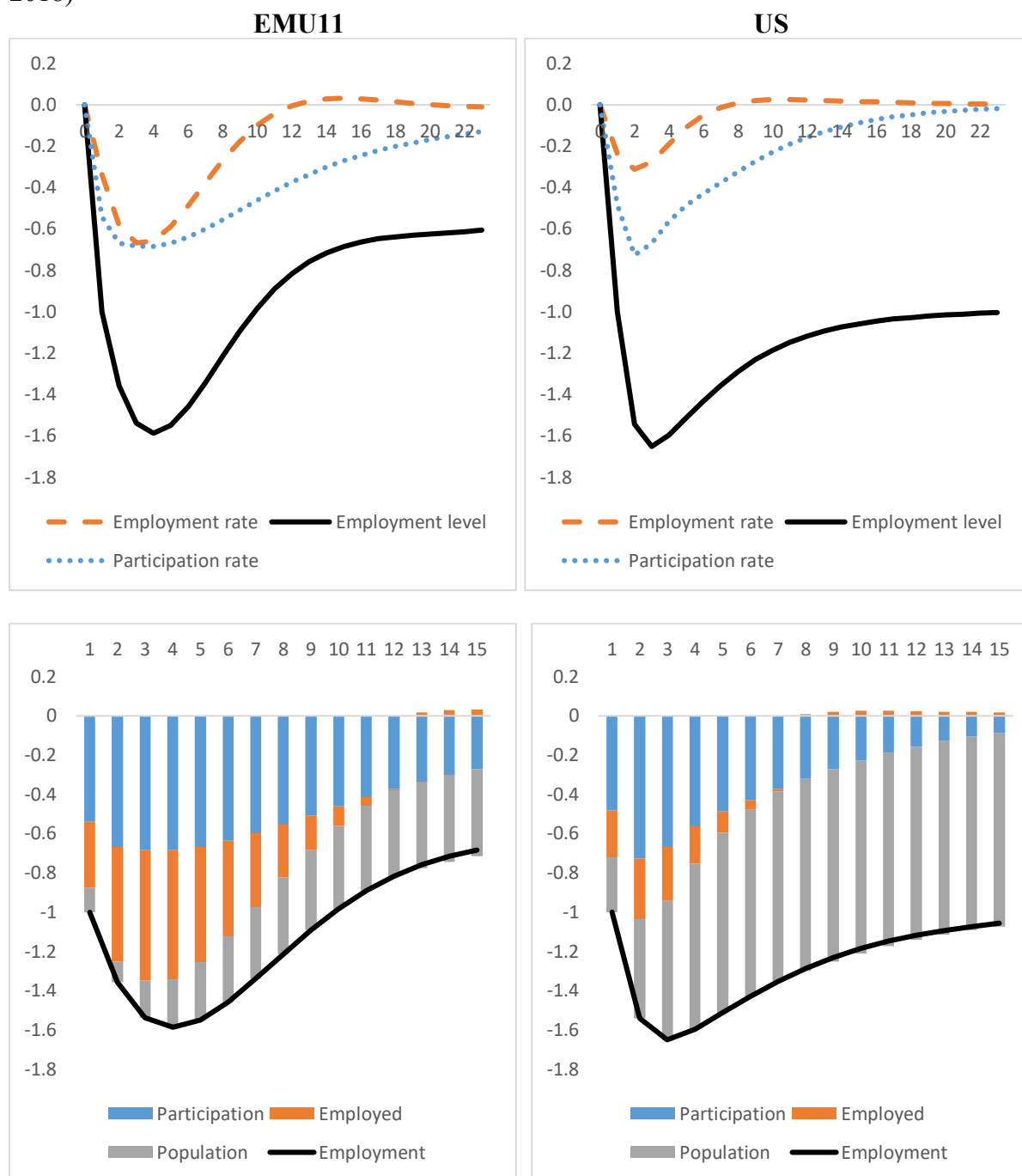
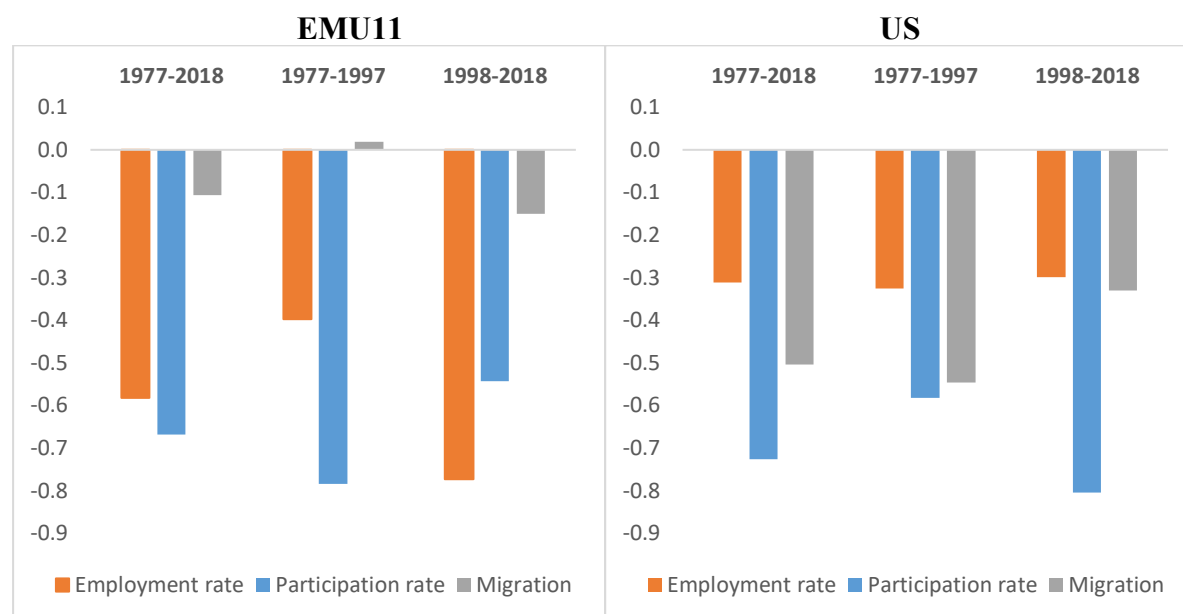


Figure 7. Response to 1 percent negative labor demand shock in the EMU11 and US (1977-2018)



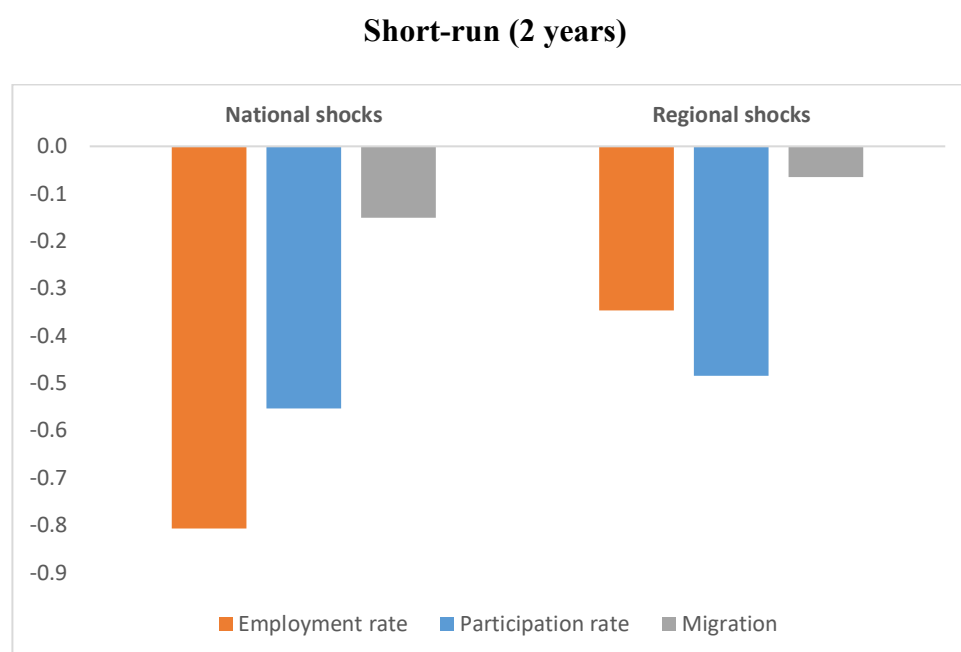
Note: Top panels show the impulse response to 1 percent relative negative labor demand shock under OLS. Units on vertical axis are percent deviation from pre-shock values. Bottom panels show the decomposition of a 1 worker regional labor demand shock to 3 adjustment margins (bottom panels). Estimates based on equations (5)-(7).

Figure 8. Response to 1 percent negative labor demand shock in the EMU11 and US: Impulse response functions – baseline and subperiods (short-run—2 years—responses).



Note: Horizontal axis denotes the period of analysis. The bars show the short-run (2-years) adjustment to 1 percent relative negative labor demand shock through each margin for each period. Units on vertical axis are percent deviation from pre-shock values. Estimates based on equations (5)-(7).

Figure 9. Response to 1 percent negative labor demand shock in the EMU11 – regional vs national shocks (1999-2017)



Note: Horizontal axis denotes the sample of analysis (countries vs regions). The bars show the short-run (2-years) adjustment to 1 percent relative negative labor demand shock through each margin. Units on vertical axis are percent deviation from pre-shock values. Estimates based on equations (5)-(7).

Figure 10. Standard deviation of the log GDP deflator- (1998-2018)

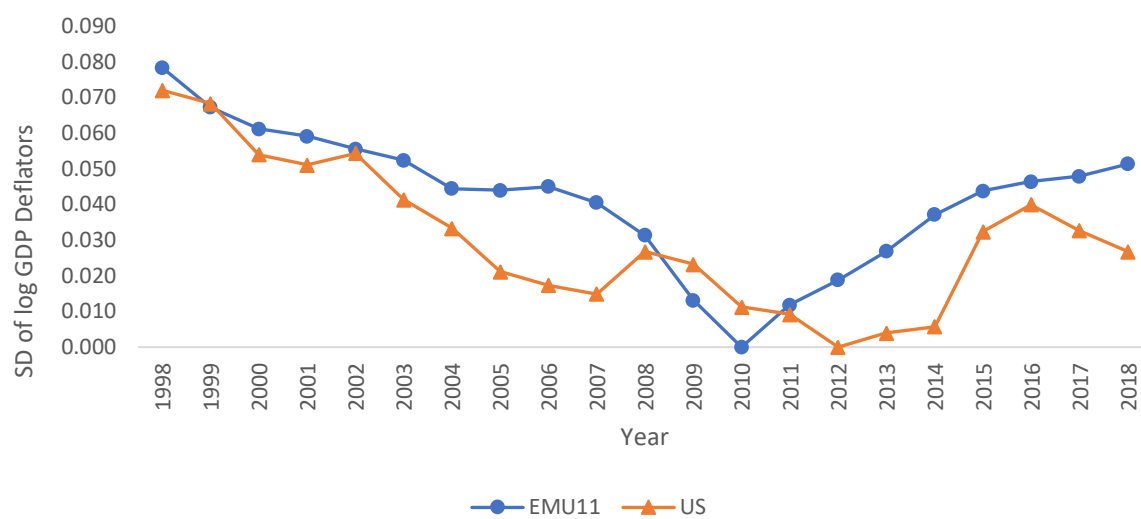


Figure 11. Standard deviation of inflation - (1998-2018)

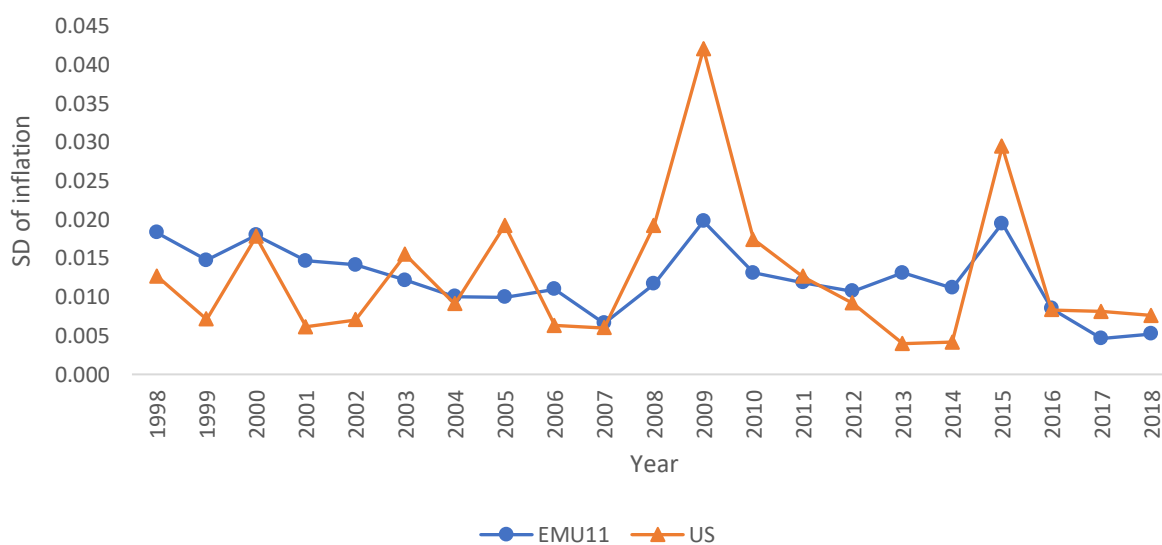
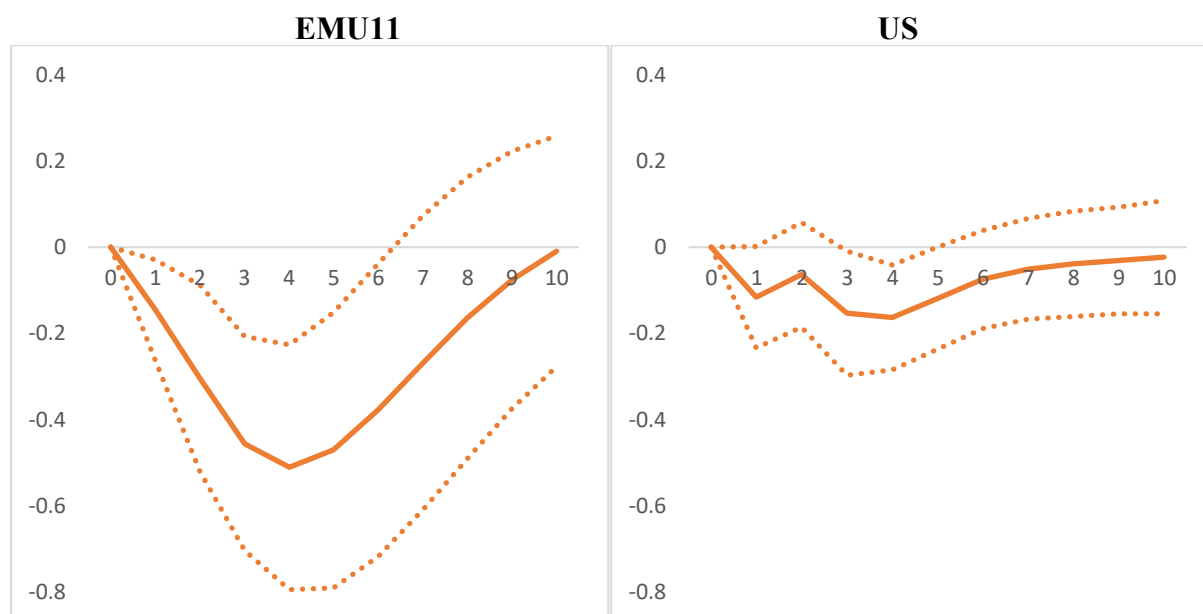
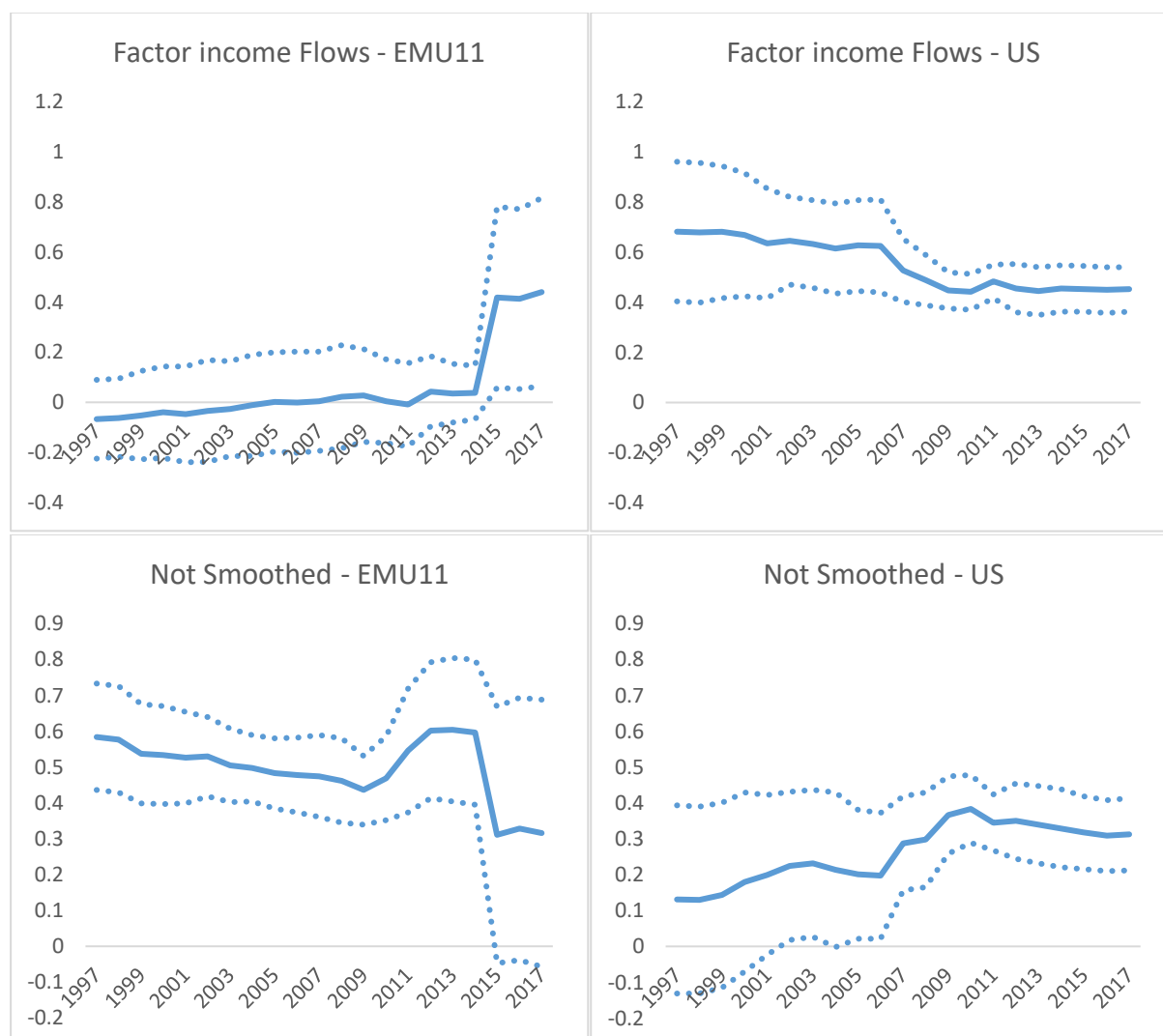


Figure 12. Response of Price Level to 1 percent negative labor demand shock in the and US – (1998-2018)



Note: The panels show the price level impulse response to 1 percent relative negative labor demand shock under OLS in EMU11 and US. Units on vertical axis are percent deviation from pre-shock values. Estimates based on equations (8)-(9). 90 percent confidence bands (obtained through bootstrap) are shown around each line.

Figure 13. Rolling-window estimates of factor income flow risk-sharing and share of shocks not smoothed



Note: Horizontal axis denotes last year of observation in 20 years estimation windows (i.e. 1997 refers to 1977-1997, 1998 refers to 1978-1998 and so on). Units on vertical axis denotes the share of adjustment to shock to GDP per capita through factor income flows (top panels) and the share of shocks not smoothed (bottom panels). Estimates based on equations (11)-(14). The charts show the point estimates (blue lines) and 90 percent confidence bands (gray dotted lines).

Table 1. Channels of output smoothing: EMU11 vs US (1977-2017)

	EMU11			US		
	Coefficient (t-stat)	N	R ²	Coefficient (t-stat)	N	R ²
Factor income Flows	0.261 (1.276)	440	0.219	0.587*** (5.995)	2040	0.483
Net taxes and transfers	-0.110 (-0.825)	440	0.187	0.031*** (4.056)	2040	0.742
Saving	0.435*** (3.774)	440	0.490	0.174** (2.446)	2040	0.177
Not Smoothed	0.414** (2.354)	440	0.566	0.207** (2.476)	2040	0.238

Note: Robust t-statistics clustered on countries (states) in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Estimates based on equations (11)-(14).

Table 2. Channels of output smoothing: EMU11 vs US (1977-1997)

	EMU11			US		
	Coefficient (t-stat)	N	R ²	Coefficient (t-stat)	N	R ²
Factor income Flows	-0.067 (-0.703)	220	0.185	0.682*** (4.020)	1020	0.502
Net taxes and transfers	0.094** (2.509)	220	0.257	0.028** (2.246)	1020	0.524
Saving	0.389*** (3.928)	220	0.444	0.159 (1.414)	1020	0.129
Not Smoothed	0.585*** (6.482)	220	0.569	0.131 (0.823)	1020	0.188

Note: Robust t-statistics clustered on countries (states) in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Estimates based on equations (11)-(14).

Table 3. Channels of output smoothing: EMU11 vs US (1998-2017)

	EMU11			US		
	Coefficient (t-stat)	N	R ²	Coefficient (t-stat)	N	R ²
Factor income Flows	0.455* (1.927)	220	0.339	0.450*** (8.295)	1020	0.479
Net taxes and transfers	-0.231 (-1.383)	220	0.320	0.036*** (3.543)	1020	0.837
Saving	0.463** (2.753)	220	0.526	0.196*** (5.779)	1020	0.431
Not Smoothed	0.313 (1.322)	220	0.576	0.318*** (5.065)	1020	0.496

Note: Robust t-statistics clustered on countries (states) in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Estimates based on equations (11)-(14).

Data Appendix

Blanchard-Katz model

For US data on employment level, participation rate and unemployment rate are taken from The Bureau of Labor Statistics (BLS).

In the case of EMU11 countries (and intranational analysis) all data are taken from OECD database.

Obstfeld-Peri price flexibility model

For US we use the GDP deflator (Nominal GDP/Real GDP) as index of relative prices. Data come from The Bureau of Economic Analysis (BEA). Conversely, data for the employment level come from The Bureau of Labor Statistics (BLS).

In the case of EMU11, we use the GDP deflator (Nominal GDP/Real GDP) as index of relative prices and data (also for the employment level) are taken from OECD database.

Risk-sharing

For this exercise we use data on GDP (GSP), net national income (NI), disposable national income (DNI) and total consumption (scaled on population to obtain the per-capita value). In the case of US data come from The Bureau of Economic Analysis (BEA).

On the other hand, for EMU11 between-country analysis, data are taken from OECD database.

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Online appendix for the paper “Moving closer? Comparing regional adjustments to shocks in EMU and the United States”

by Davide Furceri, Prakash Loungani, Pietro Pizzuto

Table A1. Business Cycles Correlation – Robustness checks

	Average correlation - EMU11			Average correlation - US		
	1977-2018	1977-1997	1998-2018	1977-2018	1977-1997	1998-2018
Hodrick–Prescott (baseline)	0.80	0.78	0.82	0.64	0.68	0.62
Baxter-King filter	0.80	0.77	0.83	0.62	0.64	0.61
Hamilton filter	0.80	0.72	0.84	0.63	0.67	0.61
	Median correlation - EMU11			Median correlation - US		
	1977-2018	1977-1997	1998-2018	1977-2018	1977-1997	1998-2018
Hodrick–Prescott (baseline)	0.87	0.82	0.92	0.70	0.76	0.70
Baxter-King filter	0.89	0.82	0.93	0.68	0.69	0.70
Hamilton filter	0.85	0.77	0.90	0.72	0.76	0.69

Note: the table reports the average and the median of the correlation coefficient of each country’s (state’s) cyclical component of real GDP with that of EMU (US) as a whole, using, in turn, different business cycles’ filter techniques.

Table A2. Business Cycles Correlation – Robustness checks – Quarterly data

	EMU11 (1996-2018)		US (2005-2018)	
	Average correlation		Average correlation	
	Quarterly data	Annual data	Quarterly data	Annual data
Hodrick–Prescott filter (baseline)	0.79	0.81	0.61	0.62
Baxter-King filter	0.82	0.83	0.66	0.63
Hamilton filter	0.77	0.78	0.55	0.53
	Median correlation		Median correlation - US	
	Quarterly data	Annual data	Quarterly data	Annual data
Hodrick–Prescott filter (baseline)	0.90	0.92	0.74	0.76
Baxter-King filter	0.92	0.93	0.81	0.75
Hamilton filter	0.83	0.88	0.70	0.69

Note: the table reports the average and the median of the correlation coefficient of each country's (state's) cyclical component of real GDP with that of EMU (US) as a whole, using, in turn, different business cycles' filter techniques. Estimations on EMU11 (US) are based on quarterly data over the period 1996-2018 (2005-2018) due to data constraints.

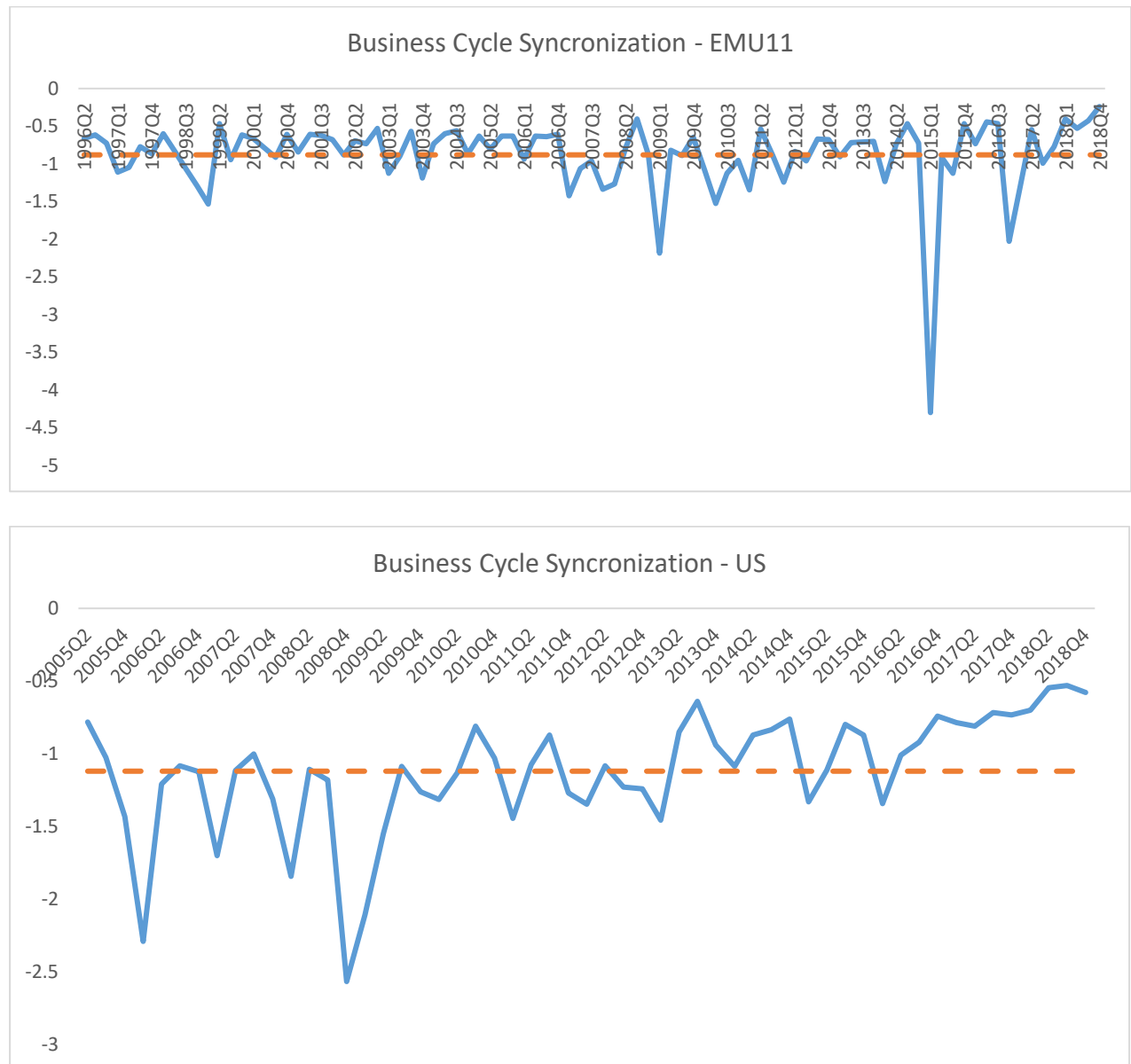
Table A3. Response to 1 percent negative labor demand shock in the EMU11 – regional vs national shocks (1999-2017)

	Employment rate			
	1 year	5 years	10 years	15 years
National shocks	-0.48	-0.39	0.33	0.05
Regional Shocks - Average	-0.34	-0.06	0.00	0.01
Regional Shocks - Median	-0.28	-0.04	0.00	0.00
Regional Shocks - First quartile	-0.19	-0.01	0.01	0.01
Regional Shocks - Third quartile	-0.50	-0.13	-0.02	0.00
	Participation rate			
	1 year	5 years	10 years	15 years
National shocks	-0.46	-0.37	-0.12	0.00
Regional Shocks - Average	-0.58	-0.04	-0.01	-0.02
Regional Shocks - Median	-0.59	-0.03	0.00	0.00
Regional Shocks - First quartile	-0.39	0.04	0.03	0.00
Regional Shocks - Third quartile	-0.76	-0.09	-0.01	0.00
	Migration			
	1 year	5 years	10 years	15 years
National shocks	-0.06	-0.30	-0.20	-0.07
Regional Shocks - Average	-0.08	-0.14	-0.15	-0.15
Regional Shocks - Median	-0.05	-0.13	-0.15	-0.16
Regional Shocks - First quartile	-0.03	-0.10	-0.11	-0.10
Regional Shocks - Third quartile	-0.07	-0.18	-0.17	-0.17

Table A4. Country-specific short-term response

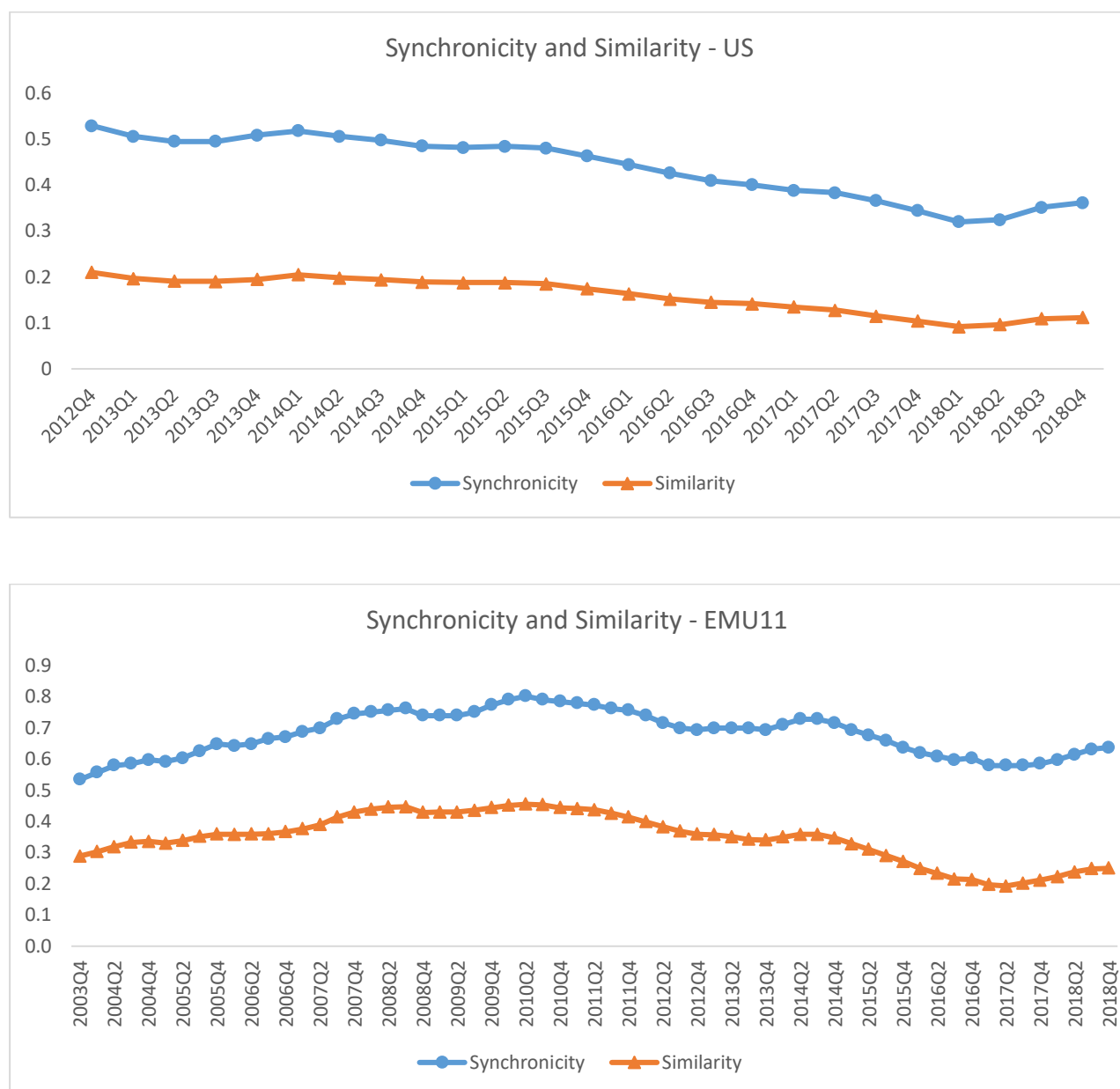
Country	Variable	First Year
AUT	Employment	-1.000
	Employment rate	-0.170
	Participation rate	-0.789
	Migration	-0.041
BEL	Employment	-1.000
	Employment rate	-0.668
	Participation rate	-0.335
	Migration	0.003
FIN	Employment	-1.000
	Employment rate	-0.288
	Participation rate	-0.604
	Migration	-0.108
FRA	Employment	-1.000
	Employment rate	-0.094
	Participation rate	-0.905
	Migration	-0.001
DEU	Employment	-1.000
	Employment rate	-0.263
	Participation rate	-0.662
	Migration	-0.075
GRC	Employment	-1.000
	Employment rate	-0.537
	Participation rate	-0.433
	Migration	-0.030
ITA	Employment	-1.000
	Employment rate	-0.252
	Participation rate	-0.375
	Migration	-0.373
NLD	Employment	-1.000
	Employment rate	-0.146
	Participation rate	-0.798
	Migration	-0.056
PRT	Employment	-1.000
	Employment rate	-0.376
	Participation rate	-0.572
	Migration	-0.052
ESP	Employment	-1.000
	Employment rate	-0.593
	Participation rate	-0.370
	Migration	-0.037

Figure A1. Business Cycles Divergence – Robustness checks – Quarterly data



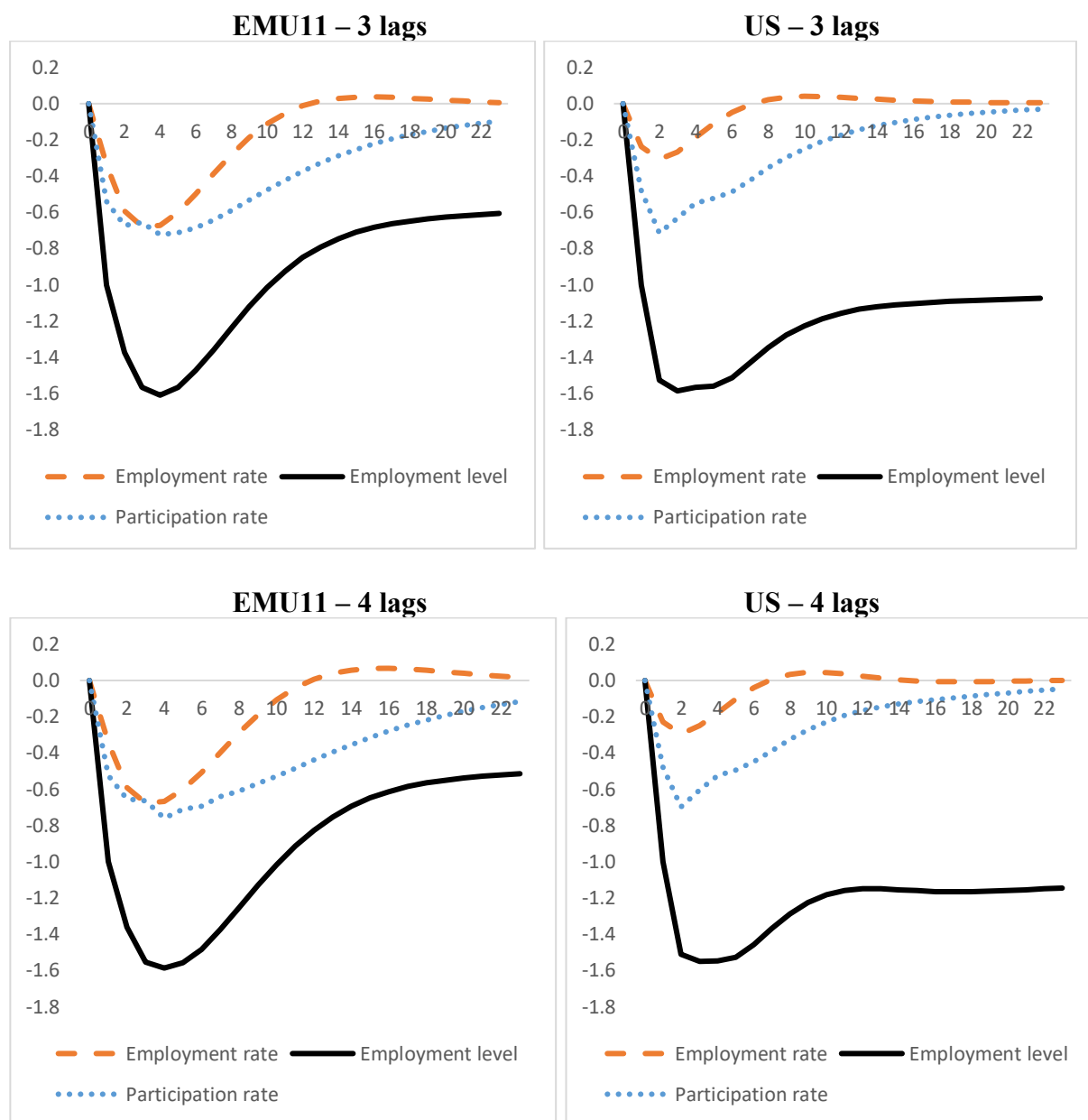
Note: The figure reports the average business cycle synchronization for the monetary union (blue line), measured as the cross-sectional average of pairwise synchronizations: $Syn_t = 1/n \sum_{ij} \varphi_{ij,t}$, where synchronicity among countries (states) is computed as the negative of the absolute divergence in GDP (GSP) growth: $\varphi_{ij,t} = -|(\ln Y_{i,t} - \ln Y_{i,t-1}) - (\ln Y_{j,t} - \ln Y_{j,t-1})|$. A more negative value indicates that the business cycles between the two states are less synchronized, while a zero value indicates a complete synchronization. The red dashed line indicates the average value of the period. Estimations on EMU11 (US) are based on quarterly data over the period 1996-2018 (2005-2018) due to data constraints.

Figure A2. Business Cycles Coherence – Robustness checks – Quarterly data



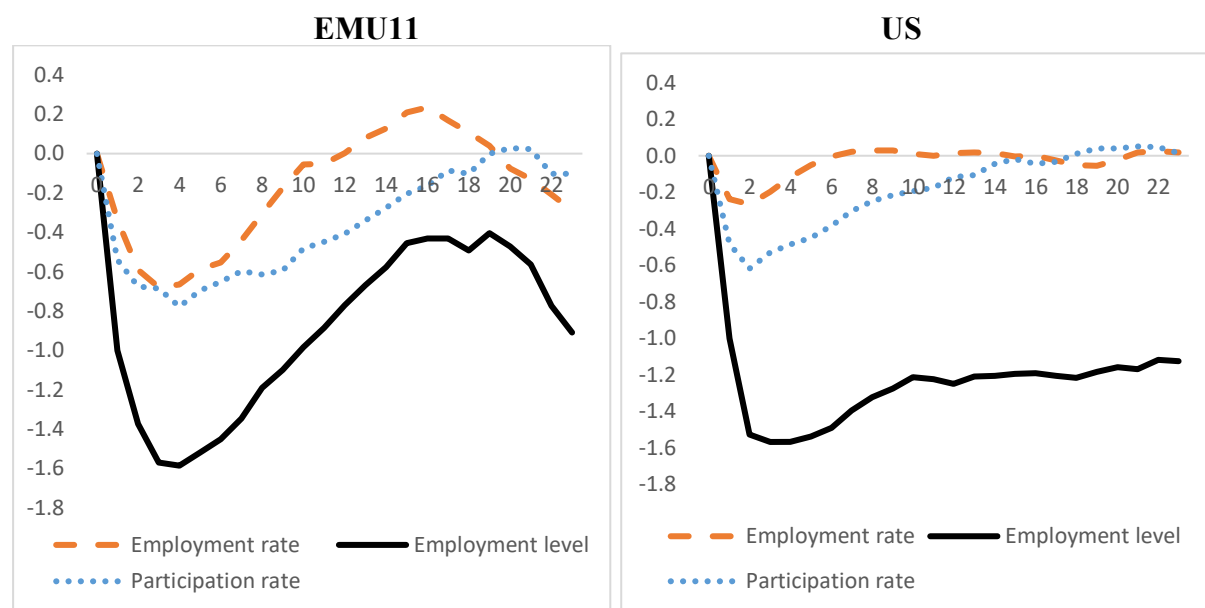
Note: business cycles synchronicity is defined as: $\varphi(t) = \frac{1}{n} \sum_{i=1}^n \frac{g_i(t)g_r(t)}{|g_i(t)g_r(t)|}$; business cycles similarity is defined as $\gamma(t) = 1 - \frac{\sum_{i=1}^n |g_i(t) - g_r(t)|}{\sum_{i=1}^n |g_i(t)|}$; where $g_i(t)$ denotes the output gap of countries (states) i at time t ; $g_r(t)$ is the reference output gap (i.e. the median of all individual countries' (states') output gaps observed at time t); n is the number of countries (states) in the monetary union. As in Mink et al (2012) charts show 8-years rolling windows estimates. Estimations on EMU11 (US) are based on quarterly data over the period 1996-2018 (2005-2018) due to data constraints.

Figure A3. Response to 1 percent negative labor demand shock in the EMU11 and US (1977-2018) – alternative lag structures



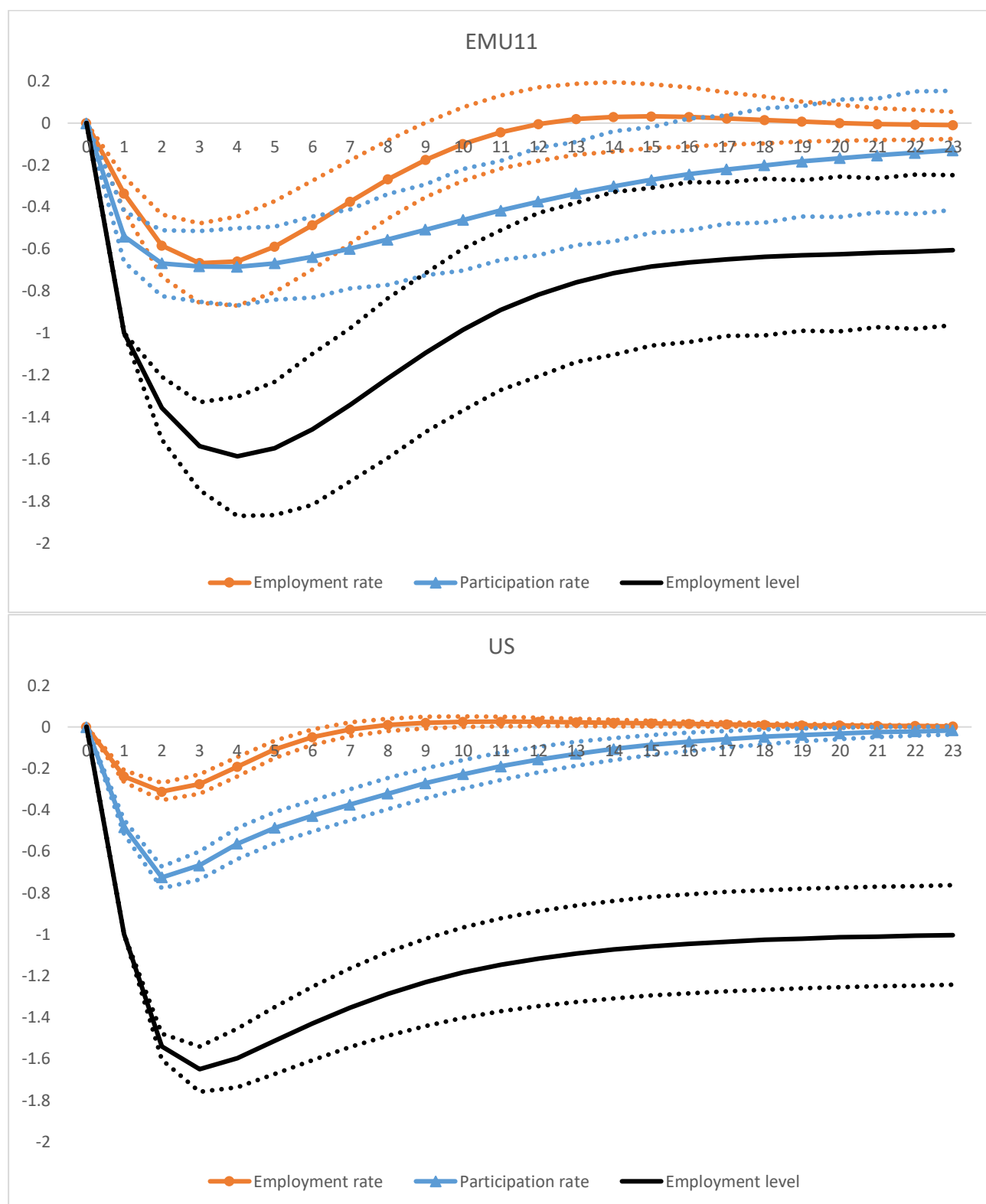
Note: The panels show the impulse response to 1 percent relative negative labor demand shock under OLS. Units on vertical axis are percent deviation from pre-shock values Top (bottom) panels shows the results obtained using three (four) lags for each variable. Estimates based on equations (5)-(7).

Figure A4. Response to 1 percent negative labor demand shock in the EMU11 and US (1977-2018) – Local Projections estimation



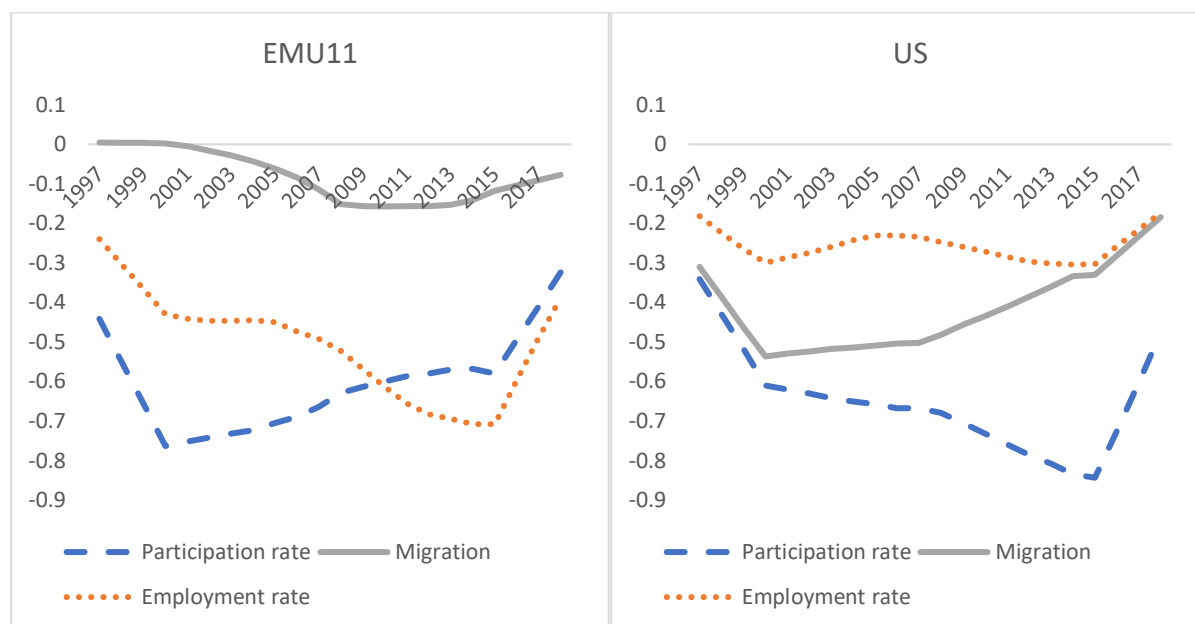
Note: The panels show the impulse response to 1 percent relative negative labor demand shock using the local projections approach by Jordà (2005). Units on vertical axis are percent deviation from pre-shock values.

Figure A5. Response to 1 percent negative labor demand shock in the EMU11 and US (1977-2018) – confidence intervals



Note: The panels show the impulse response to 1 percent relative negative labor demand shock under OLS. Units on vertical axis are percent deviation from pre-shock values. Estimates based on equations (5)-(7). 90 percent confidence bands (obtained through bootstrap) are shown around each line.

Figure A6. Rolling-window estimates of BK model - Impulse response functions—(short-run—2 years—responses) – 1977-2018



Note: The charts show the short-run smoothed (2-years) response to 1 percent negative labor demand shock in the EMU11 and US using rolling windows. Horizontal axis denotes last year of observation in 20 years estimation windows (i.e. 1997 refers to 1977-1997, 1998 refers to 1978-1998 and so on). The lines show the short-run (2-years) adjustment to 1 percent relative negative labor demand shock through each margin for each period. Estimates based on equations (5)-(7).