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Strengthening the Euro Area: The Role of National Structural Policies in Building Resilience

Technical Appendices for SDN/19/05

Shekhar Aiyar, John Bluedorn, Romain Duval, Davide Furceri, Daniel Garcia-Macia, Yi Ji, Davide Malacrino, Haonan Qu, Jesse Siminitz, and Aleksandra Zdzienicka

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BUSINESS CYCLES AND STRUCTURAL POLICIES IN ADVANCED ECONOMIES: FURTHER STYLIZED FACTS AND ANALYSIS[1]

Based on sample of 21 advanced economies (12 euro area countries) that goes back to the early 1970s, an analysis of the relationships between a country's business cycle properties and its structural policies and characteristics is conducted. In general, the findings suggest that greater product and labor market flexibility is associated with shorter and shallower recessions, faster recoveries, and longer expansions. While desirable in general, these features are crucial for countries in a monetary union, where the exchange rate cannot provide an alternative adjustment mechanism.

Business cycle dating and calculation of statistical properties. Business cycle properties are determined from the behavior of quarterly, seasonally adjusted real GDP on a constant PPP basis from the OECD, covering advanced economies from 1972:Q1 onwards. The classical cycle concept, similar to the classic NBER/CEPR business cycle, is used to identify the cycle dating and calculate cyclical properties:

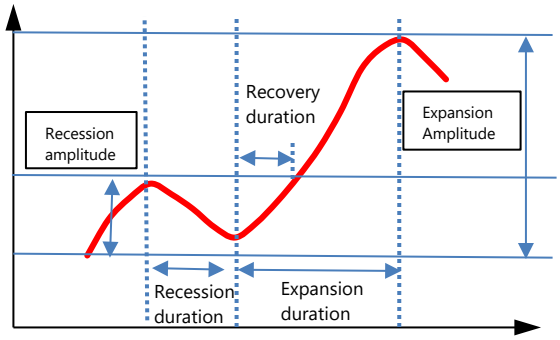
- *Classical Cycle* – Harding and Pagan's (2002) algorithm for the dating of peaks and troughs in the level path of output (local maxima and minima within a moving 3 quarter window) is used. See figure F1 for an illustration. Phases (recessions/expansions) are required to alternate and have minimal length of 2 quarters. Peak-to-trough periods (peak exclusive, trough inclusive) are recessions, trough-to-peak (trough exclusive, peak inclusive) are expansions, and recoveries are periods following identified trough (exclusive) which end when output recovers to its previous historical maximum (inclusive). It is worth noting that it is possible that recovery phases overlap with recession phases in this context. For example, recessions could occur before a recovery phase is completed, resulting multiple-dip recessions. Many countries experienced double-dip recessions since the global financial crisis. Some smoothing is used for Greece, the Netherlands, and New Zealand series by taking 4-quarter moving average for the early years in order to address anomalies in these series before the business cycle dating algorithm is applied.[2] Identified cycles for selected economies are presented alongside cycles identified by national/international institutes where available in Panels P1 and P2. The cyclical properties calculated include:
    a. Duration of phase
    b. Amplitude of phase

[1] Prepared by John Bluedorn, Yi Ji, Haonan Qu, and Jesse Siminitz.

[2] The smoothing applies to the pre-1995 series for Greece and New Zealand, pre-1985 series for Netherland to adjust for excessive zigzag patterns in these series.

See Table S1 for summary statistics regarding these cyclical properties for a selective set of advanced economies.

Figure 1.1. Diagram of Business Cycle Phases



Economic resilience and the effects of structural policies and characteristics. Structural policy indicators and characteristics may be broadly categorized as capturing: (i) labor market regulations (employment protection for regular and temporary contracts, temporary employment share); (ii) product market regulations (barriers to firm entry); (iii) international interface (exchange rate regime, financial openness, trade openness). Summary statistics of structural policy indicators and characteristics explored are shown in Table S2, with underlying variable definitions and sources in Table S3. Two different analytical approaches to assessing the role of structural policies and characteristics were employed.

1. ***Pooled linear regression:*** The below linear model is estimated, pooling across countries, with the cyclical property at the phase level being the unit of observation:

$$y = \alpha + S'\beta + X'\gamma + \epsilon$$

where:

- *y* is the cyclical property of interest (recession duration, recession amplitude in negative terms, recovery duration, expansion duration, and expansion amplitude);
- *S* is a vector of structural policy variables of interest which include binary exchange rate regime indicator, indices of product and labor market regulations, indices of employment protection legislations of regular and temporary contracts, and their interaction term to capture nonlinear effects, share of temporary employment, trade openness, and financial openness.
- *X* is a vector of controls, including time dummies and country fixed effects. In some specifications, monetary policy rates and procyclicality of fiscal policy are included for robustness check.

Baseline results from the pooled linear regression analysis are shown in Table1.4. Focusing on the statistically significant findings, they suggest that:

- A *fixed exchange rate regime* is associated with: 1) larger losses from recessions; 2) higher likelihood of recessions implied by shorter expansions; 3) less gain (or amplitude) during expansions, consistent with shorter expansion duration.
- *Stricter product market regulations* are associated with deeper and longer economic recessions. Taken at face value, the estimates imply that, if, for example, France were to loosen its product market regulation to that of the U.K., economic recessions would on average be 1.2 quarters shorter and losses in output would be about 1.3 percentage points lower on average during recessions.

- *Stricter labor (employment protection) regulation* is associated with greater losses during economic recessions and longer recovery time. Results for the interaction term between EPL regular and EPL temporary suggest that the impacts of stricter EPL for regular contracts on recession amplitude and recovery duration are weaker when EPL is more stringent for temporary contracts and vice versa. Stricter EPL for temporary contracts is also found to be linked with less gain on average during the economic expansions.
- *Higher financial openness, proxied by the Chinn-Ito index,* is associated with shorter recessions. The estimate, while statistically insignificant, also suggests expansions tend to be shorter with higher financial openness. The implied higher frequency of economic cycles for countries with more open financial accounts could reflect their larger exposure to external shocks.

A couple of variables that captures cyclical policy stances/intentions, namely policy rate and procyclicality of fiscal policy, are considered as part of robustness check of the baseline results. The estimates are presented in Table 1.5. The baseline results remain broadly unchanged.

- The coefficient estimates of exchange rate regime for expansion duration and amplitude become statistically insignificant while the sign of the estimates remains the same as those in the baseline.
- The coefficient estimates of financial openness are now statistically significant for expansion duration, supportive of higher frequency of economic cycles for countries with more open financial accounts.

2. ***Duration analysis:*** A multivariate analysis for duration of business cycle is undertaken using an accelerated failure-time model based on the Weibull distribution. The model assumes that the length of phase j , here denoted t_j, can be expressed as

$$\boldsymbol{t_j = exp\ (x_j \beta) z_j}$$

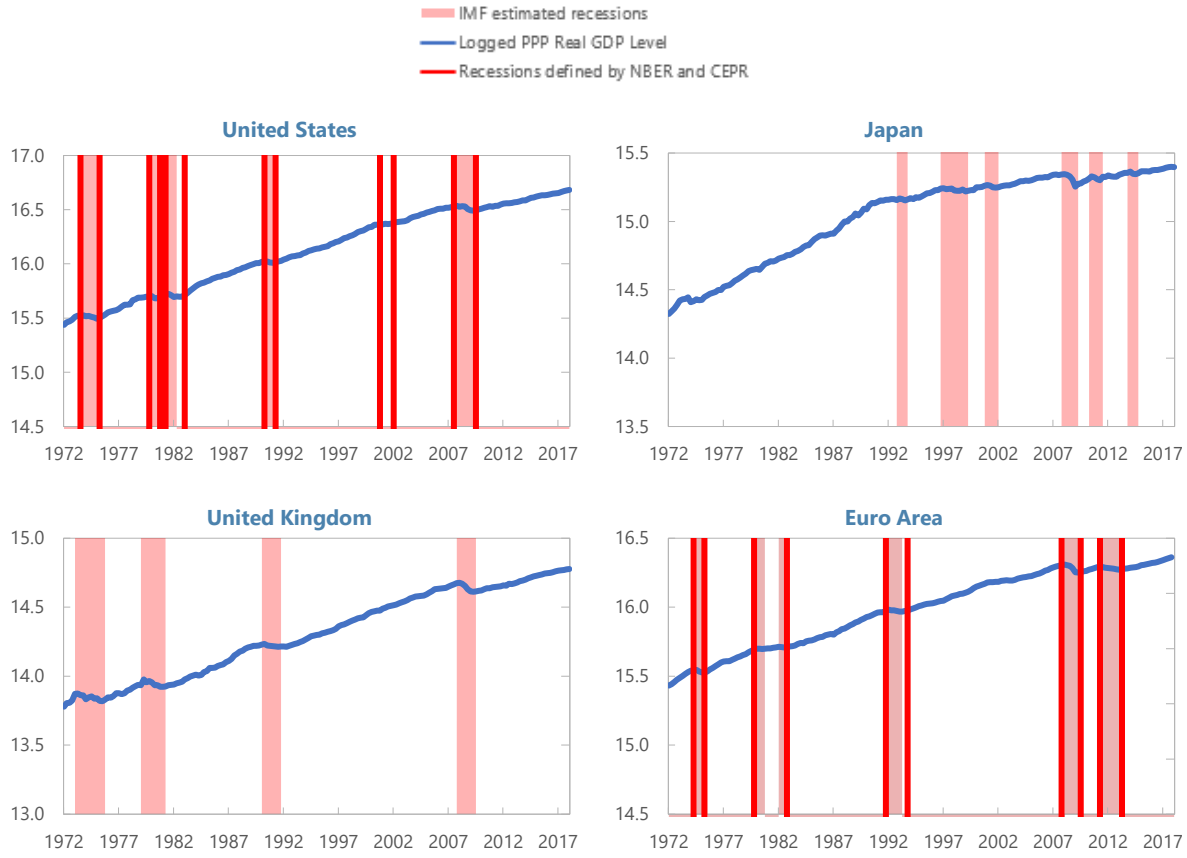
where x_j is a vector of covariates which include the structural policies variables of interest and other control variables, β is a vector of coefficients, and z_j has a Weibull distribution with shape parameter ρ. The model links structural policies and characteristics to the likelihood that an economic phase ends—in other words, what is associated with a greater chance for shorter recessions/expansions/recovery? Results are shown in Table1.6, which are consistent with the findings from pooled linear regressions:

- A *fixed exchange rate regime* is associated with longer recessions. Based on the estimates, recessions would on average be 50 percent longer when a country moves from a flexible exchange regime to a fixed one. The result is robust when the cyclical policy variables are included. The estimates also suggest a fixed exchange regime shortens expansions, though they are not statistically significant.
- *Stricter product market regulation* is correlated with longer recessions and recoveries. Taken at face value, the results imply that, if, for example, France were to loosen its product market regulation to that of the U.K., economic recessions and recoveries would on average be 25 percent and 20 percent shorter respectively.

- *Stricter EPL* tends to be associated with longer recessions and shorter expansions, though the estimates become statistically significant when the cyclical policy variables are included. Similar to the results from the pooled regressions, the estimates of the interaction term between EPL regular and EPL temporary suggest the impact of stricter EPL on regular contracts on recession and expansion duration becomes weaker with more stringent EPL on temporary contracts and vice versa.
- The estimates also suggest that *high financial openness* is associated with shorter recessions and expansions.

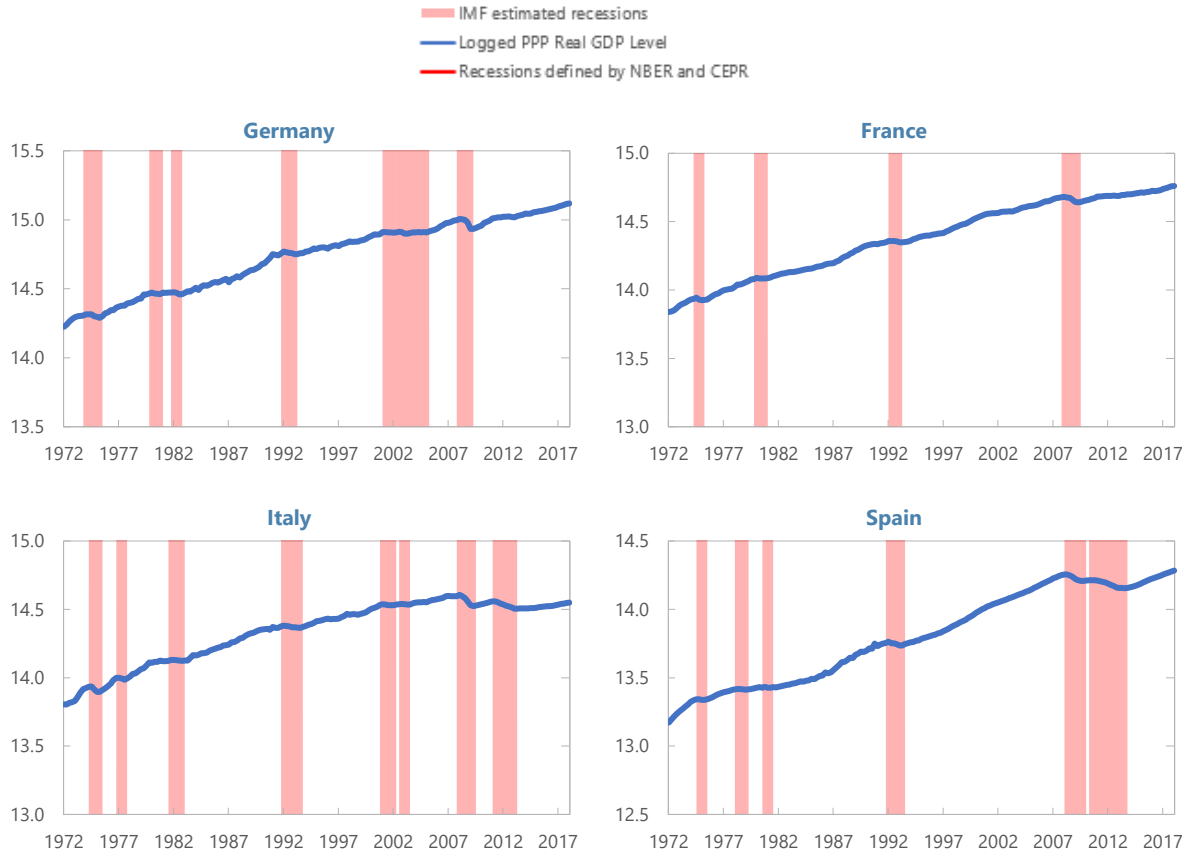
These findings provide some support to the hypothesis that greater economic flexibility is associated with greater economic resilience, as captured by less severe recessions, faster recoveries, and longer expansions.

Figure 1.2 Selected Advanced Economies



Sources: OECD; NBER; CEPR; and IMF staff calculations.
Notes: 1) Official US business cycle recessions defined by the National Bureau of Economic Research.; 2) Euro area business cycle recessions as defined by the Centre for Economic Policy Research

Figure 1.3 Selected Euro Area Economies



Sources: OECD; NBER; CEPR; and IMF staff calculations.

Table 1.1 Summary of Business Cycle Properties Harding and Pagan Approach

	USA	GBR	JPN	FRA	DEU	ITA	ESP	FRA	DEU	ITA	ESP	FRA	DEU	ITA	ESP
				All sample				Pre Euro Period				Post Euro Period			
Mean duration (quarters)															
Recession	3.4	6.5	3.7	3.3	4.4	4.1	5.0	2.7	3.5	3.8	3.0	5.0	5.7	4.5	9.0
Expansion	31.3	39.3	12.8	42.0	18.2	17.3	25.0	42.0	23.8	22.8	30.5	-	7.0	10.0	3.0
Mean Amplitude (%)															
Recession	-2.7	-4.7	-3.1	-1.9	-2.2	-2.7	-2.5	-1.2	-1.8	-1.9	-1.1	-3.9	-2.6	-3.6	-5.2
Expansion	33.9	37.6	7.7	29.7	14.4	12.4	23.9	29.7	18.8	18.6	29.7	-	5.5	4.0	0.5
Recovery (quarters)	3.4	8.0	5.2	3.0	2.6	6.4	7.6	2.0	2.3	1.8	2.3	6.0	4.0	1.0	29.0
Phase Count (#)	9	7	11	7	13	15	11	6	8	8	8	1	5	7	3
Cycle Count (#)	4	3	5	3	6	7	5	3	4	4	4	0	2	3	1

% Percent of GDP in the first quarter of phase

Table 1.2 Summary Statistics of Macro Structural Variables

	Mean	Median	Standard Deviation	IQ Range
FX (Fixed)	0.7	1.0	0.5	1.0
PMR	2.5	2.4	0.9	1.6
EPL Regular	2.2	2.3	1.0	1.2
EP Temporary	2.1	1.8	1.4	2.2
Temporary Employment Share	11.8	11.0	5.6	6.5
Openness	68.1	60.8	35.5	36.6
Chinn-Ito	1.6	2.4	1.2	1.3

Table 1.3 Definitions and Sources of Macro Structural Variables

Variable	Definition	Source
FX (Fixed)	Dummy variable for fixed exchange rate regime, equals 1 if exchange rate regime indicator has values between 1-2, and equals 0 if exchange rate regime indicator has values between 3-5, according to Ilzetzki, Reinhart, and Rogoff Classification.	Ilzetzki, Reinhart, and Rogoff (2017)
PMR	Overall product market reforms regulation series from OECD. The Index ranges from 0 to 6, with 6 being most inhibiting of competition. This series is extended backward using another OECD regulatory provisions index focusing on 7 non-manufacturing sectors in which anti-competitive regulation tends to be concentrated. The coverage of extended series starts 1975.	OECD, CEP-OCED, and LSE
EPL Regular	Employment protection legislation index from the OECD employment protection database captures the strictness of employment protection for individual and collective dismissals for regular contracts. The index ranges from 0 to 6, with 6 being the most strict. Coverage of the extended series starts 1970.	Allard-OECD-EPL
EPL Temporary	Employment protection legislation index from the OECD employment protection database captures the strictness of employment protection for individual and collective dismissals for temporary contracts. The index ranges from 0 to 6, with 6 being the most strict. Coverage of the extended series starts 1970.	Allard-OECD-EPL
Policy Rate	Central bank policy rate used to implement monetary policy stance, in percent, covers period 1970 to 2017	IFS, IMF IFS and WEO
Temporary Employment Share	The variable represents the percentage share of temporary employment of all employment, all ages (15+), from OECD Labor Market Statistics. All countries are spliced backward, stepwise with earliest available data from OECD. The only exception is USA. There're only 5 data points (year 1995, 1997, 1999, 2001 and 2005) in the original data of share of temporary employment, so data from 2006 and 2017 are spliced forward using 2005 data.	OECD
Openness	Total exports and imports in percent of gross domestic product. Retrieved from IMF WEO. Covers period 1970 to 2017.	IMF WEO
Chinn-Ito	Degree of capital control openness. Index.	Chinn and Ito (2006)
Fiscal Procyclicality	Country correlations between the cyclical components of real government expenditure and real GDP. From 1970 to 1999 is assigned to the estimates of 1970-1999 average. From 2000 to 2017 is assigned to the estimates of 2000-2009 average.	Frankel, Vegh, and Vuletin (2013)

Table 1.4 Structural Policies and Business Cycle Properties, Baseline

	(1) Recession Duration 1/	(2) Recession Amplitude 2/	(3) Recovery Duration 1/	(4) Expansion Duration 1/	(5) Expansion Amplitude 3/
FX (Fixed)	2.73	3.19**	1.96	-14.78**	-20.44*
	(1.80)	(1.36)	(2.34)	(6.85)	(9.96)
PMR	3.24**	3.26**	0.42	1.25	6.18
	(1.40)	(1.40)	(1.66)	(12.04)	(15.51)
EPL Regular	3.83	5.23**	7.90***	-10.99	-9.36
	(2.47)	(1.99)	(2.58)	(14.59)	(14.75)
EPL Temporary	2.28	1.84**	11.45***	-10.65	-20.13*
	(1.52)	(0.84)	(2.61)	(11.24)	(10.41)
EPL Regular X EPL Temporary	-0.96	-0.76*	-4.32***	1.87	2.62
	(0.67)	(0.39)	(1.09)	(4.98)	(5.32)
Temporary Employment Share	-0.09	0.08	-0.01	-0.24	-0.69
	(0.09)	(0.10)	(0.24)	(1.20)	(1.81)
Trade Openness	-0.03	0.02	0.04	-0.23	-0.30
	(0.03)	(0.02)	(0.05)	(0.50)	(0.54)
Chinn-Ito	-0.83*	-0.40	-0.97	-4.42	-7.23
	(0.41)	(0.27)	(0.86)	(5.97)	(7.08)
Time Dummies	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Observations	86	86	75	68	68
R-square	0.31	0.60	0.56	0.52	0.50

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

1/ in quarters

2/ in percent of GDP during the peak quarter

3/ in percent of GDP during the trough quarter

Table 1.5 Structural Policies and Business Cycle Properties, Robustness

	(1) Recession Duration 1/	(2) Recession Amplitude 2/	(3) Recovery Duration 1/	(4) Expansion Duration 1/	(5) Expansion Amplitude 3/
FX (Fixed)	2.74	3.01**	1.92	-6.92	-25.29
	(1.76)	(1.29)	(2.68)	(10.63)	(19.13)
PMR	3.33**	3.74**	-0.69	8.10	13.88
	(1.58)	(1.57)	(1.74)	(13.82)	(15.76)
EPL Regular	2.87	4.37*	6.69**	-8.98	-28.85
	(3.13)	(2.45)	(2.81)	(25.78)	(29.96)
EPL Temporary	2.20	1.74**	12.65***	-13.17	-46.14*
	(1.38)	(0.82)	(2.45)	(16.94)	(23.55)
EPL Regular X EPL Temporary	-0.89	-0.75**	-4.67***	2.44	12.13
	(0.59)	(0.31)	(0.96)	(6.77)	(7.95)
Temporary Employment Share	-0.07	0.04	0.14	-0.82	-1.24
	(0.08)	(0.09)	(0.30)	(1.06)	(1.60)
Policy Rate	0.00	-0.02	0.19	-3.21**	-3.68**
	(0.13)	(0.10)	(0.22)	(1.33)	(1.34)
Fiscal Procyclicality	-0.78	1.19	-2.47	8.90	-33.29
	(1.41)	(0.90)	(3.34)	(30.79)	(58.45)
Trade Openness	-0.03	0.01	0.06	0.04	-0.29
	(0.03)	(0.03)	(0.05)	(0.65)	(0.49)
Chinn-Ito	-0.90*	-0.66**	-0.19	-14.03**	-15.39
	(0.47)	(0.31)	(0.88)	(6.56)	(9.58)
Time Dummies	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Observations	81	81	68	63	63
R-square	0.30	0.61	0.59	0.57	0.55

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

1/ in quarters

2/ in percent of GDP during the peak quarter

3/ in percent of GDP during the trough quarter

Table 1.6 Structural Policies and Business Cycle Properties, A Duration Analysis

	(1) Recession Duration 1/	(2) Recession Duration 1/	(3) Recovery Duration 1/	(4) Recovery Duration 1/	(5) Expansion Duration 1/	(6) Expansion Duration 1/
FX (Fixed)	0.49***	0.50***	0.04	0.01	-0.30	-0.18
	(0.12)	(0.14)	(0.18)	(0.24)	(0.19)	(0.17)
PMR	0.65***	0.64***	0.48***	0.49***	-0.09	0.26
	(0.13)	(0.15)	(0.17)	(0.18)	(0.23)	(0.34)
EPL Regular	0.16	0.23**	0.19	0.10	-0.07	-0.33**
	(0.10)	(0.09)	(0.14)	(0.24)	(0.13)	(0.14)
EPL Temporary	0.07	0.20**	-0.01	-0.02	-0.08	-0.48***
	(0.10)	(0.10)	(0.12)	(0.16)	(0.12)	(0.16)
EPL Regular X EPL Temporary	-0.07*	-0.13***	-0.04	-0.02	0.01	0.16**
	(0.04)	(0.05)	(0.05)	(0.08)	(0.05)	(0.08)
Temporary Employment Share	-0.01	-0.00	0.03*	0.07**	0.00	0.01
	(0.01)	(0.01)	(0.02)	(0.03)	(0.01)	(0.01)
Policy Rate		0.05***		-0.00		-0.15***
		(0.02)		(0.03)		(0.03)
Fiscal Procyclicality		-0.12		-0.50		-0.42
		(0.20)		(0.38)		(0.30)
Openness	-0.00	-0.00	-0.00	-0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Chinn-Ito	-0.13***	-0.05	-0.08	-0.08	-0.16	-0.41***
	(0.04)	(0.07)	(0.11)	(0.20)	(0.11)	(0.15)
Observations	418	392	487	404	2,520	2,403
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Weibull Shape Parameter	3.754	3.858	2.015	1.952	1.343	1.376
Number of Episodes	90	82	84	74	105	96
Number of Economies	23	20	25	20	26	21
Log Likelihood	-48.38	-41.62	-88.61	-77.13	-104.9	-81.85

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

1/ in percent

STRUCTURAL POLICIES AND THE DYNAMIC EFFECTS OF CRISES[3]

This section examines the role of product and labor market reforms in shaping the response of output to systemic financial crises and major recessions. Based on a sample of 26 OECD countries over the period 1970-2013, the results suggest that these reforms tend to increase the resilience of the economy to crises. The results are robust to a battery of robustness tests and alternative identification strategies.

A. Motivation

The recovery following the Global Financial Crisis has been not only slower than in previous crises but also uneven. For example, in advanced economies, Anglo-Saxon countries have recovered faster than Continental and Northern European ones. While the literature has typically focused on the role of macroeconomic policies or structural factors (e.g., trade openness, financial depth) in affecting the response of output to crises (Spilimbergo et al. 2008; Cerra et al. 2009; WEO 2009; Furceri and Zdzienicka 2012a), there is little empirical evidence regarding the role of product and labor market reforms. This work aims to fill this gap.

B. Empirical Approach

Data on reform and crises episodes

Reforms

The analysis focuses on major reforms in product market regulation (PMR) and two key labor market policies, namely employment protection legislation for regular workers (EPL) and unemployment benefits (UB). These reforms are identified by Duval and others (2018a), who examine documented legislative and regulatory actions reported in all available OECD Economic Surveys for 26 advanced economies since 1970, as well as additional country-specific sources. Overall, 22 and 32 major product and labor market policy changes are identified for 26 advanced economies over the period 1970-2013.

These reform events are used to construct an indicator of the intensity of reforms. The indicator is a discrete variable that counts, cumulatively, the number of major policy changes implemented in a country over the sample period. The indicator increases (decreases) by 1 (-1) in the year when the reform aiming at increasing (decreasing) flexibility of product (or labor market) is implemented. This approach allows examining whether the response to crises increases with reform intensity or—put it simply—whether the resilience of an economy increases after the

[3] Prepared by D. Furceri and A. Zdzienicka.

implementation of reforms.[4] In the following, we will discuss the results using the latter interpretation.

Financial crises and other variables

Financial crisis episodes are taken from Laeven and Valencia (2018). Major recession episodes are recessions identified at quarterly frequency using the Harding and Pagan (2002) algorithm (see section 1), where the cumulative output losses as a percent of the previous peak are greater than the 75th percentile of recession losses in the sample of advanced economies. Years of a major recession are defined to be years where 2 or more quarters are designated as major recessions at the quarterly frequency. Data on the macroeconomic variables used in the analysis (output, trade openness, credit to GDP, exchange rate flexibility, government consumption to GDP) are taken from the IMF WEO and the International Financial Statistics. These variables will be used as controls or, as regards GDP series, to construct alternative macroeconomic shock series—recessions—to be considered for robustness checks.

Estimation framework

The role of structural reforms in shaping the output response to crises is assessed using the local projection method (Jordà, 2005). In particular, for each period k=0, 1, ...5, the following baseline regression is estimated:

$$y_{i,t+k} - y_{i,t-1} = \alpha_i^k + \vartheta_t^k + G(z_{it})\beta_L^k C_{i,t} + \big(1 - G(z_{it})\big)\beta_H^k C_{i,t} + \theta^k X_{i,t} + \varepsilon_{i,t}^k \qquad (1),$$

where y is the log of GDP; $C_{i,t}$ denote financial crises (or major recessions); $X_{i,t}$ is a set of controls including two lags of reforms episodes, crises, and growth. ϑ_t^k denote time fixed effects to control for global shocks and α_i^k are country fixed effects. The inclusion of country fixed effects is particularly important as it allows to control not only for differences in the average growth rate across countries but also for the initial level of regulation in each country. As shown in Duval et al. (2018b), the initial level of regulation is an essential determinant of reform, and it is also expected to affect the response of output to the shock $C_{i,t}$, so omitting it from the analysis will result in omitted estimation bias.[5] Confidence bands for the estimated impulse response functions are computed using Driscoll-Kraay standard errors.

[4] The two statements are exactly equivalent if a country experiences only one major reform, which in our sample is typically the case for labor market reforms.

[5] This issue will be explored further in the robustness checks, where we control for the interaction between the financial crisis dummy and the initial level of regulation of each country in the sample.

(continued)

The coefficients β_L^k and β_H^k capture the output impact of crises at each horizon k in cases of very little reform intensity ($G(z_{it}) \approx 1$) and very high reform intensity ($1 - G(z_{it}) \approx 1$), respectively.[6] In particular, $G(z_{it})$ is computed as follows:

$$G(z_{it}) = \exp(-\gamma z_{it})/(1 + \exp(-\gamma z_{it})), \quad \gamma > 0; \; var(z_{it}) = 1, E(z_{it})=0,$$

where z is the normalized reform indicator, with zero mean and unit variance. We calibrate γ so that we mimic the time spent by an economy without reform in our sample, where we define an economy to be in a non-reform state if $G(z_{it}) > 0.8$.[7]

C. Results

The results based on equation (1) indicate that reforms increasing product and market labor flexibility tend to enhance the resilience of the economy to a financial crisis (Figure 2.1). The effects of financial crises on output are negative and statistically significantly different from zero before any of the various reforms, while the point estimates after reforms are much smaller (although still negative). The null hypothesis that the effects of financial crises after reforms is zero cannot be rejected at standard significance levels for most horizons. This reflects both the smaller, negative point estimates and the sometimes large standard error bands (for example, around the response after unemployment insurance reforms). That said, the difference in the estimated responses between the two regimes is statistically different from zero at most of the horizons *k* (see Table 2.1 for k=5). Similar results are obtained when replacing the smooth transition function with a dummy variable which takes value 1 when $G(z_{it}) > 0.5$, and zero otherwise (Figure 2.2).

Financial crises are usually associated with severe output losses (Cerra and Saxena, 2008; Furceri and Zdzienicka 2012a, 2012b), but not all recessions coincide with financial crises, and regular recessions may also entail persistent if not permanent output losses (Blanchard, Cerutti and Summers, 2015; Bluedorn and Leigh, 2018). To test whether reforms also affect the output response to recessions, we replace the financial crisis dummy with a recession dummy. Recession episodes are identified as in the main note. The results using these recession episodes are qualitatively similar to the baseline (Figure 2.3): the output effect of recessions is economically and statistically significantly smaller after major reform.

A possible concern with the analysis is that product and labor market reform may occur at the same time as other major policy changes. This implies that the results could be biased if these policy changes affect economic resilience. To address this potential omitted bias, we expand equation (1) to control for changes in structural and policy variables that have been related with

[6] $G(z_{it})$=0.5 is the cutoff between little and high reform intensity.

[7] The choice of 0.8, while arbitrary, allows to markedly distinguish between low- and high-intensity regimes. $G(z_{it}) > 0.8$ is equivalent to γz_{it} <-1.4. Given that z is normally distributed with mean zero and variance one, the values of γ are obtained by identifying the variance of the normal distribution such that the cumulative distribution function at the value -1.4 is equal to the percent of the time in a non-reform regime. The values of γ are 4 for PMR, 10 for EPL, and 28 for UB.

resilience in the literature (trade openness, financial depth, exchange rate flexibility and government size) and their interaction with financial crises:

$$y_{i,t+k} - y_{i,t-1} = \alpha_i^k + \vartheta_t^k + G(z_{it})\beta_L^k C_{i,t} + \left(1 - G(z_{it})\right)\beta_H^k C_{i,t} + \theta^k X_{i,t} + \theta^k C_{i,t} P_{i,t} + \vartheta^k P_{i,t} + \varepsilon_{i,t}^k \quad (2),$$

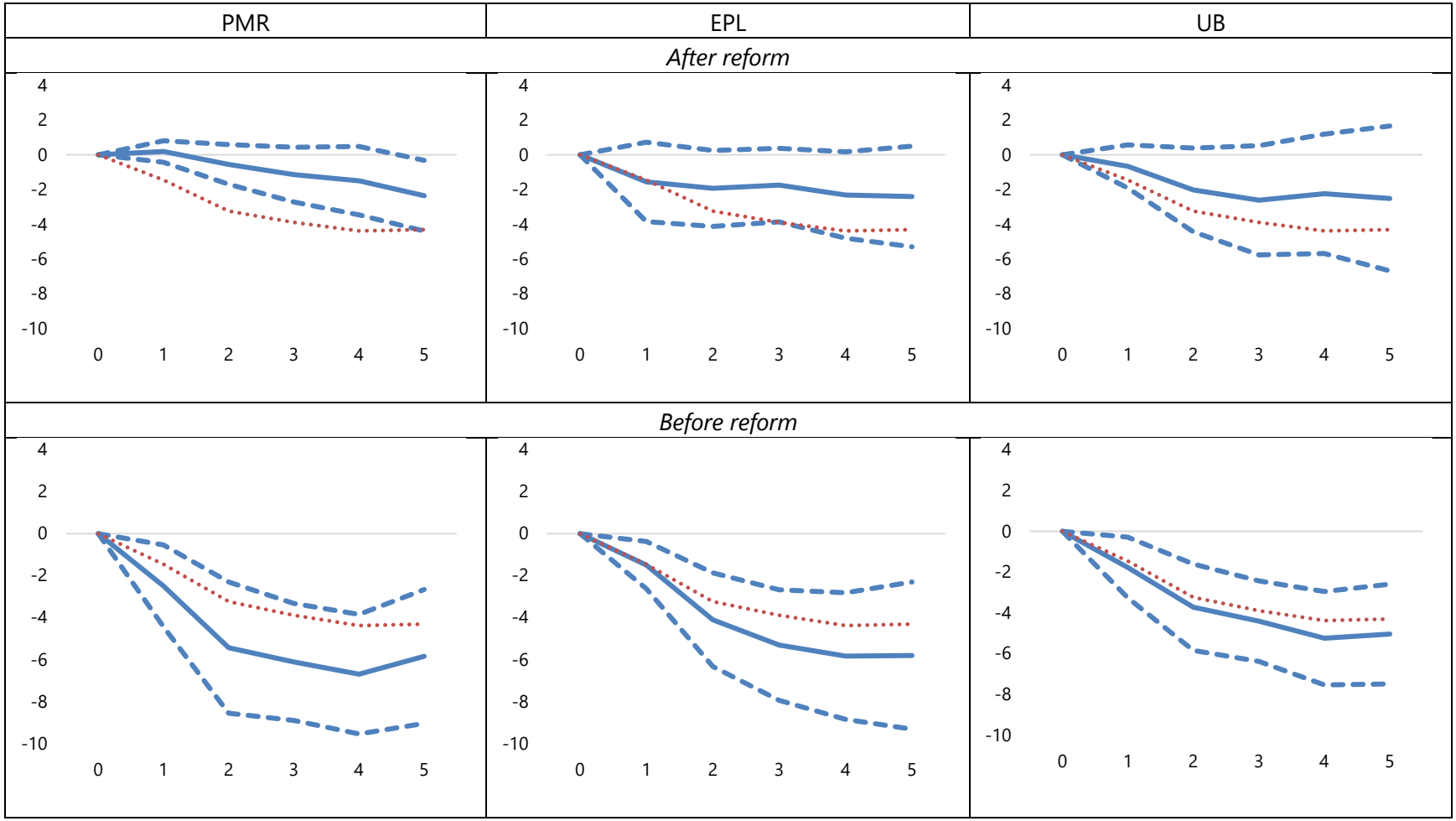
where θ^k captures the impact of changes in structural and policy variables ($P_{i,t}$) in shaping the output response to financial crises. The results reported in Figure 2.3 shows that the effects of product and labor market reforms are stronger than those obtained in the baseline, confirming that these reforms tend to increase the resilience of the economy.

Another concern is that reforms could be correlated between each other, making it difficult to separate their marginal effect. While the correlation between the reform indicators is typically low (Table 2.2), we address this issue by replicating the analysis to include all reforms simultaneously. The results are qualitatively similar to the baseline (Table 2.1).

As previously mentioned the intensity of reform is likely to depend on the initial level of regulation. To address this possible source of omitted bias, we additionally control for the interaction between the financial crisis dummy and the initial level of regulation of each country in the sample. The inclusion of these controls does not qualitatively change the results.

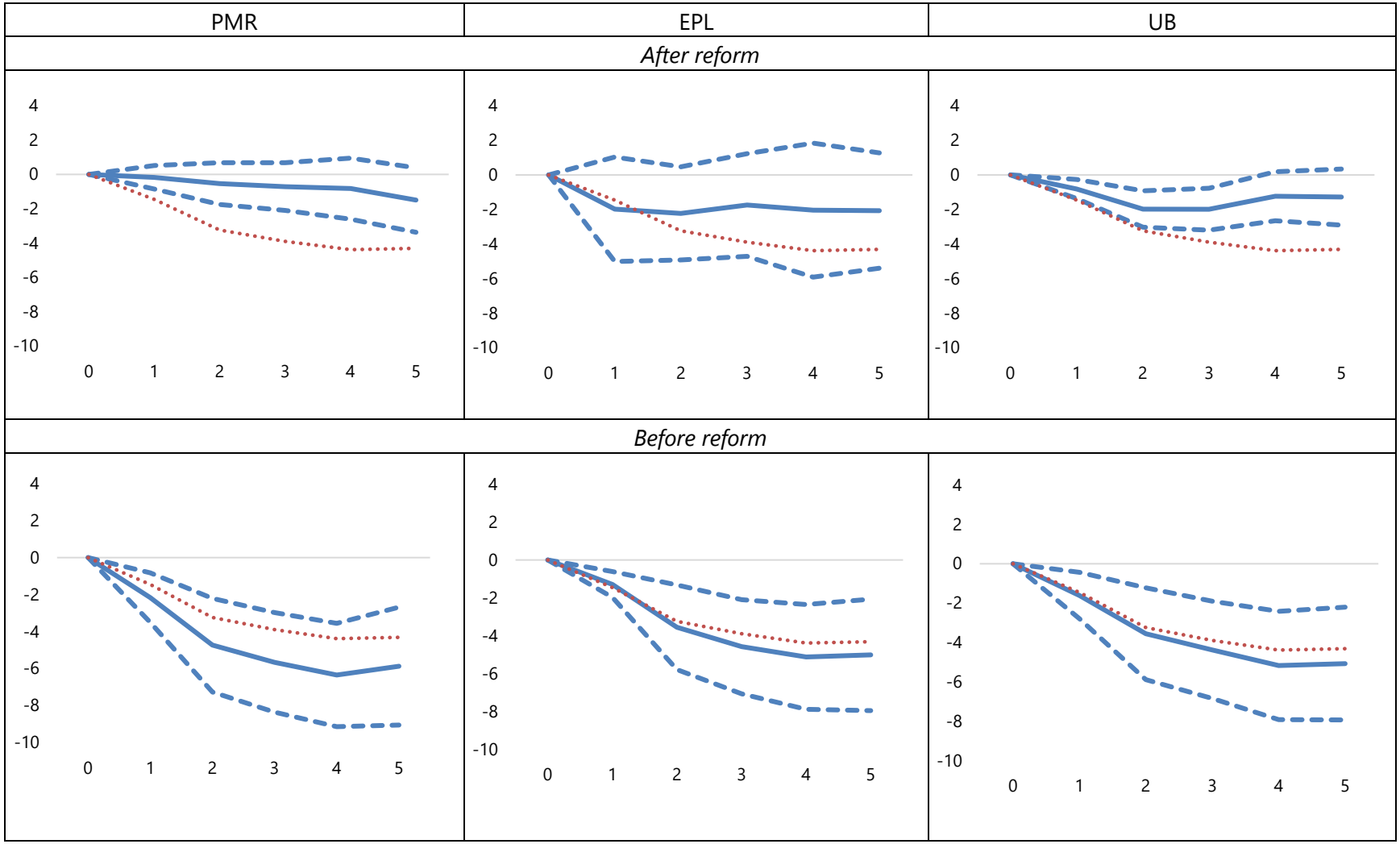
Finally, the results are also robust to alternatively restricting the sample to the period before the global financial crisis and to European economies (Table 2.1).

Figure 2.1 Impact of financial crises on output depending on product and labor market reforms (in percent)



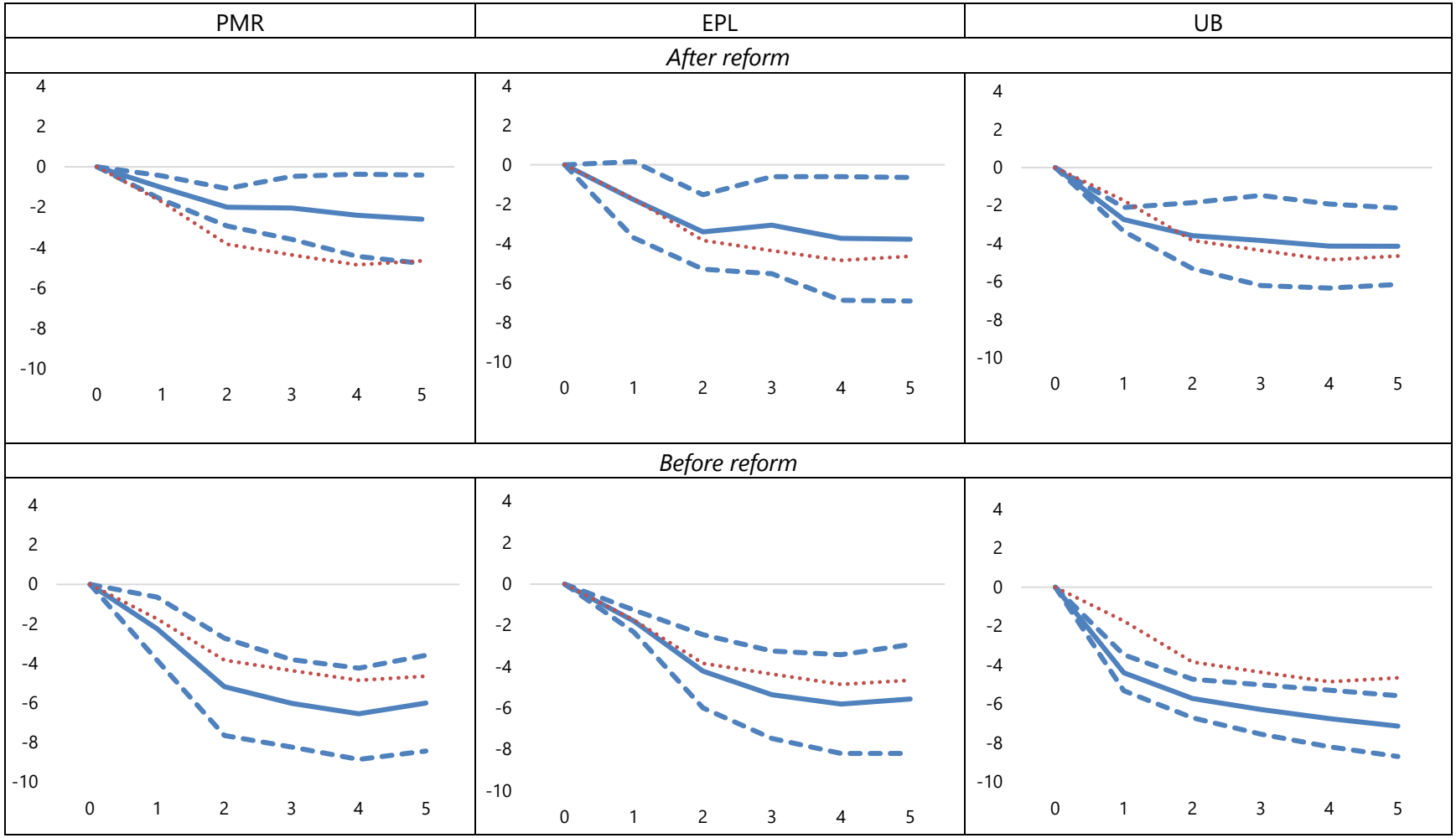
Note: The dotted red line indicates the average output response following financial crises; The solid blue line shows the average output response to financial crisis in years after ($G(z_{it}) = 1$) or before ($G(z_{it}) = 0$) reforms; dashed lines are 90-percent confidence bars. Estimates based on equation (1). X-axis denote years aftet the shock at time t=1.

Figure 2.2 Impact of financial crises on output depending on product and labor market reforms (in percent)—alternative identification



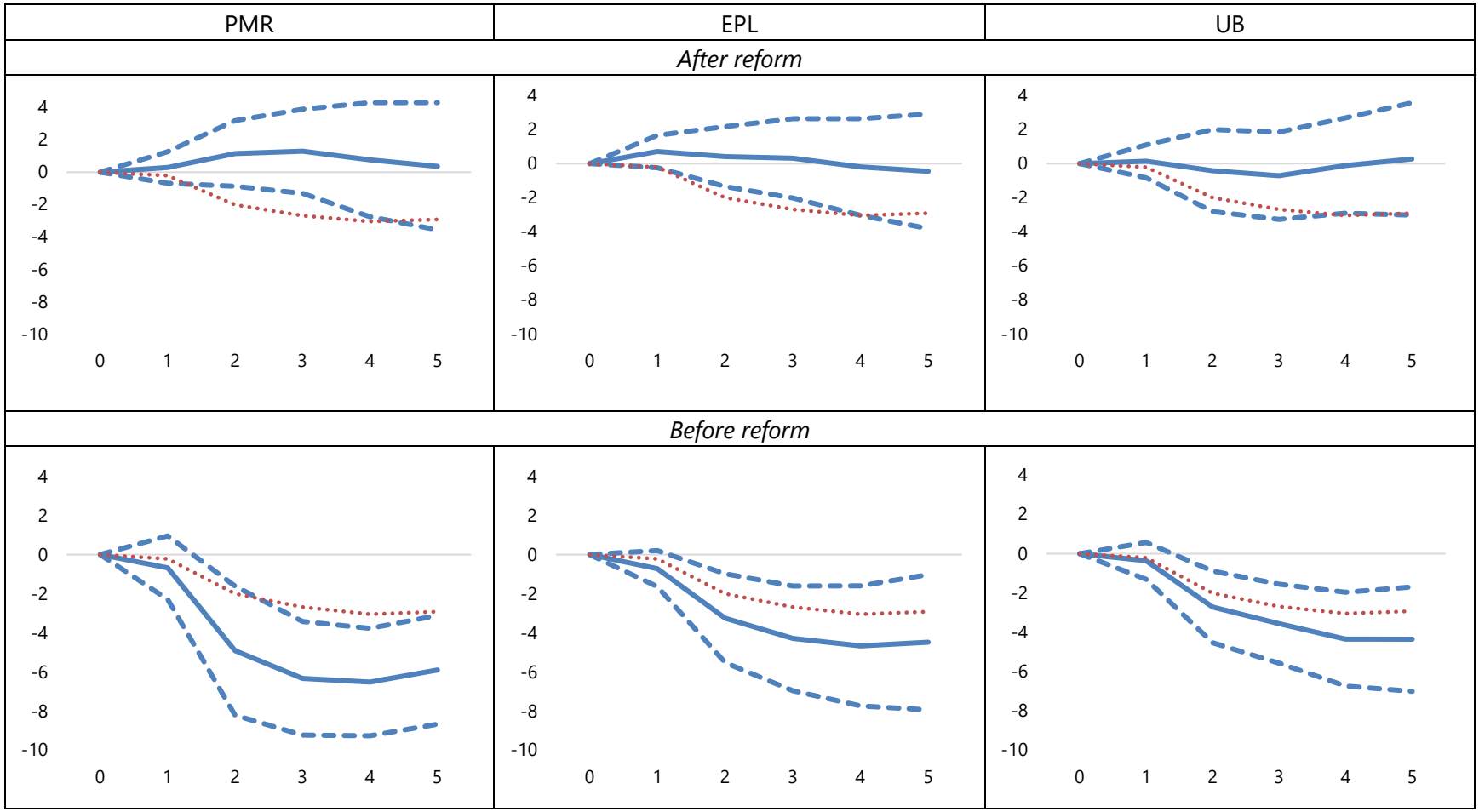
Note: The dotted red line indicates the average output response following financial crises. The solid blue line shows the average output response to financial crisis in years after ($G(z_{it}) = 1$) or before ($G(z_{it}) = 0$) reforms; dashed lines are 90-percent confidence bars. Estimates based on equation (1). X-axis denote years aftet the shock at time t=1.

Figure 2.3 Impact of major recessions on output depending on product and labor market reforms (in percent)



Note: The dotted red line indicates the average output response following major recessions; The solid blue line shows the average output response to major recessions in years after ($G(z_{it}) = 1$) or before ($G(z_{it}) = 0$) reforms; dashed lines are 90-percent confidence bars. Estimates based on equation (1). X-axis denote years aftet the shock at time t=1.

Figure 2.4 Impact of financial crises on output depending on product and labor market reforms (in percent)—controlling for other structural and policy factors



Note: The dotted red line indicates the average output response following financial crises; The solid blue line shows the average output response to financial crisis in years after ($G(z_{it}) = 1$) or before ($G(z_{it}) = 0$) reforms; dashed lines are 90-percent confidence bars. Estimates based on equation (2). Structural variables include changes in government consumption (in percent of GDP), credit-to-GDP, exchange rate regime, trade openness, and their interaction with financial crises. X-axis denote years after the shock at time t=1.

Table 2.1 Medium-term output response to crises before and after reforms

	PMR			EPL			UB		
	before	after	Diff. p-value	before	after	Diff. p-value	before	after	Diff. p-value
Baseline	-5.85***	-2.36*	0.06	-5.81***	-2.35*	0.17	-5.05***	-2.51**	0.06
Based on dummy	-5.87***	-1.49	0.01	-5.00***	-2.07**	0.07	-5.07***	-1.28	0.00
Crises and Major Recessions	-6.01***	-2.59*	0.03	-5.56***	-3.48*	0.28	-7.13***	-4.14***	0.03
Controlling for structural factors	-5.89***	0.37	0.02	-4.48**	-0.45	0.04	-4.34**	0.27	0.01
Controlling for simultaneous reforms	-7.47***	-4.53*	0.07	-6.74***	-3.60**	0.02	-7.47***	-5.25**	0.10
Controlling for initial regulation	-6.01***	-1.77	0.09	-5.96***	-1.9	0.14	-5.18***	-2.52**	0.08
Before 2009	-6.35***	-2.36**	0.02	-5.96***	-3.17	0.22	-5.80***	-2.21	0.00
Europe	-4.43*	-0.89	0.09	-3.00*	0.72	0.11	-3.14*	-0.44	0.03

Note estimates based on equation (1). ***,**,* denote significance at 1,5, and 10%, respectively.

Table 2.2 Correlations between reform indicators

	PMR	EPL	UB
PMR	1		
EPL	0.24	1	
UB	0.35	-0.06	1

CORPORATE INSOLVENCY REGIMES AND CAPITAL ALLOCATION: SECTORAL AND FIRM-LEVEL EVIDENCE [8]

This section describes the detailed methodology and results regarding how factor misallocation and reallocation across sectors and firms relate to a country's insolvency regime quality. The analysis shows that economies with better insolvency regimes tend to experience lower cross-sectoral misallocation of production factors, stronger reallocation of capital to industries with higher returns, and also stronger reallocation of capital to those firms with higher returns within each industry. Different components of the insolvency regime seem to matter for the different dimensions of capital (mis)allocation.

A. Empirical Approach

Assuming the production function at the sector level is Cobb-Douglas, (revenue) total factor productivity of a sector is defined as:

$$TFPR_{c,s,t} = \frac{VA_{c,s,t}}{\left(K_{c,s,t}\right)^{\alpha_s}\left(L_{c,s,t}\right)^{1-\alpha_s}},$$

where c denotes the country, s the sector, and t the year. VA is value added, K is the capital stock, L is total labor compensation and $1-\alpha$ is the labor share. The labor share is estimated at the sector level as the average (across countries and over time) of total labor compensation divided by value added. Following previous literature, L is measured as total labor compensation instead of hours worked. The justification is that human capital is worker specific rather than firm specific, so it can be modeled as a production input which can be reallocated across firms.

Factor misallocation across sectors is proxied by the standard deviation of $log\left(TFPR_{c,s,t}\right)$, following the approach in Hsieh and Klenow (2009).[9] [10]

Assuming a CES demand structure, the marginal product of capital is proportional to

$$MPK_{c,s,t} \propto \alpha_s \frac{VA_{c,s,t}}{K_{c,s,t}}.$$

The degree of *capital reallocation* across sectors over time can be measured with the covariance between changes in capital and the lagged marginal product of capital, normalized by value added in the country:

[8] Prepared by John Bluedorn, Daniel Garcia-Macia and Davide Malacrino.

9 Hsieh and Klenow (2009) show that TFPR can be expressed as a geometric average of the marginal products of capital and labor, weighted by their respective production function shares. Hence, dispersion in TFPR is tantamount to dispersion in marginal products, an indicator of factor misallocation.

10 This measure does not take into account unemployment. This suggests an important caveat for countries with large unemployment spikes during the Great Recession, as labor flows from lower productivity sectors to unemployment would be perceived as reducing misallocation.

$$rk_{c,t} = \frac{cov\left(K_{c,s,t} - K_{c,s,t-1}, MPK_{c,s,t-1}\right)}{VA_{c,t-1}}.$$

The change in capital is proxied with investment (gross fixed capital formation), which is useful because investment data offers better coverage and less error than capital stock data. This measure of capital reallocation amounts to a dynamic version of the Olley and Pakes (1995) decomposition and can be interpreted as the contribution to GDP growth from capital reallocation (up to a constant of proportionality).

Note that rk depends on the level difference in capital allocations and productivity across sectors, since a sector's scale matters for its contribution to GDP growth.

Similarly, *capital reallocation across firms* within a sector is also measured with the covariance between a firm's capital growth and marginal product of capital

$$\left(\alpha_s \frac{VA_{c,j,t}}{K_{c,j,t}}\right)$$

where j denotes a firm. Since the firm-level analysis will use variables in logs (as explained below), the parameter α_s will be absorbed by the sector fixed effects.

The note focuses on capital reallocation, but not labor reallocation, because the latter can be contaminated by flows into and from unemployment. In fact, a flow of labor from a sector or firm with lower-than-average marginal product of labor into unemployment would be captured as an *improvement* in reallocation. This is particularly problematic for the least resilient countries in the euro area, which experienced the largest unemployment spikes.

B. Data

Sector-Level Data

The sectoral data used to construct misallocation and reallocation measures is from EU KLEMS, covering advanced economies (European and the US) from 1995 to 2015.

Orbis Data

The analysis focuses on 15 advanced European economies (of which 11 are euro area economies) included in Orbis. The data provide firm-level measures of net investment, firm age, sector, cost of goods sold, assets, paid interest, and various other balance sheet and income statement indicators. Importantly, our data include TFP measures computed by Diez and others (2019).[11]

Data on National Insolvency Regimes and Sectoral Exposures

[11] We use their measure of TFP based on De Loecker and Warzynski (2012). The measure uses turnover revenue and cost of goods sold. See Diez and others (2019) for further details.

Indicators for national insolvency regime characteristics are taken from the OECD (Adalet-McGowan and others, 2017). We build firm turnover at the sector level (NACE Rev. 2) using EU-KLEMS data. Firm turnover is built as the ratio of the sum of firms entering and exiting a sector in a given year to the stock of firms at the beginning of the year. The measures of turnover are then averaged across countries and years to obtain a time invariant measure per sector.

C. Empirical Analysis

Sector Level

Structural rigidities can have both static and dynamic effects on factor misallocation. First, we correlate static misallocation across sectors with the quality of insolvency regimes and compare the post-GFC change in misallocation in countries with better- and worse-than-median insolvency regimes (see also section on "Strengthening Corporate Insolvency Regimes" in the main note).

To test whether the dynamic reallocation of capital to sectors with higher returns is facilitated by high-quality insolvency regimes, the following empirical model is estimated:

$$rk_{c,t} = \alpha + \beta IR_c + \varepsilon_{c,t} \quad (1),$$

where *rk* is the measure of capital reallocation defined above, *IR* is a measure of insolvency regime quality (higher values of the index indicate lower quality), and $\varepsilon_{c,t}$ is a mean-zero, independently distributed, and potentially autocorrelated error term. Negative estimates of β would reflect a positive association between the speed of capital reallocation and insolvency regime quality.

Since the effects of insolvency regimes might be more relevant in economic downturns, when firm exit is more prevalent, the analysis is replicated allowing for heterogeneous effects in recessions. Specifically, the regressor *IR* is interacted with a dummy variable that takes value 1 if years t, t-1 or t-2 are detected to be a recession as defined in the main text, and 0 otherwise.

Insolvency regime indices comprise both measures of efficiency (such as speed of resolution and number of administrative procedures required) and measures of flexibility of the relationship between creditors and debtors (such as the length to discharge and the presence of priority treatment for new financing). Using the sub-indicators provided by the OECD, the aggregate index is split into a sub-index $IR_{c(j)}^{ineff}$, which captures inefficiencies (including information on insolvency prevention and streamlining of procedures, as well as on the degree of court involvement in the proceedings) and another $IR_{c(j)}^{flex}$, which captures lack of flexibility in creditor relationships (including information on restructuring tools, the existence of fraudulent bankruptcy in the law, the right of the

employees in the proceedings, as well as time to discharge and assets exemptions).[12] The empirical model specification then becomes:

$$rk_{c,t} = \alpha + \beta_1 IR_c^{ineff} + \beta_2 IR_c^{flex} + \varepsilon_{c,t} \quad (2).$$

Firm Level

The sector-level analysis is complemented by a firm-level analysis that enables to check whether factor reallocation across firms *within* a sector is also affected by structural rigidities, with a focus on firm net investment. Following Adalet McGowan and others (2017), the analysis examines whether the link between firm-level (net) investment and firm marginal product capital is affected by the quality of the insolvency regime in the country. As sectors with higher firm turnover (that is, higher entry and exit rates) are expected to be particularly exposed to imperfect financial markets (similar to Rajan and Zingales, 1995), various measures of country-level insolvency regime quality are interacted with a measure of sector-level turnover in the estimated model:

$$\Delta k_{jt} = \beta_1 \left(mpk_{jt-1} \times Churn_{s(j)} \times IR_{c(j)} \right) + \gamma X_{jt} + \varepsilon_{jt} \quad (3)$$

where Δk_{jt} is the log change in firm j capital (net investment), mpk_{jt-1} is the log of MPK_{jt-1}, and $Churn_{s(j)}$ is a sector-level measure of firm churn (sum of entry and exit rate averaged across countries and year). X_{jt} is a collection of controls including sector and country dummies interacted with lagged log MPK to allow for differential effects of MPK on investment by sector and country. It also includes year dummies, firm age group dummies, and country-by-sector fixed effects. If the quality of the insolvency regime had no effect on firm investment, the coefficient β_1 would be statistically indistinguishable from zero. Alternatively, a negative and significant coefficient would signal that less effective insolvency regimes inhibit resource reallocation towards more productive firms.

As in the sector-level analysis, the differential effect of insolvency regime efficiency and flexibility is also tested:

[12]The distinction between efficiency and flexibility sub-indicators is based on whether deficiencies in the sub-indicators generate a deadweight loss, or whether they simply imply an economic transfer between debtors and creditors. Specifically, our measure of inefficiency is an unweighted average of the following sub-indicators: "[Absence of] Early warning mechanisms", "[Absence of] Pre-insolvency regimes", "[Absence of] Special procedures for SMEs" and "Degree of court involvement [Higher if courts are involved in more stages of liquidation and restructuring]". Our measure of lack of flexibility of restructuring is an unweighted average of the following indicators: "[Longer] Time to discharge", "[More limited] Exemption of assets", " Initiation of restructuring by creditors [is not allowed]", "Length of stay on assets in restructuring [Higher if longer]", "[Absence of] Possibility and priority of new financing", "[Absence of] Possibility to "cram-down" on dissenting creditors", "[There is mandatory] Dismissal of management during restructuring", "[Absence of] Distinction between honest and fraudulent bankrupts", "Rights of employees [higher if possibility of negotiations with employees is limited]". See Adalet-McGowan and others (2017) for details on the single indicators.

$$\Delta k_{jt} = \beta_1 \left(mpk_{jt-1} \times Churn_{s(j)} \times IR_{c(j)}^{ineff} \right) + \beta_2 \left(mpk_{jt-1} \times Churn_{s(j)} \times IR_{c(j)}^{flex} \right) + \gamma X_{jt} + \varepsilon_{jt} \quad (4)$$

As in the sector-level regressions, we also replicate the analysis allowing for heterogeneous effects in recessions (i.e. the triple interactions in equations 3 and 4 are further interacted with the recession dummy).

For robustness we also replicate all our results replacing the MPK_{jt-1} variable with revenue TFP_{jt-1}. TFP_{jt-1} is a measure of revenue TFP based on De Loecker and Warzynski (2012).

D. Samples

Sector Level

After matching OECD insolvency data with EU KLEMS data on the marginal product of capital, the final sample is composed of: Austria, Belgium, Czechia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Netherlands, Portugal, Slovak Republic, Spain, Sweden, the United Kingdom and the United States. Most countries have data for the entire period 1995-2015, and all countries have data at least for 2002-2015. When calculating TFPR dispersion, the sample is slightly restricted.

Sectors are defined at the lowest possible level of aggregation for which sufficient data is available across countries in EU KLEMS. Using EU KLEMS notation, economic sectors are grouped as follows:

10-12	22-23	31-33	B	I	P
13-15	24-25	58-60	D-E	K	Q
16-18	26-27	61	F	L	R-S
19	28	62-63	G	M-N	T
20-21	29-30	A	H	O	

Firm Level

Firm level data comprise samples from 15 European countries from Orbis. The sample includes approximately 15 million firms in the following countries: Austria, Belgium, Czechia, Estonia, Finland, France, Germany, Hungary, Italy, Norway, Poland, Portugal, Slovakia, Slovenia and Spain. A measure of churn (sum of firm entering and exiting a sector in a given year, divided by the number of firms at the beginning of the same year) is computed from EU-KLEMS and merged to the firm level data. The OECD insolvency data are also merged at the country level. The sector definition is the same as that for the sector level analysis.

E. Results

Sector level

Static: misallocation levels

As shown in the main text, countries with better insolvency quality are found to experience significantly less factor misallocation across sectors, all else equal.[13][14] There is also evidence that factor misallocation increased more after the Global Financial crisis in countries with lower-than-median insolvency regime quality.[15] This underscores the potential role of insolvency regimes in facilitating reallocation of factors across sectors after negative aggregate shocks.

Dynamic: reallocation of resources

The results from specifications (1) and (2) are reported in Table 3.1.

As shown in the first column of Table 3.1, reallocation of capital to industries with higher returns is stronger in countries with better insolvency regimes. The estimated coefficient suggests that a one standard deviation improvement in insolvency quality is associated with a 0.2 standard deviation improvement in capital reallocation. Column 2 shows that, at least at the sector level, this relationship is similar in recession and expansion periods. Column 3 tests whether the association is driven by the flexibility of restructuring or by the efficiency of insolvency procedures. While flexibility has a strong and significant impact, efficiency appears to be statistically insignificant in this regression. However, as discussed below, the opposite result is obtained in the firm-level regressions.

Firm level

Table 3.2 reports all the results from specifications (3) and (4). The results based on equation (3) are reported in columns 2 and 3. They indicate that worse insolvency regimes reduce the correlation between investment and productivity, signaling again the importance of insolvency regime for an efficient resource allocation. When we allow for the efficiency and flexibility components to have separate effects, we find that only the efficiency component matters. For comparison, these coefficients are between one fourth and one tenth of the coefficient we obtain on the marginal product of capital when we do not include any interaction.

[13] For a few countries with high average productivity such as the Netherlands and (to a lesser extent) Sweden, the OECD index reports low insolvency regime quality. This is mostly due to the lack of flexibility of insolvency regimes in those countries, which slows firm restructuring. Interestingly, those countries also tend to display high cross-sectoral factor misallocation.

[14] The sample period is 1995-2015. Breaking the sample in 2004 does not significantly alter the slope of the trendline. The results are similar if we exclude the Real Estate Activities and Financial Activities sectors, or sectors with a large involvement of the public sector.

[15] Greece is an exception to the general pattern. This may reflect the severity of the Greek downturn, with widespread closures of less productive firms and high levels of job losses (leaving only the most productive employed). Note that TFPR dispersion does not capture the inefficiency caused by idle resources (unemployment).

The results in columns 4 and 5 show that when our indicators or overall quality, efficiency and flexibility of the regime can have differential associations with capital growth along the business cycle, they display stronger associations in recession years.

Replacing MPK with TFP does deliver qualitatively similar results. The estimates for this alternative specification are reported in Table 3.3.

Table 3.1 Capital reallocation and insolvency regime quality: sector-level analysis

Dependent variable: capital reallocation (rk)			
IR	-0.20***		
	(0.1)		
IR*Recession		-0.20***	
		(0.1)	
IR*Expansion		-0.18***	
		(0.1)	
IR Flex			-0.34***
			(0.1)
IR Ineff			0.07
			(0.1)
N	233	233	233

Notes: Larger values of the insolvency indicators correspond to worse quality. An observation is a country-year. “Recession” includes years in a recession plus the two subsequent years, while “Expansion” includes the rest of years. Estimation by pooled OLS with Newey-West standard errors with 1 lag. Standard errors are in parentheses. Asterisks (***,**,*) indicate significance at the 1, 5, and 10 percent level respectively.

Table 3.2 Impact of insolvency regime on capital allocation (MPK): firm-level analysis

	(1)	(2)	(3)	(4)	(5)
	Dk	Dk	Dk	Dk	Dk
MPK	.0293***				
	(.00347)				
MPK X IR X Sector Churning		-.00783**		-.00605**	
		(.00311)		(.00304)	
MPK X IR Flex X Sector Churning			.00032		.00202
			(.00253)		(.00239)
MPK X IR Ineff X Sector Churning			-.003**		-.00253**
			(.00118)		(.00119)
MPK X IR X Sector Churning X Recession				-.00237***	
				(.000373)	
MPK X IR Flex X Sector Churning X Recession					-.000907
					(.000588)
MPK X IR Ineff X Sector Churning X Recession					-.000879***
					(.000143)
Adjusted R2	.0161	.0187	.019	.0191	.0194
Observations (Millions)	15.2	15.2	16.2	14.8	16.2

Note: The dependent variable is the log change in capital computed at the firm level from the Orbis database for 16 AEs. MPK is log revenue marginal product of capital as defined in Appendix A. IR OECD is the insolvency regime index build by the OECD and described by Adalet McGowan et al. (2017). All specifications include sector times country fixed effects, year dummies, and firm age group dummies. Specifications 2 to 5 also include interactions between firm level MPK and country dummies, as well as interactions between MPK and sector dummies. Specifications 4 and 5 also include the direct effect of a "recession indicator" defined as a dummy that takes value one if a major recession hit at time t, t-1 or t-2 and its interaction with lagged MPK. See section 2 for the definition of major recession episodes at annual frequency. Standard Errors are clustered at the country-sector level.

Table 3.3 Impact of insolvency regime on capital allocation (TFP): firm-level analysis

	(1)	(2)	(3)	(4)	(5)
	Dk	Dk	Dk	Dk	Dk
TFP	.0133***				
	(.00335)				
TFP X IR X Sector Churning		-.0153**		-.016**	
		(.00705)		(.00747)	
TFP X IR Flex X Sector Churning			.0091		.0117
			(.00805)		(.00889)
TFP X IR Ineff X Sector Churning			-.00598***		-.00604***
			(.00207)		(.00209)
TFP X IR X Sector Churning X Recession				-.00168***	
				(.000229)	
TFP X IR Flex X Sector Churning X Recession					-.0012***
					(.000451)
TFP X IR Ineff X Sector Churning X Recession					-.00048***
					(.000125)
Adjusted R2	.00922	.00978	.0101	.00987	.0103
Observations (Millions)	15.1	15.1	15.9	14.7	14.7

Note: The dependent variable is the log change in capital computed at the firm level from the Orbis database for 16 AEs. TFP is revenue TFP based on De Loecker and Warzynski (2012) and obtained using cost of goods sold from Orbis – see Diez et al. 2018 for more information. IR OECD is the insolvency regime index build by the OECD and described by Adalet McGowan et al. (2017). All specifications include sector times country fixed effects, year dummies, and firm age group dummies. Specifications 2 to 5 also include interactions between firm level TFP and country dummies, as well as interactions between TFP and sector dummies. Specifications 4 and 5 also include the direct effect of a "recession indicator" defined as a dummy that takes value one if a major recession hit at time t, t-1 or t-2 and its interaction with lagged TFP. See section 2 for the definition of major recession episodes at annual frequency. Standard Errors are clustered at the country-sector level.

MODEL-BASED ANALYSIS OF THE IMPACT OF LABOR AND PRODUCT MARKET REGULATIONS ON MACROECONOMIC RESILIENCE TO SHOCKS[16]

This Appendix presents a model-based analysis of the impact of various labor market institutions and product market regulation on the transmission of macroeconomic shocks, and their interplay with fiscal policy. The focus is on a small open economy within a currency union, but the key insights extend qualitatively to a large economy. The core of the analysis relies on simulating the impact on the economy of a given temporary shock, and comparing the impulse responses, under alternative labor and product market regulations. Under this approach, the smaller the cumulative loss in a particular macroeconomic outcome—output or employment here for simplicity—is, the more resilient the economy is considered to be.

A. Model overview

The dynamic stochastic general equilibrium model considers a monetary union that consists of two countries (a small open economy and the rest of the monetary union, no rest of the world) and two sectors (tradables and nontradables). Full technical details are provided in Cacciatore and Duval (forthcoming), who in turn build on earlier models in Cacciatore and Fiori (2016), Cacciatore, Fiori, and Ghironi (2016) and Cacciatore and others (2016a, b; 2017)—a key addition here being the presence of fiscal policy and the more extensive treatment of the role of various regulations for shock transmission.

Main features of the model

The key building blocks of the model are the following:

- *Households*—These consist of a continuum of members and maximize the present value of their utility, which depends on consumption of a basket of nontradable and (domestic and foreign) tradable goods as well as on public consumption. Households' consumption entails home bias, that is, the share of domestic goods in their tradable goods consumption basket exceeds the share of foreign goods. Due to labor and product market frictions described below, a fraction of the household members will be unemployed and receive unemployment benefits from the government. The representative household owns the capital stock and also invests in a non-contingent bond, as well as in a mutual fund of nontradable sector firms through which new entrants can finance their entry costs.

- *Firms*—There are two vertically integrated production stages. Upstream, perfectly competitive firms use capital and labor to produce a nontradable intermediate input.

[16] This technical appendix was prepared by Romain Duval and draws on Cacciatore and Duval (forthcoming).

Downstream, monopolistically competitive firms purchase intermediate inputs and produce differentiated nontradable goods. These goods are consumed, but also used by competitive firms in the tradable sector to produce a tradable good that is sold to consumers both at home and abroad.

- *Job destruction*—While the rental market for capital is fully competitive, the labor market features job-search-and-matching frictions with endogenous job creation and destruction as in Mortensen and Pissarides (1994) and den Haan, Ramey, and Watson (2000). Jobs are located in the intermediate goods sector. They can be destroyed for exogenous and endogenous motives. One endogenous motive is that jobs are subject to both common and job-specific productivity shocks in each period. If productivity is less than an endogenously determined threshold below which the value of keeping the job is less than the cost of discontinuing it, the firm dismisses the worker and pays a layoff cost. The higher the layoff cost, the lower is the productivity threshold below which jobs are destroyed. As discussed below, other labor market policies and institutions, as well as product market regulation, also affect this job destruction productivity cutoff, which is a key driver of the response of the economy to macroeconomic shocks. Layoff costs take the form of administrative costs of layoff procedures, and hence, are not transferred to workers, and therefore should not be misconstrued for severance payments. Laid-off workers become unemployed and immediately begin searching for a new job. It should be noted that all workers have similar contracts, implying that no distinction can be made between permanent and temporary workers; the implications from relaxing that assumption, and factoring in the dual job protection legislation typically seen in most actual labor markets, are touched upon qualitatively in the main note.

- *Job creation*—Job creation is subject to matching frictions. To hire a worker, firms post job vacancies, incurring a cost. The probability of finding a worker depends on the degree of tightness of the labor market and the efficiency of the matching process.[17] The representative intermediate goods producer chooses the number of vacancies, the productivity cutoff (below which jobs are destroyed), and its capital stock to maximize the present value of profits. Profits, and therefore job creation, also depend on wages, which are set each period through a negotiation process between firms and workers, so-called Nash bargaining. Stronger bargaining power of workers in this process and/or more generous unemployment benefits raise wages, and thereby reduce profits and job creation incentives, *all else being equal*. In addition, they make workers less willing to accept lower wages in the event of an adverse macroeconomic shocks, which is relevant in the context of this note. The hiring-firing

[17] In turn, matching efficiency may be thought of as being affected, among other factors. by active labor market policies. These are not specifically modeled, however, and may also be seen as affecting—for example, through the efficiency of the public employment service in handling and disseminating job offers—the cost of posting a vacancy.

(continued)

process creates dynamics (turnover) in the labor market, and employment varies depending on the endogenous variations in job creation and destruction.

- *Product market dynamics and regulation*—The number of firms serving the non-tradable goods market is endogenous.[18] Prior to entry, firms pay a sunk entry cost that reflects both a technological component (for example, sunk technological costs required to start producing electricity) and a fixed administrative cost of regulation. New entrants start producing after one period (one quarter), increasing competition amongst firms and reducing profit margins and prices for all. Entry occurs until the discounted value of future profits of a new entrant equals the sunk entry cost. Firm exit is exogenous and occurs when a firm is hit by a "death shock." This entry-exit process creates firm dynamics in the goods market. Finally, producers face (quadratic) price adjustment costs, resulting in sticky prices.

- *Monetary policy*—Since model parameters are chosen to match features of euro area macroeconomic data, monetary policy is assumed to target inflation in the euro area. The small open economy has no influence on area-wide monetary policy.

- *Fiscal policy*—The government collects taxes on labor, capital and consumption that, together with government bond issuance, finance (lump-sum) transfers to households, unemployment benefits, and public spending (on tradable and nontradable goods). A fiscal rule ensures that public debt remains stable. Specifically, increases in the public debt-to-GDP ratio induce the government to respond gradually with increases in taxes and cuts in spending, all else being equal.[19] Fiscal expansions raise output over the short term, that is, the fiscal multiplier is positive; this realistic model feature reflects in part the assumed complementarity between private and public consumption in households' utility function.[20]

- *Structural reforms*—In addition to the impact of various labor and product market reforms on resilience to macroeconomic shocks, we also explore the effect of so-called fiscal-structural reforms. These are defined as a shift of taxation away from labor toward consumption—a budget-neutral labor tax wedge cut, a reform routinely advocated to raise employment and output in many European countries.

[18] The model focuses on entry in the nontradable sector to capture the fact that most existing anticompetitive regulations in advanced economies, including in Europe, focus on the tradable sector.

[19] In the version of the model used here and in the main note, only transfers respond (negatively) to the public debt-to-GDP ratio. Results do not substantially change if other fiscal instruments are assumed to respond.

[20] See for example Feve, Matheron and Sahuc (2013). Due to the assumed complementarity, a rise in public spending makes households want to consume more, which mitigates the crowding-out of private consumption and raises the fiscal multiplier. Another conventional way of generating realistic fiscal multipliers in a DSGE context is to include a group of credit-constrained households alongside non-credit constrained ones. The model used here does not feature such heterogenous agents.

(continued)

The model is calibrated using standard values from the literature for several parameters (for example, households' discount rate or degree of risk aversion), while remaining parameters are chosen to match key features of euro area macroeconomic data (such as for example, the average rates of job separation and unemployment) over the period 1995Q1-2013Q1. As regards fiscal policy, the degree of complementarity between public and private consumption in households' utility function is set so as to deliver a cumulative public spending multiplier of .8 after 4 quarters in "normal" times—that is, when the economy is at its steady state when spending is increased.[21] For simplicity, and given the illustrative nature of the simulations, all parameters are assumed to be identical in the small open economy and the rest of the monetary union.[22]

Design of model simulations to assess the role of regulations for shock transmission

The analysis simulates a risk-premium shock that increases the required return on financial assets, depresses output and generates deflation (see also, for example, Eggertsson and Woodford, 2003). The size of this risk premium shock is set to deliver a 5 percent peak-to-trough decline in output, roughly corresponding to the fall seen in the aftermath of the 2008-2009 global financial crisis.

To assess the impact of regulations on the transmission of this shock to the small economy, these risk-premium-shock simulations are run under two alternative sets of parameters:

- *Their baseline values*. These correspond to the current set of policies and institutions in the average euro area economy.

- *Hypothetical alternative values*. These correspond to alternative parameter values that would raise output over the long term, that is, the type of "structural reforms" often discussed in the euro area context. For entry costs, layoff costs and unemployment benefit replacement rates, these are the (lower) values observed in the United States. For matching efficiency, worker bargaining power and the structure of taxation, the alternative parameter values are more illustrative. For the efficiency of the job matching process, a 50 percent increase is considered that, according to estimates by Murtin and Robin (2018), would bring average matching efficiency across the euro area roughly to the (higher) average level across Sweden and the United Kingdom. For worker bargaining power, an illustrative 10 percent decline is assumed; it is considered in the analysis because easing job protection for regular workers may not only imply lower layoff costs—which are explicitly modelled—but also possibly a weakening of worker

[21] This cumulative multiplier is equal to the net present value of the cumulative change in GDP (relative to baseline) divided by the net present value of the cumulative change in government spending, both computed over 4 quarters using the steady-state real interest rate.

[22] The monetary union's central bank is assumed to follow a strict inflation targeting regime. To this end, the policy rule features a zero weight on the output gap and an arbitrarily large weight on inflation. No interest rate smoothing is assumed. The choice of the policy rule does not matter under fixed exchange rates, given our focus on the propagation of specific shocks to an illustrative (infinitely) small open economy. It matters only in the counterfactual case where the exchange rate of the small open economy is assumed to be flexible (see Section C below), with the domestic central bank then assumed to follow the same rule as the monetary union's central bank—but focusing on domestic inflation instead. In this case, the key findings below are qualitatively robust to alternative policy rules.

(continued)

bargaining power.[23] For the structure of taxation, a one percent of GDP shift in taxation away from labor toward consumption is considered—corresponding, as noted above, to a (budget-neutral) labor tax wedge cut scenario.

Hypothetical alternative values are considered either one-by-one—to study the impact of one particular regulation on shock transmission—or jointly—to gauge the potential impact of a broad-based package of reforms. Specifically, in the charts below, "Labor and Product Market Reforms Package" refers to an alternative institutional set-up where the parameter values for entry costs, layoff costs and unemployment benefit replacement rates are set at their U.S. values, while "Extended Reform Package" refers to an alternative institutional set-up where *all* parameter values—now also including matching efficiency, worker bargaining power and the structure of taxation—are set at their hypothetical alternative values.

The transmission of public spending shocks—unanticipated increases in government consumption—is analyzed in similar fashion, that is, under both baseline and alternative sets of regulatory parameter values.[24] In addition, it is analyzed in conjunction with the risk-premium shock, that is, when the economy is in recession.

Finally, the role of the exchange rate regime for the impact of regulations on shock transmission is explored by re-running all simulations under an alternative, hypothetical, flexible exchange rate regime. Comparisons are then made between both sets of simulations that shed light on the particular importance of labor and product market regulations for shock transmission in a small open economy under a fixed exchange rate regime.

B. Regulations and shock transmission

The three channels through which regulations shape shock transmission

There are three key channels through which labor and product market regulations affect shock transmission in the model:

- *Wage flexibility*. A weaker steady-state outside option for workers—due for example to lower unemployment benefits, weaker worker bargaining power, lower layoff costs or fewer opportunities for informal work—make workers' wage claims more responsive to business conditions. As a result, wages become more pro-cyclical, the response of employment to shocks is dampened, and the overall resilience of the economy is improved, *all else being equal*.

[23] Indeed, some of the theoretical literature has used changes in worker bargaining power as shortcuts for job protection deregulation (for example, Blanchard and Giavazzi, 2003).

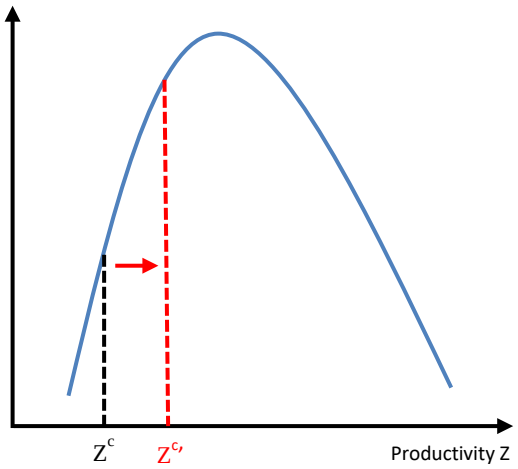
[24] The main insights form this analysis are qualitatively robust to considering other fiscal policy (capital or labor tax) shocks instead, although quantitative results differ. In particular, fiscal multipliers are consistently found to be large in more rigid economies.

- *Firm entry volatility*. Stronger competition, due for example to lower regulatory barriers to entry in product markets, leads to a larger number of firms that all make smaller profits in the steady state. When profits are smaller to start with, macroeconomic shocks trigger a smaller variation in the expected net present value from entering the market and, thereby, in firm entry. As a result, the variability in the number of new entrants is lower, and the response of the economy to shocks is smoother, all else being equal.

- *Layoff volatility*. A lower steady-state rate of job destruction, due for example to higher layoff costs, reduces the mass of jobs that are sensitive to macroeconomic shocks. This dampens the response of employment and output to shocks, all else equal. This channel is explained is Cacciatore and Fiori (2016) and reviewed in greater detail below.

The layoff volatility channel originates from the fact that the higher the productivity cutoff—the idiosyncratic productivity level below which a job is destroyed—is, the larger is the fraction of existing jobs that get destroyed in the event of a given macroeconomic shock, all else equal. This is illustrated in Appendix Figure 4.1 (see also Cacciatore and Fiori, 2016). The distribution of idiosyncratic productivity levels is assumed to be log-normal, consistent with the fact that observed wage distributions are also typically log-normal. The steady-state value of the productivity cutoff Z^c that allows the model to match the average job destruction rate actually observed across the euro area lies very much to the left of the mode of this log-normal distribution. As a result, any structural changes in the economy that raise the steady-state productivity cut-off from Z^c to a higher value $Z^{c'}$ also increase the sensitivity of job destruction to given macroeconomic shocks (a given temporary increase in the productivity cutoff driven by an adverse macro shock leads to a greater mass of additional jobs being destroyed if the initial cutoff is $Z^{c'}$ rather than if it is Z^c). As explained below, some structural reforms reduce the productivity cutoff—and therefore the sensitivity of job destruction to a given adverse macroeconomic shock, all else being equal—while others increase it.

Figure 4.1. Productivity distribution, productivity cutoff and the layoff volatility channel

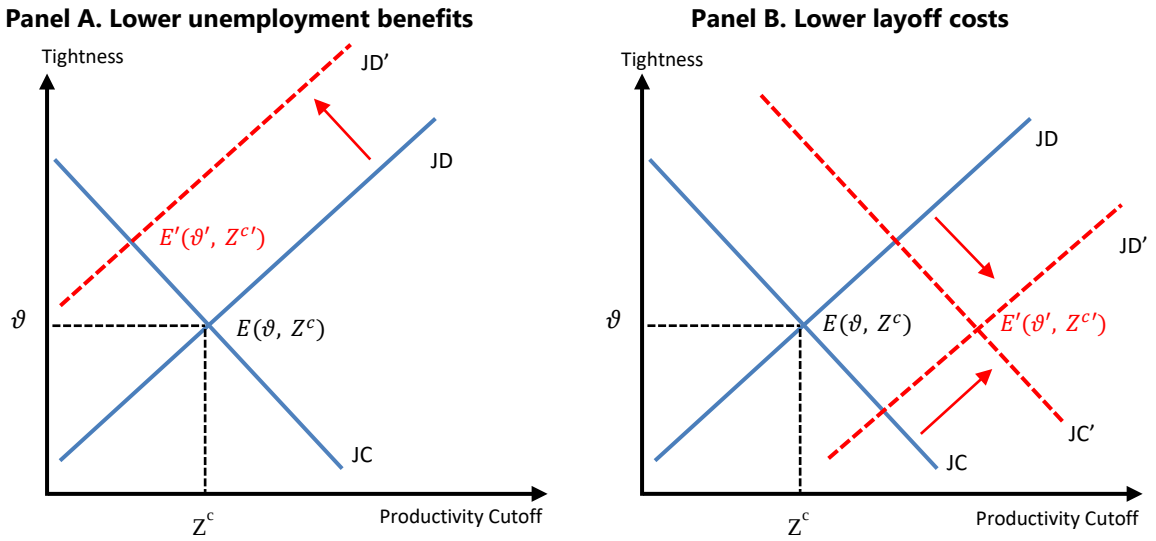


Notes: The chart shows in illustrative fashion the (log-normal) distribution of productivity levels across workers featured in the model. The steady-state value of the productivity cutoff is Z^c. Some changes reforms may increase it, to a value such as $Z^{c'}$, others may reduce it, and yet others have ambiguous effects. A given temporary increase in the productivity

cutoff driven by an adverse macroeconomic shock leads to a greater mass of additional jobs being destroyed when the initial productivity cutoff is $Z^{c'}$ rather than if it is Z^c (the probability mass is larger in the former case).

In turn, the productivity cutoff is determined by the combination of two forces depicted in Appendix Figure 4.2, namely job creation and job destruction (see also e.g. Pissarides, 2000). The job creation curve derives from the condition that firms create new jobs until the expected gain from an additional job equals the expected hiring cost (posting a vacancy and waiting for it to be filled). The reason why it is downward slopping is the following. The higher the productivity cutoff is, the more likely it is that the productivity of a newly created job will fall below that threshold at some point in the future, so the lower the expected duration and profitability of a new job are. As a result, firms create fewer jobs and labor market tightness falls—which increases the likelihood of filling a new vacancy and thereby reduces the expected hiring cost. The job destruction curve derives from the condition that firms destroy all jobs whose productivity is below the cutoff. It is upward slopping because the tighter the labor market is, the more difficult it is for firms to find new workers if they destroy jobs, so the better is the outside option of existing workers and the higher is the wage level that they can negotiate. This reduces the profitability of existing jobs, the least productive of which are thus destroyed by firms—that is, the productivity cutoff below which firms are willing to destroy jobs is higher. These two curves yield a unique set of steady-state values for labor market tightness, the productivity cutoff and, as a result, equilibrium ("structural") unemployment—which depends only on the rates of job creation and job destruction in the steady state.

Figure 4.2. Impact of selected labor market reforms through the layoff volatility channel



Notes: The chart shows in illustrative fashion the impact of a reduction in unemployment benefits (Panel A) and layoff costs (Panel B) on the productivity cutoff—and thus, by implication, on shock transmission through the layoff volatility channel. JC and JD denote the job creation and job destruction curves described in the text. A reduction in unemployment benefits shifts the JD curve leftward to JD', reducing the equilibrium value of the productivity cutoff from Z^c to $Z^{c'}$ and increasing equilibrium labor market tightness (the number of job vacancies per unemployed worker) from θ to θ'. Lower layoff costs shift both the JC and JD curves rightward to JC' and JD', respectively, increasing the equilibrium value of the productivity cutoff Z^c to $Z^{c'}$, with an ambiguous effect on labor market tightness.

Changes in labor and product market regulations can shift these curves and, as a result, affect the productivity cutoff and thereby the sensitivity of layoffs and hires to macroeconomic shocks through the layoff volatility channel:

- Lower unemployment benefits reduce workers' outside option and the wage level, for given labor market tightness. This makes jobs more profitable, lowering the productivity cutoff below which firms are willing to destroy a job. As a result, the job destruction curve shifts to the left, reducing the equilibrium productivity cutoff and dampening shock transmission through the layoff volatility channel (Appendix Figure 4.2, Panel A).[25]

- By contrast, lower layoff costs make it less costly for firms to destroy a job: for given labor market tightness, this raises the productivity level below which a firm is willing to destroy a job, that is, the job destruction curve shifts to the right. At the same time, lower expected layoff costs increase the profitability of any newly created job for given labor market tightness, shifting the job creation also to the right. With the rightward shift in both curves, the productivity cutoff unambiguously rises (Appendix Figure 4.2, Panel B), and so does shock transmission through the layoff volatility channel, all else being equal.[26]

- Enhanced job matching efficiency has qualitatively the same impact as reduced layoff costs; it increases the profitability of posting new job vacancies, shifting the job creation curve to the right and increasing the equilibrium productivity cutoff.

- Cuts in barriers to entry in product markets, lower worker bargaining power, and labor tax wedge cuts all have *a priori* ambiguous effects on the productivity cutoff and the layoff volatility channel, because they shift the job creation and destruction curves in opposite directions (for details, see Cacciatore and Duval, forthcoming, as well as the discussion of simulation results below).

Simulation results

The simulated impact of labor and product market regulations on the transmission of aggregate shocks varies across the different regulations. Comparing the response of GDP and unemployment to the risk-premium shock in the baseline parametrization versus alternative scenarios with different

[25] Note that contrary to intuition, changes in unemployment benefits do not shift the job creation curve. As shown by Pissarides (2000, Chapter 2), what ultimately matters for the firm's hiring decision is the expected gain from adding an extra worker *relative* to the marginal worker; since changes in unemployment benefits have the same impact on the wage of both of these workers, they do not directly affect job creation. Also note that steady-state unemployment depends negatively on labor market tightness and positively on the productivity cutoff (which increases steady-state job destruction). Therefore, lower unemployment benefits, which in equilibrium increase tightness and reduce the cutoff (see Appendix Figure 4.2), also reduce steady-state ("structural") unemployment.

[26] At the same time, as noted above, lower layoff costs reduce workers' outside option and increase wage flexibility, which dampens shock transmission via the wage flexibility channel mentioned above. Therefore, the overall impact of lower layoff costs on shock transmission is *a priori* ambiguous. It should be noted that lower layoff costs have an *a priori* ambiguous impact on steady-state ("structural") unemployment; their positive impact on unemployment through higher job turnover (creation and destruction) may or may not be offset by a negative impact through higher labor market tightness.

parameter values—that is, under "structural reform" scenarios—yields the following insights (Appendix Figure 4.3):

- Lower barriers to entry in product markets smooth the impact of shocks on both output and unemployment. This is primarily because of the firm entry channel mentioned above. An economy with lower barriers to entry is populated by a larger average (steady-state) number of firms with lower profits. As a consequence, aggregate shocks lead to a smaller variation in the present discounted value of business creation, which smooths the response of firm entry, job creation and job destruction to shocks.

- Lower unemployment benefits smoothen shock transmission, particularly on unemployment, even more. In the model, this is because of their effect on workers' reservation wages and, thereby, on wage flexibility—lower benefits make wages more pro-cyclical, thereby enhancing macroeconomic stabilization. This highlights, more broadly, the crucial importance of real wage flexibility for resilience to macroeconomic shocks. In addition, per the layoff channel discussed above, when benefits are lower, the productivity cutoff below which firms are willing to destroy a job is also lower, which further dampens job destruction and thereby the transmission of the risk-premium shock.

- Lower layoff costs tend to amplify the impact of shocks, although this effect is not large. This reflects two offsetting forces. On the one hand, lower layoff costs make job destruction more sensitive to adverse macroeconomic shocks (layoff volatility channel). On the other, they strengthen wage flexibility. While the net effect is *a priori* ambiguous, the former channel dominates here in the calibrated version of the model.

- Weaker bargaining power is found to have little impact on shock transmission, despite its favorable impact on wage flexibility. This is because of an offsetting increase here in (steady-state) job creation and the productivity cutoff, which makes job destruction more responsive to shocks, all else being equal (layoff volatility channel).[27]

- The effect of enhanced matching efficiency—for example through enhanced active labor market policies—on shock transmission is also rather small, albeit positive, somewhat surprisingly. This is because, in the model, while a more efficient job matching process makes it easier to fill vacancies and thereby lowers the time needed for laid-off workers to find new jobs, it also makes firms more willing to destroy jobs in the first place, since they face higher wages—due a tighter labor market—and can more easily find new workers in the future than would be the case if matching efficiency were poorer. The latter channel dominates here.

- Finally, (budget-neutral) labor tax wedge cuts are found to dampen shock transmission somewhat. This is because a shift in taxation away from labor toward consumption reduces labor

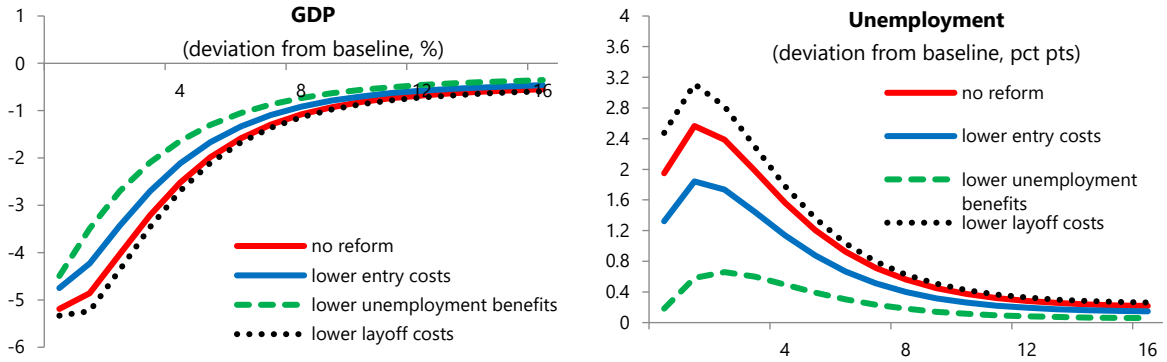
[27] In turn, this increase in the productivity cutoff reflects the net of two opposite forces. On the one hand, weaker bargaining power lower wages, increasing profitability and reducing job destruction (leftward shift in the JD curve in Appendix Figure 4.2). On the other hand, the increased profitability from newly created jobs boosts job creation (rightward shift in the JC curve). The net effect on the productivity cutoff is *a priori* ambiguous, but positive in practice in the calibrated version of the model.

(continued)

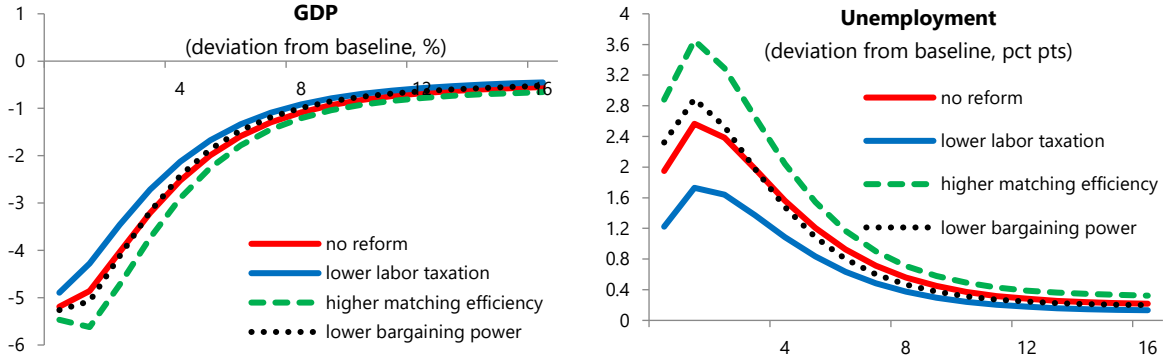
costs. This increases job creation, labor market tightness, and wages, but not enough to fully offset the reduction in labor costs. As a result, the productivity cutoff falls and hiring and firing become less volatile.[28]

Figure 4.3. Responses of output and unemployment to a risk-premium shock under alternative individual labor and product market regulations

Panel A. Responses under alternative entry costs, unemployment benefits and layoff costs



Panel B. Responses under alternative matching efficiency, worker bargaining power and labor taxation



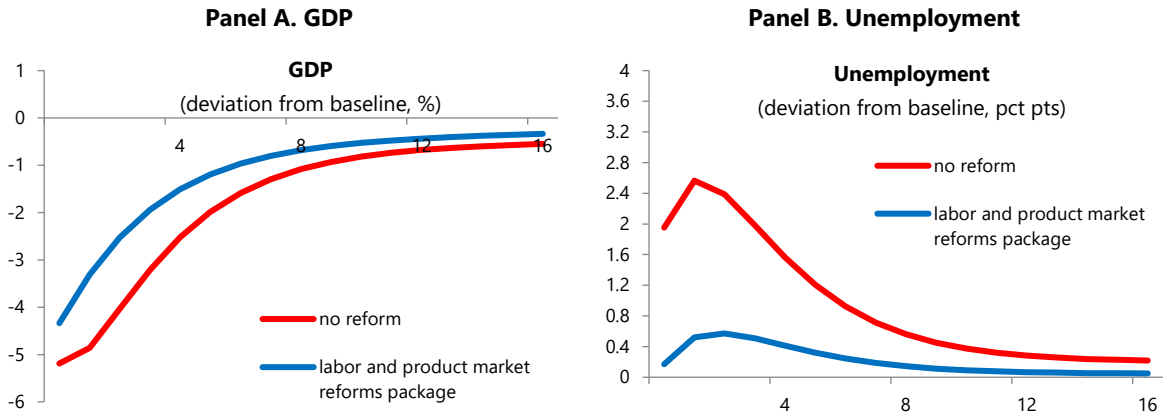
Notes: The chart shows the response of GDP and unemployment to an illustrative risk-premium shock under: the baseline parameter values of the parametrized model of the small open euro area economy ("no reform"), lower entry costs, lower unemployment benefits and lower layoff costs, respectively, with all other parameters set at their baseline values in the latter three scenarios (Panel A); the baseline parameter values of the parametrized model, higher job matching efficiency, lower bargaining power and lower labor tax wedges, respectively, with all other parameters set at their baseline values in the latter three scenarios (Panel B). See Section A for further details.

A reform package enhances macroeconomic resilience to shocks. While the effects of individual reforms vary, overall, a broad package of labor and product market reforms is found to mitigate substantially the impact of shocks. In a hypothetical scenario where barriers to entry in product markets, layoff costs and unemployment benefits would be lowered from their baseline (current) values, the response of GDP and unemployment to a risk-premium shock would be substantially

[28] In other words, the net effect of the leftward shift in the JD curve and rightward shift in the JC curve in Appendix Figure 4.2 is a reduction in steady-state job creation and destruction, that is, a reduction in the productivity cutoff. This makes job destruction and creation less sensitive to macroeconomic shocks, all else being equal (layoff volatility channel).

dampened (Appendix Figure 4.4). Resilience is strengthened further marginally in the event of an extended package featuring also a (budget-neutral) labor tax cut, lower bargaining power and enhanced matching efficiency (not shown).

Figure 4.4. Responses of output and unemployment to a risk-premium shock under "rigid" and "flexible" labor and product market regulations

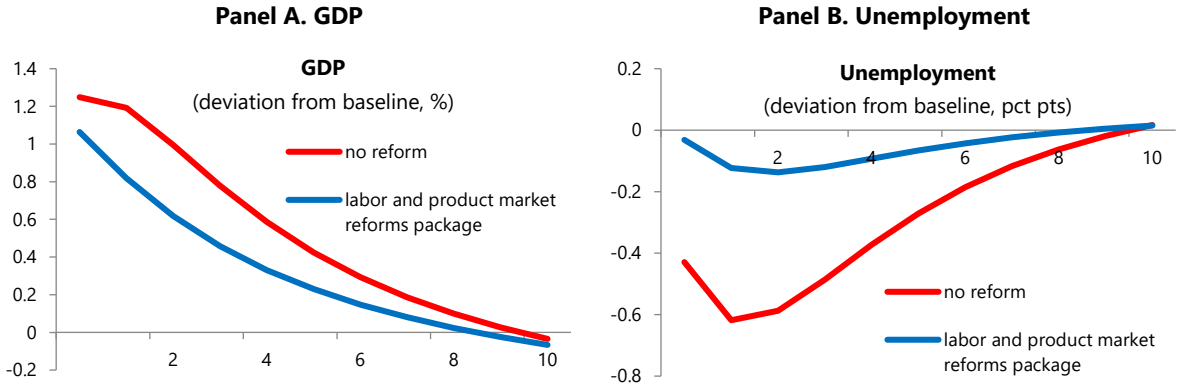


Notes: The chart shows the response of GDP and unemployment to an illustrative risk-premium shock under: the baseline parameter values of the parametrized model of the small open euro area economy ("no reform"); lower entry costs, lower unemployment benefits and lower layoff costs, considered jointly ("labor and product market reforms package"). See Section A for further details.

C. Interplay between regulations, fiscal policy and the exchange rate regime

Labor and product market regulations also affect the transmission of macroeconomic policies, just like they shape the propagation of macroeconomic shocks. Most relevant for a small open economy in a monetary union, the impact of labor and product market regulations on the transmission of fiscal policy shocks closely matches their effect on the transmission of risk-premium shocks; the effects of the various individual regulations on (fiscal) shock transmission vary, but overall a broad package combining product market, job regulation and unemployment benefit reforms weakens fiscal policy transmission in the model (Appendix Figure 4.5).

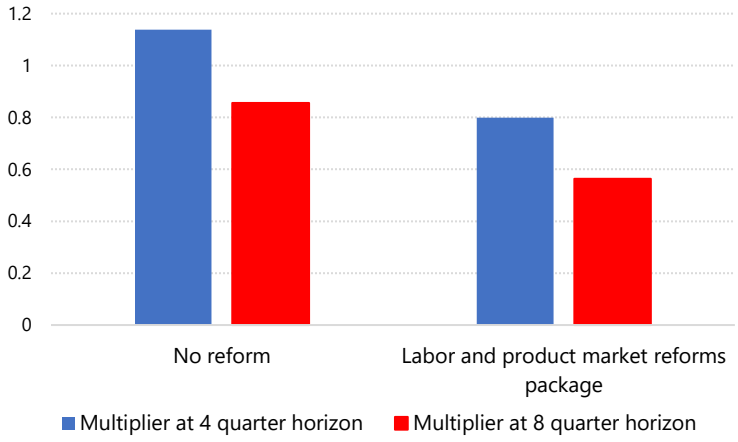
Figure 4.5. Responses of output and unemployment to a government spending shock in a recession under "rigid" and "flexible" labor and product market regulations



Notes: The chart shows the response of GDP and unemployment to an unexpected one-percentage-point-of-GDP increase in government spending under: the baseline parameter values of the parametrized model of the small open euro area economy ("no reform"); lower entry costs, lower unemployment benefits and lower layoff costs, considered jointly ("labor and product market reforms package"). See Section A for further details.

In other words, fiscal multipliers tend to be larger overall in the more "rigid" (baseline) economy than in an alternative institutional set-up with more flexible labor and product markets. This illustrated in Appendix Figure 4.6. In the recession triggered by the risk-premium shock, the government spending multiplier is over 1.1 at a 4-quarter horizon in the "rigid" (baseline) case, versus about .8 in the "flexible" one.

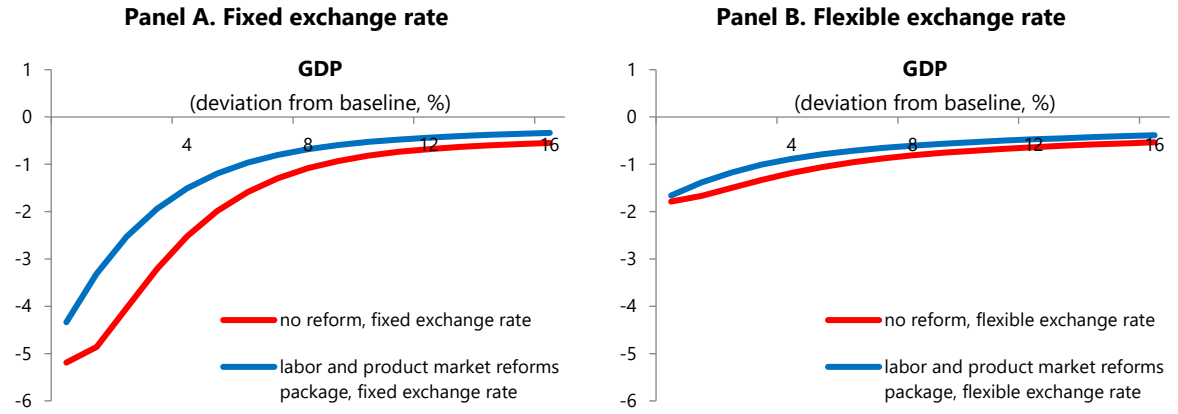
Figure 4.6. Government spending multipliers in a recession under "rigid" and "flexible" regulations



Notes: The chart shows the impact on GDP, in a recession triggered by the risk-premium shock described above, of an unexpected one percentage-point-of-GDP increase in government spending at 4-quarter and 8-quarter horizons under: baseline parameter values for entry costs, unemployment benefits and layoff costs ("No reform"); alternative, lower values for entry costs, unemployment benefits and layoff costs ("Labor and product market reforms package"). See Section A for further details.

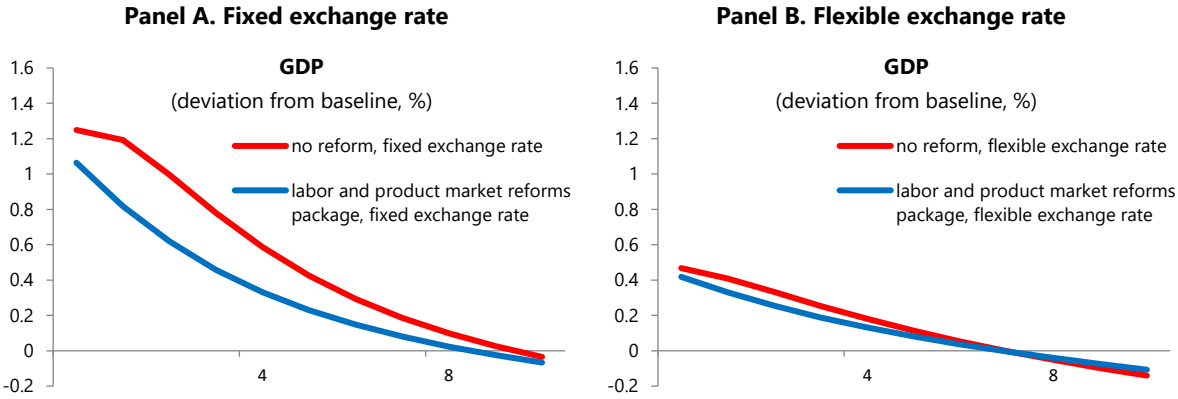
The role of labor and product market regulations for shock transmission is particularly important in a monetary union. In a counterfactual scenario under which the small open economy operates a flexible exchange rate regime, the response of output to the risk-premium shock is smoother, and the difference in responses between "rigid" and "flexible" institutional set-ups is smaller than it is under a fixed exchange rate (Appendix Figure 4.7, Panel B versus Panel A). Likewise, regulations matter less for the transmission of fiscal policy in a flexible exchange rate regime (Appendix Figure 4.8, Panel B versus Panel A).

Figure 4.7. Response of output to risk-premium shock under "rigid" and "flexible" labor and product market regulations: flexible vs. fixed exchange rate regime



Notes: The chart shows the response of GDP to an illustrative risk-premium shock in a fixed exchange rate regime (Panel A) and a flexible exchange rate regime (Panel B) under: the baseline parameter values of the parametrized model of the small open euro area economy ("no reform"); lower entry costs, lower unemployment benefits and lower layoff costs, considered jointly ("labor and product market reforms package"). See Section A for further details.

Figure 4.8. Response of output to government spending shock under "rigid" and "flexible" labor and product market regulations: flexible vs. fixed exchange rate regime



Notes: The chart shows the response of GDP to an unexpected one-percentage-point-of-GDP increase in government spending in a fixed exchange rate regime (Panel A) and a flexible exchange rate regime (Panel B) under: the baseline parameter values of the parametrized model of the small open euro area economy ("no reform"); lower entry costs, lower unemployment benefits and lower layoff costs, considered jointly ("labor and product market reforms package"). See Section A for further details.

D. Implications and limitations

The policy implications of the analysis can be summarized as follows:

- Labor and product market reforms do not only affect long-run output and unemployment levels, but also the transmission of macroeconomic shocks, particularly in a monetary union.
- While the effects of individual measures on shock transmission vary, overall a package of labor and product market reforms would help individual euro area economies—notably their labor markets—weather better adverse macroeconomic shocks.
- Most crucial to strengthening individual euro area economies' resilience to shocks is to enhance real wage flexibility. This calls for labor market reforms focused on this specific objective.
- In the absence of reforms, the need for, and the effectiveness of counter-cyclical fiscal policy are even stronger. This makes it particularly important for individual countries to build in good times the fiscal space needed for fiscal expansion to stabilize the economy in bad times. No country should be deprived of both—reform and fiscal—adjustment mechanisms.[29]

These implications are subject to a number of caveats. These essentially reflect the fact that no model-based exercise can fully capture all the relevant dimensions of the wide range of existing labor and product market regulations. Factoring in these model limitations may in some cases dampen, but in others strengthen or broaden, the policy implications of the analysis. This underscores the need for complementary empirical work. In particular:

- *Financial frictions affecting firms and the complementarity between structural policies and counter-cyclical macroeconomic policies*. The model assumes complete financial markets. One relevant consequence in the context of this note is that firms' investment decisions are not subject to credit constraints. Yet, there is mounting evidence that adverse financial shocks—such as those hitting the banking sector—affect the availability of credit and, thereby, can lead credit-constrained firms to cut investment and employment below levels that would prevail in the absence of such credit constraints.[30] By reducing firms' profits and thereby the availability of internal funds to keep on financing investment, stronger product market competition may amplify these cuts—particularly for (innovation-enhancing) intangible capital, which may be most sensitive to internal funds availability since it can cannot be pledged as collateral for a loan (Aghion, Farhi and Kharroubi, 2018). This opens the possibility that countercyclical fiscal policy be

[29] In many cases, building fiscal space in good times would also increase financial markets' confidence in the sustainability of domestic public debt. This would further strengthen the effectiveness of any future fiscal stimulus in bad times by alleviating risks that it triggers a spike in sovereign risk premia—an issue ignored here, since the analysis does not factor in any impact of public debt levels on the size of fiscal multipliers.

[30] Examples include Benmelech, Bergman and Seru (2011); Chodorow-Reich (2014); Duval, Hong and Timmer (2017); Giroud and Mueller (2017); Kalemli-Ozcan, Laeven and Moreno (2018).

more, not less, powerful in stabilizing investment and the economy in more competitive product markets.

- *Financial frictions affecting households and the effect of unemployment insurance*. The model features a representative household that consists of a continuum of individual members that provide full income insurance to each other. Lower unemployment benefits make real wages more flexible and thereby dampen shock transmission in the model. This reflects the strong responsiveness of labor demand to wages through the firm hiring channel (see e.g. Mitman and Rabinovich, 2015). However, the model abstracts from a potential counteracting force: lower unemployment benefits can lead credit-constrained unemployed households to curtail consumption, thereby weakening aggregate demand, all else being equal (see e.g., in the context of a model with heterogenous agents, Kollmann and others, 2015). In addition, unemployment benefit systems act as an automatic fiscal stabilizer when output falls below potential. While these caveats do not question the key stabilizing role of real wage flexibility, they suggest that the aggregate demand effects of unemployment benefits might matter more in practice than they do in the model. Furthermore, by providing insurance to displaced (risk-averse) workers, unemployment insurance can help them look for higher-quality jobs and take greater risks—seeking higher-pay but higher-unemployment-risk jobs—thereby raising productivity and output (Acemoglu and Shimer, 1999). Finally, the insurance role of unemployment benefits means that they are typically more helpful to the resilience of workers' well-being than they are to that of employment and output (for a discussion of the impact of Germany's early 2000s Hartz reforms on the output and welfare costs of subsequent recessions, see Krebs and Scheffel, 2017).

- *Price rigidities and the effect of product market regulation*. The model features price rigidity—in the form of price adjustment costs à la Rotemberg (1982)—but does not make the *ad hoc* assumption that such rigidity depends on the degree of product market competition. To the extent that stronger competition leads to greater price flexibility, product market deregulation might help macroeconomic adjustment to shocks even more than found here.

- *Wage rigidities and the effect of labor market regulations.* The model assumes that wages are renegotiated each period (quarter). Assuming instead that wages converge to this "equilibrium" value only slowly due to rigidities would further strengthen the key results from the analysis; most importantly, the difference in the response of output to shocks under "rigid" and "flexible" labor and product market shown in Panel A of Appendix Figure 4.5 would be even larger.[31] To the extent that labor market reforms—such as adjustments to job protection legislation or collective bargaining systems—facilitate wage (re)negotiations, they may strengthen macroeconomic adjustment to shocks beyond what is found here.

- *Temporary versus permanent contracts and the effect of employment protection legislation.* The model features only one type of job contract that is subject to one type of job protection legislation—the layoff cost. In practice, however, strict job protection for permanent workers also

[31] These simulation results are not reported here but they are available upon request.

incentivizes employers to create less-protected temporary jobs, contributing to the increased prevalence of the latter in many European and some other advanced economies (see e.g. Cahuc, Charlot and Malherbet, 2016). Since temporary jobs entail smaller layoff costs, they are more likely to be destroyed first in the event of an adverse shock—as shown by the experience of Spain, for example, during the global and euro area crises. Therefore, stricter job protection for permanent workers may end up *reducing* the cost of laying off marginal (temporary workers), thereby *amplifying*—rather than dampening as in the model built here—the response of the economy to shocks.

- *Permanent losses from macroeconomic shocks*. Temporary shocks have temporary effects in the model. Against this conventional wisdom, there has been growing evidence that recessions accompanied by financial crises lead to large permanent output losses, although the magnitude of these is still being debated (Cerra and Saxena, 2008; Jorda, Schularick and Taylor, 2013; Reinhart and Rogoff, 2009; Romer and Romer, 2017). It has even been argued that "plain vanilla" recessions may also be followed by permanently lower output (Blanchard, Cerutti and Summers, 2015; Bluedorn and Leigh, 2018). If anything, pervasive hysteresis would amplify the quantitative implications of the analysis above, and further strengthen the case for labor and product market reforms that keep output close to potential.[32]

[32] For example, based on an incomplete-market model with search unemployment and skill depreciation during unemployment—a source of hysteresis, Krebs and Scheffel (2017) estimate that lower unemployment benefits and stronger job search assistance after the so-called Hartz reforms of the early 2000s led to a substantial reduction in the output cost of recessions in Germany, including during the 2008-2009 global financial crisis.

Box 1. The Persistence of Employment Fluctuations[1]

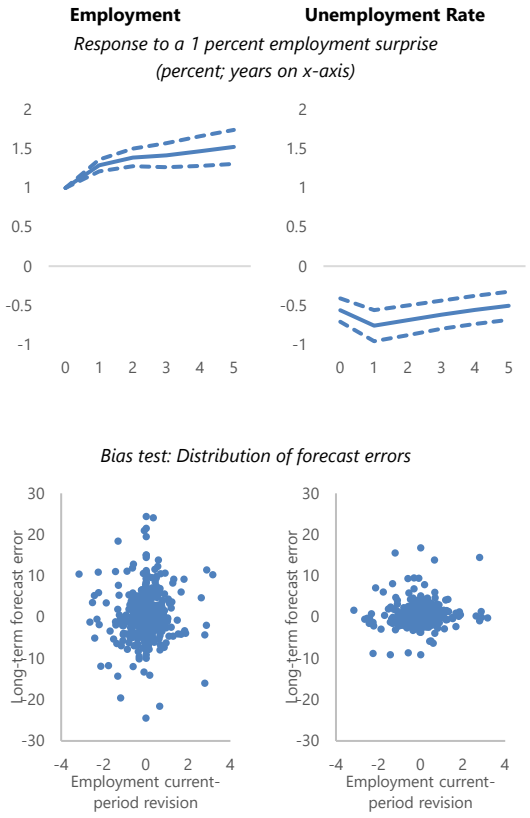
How long-lasting are fluctuations in employment? Is the persistence of shocks to employment related to national structural policies? Are euro area economies different from other advanced economies? A conventional view is that employment, labor force participation, and the unemployment rate fluctuate about broadly stable trend levels determined by structural factors such as demographics. Accordingly, recessions should be followed by above-normal growth as labor market variables revert to trend. Recent research, however, suggest that recessions can have persistent effects on economic activity and employment (Cerra and Saxena 2008; Erceg and Levin 2014; Blanchard, Cerutti, and Summers 2015; Martin, Munyan, and Wilson 2015; Yagan 2018; Bluedorn and Leigh 2018). This box examines the evidence on the persistence of employment fluctuations in 20 advanced economies through the lens of professional forecasters—namely, their views on the path of employment in response to news shocks. A key benefit of looking directly at forecasters' perceptions is that the analysis need make no strong statistical modeling assumptions. Moreover, if forecasts are generally unbiased for the actual variables, then forecast persistence is revelatory about actual persistence.

Specifically, the analysis looks at the response of the long-term (5 year ahead) forecast to revisions to the current period forecast. If forecasters view labor market fluctuations as dominated by purely transitory fluctuations, an unexpected change in a labor market variable today should bear no relationship to its expected level over long horizons. If the expected long-term level does change, then this suggests that forecasters view some component of the shock as permanent.

As the top row of Figure 1.1 suggests, forecasters view an employment expansion as *normally* having long-term effects.[2] Following a 1 percent surprise in current-period employment, forecasters adjust the forecast of employment in 5 years by an average of 1.5 percent in the same direction. Forecasters also expect the unemployment rate to fall, before gradually normalizing. But do these tell us much about the actual persistence of labor market variables? If forecasts are unbiased, then long-term forecast errors should bear little relationship to current-period surprises. The bottom row of Figure 1.1 indicates that this is the case, where the scatters appear largely cloud-like. Formal statistical tests support this impression—forecasters do not appear to over- or understate employment persistence in general.

Overall, these results are consistent with the notion that employment fluctuations are highly persistent. In a related analysis of output persistence across countries, there is evidence that countries with less flexible markets tend to exhibit greater persistence. The findings on employment also point to starker trade-offs in the conduct of countercyclical policies, suggesting that the employment costs of failing to react quickly to a downturn may be larger than commonly thought, while allowing for a high-pressure economy to run may be less.

Figure 1.1 Persistence of Employment Fluctuations



Source: IMF staff calculations.
Note: Top panel shows the estimated perceived impulse responses based on revisions to professional forecasts in percentage points along with 90 percent confidence intervals. Forecast errors in the bottom panel are in percentage points, with the sample ending in 2013 so that the last forecast error is for 2018 made in 2013.

[1] Prepared by John Bluedorn and Daniel Leigh, building on Bluedorn and Leigh (2018).

Box 2. Labor Market Reforms and Performance in Germany[1]

Following a decade of poor growth and rising unemployment, Germany enacted comprehensive labor market reforms between 2002 and 2005 – collectively known as Hartz reforms (I-IV) (Table 1). The reforms tackled various impediments to labor demand and supply. The first three stages of the reforms (Hartz I–III) sought to improve job search efficiency and labor market flexibility, while the final set of reforms (Hartz IV) entailed a major restructuring of the unemployment and social assistance system that considerably reduced the size and duration of unemployment benefits and made them conditional on tighter rules for job search and acceptance.

Table 1. Brief Description of Hartz Reforms in Germany

Law	Adoption of Law	Effective Date	Measure
Hartz I	Dec 1, 2002	Jan 1, 2003	Setting up of new Personnel Service Agencies; Support for further vocational education from the German Federal Labor Agency; Deregulation of temporary work sector.
Hartz II	Dec 1, 2002	Jan 1, 2003 and April 1, 2003	Introduction of subsidy for one-person companies (Me-inc); Introcution of low paid jobs (mini and midi-jobs) exempt from most social security taxes; Threshold size for firms subject to layoff rules raised from five to ten workers.
Hartz III	Dec 1, 2003	Jan 1, 2004	Restructuring of the Federal Labor Office.
Hartz IV	Dec 1, 2003	Jan 1, 2005	Shortening of the duration of unemployment benefits. Merging of unemployment assistance and social assistance, with benefit set at the lower level of social benefits (unemployment benefit II); A new definition of acceptable jobs with sanctions for refusal of an acceptable job.

Sources: Eichhorst and Marx(2011), Dlugosz and Wilke (2013).

The reforms ushered in an extended period of strong employment growth and unprecedented declines in unemployment (from a peak of about 11.5 percent in 2005 to 3.3 percent by end 2018). This German "employment miracle" has been accompanied by significant declines in real compensation as lower employment protection and cut to unemployment benefits under the Hartz reforms improved incentives to participate and reduced reservation wage.[2] It remains however difficult to isolate the quantitative effect of the reforms from the general wage moderation that started at the end of the 1990s to stem the offshoring of production and regain competitiveness.[3]

It has been also argued that the Hartz reforms paid off during the crisis as more efficient labor markets allowed firms to better cope with collapsing demand. The contrast with the US is striking (Table 2). From peak to trough of the recession (based on US dating), unemployment rate increased by a staggering 4.5 percent in the US but *declined* marginally in Germany – and this despite a larger GDP correction. However, it is difficult to disentangle the reforms' marginal impact during the crisis from the one of the long-established work program "Kurzarbeit".[4] This avoids social dislocation and supports domestic demand during hardship. And indeed, the employment-to-population ratio increased slightly in Germany during the crisis, while hours worked dropped significantly more than in the US. Moreover, "Kurzarbeit" allows firm to save on costs as they retain skilled labor through recessions. Nevertheless, the scheme may slow down the long-term churning process that must take place to allow swift adjustment reflecting rapidly changing technology and demand.

Table 2. Macroeconomic Indicators: Germany and the United States

	United States			Germany		
Indicator	2007:Q4	2009:Q2	Change* (%)	2007:Q4	2009:Q2	Change* (%)
Real GDP (billions of 2005 currency)	$13,326	$12,701	-4.69	€ 601	€ 568	-5.6
Unemployment rate (%)	4.8	9.3	4.5	8.3	7.9	-0.4
Employment-to-population ratio[1] (%)	48.4	45.8	-2.6	48.7	49.3	0.6
Labor forece participation rate[1] (%)	50.8	50.5	-0.4	52.9	53.2	0.3
Annual hours worked per employee[2]	100	98.1	-1.9	100	95.9	-4.1

Note: * Changes for the unemployment rate, employment-to-population ratio, and labor forece participation rate are expressed as percentage-point changes. Changes for real GDP are expressed as the percentage change.

1/ The employment-to-population ratio and labor forece participation rate are calculated using resident populations for comparison across countries

2/ Index with 2007 values normalized at 100. The varaible is at annual frequecy, and 2009 value is reported for 2009Q2.

Sources: Bureau of Economic Analysis, Eurostat, Destatis, Haver Analytics, OECD, and IMF staff calculations.

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[1] Prepared by Jean-Marc Natal.

[2] It is worth noting that the increasing number of "opening clauses" in collective agreements in the 1990s allowed firms to deviate from industry-wide standards. These opening clauses helped ensure competitiveness by affecting both hours of work and wages (Dustmann and others 2014). Engbom, Detragiache, and Raei (2015) show that displaced workers had to incur an additional 10 percent drop in earnings after the Hartz reforms.

[3] Adhikari and others (2018) point to significant positive effect on growth of the reforms.

[4] Under this program, workers can work half time and be paid up to 80 percent of their original salary with compensation from the government.

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