Annex 2.1. Decomposition methodology

This annex presents the technical details of the growth decomposition analysis in Chapter 2.[1] While the analysis is conducted at quarterly frequency over 2020Q1-Q4 with the results aggregated to annual 2020 values for the figures presented in Chapter 2, the quarterly time dimension is not denoted in the remainder of the annex in the interest of simplifying exposition.

Starting with 2020 real GDP growth outcomes, g_{2020}, the first step of the analysis deducts pre-pandemic growth trends g^* which are proxied with October 2019 WEO growth projections for the same period. This yields the first layer of the decomposition

$$g_1 \equiv g_{2020} - g^*$$

which reflects the output loss due to pandemic.

The second step focuses on the contribution of sectoral composition to output losses, as some sectors (e.g., retail and hospitality) were affected more by pandemic containment measures than others, leading to higher output losses for countries where such sectors account for a larger share of GDP. To this end, output losses are first de-constructed to the sectoral level such that

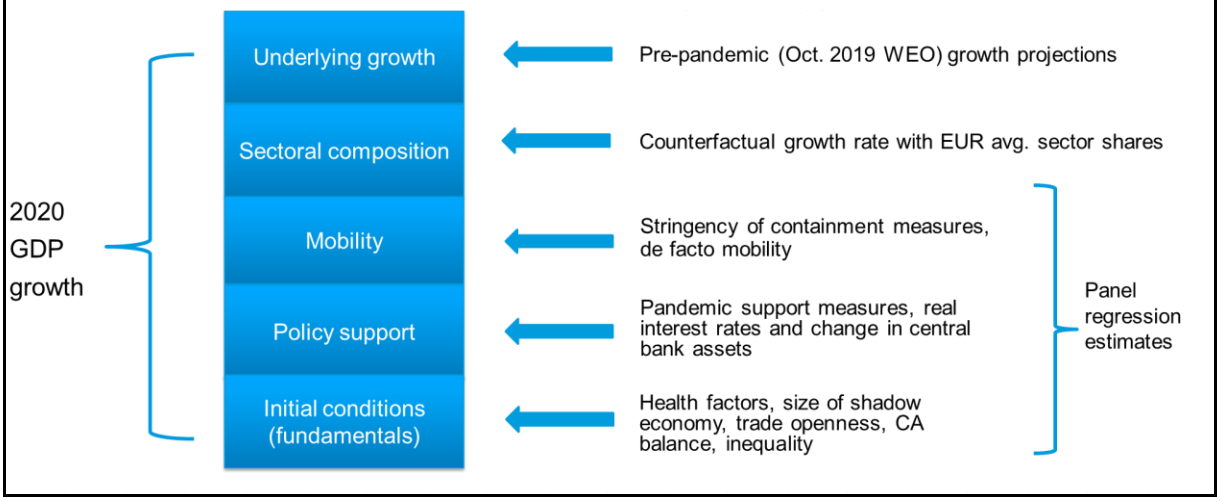
$$g_1 = \sum_{i=1}^{N} w_i (g_{2020,i} - g_i^*)$$

where i denotes sectors, of which there are $N = 10$ (see Figure 2.1 in the chapter for a sectoral decomposition), w_i represents sector i's weight, given by its share in gross value added in 2019 and $g_{2020,i}$ represents sector i's growth rate in 2020. g_i^* is the pre-pandemic growth trend for sector i. Given the absence of WEO projections at the sectoral level, g_i^* is proxied with the sectoral growth rate that would have led to the same annual shift in sector shares as observed between 2015-2019, that is

$$g_i^* = \left(\frac{w_{i,2019} - w_{i,2015}}{4 w_{i,2019}} + 1 \right) g^*$$

where $w_{i,2019}$ and $w_{i,2015}$ are the 2015 and 2019 sector shares.[2]

Annex Figure 2.1.1 Decomposition Approach



[1] The analysis builds upon the methodology of Caceres et al. (2021) by extending it to all European countries and analyzing the role of policy support and pre-pandemic country fundamentals

[2] g_i^* is calculated at quarterly frequency using the data from the corresponding quarters in 2015 and 2019. If sectoral data for 2015 is not available for a country, the latest year that has available data for all quarters is used instead.

The contribution of sectoral composition, g_2, is then attained by benchmarking actual output losses of each country against a counterfactual output loss where each sector's weight in GDP is equal to the PPP-weighted average sectoral weight of European countries, $\widetilde{w}_i$, such that

$$g_2 \equiv \sum_{i=1}^{N} (w_i - \widetilde{w}_i)\left(g_{2020,i} - g_i^*\right)$$
$$= g_1 - \sum_{i=1}^{N} \widetilde{w}_i \left(g_{2020,i} - g_i^*\right)$$

This yields the second layer of the decomposition.

The third layer of the decomposition uses panel regressions to estimate contributing factors to within-sector output losses $\left(g_{2020,i,c,t} - g_{i,c,t}^*\right)$. A separate panel regression is run for each sector i, each with country-time dimensions (c,t) over 2020Q1-2020Q4 such that

$$\left(g_{2020,i,c,t} - g_{i,c,t}^*\right) = \alpha_i + \beta_i X_c + \gamma_i P_{c,t-1} + \phi_i M_{c,t} + \varepsilon_{i,c,t}$$

where α_i is the intercept, X_c is a vector of pre-pandemic fundamentals (i.e., initial conditions from 2019), $P_{c,t-1}$ is a vector of lagged policy variables, $M_{c,t}$ is a vector of contemporaneous mobility variables, $\varepsilon_{i,c,t}$ is the residual and the remaining variables are coefficients to be estimated.[3]

Annex Table 2.1.1 provides information on data sources and variable construction. Initial conditions are standardized such that their contribution can be interpreted as the outcome of differentials from the sample average. Policy support measures and variables capturing mobility are not standardized so that their contribution captures their changes from 2019 in absolute terms, rather than against an average benchmark.

Annex Table 2.1.2 displays the estimated coefficients from sectoral panel regressions. The contributions are calculated by aggregating the products of independent variables and corresponding coefficients across sectors.[4] For example, the contribution of mobility variables in each quarter t are given by

$$\sum_{i=1}^{N} \widetilde{w}_i \hat{\phi}_i M_{c,t}$$

where counterfactual sector weights are used instead of actuals since the second layer already captures the contribution of sectoral composition.

Finally, as the dependent variable is already net of pre-pandemic growth trends, the sum of the intercept and residuals together constitute the unexplained portion, given by

$$\sum_{i=1}^{N} \widetilde{w}_i \left(\alpha_i + \varepsilon_{i,c,t}\right)$$

The residuals presented in Chapter 2 reflect this, as well as absorbing any data discrepancies between sectoral and aggregate, and quarterly and annual, growth rates.

[3] Policy variables are lagged to alleviate endogeneity, while mobility variables are included in contemporaneous time to fully capture the effects of containment measures.

[4] This makes the contributions invariant to the scaling of independent variables.

Annex Table 2.1.1. Data Sources and Construction

	Variable	Note	Source
Initial conditions	Trade openness	Defined as sum of imports and exports divided by GDP	IMF WEO
	Current account balance		IMF WEO
	Gini inequality index		WB WDI
	Size of shadow economy	As a share of official GDP in 2017	Medina & Schneider (2018)
	Median age		UN Population Division, World Population Prospects, 2017 Revision
	Hospital beds per 1000 people		OECD, Eurostat, WB WDI, National Authorities
	Share of smokers in population	Average of male and female smokers ratios	WB WDI
	Population density	People per sq. km of land	WB WDI
Policy	Fiscal support measures	Announced measures as percent of 2019 GDP. Time variation reflects different vintages of the survey	IMF COVID-19 Policy Survey
	Real interest rates	Ex-post real interest rates calculated as key policy rates less CPI inflation, in quarterly averages.	Haver Analytics, Eurostat, European Central Bank, National Authorities, IMF staff calculations
	Central bank assets	As percent of 2019 GDP	Haver Analytics, European Central Bank, National Authorities
Mobility	Stringency of containment measures	Quarterly average of higher frequency data	Blavatnik School of Government at the University of Oxford
	De facto mobility	Quarterly average of residuals from a weekly panel regression with google mobility (defined as average of mobility indicators for retail and recreation, and workplaces) as dependent variable and stringency of containment measures and country-quarter fixed effects as independent variables.	Google Mobility Reports, IMF staff calculations

Annex Table 2.1.2. Sectoral Panel Regression Results

VARIABLES	(1) 2020 Real GDP growth net of underlying growth & sectoral composition effects	(2) Agriculture	(3) Industry exc. Cons.	(4) Construction	(5) Wholesale & retail	(6) ICT	(7) Finance & insurance	(8) Real estate	(9) Prof., scientific & tech	(10) Pub. adm., educ. & social work	(11) Arts & other
Fiscal support measures	0.274***	0.126*	0.360***	0.214**	0.406***	0.105**	0.0653	0.0239	0.230***	0.126***	0.319**
	(0.0518)	(0.0696)	(0.104)	(0.0893)	(0.0690)	(0.0445)	(0.0657)	(0.0310)	(0.0707)	(0.0447)	(0.120)
Real interest rate	0.120	-0.343	0.351	0.389	-0.0764	0.343	-0.913	0.157	0.0157	0.0158	0.0888
	(0.213)	(0.463)	(0.422)	(0.378)	(0.387)	(0.392)	(0.794)	(0.243)	(0.351)	(0.262)	(1.145)
Change in central bank assets	-0.0294	0.0563	-0.157*	-0.0531	-0.0699	-0.00965	-0.0401	0.0629**	-0.0988	0.0360	0.0561
	(0.0273)	(0.0605)	(0.0788)	(0.0870)	(0.0641)	(0.0705)	(0.0602)	(0.0246)	(0.102)	(0.0257)	(0.216)
Stringency of containment	-0.178***	-0.0825***	-0.140***	-0.168***	-0.338***	-0.102***	-0.0448**	-0.0470***	-0.258***	-0.0720***	-0.485***
	(0.0133)	(0.0243)	(0.0305)	(0.0331)	(0.0255)	(0.0165)	(0.0219)	(0.0118)	(0.0261)	(0.0141)	(0.0670)
De facto mobility	0.144**	0.0660	0.163	0.225	0.148	0.0943	0.0481	0.0779**	0.0866	0.105	0.166*
	(0.0672)	(0.0869)	(0.121)	(0.160)	(0.119)	(0.0682)	(0.103)	(0.0355)	(0.0780)	(0.0668)	(0.0977)
Median age	-0.337***	-0.290	-0.732***	0.491	-0.723***	-0.261	-0.148	-0.0550	-0.325**	0.0467	-0.645
	(0.0905)	(0.240)	(0.213)	(0.374)	(0.213)	(0.219)	(0.328)	(0.143)	(0.144)	(0.102)	(0.467)
Hospital beds per 1000 people	0.200	-0.0789	-0.380	-0.406	1.245**	0.433	-0.0928	-0.0549	0.353	-0.202	-0.431
	(0.185)	(0.581)	(0.441)	(0.695)	(0.509)	(0.405)	(0.486)	(0.223)	(0.491)	(0.195)	(1.007)
Trade openness	-0.994*	-2.002	-0.563	0.346	-0.520	2.665***	-1.407	-1.488	-0.569	0.586	1.552
	(0.560)	(1.281)	(1.496)	(1.169)	(0.892)	(0.980)	(1.227)	(0.979)	(1.016)	(0.746)	(3.103)
Size of shadow economy	-0.0204	-0.0597	0.0139	0.280*	-0.130	0.0272	0.397**	-0.0436	-0.104	0.0211	0.0599
	(0.0573)	(0.120)	(0.112)	(0.150)	(0.136)	(0.120)	(0.176)	(0.0751)	(0.107)	(0.0797)	(0.226)
Share of smokers in population	-0.0478	0.265	0.0481	0.0520	-0.282	-0.226	-0.261*	-0.0711	0.111	0.194***	0.108
	(0.0620)	(0.184)	(0.147)	(0.238)	(0.170)	(0.152)	(0.140)	(0.0590)	(0.139)	(0.0519)	(0.345)
Gini inequality index	-0.0134	-0.122	-0.175	0.125	0.0139	0.561***	0.0536	-0.0243	0.127	0.0552	0.427
	(0.0939)	(0.270)	(0.229)	(0.260)	(0.251)	(0.183)	(0.196)	(0.128)	(0.153)	(0.0871)	(0.404)
Population density	-0.00441***	-0.00129	-0.00156	-0.000464	-0.0145***	-0.000937	-0.00131	-0.00288*	0.000982	-0.00192	0.0183**
	(0.00122)	(0.00313)	(0.00352)	(0.00250)	(0.00366)	(0.00202)	(0.00205)	(0.00164)	(0.00219)	(0.00127)	(0.00745)
Current account balance	0.155*	0.317*	0.395	0.0175	-0.111	0.129	0.515***	-0.00962	-0.140	0.0431	-0.759
	(0.0875)	(0.177)	(0.286)	(0.237)	(0.225)	(0.186)	(0.167)	(0.0965)	(0.177)	(0.0919)	(0.546)
Constant	-1.767***	-0.523	-0.892	2.925**	1.690	4.880***	-0.215	-0.843*	3.369***	-0.0230	5.277***
	(0.524)	(1.160)	(0.842)	(1.357)	(1.070)	(1.063)	(1.136)	(0.459)	(0.987)	(0.564)	(1.942)
Observations	164	164	164	164	164	164	164	164	164	164	164
R-squared	0.616	0.123	0.321	0.225	0.594	0.316	0.176	0.234	0.502	0.265	0.460

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Column (0) is for demonstration only while columns (1)-(10) reflect sectoral regressions used in growth decomposition.

Annex 2.2. Calibration of Policy Multipliers

In calibrating the fiscal multipliers, the chapter relies on data on the composition of announced fiscal support measures, which are available from the IMF COVID-19 Policy Survey. Particularly, the survey data permits a breakdown of fiscal support measures between above-the-line measures, liquidity measures, and below-the-line measures (Annex Figure 2.2.1). For each country and in every quarter, an average fiscal multiplier, $F_{c,t}$, is calculated using the following expression

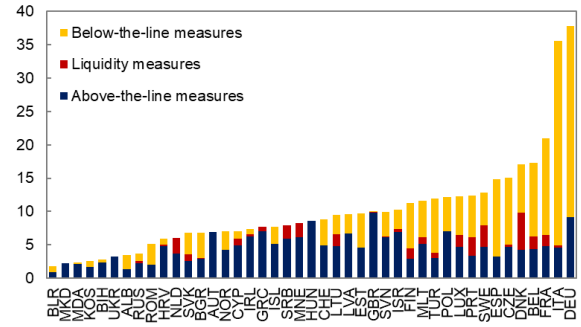
$$F_{c,t} = M_{ATL}P_{ATL,t} + M_{LIQ}P_{LIQ,t} + M_{BTL}P_{BTL,t}$$

where P_{ATL} , P_{LIQ} and $P_{BTL} = 1 - P_{ATL} - P_{LIQ}$ are respectively the share of above-the-line, liquidity and below-the-line measures and $(M_{ATL}, M_{LIQ}, M_{BTL})$ are the corresponding multipliers, which are calibrated according to recent literature on fiscal multipliers during the COVID-19 pandemic:

- M_{ATL} is calibrated to 0.83 as an average of the multipliers for spending, unconditional transfers, payroll tax cuts and unemployment insurance provided by Bayer and others (2020), Faria-e-Castro (2021) and Guerrieri and others (2020)
- M_{LIQ} is calibrated to 0.45 according to the multiplier for liquidity assistance given by Faria-e-Castro (2021)
- M_{BTL} is set to $M_{BTL} = \tau M_{LIQ}$ where the take-up coefficient, τ, is set to $1/3$ in view of the low take-up of below-the-line measures in many countries.

Note that the average fiscal multipliers vary over country and time due to the shifting compositions of fiscal measures. For each country, the contribution of fiscal policy is calculated by multiplying fiscal measures with the average multiplier for the corresponding quarter, and then using the four quarters to attain annualized values for 2020.

Annex Figure 2.2.1. Composition of Fiscal Support Measures, 2020
Percent of 2019 GDP



Sources: National authorities; and IMF staff calculations.
Note: Liquidity measures denote deferral of tax payments or accelerated refund of tax credits. Below-the-line measures include guarantees, contingent liabilities and any other measures directly affecting govt. assets and liabilities (e.g. govt. loans, equity injections or asset purchases).

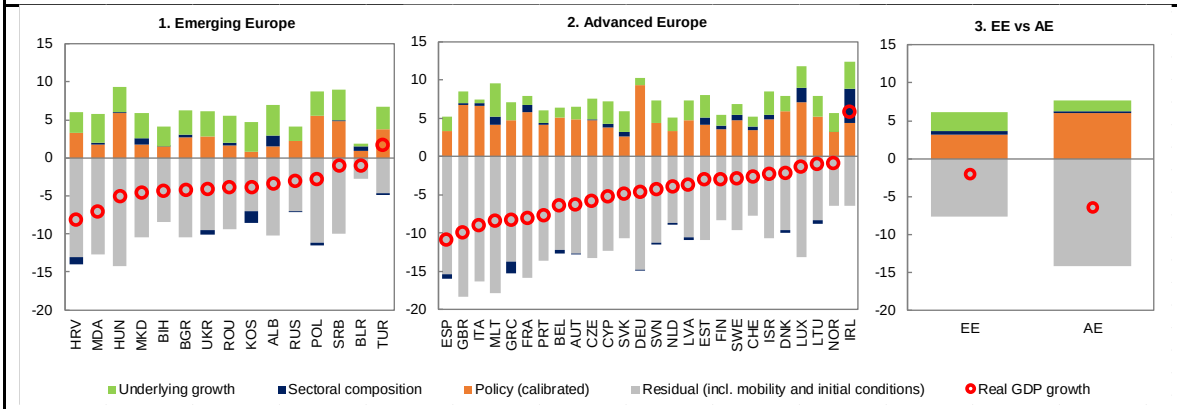
The calibration of monetary policy multipliers differentiates between policy rate cuts and an increase in the central bank balance sheet, which captures unconventional monetary policy instruments. In view of the impact of country characteristics (such as financial depth) on monetary policy transmission, the multipliers applied are differentiated between countries to the extent that the existing literature permits.[5] Annex Table 2.2.1 provides more information on the multipliers used for each country and monetary policy instrument, and their source.

Finally, the calibrated policy contributions are attained by adding up the contributions of fiscal policy, policy rate cuts, and the expansion in central bank balance sheets.

Annex Figure 2.2.2 shows the decomposition of real GDP growth under calibrated policy contributions. The contributions of underlying growth and sectoral composition, which are not based on regression estimates and

[5] Given the unavailability of estimates for each country in our sample, literature estimates are extrapolated to countries with similar characteristics whenever needed.

Figure 2.2.2. Decomposition of Real GDP Growth with Calibrated Policy Contributions
(Percentage Points)



Source: Haver Analytics; and IMF staff calculations
Note: PPP GDP-weighted averages are shown in panel 3. Residual includes the contribution of mobility and initial conditions.

therefore remain identical to the contributions presented in Figure 2.4 of Chapter 2, are also shown. The contribution of mobility and initial conditions, which are based on regressions, are excluded and become part of the residual.

Annex Table 2.2.1. Calibration of Monetary Policy Multipliers

Country	Impact of 1 p.p. cut in policy rate	Literature reference	Impact of increase in central bank assets by 1% of 2019 GDP	Literature reference
Albania	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Austria	0.42	Jarociński (2010)	0.11	Burriel & Galesi (2018)
Belarus	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Belgium	0.42	Jarociński (2010)	0.06	Burriel & Galesi (2018)
Bosnia and Herzegovina	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Bulgaria	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Croatia	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Cyprus	0.42	Jarociński (2010)	0.05	Burriel & Galesi (2018)
Czech Republic	0.42	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Denmark	0.42	Jarociński (2010), Mountford (2005)	0.08	Burriel & Galesi (2018)
Estonia	0.42	Jarociński (2010)	0.33	Burriel & Galesi (2018)
Finland	0.42	Jarociński (2010)	0.12	Burriel & Galesi (2018)
France	0.42	Jarociński (2010)	0.08	Burriel & Galesi (2018)
Germany	0.42	Jarociński (2010)	0.14	Burriel & Galesi (2018)
Greece	0.42	Jarociński (2010)	0.03	Burriel & Galesi (2018)
Hungary	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Iceland	0.42	Jarociński (2010), Mountford (2005)	0.06	Burriel & Galesi (2018)
Ireland	0.42	Jarociński (2010)	0.13	Burriel & Galesi (2018)
Israel	0.42	Jarociński (2010), Mountford (2005)	0.04	Gambacorta, Hofmann & Peersman (2014)
Italy	0.42	Jarociński (2010)	0.07	Burriel & Galesi (2018)
Kosovo	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Latvia	0.42	Jarociński (2010)	0.18	Burriel & Galesi (2018)
Lithuania	0.42	Jarociński (2010)	0.33	Burriel & Galesi (2018)
Luxembourg	0.42	Jarociński (2010)	0.15	Burriel & Galesi (2018)
North Macedonia	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Malta	0.42	Jarociński (2010)	0.03	Burriel & Galesi (2018)
Moldova	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Montenegro, Rep. of	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Netherlands	0.42	Jarociński (2010)	0.04	Burriel & Galesi (2018)
Norway	0.42	Jarociński (2010), Mountford (2005)	0.10	Gambacorta, Hofmann & Peersman (2014)
Poland	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Portugal	0.42	Jarociński (2010)	0.04	Burriel & Galesi (2018)
Romania	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Russia	0.14	Vymyatnina (2005)	0.24	Burriel & Galesi (2018)
Serbia	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
Slovak Republic	0.42	Jarociński (2010)	0.11	Burriel & Galesi (2018)
Slovenia	0.42	Jarociński (2010)	0.06	Burriel & Galesi (2018)
Spain	0.42	Jarociński (2010)	0.02	Burriel & Galesi (2018)
Sweden	0.42	Jarociński (2010), Mountford (2005)	0.10	Gambacorta, Hofmann & Peersman (2014)
Switzerland	0.42	Jarociński (2010), Mountford (2005)	0.01	Gambacorta, Hofmann & Peersman (2014)
Turkey	0.75	Büyükbaşaran, Can & Küçük (2019)	0.24	Burriel & Galesi (2018)
Ukraine	0.33	Jarociński (2010)	0.24	Burriel & Galesi (2018)
United Kingdom	0.43	Mountford (2005)	0.25	Weale & Wieladek (2016)

Note: The calibrated multipliers for an increase in central bank assets in Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Hungary, Kosovo, North Macedonia, Moldova, Montenegro, Poland, Romania, Russia, Serbia, Turkey, Ukraine are extrapolated from the average of the multipliers estimated by Burriel & Galesi (2018) for Estonia, Latvia, Lithuania and the Slovak Republic.

References

Bayer, C., B. Born, R. Luetticke, and G. J. Müller. 2020. "The Coronavirus Stimulus Package: How large is the transfer multiplier?" CEPR Discussion Papers 14600.

Burriel, P. and A. Galesi. 2018. "Uncovering the heterogeneous effects of ECB unconventional monetary policies across euro area countries." *European Economic Review* 101, 210-229.

Büyükbaşaran, T., G. K. Can, and H. Küçük. 2019. "Identifying Credit Supply Shocks in Turkey." Central Bank of the Republic of Turkey, Working Paper No: 19/06

Caceres, C., B. Gruss, and S. Weber. 2021. "Differences in Output Performance Between Europe and the US During Covid-19." Box in the April 2021 Regional Economic Outlook Update for Europe, International Monetary Fund.

Faria-e-Castro, M. 2021. "Fiscal policy during a pandemic." *Journal of Economic Dynamics and Control* 125, 104088.

Gambacorta, L., B. Hofmann, and G. Peersman. 2014. "The effectiveness of unconventional monetary policy at the zero lower bound: A cross-country analysis." *Journal of Money, Credit and Banking* 46(4), 615-642.

Guerrieri, V., G. Lorenzoni, L. Straub, and I. Werning. 2020. "Macroeconomic implications of COVID-19: Can negative supply shocks cause demand shortages?" NBER Working Papers 26918, National Bureau of Economic Research, Inc.

Jarociński, M. 2010. "Responses to monetary policy shocks in the east and the west of Europe: a comparison." *Journal of Applied Econometrics* 25(5), 833-868.

Medina, L., and M. F. Schneider. 2018. "Shadow economies around the world: what did we learn over the last 20 years?" IMF Working Papers 2018/017, International Monetary Fund.

Mountford, A. 2005. "Leaning into the wind: a structural VAR investigation of UK monetary policy." *Oxford Bulletin of Economics and Statistics* 67(5), 597-621.

Vymyatnina, Y. 2005. "Monetary policy transmission and Bank of Russia monetary policy." European University at Saint-Petersburg Department of Economics Working Paper.

Weale, M. and T. Wieladek. 2016. "What are the macroeconomic effects of asset purchases?" *Journal of Monetary Economics* 79, 81-93.