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Fiscal Policy in the Age of COVID-19: Does It "Get in All of the Cracks"?

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Abstract

We study the effects of fiscal policy in response to the COVID-19 pandemic at the firm, sector, country and global levels. First, we estimate the impact of COVID-19 and policy responses on small and medium-sized enterprise (SME) business failures. We combine firm-level financial data from 50 sectors in 27 countries, a detailed I-O network, real-time data on lockdown policies and mobility patterns, and a rich model of firm behavior that allows for several dimensions of heterogeneity. We find that absent government support, the failure rate of SMEs would have increased by 9 percentage points, significantly more so in emerging-market economies (EMs). With policy support it increased by only 4.3 percentage points, and even decreased in advanced economies (AEs). We also find that fiscal policy was poorly targeted: most of the funds disbursed went to firms that did not need it. Nevertheless, we find little evidence of the policy merely postponing mass business failures or creating many "zombie" firms: failure rates rise only slightly in 2021 once policy support is removed. Next, we build a tractable global intertemporal general equilibrium I-O model with fiscal policy. We calibrate the model to 64 countries and 36 sectors. We find that a sizeable share of the global economy is demand-constrained under COVID-19, especially so in EMs. Globally, fiscal policy helped offset about 8% of the downturn in COVID-19, with a low "traditional" fiscal multiplier. Yet it significantly reduced the share of demand-constrained sectors, preserving employment in these sectors. Fiscal policy exerted small and negative spillovers to output in other countries but positive spillovers on employment. A two-speed recovery would put significant upward pressure on global interest rates which imposes an additional headwind on the EM recovery. Corporate and sovereign spreads rise when global rates increase, suggesting that EMs may face challenging external funding conditions as AEs normalize.

Topics: Coronavirus disease (COVID-19); Fiscal policy; Firm dynamics; International topics

JEL codes: E62, F41, D57

1 Introduction

COVID-19 was a shock of unprecedented complexity and severity, and led to the largest contraction since the Great Depression.[1] Countries and individuals responded to the pandemic by going into lockdown and social distancing, which helped push more than 90 percent of the world into a recession in 2020. While the COVID-19 crisis is global, the exposure and policy response to the shock has varied greatly across sectors and countries. Some sectors, like higher education, could switch relatively easily to online delivery of content, while others, like tourism, were heavily impacted. These sectoral vulnerabilities contributed to cross-country differences in both exposure to the COVID-19 shock and a differential need for policy support.

Of paramount concern was limiting the economic damage caused by health-mandated lockdowns and social distancing.[2] Policymakers sprung into action, enacting fiscal and monetary policies that were unprecedented both in terms of speed and scale. To deliver this support to firms and workers in the midst of the pandemic, governments often had to use the pipelines of existing institutional programs. Many advanced economies were able to adopt a "what ever it takes, at whatever cost" approach. For the rest of the world, fiscal space also mattered. For instance, while the response of emerging markets (EMs) was large relative to their own historical standards, it remained much smaller than that of advanced economies (AEs), as shown in Fig. 1. The extent to which these fiscal policies were successful in minimizing the impact of COVID-19 on output, employment, and firms remains an important open question.

A great scientific achievement of the past year is the development of multiple effective vaccines. However, global inequality in access to these vaccines and the uneven pace of vaccinations around the world have led to a bifurcated recovery in 2021, with AEs pulling well ahead of EMs.[3] In many countries, the government and corporate sector have emerged from the crisis with substantially higher debt, triggering concerns about both the extension and tapering of fiscal support. Extending fiscal support runs the risk of putting upward pressure on global interest rates and increasing the share of "zombie" firms that hog productive resources and hinder productivity growth.[4] Conversely, aggressive tapering runs the risk of pushing leveraged, but otherwise healthy, firms over the edge, precipitating a downturn in aggregate demand that could hurt trading partners through the global trade and production network.

This paper studies these three dimensions of unevenness: sectors and countries have been differentially exposed to COVID-19; countries have implemented different policy packages;

[1] According to the IMF, World Economic Outlook April 2021, the global economy contracted by 3.27 percent in 2020. During the Great Recession of 2009, the global economy contracted only by 0.09 percent.

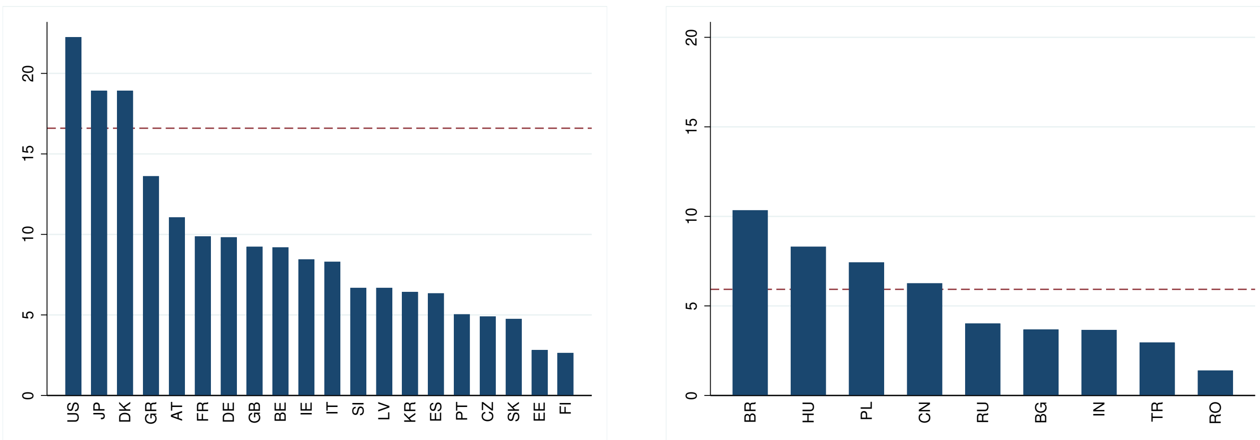
[2] For an early exposition of the argument, see Gourinchas (2020).

[3] Çakmaklı, Demiralp, Kalemli-Özcan, Yeşiltaş and Yıldırım (2021).

[4] These concerns feature prominently in policy discussions. See, inter alia, G30 (2020). See also Barrero, Bloom and Davis (2020).

and countries are facing different speeds of recovery with potentially different corporate and public sector vulnerabilities. Along all three dimensions, COVID-19 and fiscal policies have the potential to generate important effects and spillovers across firms, sectors, and countries. Our aim is to evaluate whether fiscal policies were able to "get in all of the cracks"; by being large and broadly available, did enough liquidity support reach struggling firms, and does the large AE fiscal stimulus help fiscally-constrained EMs?[5]

Figure 1: Fiscal Spending in the Pandemic (% of GDP)



(a) Advanced (b) Emerging

Notes: Source: IMF Fiscal Policy Database. The figure reports estimates of additional discretionary fiscal spending and foregone revenue during 2020 as a share of GDP. These numbers are calculated as the sum of the "non-health" and"accelerated spending" above the line categories. The red dashed line shows group averages: 16.60 for AEs and 5.93 for EMs.

We proceed in three steps, from the micro to the macro, from the closed economy to the global one, and then extending beyond fiscal to monetary and financial policies. In our first exercise, we develop a rich and flexible framework that combines a model of firm behavior with detailed firm-level financial data covering 27 countries—18 advanced economies (AEs) and 9 emerging markets (EMs). This approach allows us to estimate the impact of the COVID-19 crisis on business failures among some of the most at-risk firms in the economy: small and medium-sized enterprises (SMEs).[6] With small cash buffers, more limited access to external finance, and higher dependence on bank financing, SMEs are particularly vulnerable to a crisis like COVID-19, when plummeting revenues can quickly translate into illiquidity and insolvency. This potential vulnerability of SMEs to the COVID-19 shock is a primary concern for policymakers around the world, as evidenced by the more than 500 government programs targeting these firms.[7]

Given our focus on sectoral and firm outcomes, we start with a partial equilibrium, closed

[5] Our quote refers to Stein (2013)'s famous statement that "monetary policy gets in all of the cracks."

[6] SMEs account for a striking 99.8 percent of all employer firms in many countries, and over 50 percent of employment and gross output (Kalemli-Özcan, Sorensen, Villegas-Sanchez, Volosovych and Yesiltas (2015)).

[7] See the Financial Response Tracker at som.yale.edu.

economy analysis that takes as an input the decline in aggregate economic activity in 2020, and the recovery in 2021. First, the model incorporates potentially important sectoral input-output (I-O) linkages. The I-O structure captures how, for instance, the decline in the demand for travel indirectly impacts the demand for car rental services, which in turn impacts the demand for automobiles, and so on. The model also proposes a rich representation of the COVID-19 shock as a combination of sectoral vs. aggregate, and supply vs. demand shocks. On the supply side, COVID-19 negatively impacts productivity and restricts employment in non-essential sectors. On the demand side, aggregate spending may decline because output declines and because households become more uncertain about the future. Demand also moves away from some sectors (e.g., tourism) and towards others (e.g., online retail). In calibrating these COVID-19 shocks, we allow for sectoral and country heterogeneity in shocks by using sector level O*Net data and country-level, real-time data on lockdown stringency and the Google Mobility Index. Finally, the model also takes into account how business failures reallocate demand both across sectors and within sectors among surviving businesses.

To evaluate firm failures, we follow Gourinchas, Kalemli-Özcan, Penciakova and Sander (2020, 2021a) and adopt a liquidity-based criterion: Firms remain in business as long as their cash balances and operating cash flow are sufficient to cover financial expenses.

We start our empirical exercises by rewinding the clock back to January 2020 and asking: What would have happened in the absence of any policy support? For each country, we feed into the model the sequence of intensity-adjusted shocks they experienced in 2020 but turn off all support programs. This purposefully dire scenario sets the stage for understanding both the uneven economic impact of the COVID-19 shock across firms, countries, and sectors, as well as the aggregate and sectoral implications of various support programs. This provides our **first important result**: In the absence of policy support, business failures would have skyrocketed, increasing by 9 percentage points on average. The impact was uneven as countries differed in their industry composition, in the severity of the pandemic, and in the degree of financial fragility of their SMEs. We find that failures would have only increased by 5.65 percentage points in AEs, but by 12.53 percentage points in EMs. I-O linkages play an important role in this result, highlighting the importance of complementarities in the production network. I-O linkages amplify failures in EMs and drive the divergence between the two groups. We trace part of our finding back to a higher sourcing concentration of intermediate inputs in EMs.

We then turn on fiscal support. We focus on three widely used policies – tax waivers, cash grants, and pandemic loans – and calibrate them to actual use based on country-specific data on intensity, duration, as well as overall take-up rate. Once this array of policies is implemented, we estimate that business failures would have increased only by 4.3 percentage points relative to a normal year. In short, we find that support programs were at scale and prevented more than half of the business failures. In AEs, we even find that business failures declined (-0.43 percentage points) below a normal year!

Our model allows us to dig deeper and analyze which firms and sectors were affected by these policies. A key question for policymakers is whether fiscal support was directed to the right firms. Insufficient or poorly targeted support could lead to excessive failures and could keep the "wrong" firms alive. To address this question, we first categorize firms into "at-risk" firms that would not survive COVID-19 without policy support, and others. Next, we consider the effect of policy support on firm survival, which allows us to split the at-risk group into those firms that are saved by policy and others. Finally, we separate the saved firms into "zombies" and non-zombies based on their ability to cover their debt payments prior to COVID-19.

This leads us to our **second important result**: While support policies saved a large number of businesses, they were poorly targeted and therefore expensive. Their success in preventing many firm failures, especially in AEs, is primarily because the packages were large enough in scale. Of the firms that are alive at the start of 2020, 17 percent fail under the no policy scenario. Policy saves 36 percent of these at-risk firms, spending 5.10 percent of GDP. A total of 89 percent of all funds disbursed (4.53 percent of GDP out of 5.10 percent) go to firms that did not need policy to survive. Fortunately, we find that zombie firms represent a small share of firms saved by policy (13 percent), and a very small share – 2 percent – of the funds disbursed (.10 percent of GDP). Given the speed at which governments needed to act, a good argument can be made that speed trumps efficiency in the short run: battlefield surgery is not micro-surgery. Our conclusion is that fiscal support in 2020 achieved important macroeconomic results, despite the poor targeting.

With these results in hand, we run the clock forward for 2021. An increasing worry among policymakers is that overly generous policies in 2020 may have created a ticking time-bomb of firm failures about to explode as soon as policy support wanes. We have already established that few pre-COVID zombie firms were kept alive because of fiscal support in 2020. The worry is that many of the remaining firms saved by policy may themselves become zombies in the future. In that scenario, either these firms would fail en masse with adverse consequences for economic activity and labor markets, or policymakers would face strong pressures to keep supporting them, at great costs to society in terms of misallocated resources.

Our **third important result** is that we see only a relatively modest uptick in business failures in 2021 as countries re-open their economy and scale down support. Our predicted failure rate in 2021 is only 2.3 percentage points higher than normal times, with 1.9 percentage points of this coming from firms saved in 2020. Overall, we find that 30 percent of the firms saved in 2020 by the policy support fail by the end of 2021, of which 13 percent are zombies. Our conclusion is that there is no impending sign of a "zombification" of the global economy in the wake of the pandemic, even as firms start repaying their pandemic loans. This is an important finding since it suggests the fiscal cost could be significantly lower.

Next, we move on to our second model exercise where we evaluate how different fiscal packages in AEs and EMs impacted the global economy. We therefore shift focus from business-oriented fiscal programs to more general transfer programs of the kind implemented during the pandemic. To do so, we develop a tractable, intertemporal, and general equilibrium global model of trade with production networks. This allows us to better understand how changes in the global fiscal stance might spill over to other countries and affect global interest rates.

The general equilibrium model borrows from the recent heterogeneous agent literature. A share of households is "hand-to-mouth" and consumes their income. The remaining households smooth their consumption over time and are subject to precautionary shocks that lead them to increase savings in the face of COVID-19 uncertainty. We borrow many parts of the analysis from our first partial equilibrium model: firms face aggregate and sectoral demand and supply shocks. We discipline the model with the use of the OECD's ICIO global input-output matrices, covering 64 countries and 36 sectors, representing 90 percent of world output and trade.[8] Conceptually, I-O linkages, coupled with incomplete markets and nominal rigidities, can give rise to "Keynesian supply-shocks," that is, a situation where a supply shock in one sector (e.g., a limit on how many workers can be employed in a sector, or a decline in productivity), morphs into a decline in demand in other sectors (Guerrieri, Lorenzoni, Straub and Werning, 2020; Baqaee and Farhi, 2020b). Our general equilibrium approach allows us to estimate which sectors are demand-constrained during COVID-19, providing us with a direct estimate of the potential for stimulative policies to support activity. We are now also able to characterize how fiscal transfers in any country help alleviate the global downturn, as well as measure cross-border fiscal spillovers.

We feed into the model both a non-COVID scenario – constructed from the 2019 WEO's nominal GDP forecasts for 2020 – and a COVID scenario with realized 2020 nominal GDP and the associated fiscal packages in each country. By comparing the two, we can unpack the relative importance of the COVID shocks, fiscal policy, and precautionary savings in shaping 2020 global outcomes. Comparing COVID to non-COVID, we estimate a significant drop in real output (7.9 percent of GDP), together with a surge in private savings. This explains why global interest rates did not surge, and why AEs did not run large trade deficits. Moreover, we estimate that 31 percent of the global economy was demand-constrained in 2020, especially so in EMs (35 percent). Through the lens of the model, this is accounted for by EMs' limited fiscal space relative to AEs. This is our **fourth important result.** Notice the importance of our global

[8] ICIO data has 65 countries where the last country combines remaining countries into a ârest of the world.â Hence ICIO itself captures the entire world trade and production network.

I-O model in linking the gap in fiscal space across countries to the share of demand constrained sectors in each country, which in turn will help us understand global fiscal spillovers.

We then run a number of counterfactual exercises. These are designed to better understand the effectiveness of the global fiscal response to COVID-19 and to measure cross-border policy spillovers. In the first counterfactual, we shut down fiscal policy in all countries. Under that scenario, real global output would have been lower by 0.67 percent (0.97 percent for AEs and 0.23 percent for EMs), while global interest rates would have decreased by 64 basis points. At first glance it appears that fiscal policy had a relatively modest effect on global output, helping to recover only 8 percent of the COVID-induced decline in total output. This, however, is not surprising since a large share of activity was supply-constrained. When looking at demand-constrained activity, we find that the fiscal impulse of 11 percent of GDP reduced the share of demand-constrained output by about 10 percent of total GDP. The immediate corollary is that while fiscal policy has a low "traditional" fiscal multiplier, it can still reallocate aggregate activity to reduce demand-deficiencies and preserve employment in demand-constrained sectors. Moreover, our results highlight an important sectoral spillover: As output and prices expand in demand-constrained sectors in response to policy, supply-constrained sectors contract as their marginal costs increase through the I-O network. Hence total output increases less than the expansion in demand-constrained sectors. This is our **fifth important result**.

We then turn to the question of fiscal spillovers. To do this we consider counterfactual scenarios where we only turn on fiscal policy in a country or group of countries. We find that – regardless of which country implements fiscal policy – the spillovers to other countries are always negligible and often slightly negative. This is our **sixth important result**: Faced with COVID-19, countries had to rely on their own fiscal space and fiscal policy can be beggar-thy-neighbor. In particular, we don't find much support for the view that aggressive fiscal policy in AEs was a positive tide that lifted economic activity everywhere, especially in EMs. There are two key macro channels behind these negative spillovers, higher interest rates and higher terms of trade, both of which hurt output for the rest of the world. In addition, the global I-O network also plays a role due to the same composition effect behind the low fiscal multiplier.

Next, we consider what would happen in a future two-speed recovery in which AEs, thanks to their successful vaccination drive, pull ahead of EMs. One concern is that a lagging recovery in EMs could feed back and slow down the recovery in AEs, causing a serious drag on global growth.[9] To evaluate this scenario, we consider what would happen if the COVID-19 shock recedes in AEs, including the precautionary shocks. We find that, in such a scenario, growth would rise significantly in AEs (8.68 percent) due to the improved situation

[9] Çakmaklı et al. (2021) estimate these costs to be as high as 4 to 6 trillion dollars globally. As demand normalizes differentially in different set of countries and supply remains constrained in certain sectors, spillbacks via the global I-O network can lead to AEs bearing as much as 48 percent of the global costs.

of their domestic economies, but fall further in EMs (-0.47 percent) due to their continued exposure to the pandemic, to a surge in global interest rates (from 0 percent to 2.62 percent), and to a deterioration in EMs' terms of trade. This constitutes our **seventh important result**: A two-speed recovery from the pandemic could significantly hurt EMs beyond 2020.

In order to empirically analyze the impact of a possible increase in global rates on EMs' external outlook, we revisit and update Kalemli-Özcan (2019) to establish our **eighth important result**: Increases in global natural rates and/or a possible increase in policy rates by the U.S. Federal Reserve will lead to higher borrowing costs for EMs due to higher risk premia. These results support our view that financial vulnerability can be a key concern in the coming years, giving a central role to monetary policy rather than fiscal policy.

Overall, our analysis can answer the question that we asked at the outset: Can fiscal policy "get in all of the cracks" under a shock like COVID-19? In spite of its poor targeting, fiscal support to businesses was successful in keeping many âat-riskâ SMEs alive. In spite of a low multiplier – that is, a modest impact on increasing *aggregate* economic activity – fiscal policy did its job by *reallocating* activity towards demand-deficient sectors. In terms of global effects, fiscal policy had small but negative real spillovers to other countries, while having positive employment spillovers. As a result, fiscal policy did "get in all of the cracks."

Going forward, our results imply that the balance of risks is unfavorable for EMs for several reasons: they have limited fiscal space; they face a continued pandemic; and they face a possible surge in global interest rates and risk premia. While we find little evidence of a zombification of the economy or an upcoming wave of default, financial vulnerabilities have increased, especially in EMs. These vulnerabilities are likely to increase further if/when markets reprice risk; if fiscal policy impulses in advanced economies start putting excessive pressure on global real interest rates; and if/when the U.S. Federal Reserve starts to normalize its policy. In an environment with increased leverage and low fiscal space, future monetary and financial spillovers could be strongly negative. Our findings have important policy implications. Most importantly, they suggest that the global policy mix should pivot away from fiscal support to careful macroprudential and monetary/financial policies, such as monitoring leverage in the private sector, debt restructuring, and making sure international capital flows are not restricted.

The paper proceeds as follows. Section 1.1 provides an overview of the literature. Section 2 presents the model we use for the business failures, takes the model to data, and discusses the results. Section 3 lays out the global model. Section 4 presents results on the effects of higher global rates on emerging markets. Section 5 discusses the policy implications and concludes.

1.1 Literature

Our study relates to a number of different strands. First, many papers incorporate the sectoral unevenness of the COVID-19 shock; papers such as Dingel and Neiman (2020); Mongey, Pilossoph and Weinberg (2020); Coibion, Gorodnichenko and Weber (2020) explore the impact of this unevenness on labor markets. Like Dingel and Neiman (2020), we use data from the Occupational Information Network (O*NET) to inform the model about sectoral supply and demand shocks. Second, some papers such as Goolsbee and Syverson (2020); Chetty, Friedman, Hendren, Stepner and Team (2020); Cavallo (2020); Cox, Ganong, Noel, Vavra, Wong, Farrell and Greig (2020) use real-time data to understand the impact of COVID-19 on mobility and consumption patterns. In a similar manner, we use real-time data on mobility patterns and lockdown stringency to measure country heterogeneity.

Third, we relate to papers such as Baqaee and Farhi (2020a,b); Barrot, Grassi and Sauvagnat (2020); Woodford (2020); Gottlieb, Grobovsek, Poschke and Saltiel (2020), which explore the importance of I-O networks for sectoral shocks and their aggregate consequences. We also work with the global trade and production network as in Çakmaklı, Demiralp, Kalemli-Özcan, Yeşiltaş and Yıldırım (2020); Çakmaklı et al. (2021); Bonadio, Huo, Levchenko and Pandalai-Nayar (2020). Fourth, we are similar, in spirit, to papers such as Barrero et al. (2020); Guerrieri et al. (2020); Krueger, Uhlig and Xie (2020), as they explore the distinction between the demand and supply component of the COVID-19 shock and the sectoral reallocation it induces.

Fifth, we relate to papers that study the effects of COVID-19 on business failures. Many papers focusing on the United States use data on large, publicly listed firms (e.g., Acharya and Steffen (2020), Greenwood, Iverson and Thesmar (forthcoming), Crouzet and Gourio (2020)). These studies find that large firms could smooth out the COVID-19 shock by drawing on their credit lines (e.g., Greenwald, Krainer and Paul (2020)). Greenwood et al. (forthcoming) and Hanson, Stein, Sunderman and Zwick (forthcoming) conjecture that extensive government support is needed for SMEs, as liquidity shortfalls and court congestion will lead to excess liquidation. We focus on SMEs. Studies that use data on small firms for European countries (e.g., Demmou, Franco, Sara and Dlugosch (2020); Carletti, Oliviero, Pagano, Pelizzon and Subrahmanyam (2020); Schivardi and Romano (2020); Cros, Epaulard and Martin (2021)) do not rely on a structural model of the firm and often consider a simple empirical rule to project cash flow under COVID-19. Some studies also explore the question of solvency-related bankruptcies, while we limit our focus to liquidity-related bankruptcies, as in our previous work that also focused on SME failures in the absence of I-O network (Gourinchas et al. (2020, 2021a)). We are not aware of any study estimating the extent of bankruptcies for U.S. SMEs.

Sixth, papers such as Granja, Makridis, Yannelis and Zwick (2020); Elenev, Landvoigt and Van Nieuwerburgh (2020); Core and De Marco (2020) evaluate the targeting and effectiveness of policy such as the Paycheck Protection Program in the United States. Greenwood et al. (forthcoming), Blanchard, Philippon and Pisani-Ferry (2020), and Hanson et al. (forthcoming) suggest that the government could subsidize debt restructuring, provide tax credit to lenders, or take an equity stake in the private sector. Brunnermeier and Krishnamurthy (forthcoming) caution that these types of government policies may create a debt overhang effect. Drechsel and Kalemli-Özcan (2020a) propose a negative tax on SMEs that can be clawed back later, via an excess profits tax. In a similar vein, Landais, Saez and Zucman (2020) encourage direct government support to firms via grants rather than loans.

Seventh, we relate to papers that study the spillovers of fiscal policy. On the theory side, Frenkel and Razin (1987) offer a classic treatment (see also Corsetti, Meier and Müller (2010)). Our paper is also related to the empirical literature measuring the international spillovers of fiscal policy (see, for example, Auerbach and Gorodnichenko (2013); Faccini, Mumtaz and Surico (2016) for recent contributions). Last but not least, our paper has implications for the size of transfer multipliers under a COVID-19 shock. Ramey (2019) provides a recent overview of the empirical literature on fiscal multipliers. As that paper emphasizes, fiscal multipliers vary greatly with country characteristics when looking at government purchases or tax rebates and whether the economy is recovering from a financial crisis. Our estimates of a low government-transfer multiplier are specific to the COVID-19 episode that we study.

2 Fiscal Support and SME Failures

This section presents the model we use to analyze SME failures. The model proposes a rich representation of the COVID-19 shock as a combination of sectoral and aggregate supply and demand shocks. The economy is composed of many different sectors. In each sector, firms operate a production technology and can adjust output prices and labor and intermediate inputs in the short and medium run. A rich input-output (I-O) structure, matched to the data, connects firms from different sectors. Our analysis also incorporates the effect of firm exit via an extensive margin. Applying the model using firm-level data, we can evaluate which SMEs were vulnerable to business failure under COVID-19 and evaluate the impact of various policy support scenarios. We present a succinct version of the model in the next section, relegating most of the details to Appendix A.

2.1 An Overview of the Model

This section presents an overview of the key theoretical relationships that inform our empirical design.

An economy consists of J sectors indexed by j, each populated by an initial mass of firms $\mathcal{N}_j$. Within a sector, each firm, indexed by i, is small and produces a distinct variety of a single good, which we refer to as good i. Good i can be used for final consumption, and also as an intermediate input into other firms' production process.

2.1.1 Production and Productivity Shocks

Each firm produces according to the following production function:

$$y_{ij} = z_{ij}\left(\alpha_j \mathrm{k}_{ij}^{(\sigma-1)/\sigma} + \beta_j\left(A_j\ell_{ij}\right)^{(\sigma-1)/\sigma} + \gamma_j\sum_k \vartheta_{jk}\int_0^{\mathcal{N}_k} x_{ij,lk}^{\frac{\sigma-1}{\sigma}}\mathrm{d}l\right)^{\frac{\sigma}{\sigma-1}} \tag{1}$$

In Eq. (1), y_{ij} denotes gross output of good i in sector j, k_{ij} represents any fixed factor, including capital, entrepreneurial talent, etc..., ℓ_{ij} is a labor input, and $x_{ij,lk}$ represents the intermediate demand for good l in sector k used as intermediates in firm i sector j. A_j denotes sector-specific labor-augmenting productivity, while z_{ij} is a constant firm-specific productivity parameter. The parameters α_j, β_j, γ_j, and ϑ_{jk} control the expenditure shares on fixed factors, labor, and intermediate inputs, respectively. These parameters are sector specific and govern the input-output structure of the economy. They will be matched to their empirical counterparts. Finally, $\sigma \leq 1$ is the elasticity of substitution between any two inputs, assumed common to all sectors.[10,11]

COVID-19 directly impacts sectoral labor productivity A_j. This captures the notion that workers may become less productive as they are forced to work remotely. On-site workers may also become less productive, if health measures force a reorganization of production sites. This productivity shock varies across sectors based on their dependence on remote work and potential for spatial distancing.

Firms are price takers on input markets, and cost minimization yields the following input demands:

$$w_j\ell_{ij} = \beta_j^{\sigma}\left(\frac{z_{ij}A_j p_{ij}}{w_j}\right)^{\sigma-1} p_{ij}y_{ij} \quad ; \; p_{lk}x_{ij,lk} = \left(\gamma_j\vartheta_{jk}\right)^{\sigma}\left(z_{ij}\frac{p_{ij}}{p_{lk}}\right)^{\sigma-1} p_{ij}y_{ij}, \tag{2}$$

where p_{ij} denotes the price of good i in sector j, and w_j the sectoral wage.

[10] In general, I-O models with exit and gross complements feature strong amplification: if a variety disappears, the downstream network (i.e., firms using this variety as an input) shuts down as the expenditure share on the disappearing varieties approaches to 1. Our set-up circumvents this difficulty by summing only over the mass of surviving varieties $\mathcal{N}_k$. Inputs that disappear drop from the production technology altogether and downstream firms don't formulate demands for these inputs.

[11] The assumption that the elasticity of substitution σ is common across sectors and the same for all inputs within sectors is a simplification that makes our set-up slightly more tractable.

2.1.2 Labor Market and Labor Supply Shocks

In addition to the sector-specific productivity A_j, we assume that COVID-19 restricts the share of workers that can safely continue working. This captures the idea that firms in some sectors may be forced to send workers home, and these workers may be unable to perform their tasks remotely. Formally, if the pre-COVID labor supply in sector j is $\bar{L}_j$, we assume that at most $x_j\bar{L}_j$ of sector j workers can potentially be allowed to work during lockdown, where $x_j \leq 1$. The remaining workers are either unemployed or furloughed so that firms do not shoulder the corresponding payroll expenses. The constraint applies at the sectoral level, capturing the idea that intersectoral mobility may be very limited in the short run; for example, unemployed waiters or flight attendants cannot immediately be hired in the healthcare sector. The labor supply shocks x_j vary by sectors. For instance, essential sectors face no restriction on employment ($x_j = \infty$). Employment restrictions are stronger in sectors that are more reliant on face-to-face interactions, and where remote work is more difficult.

We impose that wages in all sectors are fully rigid, both downwards and upwards, at their pre-COVID level, denoted by $\bar{w}_j$.[12] This means that sectoral employment must satisfy:

$$L_j = \int_0^{\mathcal{N}_j} \ell_{ij} \mathrm{d}i \leq x_j \bar{L}_j \ ; \ w_j = \bar{w}_j, \tag{3}$$

where the left hand side represents sectoral labor demand aggregating over all surviving firms.

Eq. (3) is an important constraint. When it is slack, $L_j < x_j\bar{L}_j$, we say that sector j is *demand-constrained* in the sense that the sectoral demand for labor falls below the (possibly already reduced) sectoral labor supply. Firms are on their labor-demand curve and the binding constraint is that sectoral wages cannot adjust downwards. These sectors experience Keynesian unemployment.

When the constraint is tight, $L_j = x_j\bar{L}_j$, we say that sector j is *supply-constrained* in the sense that firms would like to hire more workers but are unable to do so. The binding constraint is that sectoral wages cannot adjust upwards. In that case, labor is rationed and firms are not on their labor demand curve.[13]

A recent theoretical literature, informed by the experience of COVID-19, studies the conditions under which a supply shock in a given sector (a decline in A or x) can morph into

[12] A common assumption in the literature is that wages are rigid downward but flexible upward. Given how large some sectors' labor supply was curtailed, assuming upwardly flexible wages and an inelastic labor supply would yield implausibly large wage increases in supply-constrained sectors. Empirically, wages are more flexible upwards, but that flexibility is limited. See Grigsby, Hurst and Yildirmaz (2021) for incumbents and Hazell and Taska (2020) for new hires.

[13] We assume that each surviving firm is rationed proportionately so that $\ell_{ij} = \bar{\ell}_{ij} x_j (\bar{\mathcal{N}}_j / \mathcal{N}_j)$. Firms still set their price at marginal cost, conditional on the amount of labor ℓ_{ij} they can employ. This generates rents, which increase profits.

a demand deficiency in other sectors, potentially causing Keynesian unemployment.[14] Sufficiently strong complementarities in production and/or in final demand are critical for this to happen. Our set-up allows for both supply- and demand-constrained sectors.

2.1.3 Demand and Demand Shocks

Final demand takes the following form:

$$D = \left[\sum_j \mathcal{N}_j \xi_j D_j^{(\eta-1)/\eta}\right]^{\eta/(\eta-1)} \quad , \quad D_j = \left(\frac{1}{\mathcal{N}_j}\int_0^{\mathcal{N}_j} d_{ij}^{(\rho_j-1)/\rho_j} \mathrm{d}i\right)^{\rho_j/(\rho_j-1)} . \tag{4}$$

In this expression, the level of aggregate real final demand D is a CES aggregator over sectoral demands D_j. In turn, D_j is obtained by aggregating over the demand for the different varieties available within the sector, denoted by d_{ij}. η is the elasticity of substitution of final demand between sectors j, while ρ_j is the elasticity of substitution between varieties within sector j. ξ_j denotes a sectoral demand shifter. Finally, the mass of available varieties $\mathcal{N}_j$ enters preferences, controlling the extent of love-of-variety effects.

COVID-19 leads to significant changes in final expenditure patterns. Due to endogenous social distancing or government mandates, the demand for some goods such as hospitality or travel declined abruptly, while that for others such as online food delivery increased substantially. We capture these changes through shocks to ξ_j. In addition, the pandemic led to changes in the overall level of final expenditures, PD, where P denotes the aggregate price level.

The preferences described in Eq. (4) lead to the following simple final demand system when we impose $\eta = 1$:[15]

$$p_{ij} d_{ij} = \mathcal{N}_j^{1-\rho_j} \xi_j \left(\frac{p_{ij}}{P_j}\right)^{1-\rho_j} PD. \tag{5}$$

In this expression, P_j denotes the price index for final demand in sector j.[16] Eq. (5) illustrates how final expenditures on good i vary with the sectoral shock ξ_j, aggregate demand PD, and the share of surviving firms in the sector, $\mathcal{N}_j$.

Together with the demand for intermediates from Eq. (2), we can write the nominal market

[14] See Guerrieri et al. (2020); Baqaee and Farhi (2020b).

[15] Our assumption is broadly consistent with Baqaee and Farhi (2020b); Atalay (2017); Boehm, Flaaen and Pandalai-Nayar (2019).

[16] The Fischer-ideal price indices are defined by $P_j = \left(\mathcal{N}_j^{-\rho_j} \int_0^{\mathcal{N}_j} p_{ij}^{1-\rho_j} \mathrm{d}i\right)^{1/(1-\rho_j)}$. These price indices do not correspond to Bureau of Labor Statistics prices. The latter is typically defined as a chained index over a fixed set of varieties, only periodically adjusted.

clearing condition for good i as:

$$p_{ij}y_{ij} = p_{ij}d_{ij} + \sum_k \int_0^{\mathcal{N}_k} p_{ij}x_{lk,ij}\mathrm{d}l \tag{6}$$

, where the first term represents the final demand for good i and the second term sums the intermediate demands originating from all firms l in sectors k.

2.1.4 Equilibrium for a Given Pattern of Business Failures

Given a distribution of surviving firms, $\mathcal{N}_j$, a level of aggregate final expenditures PD, values for the sectoral supply (A_j, x_j), and demand (ξ_j) shocks, an equilibrium of this economy is a set of prices and output (p_{ij}, y_{ij}), final and intermediate demands d_{ij} and $x_{ij,lk}$, wages w_j, and employment L_j, such that (a) firms minimize costs, Eq. (2); (b) the labor market clears, Eq. (3); (c) final demand satisfies Eq. (5); (d) and the market for each good clears, Eq. (6).

Using a Jonesian "hat" to denote a log-linearized variable (i.e., $\hat{x} \equiv \log(x/\bar{x})$ where $\bar{x}$ denotes a non-COVID value), we can express the set of log-linearized equilibrium conditions as follows:

$$(\Omega_j^\ell + \Omega_j^x)\hat{p}_j = \frac{1}{\sigma}(1 - \Omega_j^\ell - \Omega_j^x)\hat{y}_j + \Omega_j^\ell\left(-\hat{A}_j + \max\left\langle 0, \hat{w}_j^{\text{flex}}\right\rangle\right) + \sum_k \Omega_{jk}^x \hat{p}_k, \tag{7a}$$

$$\lambda_j\hat{y}_j = \omega_j(\tilde{\xi}_j - \hat{\mathcal{N}}_j + \widehat{PD}) - (\sigma\lambda_j + (1-\sigma)\omega_j)\hat{p}_j + \sum_k(\sigma\hat{p}_k + \hat{y}_k)\Omega_{kj}^x\lambda_k, \tag{7b}$$

$$\hat{L}_j = \hat{x}_j + \min\left\langle 0, \sigma\hat{w}_j^{\text{flex}}\right\rangle, \tag{7c}$$

$$\sigma\hat{w}_j^{\text{flex}} \equiv \sigma\hat{p}_j - \hat{x}_j - (1-\sigma)\,\hat{A}_j + \hat{y}_j + \hat{\mathcal{N}}_j, \tag{7d}$$

where $\Omega_j^\ell = w_j\ell_{ij}/p_{ij}y_{ij}$ denotes the labor share in gross output; $\Omega_{jk}^x = \int_0^{\mathcal{N}_k}(p_{lk}x_{ij,lk}/p_{ij}y_{ij})\mathrm{d}l$ denotes the share of intermediates from sector k in gross output; and $\Omega_j^x = \sum_k \Omega_{jk}^x$ is the share of intermediate inputs in gross output.[17] $\hat{w}^{\text{flex}}$ denotes the change in the sectoral wage that employees would obtain if wages were flexible, defined in Eq. (7d). In Eq. (7b), $\lambda_j = \int_0^{\mathcal{N}_j} p_{ij}y_{ij}\mathrm{d}i/PD$ denotes the Domar weight for industry j (i.e., the ratio of gross sectoral output to total value-added), while $\omega_j = P_jD_j/PD$ denotes the share of final expenditures on sector j. $\tilde{\xi}_j$ is a normalized expenditure shifter defined as $\tilde{\xi}_j \equiv (\hat{\xi}_j + \hat{\mathcal{N}}_j) - \sum_k \omega_k(\hat{\xi}_k + \hat{\mathcal{N}}_k)$.[18] The term $\hat{\mathcal{N}}_j$ captures the reallocation of demand within sector j: When more business fail in sector j (a more negative $\hat{\mathcal{N}}_j$), each surviving firm faces higher individual demand.

[17] We assume these shares are sufficiently similar for all firms i in sector j so that we can drop the firm subscript.

[18] This variable captures the reallocation of demand across sectors that occurs because of changes in preferences (ξ_k) but also because of business failures $\mathcal{N}_k$. Observe that $\tilde{\xi}_j$ only responds to relative movements in demand or business failures. If business failures are the same in all sectors ($\hat{\mathcal{N}}_k = \hat{\mathcal{N}}$), $\tilde{\xi}$ remains unchanged: there is no reallocation of demand across sectors.

Let's describe each equation in turn. Eq. (7a) represents a *sectoral supply curve* based on a standard price ($\hat{p}_j$), which equals marginal cost relationship. Marginal cost has three terms: a term depending on output ($\hat{y}_j$) representing diminishing returns in the short run due to the fixed factors $k_{i,j}$; a term representing changes in labor productivity ($\hat{A}$); and a term representing changes in the shadow wage (given by the maximum of the flex price wage and 0). Finally, marginal cost may rise because of increases in intermediate prices $\hat{p}_k$.

Eq. (7b) represents a *sectoral demand curve*. Demand for *per-firm* output is higher when preferences shift towards sector j ($\hat{\tilde{\xi}}$ rises), when there are fewer firms ($\mathcal{N}_j$) in sector j competing for a given level of sectoral demand, when aggregate demand ($\widehat{PD}$) rises, when output prices ($\hat{p}_j$) fall, and when demand from other firms in other sectors $\sigma\hat{p}_k + \hat{y}_k$ is high. Intermediate demand is controlled by Ω^x_{kj}. A shock to the demand for good k propagates "upstream" as it affects the demand for good j that is used as an input in sector k.

Eq. (7c) determines the level of employment in each sector and whether it is supply- or demand-constrained. Eq. (7) constitute a system of $4J$ equations in $4J$ unknowns ($\hat{p}_j$, $\hat{y}_j$, $\hat{w}^{\text{flex}}_j$, $\hat{L}_j$), given sectoral supply shocks $\hat{A}_j$, $\hat{x}_j$, sectoral demand shocks $\hat{\tilde{\xi}}_j$, aggregate demand shocks $\widehat{PD}$, and extensive margin $\hat{\mathcal{N}}_j$.

Eq. (7d) is a *labor demand equation* that links the flexible price wage (that would clear markets in an unconstrained equilibrium) to output, output prices, and productivity. This wage determines the shadow wage when a sector is supply constrained – $\hat{w}^{flex}_j > 0$, and is determined by the change in labor available, sectoral output, output prices, labor productivity, and the number of firms in the sector $\mathcal{N}_j$. The final term arises because the labor supply shock binds at the sector level; as more firms fail, labor is released to be used by the remaining firms.

2.1.5 Extensive Margin: Business Failures

As in Gourinchas et al. (2020, 2021a), we adopt a simple "static" decision rule for business failures that focuses on liquidity shortfalls, not solvency: Firms remain in business as long as their cash balances and their operating profits are sufficient to cover their financial expenses. Otherwise, they are forced to close. Illiquidity may not lead to insolvency if illiquid firms can access credit markets or external sources of funds, or postpone payments on their accounts payable. Nevertheless, we consider that our criterion is the most relevant for SMEs under COVID-19 where many SMEs had limited access to external finance even in normal times.

Our criterion says that a business fails under COVID-19 as soon as cash and operating cash flow are insufficient to cover financial expenses, that is:

$$\mathcal{Z}_{ij} + CF_{ij} < FE_{ij}, \tag{8}$$

where $\mathcal{Z}_{ij}$ denotes the firm's initial cash balances, FE_{ij} denotes financial expenses during the year, and CF_{ij} is operating cash flow, defined as revenues minus variable costs, fixed costs, and business taxes. Given a solution to the system Eq. (7), we can construct a conterfactual measure of operating cash flow under COVID-19 and evaluate which businesses survive. This allows us to recover a business failure rate $\hat{\mathcal{N}}_j$ for each sector. A full equilibrium including the extensive margin is a fixed-point of Eqs. (7) and (8). Appendix A.5 provides additional details on how we solve the model.

2.2 Taking the Model to the Data

2.2.1 Describing Firm Level Data

The source of our firm level data is Orbis from BvD-Moody's. Orbis collects firm financial statements for over 200 million privately held and publicly listed companies around the world, and harmonizes them into an internationally comparable format. Our analysis covers 19 advanced economies (Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Latvia, Portugal, Slovenia, Slovakia, Spain, and the United Kingdom) and 9 emerging economies (Bulgaria, Brazil, China, Hungary, India, Poland, Romania, Russia, and Turkey). We use key variables from firms' 2018 balance sheet and income statements in order to evaluate firm failures, including firm cash flow, cash stock, financial expenses, revenue, wage bill, material cost, net income, depreciation, and taxation. Our analysis focuses on SMEs, which we define following the European Union's revenue-based definition of €50 million in revenue or less.[19]

2.2.2 Describing Input-Output Linkages

We use the World Input-Output Database (WIDO) to calibrate each country's I-O structure.[20] For each country, we use the World Input-Output Table to construct a *domestic* I-O matrix that measures the fraction of intermediate inputs that each industry purchases from itself and all other industries.[21] We also obtain information on each industry's intermediate input share and share of total gross output from WIDO. Finally, we use country- and sector-specific data

[19] Importantly, our sample does not include the United States. The main reason for this is that ORBIS's coverage of SMEs' income statement data for that country is insufficient to achieve representativeness.

[20] We use the 2014 World Input-Output Tables from World Input-Output Database, which is the latest year available.

[21] WIDO aggregates two-digit ISIC codes into 56 sectors. Our analysis excludes the Financial and Insurance Activities (one-digit sector K), Public Administration (O), Activities of Households as Employers (T), and Activities of Extraterrestrial Organizations (U) sectors, which are included in WIDO I-O tables. We redistribute intermediate input purchases of these excluded sectors to all remaining sectors based on the intermediate input shares of each excluded sector.

on compensation of employees from OECD National Accounts to calibrate the labor share.

2.2.3 Describing the Shocks

Our model framework incorporates four shocks that represent the COVID-19 crisis – sector-specific labor productivity (A_j) and labor supply (x_j), sector-specific demand (ξ_j), and aggregate demand (PD). We measure aggregate demand using the quarterly, country-level GDP growth estimates and projections for 2020 and 2021 from the OECD Economic Outlook. We measure the remaining three shocks at the country-sector level by first calibrating the magnitude of each shock at the sector level and then interacting each shock with the intensity of the COVID-19 crisis in each country.

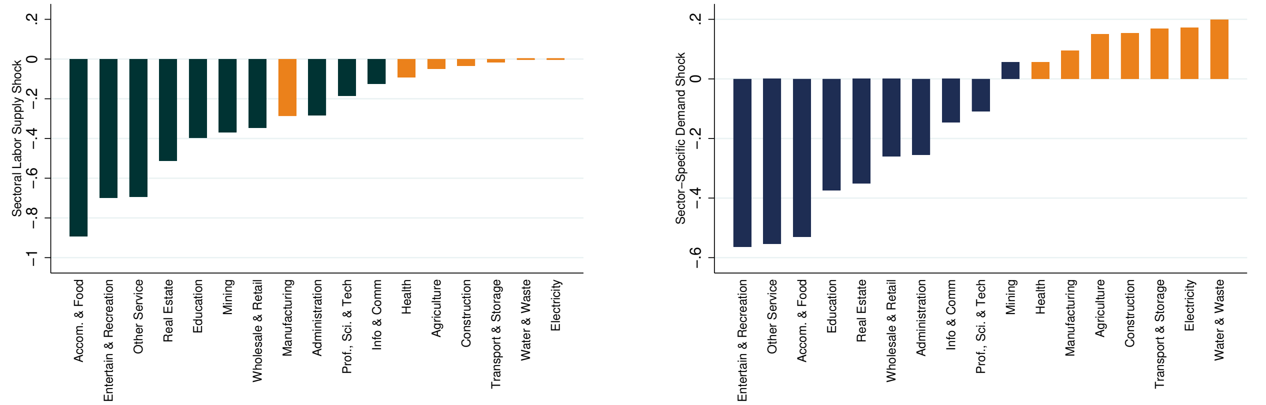
To construct estimates of the COVID-19 labor productivity, labor supply, and sector-specific demand shocks, we interact sector-specific measures of these shocks that are constant across countries and over time with weekly, country-level measures of COVID-19 intensity. The sector varying component of the shocks are created using pre-pandemic data and defined at the four-digit NACE level and then aggregated to WIDO sectors. The sector-specific labor supply shock captures that firms were only able to retain a fraction of their pre-pandemic workforce during COVID-19 due to workplace restrictions and social distancing. To calibrate that shock, we follow Dingel and Neiman (2020) and evaluate the feasibility of remote work in each sector. We assume that firms in non-essential sectors can only retain the fraction of their pre-pandemic workforce that can work remotely, while firms in essential sectors are able to retain both onsite and remote workers.[22] The left panel of Fig. 2 depicts the severity of the labor supply shock across sectors, with service sectors being the hardest hit and essential infrastructure sectors remaining unaffected.

The sector-specific demand shock captures how COVID-19 reallocated aggregate expenditure across sectors. To calibrate this shock, we evaluate the reliance of each sector on face-to-face interactions. We assume that firms in non-essential sectors face a demand shifter equal to one minus their "interaction share," while firms in essential sectors face a demand shifter equal to one. These demand shifters are then normalized to be consistent with aggregate demand. The right panel of Fig. 2 shows how demand shifted away from customer-oriented sectors like Arts, Entertainment & Recreation, and towards essential sectors like Construction.

The labor productivity shock captures the loss in productivity that arose from onsite workers shifting suddenly to remote work. In calibrating this shock, we assume that productivity is a weighted average of onsite and remote workers, and that remote workers are 20 percent less productive than onsite workers. We assume that 100 percent of workers in non-essential sec-

[22] We use the CISA's Guidance on the Essential Critical Infrastructure Workforce to categorize sectors as essential or non-essential.

Figure 2: Sectoral Labor Supply & Sector-Specific Demand Shocks



(a) Sectoral Labor Supply

(b) Sector-Specific Demand

Notes: Depicts the COVID-19 secotral labor supply (left panel) and sector-specific demand (right panel) shocks by one-digit NACE sector, as the percent change relative to the non-COVID scenario. Shocks are first aggregate from the WIDO sector level to one-digit NACE by taking a simple average across WIDO sectors within each country. The gross value added sector share of each country is used to aggregate one-digit sector shocks across countries. Blue bars represent sectors composed predominately of non-essential sub-sectors. Orange bars represent sectors composed predominately of essential sub-sectors.

tors are remote during COVID-19, and use the 2018 American Community Survey to estimate the pre-pandemic share of remote workers in each sector.

We let these sector-varying measures represent the worst and most strict of COVID-19 social distancing and lockdown policy and then moderate these measures by interacting them with weekly, country-level measures of COVID-19 intensity. The intensity of the economic effects of COVID-19 is driven both by legally mandated lockdowns and by individuals' fear of the virus. We therefore opt to incorporate measures of both in our intensity measures. Specifically, we measure the intensity of the supply shocks (labor supply and productivity) using the Oxford Government Response Tracker's (OxCGRT) stringency index and of the demand shock using Google mobility data on mobility trends for retail and recreation.[23] OxCGRT tracks 23 indicators of government response including containment and closure, economic, health system, and vaccine policies. The stringency index we use measures the intensity of "lockdown style" policies including workplace, school, and public transport closings, cancellation of public events, restrictions on gatherings, stay-at-home requirements, and restrictions on domestic and international travel.[24] We rescale the stringency index so that it ranges from 0 to 1, with higher values indicating more intense "lockdowns."

Google mobility data tracks mobility trends for places like groceries and pharmacies, parks, transit stations, markets and stores, residential areas, and workplaces in 2020 and 2021 relative to a baseline five-week period between January and early February 2020. To measure the

[23]For the supply shock intensity, see the Oxford Government Response Tracker. For the demand shock intensity, see Google's COVID-19 Mobility Reports.

[24]The official stringency index also includes an indicator of public health information campaigns, which we exclude from our measure.

country-level intensity of the COVID-19 demand shock, we focus on mobility trends for retail and recreation. We re-scale the data to range between -1 and 1, with negative values indicating an improvement in demand relative to the baseline period and positive values indicating a deterioration in demand condition, or higher intensity of the demand shocks, relative to the baseline period.

Because our weekly measures of country-level supply and demand shock intensity are available through the end of May, we extrapolate them through the end of 2021 separately for advanced and emerging economies. We assume that the intensity of both supply and demand shocks falls to zero in advanced economies by the first week of September to reflect the pace of vaccinations and reopening occurring in these countries throughout summer. For emerging economies, we assume that the intensity of supply and demand shocks remains constant through the end of the year, reflecting the slower pace of vaccinations and reopening in these countries.

To get a sense how how the intensity of supply and demand shocks varies across countries, Fig. 3 depicts the average supply and demand shock intensity during 2020 across our sample of countries. While there is quite a bit of heterogeneity in intensity across countries, on average the intensity of both supply and demand shocks is higher in emerging than in advanced economies. Moreover, across both sets of countries, the supply shock intensity is nearly twice that of the demand shock intensity.

2.2.4 Describing the Policies

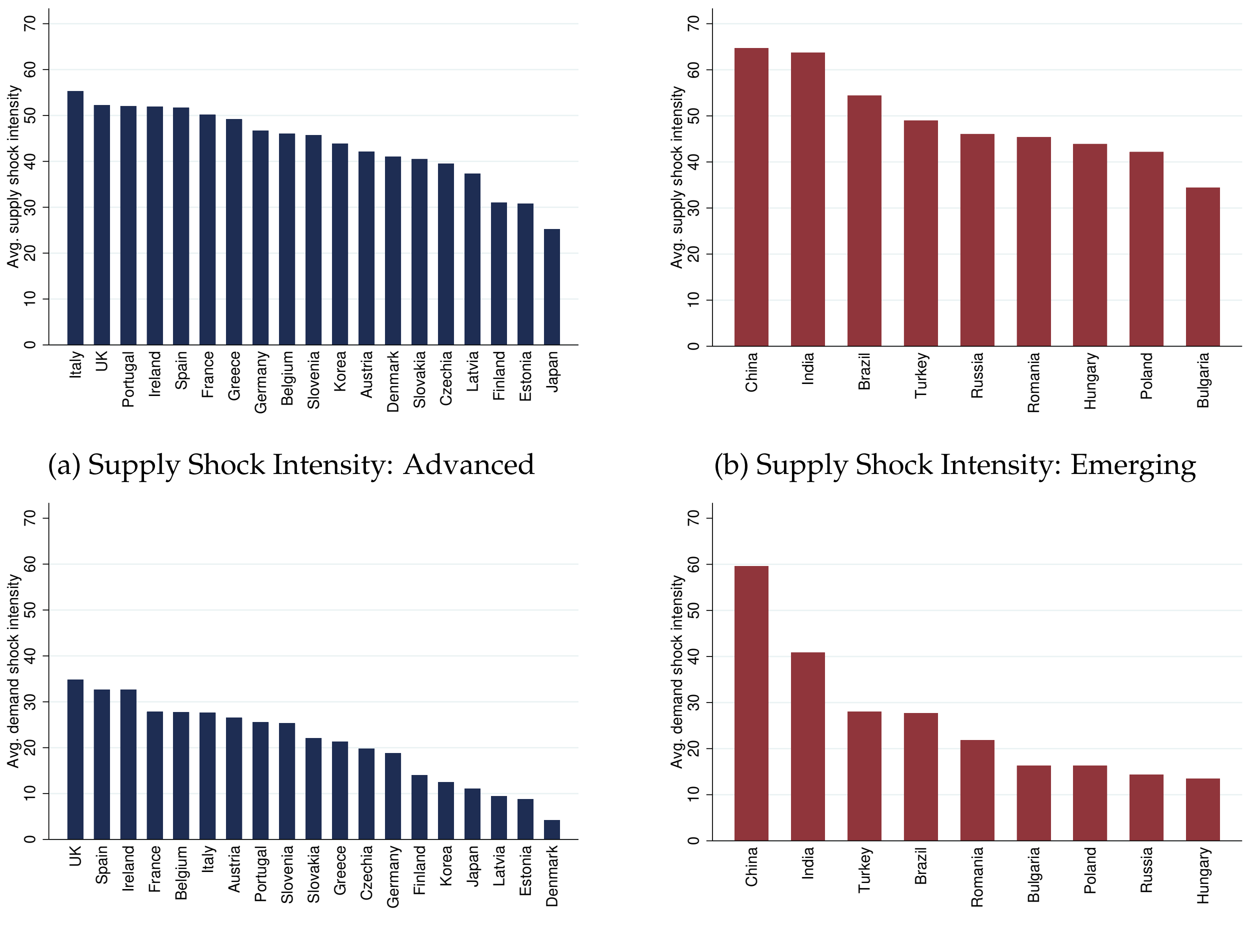
We consider three types of fiscal support policies that are calibrated to match real-world aggregate policy costs: (a) tax waivers where firms do not need to pay a portion their 2020 tax bill due for 2020; (b) cash grants equal to a fraction of firms' pre-COVID labor costs; and (c) government-guaranteed loans that we refer to as "pandemic loans."[25] Starting with pandemic loans, we adopt a disbursement formula for firm i in country c broadly similar to that implemented by several Euro-area countries:

$$P_{i,c} = \theta_{c,loan} \max\{\text{Revenue}_{i,2018}, 2 \cdot \text{Labor costs}_{i,2018}\}. \tag{9}$$

In this formula, $\theta_{c,loan}$ is a parameter calibrated to match the overall amount disbursed under that policy in that country. We calibrate similarly the other two policies with parameters $\theta_{c,tax}$ and $\theta_{c,grant}$ that can vary based on the length of availability of the policy support and its generosity. We use data from OECD (2021), ESRB (2021), and IMF (2021a) to calibrate the parameters $\{\theta_{c,tax}, \theta_{c,grant}, \theta_{c,loan}\}$ to both match the aggregate amounts of announced policy and

[25] We exclude from our analysis policies – such as rent waivers or interest waivers – for which we lack estimates of their overall fiscal cost.

Figure 3: Average Supply and Demand Shock Intensity in 2020



(a) Supply Shock Intensity: Advanced

(b) Supply Shock Intensity: Emerging

(c) Demand Shock Intensity: Advanced

(d) Demand Shock Intensity: Emerging

Notes: Depicts the average intensity of sectoral supply (top) and demand (bottom) shocks, separately for advanced (left) and emerging (right) economies during 2020. Supply shock intensity is measured using the OxCGRT stringency index, and demand shock intensity is measured using Google Mobility data.

adjust for less than full take-up of the various policies by firms.[26] All remaining data needed to implement the policies – taxation, revenue, labor costs – come from Orbis. We assume that all policy support is paid out in week 10 of 2020.[27]

2.3 Empirical Results

We now present our main empirical results. We begin with estimates of SME failure rates absent government support. We then describe the extent to which government support, calibrated to actual policies, mitigated the rise in business failures. Finally, we consider the impact of COVID-19 and associated policies for 2021, with a specific focus on the possibility that policies may have postponed inevitable failures, or given rise to an army of "zombie" firms.

2.3.1 Failure Rates Absent Government Action for 2020

We first estimate business failure rates in 2020 in the absence of government interventions. These estimates serve as a baseline against which we evaluate the effect of various government interventions. For the baseline scenario, we allow for demand to be impacted by firm exit via the extensive margin and calibrate $\sigma = 0.2$, which is an empirically relevant estimate for σ in the literature as estimated by Atalay (2017), Boehm et al. (2019), and Carvalho, Nirei, Saito and Tahbaz-Salehi (2021). We take into account each country's domestic I-O structure, sectoral heterogeneity in labor supply, productivity and demand shocks, and country heterogeneity in the intensity of supply and demand shocks. The COVID-19 shocks begin in most countries around the second week of March 2020 (week 11), with the earliest onset being in China at the end of January (week 4) and in Italy in the middle of February (week 8).

Aggregate SME Failure Rates. Table 1 reports the increase in failure rate for all countries, advanced economies, and emerging economies absent government interventions. Column (1) reports the estimated failure rate in a non-COVID year, under our liquidity criterion. This failure rate is higher than the typical failure rate for all firms since it focuses only on SMEs. It may also be high because we focus on a liquidity criterion that ignores potential external sources of funding that might be available to SMEs in normal times. Column (2) reports the estimated failure rate under COVID-19, and column (3) reports the difference between the two (Δ). This last column is our preferred measure for business failures purely due to COVID-19. Our estimates indicate a very substantial increase in failure rates due to COVID-19 – almost

[26] Details on the calibration are in Appendix A.6.

[27] We find in our previous work with a similar framework that varying the timing of policy has very limited effect on firm failures – see (Gourinchas et al., 2020, p. 41) – and that all countries in our sample other than China and Korea first implemented lockdowns between weeks 8 and 12 of 2020 with a median of 10 weeks.

Table 1: 2020 Aggregate SME Failure Rate, Absent Government Support

	(1) Non-COVID	(2) COVID	(3) Δ (pp)
All	9.80	18.80	9.00
Advanced	7.88	13.53	5.65
Emerging	11.82	24.35	12.53

Note: Failure rates are first calculated at the one-digit NACE level and aggregated to the country level using 2018 sector gross value added as weights. Failure rates are aggregated across countries using GDP as weights.

doubling from normal years – of 9.00 percentage points. We also find that the increase is more than twice as large for EMs (12.53 percentage points) as compared to AEs (5.65 percentage points).

Sectoral and Country Heterogeneity. Underlying the 9.00 percentage points increase in aggregate failure rates across countries is substantial heterogeneity across sectors and countries. Table 2 reports the non-COVID and COVID failure rates and their difference, aggregated up to the country level. There is substantial cross-country heterogeneity even within groups of countries. For instance, the increase in failure rates in AEs varies from 1.14 pp in Finland and 1.25 pp in Denmark, to 9.58 pp in Italy and 8.87 pp in the United Kingdom. Similarly, the increase in failure rates in EMs varies from 25.86 pp in India to 3.60 pp in Russia. Behind these results lie differences in sectoral composition (e.g., countries relying more heavily on more affected sectors), differences in the financial health of SMEs (e.g., SMEs with relatively thin cash buffers, as documented in our earlier work, Gourinchas et al., 2020), as well as differences in the I-O structure and in the length and intensity of lockdown policies and voluntary social distancing captured by our mobility index.

To highlight the importance of sectoral heterogeneity, Table 3 reports the results at the one-digit NACE level. The most vulnerable sector, by far, is Wholesale and Retail Trade, with a projected 28.40 percentage point increase in failures, followed by Professional, Scientific and Technical Activities (15.53 percent), Business Administration Services (14.89 percent), Real Estate (14.13 percent), and Information and Communication Services (13.69 percent). At the other extreme, we find a slight decline in failure rates in Accommodation and Food Services (-1.19 percentage points) and moderate increases in Human Health and Social Work (0.45 percentage points), Manufacturing (1.21 percent), and Construction (1.53 percentage points).[28]

[28] The decline in Accommodation and Food Services might seem surprising, given that this sector was heavily affected by COVID-induced lockdowns. This is largely the result of taking into account the I-O structure of the economy. Without the I-O structure, the business failures increase by 8 percentage points in this sector. We discuss the sectoral impact of the I-O structure further below.

Table 2: Country Heterogeneity

Country	(1) Non-COVID	(2) COVID	(3) Δ
Advanced Economies			
Austria	9.89	13.97	4.08
Belgium	6.89	11.98	5.09
Czech Republic	7.40	10.35	2.95
Germany	9.33	13.60	4.27
Denmark	12.64	13.89	1.25
Estonia	9.77	11.23	1.46
Spain	7.34	15.63	8.29
Finland	7.38	8.52	1.14
France	6.84	13.95	7.11
UK	10.92	19.90	8.97
Greece	8.37	11.48	3.11
Ireland	8.52	13.46	4.94
Italy	7.61	17.19	9.58
Japan	4.03	7.07	3.03
Korea	11.71	17.05	5.34
Latvia	19.19	20.79	1.59
Portugal	9.75	15.51	5.77
Slovenia	6.51	13.66	7.15
Slovakia	9.01	12.17	3.16
Emerging Markets			
Bulgaria	7.29	9.99	2.71
Brazil	14.62	19.03	4.41
China	11.30	24.10	12.81
Hungary	7.49	11.62	4.13
India	11.88	37.74	25.86
Poland	8.60	14.64	6.04
Romania	10.90	13.61	2.71
Russia	12.46	16.06	3.60
Turkey	17.25	24.46	7.21

Note: Country-level failure rates under non-COVID evaluate the fraction of firms facing a liquidity shortfall in 2018, and under COVID are evaluated under our baseline scenario. Country-level results represent the weighted average of one-digit NACE failure rates, where weights are given by 2018 sector gross value added.

Table 3: Sector Heterogeneity

	(1) Non-COVID	(2) COVID	(3) Δ (pp)
Agriculture	12.29	18.18	5.89
Mining	12.47	16.03	3.56
Manufacturing	9.66	10.87	1.21
Electricity, Gas and Air Con	9.05	12.99	3.94
Water and Waste	5.90	8.68	2.78
Construction	8.51	10.04	1.53
Wholesale & Retail	8.92	37.32	28.40
Transport & Storage	7.72	14.12	6.40
Accom. & Food Service	11.13	9.94	-1.19
Info. & Comms	10.50	24.19	13.69
Real Estate	10.19	24.32	14.13
Prof., Sci., & Technical	10.86	26.39	15.53
Administration	8.94	23.82	14.89
Education	11.81	16.09	4.28
Health and Social Work	8.18	8.63	0.45
Arts, Ent, & Recreation	12.73	16.69	3.96
Other Service	9.83	13.88	4.05

Note: Sector failure rates are first calculated at the one-digit NACE level for each country, and then aggregated across countries using (country x sector) gross value added as weights.

The Role of the Extensive Margin and Production Networks. Next, we unpack the relative importance of two novel mechanisms in our analysis: the extensive margin (i.e., the fact that failing firms release resources and free up demand for surviving ones) and the I-O structure (i.e., the fact that business failures in one sector can propagate upstream to suppliers and downstream to customers via the production network).

Table 4 reports our estimates. Columns (1)-(3) consider a set-up that ignores the impact of the extensive margin and I-O structure. This is similar to our earlier work (Gourinchas et al., 2020). In that simplified set-up, business failures don't affect the demand for a surviving firm's products. Moreover, intermediates are produced elastically at a constant price. Interestingly, the aggregate increase in business failures (8.51 pp) is quite similar to that of our baseline scenario in the current paper (9.00 pp). The main difference, however, is a convergence of the estimates between AEs and EMs, with much larger estimates for AEs (8.93 pp vs. 5.65 pp) and much lower ones for EMs (8.06 pp vs. 12.53 pp). Columns (4)-(6) turn on the extensive margin, still ignoring the production network. The overall COVID-induced failures decrease from 8.51 pp to 6.81 pp. This is quite intuitive. As we discussed when presenting the model, the extensive margin reallocates demand both across sectors and within sectors. As some firms fail, demand is reallocated to the remaining surviving firms. We observe, however, that the

Table 4: The Role of the Extensive Margin and the Input-Output Network

	No Extensive Margin, No IO			Extensive Margin, No IO			No Extensive Margin, With IO		
	(1) Non-COVID	(2) COVID	(3) Δ	(4) Non-COVID	(5) COVID	(6) Δ	(7) Non-COVID	(8) COVID	(9) Δ
All Countries	12.04	20.55	8.51	9.58	16.39	6.81	12.02	22.98	10.96
Advanced	9.90	18.83	8.93	7.66	14.31	6.64	9.89	17.76	7.88
Emerging	14.29	22.36	8.06	11.59	18.58	7.00	14.26	28.46	14.20

Note: This table reports the relative importance of the extensive margin and Input-Output structure for the aggregate results. Failure rates are first calculated at the one-digit NACE level and aggregated to the country level using 2018 sector gross value added as weights. Failure rates are aggregated across countries using GDP as weights.

failure rate remains quite similar for AEs and EMs (6.64 pp vs. 7.00 pp). Columns (7)-(9) ignore the extensive margin and turn on the I-O structure. These significantly increase the failure rate (from 8.51 pp to 10.96 pp). Importantly, it leads to a very significant divergence between AEs and EMs (7.88 pp vs. 14.20 pp). The results in Table 4 suggest that the production network makes firms in EMs more vulnerable to COVID-type shocks, while providing some degree of insurance for AEs.[29]

Other papers have emphasized differences in the stringency of lockdowns (Bonadio et al., 2020), or the interaction between the global I-O network and the differential speed of vaccinations (Çakmaklı et al., 2020). The results in this table hold the intensity of lockdowns and the severity of the pandemic constant. They illustrate how the different countries' exposure to the production network may make them more or less sensitive to a COVID-19-type shock. This is a novel result. Specifically, the sourcing of inputs from other sectors appears more concentrated in EMs relative to AEs.[30]

2.3.2 Impact of Government Interventions for 2020

Next, we use our model to analyze the effectiveness of government interventions targeted to SMEs, as described in Section 2.2.4. For each country in our sample, we feed into the model an estimate for the actual policies implemented by that country.[31] The results are reported in Table 5.

Column (1) shows the change in failure rates under no policy support. This is simply a repeat of Column (3) from Table 1. Column (2) estimates the fiscal cost of saving all SMEs at

[29]This is a general pattern among EMs. The predicted increase in failure rates when taking into account the I-O structure is particularly pronounced for China (12.65 pp vs. 4.39 pp), India (37.06 pp vs. 30.48 pp), and Turkey (6.41 pp vs. 1.32 pp). Among AEs, the increase is most pronounced for Korea (8.09 pp vs. 2.17 pp).

[30]A Herfindahl-Hirschman index for such concentration is 0.12 for EMs vs. 0.07 for AEs.

[31]We limit ourselves to policies for which we have reasonably accurate information regarding aggregate disbursements. Specifically, we focus on tax waivers, grants, and pandemic loans. These policies are the most common policies across countries as highlighted in the ESRB Policy Report ESRB (2021).

Table 5: The Impact and Cost of 2020 Policy Intervention

	No Policy Support		With Policy Support	
	(1) Δ (pp)	(2) Hypothetical Costs (%, GDP)	(3) Δ (pp)	(4) Actual Funds Disbursed (%, GDP)
All	9.00	0.80	4.30	4.05
Advanced	5.65	0.13	-0.43	6.08
Emerging	12.53	1.50	9.28	1.91

Note: Failure rates are first calculated at the one-digit NACE level and then aggregated to the country level using 2018 sector gross value added as weights. Because firm coverage in Orbis is imperfect, to calculate aggregate costs we scale total costs by the inverse of the coverage ratio of Orbis (based on one-digit data on value added for policy costs). All data is based on 2018 numbers. Failure rates and policy costs are aggregated across countries using GDP as weights.

risk because of COVID-19, under a hypothetical policy where at-risk firms can be accurately identified in real-time.[32] This number is calculated as the minimum cash grant necessary for at-risk firms to meet their existing financial obligations, despite the decline in their cashflow, under our liquidity criterion Eq. (8). The table illustrates that, despite the large size of the COVID-19 shock, the overall cost would remain quite modest, between 0.13 percent of GDP for AEs and 1.50 percent for EMs. This number provides an important benchmark since it is the most cost-effective policy to save all at-risk SMEs under COVID-19.

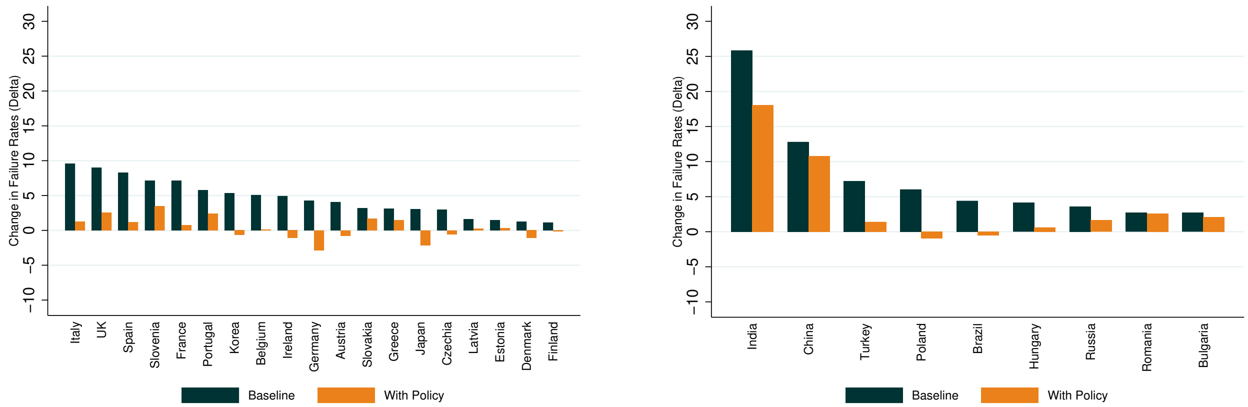
Next, Columns (3)-(4) present similar calculations under the actual policies implemented by these countries. Column (3) shows the overall increase (Δ) relative to non-COVID under real-life policies. The results are striking. Instead of the overall 9 pp increase in failure rate in the absence of policy, our estimates indicate that fiscal policy managed to offset more than half of that increase, down to 4.30 pp. The impact is particularly striking for AEs, where we estimate that the failure rate under COVID-19 in 2020 actually decreased (-0.43 pp) relative to non-COVID. For EMs, the reduction is more modest (from 12.53 pp to 9.28 pp), but still significant.

The size of the business support programs in each group of countries is a first-order factor behind this divergence. Similar to the differences in the size of the entire fiscal packages described in the introduction (see Fig. 1), the amounts disbursed to help SMEs differ significantly for each group of countries, as shown in Column (4). These funds stand at 6.08 percent of GDP for AEs, more than three times as high (as a share of GDP) relative to EMs (1.91 percent). Clearly, advanced economies were able to respond much more aggressively, both in absolute terms and in relation to the size of their economy.[33] Importantly, as discussed previ-

[32]This calculation ignores the fact that it might not be desirable to save all at-risk SMEs since some might be zombie firms. We discuss this issue below.

[33]Looking at the distribution across countries, Japan stands as a clear outlier, with 11.07 percent of its GDP disbursed to support SMEs, followed by Italy with 7.93 percent of its GDP. At the other extreme, Romania only

Figure 4: Change in SME Failure Rates with Policy Support: By Country



(a) Advanced (b) Emerging

Notes: The bars depict the change in failure rates under the COVID baseline and with policy scenarios relative to non-COVID. Country-level results represent the weighted average of one-digit NACE failure rates, where weights are given by 2018 sector gross value added.

ously, funds disbursed does not equate fiscal costs. A substantial share of the relief received by SMEs in AEs occurred through government guaranteed loans and the amount recorded in Column (4) of Table 5 includes these loan amounts. To the extent these loans will be repaid, the cost to the public purse will be significantly lower.

Comparing Columns (4) and (2) reveals that AEs disbursed a very large amount (6.08 percent) compared the cost of the hypothetical policy (0.13 percent) needed to save all at-risk SMEs. This suggests that, while successful in the aggregate, fiscal support may have been very inefficiently targeted. For EMEs, the amount disbursed is only slightly above that needed to save all at-risk firms (1.91 percent vs. 1.50 percent). Still, support is also poorly targeted in EMs, as we show below.

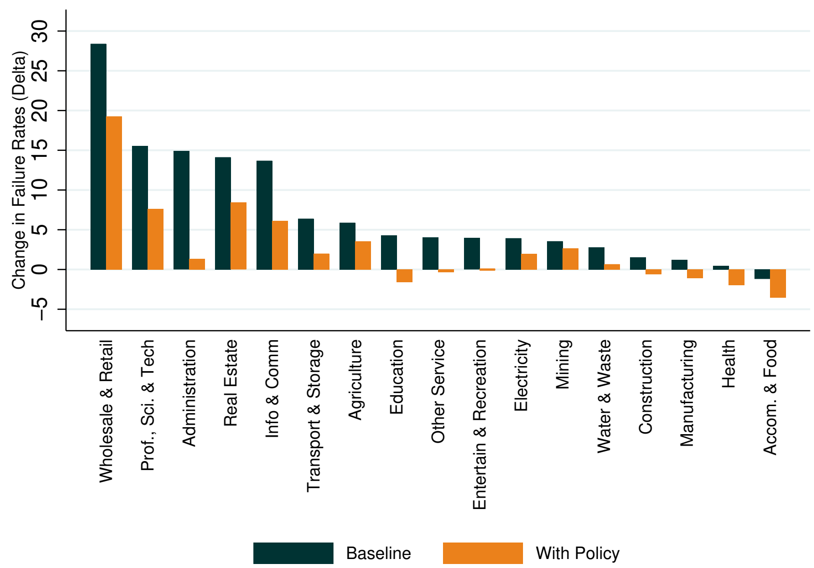
Heterogeneity across Countries and Sectors. Fig. 4 reports our estimate of the change in failure rates in 2020 with fiscal support in place. The left diagram (Advanced Economies) illustrates the extent to which fiscal support compressed – or even completely eliminated in the cases of Korea, Ireland, Austria, Germany, and Japan – the increase in business failures. That compression is also quite apparent for emerging markets, outside of India and China.

Fig. 5 reports the change in failure rates by sector with and without policy support. The figure illustrates a uniform compression at the sectoral level. We can also see how fiscal support generated lower levels of failures (compared to non-COVID) in Accommodation and Food Services, Health, Education, Manufacturing, and Construction.

These results are in line with anecdotal evidence on bankruptcy filings that seemed to have declined under COVID, compared to a normal year (e.g., IMF (2021b)). Taken together, they

disbursed 0.06 percent of GDP to support its SMEs, and Bulgaria 0.9 percent.

Figure 5: Change in SME Failure Rates with Policy Support: By Sector



Notes: The bars depict the change in failure rates under the COVID baseline (blue) and with policy (orange) scenarios relative to non-COVID. Sector failure rates are first calculated at the one-digit NACE level for each country, and then aggregated across countries using (country x sector) gross value added as weights.

also raise two important concerns that have been the focus of much recent policy discussions. First, policies may have been inefficiently targeted, directing resources towards firms that did not need them. Second, they may have helped too many firms to survive COVID-19, creating a potential hangover of SMEs ready to collapse as soon as fiscal support is removed (e.g., G30 (2020)).

Heterogeneity Across Firms. We now address this issue by studying the composition of firms that received fiscal support in 2020 to understand whether or not policies were well targeted and if generous fiscal support created any zombie firms in the economy. Then we turn to study the set of firms that were saved by the policy (would have failed in the absence of policy) and separate these firms into zombies and non-zombies. We define zombies as those firms with an interest coverage ratio ($^{EBIT}/_{Financial\ Expenses}$) below one in three consecutive years before COVID-19.[34]

Tables 6 and 7 focus on the effectiveness of policy at saving firms. In Table 6, we report "firms-at-risk," "jobs-at-risk," and "wages-at-risk" from failure in the absence of policy sup-

[34]In order to maximize the number of firms that be can categorize as zombie vs. non-zombie, we first evaluate whether a firm has an ICR below one in 2016–2018, or 2015–2017, or 2014–2016. For firms that we cannot evaluate the ICR criteria for three consecutive years (due to missing data), we evaluate whether the firm has an ICR below one in 2017–2018, or 2016–2017, or 2015–2016, or 2014–2015.

Table 6: Firms, Jobs and Wages at Risk

	Firms at risk	Jobs at risk (%, Empl)	Wages at risk (%, GDP)
All Countries	16.43	5.06	4.49
Advanced Economies	13.53	4.37	5.00
Emerging Economies	24.78	7.91	3.05

Notes: Firms at risk are first calculated at the one-digit NACE level and aggregated to the country level using 2018 sector gross value added as weights. Because firm coverage in Orbis is imperfect, to calculate aggregate funds disbursed, jobs, and wages, we scale each by the inverse of the coverage ratio of Orbis (based on one-digit data on value added for funds disbursed and wages and employment for jobs). All data is based on 2018 numbers. Funds disbursed and firms, jobs, and wages at-risk are aggregated across countries using GDP as weights. Due to data limitations, firms in China cannot be classified into zombie and non-zombie groups. The country is therefore excluded from aggregation in this table.

port.[35] "Firms-at-risk" are those firms that fail under a no-policy scenario (baseline), with "jobs at risk" and "wages at risk" relating to jobs and wages paid at those firms. Of the firms that are alive at the start of 2020, almost 17 percent fail under our no policy scenario. The jobs and wages lost at these firms represent 5 percent of total employment and 4.5 percent of wages in GDP.

Table 7 shows that although support policies helped avoid some of these losses, they were poorly targeted. On average, 5.10 percent of GDP was disbursed as policy support and saved 36 percent of the firms, 46.8 percent of the jobs, and 36.5 percent of the wages that were at risk due to COVID-19. Yet, only 6 percent of the funds disbursed (0.29 percent out of 5.1 percent) went to saving the firms that account for these jobs and wages. The vast majority of the funds (88 percent) were spent on firms that would have survived to the end of 2020 without the support, and the remaining 6 percent was spent on firms that failed despite the support. These insights apply to both AEs and EMs. In both groups of countries, policy support disbursed most funds to firms that did not need the support and failed to deliver sufficient support to at-risk firms.

Table 7 also shows that concerns about support saving zombie firms is not entirely warranted. Zombies account for only 2 percent of all funds disbursed. They also account for only 13 percent of firms, 15.4 percent of jobs, and 14 percent of wages saved by policy support. These insights apply even if we look at AEs and EMs separately.

[35] "Firms at risk" is equivalent to the COVID-19 failure rate reported in Table 1. Note that in this section we decompose firms into zombies and non-zombies. Due to data limitations, we cannot perform this decomposition for most firms in China. Consequently, China has been excluded from the "all" and "emerging market" results. Accordingly, the numbers are slightly different from those in Table 1.

Table 7: Efficacy of 2020 Policy Interventions

	Funds Disbursed (%, GDP)	Firms Saved (% of at risk)	Jobs Saved (% of at risk)	Wages Saved (% of at risk)
All Countries				
All Firms	5.10	36.0	46.8	36.5
Survive without Policy	4.53	0.00	0.00	0.00
Survive because of Policy	0.29	36.0	46.8	36.5
Of which, zombie firms	0.10	13.0	15.4	14.0
Advanced Economies				
All Firms	6.08	45.1	57.0	38.8
Survive without Policy	5.49	0.00	0.00	0.00
Survive because of Policy	0.33	45.1	57.0	38.8
Of which, zombie firms	0.12	16.4	17.6	15.0
Emerging Economies				
All Firms	2.28	21.8	24.1	25.2
Survive without Policy	1.76	0.00	0.00	0.00
Survive because of Policy	0.17	21.8	24.1	25.2
Of which, zombie firms	0.06	7.5	10.5	9.2

Notes: Firms saved are first calculated at the one-digit NACE level and aggregated to the country level using 2018 sector gross value added as weights. Because firm coverage in Orbis is imperfect, to calculate aggregate funds disbursed, jobs, and wages, we scale each by the inverse of the coverage ratio of Orbis (based on one-digit data on value added for funds disbursed and wages and employment for jobs). All data is based on 2018 numbers. Funds disbursed and firms, jobs, and wages saved are aggregated across countries using GDP as weights. Funds disbursed are expressed as a percent of GDP. Firms, jobs, and wages saved are expressed as a percent of those at risk. Due to data limitations, firms in China cannot be classified into zombie and non-zombie groups. The country is therefore excluded from aggregation in this table.

2.3.3 Impact of Government Interventions and Scaling Back Policies in 2021

While we have shown that policy was effective at saving firms in 2020, a natural question is whether these firms survive once policy is scaled back. We investigate this question by extending our analysis to 2021.

As of the end of May 2021, the COVID shock was still going strongly in many countries, according to OxCGRT and Google mobility indices. At the same time, the vaccination drive was well underway in AEs, and these economies were on trajectory to re-open. We consider a scenario where COVID-19 disappears for AEs (the supply shocks return to normal) and remains constant for EMs. Under that scenario, firms that received pandemic loans are asked to start repaying them in 2021.[36]

The results are shown in Table 8, where Columns (1)-(3) show the excess 2021 failure rates of policy without any repayment required and Columns (4)-(6) show excess failure rates if repayment of policy support is required. Failure rates in 2021 are only 2.3 percentage points higher than normal (non-COVID) times if we do not require policy support to be repaid (Column 1) and 2.6 percentage points higher if pandemic loan repayments begin in 2021 (Column 4). Almost all of this increase, 1.9 pp of the 2.3 pp (and 2.1 pp of the 2.6 pp under the repayment scenario), comes from failures among firms that were saved by policy support in 2020.

Since firms that survived 2020 because of policy support account for much of the rise in 2021 failure rates, we evaluate their 2021 outcomes in Table 9. A total of 70.2 percent of firms that survived to the end of 2020 because of policy support also survive until 2021, while the remaining 29.8 percent fail. Regarding zombies, of all the firms that survive 2020 because of policy support, 22.6 percent are zombies that also survive to the end of 2021 and 13.3 percent are zombies that fail by the end of 2021.

Overall, fiscal policy prevented a large increase in firm failures by halving the failure rate, but it was inefficiently targeted. Out of at-risk firms, only 36 percent were saved, corresponding to 47 percent of jobs-at-risk and 37 percent of wages-at-risk. On average, almost 6 percent of GDP was spent but only 6 percent of this sum (0.36 percent of GDP) went to saving at-risk firms (and associated jobs and wages). The vast majority of the rest went to strong firms that could have survived COVID-19 without policy support. On the bright side, fiscal support did not create a lot of zombie firms, contrary to conventional wisdom. Only 2 percent of the funds were spent on zombies, and by the end of 2021, a mere 22 percent of the firms were zombies that were saved by policy in 2020.

[36] Pandemic loans are assumed to be interest-free, five-year loans. Consequently, under the repayment scenario we impose that firms are required to pay one-fifth of their loan by the end of 2021.

Table 8: Change in Failure Rates in 2021

	No Repayment			With Repayment		
	(1) All	(2) Advanced	(3) Emerging	(4) All	(5) Advanced	(6) Emerging
Failure 2021 (pp)	2.30	1.24	5.33	2.59	1.53	5.67
Failure 2020 by Group (pp)						
Survive 2020 without Policy	0.44	-0.16	2.18	0.51	-0.11	2.28
Survive 2020 because of Policy	1.86	1.41	3.15	2.09	1.63	3.39

Note: Failure rates are evaluated at the end of 2021 as a fraction of firms that survive to the end of 2020. The failure rates are reported as the difference between a scenario in which COVID shocks are active (policy equal take-up and policy equal take-up + repayment) and a scenario in which they are turned off (non-COVID). Failure rates are first calculated at the one-digit NACE level and aggregated to the country level using 2018 sector gross value added as weights. They are then aggregated across countries using GDP as weights. The first row reports the overall change in failure rates, and the last two rows decompose this change into firms that survived to the end of 2020 without policy support and those that survived to the end of 2020 due to policy support. Due to data limitations, firms in China cannot be classified into zombie and non-zombie groups. The country is therefore excluded from aggregation in this table.

Table 9: 2021 Outcomes as % of Firms that Survived 2020 with Policy Support

	All	Advanced	Emerging
Survive until end 2021	70.2	73.1	60.5
of which, zombie firms	22.6	22.9	21.6
Fail 2021	29.8	26.9	39.5
of which, zombie firms	13.3	13.5	12.7

Note: Reports the distribution of 2021 outcomes of all firms that survive to the end of 2020 due to policy support (i.e., the denominator is the number of firms that survive 2020 with policy support). Due to data limitations, firms in China cannot be classified into zombie and non-zombie groups. The country is therefore excluded from aggregation in this table.

3 A Global Input-Output Model of Fiscal Spillovers

The analysis thus far has documented the uneven effects on firms from different fiscal stimulus in advanced vs. emerging economies under the assumption of fixed aggregate demand in each country. However, fiscal policy in AEs may have important spillovers that could affect demand and outcomes in EMs. To investigate this, our second exercise moves from a closed economy, partial equilibrium firm-level analysis to a multi-country, multi-sector, intertemporal general equilibrium analysis.

In what follows, we ignore the extensive margin caused by business exit and assume that in each country and sector, output is produced by a representative firm. Our focus shifts from fiscal policies designed to support the business sector and avoid business failures, to a broader set of transfer policies designed to support aggregate activity in the context of adverse supply shocks. Two questions are of particular interest to us. First, we want to assess the extent to which aggregate fiscal support was desirable (i.e., the extent to which economies are facing Keynesian supply shocks along the lines of Baqaee and Farhi (2020b); Guerrieri et al. (2020)). Second, we are interested in the importance of fiscal spillovers (i.e., the extent to which fiscal stimulus in a country or group of countries influences macroeconomic outcomes in the rest of the world). Section 3.1 presents a succinct version of the model, with most derivations relegated to Appendix B. Section 3.2 explains the mapping from the model to the data. Section 3.3 presents our empirical findings.

3.1 An Overview of the Global Model of Trade and Production Network

The economy consists of N countries indexed by m, n, and o, and J sectors indexed by j, k, and l. There are two periods: the present, denoted without stars, and the future, denoted with stars ($*$). COVID-19 is modeled as a transitory shock that occurs during the first period. In the second period, the economy settles on its long-run equilibrium with markets clearing and full employment. Each country is a small open economy, taking the global nominal risk-free rate i as given. This global interest rate will be pinned down by the requirement that global trade balances sum to 0 in all periods: $\sum_n TB_n = 0$.

We begin by characterizing the intratemporal equilibrium for a given level of aggregate expenditures. We then characterize the intertemporal allocation of spending and production.

3.1.1 The Intratemporal Equilibrium of the Global Model

Production. To simplify derivations, we modify the production function of Section 2. Good j in country n is produced with a Cobb-Douglas aggregator between fixed factor k_{nj}, labor L_{nj}, and an intermediate input bundle x_{nj}. This bundle is itself obtained as a CES aggregate from goods from all sectors and countries:

$$y_{nj} = \mathrm{k}_{nj}^{\alpha_{nj}} \left(A_{nj} L_{nj}\right)^{\beta_{nj}} x_{nj}^{\gamma_{nj}} \quad ; \quad x_{nj} = \left(\sum_k \sum_m \vartheta_{nj,mk} x_{nj,mk}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \tag{10}$$

where $x_{nj,mk}$ denotes the intermediate input use of good k from country m, in sector j of country n. The parameters β_{nj}, γ_{nj}, and $\alpha_{nj} = 1 - \beta_{nj} - \gamma_{nj}$ control the expenditure shares of labor, intermediate inputs, and fixed factors in gross revenues, while the coefficients $\vartheta_{nj,mk}$ control the shape of the domestic and international production networks. σ denotes the elasticity of substitution between any two intermediate inputs.

Firms are price takers and cost minimization yields the following input demands:

$$w_{nj} L_{nj} = \beta_{nj} p_{nj} y_{nj} \; ; \; P_{nj}^x x_{nj} = \gamma_{nj} p_{nj} y_{nj}, \tag{11a}$$

$$\pi_{nj,mk}^x \equiv \frac{p_{n,mk} x_{nj,mk}}{P_{nj}^x x_{nj}} = \frac{\vartheta_{nj,mk}^{\sigma} p_{n,mk}^{1-\sigma}}{\sum_o \sum_l \vartheta_{nj,ol}^{\sigma} p_{n,ol}^{1-\sigma}}, \tag{11b}$$

where w_{nj} is the (sector specific) wage in country n, p_{nj} denotes the price of good j produced and sold in country n, and $p_{n,mj}$ is the price of the same good in country n, sourced from country m. We allow for iceberg transport costs $\tau_{n,mj} \geq 1$ when good j is shipped from country m to country n, with $\tau_{n,nj} = 1$. Arbitrage on the goods market imposes $p_{n,mj} = \tau_{n,mj} p_{mj}$.

P_{nj}^x is the ideal-Fischer price index for intermediate goods and $\pi_{nj,mk}^x$ measures the share of intermediates from country m sector k in sector j country n's total spending on intermediate inputs (such that $\sum_k \sum_m \pi_{nj,mk}^x = 1$).

Labor Markets. As in Section 2, we assume wages are fixed and equal to $\bar{w}_{nj}$ during COVID-19, while only a fraction $x_{nj} \leq 1$ of workers in country n sector j are able to work. If $\bar{L}_{nj}$ denotes the supply of labor in normal times, equilibrium on the labor markets requires:

$$L_{nj} \leq x_{nj} \bar{L}_{nj} \; ; \; w_{nj} = \bar{w}_{nj}. \tag{12}$$

As before, when the inequality is strict, sectors are *demand-constrained* and there is Keynesian unemployment. When it is slack, sectors are *supply-constrained* and labor is rationed. The supply shocks A_{nj} and x_{nj} vary by country and sector.

Final Demand. Final demand takes the following form:

$$D_n = \left[\sum_j \xi_{nj} D_{nj}^{(\eta-1)/\eta}\right]^{\eta/(\eta-1)} \quad ; \quad D_{nj} = \left(\sum_m \zeta_{n,mj} d_{n,mj}^{(\rho-1)/\rho}\right)^{\rho/(\rho-1)}. \tag{13}$$

In this expression, D_{nj} is an Armington aggregator of the demand for varieties of good j sourced from different countries m, $d_{n,mj}$. The constant parameters $\zeta_{n,mj}$ control expenditure shares and capture potential country heterogeneity in final demand, such as consumption home-bias. ξ_{nj} represents a country and sector-specific demand shifter. The parameter $\rho \leq 1$ is akin to a trade elasticity. It controls the price elasticity of demand across different origins.

Denote P_{nj} as the ideal-Fischer price index for sector j in country n, and P_n as the overall price index in country n. For a given level of aggregate nominal expenditures $P_n D_n$, we can express country n's expenditure share on goods j sourced from country m, $\omega_{n,mj}$, under the assumption that $\eta = 1$ as in Section 2 :

$$\omega_{n,mj} \equiv \frac{p_{n,mj} d_{n,mj}}{P_n D_n} = \zeta_{n,mj}^{\rho} \xi_{nj} \left(\frac{p_{n,mj}}{P_{nj}}\right)^{1-\rho}. \tag{14}$$

Together with the demand for intermediates from Eq. (11b), we can write the nominal market-clearing condition for good j produced by country n:

$$p_{nj} y_{nj} = \sum_m p_{m,nj} d_{m,nj} + \sum_m \sum_k p_{m,nj} x_{mk,nj}. \tag{15}$$

Equilibrium for a Given Level of Aggregate Expenditures. Given a level of aggregate expenditures $P_n D_n$ in each country, supply shocks A_{nj}, x_{nj}, and demand shocks ξ_{nj}, an intratemporal equilibrium of the global model consists of a set of sectoral prices and output p_{nj}, y_{nj}, final and intermediate demands $d_{n,mj}$ and $x_{nj,mk}$, wages w_{nj}, and employment L_{nj} such that (a) firms minimize costs, Eq. (11); (b) the labor market clears, Eq. (12); (c) final demand satisfies Eq. (14); and (d) the market for each good clears, Eq. (15).

In what follows, we specialize the model to the case of unit elasticities ($\sigma = \rho = 1$) for which we can obtain a tractable exact solution.[37] Appendix B provides the details. As in Section 2, the equilibrium consists of a bloc of sectoral supply and demand curves for each country and sector. With unit elasticities, the demand bloc determines nominal gross output $p_{nj} y_{nj}$ and final aggregate expenditures $P_n D_n$ in all countries and sectors as a function of the sectoral demand shocks ξ_{mk} and nominal aggregate value-added V_m. In matrix form, we can

[37] The I-O network remains relevant in the model with unit elasticities because of the sectoral demand shocks.

write:

$$py = \mathcal{H}(\xi)V \quad ; \quad PD = \mathcal{M}(\xi)V, \tag{16}$$

where py is the $NJ \times 1$ vector of gross nominal output in each sector $p_{nj}y_{nj}$, V is the $N \times 1$ vector of value added, PD is the $N \times 1$ vector of nominal final demands, and $\mathcal{H}(\xi)$ and $\mathcal{M}(\xi)$ are respectively an $NJ \times N$ and an $N \times N$ matrix that depend on the sectoral demand shocks ξ, and are defined in appendix B.

While the supply shocks A_{nj} and x_{nj} do not matter for nominal gross output, they do matter for real output and prices. We show in Appendix B how the supply block can be solved under exact hat-algebra to yield prices p_{nj} and output y_{nj} in all countries and sectors.

3.1.2 The Intertemporal Equilibrium

To complete the characterization of the equilibrium, we now solve for the allocation of nominal value added V and V_*. We build on the frameworks of Guerrieri et al. (2020) and Baqaee and Farhi (2020b) to introduce fiscal policy and aggregate output determination in a tractable manner.[38]

Households. In each country and sector, there is a mass $\bar{L}_{nj}$ of households, each specialized in the sector they are employed in. The mass of households in country n is $\bar{L}_n = \sum_j \bar{L}_{nj}$. Each household supplies inelastically one unit of labor in each period.

Household h in country n has the following intertemporal preferences:

$$(1-\delta_h)\,\frac{c_{nh}^{1-1/\phi}-1}{1-1/\phi} + \delta_h \frac{c_{nh*}^{1-1/\phi}-1}{1-1/\phi}, \tag{17}$$

where c_{nh} denotes today's consumption, c_{nh*} is future consumption, $\delta_h \in [0,1]$ controls households' preference for the present, and ϕ is the intertemporal elasticity of substitution. While ϕ is a common parameter, we allow δ_h to vary across countries. We assume that c_{nh} and c_{nh*} are defined according to Eq. (13). Specifically, aggregate final expenditures in country n in the current period are given by $D_n = \int c_{nh} dh$.

Fiscal policy. Our analysis focuses on the role of fiscal policy to alleviate COVID-19. To do so, we focus on the role of fiscal transfers to households and ignore government expenditures.[39]

[38] See also the seminal work of Frenkel and Razin (1987).

[39] Equivalently, we could consider that the final demand system Eq. (14) represents the combined final demand from the household and government sectors.

We consider two types of fiscal transfers. First, governments may support the income of workers who lost their job due to COVID-19. They can do so either by providing more generous unemployment benefits, or via short-time work schemes such as the Kurzarbeit program implemented in many European countries (Giupponi and Landais, 2020). These programs cover a fraction of the worker's wages during a lockdown. The two approaches are equivalent in our set-up. Second, the government may implement unconditional transfers to households.

The total fiscal transfer in country n during COVID-19, T_n, can be expressed as:

$$T_n = \sum_j \left(\bar{L}_{nj} - L_{nj}\right) \varrho_n w_{nj} + \kappa_n \bar{L}_n. \tag{18}$$

In the first term, $0 \leq \varrho_n \leq 1$ represents the replacement rate, assumed common to all industries but possibly varying by country. $\varrho_n = 0$ means that unemployed workers get no income support, while $\varrho_n = 1$ means that the government covers 100 percent of unemployed workers' lost labor income. κ_n represents the dollar amount of unconditional transfers received by everyone. The government finances these transfers by issuing debt in the present period. This debt is repaid in the future by raising a lump-sum tax. From the government budget constraint, the *per capita* future tax is $t_{n*} = T_n (1 + i) / \bar{L}_n$, where i is the global risk-free nominal interest rate at which countries can borrow/lend internationally.

Aggregate Demand Determination. We make two assumptions that greatly simplify the determination of aggregate expenditures. First, we assume that a fraction μ_n of country n households cannot borrow and are very impatient ($\delta_h \approx 0$), so that these households always consume the entirety of their income in each period.[40] We call these households "hand to mouth" (HtM). The remaining households are on their Euler equation. We call these households "Ricardian" (R). Second, we assume that all households in country n receive the same capital income regardless of the sector they work in, their employment status, or whether they are constrained or not. In other words, we abstract from international and intranational portfolio determination by assuming that domestic capital is held uniformly across households.

Denote V_n as aggregate nominal value-added in country n in the current period, and V_{n*} as future nominal value-added. Solving for aggregate final expenditures from both types of households, we obtain a very convenient characterization:

$$P_n D_n = \mu_n \left(V_n + T_n\right) + (1 - \mu_n)(1 - \delta_n) \left(V_n + \frac{V_{n*}}{1 + i}\right). \tag{19}$$

[40] This assumption is different from Guerrieri et al. (2020) and Baqaee and Farhi (2020b). In these papers, constrained households have the same preferences as unconstrained ones. As a result, constrained but employed households wish to save and are also on their Euler equation.

Eq. (19) has a number of interesting properties for our analysis. First, if there are no HtM households ($\mu_n = 0$), then fiscal policy has no effect. This is intuitive since in that case all households are Ricardian and realize that transfers received today have to be repaid tomorrow. Second, aggregate demand depends only on the overall fiscal package T_n, and not the breakdown between transfers to unemployed workers ϱ_n and unconditional transfers κ_n. This is also intuitive: HtM and Ricardian households receive the same transfer, in expectation. Hence a fraction μ_n of the total fiscal package T_n goes to HtM households who have a MPC of 1. Third, Keynesian unemployment ($L_n < \bar{L}_n$) matters for aggregate expenditures: higher unemployment lowers total value added V_n, reducing income and therefore aggregate demand $P_n D_n$, especially so for HtM households with a unit MPC. A lower aggregate demand feeds into lower output, hence potentially increasing unemployment as more sectors become demand-constrained. This is a typical Keynesian cross-feature generated by the nominal wage rigidities. Lastly, aggregate expenditures decrease as the discount factor δ_n and interest rate i increase. This is also intuitive: more patient R households want to postpone consumption when δ_n increases, while a higher interest rate reduces expenditures via a wealth effect.

3.1.3 Global Trade Imbalances

In our model, unlike most other global I-O models in the literature, total value added V_n need not equal aggregate expenditures $P_n D_n$. The difference is equal to the aggregate trade balance for country n, TB_n:

$$
\begin{aligned}
TB_n &\equiv V_n - P_n D_n \\
&= \sum_{m,j} p_{m,nj} d_{m,nj} + \sum_{mk,j} p_{m,nj} x_{mk,nj} - \sum_{m,j} p_{n,mj} d_{n,mj} - \sum_{mk,j} p_{n,mk} x_{nj,mk},
\end{aligned}
\tag{20}
$$

where the second line expresses the trade balance as gross exports minus gross imports.

Using Eq. (19), the trade balance in country n satisfies:

$$
TB_n = (1 - \mu_n) \left(\delta_n V_n - (1 - \delta_n) \frac{V_{n*}}{1+i} \right) - \mu_n T_n. \tag{21}
$$

The first term represents the smoothing of permanent income by Ricardian households. To the extent that the decline in output during COVID-19 is temporary, $V_n < V_{n*}$ and this term is likely negative, contributing towards a trade deficit. The second term represents a *twin deficit*: HtM households spend the transfer they receive. This unambiguously worsens the trade balance. Conversely, a precautionary shock (an increase in δ_n), or an increase in the global interest rate i, reduce trade deficits, the latter through a wealth effect.

Eq. (21) provides a way to analyze global imbalances during the pandemic. First, output temporarily declined in all countries. Everything else equal, Ricardian households in each country would have liked to borrow to smooth consumption, resulting in larger trade deficits. Second, most countries expanded fiscal policy. Everything else equal, this too would generate larger trade deficits. Restoring the global equilibrium would have required an increase in the global interest rate i so that $\sum_n TB_n = 0$. This did not happen. Instead, global interest rates remained at historically low levels, and trade balances did not deteriorate markedly.

Through the lenses of the model, this suggests that COVID-19 was also associated with a surge in desired private saving, captured in the model via an increase in δ_n. Globally, the increase in desired private savings had to be sufficiently strong to offset the decline in current output, as well as the increase in fiscal transfers: Countries did not run large trade deficits and global interest rates did not surge because higher public deficits were mostly financed from larger domestic private savings. Our estimation procedure allows us to recover the precautionary shocks under COVID-19, largely validating this insight.

Eq. (21) also provides us with a way to understand the cross-country pattern of global imbalances. For instance, AEs have a lower share of HtM households compared to EMs. Everything else equal, this implies a stronger smoothing motive in AEs, and more private dissavings in response to a given negative shock. It also implies a smaller impact of a given fiscal transfer. For the same reason, Eq. (21) tells us that a given precautionary shock or change in the global interest rate has a larger impact on AEs than EMs.

Overall, Eq. (21) provides a rich but tractable representation of the determinants of global imbalances that takes into account heterogeneity in the intensity of the COVID-19 shock across countries, in the fiscal responses, in households access to credit, and in the global I-O structure of the economy.

3.2 Taking the Model to the Data

To estimate the model, we need empirical counterparts for the following objects: $\{\pi^x_{nj,mk}\}$, $\{\xi_{nj}\}$, and $\{\zeta_{n,mj}\}$ – intermediate and final demand spending shares – as well as β_{nj}, γ_{nj} – labor and intermediate shares of sales. All these quantities, except β_{nj}, we obtain from the ICIO world input-output tables (OECD, 2015), giving us a sample of 64 countries (plus a "rest of the world" composite) and 36 sectors. We obtain β_{nj} from the OECD Trade in Employment (TiM) data on compensation of employees.[41]

We obtain information on COVID-related transfers T_n from the IMF's COVID Fiscal Monitor Database IMF (2021a). For μ_n, we obtain estimates of the share of hand-to-mouth house-

[41]Specifically, we use data on labor compensation's share of value added from the OECD TiM database and data on value added and gross output from the ICIO I-O tables to obtain a measure of labor compensation's share of gross output for each country-sector.

Table 10: Model Inputs

	$\tilde{\xi}$ (1)	$\hat{x}$ (2)	$\hat{A}$ (3)	$\frac{T_n}{V_n}$ (%) (4)	μ_n (5)
All Countries	1.00	0.87	0.96	11.34	0.29
Advanced Economies	1.01	0.87	0.96	15.72	0.25
Emerging Economies	0.99	0.85	0.96	4.83	0.35

Notes: This table reports inputs into the global I-O model. The first column reports the average sectoral demand shock ξ. The second column reports the average sectoral supply shock x. The third column reports the average productivity shock A, column (4) reports the average size of the fiscal transfers relative to GDP, and the last column reports the average share of liquidity-constrained agents. All entries are weighted by sectoral and country value-added.

holds for several European countries from Almgren, Gallegod, Kramer and Lima (forthcoming). For the remaining countries, we use fitted values from a regression of μ_n on country GDP per capita. The slope is negative, indicating that less wealthy countries have a higher share of hand-to-mouth households. See Appendix Section B.3.3 for further details.

We use the same data for our COVID shocks as described in Section 2.2.3. Given our lockdown intensity measures vary at a daily frequency, we average them over the year and then apply these to the sectoral shocks ξ, x and A, which are themselves aggregated from four-digit NACE to the 36 ICIO sectors.

Table 10 summarizes these model inputs. Column (1) shows the average change in the overall level of demand (ξ), Column (2) shows the average labor supply contraction ($\hat{x}$), Column (3) the average decline in productivity, and Column (4) the average level of fiscal spending as a percent of GDP. EMs receive worse shocks, yet EM governments in this sample are spending less than a third of AE governments on fiscal support (4.83 vs. 15.72 percent of GDP). Column (5) shows the average value of the share of liquidity constrained households (μ_n) in each country with around 25 percent of households in AEs and 35 percent of agents in EMs classified as hand-to-mouth households.

Characterizing the Global Equilibrium. Solving the intertemporal block requires that we impose two normalizations. These normalizations can be interpreted as a choice of numeraire – or equivalently, as a monetary policy rule for a reference country. Our normalization, discussed in detail in the appendix, consists of assuming that the reference country follows a policy of nominal GDP targeting. Because the normalization also imposes that we measure output relative to that of the reference country, we select a small advanced open economy, New Zealand, as our reference country.

Table 11: COVID vs. Non-COVID

	δ_n Non-COVID (%) (1)	δ_n COVID (%) (2)	$\Delta\delta_n$ Rate (pp) (3)	Δ Trade Balance (% GDP) (4)	ΔP (% Change) (5)	ΔY (% Change) (6)	Δ # Supply Constrained (%) (7)	Δ Keynesian Unemployment (pp) (8)
All Countries	94.71	95.45	0.74	0.00	2.05	-7.90	69.15	1.40
Advanced Economies	94.81	95.52	0.71	-0.43	3.32	-8.01	70.71	0.97
Emerging Economies	94.56	95.35	0.79	0.64	0.17	-7.73	66.83	2.05

Notes: The table reports the discount factors under a non-COVID counterfactual (col. (1)); the discount factors under COVID (col. (2)); and the change between the two (col. (3)); the change in the trade balance-to-GDP ratio (col. (4)) and the decomposition of nominal GDP changes into real GDP and GDP deflator (cols. (6) and (5)); Col. (7) reports the share of value added originating from supply-constrained sectors. 100 minus that number represents the share of value-added originating from demand-constrained sectors. Source: See text. Authors' calculations.

3.3 Empirical Findings

COVID vs. Non-COVID. We start with counterfactual data on value-added in 2020 under a non-COVID scenario, denoted as V_n^{NC}. We construct these from the 2019 WEO's nominal dollar value-added forecasts for 2020. Through the lens of the model, this data allows us to construct baseline estimates of the discount factors under non-COVID, denoted as δ_n^{NC}.[42] We then feed into the model realized nominal dollar value-added for 2020, V_n, and recover the sequence of discount factors under COVID-19, δ_n, consistent with the global equilibrium.[43]

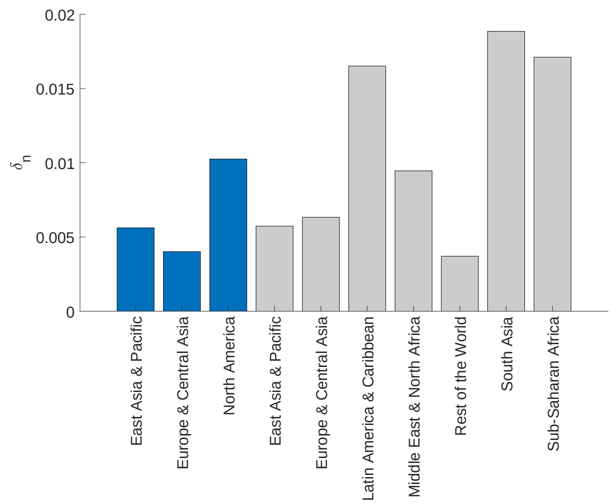
Columns (1) and (2) of Table 11 report the average (value-added weighted) discount rate for all countries in our sample as well as the subset of advanced (AE) and emerging (EM) economies, under non-COVID and COVID, respectively. Column (3) reports the difference between the two. We observe a strong increase in the discount factor during COVID-19, of 0.74 percentage points, from 0.9471 to 0.9545. All regions experience an increase in δ_n as we can see in Panel (a) of Fig. 6.

The table also reports the change in the ratio of the trade balance to GDP from non-COVID to COVID. By construction, this is 0 for the world as a whole. The table indicates that the trade balance for EMs improved under COVID-19 relative to non-COVID by 0.64 percent of GDP, while that of AEs worsened by 0.43 percent of GDP. Panel (b) of Fig. 6 shows that the improvement in the trade balance for EMs, and worsening for AEs, occurred across almost all geographical areas. Two points are worth noting here. First, from Eq. (16), the trade balance both under COVID and non-COVID is entirely determined from the intratemporal block of the model. Formally, the trade balance is constructed from the WEO nominal value-added inputs, the sectoral demand shocks, and the I-O network according to $TB^{NC} = (I - \mathcal{M}(\xi^{NC})V^{NC}$ and $TB = (I - \mathcal{M}(\xi)V$ respectively. Second, the change in the trade balance from a non-COVID 2020 scenario to a COVID 2020 scenario with fiscal policy is conceptually different from the

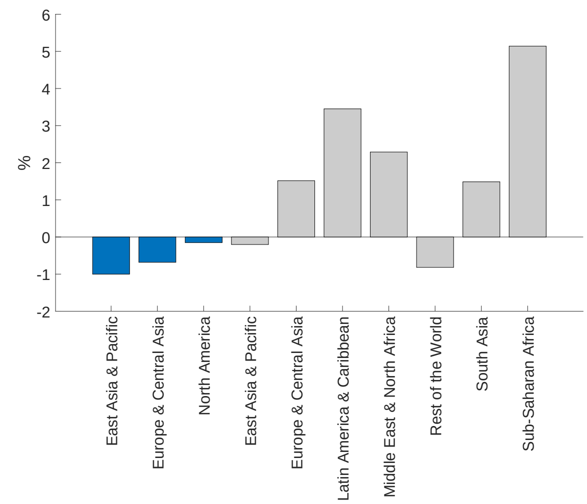
[42] As discussed in Appendix B, we calibrate the model so that the average discount rate under non-COVID is as close as possible to 0.95. This implies a MPC for Ricardian households close to 5 percent. We also impose a dollar nominal interest rate equal to its value in February 2020 of 1.58 percent.

[43] This calculation also imposes a nominal interest rate under COVID of i=0 percent.

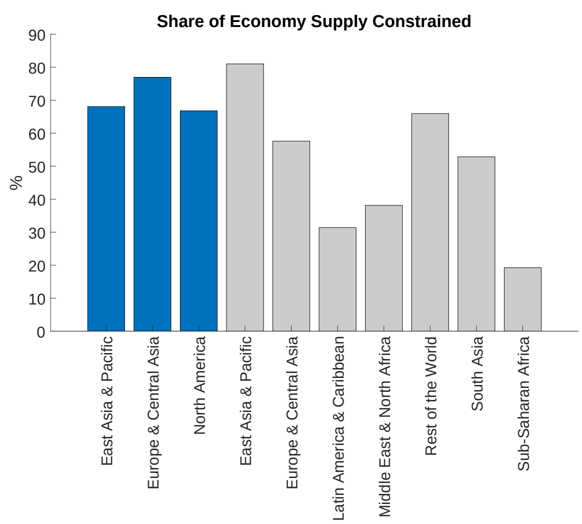
Figure 6: The Impact of COVID-19 on Macroeconomic Outcomes



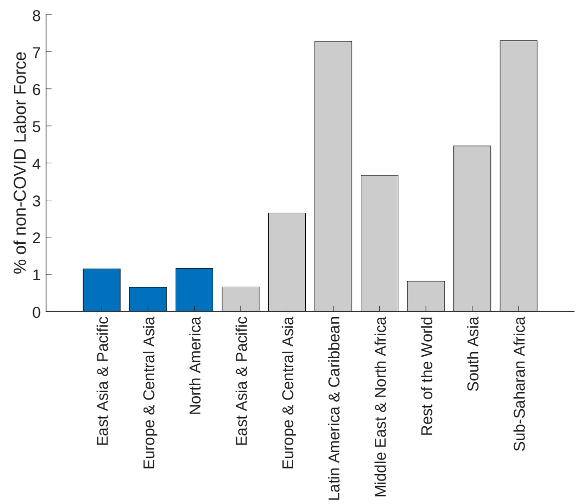
(a) Change in savings rate δ_n



(b) Change in trade balance-to-GDP ratio



(c) Share of economy supply-constrained



(d) Change in Keynesian Unemployment (% Non-COVID Labor Force)

Notes: Panel (a) reports the change in the discount factor δ_n under COVID relative to non-COVID. Panel (b) reports the change in the trade balance-to-GDP ratio from Non-COVID to COVID; Panel (c) reports the share of value added that originates in supply-constrained sectors under COVID; Panel (d) reports the the change in Keynesian unemployment as a percent of the non-COVID labor force observed change from 2019 to 2020.

Column (6) of Table 11 reports the change in real GDP from non-COVID to COVID.[44] As expected, we find that real GDP fell across the board from non-COVID to COVID, with an overall decline in real output of 7.9 percent. That decline is quite similar for AEs and EMs. Since the 2019 WEO was predicting a 3.41 percent global growth rate for 2020, and the actual 2019-2020 global growth rate was -3.27 percent, the WEO gap from 2020 COVID to predicted 2020 non-COVID was 6.68 percent, a number slightly smaller than our estimates based on our structural model.

Column (5) reports the corresponding changes in the GDP deflator. Overall, the GDP deflator increases by 2 percent with a striking difference between AEs and EMs. On average, AEs GDP deflator increased by 3.32 percent relative to non-COVID, while that of EMs increased by only 0.17 percent.[45] Column (7) in Table 11 reports the fraction of sectors that end up supply-constrained under COVID-19.[46] Since these shares are weighted with value-added (both at the sector and country level), the number represents the share of the economy that is supply-constrained sectors.

Column (7) contains a number of important insights. First, under COVID-19, the fraction of global GDP that is supply-constrained is around 69 percent, implying that 31 percent is demand-constrained. This forcefully indicates that Keynesian supply-shocks are a major macroeconomic feature for most countries in the world during COVID-19. Demand-constrained sectors occur through the reallocation of final and intermediate demand via the I-O structure. The finding that they represent 31 percent of the economy suggests that there is substantial scope for stimulative policies, such as fiscal transfers to lift sectoral output and employment, validating the analysis of Gourinchas (2020); Baqaee and Farhi (2020b); Guerrieri et al. (2020); Woodford (2020).

Second, we observe that AEs have a higher share of supply-constrained sectors than EM: 70.71 percent vs. 66.83 percent. The direct implication is that that there is more scope for additional fiscal and other stimulative policies to lift economic activity in EMs than AEs. Panel (c) of Fig. 6 shows that there is some variation across geographical areas, but most EM groups with the exception of East-Asia and Pacific have a lower share of supply-constrained output.

[44] We construct real GDP using value-added shares and changes in real gross output obtained from exact hat-algebra. Since V^{NC} and V are data inputs, the decomposition of nominal GDP into real GDP and its GDP deflator is independent from the intertemporal block of the model. It does, however, depend on the entire distribution of COVID shocks: A, x, and ξ.

[45] The difference between AEs and EMs in the price response arises entirely from the I-O structure of the economy. In an unreported counterfactual exercise, we shut down the I-O network by assuming that all sectors produce with labor as the only variable input. Under that scenario, price changes were quite comparable across AEs and EMs. This suggests that the price decline in EMs, relative to AEs, arises from the structure of their intermediate production network: more sectors in EMs experienced decline in intermediate input prices.

[46] By assumption, 100 percent of sectors are supply-constrained sectors under non-COVID, since we assume that, in the absence of COVID, all sectors would have been at their potential output.

There are two possible explanations for this result. First, we know that fiscal policy has been substantially more aggressive in AEs than EMs. This may have contributed to lifting demand constraints more in the former group of countries than the latter. Second, the nature of the COVID-19 shock itself and its interaction with the I-O network may cause more demand-constrained sectors in EMs than AEs. We will explore in depth which of these explanations is the correct one in our counterfactual analysis.

The last column of Table 11 reports the change in Keynesian unemployment between non-COVID and COVID and Panel (d) of Fig. 6 reports the breakdown by geographical area. We measure Keynesian unemployment as the fraction of the labor force (summed across all sectors) that is unemployed because of demand deficiencies. To illustrate the idea behind our measure, consider a sector that employs 100 workers before COVID-19. Suppose health restrictions allow only 70 workers in that sector. Suppose further that actual employment is only 60 workers because of demand deficiencies. We would say that 10 workers experience Keynesian unemployment.[47] The increase in unemployment due to demand deficiencies represents 1.40 percent globally, with 0.97 percent in AEs and 2.05 percent in EMs.

These results suggest rich and complex dimensions of heterogeneity in how countries were affected by and responded to COVID-19.

Counterfactual Analysis. We now consider a number of counterfactual exercises. Each counterfactual scenario corresponds to a different fiscal transfer profile, T^c, where the "c" superscript stands for "counterfactual." In each counterfactual, we hold the precautionary and COVID shocks constant, and solve for counterfactual value added V^c, V^c_*, and a counterfactual global interest rate i^c.[48]

The results are presented in Tables 12 and 13. In both tables, each row corresponds to a different counterfactual scenario. To ease comparisons, each scenario is compared to a scenario with COVID but without any fiscal policy (i.e., $T^c = 0$), which is itself a counterfactual.[49]

The first row of Table 12 compares the actual scenario (COVID with observed fiscal policy) to the baseline COVID with no fiscal policy (hereafter, "the baseline"). The first two columns report the change in the trade balance from the baseline for AEs (Column (1)) and EMs (Column (2)). The results confirm our previous analysis: The trade balance of AEs deteriorated by 0.17 percent of GDP due to their more aggressive use of fiscal policy, while that of EM rose by 0.26 percent of GDP. Columns (3)-(5) report the change in real value-added from the baseline,

[47] Formally, Keynesian unemployment represents $\sum_j (L_{nj} - x_{nj}\bar{L}_{nj})$.

[48] As discussed in Appendix B, we normalize output by assuming that our reference country, New Zealand, stabilizes nominal GDP across counterfactuals.

[49] With the exception of the reference country, which is always assumed to implement its own fiscal policy, for consistency across results.

Table 12: Effects of Different Fiscal Policies (All Relative to No Fiscal Policy)

	Trade Balance (% GDP)		Δ Real GDP (%)			Δ Prices (%)			Interest Rate (%)
	AE	EM	All	AE	EM	All	AE	EM	
Scenarios	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Relative to COVID w.o. Fiscal Policy									
2020 (COVID + Fiscal)	-0.17	0.26	0.67	0.97	0.23	3.00	3.53	2.21	0.00
No AE Stimulus	0.17	-0.26	0.12	-0.06	0.38	0.74	0.11	1.67	-0.44
US Only Stimulus	-0.17	0.25	0.32	0.57	-0.05	1.34	2.04	0.29	-0.48
No EME Stimulus	-0.35	0.51	0.56	1.03	-0.15	2.26	3.42	0.53	-0.48
Relative to 2020									
AE Recovery	-0.76	1.12	5.00	8.68	-0.47	-3.08	-3.15	-2.99	2.62
+Fiscal Policy	-1.09	1.61	4.85	8.81	-1.03	-2.85	-1.73	-4.52	5.92

Notes: The table reports the change in the trade balance-to-GDP ratio (cols (1)-(2)); real value-added (cols (3)-(5)); GDP deflators (cols (6)-(8)); and the level of the global dollar interest rate under various counterfactuals. All changes in the first four rows are relative to a COVID-without-fiscal-policy baseline. Changes in the last two rows are relative to the 2020 COVID-with-fiscal-policy baseline.

by country group. It indicates that fiscal policy from all countries lifted real output by close to 1 percent of GDP in AEs and by only 0.23 percent of GDP in EMs. Since real output declined by close to 7.9 percent from non-COVID to COVID with policy (see Table 11), this number tells us that fiscal policy offset only $0.67/(7.9 + 0.67) = 7.8$ percent of the decline in real output due to COVID (10.8 percent for AE and only 3.9 percent for EM).

Columns (6)-(8) of Table 12 report the change in GDP deflator. We find that fiscal policy had a significant effect on prices, between 2 and 3 percent. This is not surprising since fiscal transfers do not appear to increase real output significantly. Lastly, Column (9) reports the level of the global dollar nominal interest rate. By assumption, that interest rate is 0 percent under COVID.[50]

Columns (1)-(3) of Table 13 report the increase in the share of output that is supply-constrained. In response to fiscal policy, both groups of countries see an increase in the share of supply-constrained output. When combining Table 13 with Table 11, we observe that most of the difference in the share of supply-constrained value added arises from fiscal policy in AEs being more aggressive than EMs.[51] Columns (4)-(6) report the change in Keynesian unemployment. Turning on fiscal policy reduces Keynesian unemployment by 1.27 percentage points, 1.62 percent in AEs and 0.75 percent in EMs.

[50] Under the baseline, the global interest rate would instead have been -0.64 percent. This indicates that in the baseline COVID-without-fiscal-policy scenario, the economy would have hit the zero lower bound (ZLB). Because prices are flexible and increasing for supply-constrained sectors in our model, a ZLB has only limited effects. Indeed, if we impose a ZLB and solve for the corresponding output that clears markets, we find that output would have been 0.12 percent lower, more or less uniformly under the baseline. In what follows, we ignore the ZLB and allow negative nominal interest rates. As we see from Table 12, nominal rates never turn very negative under our counterfactual scenarios.

[51] Specifically, we can back out the share of supply-constrained value-added under the baseline scenario as 70.71 â 12.52 = 58.19 percent for AEs, and 66.83 â 7.89 = 58.94 for EMs. These numbers are almost exactly identical.

How should we interpret these findings? At first glance, the small response of aggregate real output suggests a relatively low multiplier from fiscal policy under COVID-19. From Table 10, the size of fiscal transfers was around 11.3 percent of global GDP. With an increase in global output of only 0.67 percent, this represents a fairly low multiplier, close to 0.059. But traditional multipliers can be somewhat misleading in a COVID environment. First, note that we focus here on transfers, and not government expenditures. The effect of transfers, like that of tax cuts in textbook models, is mediated by the MPC of households. From Eq. (19), only a fraction μ_n of the overall fiscal transfers affects nominal aggregate demand. Second, many sectors are supply-constrained as shown in Columns (1)-(3) of Table 13. Stimulative policies in these sectors will result in rising prices, with limited or no impact on real output.[52] In other words, it is to be expected that output will decline under COVID, even with a strong fiscal impulse.

If we restrict the focus to demand-constrained sectors, we see that their share decreased from 42 percent of total output to 31 percent, suggesting that fiscal policy was indeed successful in closing demand-deficiencies caused by COVID-19. Looking more specifically at Keynesian unemployment in Columns (4)-(6) of Table 13 and Table 11, we see that fiscal support eliminated 1.27 percentage points of the 2.67 percent (1.40 + 1.27) Keynesian unemployment due to COVID (1.62 of 2.59 for AEs and 0.75 of 2.8 for EMs).

The finding that aggregate activity did not increase significantly while the share of demand-constrained sectors and Keynesian unemployment decreased illustrates an important composition effect due to I-O linkages. As fiscal policy closes the output gap in demand-constrained sectors, their prices rise. This raises marginal costs in downstream sectors. When these downstream sectors are supply-constrained, this does not affect their equilibrium employment – which remains rationed – but reduces their output. Thus, fiscal transfers reallocate aggregate demand across sectors in a way that reduces demand deficiencies and preserves employment, but without much increase in total real GDP.

The second row of Tables 12 and 13 considers a counterfactual scenario where only EMs implement fiscal transfers under COVID-19. As before, we evaluate this scenario against the baseline COVID-19 scenario without any fiscal response. Not surprisingly, the effects on the trade balance are now flipped: if only EMs do fiscal policy, their trade balance deteriorates relative to that of AEs. Global interest rates would be lower under that scenario, reflecting the smaller scale of the global fiscal stimulus, originating only from EMs.

Interestingly, we find that real GDP in AEs would fall by a small amount (0.06 percent) as a result of fiscal policy in EMs. This indicates mildly negative real spillovers of fiscal policy. However, we also find that Keynesian unemployment would fall in both regions (-0.01 pp in

[52] The fact that stimulating demand via fiscal policy under supply constraints may not be enough to recover from a shock like COVID-19 is originally argued by Drechsel and Kalemli-Özcan (2020b).

Table 13: Effects of Fiscal Policies on Demand Constrained Sectors

Scenarios	Δ # Demand Constrained			Δ Keynesian Unemployment(pp)		
	All (1)	AE (2)	EM (3)	All (4)	AE (5)	EM (6)
	Relative to COVID w.o. Fiscal Policy					
2020 (COVID + Fiscal)	-10.66	-12.52	-7.89	-1.27	-1.62	-0.75
No AE Stimulus	-3.04	-0.05	-7.49	-0.26	-0.01	-0.63
US Only Stimulus	-2.11	0.00	-5.24	-0.09	0.01	-0.23
No EME Stimulus	-7.47	-12.15	-0.52	-1.02	-1.62	-0.13
	Relative to 2020					
AE Recovery	12.90	13.61	11.85	0.13	-0.56	1.15
+Fiscal Policy	8.60	1.22	19.56	0.51	-0.55	2.09

Notes: The table reports the change in the share of value-added originating in supply-constrained sectors (cols (1)-(3)) and the change in the Keynesian Unemployment Rate (cols (4)-(6)). All changes in the first four rows are relative to a COVID-without-fiscal-policy baseline. Changes in the last two rows are relative to the 2020 COVID-with-fiscal-policy baseline.

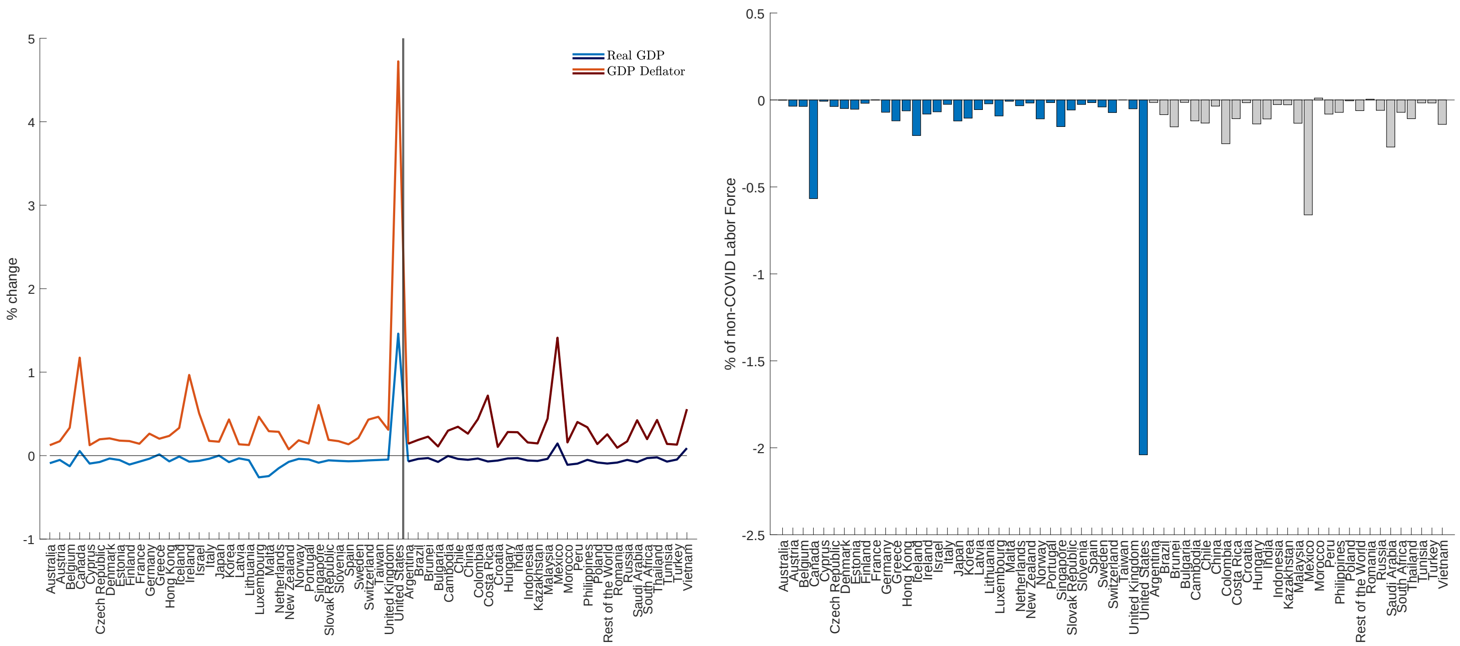
AEs and -0.63 pp in EMs). The next two scenarios consider the case of U.S. fiscal policy only, and of AEs fiscal policy only. The results confirm that real fiscal spillovers are very small and mildly negative, while that on Keynesian unemployment are somewhat larger and positive. In the case of U.S. fiscal policy only, we find that output in EM would decline by 0.05 percent, but Keynesian unemployment would decrease by 0.08 percent. Panel (a) of Fig. 7 reports the distribution of changes in real GDP and GDP deflator across all countries caused by the U.S. fiscal stimulus, while that of Panel (b) reports the change in Keynesian unemployment. The figure illustrates that only a few countries (especially Mexico and Canada) would see their real output increase, but many countries would see a modest decrease in Keynesian unemployment.

These results suggest that the composition channel discussed above operates both domestically, but also across borders (at a smaller scale).[53] In addition, there are additional channels through which fiscal policy in one country could adversely affect real output in others. First, everything else equal, we find that a stronger fiscal impulse raises global interest rates. For instance, in the U.S. fiscal policy scenario, global rates would increase from -0.64 percent to -0.48 percent. Higher interest rates reduce aggregate demand globally through a wealth effect. To the extent that countries exhibit some home bias, this dampens domestic aggregate demand and can negatively affect real output. Second, there is a terms-of-trade effect. Fiscal policy in the United States, partly financed via external borrowing, primarily raises demand for U.S.-produced goods, which leads to an increase in their price relative to that of foreign goods. The corresponding improvement in the terms of trade can also contribute to a decline in real output in the rest of the world.

The overwhelming message from these three counterfactual exercises is that fiscal policy

[53] The cross-border scale may become larger if intermediate goods elasticity of substitution (σ) is less than 1.

Figure 7: The Effect of U.S. Fiscal Policy on Other Countries



(a) Real Value Added and GDP Deflator

(b) Change in Unemployment

Notes: The left panel reports the change in real value-added (blue lines) and the change in the GDP deflator (red lines) from the baseline (COVID without fiscal policy) to a counterfactual with only U.S. fiscal policy. The right panel shows the change in the unemployment rate from the same change in counterfactual.

in AEs has complex effects on the rest of the world. Traditional measures such as output spillovers and multipliers may be somewhat misleading when part of the economy is shut down. Instead, we find that fiscal policy – either domestically or across borders – can significantly help support activity in demand-constrained sectors. While there is no evidence that large-scale fiscal packages in the United States and other advanced economies helped support aggregate activity in the rest of the world during the pandemic, they may have alleviated the decline in employment. Quantitatively, however, our results overwhelmingly suggest that policy support comes mainly from domestic policies, which requires having the appropriate fiscal space.

AE Recovery and Divergence. We conclude with a final, and somewhat different, set of counterfactual scenarios. We first consider what happens if the world economy experiences a two-speed recovery from the pandemic. Specifically, we ask what would happen when the pandemic disappears in AEs – owing to their aggressive vaccination drive – but remains present in EMs – owing to their lack of vaccination capacity. To implement that scenario, we consider what would happen in two steps. In the first step, we turn off the COVID-19 shocks and the precautionary shock in AEs, while keeping them in EMs. Furthermore, we assume that all countries stop doing fiscal stimulus. This captures the notion that fiscal stimulus is not needed in AEs any longer, and that EMs may have exhausted their fiscal space. We also now use the 2020 COVID-with-fiscal-policy scenario as a baseline, so that we can interpret the numbers are projections from 2020. Row (5) of Table 12 presents the results. First we observe that the decrease in private savings in AEs (as the precautionary shock recedes) would more than offset the improvement in public saving. As a result, global interest rate would rise and reach 2.92 percent, and AEs would run larger trade deficits (-0.76 percent of GDP) financed from EMs (1.12 percent of GDP). Second, this would adversely impact growth in EMs: compared to the 2020 scenario with COVID, growth in EMs would decrease by 0.47 percent, while that of AEs would increase by 8.68 percent. Third, the model suggests that the price pressures are transitory: as supply restrictions are lifted, the share of supply-constrained sectors decreases and so do price pressures, both in AEs and EMs. The decline in price is broadly similar to the increase in the 2020 COVID scenario.

The last row of Table 12 then considers the implications of continued fiscal stimulus in AEs, despite the recovery from COVID-19. The results suggest stronger and more damaging negative spillovers, with output growth in EMs falling by another 0.56 percent. This is in part driven by the surge in global interest rates needed to clear global savings markets, from 2.62 percent to 5.92 percent. The results from this table confirm that fiscal policy spillovers from AEs can be negative and important, especially so as these countries pull out of the pandemic ahead of EMs.

4 Global Rates, U.S. Monetary Policy, and Emerging Markets

Our third and final empirical exercise is to study the role of a possible increase in global rates on EMs' external outlook. The global I-O model from Section 3 shows that a two-track recovery can generate negative spillovers to EMs through a rise in global rates. So far, the analysis has abstracted from macroeconomic risk. A natural question at this juncture is to consider the impact of higher global rates on risk premia, especially for EMs.

We know from the literature on the global financial cycle (Rey, 2013, e.g.), that changes in U.S. monetary policy affect risky asset prices globally. In particular, Kalemli-Özcan (2019) shows that U.S. monetary policy changes spill over to EMs through fluctuations in risk premia in short rates, whereas this is not the case for AEs. A contractionary monetary policy in the United States leads to more capital outflows from EMs than AEs due to "yield oriented" short-term global investors.[54] As shown by Kalemli-Özcan (2019), in the case of EMs, movements in local interest rates reflect the sensitivity of capital flows to risk perceptions affected by the

[54] See Gourinchas, Ray and Vayanos (2021b) for a model of global portfolio re-balancing in response to conventional and unconventional monetary policy.

changes in U.S. monetary policy.

In this section, we extend these previous results by studying the response of interest rates/spreads on private and government borrowing in EMs to higher global natural rate, as well as to monetary policy surprises in the United States.

We start by regressing a standard measure of EM sovereigns' external borrowing costs that includes default risk, JP Morgan's Emerging Market Bond Index (EMBI), on a measure of the global natural real rate, denoted by r^*. Our sample is from 1996q1 to 2018q4. For r^*, we use data from the NY Federal Reserve on the U.S. natural interest rate.[55]

We run the following panel regression at the country (c)-quarter (t) level:

$$EMBI_{ct} = \alpha_c + \beta \log(1 + r^*_{t,US}) + \omega X_{ct} + \epsilon_{ct},$$

where α_c is a country fixed-effect and X represents controls such as the VIX, the growth rate and inflation rate differentials and lags of the dependent variable.

Table 14 shows the results. A higher r^* is associated with higher EMBI spreads as shown in column (1) during the first half of the sample before the global financial crisis (GFC). However, as shown in column (2), this effect disappears once we control for the VIX, a well-known measure of global risk aversion and uncertainty. A higher VIX is also associated with higher EMBI spreads. After the GFC period, there is no association between r^* and EMBI spreads, whereas the association with VIX stays positive as before, although smaller in magnitude.

The EMBI covers only a small number of EMs, with relatively liquid sovereign bond markets. We extend our sample by focusing more generally on governments' borrowing spreads defined as the rate on T-bills for a given country, minus the corresponding U.S. rate at the same maturity. To highlight the differential effect on EMs vs AEs, we run the following difference-in-differences regression, again at the country-quarter level:

$$\text{Government Bond Spread}_{ct} = \alpha_c + \lambda_t + \beta \log(1 + r^*_{t,US}) \times \text{Emerging}_c + \omega X_{ct} + \epsilon_{ct},$$

where α_c is a country fixed effect, λ_t is a time fixed effect, and "Emerging" is a dummy variable that takes the value 1 for EMs. Notice that we use a more restrictive specification with time fixed-effects, which absorbs some of the controls used in the previous regression, such as the VIX. We construct our dependent variable using short-term (12 month) government bond spreads.

[55] This data provides estimates for the natural rate of interest, defined as "the real short-term interest rate expected to prevail when an economy is at full-strength and inflation is stable" for several countries following the estimation approach of Holston, Laubach and Williams (2017). r^* The approach uses estimates of inflation, GDP, federal funds rate, and other macroeconomic variables to infer the natural rate of interest. See https://www.newyorkfed.org/research/policy/rstar for details.

Table 14: Global Natural Rate and EMBI

	Before GFC		After GFC	
	(1)	(2)	(3)	(4)
$\log(1 + r^*_{t,US})$	79.444***	12.503	2.400	-6.142*
	(17.495)	(12.367)	(4.282)	(3.382)
$\log(VIX_t)$		0.782***		0.265***
		(0.075)		(0.037)
Obs.	497	318	1554	917
Adj. R^2	0.72	0.93	0.66	0.92
Country FE	✓	✓	✓	✓
Controls		✓		✓

Note: Robust standard errors in parenthesis. *, **, and *** denote significance at the 10, 5, and 1 percent level. Controls include up to four lags of the dependent variable, inflation differential, and GDP growth differential (both vis-a-vis the United States).

Table 15: Global Natural Rate and Government Bond Spreads

	(1) All	(2) Before GFC	(3) After GFC
$\log(1 + r^*_{t,US}) \times$ Emerging	-0.130	2.517***	-0.804**
	(0.098)	(0.385)	(0.328)
Obs.	3039	1049	1989
Adj. R^2	0.76	0.78	0.79
Country FE	✓	✓	✓
Time FE	✓	✓	✓

Note: Robust standard errors in parenthesis. *, **, and *** denote significance at the 10, 5, and 1 percent level.

Table 15 shows the results by reporting the coefficient β. Overall, column (1) seems to show no statistical difference between EMs and AEs in terms of government bond spreads' response to changes in r^*. However, we see from Column (2) that this is not the case pre-GFC (1996-2008). Over that period, a higher r^* leads to higher government bond spreads in EMs, relative to AEs. Given the effective lower bound both for r^* and government borrowing rates during the period after the GFC, characterized by expansionary monetary policy in all AEs and in some EMs, there may not be enough variation in the data to identify a differential effect for the late period as shown with an insignificant estimate in column (3).

A better measure in this regard can be obtained by looking directly at private sector borrowing spreads instead of sovereign spreads. We run the same regression as before but using private sector loan spread. For our dependent variable, we use short-term loan spreads for households and firms (with maturity less than 12 month) vis-a-vis U.S. short-rates (three-

Table 16: Global Natural Rate and Private Sector Loan Spread

	All			After GFC
	(1)	(2)	(3)	(4)
$\log(1+r^*_{t,US})$	-0.184***	-0.041***		
	(0.017)	(0.012)		
$\log(1+r^*_{t,US})\times$ Emerging	0.332***	0.053**	0.302***	0.818***
	(0.043)	(0.025)	(0.046)	(0.208)
$\log(VIX_t)$		0.002***		
		(0.000)		
Obs.	1458	1244	1458	787
Adj. R^2	0.55	0.87	0.57	0.63
Country FE	✓	✓	✓	✓
Time FE			✓	✓
Controls		✓		

Note: Robust standard errors in parenthesis. *, **, and *** denote significance at the 10, 5, and 1 percent level. Controls include lags of the dependent variable, inflation differential, and GDP growth differential.

month T-bill). Table 16 shows the results. EMs' private borrowers always face a higher spread when r^* increases, both over the entire sample and also post-GFC. These results are robust to controlling for the VIX and our other controls, or time fixed-effects as shown in columns (2) and (3).

Our measure of the global natural rate is an equilibrium object. It will respond to shifts in desired savings or investment, productivity, demographics, and other forces, such as the demand for safe assets. Hence, the above regressions should not be given a strict causal interpretation. To identify the effect of higher risk premia on emerging markets' spreads, we turn now to the impact of exogenous surprise shocks to U.S. monetary policy, which are known to effect investors' risk sentiments (e.g. Rey, 2013; Kalemli-Özcan, 2019). To do so, we run local projections of government bond spreads on these surprises, separately for EMs and AEs.

Conventional models of monetary policy transmission imply that domestic credit costs should respond to monetary policy actions and that this response should depend on the expected path of the central bank's policy instrument, which is the short-term interest rate in normal times. Gertler and Karadi (2015) argue that, in the presence of financial frictions, the response of credit costs to monetary policy may in part reflect movements in credit spreads. Following the work of Gürkaynak, Sack and Swanson (2005), Gertler and Karadi (2015) use unexpected changes during a short window in federal funds rate and Eurodollar futures on Federal Open Market Committee (FOMC) dates to measure U.S. monetary policy surprises. They use these measures as exogenous shocks to monetary policy in a VAR framework to evaluate the immediate response (and persistence) of output, inflation, and interest rates to monetary policy shocks. By using such high-frequency identification, one can rule out the simultaneity of economic news and monetary policy.[56]

Kalemli-Özcan (2019) used the same U.S. monetary policy surprises in a local projections framework in order to estimate causal effects running from U.S. monetary shocks to foreign government bond spreads, for AEs and EMs separately. We update her work here by extending the data using monetary policy surprises from Jarociński and Karadi (2020) and run the following regression:

$$(i_{c,t+h} - i_{US,t+h}) = \alpha_c + \beta_h \hat{i}_{US,t} + \beta_h^w W + \epsilon_{c,t+h}, \quad h = 0, 1, 2, 3...,$$

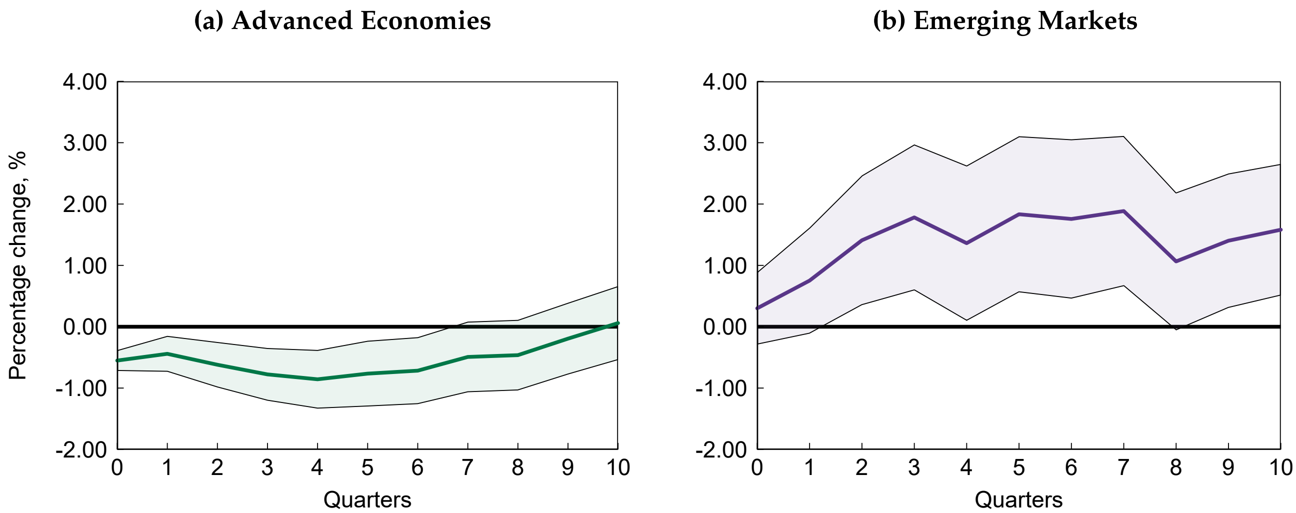
where $(i_{c,t+h} - i^{US}_{t+h})$ is the 12-month government bond rate differential at time $t+h$ in a given country c, vis-a-vis the U.S., α_c is a country fixed effect, $\hat{i}_{US,t}$ is the estimated exogenous U.S. monetary policy shock at time t, and β_h is the associated impulse response coefficient.

We estimate $\hat{i}_{US,t}$ using a first-stage regression of three-month U.S. treasury rates on the instrument Z_t. The instrument is the surprise in three-month ahead U.S. Fed fund futures. β_h has the same interpretation as the usual impulse response coefficients estimated by SVAR-IV (structural vector autoregression with instrumental variables). W is the set of control variables. W includes four lags of the dependent variable, the instrumented variable, and fundamentals (growth differentials and inflation differentials).

The results are shown in Fig. 8. As in Kalemli-Özcan (2019), we find that, in EMs, the 12-month government bond spreads increase by 2 percentage points after three quarters in response to a 1 percentage point "surprise" increase in U.S. monetary policy rate. In contrast, in AEs, we see the opposite pattern. The government bond rate differentials decrease by about 0.5 percentage points after one quarter and 1.7 percentage points after six quarters and exhibit more persistent responses. This result suggests that country-specific investment risk is higher for EMs after a contractionary U.S. monetary shock, while this does not happen in AEs.

[56]Recent literature argues that these unexpected changes may also incorporate an information effect, that is, the private sector may learn from the Federal Reserve decisions about information it has about the state of the economy. See Nakamura and Steinsson, 2018.

Figure 8: U.S. Monetary Policy Surprise Shocks and Government Bond Spreads



Note: Impulse responses of 12-month government bond rate differentials are obtained from panel local projections of 79 EMEs and 14 AEs from 1990Q2-2016Q4. 95 percent confidence intervals (calculated using Newey-West standard errors) are shown by the shaded areas. The U.S. policy (three-month treasury rate) is instrumented by Jarociński and Karadi (2020) shock FF4 (estimated from surprises in three-month Fed fund futures). The domestic monetary policy response of country c is controlled. The first-stage effective F-statistic of Montiel-Olea and Pflueger (2013) is 196.9 for EMEs and 211.2 for AEs.

5 Conclusion

We study the global effects of COVID-19 on firms, sectors, and countries, evaluating the effectiveness of fiscal policy as liquidity support for firms, in stimulating the economy, and in offsetting the pandemic. We measure the spillovers of fiscal policy between firms within a country, and across sectors and countries using a tractable global macro model with trade and production networks.

We establish eight main results. First, we show that fiscal policy was successful in reducing SMEs failure rate from 9 percentage points to 4.3 percentage points, relative to non-COVID, more than fully offsetting the impact of COVID-19 on business failures in AEs. Second, although fiscal policy saved many businesses, we establish that it was poorly targeted. Most of the funds disbursed were spent on firms that did not need it. Third, despite the poor targeting, we don't find any evidence of an impending wave of bankruptcies. According to our estimates, the policy did not create many zombie firms; we expect the failure rate to increase by a modest 2.3 percentage points in 2021. Fourth, calibrating our global model, we establish that fiscal policy was successful in stimulating demand in demand-constrained sectors, especially in AEs, given the size of their fiscal packages, though resulting price increases propagate and shrink supply-constrained downstream sectors. Fifth, we estimate quite low "conventional" fiscal multipliers due to shrinking supply-constrained sectors; however, fiscal policy was successful in preserving employment in demand-constrained sectors. Thus, fiscal policy reallocated demand across sectors, decreasing unemployment, but did not increase total output much. Sixth, we do not find that outsized fiscal packages in AEs lifted economic activity in EMs; on the contrary, we measure small – and often negative – cross-border fiscal spillovers. Thus, the lack of fiscal space in EMs was not compensated by outsize fiscal packages in AEs. Seventh, according to our estimates, a two-speed recovery will push global interest rates up, which would hurt EMs more. Last but not least, we show that EMs will face tighter external financing conditions, through a rise in risk premia, in the event of U.S. monetary policy normalization.

Taken together, our results suggest that fiscal policy did "get in all of the cracks" in the economy under COVID-19. The key intuition for this result relies on two features related to the COVID-19 shock and the global economy. First, fiscal policy works differently under COVID-19, where both supply and demand shocks, as well as supply and demand-constrained sectors, coexist. Second, fiscal policy can only stimulate output in demand-constrained sectors, but all sectors and countries are linked through a global trade and production network. This means that the "traditional" impact of transfer policies may be muted, while transfer policies still manage to support demand and employment in demand-constrained sectors. Building on these key features, we conclude that fiscal policy is able to "get into all of the cracks" during the COVID-19 pandemic. Despite this, we also find quantitatively that U.S. fiscal policy is insufficient to lift all the boats in the global economy.

Our work has a number of potentially important policy implications. For instance, as advanced economies re-open, the fiscal impulse in these countries should be revised downwards. Advanced economies present little risk for an upcoming wave of business failures. On the contrary, the danger is that continued fiscal support in AEs, in the context of a normalization of private demand, would result in a rapid increase in global interest rates and possible price inflation. The policy mix in AEs should therefore pivot away from fiscal support. Instead, our analysis shows that an early tightening of monetary policy in AEs could have strong adverse consequences on EMs, especially as the latter still struggle to find their way out of the pandemic. In the context of increased leverage both for the private and public sectors, we consider that careful and coordinated macroprudential and monetary/financial policies will be essential to stabilize the global economy.

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Appendices

A Details on the Model for Section 2

A.1 Final Demand

Final demand D is a CES aggregator over sectoral final demands D_j:

$$D = \left[\sum_j \mathcal{N}_j \xi_j D_j^{(\eta-1)/\eta} \right]^{\eta/(\eta-1)}. \tag{A.1}$$

Sectoral final demands satisfy:

$$D_j = \left(\frac{1}{\mathcal{N}_j} \int_0^{\mathcal{N}_j} d_{ij}^{(\rho_j-1)/\rho_j} \mathrm{d}i \right)^{\rho_j/(\rho_j-1)}, \tag{A.2}$$

where d_{ij} denotes the final demand for firm i in sector j and ρ_j is a sector-specific elasticity of substitution between varieties.

Denote p_{ij} as the price of variety i in sector j, P_j as the price index in sector j, and P as the overall price index. For a given level of aggregate expenditures, PD, we can express final expenditures on variety i from the usual utility maximization problem:

$$p_{ij} d_{ij} = \mathcal{N}_j^{\eta-\rho_j} \xi_j^{\eta} \left(\frac{p_{ij}}{P_j} \right)^{1-\rho_j} \left(\frac{P_j}{P} \right)^{1-\eta} PD, \tag{A.3}$$

where the ideal-Fischer price indices satisfy:

$$P_j = \left(\mathcal{N}_j^{-\rho_j} \int_0^{\mathcal{N}_j} p_{ij}^{1-\rho_j} \mathrm{d}i \right)^{1/(1-\rho_j)} \; ; \; P = \left[\sum_j \left(\xi_j \mathcal{N}_j \right)^{\eta} P_j^{1-\eta} \right]^{1/(1-\eta)}. \tag{A.4}$$

We denote with a Jonesian "hat" the log-deviation of a variable during COVID-19, relative to its non-COVID value, for example, $\hat{\xi}_j \equiv \log(\xi_j / \bar{\xi}_j)$. Since all shocks will be defined at the sector level, all firms within a sector will be adjusting their price in the same proportion, so that $\hat{p}_{ij} \equiv \hat{p}_j$. Similarly, demand for all varieties within a sector will be adjusting in similar proportions, $\hat{d}_{ij} \equiv \hat{d}_j$.

We log-linearize Eqs. (A.3) and (A.4) under the assumption that business failures under COVID-19 are uncorrelated with the distribution of firms' initial prices and obtain an expression for final expenditures in sector j. Formally, this assumption implies that $\int_0^{\mathcal{N}'_j} p_{ij}^{1-\rho_j} \mathrm{d}i/\mathcal{N}'_j = \int_0^{\mathcal{N}_j} p_{ij}^{1-\rho_j} \mathrm{d}i/\mathcal{N}_j$. In words, the average price per firm is unaffected by the disappearance of some varieties. We obtain:

$$\hat{p}_j + \hat{d}_j = \tilde{\hat{\xi}}_j - \hat{\mathcal{N}}_j + (1-\eta)\left(\hat{p}_j - \sum_k \omega_k \hat{p}_k\right) + \widehat{PD}. \tag{A.5}$$

In this expression, $\omega_k = P_k D_k / PD$ denotes the share of final expenditures on sector k and $\tilde{\hat{\xi}}_j$ is a normalized expenditure shifter defined as:

$$\tilde{\hat{\xi}}_j \equiv \eta \hat{\xi}_j + \hat{\mathcal{N}}_j - \sum_k \omega_k (\eta \hat{\xi}_k + \hat{\mathcal{N}}_k). \tag{A.6}$$

Aggregating to the sectoral level, we obtain:

$$\hat{P}_j + \hat{D}_j = \tilde{\hat{\xi}}_j + (1-\eta)\left(\hat{p}_j - \sum_k \omega_k \hat{p}_k\right) + \widehat{PD}. \tag{A.7}$$

We specialize the model by assuming a unit elasticity of demand across sectors, $\eta = 1$, to obtain:

$$\hat{p}_j + \hat{d}_j = \tilde{\hat{\xi}}_j - \hat{\mathcal{N}}_j + \widehat{PD}. \tag{A.8}$$

Eq. (A.8) expresses final demand expenditures as a function of the relative preference shocks, business failures, and changes in aggregate demand.

A.2 Firms and the Sectoral Supply Curve

We assume that each firm produces according to the following single-nest production function:

$$y_{ij} = z_{ij}\left(\alpha_j k_{ij}^{(\sigma-1)/\sigma} + \beta_j \left(A_j \ell_{ij}\right)^{(\sigma-1)/\sigma} + \gamma_j \sum_k \vartheta_{jk} \int_0^{\mathcal{N}_k} x_{ij,lk}^{\frac{\sigma-1}{\sigma}} \mathrm{d}l\right)^{\frac{\sigma}{\sigma-1}} \tag{A.9}$$

Faced with sectoral wage w_j and intermediate prices p_{lk}, firm i formulates the following input demands:

$$\ell_{ij} = \left(\frac{\beta_j p_{ij}}{w_j}\right)^{\sigma} \left(A_j z_{ij}\right)^{\sigma-1} y_{ij} \tag{A.10a}$$

$$x_{ij,lk} = \left(\frac{\gamma_j \vartheta_{jk} p_{ij}}{p_{lk}}\right)^{\sigma} z_{ij}^{\sigma-1} y_{ij}. \tag{A.10b}$$

A.2.1 Labor Market Equilibrium

Sectoral employment must satisfy:

$$L_j \leq x_j \bar{L}_j \ ; \ w_j = \bar{w}_j.$$

To figure out which sectors are demand- or supply-constrained, we solve for the flexible wage w_j^{flex} that clears the sectoral labor market. Equating sectoral labor supply $x_j L_j$ to labor demand $\int_0^{\mathcal{N}_j} \ell_{ij} \mathrm{d}i$ and substituting Eq. (A.10a), we obtain:

$$x_j L_j \ = \ \int_0^{\mathcal{N}_j} \ell_{ij} \mathrm{d}i = \int_0^{\mathcal{N}_j} \left(\frac{\beta_j p_{ij}}{w_j^{\text{flex}}} \right)^{\sigma} \left(A_j z_{ij} \right)^{\sigma - 1} y_{ij} \mathrm{d}i.$$

Under the assumption that business failures are independent from the initial distribution of labor demands, we can log-linearize this expression. This assumption allows us to treat each failing firm as being drawn randomly from the set of existing firms, regardless of its employment level. Formally, we assume $\frac{1}{\mathcal{N}_j} \int_0^{\mathcal{N}_j} \ell_{ij} \mathrm{d}i = \frac{1}{\bar{\mathcal{N}}_j} \int_0^{\bar{\mathcal{N}}_j} \ell_{ij} \mathrm{d}i$. In words, the pre-COVID average employment level of surviving firms is equal to the pre-COVID average firm-level employment among all initial firms. We obtain:

$$\sigma \hat{w}_j^{\text{flex}} = -\hat{x}_j + \sigma \hat{p}_j - (1 - \sigma) \hat{A}_j + \hat{y}_j + \hat{\mathcal{N}}_j, \tag{A.11}$$

Equilibrium change in sectoral employment satisfies:

$$\hat{L}_j = \min \left\langle \hat{x}_j, \hat{x}_j + \sigma \hat{w}_j^{\text{flex}} \right\rangle. \tag{A.12}$$

Sectors where $\hat{L}_j < \hat{x}_j$ (or equivalently $\hat{w}_j^{\text{flex}} < 0$) are demand-constrained, while sectors where $\hat{L}_j = \hat{x}_j$ (or equivalently $\hat{w}_j^{\text{flex}} \geq 0$) are supply-constrained.

A.2.2 Sectoral Supply Curve

We now substitute intermediate input demand Eq. (A.10b) and (for demand-constrained sectors) labor input demand Eq. (A.10a) back into the production function Eq. (A.9), and log-linearize to obtain:

$$(\Omega_j^{\ell} + \Omega_j^{x}) \hat{p}_j = \frac{1}{\sigma} (1 - \Omega_j^{\ell} - \Omega_j^{x}) \hat{y}_j + \Omega_j^{\ell} (\hat{w}_j^{s} - \hat{A}_j) + \sum_k \Omega_{jk}^{x} \hat{p}_k, \tag{A.13}$$

In Eq. (A.13), $\hat{w}_j^s$ is a *shadow wage*, equal to 0 for demand-constrained sectors and equal to

$\hat{w}_j^{\text{flex}}$ for supply-constrained sectors: $\hat{w}_j^s = \max\left\langle 0, \hat{w}_j^{\text{flex}}\right\rangle$. The intuition for the latter result is that, for firms in supply-constrained sectors, labor input is fixed at ℓ_{ij}, consistent with w_j^{flex}. Hence firms' production decisions are *as if* they are facing this shadow flexible wage (with profits based on the actual wage paid).

A.3 The Sectoral Demand Curve

Log-linearizing Eq. (6), replacing $\hat{d}_j$ from Eq. (A.8) and $\hat{x}_{lkij}$ from Eq. (A.10b), we obtain:[57]

$$\lambda_j \hat{y}_j = \omega_j(\tilde{\xi}_j - \hat{\mathcal{N}}_j + \widehat{PD}) - (\sigma\lambda_j + (1-\sigma)\omega_j)\hat{p}_j + \sum_k (\sigma \hat{p}_k + \hat{y}_k)\Omega^x_{kj}\lambda_k. \tag{A.14}$$

where $\lambda_j = \int_0^{\mathcal{N}_j} p_{ij} y_{ij} \mathrm{d}i / PD$ denotes the Domar weight for industry j, that is, the ratio of gross sectoral output to total value-added.

To summarize, Eqs. (A.11), (A.13) and (A.14) constitute a system of $3J$ equations in $3J$ unknown ($\hat{p}_j$, $\hat{y}_j$, $\hat{w}_j^s$ for each sector j), given the sectoral supply shocks $\hat{A}_j$, $\hat{x}_j^L$, sectoral demand shocks $\tilde{\xi}_j$, aggregate demand shocks $\widehat{PD}$, and the extensive margin $\hat{\mathcal{N}}_j$.

A.4 Business Failures

Operating cash flow is defined as:

$$CF_{ij} = p_{ij} y_{ij} - w_j \ell_{ij} - \sum_k \int_0^{\mathcal{N}_k} p_{ij,lk} x_{ij,lk} \mathrm{d}l - F_{ij} - T_{ij} = \pi_{ij} - F_{ij} - T_{ij}, \tag{A.15}$$

where π_{ij} are variable profits, that is, revenues minus labor and intermediate input costs. As long as fixed costs (e.g., rent and interest payments) and business taxes (often assessed on previous years) are not affected by COVID-19, the change in cash flow $CF_{ij} - \overline{CF}_{ij}$ due to COVID will equal the change in variable profits $\pi_{ij} - \bar{\pi}_{ij}$.

A business fails under COVID-19 as soon as cash and operating cash flow are insufficient to cover financial expenses:

$$\mathcal{Z}_{ij} + CF_{ij} < FE_{ij},$$

where $\mathcal{Z}_{ij}$ denotes the firm's initial cash balances and FE_{ij} its financial expenses during the year. Subtracting non-COVID cash flow, firms fail when:

$$\pi_{ij} - \bar{\pi}_{ij} < FE_{ij} - CF_{ij} - \mathcal{Z}_{ij}. \tag{A.16}$$

[57] For this derivation, we use the fact that the goods market equilibrium Eq. (6) links the Domar weights λ_j and the expenditure shares ω_j as follows: $\lambda_j = \omega_j + \sum_k \Omega^x_{kj}\lambda_k$.

The term on the right-hand side can be observed in our firm-level data; the term on the left can be constructed from the model. Under COVID-19, variable profits change differentially for demand- and supply-constrained firms. Intuitively, because supply-constrained firms are rationed and wages cannot increase, these firms earn higher variable profits.

Formally, substituting labor and intermediate input demands from Eq. (A.10) into the definition of variable profits and log-linearizing, we can write the change in variable profits for demand-constrained firms as:

$$\begin{aligned}\pi_{ij} &= \bar{\pi}_{ij} \\ &+ p_{ij}y_{ij}\left[(1-\Omega_j^\ell-\Omega_j^x)(\hat{p}_j+\hat{y}_j)+(1-\sigma)\left(\Omega_j^\ell(\hat{p}_j+\hat{A}_j)+\sum_k \Omega_{jk}^x(\hat{p}_j-\hat{p}_k)\right)\right].\end{aligned} \tag{A.17}$$

Supply-constrained firms are not on their labor demand curve. For these firms, $\ell_{ij} = x_j \bar{\ell}_{ij}$. Substituting intermediate input demand from Eq. (A.10b) and log-linearizing yields the following change in variable profits for supply-constrained firms:

$$\begin{aligned}\pi_{ij} &= \bar{\pi}_{ij} \\ &+ p_{ij}y_{ij}\left[(1-\Omega_j^x)(\hat{p}_j+\hat{y}_j)-\Omega_j^\ell\hat{x}_j+(1-\sigma)\sum_k \Omega_{jk}^x(\hat{p}_j-\hat{p}_k)\right].\end{aligned} \tag{A.18}$$

In both cases, everything else equal, an increase in the price of intermediate inputs $\hat{p}_k$ reduces variable profits when $\sigma < 1$. This is because the higher price of intermediate inputs increases the expenditure share on intermediates.

Given a pattern of changes in sectoral prices and outputs $\hat{p}_j$ and $\hat{y}_j$, as well as supply shocks $\hat{A}_j$ and $\hat{x}_j$, we can evaluate Eqs. (A.17) and (A.18) firm by firm to recover the extensive margin $\hat{\mathcal{N}}_j$. Together with Eqs. (A.13), (7b) and (7d), this provides us with a system of $4J$ equations in $4J$ unknowns.

A.5 Additional Details on Solving the Model with Business Failures

We first rewrite Eqs. (A.13) and (A.14) in matrix form. Define the $J \times J$ matrix Ω whose (j,k) element is Ω_{jk}^x, and the $J \times 1$ vectors Ω^ℓ, Ω^x, $\hat{p}$, $\hat{y}$, $\hat{A}$, $\tilde{\xi}$, $\hat{w}^s$, $\hat{\mathcal{N}}$, λ, and ω, with corresponding elements for each sector j. We can write the demand and supply blocs in matrix form as:

$$\left(\Omega^\ell+\Omega^x\right)\circ\hat{p} = \frac{1}{\sigma}(1-\Omega^\ell-\Omega^x)\circ\hat{y}+\Omega^\ell\circ(\hat{w}^s-\hat{A})+\Omega\hat{p} \tag{A.19a}$$

$$\left(I-\Omega^T\right)(\lambda\circ\hat{y}) = \omega\circ\left(\tilde{\xi}+\widehat{PD}-\hat{\mathcal{N}}\right)-[\sigma\lambda+(1-\sigma)\,\omega]\circ\hat{p}+\sigma\Omega^T(\lambda\circ\hat{p}) \tag{A.19b}$$

where the notation $x \circ y$ denotes the Hadamard product of vectors x and y (i.e., element by element multiplication) and Ω^T is the matrix transpose of Ω.

Eq. (A.19) constitutes a linear system of $2J$ equations with $2J$ unknown ($\hat{p}$ and $\hat{y}$), given the shocks $\tilde{\xi}$, $\hat{A}$, $\widehat{PD}$, wages $\hat{w}^s$, and business failures $\hat{\mathcal{N}}$.

Next, note that for generic vectors x and y, we can write $x \circ y = \text{Diag}_x y$ where Diag_x is a diagonal matrix with vector x inserted on the diagonal. It follows that we can solve the linear system as follows:

$$\hat{p} = \Psi^{-1}\left(\text{Diag}_{1-\Omega^\ell-\Omega^x}\text{Diag}_\lambda^{-1}\left(I-\Omega^T\right)^{-1}\text{Diag}_\omega\left(\tilde{\xi}+\widehat{PD}-\hat{\mathcal{N}}\right)+\sigma\text{Diag}_{\Omega^\ell}(\hat{w}^s-\hat{A})\right) \tag{A.20a}$$

$$\begin{aligned}\hat{y} = {} & \text{Diag}_\lambda^{-1}\left(I-\Omega^T\right)^{-1}\text{Diag}_\omega\left(\tilde{\xi}+\widehat{PD}-\hat{\mathcal{N}}\right) \\ & -\left(\sigma+(1-\sigma)\,\text{Diag}_\lambda^{-1}\left(I-\Omega^T\right)^{-1}\text{Diag}_\omega\right)\hat{p},\end{aligned} \tag{A.20b}$$

where

$$\Psi = \sigma\left(I-\Omega\right)+(1-\sigma)\,\text{Diag}_{1-\Omega^\ell-\Omega^m}\text{Diag}_\lambda^{-1}\left(I-\Omega^T\right)^{-1}\text{Diag}_\omega, \tag{A.21}$$

and Ψ^{-1} denotes the matrix inverse of Ψ.

In vector form, the shadow wage satisfies (from Eq. (A.11)):

$$\sigma\hat{w}^s = \max\left\langle 0, -\hat{x}+\sigma\hat{p}-(1-\sigma)\,\hat{A}+\hat{y}+\hat{\mathcal{N}}\right\rangle, \tag{A.22}$$

while the extensive margin $\hat{\mathcal{N}}$ is obtained from Eqs. (A.17) and (A.18) evaluated firm by firm given sectoral prices, quantities and shocks.

We solve this iteratively by using the weekly temporal structure of our model. Specifically, starting with $\hat{\mathcal{N}} = \hat{w}^s = 0$ in the first week, we solve Eq. (A.19) for $\hat{p}$ and $\hat{y}$ in the first week of the year. We then compute the extensive margin $\hat{\mathcal{N}}$ for that first week according to Eqs. (A.17) and (A.18). Next, we construct the shadow wage $\hat{w}^s$ that would have cleared markets in that first week, given $\hat{p}$, $\hat{y}$ and $\hat{\mathcal{N}}$ just calculated. We then assume that this shadow wage and the extensive margin $\hat{\mathcal{N}}$ apply in the *second* week of the year. This allows us to solve Eq. (A.19) for the second week, which deliver new estimates for $\hat{p}$ and $\hat{y}$, etc....

A.6 Policy Calibration

We use data from a variety of sources to calibrate the parameters $\{\theta_{c,tax}, \theta_{c,grant}, \theta_{c,loan}\}$ to both match the aggregate amounts of announced policy and adjust for less than full take-up of the various policies by firms. Specifically, we use OECD (2021) to check which countries used which policies. We then use data on policy costs from the European Systemic Risk Board (ESRB, 2021) and supplement this with a manual classification of specific policies based on descriptions from the IMF's Database of Fiscal Policy Responses (IMF, 2021a).[58] For some countries, the OECD (2021) indicates that they enacted a policy but we could not find any costs for these countries. In these cases, we impute the overall policy cost for that country based on whether that country is an advanced or emerging country and the average amount spent by these governments.

Table A.1 shows the announced policy costs for each of the three policies for each country in our sample.[59] These reported numbers reflect the announced size of policies. Amounts disbursed may be lower if governments imperfectly estimate the set of eligible firms, or if firms neglect to apply for support. We were unable to find country-level information on take-up by country. Instead, we use ESRB (2021)'s average take-up rates for the sample of countries they cover and assume that take-up was the same in all countries in our sample, equal to these average numbers.

To map these aggregate costs to estimate each $\theta_{c,p}$, we first calculate and estimate the aggregate cost of policy p, $\text{Cost}_{c,p}$, under the assumption that $\theta_{c,p} = 1$ (equivalent to one year of policy support at 100 percent of the disbursement formula), adjusting for the fact that Orbis data only covers a subset of all firms in a country. Then we estimate $\theta_{c,p}$ by scaling up or down to the actual policy cost. Mathematically:[60]

$$\theta_{c,p} = \frac{\text{Actual Cost}_{c,p}}{\text{Cost}_{c,p}}$$

The numerator is the actual cost (adjusted for take-up) and the denominator is the cost of providing one year of 100 percent policy support. Therefore, if we calculate for a country that a policy would cost 2 percent of GDP if implemented at 100 percent for a year and in the data it cost 1.5 percent of GDP, then $\theta_{c,p} = \frac{1.5}{2} = 0.75$.

The scaling factor applies to each firm. This means that we are agnostic about potential positive selection into policy support by firms, or negative selection from turning down applicants.

[58] Within the three categories of support described above, we restrict ourselves to policies targeting SMEs. Policies that did not fit into these three categories or did not include an SME component were not included in our estimates. Therefore the numbers we compile from the IMF (2021a) possibly understate the overall level of policy support provided. We know from the OECD data that occasionally a policy was implemented in a given country but we were unable to find any cost estimate from the ESRB or IMF data sources.

[59] An asterisk indicates that the policy cost number was imputed as described above.

[60] The denominator is calculated as follows:

$$\text{Cost}_{c,p} = \sum_s \left(\frac{VA_s^{Orbis}}{VA_s} \right)^{-1} \sum_{i \in i(s)} Cost_{i,p}^{Orbis}$$

Table A.1: Announced Policy Costs by Type and Country

		Costs (% of GDP)			
Country	Source	Tax Waiver	Pandemic Loans	Cash Grant	Total
Austria	ESRB	2.51	3.76	3.01	9.28
Belgium	ESRB	1.74*	10.57	0.52	12.82
Bulgaria	ESRB	0.58	0.72	1.23	2.53
Brazil	IMF	2.71	5.23	0.00	7.93
Switzerland	IMF	0.00	6.10	0.48	6.58
China	IMF	1.78	1.31	1.54*	4.62
Czech Republic	ESRB	1.24	14.87	1.70	17.81
Germany	ESRB	1.21	11.97	2.28	15.46
Denmark	ESRB	7.13	2.03	2.43	11.59
Estonia	ESRB	0.29	5.88	1.37	7.54
Spain	ESRB	0.92	11.78	1.51	14.21
Finland	ESRB	1.87	1.75	1.71	5.33
France	ESRB	2.14	12.37	1.64	16.15
UK	ESRB	0.84	2.80	2.78	6.42
Greece	ESRB	0.66	1.71	3.01	5.38
Hungary	ESRB	0.90	5.76	0.89	7.56
Ireland	ESRB	1.29	0.99	2.92	5.20
India	IMF	0.09	4.82	0.74	5.65
Italy	ESRB	1.29	21.59	2.19	25.08
Japan	IMF	5.79	25.40	2.34	33.52
Korea	IMF	2.29	10.35	2.99	15.63
Latvia	ESRB	0.77	4.48	0.56	5.82
Netherlands	ESRB	0.41	0.59	1.52	2.52
Poland	ESRB	0.03	16.08	1.54*	17.64
Portugal	ESRB	0.30	6.35	0.97	7.63
Romania	ESRB	0.06	0.10	0.00	0.16
Russia	IMF	1.34	0.94	1.32	3.60
Singapore	IMF	0.58*	4.69	15.86	21.13
Slovenia	ESRB	2.19	4.58	1.77*	8.55
Slovakia	ESRB	0.49	4.34	1.77*	6.61
Turkey	IMF	0.54	8.95	0.97	10.46

Note: * indicates if the policy was imputed from the average of its group (either advanced or emerging).

We scale each one-digit NACE sector s by the inverse of the share of value added captured by Orbis

B Details on Model for Section 3

B.1 Intratemporal Bloc

B.1.1 Final Demand

Final demand in country n is a CES aggregator over sectoral final demands D_{nj} according to:

$$D_n = \left[\sum_j \xi_{nj} D_{nj}^{(\eta-1)/\eta}\right]^{\eta/(\eta-1)} \tag{B.1}$$

Sectoral final demands satisfy:

$$D_{nj} = \left(\sum_m \zeta_{n,mj} d_{n,mj}^{(\rho-1)/\rho}\right)^{\rho/(\rho-1)}$$

Denote p_{nj} as the price of good j in country n, and $p_{n,mj} = \tau_{n,mj} p_{mj}$ as the price of the same good in country n sourced from country m. Denote P_{nj} as the ideal-Fischer price index for sector j in country n, and P_n as the overall price index in country n. For a given level of aggregate nominal expenditures $P_n D_n$, we can express country n's expenditure share on goods j from country m, $\omega_{n,mj}$, as:

$$\omega_{n,mj} \equiv \frac{p_{n,mj} d_{n,mj}}{P_n D_n} = \zeta_{n,mj}^{\rho} \xi_{nj}^{\eta} \left(\frac{p_{n,mj}}{P_{nj}}\right)^{1-\rho} \left(\frac{P_{nj}}{P_n}\right)^{1-\eta}, \tag{B.2}$$

where the ideal-Fischer price indices satisfy:

$$P_{nj} = \left(\sum_m \zeta_{n,mj}^{\rho} p_{n,mj}^{1-\rho}\right)^{1/(1-\rho)} \quad ; \; P_n = \left(\sum_j \xi_{nj}^{\eta} P_{nj}^{1-\eta}\right)^{1/(1-\eta)}. \tag{B.3}$$

We also define country n's expenditure share on good j, $\omega_{nj} = \sum_m \omega_{n,mj}$ and the share of country n expenditures on good j sourced from country m, $\varpi_{n,mj} \equiv p_{n,mj} d_{n,mj} / P_{nj} D_{nj} = \omega_{n,mj}/\omega_{nj}$. Note that $\sum_j \omega_{nj} = 1$ and $\sum_m \varpi_{n,mj} = 1$.

Under the simplifying assumption that $\eta = \rho = 1$, expenditure shares satisfy

$$\omega_{n,mj} = \zeta_{n,mj} \xi_{nj},$$

$\left(\left(\frac{VA_s^{Orbis}}{VA_s}\right)^{-1}\right)$ to ensure that our calculated policy costs are representative of the whole economy.

and vary with the sectoral demand shocks ξ_{nj}.

B.1.2 Firms and the Sectoral Supply Curve

Under the assumption of unit elasticity, the sectoral input demand curves Eq. (11) simplify to

$$w_{nj}L_{nj} = \beta_{nj}p_{nj}y_{nj} \ ; \ P^x_{nj}x_{nj} = \gamma_{nj}p_{nj}y_{nj}, \tag{B.4a}$$

$$\pi^x_{nj,mk} \equiv \frac{p_{n,mk}x_{nj,mk}}{P^x_{nj}x_{nj}} = \vartheta_{nj,mk} \tag{B.4b}$$

Labor market Equilibrium. Wages are rigid downwards in our model. If $\bar{w}_{nj}$ denotes the pre-COVID wage, sectoral employment with rigid wages must satisfy:

$$L_{nj} \leq x_{nj}\bar{L}_{nj} \ ; \ w_{nj} = \bar{w}_{nj}.$$

We can figure out which sectors are demand- or supply-constrained by solving for the flexible wage w^{flex}_{nj} that would clear the sectoral labor market. Equating labor supply and labor demand from Eq. (B.4a), we obtain:

$$w^{\text{flex}}_{nj} = \frac{\beta_{nj}p_{nj}y_{nj}}{x_{nj}\bar{L}_{nj}} \tag{B.5}$$

and sectors are demand constrained when $\bar{w}_{nj} > w^{\text{flex}}_{nj}$, and supply constrained otherwise.

The Sectoral Supply Curve. Substituting variable input demands in the production function and regrouping terms yields:

$$(p_{nj}y_{nj})^{\alpha_{nj}} = \mathrm{k}^{\alpha_{nj}}_{nj}\left(A_{nj}\frac{\beta_{nj}}{w^s_{nj}}\right)^{\beta_{ni}}\left(\frac{\gamma_{nj}}{P^x_{nj}}\right)^{\gamma_{nj}} p_{nj} \tag{B.6}$$

where w^s_{nj} is a shadow wage defined as $w^s_{nj} = \max < \bar{w}_{nj}, w^{\text{flex}}_{nj} >$. This allows to compactly write the supply curve faced by demand and supply constrained sectors in a single equation.

Eq. (B.6) represents the *sectoral supply curve* for country n sector j. The input-output structure of the economy is apparent in Eq. (B.6): prices in country n sector j depend on prices in all other countries m and sectors k as controlled by P^x_{nj}.

Using "hats" to denote the ratio of variables between a given scenario and a baseline (i.e., $\hat{p}_{nj} = p_{nj}/\bar{p}_{nj}$), we can express the supply curve as:

$$(\hat{p}_{nj}\hat{y}_{nj})^{\alpha_{nj}} = \left(\frac{\hat{A}_{nj}}{\hat{w}^{s}_{nj}}\right)^{\beta_{ni}} \left(\hat{P}^{x}_{nj}\right)^{-\gamma_{nj}} \hat{p}_{nj} \tag{B.7}$$

where

$$\hat{P}^{x}_{nj} = \prod_{mk} \hat{p}_{mk}^{\vartheta_{nj,mk}}$$

B.1.3 The Sectoral Demand Curve

Substituting intermediate and final demand, we can rewrite Eq. (15) as:

$$p_{nj}y_{nj} \quad = \quad \sum_{m} \omega_{m,nj} P_m D_m + \sum_{mk} \Omega^{x}_{mk,nj} p_{mk} y_{mk} \tag{B.8}$$

where $\Omega^{x}_{nj,mk} = \gamma_{nj}\vartheta_{nj,mk}$. Because expenditures shares are constant with unit elasticities, this system can be solved for sectoral nominal expenditures given aggregate expenditures. To proceed, let's write the system in vector form as:

$$py = \Omega^{dT} PD + \Omega^{xT} py, \tag{B.9}$$

where py is the NJ by 1 vector with element $p_{nj}y_{nj}$, PD is the N by 1 vector with element $P_n D_n$, Ω^x is an NJ by NJ matrix with element nj, mk equal to $\Omega^{x}_{nj,mk}$, and Ω^d is an N by NJ matrix with element n, mj given by $\omega_{n,mj} = \zeta_{n,mj}\xi_{nj}$. In the above equation, T denotes the transpose operator. Solving for py, we obtain:

$$py = \left(I - \Omega^{xT}\right)^{-1} \Omega^{dT} PD. \tag{B.10}$$

Eq. (B.10) represents the *sectoral demand curves*. The global I-O structure of the economy is apparent from that equation: nominal output in country n sector j depends on the final demands in all other countries, as controlled by Ω^d as well as the intermediate demands in all other countries and sectors, as controlled by Ω^x.

The next step is to calculate country-level nominal value-added V_n. Recall that $V_n = \sum_j (1 - \gamma_{nj}) p_{nj} y_{nj}$. It follows that we can solve for the vector of value-added V, as:

$$V = S_N Diag_{1-\gamma} py = S_N Diag_{1-\gamma} \left(I - \Omega^{xT}\right)^{-1} \Omega^{dT} PD \equiv M^V PD, \tag{B.11}$$

where S_N is an N by NJ matrix that sums over sectors within each country and M^V is an N by

N matrix that maps a given vector of nominal final expenditures PD into the corresponding vector of nominal value-added V given the demand system.

Note that, with unit elasticities, the supply block does not matter for nominal expenditures. Given a global level of nominal output (either PD or V), all sectoral nominal outputs py are determined by Eq. (B.10). The supply block Eq. (B.6) matters for the breakdown between changes in prices $\hat{p}$ and changes in real output $\hat{y}$.

We can summarize the demand block with the following equations:

$$py = \mathcal{H}(\xi)V \quad ; \quad PD = \mathcal{M}(\xi)V, \tag{B.12}$$

where $\mathcal{M}(\xi) = (M^V)^{-1}$ and $\mathcal{H}(\xi) = (I - \Omega^{xT})^{-1}\Omega^{dT}\mathcal{M}(\xi)$.

Finally, observe that the aggregate trade balance $TB_n = V_n - P_n D_n$ is obtained immediately as (in vector form):

$$TB = V - PD = (M^V - I)PD = (I - \mathcal{M}(\xi))V. \tag{B.13}$$

For a given realization of aggregate value added (in levels), the intratemporal block Eqs. (B.6) and (B.10) allows us to solve for aggregate final expenditures, trade balances, prices, and output in all countries. Under financial autarky, the model is closed by imposing the condition that aggregate final expenditures equal value-added: $PD = V$. This completely characterizes the model. Our set-up allows for intertemporal borrowing and lending and global imbalances. To characterize aggregate nominal value added in each period, we turn to the intertemporal block of the model.

B.2 Intertemporal Equilibrium

B.2.1 Aggregate Demand Determination

Hand-to-Mouth Households. HtM households consumer their disposable income in each period. This yields:

$$\begin{aligned}
P_n C_n^H &= \mu_n \sum_j \left[\varpi_{nj}\left(L_{nj} + \varrho_n\left(\bar{L}_{ni} - L_{nj}\right)\right) + \varkappa_n \bar{L}_{nj} + \kappa_n \bar{L}_{nj}\right] \\
&= \mu_n \left(V_n + T_n\right) \\
P_{n*} C_{n*}^H &= \mu_n \sum_j \left[w_{nj*}\bar{L}_{nj} + \varkappa_{n*}\bar{L}_{nj} - t_{n*}\bar{L}_{nj}\right] \\
&= \mu_n \left(V_{n*} - T_n\left(1+i\right)\right),
\end{aligned}$$

where we substituted the government budget constraint and used the definition of value-added $V_n = \sum_j \bar{w}_{nj} L_{nj} + \varkappa_n \bar{L}_{nj}$ and $V_{n*} = \sum_j (w_{nj*} + \varkappa_{nj*}) \bar{L}_{nj}$. To understand this expression, note that the first term inside the brackets represents the labor income of HtM households in sector j, the second term represents the unconditional transfers, and the last term represents capital income. The sum is the total income of HtM households in sector j. These households have a marginal propensity to consume (MPC) equal to 1, so this is also their total consumption. There are $\mu_n \bar{L}_{nj}$ HtM households in sector j. Summing over sectors yields the above expression.

Ricardian Households. The intertemporal budget constraint of household h is

$$P_n c_{nh} + \frac{P_{n*} c_{nh*}}{1+i} = \bar{w}_{nh} \left(1 - 1_h \left(1 - \varrho_n\right)\right) + \kappa_n + \varkappa_n + \frac{w_{nh*} - t_{n*} + \varkappa_{n*}}{1+i}, \tag{B.14}$$

where 1_h is an indicator equal to 1 if household h is unemployed. The probability of being unemployed is equal to the sectoral unemployment rate: $1 - L_{nj}/\bar{L}_{nj}$. In that expression, $\varkappa_n$ and $\varkappa_{n*}$ denote the capital income received by household h in country n in each period. We assume that all households – whether constrained or unconstrained – hold the same portfolio and therefore receive the same capital income $\varkappa_n$.

Ricardian households in country n have a common discount factor δ_n. These households are on their Euler equation that takes the form:

$$c_{nh} = c_{nh*} \left[\frac{\delta_n}{1-\delta_n} \left(1+i\right) \frac{P_n}{P_{n*}} \right]^{-\phi}.$$

Substituting into the intertemporal budget constraint Eq. (B.14) and aggregating over Ricardian households yields the following expression for total Ricardian consumption expenditures $P_n C_n^R$ when $\phi = 1$, after substituting the government budget constraint:

$$\begin{aligned} P_n C_n^R &= \left(1-\mu_n\right)\left(1-\delta_n\right) \left[V_n + \frac{V_{n*}}{1+i} \right] \\ P_{n*} C_{n*}^R &= \left(1-\mu_n\right) \delta_n \left(1+i\right) \left[V_n + \frac{V_{n*}}{1+i} \right] \end{aligned}$$

To understand this expression, note that the term in brackets times $(1-\mu_n)$ is the permanent income of all R households. It does not depend on transfers because these households are Ricardian. Permanent income times a MPC of $(1-\delta_n)$ yields the consumption of R households.

Adding up HtM and R households demands, we obtain an expression for aggregate nominal expenditures today and in the future:

$$P_n D_n = \mu_n (V_n + T_n) + (1-\mu_n)(1-\delta_n)\left[V_n + \frac{V_{n*}}{1+i}\right] \quad \text{(B.15a)}$$

$$P_{n*} D_{n*} = \mu_n (V_{n*} - T_n(1+i)) + (1-\mu_n)\delta_n (1+i)\left[V_n + \frac{V_{n*}}{1+i}\right] \quad \text{(B.15b)}$$

Together with the supply block equations Eq. (B.12), the demand block Eq. (B.15) provides us with a system of $4N$ equations. Note that one of these equations is redundant according to Walras' law, so we have a total of $4N-1$ equations in $4N+1$ unknowns ($P_n D_n$, $P_{n*} D_{n*}$, V_n, V_{n*}, and the global interest rate i), given fiscal policy T_n, the share of hand-to-mouth households μ_n, and the precautionary shock δ_n.

We need to impose two normalizations to fully characterize the equilibrium. These normalizations have the interpretation of a choice of numeraire in each period. They are discussed in the next subsection.

B.3 Details on the Data for Section 3

B.3.1 Removing Inventories from ICIO

OECD (2015) provides data on purchases and sales by country and sector (including final expenditure). Before converting this data into the model objects, we first need to account for changes in inventories – the variable the ICIO uses to represent discrepancies between sales and purchases. Not correcting for these gaps can be problematic when we apply this data to a model where market clearing is imposed. To address this, we follow Bonadio et al. (2020) and Huo, Levchenko and Pandalai-Nayar (2019) who implement a similar procedure that Dekle, Eaton and Kortum (2008) apply to trade deficits. This procedure treats inventories as wedges in our market-clearing condition that we then close using exact hat algebra. Unlike these other papers, in our procedure, we do *not* wish to close trade balances. Our procedure closes these wedges while allowing trade balances to adjust in a way that is consistent with the model.

We adjust our market clearing condition Eq. (15) to include wedges ψ_{nj} that account for market clearing not holding exactly in the data.

$$py_{nj,-1} = \sum_m pd_{m,nj,-1} + \sum_{mk} px_{mk,nj,-1} + \psi_{nj,-1},$$

where -1 refers to the pre-COVID period. We seek to set $\psi_n j = 0$ in a model-consistent manner.

We then apply hat algebra to this equation and obtain the following:

$$py_{nj,-1}\widehat{py}_{nj} = \sum_m \omega_{m,nj} PD_m \widehat{PD}_m + \sum_{mk} \gamma_{mk} py_{mk} y_{mk} \pi^x_{mk,nj} \widehat{py}_{mk} + \psi_{nj,-1}\hat{\psi}_{nj} \tag{B.16}$$

From Eq. (B.11), we have a relationship between $\widehat{PD}$ and $\hat{V}$ that implicitly pins down the trade balance.

$$PD_{n-1}\widehat{PD}_n = M^V V_{n,-1}\hat{V}_n$$

To solve the system, we need to take a stand on how either $\hat{V}$ or $P\hat{D}$ adjusts. We set $\widehat{PD} = 1$ and then solve Eq. (B.16) for $\widehat{py}$ when $\hat{\psi}_{nj} = 0$.

B.3.2 Constructing IO Quantities from ICIO

Once we have ICIO data with the inventories wedge closed, we proceed to construct the IO matrices Ω^x and Ω^d. Ω^x is an NJ Ã NJ matrix with entry $\gamma_{nj}\pi_{nj,mk}$, which is the share of sales that firms in country n and sector j spend on goods from country m and sector k. Ω^d is an NJ Ã N matrix with entry $\omega_{m,nj}$, which is the share of final spending country m spends on goods produced in sector j by country n. With these two matrices, we can construct M^V according to Equation B.11.

There are 11 sectors where firms have $\gamma_{nj} > 1$. Given that in our model this implies that supply curves are downward sloping, we set γ_{nj} in these sectors equal to the median value of γ_{nj} in the same sector in other countries.

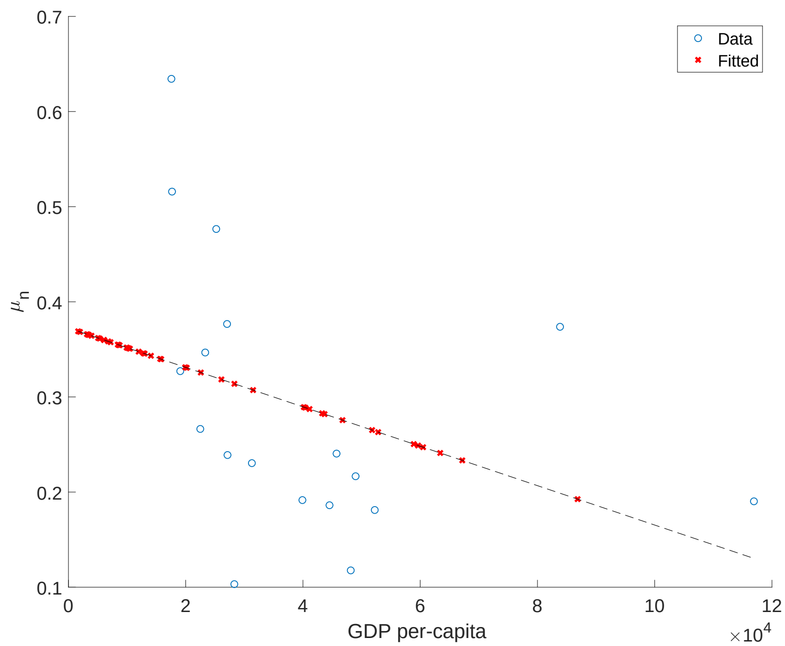
Our measure of the labor share of sales β_{nj} comes from the OECD's Trade in Employment (TiM) data. We start with data on labor compensation's share of value-added from TiM and use data on value-added and gross output from the ICIO I-O tables to construct the labor share of gross output (β_{nj}) for each country-sector. We document 12 instances where $\beta_{nj} + \gamma_{nj} > 1$ – again a case that would imply a downward sloping supply curve in our model. We make the same adjustment to β_{nj} as for the $\gamma_{nj} > 1$ case.[61]

B.3.3 Interpolating the Share of Constrained Agents μ_n

As described in Section 3.2, we are missing data on μ_n for several countries. Figure B.1 shows the data and imputed values for mu_n.

[61] In one case, taking the median of β_{nj} over other sectors still gives $\gamma_{nj} + \beta_{nj} > 1$. In this case we use the 20th percentile of β_{nj} across other countries.

Figure B.1: Actual and Fitted Values for μ_n



As can be seen, we are missing data mostly for low-income countries and for these countries we impute a μ_n mostly between 0.3 and 0.4 for these countries.

B.3.4 Shocks

For the sectoral shocks (ξ, x, A), we follow the same procedure described in Section 2.2.3. The sectoral dimension of these shocks remains the same, and for COVID intensity by country we again use the OxCGRT stringency Index for the supply shocks and the Google Mobility data for ξ. We lack Google Mobility data for Brunei, China, Cyprus, Iceland, and Tunisia, and instead use the OxCGRT index for these countries for all shocks.

These stringency indices are averaged for each country over 2020 and then multiplied by the O*NET data for each sector. All sectoral shocks are then aggregated to the 36 ICIO sectors.

B.4 Details on the Solution of the Intertemporal Block

We now detail how we solve the intertemporal model. We start by constructing the matrices Ω^d and Ω^x from the 2015 global I-O network. With these matrices, we can construct the mapping $\mathcal{M}(\xi^{NC})$ from value-added V to final expenditures PD in a non-COVID year where the âNCâ superscript refers to non-COVID. Next we construct estimates of the fraction of HtM households μ_n in all the countries we consider, as explained in section B.3.3.

Step 1: Solving the Non-COVID Scenario. We consider first a non-COVID scenario. In that scenario, we assume that fiscal stimulus $T = 0$ for all countries. Further, we assume that nominal value-added under non-COVID would have been equal to the 2019 (i.e., pre-COVID) WEO projection for 2020, denoted by V^{NC}. Observe first that, given V^{NC}, the demand block can be solved for aggregate expenditures PD^{NC} and trade balances TB^{NC}, independently of the intertemporal block, using $\mathcal{M}(\xi^{NC})$.

Taking V^{NC} as data, we solve the intertemporal block Eq. (B.15) for the unobserved discount rates δ_n^{NC}. To do so, we need two normalizations. One is achieved by inputting the 2019 dollar interest rate of 1.58 percent (i.e., assuming that interest rates would have remained unchanged at their 2019 level in a non-COVID scenario). The other is obtained by inputting the future value added V_{r*}^{NC} for a reference country r. We do this in two steps. First, we take the 2019's WEO forecast of nominal GDP for that country in 2024. Then we scale that forecast by a scaling factor to construct V_{r*}^{NC}. That scaling factor is chosen such that the average MPC for Ricardian households across all countries (i.e., the value added-weighted average of the δ_n^{NC}) is equal to 0.95.[62,63] This delivers an average MPC of 5 percent for Ricardian households in non-COVID. We obtain a scaling factor of 15.86. The interpretation of that scaling factor is that the second period in the model represents the discounted value of future periods. It is equivalent to discounting these future periods at a rate of (15.86 - 1)/15.86 = 0.937. We discuss below our choice of the reference country.

With these assumptions in place, we can solve for the set of discount factors under non-COVID, δ^{NC}.

Step 2: Solving the COVID Scenario. The next step considers a baseline COVID scenario with fiscal policy. First, we construct the matrix $\mathcal{M}(\xi)$ that maps value-added into final expenditures under COVID. We then proceed as in step 1. First, we take dollar nominal value-added in 2020, V from the data.[64] Given these nominal value added, the demand and supply blocks can be solved separately from the intertemporal block, with the demand block providing us with estimates of final expenditures PD and trade balances TB using $\mathcal{M}(\xi)$. We then make two normalizations in the same way as in step 1. First we input a global nominal dollar interest rate of 0 percent. Second, we adjust the 2020 WEO forecast of output in 2024 for the reference country r by the same scaling factor as in step 1 to construct V_{r*}. With these two normaliza-

[62] The empirical literature on MPCs obtains a wide range of results. For instance, Misra and Surico (2014) find that a large share of households have an MPC out of tax rebates that is indistinguishable from zero. On the other hand, Lewis, Melcangi and Pilossoph (2021) estimate a lower bound on the MPC out of tax rebates of 16 percent.

[63] Our algorithm delivers an average MPC of 5.29 percent, slightly above 5 percent.

[64] For some countries, 2020 nominal GDP data is not yet available. For these countries we replace 2020 GDP with the April 2021 WEO forecasts for those countries. In one case – Vietnam – the change in nominal GDP forecast from the October 2019 WEO to April 2021 was over 15 percent. We therefore impute the COVID-non-COVID change using the (size-weighted) average of Cambodia and Thailand's COVID - non-COVID change.

tions, and given the observed fiscal transfer T, we can solve for the new precautionary shocks δ_n needed for the intertemporal equilibrium to be satisfied.

Step 3: Fiscal Policy Counterfactuals. The third step consists of constructing counterfactual COVID outcomes under alternative fiscal policies. To do so, we consider a set of counterfactual fiscal policies T^c. We hold the precautionary shocks at their estimated COVID-19 values, δ_n, implicitly assuming that fiscal policy has no effect on the precautionary savings of households. We then solve the intertemporal block Eq. (B.15) for the counterfactual value-added V^c and V_*^c, as well as the counterfactual global interest rate i^c. To do so, we again need two normalizations. These normalizations are obtained by assuming that nominal GDP in the reference country remains unaffected by the counterfactual experiment, at V_r and V_{r*} respectively.

Not surprisingly, this normalization has a monetary policy interpretation. It is equivalent to assuming that the reference country r targets nominal GDP across scenarios (not necessarily across periods). It implies that our counterfactual results for country $n \neq r$, V_n^c, are relative to that of the reference country r. For that reason, we want to pick a country that is less likely to be affected across counterfactuals, and whose data is of high quality. We pick New Zealand as our reference country.[65]

Step 4: AE Recovery Counterfactual. Finally, we present estimates for an "AE Recovery" counterfactual. For this scenario, we want to consider an environment where AEs have made sufficient progress in their vaccination drive to recover from COVID-19, but EMs have not. That is, the COVID shocks A, x, and ξ for EMs, but set them back to their non-COVID levels in AEs. In addition, we assume that the precautionary shock in AEs also returns to non-COVID levels ($\delta_n = \delta_n^{NC}$), but not for EMs. Finally, we assume that EMs have exhausted their fiscal space, so we set $T = 0$ for these countries. We consider two cases for AE fiscal policy: where they also set T = 0 and where AEs keep their fiscal stimulus – despite the fact that their economy is not exposed to COVID any more. This last assumption captures the notion that some AEs may keep fiscal stimulus going on for longer than necessary. As in the other fiscal policy counterfactuals, we assume that V_r and V_{r*} remain unchanged.

Zero Lower Bound In solving for the various counterfactuals, we also consider a scenario where a zero nominal lower bound (ZLB) may constrain output. Specifically, we consider what happens if the global nominal interest rate cannot fall below zero in the counterfactuals. To solve that case, we set $i^c = 0$ and solve for the level of output in the reference country V_r^c, such that the intertemporal equilibrium Eq. (B.15) holds. Intuitively, if the nominal interest

[65]Naturally any country we pick will be affected by its own fiscal policy, so in all counterfactuals we leave fiscal policy unchanged in the reference country.

rate cannot fall, the wealth of R housheholds does not rise sufficiently to clear markets. This requires a decline in output, which, via a standard Keynesian-cross argument, lowers aggregate demand but at a lower rate.[66] This yields similar results to the no-ZLB case shown.

[66]Note that our calibration for the baseline COVID-with-fiscal-policy scenario in step 2 is robust to the ZLB assumption since we input observed value-added V and also an interest rate i where the observed V already reflects any falls caused by the ZLB binding.