COVID-19 AND EMERGING MARKETS:
AN EPIDEMIOLOGICAL MODEL WITH INTERNATIONAL PRODUCTION NETWORKS AND CAPITAL FLOWS

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ABSTRACT

We quantify the macroeconomic effects of COVID-19 for emerging markets using a SIR-multisector-small open economy model and calibrating it to Turkey. Domestic infection rates feed into both sectoral supply and sectoral demand shocks. Sectoral demand shocks also incorporate lower external demand due to foreign infection rates. Infection rates change endogenously with different lockdown policies. To calibrate the model, we use indicators of physical proximity and tele-workability of jobs to measure supply shocks. We use real-time credit card purchases to pin down demand shocks. Our results show that the optimal policy, which yields the lowest economic cost and saves the maximum number of lives, can be achieved under a full lockdown of 39 days. Partial and/or no lockdowns have higher economic costs as it takes longer to control the disease and hence to normalize the demand. Economic costs are much larger for an open economy because of the amplification role of international input-output linkages. Lower capital flows exacerbate this amplification as capital flows are the key form of financing for the production network. We document that sectors with stronger international input-output linkages and higher external debt suffer worse COVID losses and as a result have larger fiscal needs.

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"Best safety lies in fear."

– William Shakespeare

1   Introduction

The COVID-19 shock may soon lead to the biggest emerging market (EM) crisis of modern times. EMs observe a collapse in domestic and external demand, record capital outflows, higher external borrowing costs, a commodity bust, and depreciating currencies. At the same time, EM governments increase domestic borrowing via unconventional policies to assemble fiscal resources to fight the pandemic. This puts further pressure on external finance premium, reducing capital inflows and making it harder to rollover the external debt. In this paper, we focus on this complex embrace between domestic fiscal needs and external financing needs. In order to estimate the amount of fiscal resources needed to cover the economic costs, we develop an epidemiological Susceptible-Infected-Recovered (SIR)- multi-sector-macro model for a small open economy that is linked to an international production network.[1] Our work differs starkly from the rapidly growing COVID-19 literature that focuses on closed economies, mostly advanced countries.[2]

Our main result is that, small open economies/emerging markets have much bigger fiscal needs to offset the costs of COVID-19 crisis. Larger fiscal needs arise from the fact that, these countries face more sizable shocks due to their reliance on external demand, trade and capital flows. We document a direct relationship between the fiscal needs and trade and capital flows at the sectoral level. Furthermore, we show that the fiscal needs are lower under full lockdown compared to a partial lockdown. This is because demand normalizes sooner under a full lockdown as the infection rates go down faster.

We develop an epidemiological-econ model to calculate the economic costs of the pandemic so that we can estimate the fiscal needs. We take into account the effects of the COVID-19 shock through infection rates on domestic demand as well as foreign demand. Our approach has the advantage of being simple and easily mapped to real time data. We calibrate our model to Turkey by using

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[1]See Cakmakli et al. (2020) for the earlier working paper version of our model, April (2020).

[2]See Arellano et al. (2020) who also focuses on emerging markets by analysing sovereign debt and default risk under COVID shock with a SIR and sovereign debt model.

Turkey's international linkages to 65 other countries via capital flows and through 36 sectors within the international production network.

The key properties of our model are as follows. The ability to work from home determines the size of the supply shock in non-essential sectors (as also done in the closed economy literature). For the essential sectors, the nature of the physical proximity of the job dictates the supply shock. Infection rates are higher for people with those jobs that necessitate closer proximity. Hence, sectors with a higher fraction of such jobs are hit harder by the supply shock. On the demand side, our model contains a domestic component and a foreign component for sectoral demand shocks. Both types of demand decline as the number of infections increase and the lowest point is calibrated using real time credit card purchases. We have a short run model where the output is demand determined with fixed prices. We use international input-output (I-O) linkages to transform changes in final foreign demand into changes in demand for domestic intermediate sectors. We show that, almost 30 percent of the economic costs we estimate stem from lower external demand.

Once we estimate the economic cost for each sector from the model, we take these as the minimum level of fiscal need for a given sector and document the link between domestic fiscal needs and external finance. We empirically associate each sector's loss to its I-O linkages with the other domestic and international sectors. We also connect the sectoral losses to country-sector capital flows. The I-O link to other sectors is measured as a weighted average of the links to 65 countries that Turkey trades with. External finance needs are captured by using data on country-pair capital flows.[3] Sectors with stronger external links have larger fiscal needs. This is because, as we document, sectors with stronger I-O links suffer from larger COVID-19 related losses and sectors who finance these stronger production links through capital flows suffer even more.

Contrary to the popular belief that no lockdown policies would minimize economic costs, we show that such policies are actually costlier than an effective full lockdown given the importance of the demand shocks. Our findings are consistent with recent findings of Goolsbee and Syverson (2020) who shows that, using real time data, legal shutdown orders account for only a modest share of the decline of economic activity. Our model based estimate for the total cost of containing the

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[3]We use country-pair specific capital flows to gauge the external finance needs of that sector by connecting sector to the country via I-O links. See also Kalemli-Özcan et al. (2014).

pandemic immediately, with a Chinese style full lockdown is about 5.8 percent of the GDP (at an annualized rate). This implies that output declines by 17.5 percent during the quarter in which the lockdown is imposed, compared to the previous quarter. After the lockdown ends, if the economy returns to normal during the rest of the year, as demand normalizes, then the shock is smoothed out, leading to a decline of 5.8 percent of annual GDP. Under no lockdown, this cost increases from 5.8 to 11 percent of GDP annually. The reasoning is that, under no lockdown (or partial lockdown), even though businesses remain open, there are still interruptions in supply, and demand declines as people get infected. This is because as infections increase, people cut spending due to fear factor and demand declines for sectors that possibility of infection is higher (travel, restaurants) and this decline feeds into other sectors via I-O links. Full lockdown, on the other hand, is optimal since it is able to contain the pandemic more quickly, within approximately one month. Hence it yields the minimum economic cost which saves the maximum number of lives.

Several recent closed economy papers employing epidemiological models similar to us, including Acemoglu et al. (2020), Alvarez et al. (2020), Farboodi et al. (2020), and Eichenbaum et al. (2020) reach comparable conclusions where imposing full lockdowns or stricter measures at the *early* stages of the pandemic lower economic costs due to normalizing aggregate demand. We argue that, for an open economy, the effects are even bigger as lower external demand amplifies the domestic demand shock via sectoral I-O linkages. Most of the literature on global supply chains have similar amplification via I-O linkages but they focus on the role of sectoral supply shocks, not demand (See Barrot et al. (2020), Bonadio et al. (2020), and Baqaee et al. (2020)).[4] We show that once the number of infections reach a certain threshold, demand stalls and remains rather sluggish so long as the infection numbers do not exhibit a substantial decline. In fact, even if the domestic infection numbers are reduced, economic recovery will not be complete until the pandemic is contained abroad and foreign demand improves consequently. Thus, the course of the pandemic abroad affects domestic sectors differentially via international I-O linkages. In this framework, even if the supply channels remains unrestricted, demand drags the equilibrium output down and elevates the size of economic costs so

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[4]In a model with no infection dynamics (SIR), Baqaee and Farhi (2020a) exploits nonlinear production networks in a general equilibrium framework and show that non-linearities amplify the impact of COVID-19 between 20 to 100 percent. See also Baqaee and Farhi (2020b). The work by Guerrieri et al. (2020) do not include an infection dynamics model either but underlines the importance of a multi-sector economy, where supply shocks can turn into larger aggregate demand shocks as in our model.

long as the health issues are not resolved.[5]

The heterogeneity in infection rates by the job type and age are critical in our framework. In no lockdown scenario, most of the population is fully exposed to the outbreak. Nevertheless, the working population is under higher risk compared to the non-working population. In partial lockdown scenario, teleworkable occupations start working from home and hence the base infection rate declines for this group. It is important to note that the individuals in the highest risk group, ages 65 and above, as well as the younger people are assumed to have lower infection rates because they do not work or because they switch to distanced learning. This is consistent with the optimal setting identified by Acemoglu et al. (2020). The infection rate is still high for the on-site workers. In full lockdown, we assume that only the essential sectors require their non-teleworkable employees on-site. This is why the infection rate declines substantially for the remainder of the population that stays home under full lockdown and therefore normalizing the demand.

Our benchmark estimates of economic costs (or fiscal needs) are estimated in the absence of any policy action. Costs might decline when fiscal and monetary policy responses are taken into consideration. We prefer to provide our baseline estimates based on no policy action so that the minimum magnitude of the fiscal policy packages can be clearly identified. This approach makes our findings particularly relevant under the current threat of a second wave after reopening. In the case of a second wave countries may need to go back to lockdowns and undertake new policy action. The risks and the costs of a second wave are explicitly captured in our model. If the economy opens up prematurely, the increase in the number of infections would stall demand again, even if the businesses remain open. The consequent economic costs may lead to lasting economic damage by extending the duration of the recession. Indeed, we show that the duration of a lockdown that is needed to contain the virus increases to more than one year, if the lockdown ends prematurely.[6]

Our findings are consistent with the early experiences of small open economies such as New Zealand, Denmark and Greece. These countries implemented full lockdown before the number of

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[5]Closed economy version of this result is emphsized by Chetty et al. (2020), who uses real time data to show that traditional macroeconomic tools, such as stimulating aggregate demand or providing liquidity to businesses, cannot restore employment when consumer spending is constrained by health concerns.

[6]See https://www.thelancet.com/journals/lanpub/article/PIIS2468-2667(20)30073-6/fulltext, that argues that reopening too soon before the R number is below one might trigger another peak. The case of Singapore is an example with recurring lockdowns: https://www.theguardian.com/world/2020/apr/21/singapore-coronavirus-outbreak-surges-with-3000-new-cases-in-three-days

patients reached critical levels and contained the virus rather rapidly. Consequently, they gradually began to lift lockdown restrictions before the end of April. Another country is South Korea, who did not implement a full lockdown but did extensive testing and contact tracing.[7] If we look at industrial production numbers for April, we observe that the decline in industrial production in these countries is similar to our baseline estimates. For example, in Greece, industrial production shrunk 12.3 percent in April compared to previous month, respectively, which is similar to our 17 percent loss during the lockdown quarter. Greece and South Korea annualized GDP growth rates turn out to be -6.2 and -5.3 percent, respectively, which is close to our -5.8 percent annualized estimate. Out of emerging markets, only Mexico's second quarter GDP is available, and that shrunk -17.4 percent, which is comparable to our annual estimates of no lockdown countries as Mexico did not do any lockdown. Turkish experience can be considered as an "enhanced partial lockdown" which is a mixture of full lockdown and partial lockdown periods and hence provide rich information for our calibration of different scenarios. Thus, the real annual costs for Turkey might fall within our range of 5.8 and 11 percent of GDP at the end of 2020. So far, industrial production in Turkey fell 7 percent, and 32 percent in March and April 2020 respectively. In May, IP growth picked up but it remains well below its level prior to the pandemic.[8]

The remainder of this paper is organized as follows: In Section 2, we provide an overview of the literature on COVID-19 pandemic, explaining our contribution. In Section 3, we briefly go over the environment in which Turkey entered the COVID-19 crisis, the policies adopted by Turkey to deal with the pandemic so far, and compare to other countries. Section 4 describes the model that allows us to estimate the sectoral and aggregate COVID costs and fiscal needs. Our quantitative findings are summarized in Section 5, where we show that costs are larger for an open economy due to I-O linkages and we empirically link the costs and fiscal needs to capital flows. Section 6 considers the policy alternatives to finance the economic costs of the pandemic, focusing on both domestic and external finance. Section 7 describes the historical experiences. Section 8 concludes.

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[7]Recent work suggests that testing and tracing can mimic the benefits of a full lockdown. See Zilibotti et al. (2020).

[8]It is hard to compare model based estimates to real data from emerging markets, without the release of second quarter GDPs as most EMs observed the pandemic later than advanced economies and started their lockdowns almost at the end of the first quarter. Turkish second quarter growth number is not due until August 31, 2020.

2 COVID-19 Literature and Our Contribution

There is a rapidly growing literature that aims to capture the economic impact of COVID-19 crisis. Many papers utilize SIR models or its extensions to incorporate the infection dynamics into their analysis. Papers such as Stock (2020) and Alvarez et al. (2020) consider a standard SIR model and focus on the trade off between unemployment that arises from lockdowns versus the number of deaths due to the pandemic. They reach the conclusion that the optimal policy is a full lockdown that covers the majority of the population where the restrictions are removed gradually afterwards.

Acemoglu et al. (2020) considers a multi-risk SIR model by focusing on the structural differences in the severity of infections for distinct age groups that affect lockdown policies and economic costs. They show that targeted measures such as full lockdown for the elderly group could be more effective. Alon et al. (2020) also considers a closed economy model but approaches the problem from the developing country perspective, considering market distortions and the presence of an informal sector and hand to mouth consumers. They realize that such economies cannot fully lockdown and argue that lockdowns on the elderly population might be better. Alfaro et al. (2020) focuses on the effect of informality and firm size in the emerging markets and highlights the importance of taking into account the informal sector while developing responses to COVID-19 pandemic.

Combining supply and demand in a SIR framework Farboodi et al. (2020) internalizes the individual choices for social distancing and study both laissez-faire and social optimum scenarios. They find that even in the laissez-faire case individuals choose to sharply reduce their activity but the socially optimal response imposes severe restrictions at the onset of the outbreak. Eichenbaum et al. (2020) incorporate supply and demand in a SIR model as well, where the government is assumed to alter the individuals' activities through a consumption tax and again find that relatively severe containment at the beginning of the pandemic is the most socially optimum response. Krueger et al. (2020) extends the model by Eichenbaum et al. (2020) and introduces differential transmission rates based on the consumption or employment choice. They aim to capture the interplay between infection dynamics and the demand side or the supply side –but not both of them simultaneously.

The above cited literature do not feature sectoral heterogeneity for demand and supply shocks together. However, the recent empirical evidence shows the magnitude of the demand shock to

be very large and vary by sector, as we model. Specifically, using granular data, Chetty et al. (2020) document a decline of 39% in consumer spending in the top-quartile of income distribution and 13% in the bottom quartile in the United States during the first month of the pandemic. The decline is heterogenous across sectors with more significant drops in industries requiring in-person contacts. Geographically, the decline in spending is larger in those regions where the COVID-19 incidences are higher. Overall, the authors emphasize that at the initial stages of the pandemic, the fear of contacting the disease is the main source of the decline in spending. Similarly, using cell phone data to track movements of individuals, Goolsbee and Syverson (2020) show that even though the consumer traffic fell by 60%, only 7% could be explained by the shutdown restrictions. The authors suggest that the changes in consumer behavior is most likely to be tied with the fear of infection. In sum, these results highlight the importance of incorporating the sectoral demand changes into the model.

To the best of our knowledge, our paper is the first to incorporate both supply and demand shocks at the sector level for an open economy operating within the international production network, making full use of international I-O linkages.[9] We estimate our COVID losses by considering the effects of domestic and foreign sectoral shocks and their amplification through I-O linkages. Linking the economic losses/fiscal needs to I-O trade links and capital flows empirically, provides evidence on the relationship between fiscal needs and external financing needs of EMs.

Figure 1 summarizes our theoretical framework. We ponder the figure for a given industry. After we separate sectors into essential and non-essential sectors, we capture supply shocks by quantifying how susceptible each industry is to the transmission of the virus among its employees. The transmission dynamics of the virus would differ depending on whether the workers are on-site or at a remote location like home. We use Dingel and Neiman (2020)'s list of teleworkable occupations to capture the proportion of employment that can be fulfilled at remote locations in each industry. Among the professions that need to be carried out on the work site, we assume that the viral transmission depends on the physical proximity between the workers or between the workers and the customers. An on-site worker could be exposed to infection either at work or outside work. Us-

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[9]The only other paper that we are aware of considering both demand and supply shocks at the sectoral level is by del Rio-Chanona et al. (2020) with an extension in Pichler et al. (2020). Their analysis is also for an open economy, focusing on the UK. They incorporate domestic demand shocks for the UK based on hypothetical predictions of an influenza pandemic from a CBO report in 2006.

Figure 1: The effects of COVID-19 in a multi-sector open economy: A Schematic of the Model
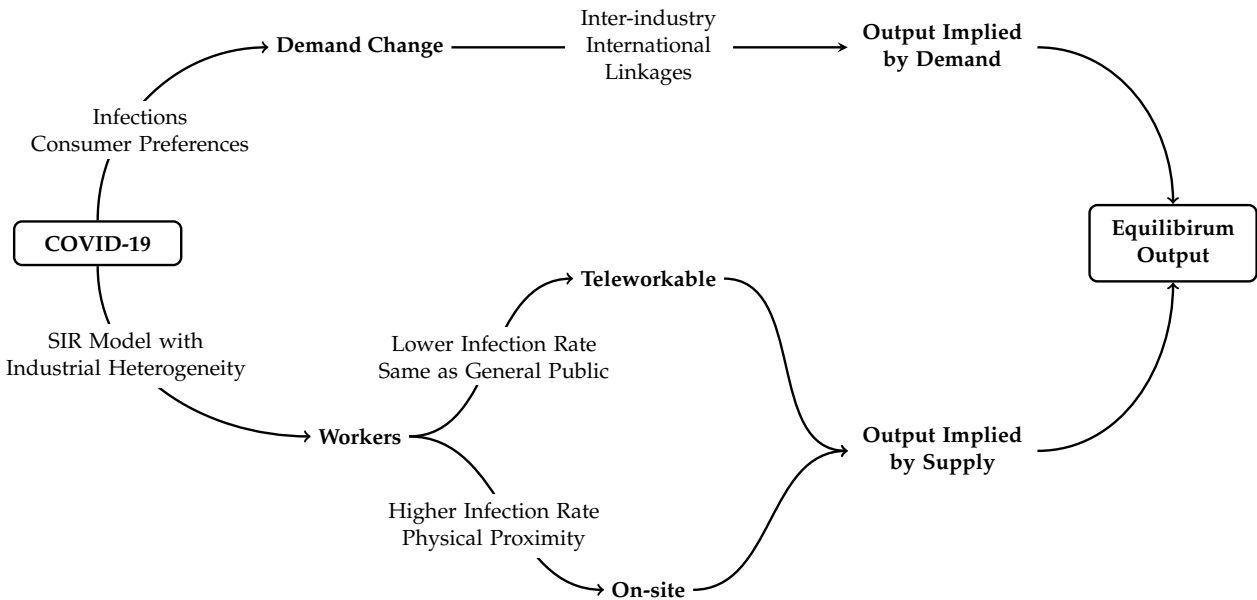
NOTES: We implement two main lockdown scenarios: *partial* and *full*. Under partial lockdown, all industries remain open while the teleworkable portion of the employees work from home. The restrictive measures result in a low infection rate for the teleworkables and the general public, but the infection rate remains high for the on-site workers. Under full lockdown, only the essential industries remain open and the workers in the non-essential sectors stay at home. With these extreme measures, the infection rates are lowered for almost everyone. The lockdowns affect the supply channel directly via workers and the demand channel by mitigating the number of infected individuals, which in turn change the consumption profiles.

ing the teleworkable share of an industry and the physical proximity measure as part of the SIR model, we estimate the proportion of the work force in each industry that would be impaired during the time of the pandemic. Of course, the viral transmission dynamics will be affected by the implementation of different lockdown policies. Thus, we calculate our sectoral supply shock under different scenarios. Under partial lockdown scenario, we assume that all businesses are open, but the teleworkable share of the employees remain home. The viral transmission is lower among the teleworkable employees and the general public, but the transmission rate is still high among the on-site workers. Under full lockdown scenario, we assume that all businesses except the essential ones are closed and all employees working in the closed sectors remain home. The viral transmission rates drop to a lower level for all the workers in the non-essential sectors.

The pandemic affects the demand side as well. The economics profession unanimously agrees that the prerequisite for economic recovery is the elimination of the virus so that demand normal-

izes.[10]We have a disproportionate role of demand in our model as we focus on both domestic and external demand shocks, where shocks are propagated through domestic and international input-output linkages. In the upper half of Figure 1, we illustrate the changes in demand due to the pandemic that ultimately affect the equilibrium output. We consider two scenarios for demand: one for the normal times and one during the brunt of the pandemic. To proxy for demand shocks during the peak of the pandemic, we use data on credit card purchases provided by the Central Bank of the Republic of Turkey (CBRT).[11] For the few sectors where the credit card data is missing, we use other proxies for real-time demand reduction. For pre-COVID demand, we use consumption spending from Turkish national accounts. During the course of the pandemic, we expect demand to adjust from its pre-COVID levels to the lowest possible level under COVID shock. We model this adjustment with a reduced form function where demand deviates from its normal patterns as a function of the number of infected people. Hence, the demand profile changes depending on the infection levels in the population, which, in turn, is mitigated by the lockdown decisions. The sooner the infection numbers decline, the sooner demand normalizes.

Our open economy framework makes the role of global coordination clear. If the lockdown can be implemented with global synchronization, the pandemic will be controlled faster. As the number of infections decline globally, demand returns to pre-pandemic levels faster as both domestic and foreign demand normalize sooner. Thus, the economic costs of the pandemic can be kept at a minimum level. The last stage in Figure 1 combines demand and supply sides together to reach market equilibrium, where the minimum of both sides determines the equilibrium level of production for a given industry.

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[10]See IMF World Economic Outlook, April 2020. Also contributions in Baldwin and di Mauro (2020). Former Federal Reserve Chairman Bernanke noted in late March that "Nothing will work if health issues aren't resolved," sending a clear message to governments. See the transcript of Bernanke's interview on March 25 is available at this link: https://www.cnbc.com/2020/03/25/cnbc-transcript-former-fed-chairman-ben-bernanke-speaks-with-cnbcs-andrew-ross-sorkin-on-squawk-box-today.html

[11]Similarly, Andersen et al. (2020a) use transaction-level customer data from the largest bank in Denmark to estimate consumer responses to the COVID-19 pandemic and the partial shutdown of the economy, see also Carvalho et al. (2020) who uses similar data from BBVA for Spain.

# 3 The Initial Conditions, Policies, Fiscal and External Financing Needs

3.1 Background

This section summarizes the economic environment in Turkey before the pandemic to provide a background on initial conditions. Initial conditions when the countries enter the COVID crisis matter because existing vulnerabilities such as high debt, low FX reserves, weak balance sheets, and limited policy credibility will exacerbate the impact of the crisis.

Since 2017, the inflation rate had been on the rise while Turkish Lira (TL) depreciated. Triggered by the political tension between Turkey and US, August 2018 marked the beginning of an exchange rate crisis, where rapidly depreciating TL brought many companies with FX debt to the edge of bankruptcy. The significant decline in economic growth led to an improvement in the current account deficit because Turkey's production heavily relies on imports of intermediary goods. The growth rate in the first quarter of 2020 reached 4.5 percent and the unemployment rate declined to 12.7 percent.

Capital outflows by non-residents during COVID-19 led to a wave of depreciation in TL, which required FX interventions and brought FX reserves to low levels. As of July 17, 2020, *net* reserves of Central Bank of the Republic of Turkey (CBRT) stood at $31 billion, of which over $55 billion was obtained through swap agreements as of May 2020, indicating significantly negative levels of net reserves for CBRT. IMF-defined budget deficit that excludes one-time transfers stands close to 5 percent of GDP while the current account deficit is around 2.5 percent of GDP, as an average over the last 5 years.

Figure 2: External Debt and Currency Decomposition

(a) Decomposition in terms of Ownership (b) Currency Decomposition
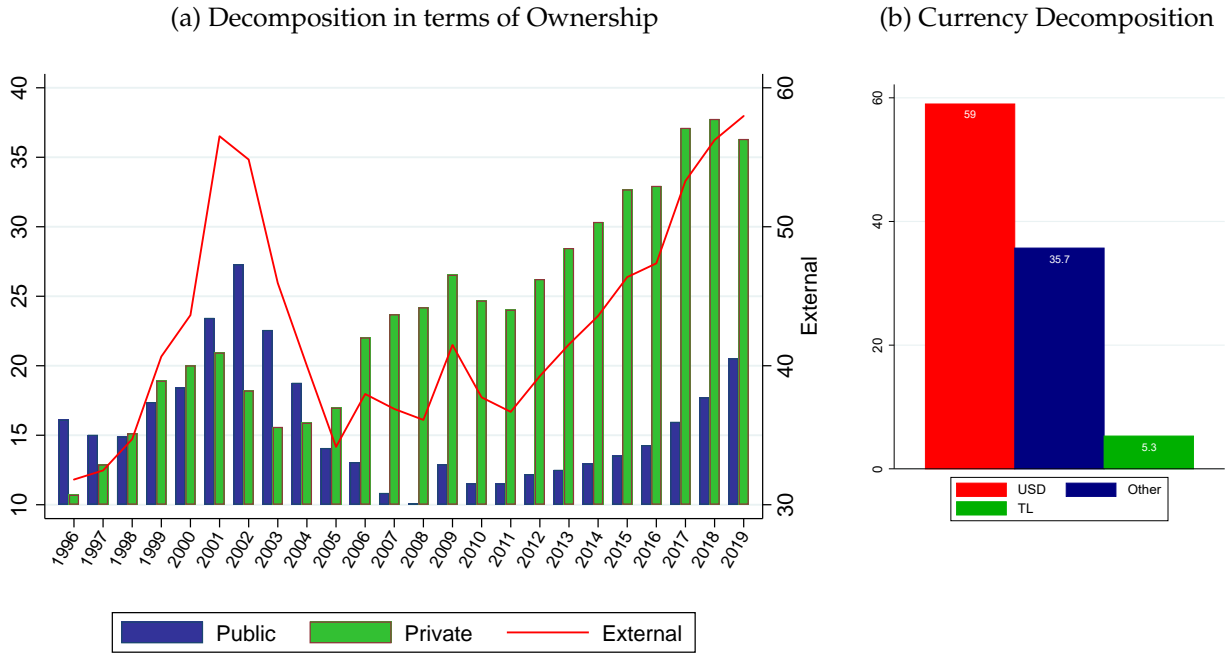
NOTES: (a) This panel plots external debt (right x-axis) alongside with its public-private composition (left x-axis) for Turkey. Debt values are expressed as percentage of GDP. (b) This panel shows the currency composition of total external debt as of December 2019. Source: Turkey Data Monitor

Turkey relies heavily on capital flows to finance its external debt, which stood at 60 percent of GDP at the end of 2019. Figure 2a shows the changes in the composition of external debt over time. In 2001, total external debt was 57 percent of GDP. Of this, public sector debt was 24 percent, while the private sector debt was 22 percent.[12] Macroprudential measures that were implemented in the aftermath of the 2001 crisis led to a substantial reduction in total external debt in the years immediately after the crisis. Nevertheless, the abundant liquidity provided by the major advanced country central banks in the post-2008 period as part of the widescale QE programs, changed the borrowing patterns in Turkey. The external debt gradually increased with the composition tilting towards private sector borrowing. By the time we reached 2019, total external debt was once again comparable to 2001 levels with 56 percent of the GDP. Different from 2001, however, this time the lion's share was held by the private sector debt which was 36 percent of the GDP while the public debt was 21 percent of GDP. Another interesting pattern that is observed in Figure 2a is the increasing trend in

[12]The sub-components do not add up because the remainder of the external debt is held by CBRT

public borrowing in the period after 2012. This is particularly critical in the period after 2018, which corresponds to a gradual decline in private sector borrowing that is replaced by an increase in public sector borrowing so that total external debt maintains its upwards trend. As of December 2019, almost 60 percent of total external debt is denominated in USD (see Figure 2b). The composition of debt has immediate implications for the policy prescriptions needed to address the private sector debt problem during COVID-19 crisis and bring forward the importance of well designed policies to address loan restructuring, non-performing loans, and non-viable firms.

In terms of maturity structure, out of a total external debt of $437 billion, $124 billion was short-term (17 percent of GDP), and $93 billion of this was held by the private sector. BIS data reflects that $96 billion of the total external debt belongs to the banking system. Meanwhile, the external debt that needs to be rolled over in 2020 is $169 billion, which is approximately 23 percent of GDP. The banking sector's share in short term debt is $81 billion.[13] If the rollover ratios stay at the current levels, then Turkey needs around $30 billion, however, if they go down to the level observed during Great Financial Crisis (GFC), then Turkey might need around $90 billion in 2020, a number that is much larger than any existing swap line and international arrangement available for EMs.[14]

In terms of market sentiment and global investors' risk perceptions, EMs seem to be in the middle of a strong risk-off shock, as risk premium, measured by five-year CDS premium increased sharply (See Figure 3). Given the surge in the sovereign risk premium after the COVID-19 shock, rolling over existing external debt would be much costlier, which could raise the fiscal deficit, leading to a prolonged period of higher indebtedness. From the beginning of the year until the week of April 24, 2020, $2.7 billion of equity and $5.5 billion of government bonds held by foreign investors were sold-off to domestic investors in the secondary market.[15] These numbers may not be as big in the context of total external debt but notice that these are local currency government bonds that were

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[13] We use the annual GDP of 2019 to express the January 2020 values as a percentage of GDP in this section.

[14] In a recent report, Bürümçekçi (2020) notes that the current rollover ratio for the banking system is around 73 percent, which receded to 45 percent during 2007-2009 crisis, and 35 percent during 2001 crisis. For the public sector, rollover risk looks minimal for 2020. Turkish government already issued $4 billion of Eurobonds so far, and another $2 billion is due in June 2020. Indeed, when we look at the last 20 years, we note that there were only three instances where debt coming due was not covered with new issuance. Yet none of these events resulted in a missed payment or recontracting of debt. The closest case of partial default was during 2001-2002 crisis that was avoided due to IMF funding. See Figure A.2 in Appendix based on Stoppok and Trebesch (2020).

[15] As for corporate bonds, the sell off started in the last week of February but the total volume of these transactions are rather negligible with a total of $86.5 million outflow from January 3 to April 24, 2020. This is due to the low share of corporate bonds relative to bank loans and government bonds in external debt. See di Giovanni et al. (2019).

held by foreign investors. As local currency bonds become riskier with the ongoing depreciation of TL, foreigners load-off these bonds first.

Figure 3: The Risk Premium as Measured by CDS Spread

(a) Raw CDS Values

(b) Normalized CDS Values
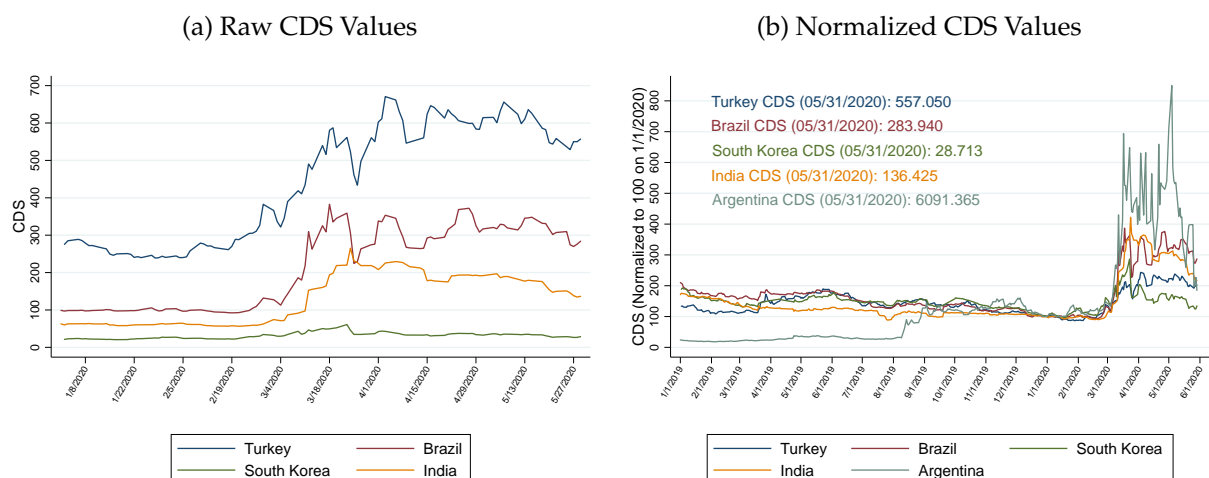
NOTES: NOTES: This figure plots risk premium for Turkey, Brazil, South Korea, India and Argentina which are measured by the 5-year CDS rate (World Government bonds) for these countries. Panel (a) shows the raw values and Panel (b) shows the normalized values. Source: Bloomberg.

In addition to bonds and equities held by non-residents, more than 1/3 of total external funding is obtained through bank loans in Turkey, which is almost all in FX. These loans finance the foreign currency debt in the non-tradeable sector. Half of the entire corporate sector debt is in FX and most of it is borrowed from domestic banks.[16] To dig deeper into the short-term risks, and considering the market dynamics in the aftermath of the 2007-2009 global financial crisis for EMs, we also need to look at cross-border loans. As shown in Figure 4, Turkish banks had been net payers in the external long-term loans for a while.

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[16]See di Giovanni et al. (2019).

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Figure 4: Rollovers of External Loans by Turkish Banks
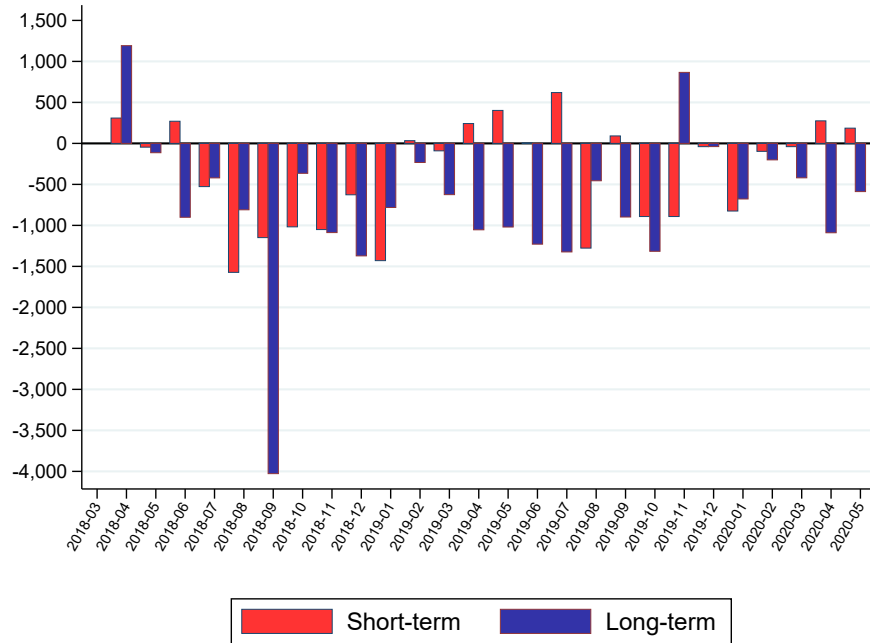
NOTES: This figure plots rollovers of external loans belonging to Turkish Banks. Loan rollovers refer to monthly-net values expressed in terms of millions of USD. Source: Turkey Data Monitor.

In January 2020, Turkish banks paid to foreign financial institutions a net of $0.8 billion over what they borrowed in short-term loans and $0.7 billion in long-term loans. While short term loan rollovers have improved in the subsequent months, the situation did not improve for long term rollovers. In May 2020, Turkish banks paid $0.6 billion in long-term loans This suggests that they need to borrow large amounts each month to prevent any interruptions in their domestic lending at home.

Overall, these numbers suggest that, there is quite a bit of foreign investment still in the country given the extent of external debt. Thus, although there are still many horses in the barn, it is important not to scare the horses given the extent of FX debt in the corporate sector, which can lead to massive bankruptcies with a spiraling depreciation of TL. In fact, while most sectors are adversely affected from COVID-19, those sectors with higher levels of FX exposure are hit harder because of the increase in their debt burden during the COVID-19 shock. In Figure 5, we plot the sectoral FX debt against the economic loss from the pandemic under the scenario in which no ac-

Figure 5: Sectoral Relation between FX Exposure and Economic Cost of the COVID-19 Shock
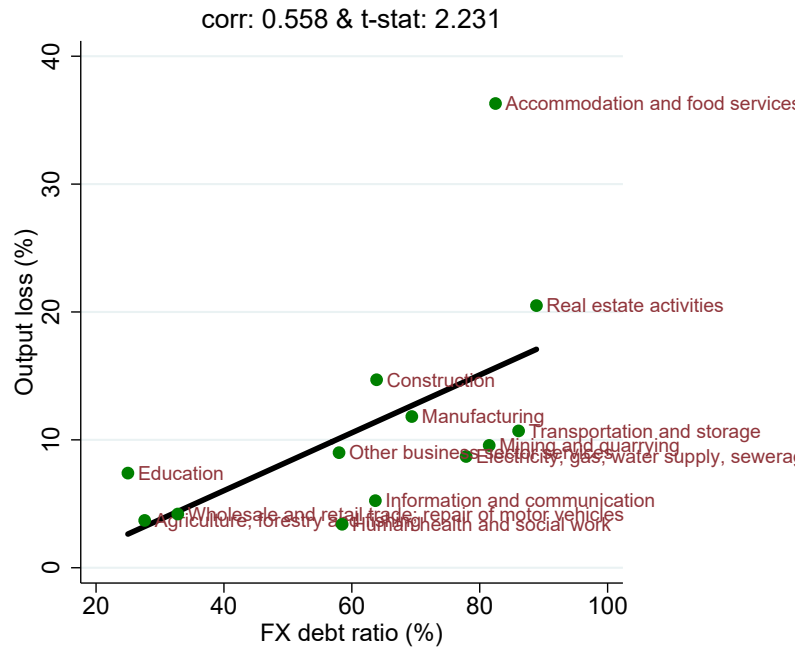
NOTES: This figure plots 2016 values for sectoral FX exposure (measured as the ratio of foreign currency debt in total debt) against the economic cost of the COVID-19 shock that we estimate under no lockdown scenario in which no policy action is taken against the pandemic. We measure the sector-level economic cost as the percentage change in output for a given sector during pandemic relative to its pre-pandemic level. The information on currency composition of debt is obtained from the "Company Accounts" data that has been compiled by the Central Bank of Turkey.

tion is taken against the pandemic. While we elaborate on how we calculate the economic costs in the next section, we present the loss variable somewhat prematurely in this section to illustrate that the exchange rate depreciation works as an amplification mechanism during the pandemic. In fact, those sectors that rely more heavily on FX funding experience sharper declines in their output during the COVID crisis. As we show below, this relation is not about a sector being tradeable or not but rather how strong is the sector's connection to international I-O links and how high the sector's external financing needs which can be financed both domestically and externally, mostly in foreign currency.

3.2 Policy Response to COVID-19

In terms of monetary and financial policies, CBRT cut rates by 100 basis points immediately during their emergency meeting on March 18, 2020 and again on April 22. The announcement that came on March 31 eased collateral requirements to borrow from the CBRT and opened the door for unlimited bond purchases where it was stated that "…limits might be revised depending on market conditions."[17] CBRT and BRSA (Banking Regulation and Supervision Agency) introduced several financial repression measures in the following days that increase the risk exposure of the banking system, encouraging banks to lend at low rates or buy government bonds.[18] They have also introduced certain capital flow management measures that reduced domestic banks' reserve requirements for foreign currency deposits and put limits on the daily amounts of domestic banks' swap transactions.[19] Notice that although it is important to react early to the pandemic, for an EM, market perception of such measures is just as important. This is because potential risks and hence the external borrowing costs are priced by global investors. Thus, effective and transparent communication of policy actions is as critical as the actions themselves.

In terms of fiscal policy, the stimulus package announced by government on March 18 is consistent with the general framework adopted by other countries. There is postponement of tax obligations, social security premiums and credit payments of the companies in the services sector. The limits of the Credit Guarantee Fund have been increased to make bank loans more accessible. Temporary income support is provided to those workers whose companies have ceased production due to the pandemic. Furthermore, a cash assistance program for needy families has been launched. While the original package announced on March 18 was announced to be 2 percent of GDP, the scope of the package has been expanded in line with the evolving conditions. The Minister of Finance and Treasury announced on May 29 that the pandemic related government expenditure has already reached 260 billion TL. Even with the revised numbers, however, the package still remains

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[17]https://www.tcmb.gov.tr/wps/wcm/connect/EN/TCMB+EN/Main+Menu/Announcements/Press+Releases/2020/ANO2020-22

[18]https://www.bloomberg.com/news/articles/2020-04-18/turkey-announces-new-regulation-to-boost-lending-bond-purchase and https://www.reuters.com/article/health-coronavirus-turkey-banks/turkeys-banking-watchdog-sets-deposit-ratio-to-boost-loans-idUSL8N2C607I

[19]https://www.reuters.com/article/health-coronavirus-turkey-banks/turkish-regulator-slashes-limits-on-banks-fx-transactions-idUSL5N2C00OI

https://www.bloombergquint.com/global-economics/turkish-lira-falls-as-regulator-limits-bank-forex-swap-deals

to around 5 percent of GDP. To put this number into perspective, Figure 6 shows a comparison of the fiscal measures undertaken by the G20 countries, where the average size of the fiscal stimulus is about 10 percent with Germany leading the pack with 32 percent. It is clear that the Turkish package is small, lagging behind 16 of the G20 countries. This reflects the limited fiscal space of EMs relative to advanced economies.

Figure 6: Fiscal Measures announced by the G20 countries
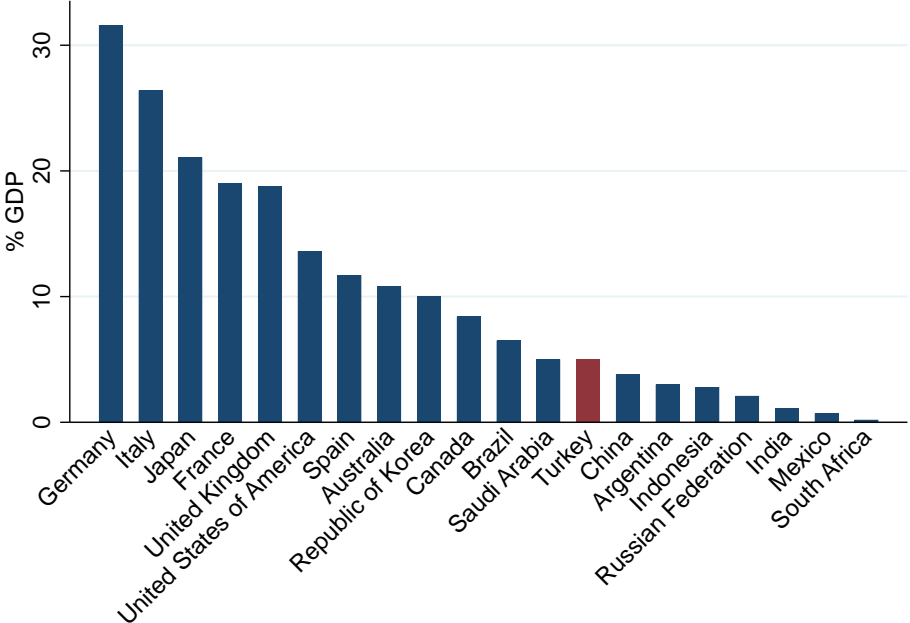
NOTES: This figure plots the COVID-19 relief packages adopted by the countries as a percentage of their GDPs. The fiscal policy measures that are shown in this figure are obtained from the IMF Policy Tracker (https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19) as of April 29, 2020 except for South Africa and the United Kingdom, for which the values of the stimulus packages are not explicitly stated. For these countries, we gathered the necessary information from alternative resources. A detailed comparison of the fiscal measures as well as the data sources are presented in Table A.1 of the Appendix.

In terms of the direct transfer payments, the stimulus package contains several channels of social assistance such as transfer payments for the needy families, enhanced employment protection by loosening short-term work allowance rules, a temporary ban on layoffs with a state subsidy for affected workers and unemployment insurance benefits. These transfer payments add up to 12 billion TL, which is only about 4.6 percent of the total stimulus package. Given the asymmetric nature of the crisis that hit the lower income groups much harder, transfer payments are critical to

provide the much needed income relief and revive demand. Should the transfer payments cover only those who lost their income or should they be in the form of "helicopter money" in the Turkish context, which has a sizeable informal economy? The answer depends on the extent of funding that is available to support the economy. A generous program that does not trigger longer term macroeconomic imbalances can minimize the economic damage and prevent long term risks. A less comprehensive program, on the other hand, would delay the speed of recovery. In the next section, we provide a model that estimates these costs and offers important input for the policy makers regarding the necessary size of the stimulus package.

4   Estimating the Economic Costs Under Different Lockdown Scenarios

In this section, we develop a model that illustrates how COVID-19 affects the economy. We illustrate that despite the increasing costs due to business closures, a full lockdown contains the virus in the fastest way. As we compare the recovery paths with and without the lockdown, we observe that a full lockdown lasts for approximately 40 days while partial lockdown cannot contain the virus within a year. Because the duration of the lockdown increases substantially, the economic costs of a partial lockdown are significantly higher than full lockdown. The mortality numbers present a stark contrast across alternative scenarios as well. Full lockdown, which has the lowest economic costs also stands out as the best option that minimizes the number of deaths. Only 0.002 percent of the population dies in a well implemented full lockdown whereas the numbers range between 0.32 to 0.96 percent in the case of partial lockdown. In the model we do not quantify the economic costs of lost lives (see e.g., Greenstone and Nigam (2020)) under alternative lockdown scenarios. Had we incorporated the costs of deaths, the superiority of full lockdown would be even more striking.

4.1   The SIR Model for Pandemic

We start with introducing the model of the pandemic, which is the main workhorse in many epidemiological studies, see for example Allen (2017) among others. Let's take a population of size N. At any given time, we can split the population into three classes of people: Susceptible (S_t), Infected (I_t) and Recovered (R_t) as of time t. The susceptible group does not yet have immunity to disease,

and the individuals in this group have the possibility of getting infected. The recovered group, on the other hand, consists of individuals who are immune to the disease.[20] The Susceptible-Infected-Recovered (SIR) model builds on the simple principle that a fraction of the infected individuals in the population, $\frac{I_{t-1}}{N}$, can transmit the disease to susceptible ones S_{t-1} with an (structural) infection rate of β. Therefore, the number of newly infected individuals in the current period is $\beta S_{t-1}\frac{I_{t-1}}{N}$. The newly infected individuals should be deducted from the susceptible individuals in the current period. Meanwhile, in each period, a fraction γ of the infected people recovers from the disease, which in turn reduces the number of actively infected individuals.[21] To track any changes in the number of individuals in the above-mentioned three groups, the following set of equations is used:

$$\Delta S_t = -\beta S_{t-1}\frac{I_{t-1}}{N} \tag{1}$$

$$\Delta R_t = \gamma I_{t-1} \tag{2}$$

$$\Delta I_t = \beta S_{t-1}\frac{I_{t-1}}{N} - \gamma I_{t-1} \tag{3}$$

The law of motion for the number of infected individuals shows the trajectory of the pandemic at the aggregate level. Note that, $\Delta S_t + \Delta R_t + \Delta I_t = 0$ holds at any given time, assuming that the size of the population remains constant.

We modify the conventional SIR model to allow for sectoral heterogeneity in terms of the size and working conditions that can lead to distinct infection trajectories in each sector. The transmission of the virus requires close physical proximity. Hence, employees working in the industries with higher physical proximity are infected with a higher probability.[22]

We assume that the economy is composed of K sectors. We denote the industries by subscript $i = 1, \ldots, K$. Each industry has L_i workers and there is also the non-working population which we denote by N_{NW}. Each industry has two types of workers: (i) employees who can perform their jobs remotely (i.e., teleworkable) and (ii) employees who need to be on-site to fulfill their jobs. In each industry, we denote the number of employees in the first group with TW_i and the second group with

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[20]Immunity can be developed either because the individual goes through the infection or because she gets vaccinated.
[21]See also Atkeson (2020), Bendavid and Bhattacharya (2020), Dewatripont et al. (2020), Fauci et al. (2020), Li et al. (2020), Linton et al. (2020), and Vogel (2020) on different mortality estimates.
[22]A report by DISK labor union in Turkey claims a three-fold increase in infection rates among workers: http://disk.org.tr/2020/04/rate-of-covid-19-cases-among-workers-at-least-3-times-higher-than-average/

N_i. Hence:

$$L_i = TW_i + N_i. \tag{4}$$

For the disease propagation, we lump the non-working population and the employees in the tele-workable jobs together, and call them the at-home group. We denote the at-home group with index $i = 0$. The total number of individuals in this group is:

$$N_0 = N_{NW} + \sum_{i=1}^{K} TW_i. \tag{5}$$

Suppose that the infection rate in the at-home group is β_0. In order to account for heterogeneous physical proximities across industries, we compute the rate of infection for each industry i, denoted by β_i, as:

$$\beta_i = \beta_0 \text{Prox}_i \qquad \text{for} \quad i = 1, \dots, K \tag{6}$$

where Prox_i is the proximity index for industry i.[23] It is plausible to think that the decline in demand during COVID-19 in a particular industry would lead to a decline in proximity (see Eichenbaum et al. (2020)). Nevertheless, we do not incorporate this in our model and take the proximity rates as exogenous.

Here, $S_{i,t}$, $I_{i,t}$ and $R_{i,t}$ denote the number of susceptible, infected and recovered individuals, respectively, with $N_i = S_{i,t} + I_{i,t} + R_{i,t}$ denoting the total number of on-site individuals in industry i and the at-home group ($i = 0$). Susceptible individuals in the at-home group can get infected from the infected individuals in the entire society:

$$\Delta S_{0,t} = -\beta_0 S_{0,t-1} \frac{I_{t-1}}{N} \tag{7}$$

where $I_t = \sum_{i=1}^{K} I_{i,t} + I_{0,t}$ captures the total number of infected individuals. An on-site worker in

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[23]We obtain the physical proximity values at the occupation level from O*NET dataset. O*NET collects the physical proximity information through surveys with following categories: (1) I don't work near other people (beyond 100 ft.); (2) I work with others but not closely (e.g., private office); (3) Slightly close (e.g., shared office); (4) Moderately close (at arm's length); (5) Very close (near touching). We divide the category values by 3 to make category (3) our benchmark. Specifically, a proximity value larger than 1 indicates a closer proximity than the 'shared office' level and smaller than 1 corresponds a less-dense working conditions. We create a single physical proximity value for each occupation by doing a weighted average of the normalized category values. We calculate the proximity values at the industry level after removing the teleworkable portion from the employees. We use Dingel and Neiman (2020)'s list of teleworkable occupations to capture the proportion of employment that can be fulfilled at remote locations in each industry.

sector i, however, could be exposed to infection either at work, at the rate of $\beta_i S_{i,t-1} \frac{I_{i,t-1}}{N_i}$, or outside work, that involves all the remaining activities including family life, shopping and commuting at the rate $\beta_0 S_{i,t-1} \frac{I_{t-1}}{N}$. Hence, the number of susceptible individuals among the on-site workers in industry i changes as:

$$\Delta S_{i,t} = -\beta_i S_{i,t-1} \frac{I_{i,t-1}}{N_i} - \beta_0 S_{i,t-1} \frac{I_{t-1}}{N} \tag{8}$$

The recovery rate is the same for all types of infected individuals:

$$\Delta R_{i,t} = \gamma I_{i,t-1} \tag{9}$$

The number of infected individuals changes as the susceptible individuals get infected and some infected individuals recover from the disease:

$$\Delta I_{i,t} = - \left(\Delta R_{i,t} + \Delta S_{i,t} \right) \tag{10}$$

According to the initial report by the World Health Organization (WHO),[24] the median recovery time for the mild cases is reported to be approximately 2 weeks. The mean recovery time could be longer when we include the severe cases. In this paper, we err on the optimistic side and set $\gamma = 1/14 \approx 0.07$ to establish a mean recovery time of 14 days. In the same report, the $R_0 \equiv \beta/\gamma$ of the disease, which captures the average number of individuals infected by a person carrying the disease, was estimated to be 2 to 2.5. Here, we use the lower end. In the absence of industrial heterogeneity, $R_0 = 2$ and $\gamma = 0.07$ implies $\beta = 0.14$. These values are in line with those used in Stock (2020) and Pindyck (2020) who primarily focus on calibration of the SIR model for tracking the evolution of the COVID-19 pandemic under different scenarios.

With industrial heterogeneity, we match the employment size weighted average β_i's of the infected individuals to β. For an on-site worker in industry i, the implied β parameter can be approximated by $(\beta_0 + \beta_i)$.[25] For a non-working individual, this parameter is only β_0. Using Equation (6),

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[24]https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf
[25]According to the DISK report cited in Footnote 22, the infection rate is 3 times higher for workers compared to the non-working population. Here, we take a moderate stance and set the rate to be 2 times higher on average for the workers.

we impose:

$$\beta_0 \frac{N_0}{N} + \sum_{i=1}^{K}(\beta_0 + \beta_i)\frac{N_i}{N} = \beta_0 + \beta_0 \sum_{i=1}^{K}\text{Prox}_i\frac{N_i}{N} = \beta \tag{11}$$

Hence, we solve for β_0 in terms of β, industry size, and the proximity levels as:

$$\beta_0 = \beta \left(1 + \sum_{i=1}^{K}\frac{\text{Prox}_i N_i}{N}\right)^{-1} \tag{12}$$

with $\beta = 0.14$ based on the WHO report.

4.2 Production

We specify a simplified version of the production function where output is a linear function of labor. This treatment emphasizes the impact of the pandemic on production through changes in labor supply. Here, we implicitly assume that the amount of the capital stock remains the same in the short-run, and therefore, can be omitted during normal times as well as the pandemic period. We model production as a function of the number of workers in industry i as:[26]

$$Y_{i,t} = Z_i L_{i,t} \tag{13}$$

where Z_i denotes the productivity of workers in sector i.

During the pandemic period, the level of production decreases because the infected individuals cannot work until they recover from the disease. We have two groups of workers, at-home and on-site. Hence, the total number of available workers at time t will be:

$$\tilde{L}_{i,t} = (N_{i,t} - I_{i,t}) + TW_i\left(1 - \frac{I_{0,t}}{N_0}\right) \tag{14}$$

where $N_{i,t}$ is the number of on-site workers, $I_{i,t}$ is the number of infected workers among on-site workers, and TW_i is the number of at-home workers (i.e. those who can work remotely) in industry i. The ratio $I_{0,t}/N_0$ captures the fraction of individuals who are infected in the at-home group, which includes the non-working population as well as all at-home workers (i.e. teleworkers) in the

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[26]This is typical in global supply chain models as in Bonadio et al. (2020).

economy. Therefore, the production in industry i changes to:

$$Y_{i,t}^S = Z_i \tilde{L}_{i,t} \tag{15}$$

4.3 Demand

During the pandemic period, consumer priorities and preferences change dramatically due to many reasons. First, there is fear of infection. In order to minimize the risks of getting infected, individuals alter their behavior and change their consumption patterns, such as refraining from public events or malls. The fear of infection is related to the number of infected individuals in the society. Second, there is fear of transmitting the disease to others. Individuals may choose to minimize their social interactions with a precautionary motive, in order to avoid infecting others inadvertently. The risk of transmission is particularly high for asymptomatic cases. Recent empirical evidence verifies this claim. Using granular data, Chetty et al. (2020) document a decline of 39% in consumer spending in the top-quartile of the income distribution and 13% in the bottom quartile in the United States during the first month of the pandemic. The decline is heterogenous across sectors, with more significant drops in industries requiring in-person contact. Geographically, the decline in spending is larger in those regions where the COVID-19 incidences are higher. Overall, the authors emphasize that at the initial stages of the pandemic, the fear of contacting the disease is the main source of the decline in spending. Similarly, using cell phone data to track movements of individuals, Goolsbee and Syverson (2020) show that even though the consumer traffic fell by 60%, only 7% could be explained by the shutdown restrictions. The authors suggest that the changes in consumer behavior is most likely to be tied with the fear of infection.

In addition to the fear factor, there is uncertainty about the duration of the pandemic and the related economic outlook which affects demand. Aggregate expenditure typically declines during times of elevated uncertainty. Furthermore, there is a direct income effect. Individuals lose their income stream either when they get laid-off or when they experience a sharp decline in demand for their output.

In order to capture the change in demand patterns during the pandemic, we consider two demand profiles, one corresponding to normal times and the other one corresponding to the brunt of

the pandemic. We determine the demand for each industry during normal times from the consumption data in national accounts. As for the COVID-19 period, we estimate changes in the expenditure levels during the pandemic using credit card spending data. For the sectors where we do not have the credit card data, we use industry reports and expert opinions.[27] The progression of the pandemic and the normalization of demand as the pandemic fades is a gradual process. In order to capture this steady adjustment, we assume that the individuals move between these two profiles smoothly, as a function of the number of infected individuals in the country. After determining demand, we use the input-output framework and map the final good consumption back to output in each industry.

In modeling the demand side, we first express the utility function of a representative agent who maximizes her utility by optimally allocating her income on the expenditure of different final goods. Following the literature on input-output analysis (see e.g. Acemoglu et al. (2012), among others), we assume that the representative agent has a Cobb-Douglass utility function:

$$U(e_1, \ldots, e_n) = \prod_{i=1}^{n} e_i^{\alpha_i}, \tag{16}$$

with e_i denoting the level of expenditure in industry i, and α_i representing the share of industry i in total expenditure with $\sum_{i=1}^{n} \alpha_i = 1$ and $0 < \alpha_i < 1$ for all $i = 1, \ldots, n$. The utility function in (16) incorporates a budget restriction which implies that the total income (w) equals total expenditure, i.e., $w = \sum_{i=1}^{n} e_i$. With the Cobb-Douglass utility function, α_i determines the share of industry i in the expenditure so that $e_i = \alpha_i w$ for $i = 1, \ldots, n$.

During times of the pandemic, demand patterns change. For the sake of simplicity, we assume that changes in demand come from two channels. First, the pandemic changes preferences and priorities, which implies an adjustment in sectoral weights. The utility function transforms into:

$$\tilde{U}(e_1, \ldots, e_n, I) = \prod_{i=1}^{n} e_i^{\tilde{\alpha}_i(I)}, \tag{17}$$

with the Cobb-Douglas exponents depending on the number of infections and $\tilde{\alpha}_i(I) = \alpha_i$ for a small number of infections, i.e., $I \leq 0.1\bar{I}$, where $\bar{I}$ is a scaling parameter for infections. In the Turkish

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[27]Expected final demand changes and the resources we use in this estimation are presented in Table A.3 of the Appendix.

context, we set $\bar{I} = 50,000$ to capture a relevant range for the number of of infections (see below for our simulations). This limit implies that the utility function returns to normal times if the number of infections remain below 5,000. For large I, the limit level is defined as $\lim_{I \to \infty} \tilde{\alpha}_i(I) \equiv \bar{\alpha}_i$ with $\sum_{i=1}^{n} \bar{\alpha}_i = 1$ and $0 < \bar{\alpha}_i < 1$ for all $i = 1, \ldots, n$.

In addition to the changes in preferences during the pandemic, demand also changes due to the income effect. We assume that the available income for expenditure decreases by a ratio of $1 - \eta(I)$ compared to normal times. We assume that $\eta(I)$ is a decreasing function of the number of infections and satisfies $\eta(I) = 1$ for $I \leq 0.1\bar{I}$. For large I, i.e., $\lim_{I \to \infty} \eta(I) = \bar{\eta}$ with $0 < \bar{\eta} \leq 1$. In this set up, the minimum level of income that is necessary for survival at the brunt of the pandemic is given by $\bar{\eta} \times w$, which can be achieved through transfer payments. While we capture the effects of the pandemic by modelling the demand parameters α and η as a function of the number of infections, the specification can be generalized to include consumer sentiment or the trustworthiness of the policies as the determinants of these key demand parameters. Hence, the impact of a decline in capital inflows, or a decline in policy credibility during the pandemic can be analyzed by adjusting the demand parameters within our framework.

To determine the level of output implied by the changes in demand during the pandemic, we first express the expenditure in each industry as a function of the number of infections. Next, we construct a ratio, $\delta_i(I)$, which shows the expenditure in industry i when the infection level is I relative to the expenditure during normal times. The numerator in this ratio is dependent on both the income channel and changes in priorities. By combining both channels, we can write $\delta_i(I)$ as:

$$\delta_i(I) = \frac{\tilde{\alpha}_i(I)\eta(I)}{\alpha_i}. \tag{18}$$

As the demand ratio approaches 1, it signals that the number of infections decline and demand normalizes. As the demand ratio approaches 0, it reflects that the number of infections increase and demand shrinks due to the pandemic. Using this ratio, we write the limiting cases for $\delta_i(I)$. For small I (i.e., $I \leq 0.1\bar{I}$), $\delta_i(I) = 1$. Thus, for a small number of infections, demand remains intact such that the ratio of demand during normal times equals demand during the pandemic.[28]

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[28]We use the number of infected patients in Turkey as the determinant of global demand change in a particular industry. While it is possible for a given country to handle the pandemic better or worse than Turkey, we argue that the

For large I, which corresponds to the peak of the pandemic, $\lim_{I \to \infty} \tilde{\alpha}_i(I) \equiv \bar{\delta}_i = \frac{\bar{\alpha}_i \bar{\eta}}{\alpha_i}$. If the demand for an industry i completely collapses during the pandemic (e.g., the airline industry), then $\bar{\delta}_i = 0$. If there is no change in demand during the pandemic (e.g. food industry), then, $\bar{\delta}_i = 1$. We assume that $\bar{\delta}_i$ is the utmost demand change in a particular sector that is globally valid under a fully developing pandemic.

Changes in demand at any given time is a function of the number of infected individuals in the population. In this framework, we assume that the ratio of demand, $\delta_i(I)$, smoothly fluctuates between 1 when nobody is infected and $\bar{\delta}_i$ when a very large number individuals get infected using the functional form [29] as:

$$\delta_i(I) = \begin{cases} 1 & \text{if} \quad I \leq 0.1\bar{I} \\ \bar{\delta}_i \frac{1+(I/\bar{I}-0.1)}{\bar{\delta}_i+(I/\bar{I}-0.1)} & \text{if} \quad I > 0.1\bar{I} \end{cases} \tag{20}$$

It is important to note that the overwhelming uncertainty about the course of the virus may suppress economic confidence for a longer period of time. To the extent that the actual normalization is slower than what is implied by Equation (20), we err on the conservative side by assuming a faster recovery.

Given the smooth transition function, we now model the changes in the final demand levels using δ values. Let's illustrate the final demand of country c in industry i with $F_{c,i}$. Accordingly, the new level of final demand in industry i in country c during the pandemic becomes:

$$\tilde{F}_{c,i}(I) = F_{c,i}\delta_i(I) \tag{21}$$

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number of infections and the consequent demand shifts in Turkey would not be that far off from the global course of the pandemic. In fact, a recent report by the ECB (Chapter 3, ECB Economic Bulletin, Issue 3 / 2020) highlights the striking resemblance between the timing of demand collapse in Turkey and the Euro Area: (https://www.ecb.europa.eu/pub/pdf/ecbu/eb202003.en.pdf on Economic Activity.

[29]This inverse hyperbolic functional form provides a smooth transition between the two limiting cases, for small and large I, where the marginal impact of the number of infections changes at a rate that is inversely proportional to the number of infections. The specification flexibly allows for changes across sectors as $\bar{I}$ and δ_i are the tuning parameters that determine the limits and the speed of the convergence.

The smooth transition in Equation 20 between the limiting cases can be achieved with the following functional forms for $\eta(I)$ and $\tilde{\alpha}_i(I)$ for $i = 1, \ldots, n$:

$$\begin{aligned} \eta(I) &= 1 \quad \text{and} \quad \tilde{\alpha}_i(I) = \alpha_i & \text{if} \quad I \leq 0.1\bar{I} \\ \eta(I) &= \bar{\eta}\frac{1+(I/\bar{I}-0.1)}{\bar{\eta}+(I/\bar{I}-0.1)} \quad \text{and} \quad \tilde{\alpha}_i(I) = \frac{\bar{\alpha}_i}{\alpha_i}\frac{\bar{\eta}+(I/\bar{I}-0.1)}{\bar{\delta}_i+(I/\bar{I}-0.1)} & \text{if} \quad I > 0.1\bar{I} \end{aligned} \tag{19}$$

where $\tilde{F}_{c,i}(I)$ represents the revised demand during the pandemic when the number of infections is I.

In order to map the changes in the final demand for each sector to the output level in each industry, we use the input-output framework. Using a closed-economy version of the input-output relations would neglect the impact of foreign trade on aggregate expenditure. Turkey is an open economy with a trade-to-GDP ratio of almost 63% as of 2019 (See Figure 7).

Figure 7: Trade Volume (% of GDP)
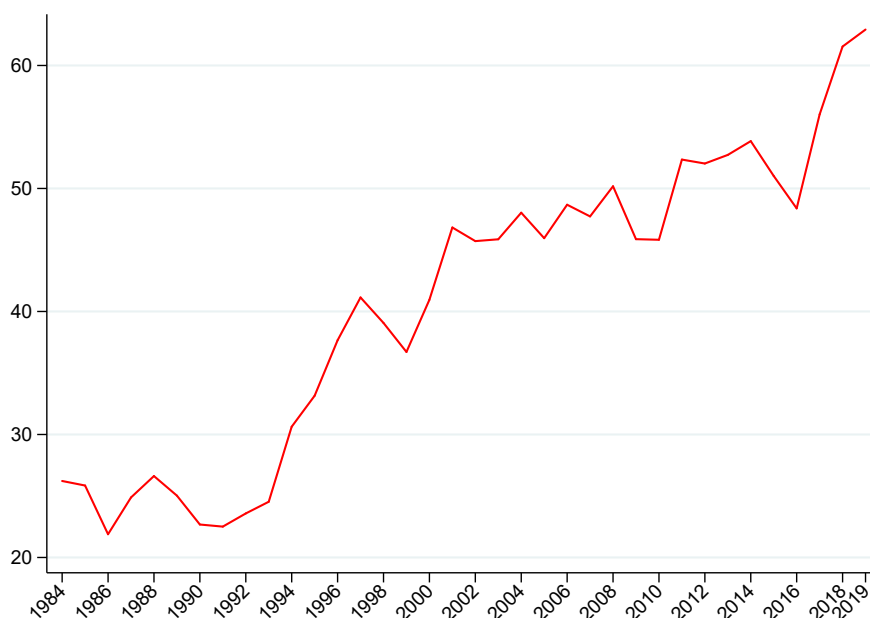
NOTES: This figure plots trade volume for Turkey, which is measured as the share of imports of goods & services and exports of goods & services in GDP. Source: World Development Indicators.

In order to account for the international linkages to fully capture the impact of final demand on production, we utilize OECD Inter-Country Input-Output (ICIO) Tables.[30] ICIO provides us with input usages of industry i in country c from any industry in any country. As shown in Figure A.1, we have 36 industries and 69 entities (corresponding to 65 countries), giving us a matrix of 2484 × 2484 entries. The final demand vector has 2484 entries and we index the entries of this vector by j, corresponding to each country-industry combination. By dividing the rows of ICIO matrix with the

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[30]https://www.oecd.org/sti/ind/inter-country-input-output-tables.htm

total output of industry j, we obtain the direct requirements matrix $\mathbf{A}$. This matrix summarizes the usage of each intermediate input to generate \$1 worth of output. Output of each industry is either used as an intermediate input or consumed as final demand. Using matrix notation, we decompose the total output into intermediate and final usage as:

$$Y = \mathbf{A}Y + F \tag{22}$$

Here, Y denotes the output vector and F denotes the final demand vector whose entries are Y_j and F_j respectively, while j is an index over all (c, i) combinations.[31] Therefore, we can solve for the output to satisfy the final demand as:

$$Y = (\mathbf{I} - \mathbf{A})^{-1}F \tag{23}$$

From this equation, we write the total output of country c as:

$$Y_c = \sum_{i=1}^{n} Y_{c,i} \tag{24}$$

Using the demand change from Equation (21) during the infection, the demand channel changes the output as:

$$Y_t^D = (\mathbf{I} - \mathbf{A})^{-1}\tilde{F}(I_t). \tag{25}$$

where Y_t^D represents the output and $\tilde{F}(I_t)$ represents the vector of demand at time t as a function of the number of infections, I_t. Therefore, the output also changes with the dynamics of the pandemic.

4.4 Equilibrium

In equilibrium, production declines by the largest magnitude that is implied by either supply or demand side. In other words, during the pandemic, we expect the output vector to be:

$$Y_t^{EQ} = \min(Y_t^S, Y_t^D) \tag{26}$$

where min represents element by element minimum function for two vectors, namely Y_t^S and Y_t^D.

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[31] With a slight abuse of the notation, we drop the subscript to refer to vectors or matrices of the variables. For simplicity, we often use (c, i) to refer to an entry instead of j when we refer to vector entries

The value-added of the output in industry i in country c is calculated from the shares of value added in each industry during normal times as:

$$VA_{t,c,i}^{EQ} = Y_{t,c,i}^{EQ} \frac{VA_{c,i}}{Y_{c,i}} \qquad (27)$$

Therefore, GDP of the country c at time t can be obtained through:

$$GDP_{t,c}^{EQ} = \sum_{i=1}^{n} VA_{t,c,i}^{EQ} \qquad (28)$$

4.5 Data

In our analysis, we use OECD ICIO Tables for 2015. As industrial classification, OECD uses an aggregation of 2-digit ISIC Rev 4 codes to 36 sectors. Throughout our analysis, we will make use of this classification labeled as OECD ISIC Codes.

To calculate the industry level teleworkable share and the physical proximity measures, we use the occupational composition of the industries. We use the list provided by Dingel and Neiman (2020) for the occupations which can fulfill their tasks remotely. For the workers that continue to do their jobs on-site, we assume that the infection rate depends on the physical proximity that is required in their workplace. To calculate the proximity requirements for the occupations, we use the self-reported Physical Proximity values available in the Work Context section of the O*NET database.[32] We divide the O*NET categories into 3 to have values larger than 1 if the reported category for the physical proximity is 3 (Slightly close (e.g., shared office)) or higher. We create a single proximity value for each occupation by weighting the normalized score with the percentage of answers in each category. To obtain industry-level teleworkable share and proximity values, we calculate the weighted average of the values corresponding to the occupations in each industry using the Occupational Employment Statistics (OES) provided by the U.S. Bureau of Labor Statistics (BLS). OES data follows four-digit NAICS codes to classify industries. In order to convert proximity data to OECD ISIC codes, we make use of the correspondence table between 2017 NAICS and ISIC

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[32]"O*NET OnLine Help: Find Occupations." O*NET OnLine, National Center for O*NET Development, www.onetonline.org/help/online/find_occ. Accessed 1 April 2020. Dingel and Neiman (2020) also use several measures from O*NET to identify which occupations are teleworkable.

Revision 4 Industry Codes, provided by the U.S. Census Bureau. We provide the teleworkable share and the proximity index for the industries in Table A.2 of the Appendix.

We obtain employment data from the Turkish Social Security (SGK) Agency. SGK follows four-digit NACE Revision 2 codes to classify industries. In order to aggregate employment data to 36 OECD ISIC codes, we make use of the Eurostat correspondence table between NACE Revision 2 and ISIC Revision 4 Industry Codes. SGK lacks the data on the number of employees working in the "Public Administration Sector," so we fill this information using the relevant data provided by the President's office.

We use publicly available credit card spending data from the CBRT to calculate the estimated demand changes during the pandemic in each industry. The list of OECD ISIC industries, and the expected changes are listed in Table A.3 of the Appendix along with explanations. In Table A.5 of the Appendix, we provide the matching we used with CBRT spending data and OECD ISIC industries. The data on credit card spending is not available for the full set of sectors. In this case, we use projections based on sectoral reports, experiences of other countries and historical data on the specific sector as well as the whole manufacturing sector. While the aggregate demand shock is computed as 23% when we focus only on the sectors with credit card spending data, it is 16% when we consider the full set of sectors. Therefore, our sensitivity analysis indicate little or no change in our findings qualitatively.

Under full lockdown, only a few industries are active. We use the decree issued by Turkish Ministry of Interior on April 10, 2020 to identify these industries. Turkish full lockdowns are typically on weekends and holidays and thus the list did not include some critical sectors. We supplemented the list with the food sector as well as household and sanitary goods. The list of these sectors is given in Table A.4 of the Appendix. From these industries and using the employment data at 4 digits, we calculated the share of each OECD ISIC industry that would remain active during the lockdown. Finally, we calculated the share of public employees that are not affected by the lockdown using the publicly available information, which is listed in Table A.6 of the Appendix.

5 Quantitative Analysis

5.1 Infection Rates under Alternative Lockdown Scenarios

In this section, we illustrate the consequences of alternative lockdown scenarios within our framework. In these scenarios, we impose changes on β_0 (i.e., the infection rate of the non-working population) and possibly on β_i for (i.e., the infection rate of the working population in industry i) and simulate the course of the pandemic. The decline in β reflects the effectiveness of a particular lockdown scenario which depends on country characteristics such as demographic dynamics, whether or nor there is a more authoritarian culture with less resistant public, the influence of the scientific committees in shaping political decisions, or the ability of a trustworthy and independent media in affecting public sentiment. The effectiveness of the lockdown also depends on the recovery rate that depends on the quality of healthcare services as well as ICU capacity.

We assume that the pandemic is successfully contained if the number of total infections declines to 5000 after observing the peak. These simulations allow us to calculate the economic costs of alternative lockdown scenarios. [33]

We start with the no lockdown scenario and compare it to partial lockdown where certain restrictions are imposed on daily life to incorporate social distancing rules while businesses remain open. This implies that under partial lockdown β_0 is diminished compared to the case where no action is taken, but β_i for $i = 1, \ldots, n$ remain unchanged. We consider three cases of partial lockdown where the infection rate, β_0 is reduced by the proportion of 0.5, 0.25 and 0.10 compared to the reference setting. Figure 8 displays the evolution of the number of infected patients under these four scenarios when a hypothetical lockdown is implemented for 240 days, starting early on the 10th day and remains active until the 250th day.

As can be seen from the figure, in case no action is taken against the COVID-19 pandemic, which is shown with the blue line, the pandemic advances at a rate implied by the benchmark reproduction

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[33]We note that the 5000 threshold that is assigned for the containment of the pandemic differs from the notion of Critical Community Size (CCS) (Bartlett, 1960). CCS is the threshold for the number of susceptible individuals to die out by itself. Instead, the 5000 threshold that we set in the model represents the number of infectious individuals who can be feasibly tested, traced, and eventually quarantined so that the pandemic can be contained successfully. We assume that for each infected individual, we need to test ten additional people on average. Thus, if there are 5000 patients, tracing the infection requires about 50,000 tests, which is close to the current testing capacity in Turkey.

Figure 8: No lockdown versus Partial Lockdown Scenarios
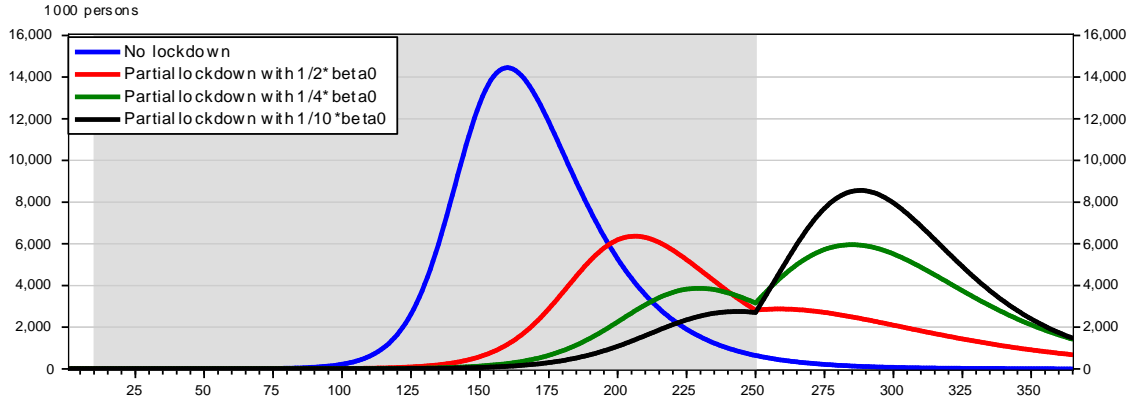
rate of $R_0 = 2$. This implies that the pandemic reaches its peak around the 150th day with a total toll

of around 14 million infections. Following this state of "herd immunity", the number of infections

starts to decline. After approximately 300 days, the virus is taken under control. Under the no

lockdown scenario, 1.13 percent of the population dies if we assume a 1.5 percent mortality rate.

The GDP declines 11.0% in this case. We should remind the readers that the economic costs that

are expressed in terms of GDP should not be misinterpreted as annual growth forecasts. We merely

express the cost of the lockdown in terms of the GDP.

Under partial lockdown scenarios, the reproduction number declines below 2 due to lower infec-

tion rates but remains above 1 in all three scenarios. Specifically, we assume that the lower infection

rate dampens the rate at which the pandemic evolves, nevertheless it is not sufficient to contain it

altogether. This is due to the fact that businesses remain open, which feeds the virus within the

industries and affects the overall course of the pandemic. If the infection rate is relatively high

$(0.5 \times \beta_0)$, which is shown with the red line, the GDP declines 11.6 percent. If the infection rate is

moderate $(0.25 \times \beta_0)$, shown with the green line, the GDP declines by 10.9 percent. If the infection

rate is relatively low $(0.1 \times \beta_0)$, shown with the black line, the GDP declines by 10.5 percent.

None of the 240-day partial lockdown scenarios that we considered in Figure 8 were successful

in containing the pandemic. When the lockdown is removed on day 250, all three partial lockdown

scenarios have approximately the same number of infections. Once the lockdown is removed, how-

ever, the virus follows a different course in each scenario. For the low infection rate scenarios (green and black lines) the number of new cases increase rapidly, leading to peak levels within 50 days after the lockdown. Meanwhile the high infection rate and no lockdown scenarios show a steady decline (the blue and red lines). This is because less people get infected during partial lockdown (and get immunity) under the low infection rate scenarios, shown by the area under the black and green lines. Hence, by the time the lockdown is removed, the number of susceptible people are significantly higher under the low infection rate scenarios, increasing the effective R_0 $(= \beta/\gamma)$. Thus, in the absence of an efficient drug or vaccination, a partial lockdown may need to continue indefinitely, until the number of cases decline to 5000. Figure 9 shows the simulation results if partial lockdown lasts for a full year. As in Figure 8, we assume that the industries are operating as usual and thus β_i's (for $i = 1, \ldots, K$) remain unaffected. In terms of the economic implications, the increase in the number of infections through a second wave due to a premature reopening prevents the economy from a jump start. Even though the supply side remains unrestricted, demand remains supressed due to the increase in the number of infections, dragging the economic growth. These implications are supported by a recent study Andersen et al. (2020b) that compares Denmark which had a full lockdown, with Sweden, with partial and voluntary lockdown. Aggregate spending dropped 29 per cent in Denmark and 25 per cent in Sweden. These numbers suggest that merely opening the economy does not imply that demand will be normalized until the outbreak is contained. Thus, a partial lockdown policy might not yield the lowest economic costs as implied by our model.

Figure 9: Alternative Scenarios under Partial Lockdown for Full Year
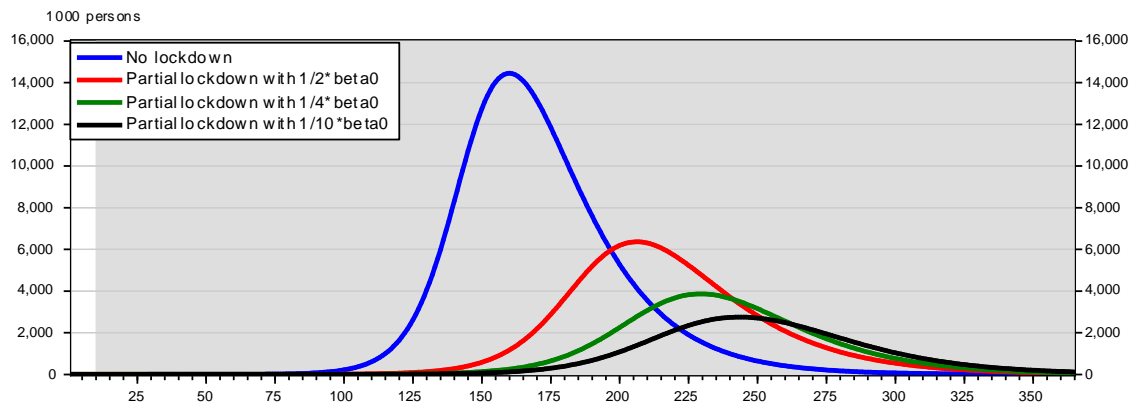
Compared to Figure 8, we observe that the main advantage of an extended partial lockdown is that it flattens the curve by spreading the number of infections over time and allowing for a larger recovery rate. In terms of the economic costs, the additional economic costs of the longer partial lockdown hover around 0.5 percent of the GDP. The added costs despite the extended duration of the lockdown are limited. This is due to the fact that the decline in demand already reaches a maximum level at the earlier stages of the lockdown and successive reductions in production only reflect the decline in supply due to increased number of infections.

Figure 10 illustrates the implications of our model under full lockdown. If the lockdown is put into practice when the number of infections is around 80,000, a fully effective procedure lowers the reproduction rate to zero ($R_0 = 0$), which is shown by the blue line, and contains the pandemic within 39 days (the gray shaded area). The consequent decline in GDP is about 5.8 percent. If the lockdown is not very effective and the infection continues to spread with some minimal reproduction number ($R_0 = 0.02$), then the duration of the lockdown increases by 15 days (yellow shaded area) to 54 days and the GDP declines by 7.6 percent.

Figure 10: Alternative Scenarios under Full Lockdown
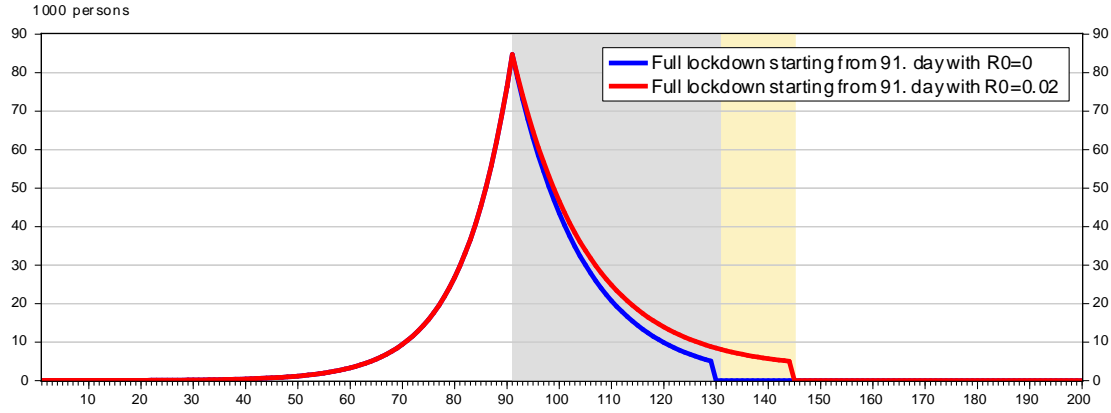
The costs of delaying full lockdown are shown in Figure 11. The benchmark scenario that is illustrated in Figure 10 is shown with the blue line. If the lockdown is delayed by only one day, the number of infections increases by more than 10,000. In the model, we assume that the number of infections increases faster than the official statistics, which report only the tested patients. Under

these circumstances, a 39-day lockdown is no longer sufficient to control the pandemic. Thus, in exchange for a one-day delay, the lockdown needs to be extended by two more days (the red line), which increases the costs of the lockdown to 5.9 percent of the GDP. If there is a two-day delay (the green line), this time the duration of the lockdown increases to 43 days and the decline in GDP is 6.2 percent. If the lockdown is delayed by one week (the black line), the decline in GDP is 7.3 percent. After 100 days, the virus starts to spread again and hence prematurely ending the lockdown is rather ineffective.

Figure 11: Costs of Delay in Implementing Full Lockdown
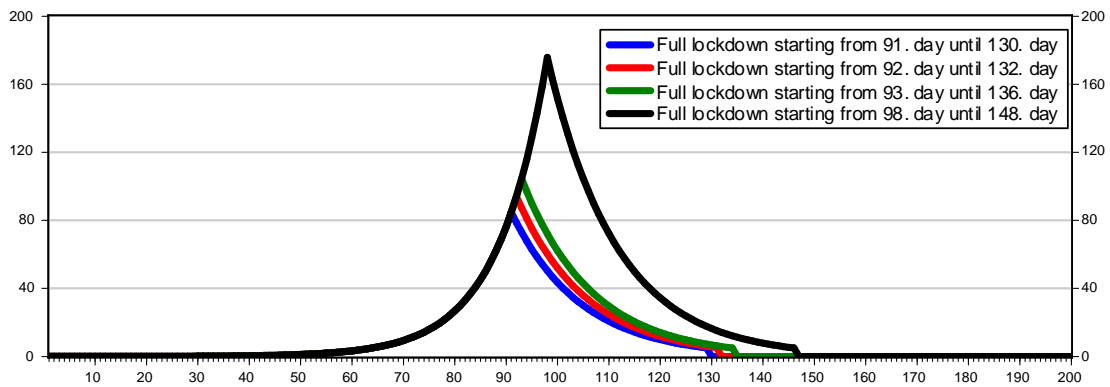
As we compare the economic costs under full lockdown (Figures 10 and 11) with those of partial lockdown (Figures 8 and 9), we note that the costs of full lockdown are lower than any of partial lockdown scenarios.

As we compare the the number of deaths under alternative scenarios, we observe that 0.001 percent of the population dies under an effective full lockdown, compared to 1 percent of the population under no lockdown and about 0.8 percent of the population under partial lockdown scenarios that last for 250 days. If partial lockdown is extended to a full year, then the number of deaths decline to about 0.5 percent of the population.

5.2 The Role of External Demand Shocks

The aggregate costs of COVID-19 shock that we calculated in the previous section embeds supply and demand channels in Turkey as well as abroad. In this section, we illustrate the role of external demand and supply in total costs. In order to better illustrate the role of international linkages for the Turkish economy, we consider two alternative scenarios.

The final demand of country c in industry i is met by domestic production and imports of final goods. Formally, we write the final demand as:

$$F_{c,i} = \sum_{c'} F_{c,c',i} \tag{29}$$

where $F_{c,c',i}$ denotes goods or services produced by industry i in country c' and consumed in country c. Following Equation 21, we write the final demand in country c in industry i at the peak of the pandemic as:

$$\bar{F}_{c,i} = F_{c,i}\bar{\delta}_{c,i} \tag{30}$$

Different than Equation 21, in this section we allow for country specific demand shocks. The corresponding output to satisfy this final demand level is obtained by:

$$\bar{Y} = (\mathbf{I} - \mathbf{A})^{-1}\bar{F} \tag{31}$$

From this equation, we write the total output of country c as:

$$\bar{Y}_c = \sum_{i=1}^{n} \bar{Y}_{c,i} \tag{32}$$

The value-added portion of the output is calculated from the shares of value added in each industry during normal times. The total value-added (GDP) in country c can thus be written as:

$$\overline{GDP}_c = \sum_{i=1}^{n} \bar{Y}_{c,i} \frac{VA_{c,i}}{Y_{c,i}}. \tag{33}$$

The matrix for intermediate goods is obtained from the direct requirements matrix and the output

vector:

$$\overline{INT} = \mathbf{A}\bar{Y}. \tag{34}$$

Each entry of the matrix INT corresponds to the usage of intermediate goods by industry i in country c from industry i' in country c'. Combining imports of intermediate goods and final goods, we write the total imports for country c as:

$$\overline{\text{imports}}_c = \sum_{c' \neq c} \sum_{i=1}^{n} \left(\bar{F}_{c,c',i} + \sum_{i'=1}^{n} \overline{INT}_{c,i,c',i'} \right) \tag{35}$$

Similarly the total exports by country c is:

$$\overline{\text{exports}}_c = \sum_{c' \neq c} \sum_{i=1}^{n} \left(\bar{F}_{c',c,i} + \sum_{i'=1}^{n} \overline{INT}_{c',i',c,i} \right) \tag{36}$$

As a result, a decline in foreign demand for final goods will create sectoral output declines in many domestic sectors, which will add to aggregate output decline in Turkey. To highlight this mechanism, we present three scenarios.

Scenario 1 assumes the same proportionate demand shock in Equation 30 for the whole world. For example, if we estimate that the demand for automobiles decline by 60 percent based on Turkish data, we assume that the demand for automobiles declines by 60 percent throughout the world. Figure 12 shows how much total output, exports and imports change at the brunt of the pandemic relative to normal times for alternative scenarios. In the baseline scenario, the decline in terms of total output is 19.8 percent (Scenario 1 in Figure 12). Interestingly, imports decline less (17.9 percent) compared to exports (23.4 percent). This is consistent with the nature of the Turkish economy which is highly dependent on imports of intermediate goods. On the exports side, a further breakdown indicates that the 27.4% decline in terms of final goods is higher than the 18.8% decline in intermediate goods (not shown). Similarly, on the imports side, the 19.7% decline in intermediate goods is higher than the 16.1% decline in final goods (not shown).

Under scenario 2, we assume that the demand in Turkey declines but the international demand for final goods is back to its normal (see Scenario 2 in Figure 12). Using the automobile example above, this implies that the domestic demand for automobiles shrinks to 60% of normal levels but

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Figure 12: Demand Shocks for an Open Economy with I-O Links
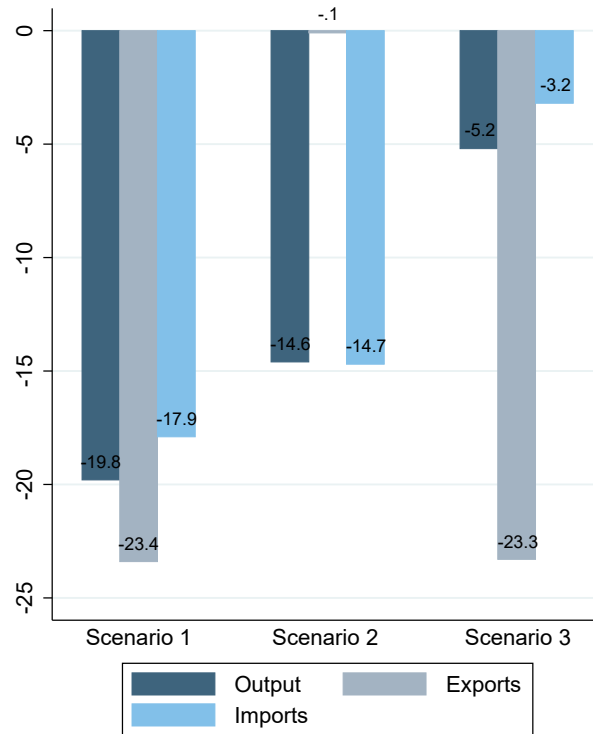
NOTES: This graph illustrates the impact of three different scenarios for demand shocks. In the first scenario, all the countries are assumed to experience the same demand shifter during the pandemic. In the second scenario, only Turkey experiences a demand shock but the international demand levels are intact. In the final scenario, the international demand levels are down but the demand in Turkey is at pre-pandemic levels. The number written on each bar corresponds to the percentage change in the relevant variable in the underlying scenario relative to its pre-pandemic level.

the international demand remains at its normal levels. In this setting, the decline in terms of total output is 14.6 percent at the brunt of the pandemic. The decline in imports is 14.7% but the decline in exports is only 0.1%.

Lastly, in scenario 3, we model the setting where the demand in Turkey is intact but the demand in international markets has plummeted (see Scenario 3 in Figure 12). Under this scenario, the decline in output is 5.2% solely because of international linkages. As expected, the exports are hit the hardest with a decline of 23.3% and imports decline by 3.2%.

If we compare Scenario 1 and Scenario 3, we can see the role of demand in total economic costs. The decline in foreign demand solely account for almost 27 percent of the decline in aggregate out-

put. Notice that we run these scenarios under no lockdown policy in the absence of any policy action.[34]

5.3 Sectoral Breakdown of Economic Costs

In this section, we analyze the economic costs at the sectoral level. Heterogeneity in sectoral costs may stem from several channels. Sectors that are closed down due to isolation measures (i.e. nonessential sectors), those that are hit hardest by the collapse in demand such as the services sectors, or those industries where teleworking is not very feasible will be hit harder. As for the role of international linkages, those sectors with greater exposure to international spillovers, particularly with those countries that had larger domestic outbreaks would be more affected. Similarly, those industries that rely more on external finance would experience the pinch of tightening in global financial conditions. In the next sub-section, we focus on the role of trade linkages. In the following sub-section, we calculate the sectoral economic costs in our framework under different scenarios. Using these sectoral costs, in the last sub-section, we disentangle the role of trade and external funding in sectoral costs in a regression framework.

5.3.1 The Role of Trade Linkages in Sectoral Costs

In this section, we investigate the role of international linkages in determining sectoral costs. International linkages would affect economic costs through trade relationships as well as capital inflows. Those sectors that are more closely connected to international value chains as well as those sectors that are dependent on external funding would be affected more from the global developments.

Figure 13 allows us to get a glimpse of the role of trade from the international input-output tables. The figure illustrates the share of imports in total intermediate inputs (the left panel) and the share of exports in total output (the right panel). The left panel shows the potential role of supply chains

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[34]The work by Bonadio et al. (2020) shows that a third of the output loss is due to global supply chains. Different from our framework where we have both supply and demand shocks, Bonadio et al. (2020) only assume sectoral supply shocks. These shocks are caused by the fraction of workers not being able to work because of the measures adapted by the country. Despite these differences, however, our predicted declines in GDP are similar because their supply shock, which affects all the workers in the economy, is large. The supply shock is assumed to be caused by the workers not showing up for work and is captured by the severity index of the lockdown by the Oxford Blavatnik School of Government Coronavirus Government Response Tracker https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker. The severity index does not necessarily reflect the proportion of workers not able to work, however.

in COVID-19 crisis. While we do not explicitly incorporate these supply shocks into our model, they are implicitly captured through changes in final demand. The left panel indicates that sectors such as paper products, computers and electronics ,electrical equipment, rubber and plastic, coke and refined petroleum, as well as pharmaceuticals rely more on intermediate inputs. Thus, we would expect these sectors to be more severely affected from the pandemic, due to disruptions in supply chains.

Turning to the right panel, motor vehicles, transportation equipment, electrical equipment, computer and electronics and tourism relates services sectors such as accommodation and food services are the sectors that rely more on external demand. Thus, the deep recessions that are expected in Turkey's major export markets such as the Euro Area, UK, or the US would hit these sectors the most, consistent with our analysis in Figure 12.

Figure 13: Import and Export Share

(a) Import Share in Intermediate Inputs   (b) Export Share in the Output
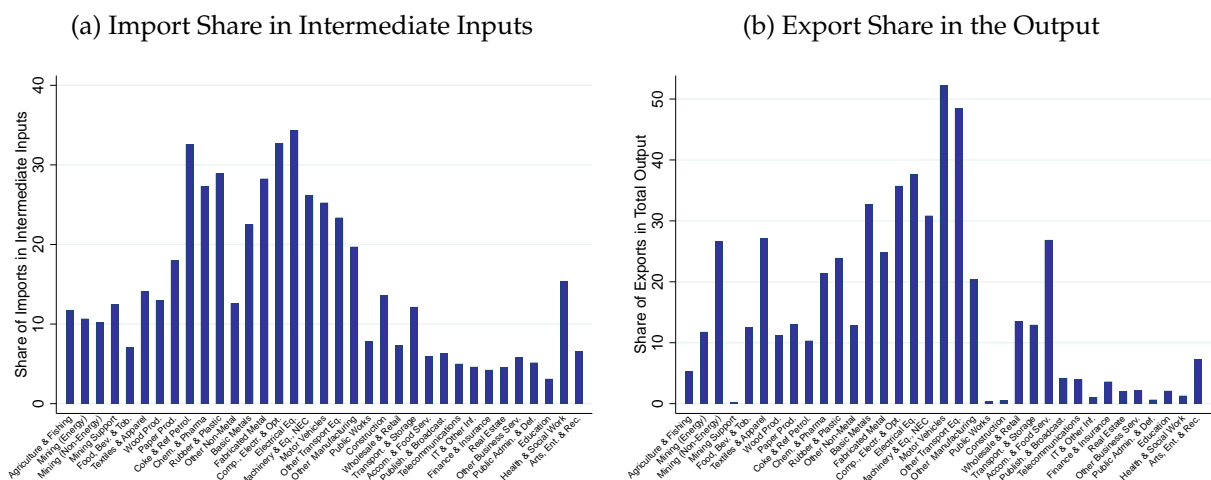
NOTES: (a) This figure plots the share of imports in the intermediate inputs. (b) This figure plots the exports as a share of output for each sector. Source: OECD ICIO Tables.

5.3.2 Sectoral Breakdown of Economic Costs under Different Scenarios

In the previous sub section, we highlighted the role of international linkages in sectoral costs. Armed with this intuition, we now illustrate how the economic costs related to the COVID-19 shock differ across industries under the alternative lockdown scenarios. Figure 14 shows how hard each sector is hit from the pandemic under alternative lockdown scenarios. Consistent with our earlier find-

ings, we observe that the full lockdown has the lowest economic costs compared to the alternatives. In terms of sectoral heterogeneity, we note that teleworkable or essential sectors are less severely affected because they continue functioning for all lockdown scenarios (such as education, IT, public administration). Meanwhile, non-essential sectors or those that require on-site work are more severely affected (such as accommodation and food services, arts, entertainment, and recreation, construction).
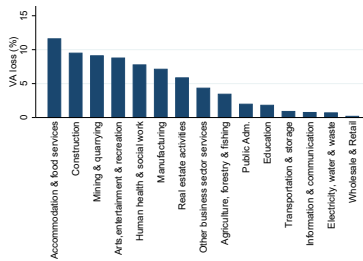
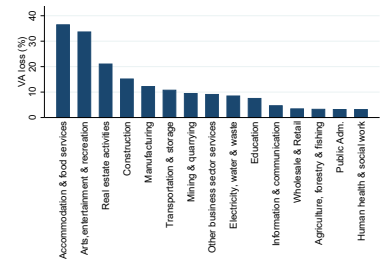Figure 14: Sectoral Heterogeneity in terms of Economic Cost of COVID-19 Shock

(a) **Scenario 1:** No Lockdown, $\beta = 0.14$
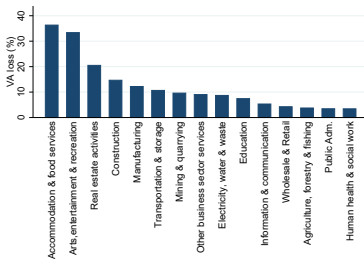
(b) **Scenario 2:** Full Lockdown, 91-131, $R_0 = 0$

(c) **Scenario 3:** Partial Lockdown, 10-250, $0.25 \times \beta_0$

NOTES: This figure shows how the economic cost of COVID-19 shock differs across sectors in a particular lockdown scenario. The panels show three alternative scenarios: (a) No action is taken against the COVID-19 pandemic; (b) A lockdown is put into practice between the 91st and 131st days of the pandemic and is fully effective with zero reproduction number; (c) A partial lockdown is put into practice between 10th-250th days of the pandemic that evolves with a moderate infection rate ($0.25 \times \beta_0$). For each scenario, we measure the sector-level economic cost as the percentage change in overall economic activity (proxied by value added) for a given sector during pandemic relative to its pre-pandemic level. Economic costs are aggregated from the 2-digit OECD ISIC codes to the 1-digit NACE code using 2-digit sector value added values that we obtain from the OECD ICIO Tables. NACE 1-digit sectors are A, B C, D&E, F, G, H, I, J, L, M&N, P, Q, R&S. In each panel, the sectors are ranked in a descending order according to the magnitude of economic cost under the corresponding scenario.

After documenting the heterogenous economic costs of the pandemic for different sectors, we investigate whether these costs are accrued from demand or supply pressures. Figure 15 counts the days in which output implied by the demand channel or supply channel prevails to bring about the equilibrium output in a given industry.

To interpret the findings present in this figure, we consider three benchmark scenarios: Panel (a) compares the no lockdown (blue line in Figure 8) scenario against full and effective lockdown (blue line in Figure 10), and partial lockdown with moderate infection rate (green line in Figure 9). Panel (a) suggests that under the no lockdown scenario, the demand channel, shown by the red bars, drives output in almost all days until the virus is fully contained. The supply channel, presented by

the blue bars, prevails only in the early days of the pandemic (not shown). Among the 15 industry groups, "Accommodation and food services," "Arts, entertainment, recreation and other service activities," and "Real estate activities" are those that result in the highest economic costs of 36%, 33%, and 20% of the value added generated in those sectors, respectively. This is not only because goods produced in those categories (which are all provided by the services sector) cannot be consumed from home, but also because people prefer delaying their consumption until the uncertainty regarding the containment of the pandemic resolves. Furthermore, another aspect of sectoral heterogeneity is clearly seen under no lockdown scenario such that the demand channel prevails longer in those sectors. This is because households are more likely to cut back on their expenditure on the goods produced by those non-essential sectors following the COVID-19 shock .

Figure 15: Supply and Demand Pressures under Benchmark Lockdown Scenarios

(a) **Scenario 1:** No Lockdown, $\beta = 0.14$

(b) **Scenario 2:** Full Lockdown, 91-131, $R_0 = 0$

(c) **Scenario 3:** Partial Lockdown, 10-250, $0.25 \times \beta_0$
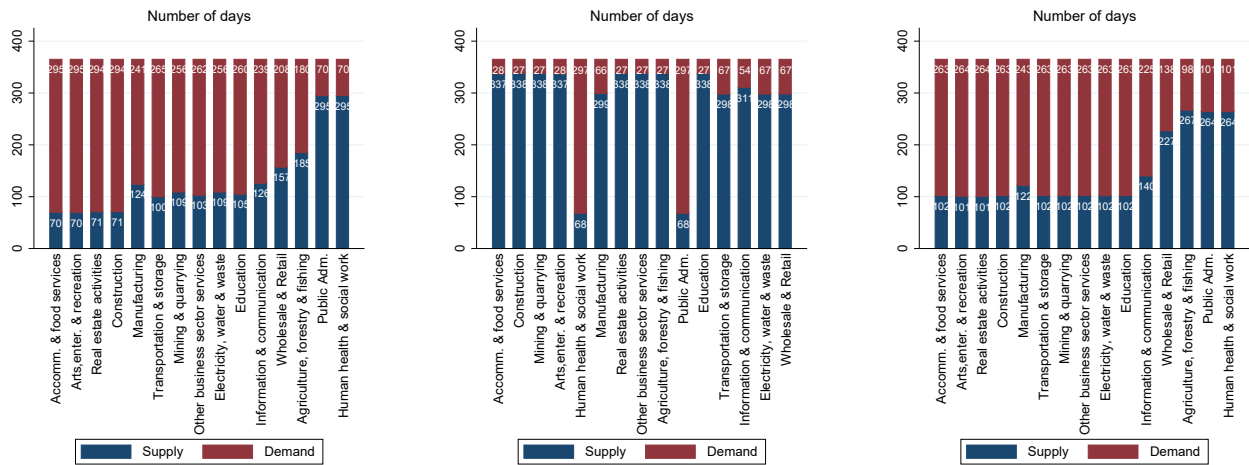
NOTES: In this figure, each bar shows the number days in which the supply channel (shown by the blue bars) or the demand channel (shown by the red bars) prevails to bring the economy into equilibrium in a given industry. The panels show three alternative scenarios: (a) No action is taken against the COVID-19 pandemic; (b) A lockdown is put into practice between the 91st and 131st days of the pandemic and is fully effective with zero reproduction number; (c) A partial lockdown is put into practice between 10th-250th days of the pandemic that evolves with a moderate infection rate ($0.25 \times \beta_0$). For each scenario, we measure the sector-level economic cost as the percentage change in overall economic activity (proxied by value added) for a given sector during pandemic relative to its pre-pandemic level. Economic costs are aggregated from the 2-digit OECD ISIC codes to the 1-digit NACE code using 2-digit sector value added values that we obtain from the OECD ICIO Tables. NACE 1-digit sectors are A, B C, D&E, F, G, H, I, J, L, M&N, P, Q, R&S. In each panel, the sectors are ranked in a descending order according to the magnitude of economic cost under the corresponding scenario.

Under full lockdown scenario, the supply channel drives output due to the closure of all non-

essential industries, whereas the demand channel prevails approximately 30 days before the restrictions are implemented (Panel (b)). Among the 15 industry groups, "Accommodation and food services," "Construction" and "Mining and non-quarrying of non-energy producing products" are those that result in the highest economic costs of 12%, 9.5%, and 9.1% of the valued added generated in those sectors, respectively. Different from the no lockdown scenario, sectoral heterogeneity is not highly pronounced in terms of supply and demand pressures under this scenario. To be specific, after the restrictions are implemented the supply channel dominates for all the sectors excluding "Human health & social work," and "Public administration."

Panel (c) shows that under partial lockdown that is put into practice between 10th-250th days of the pandemic and evolves with a moderate infection rate ($0.25 \times \beta_0$), the supply channel dominates in the first 100 days of pandemic. On the other hand, demand drives output for the rest of the year, including the days in which new peak levels are reached after the partial lockdown is prematurely removed. This is because of the fact that businesses remain open, which feeds the virus within the industries and increases the uncertainty about the containment of the pandemic. Among the 15 industry groups, "Accommodation and food services," "Arts, entertainment, recreation and other service activities," and "Real estate activities" are those that result in highest economic costs of 36%, 34%, and 21% of the value added generated in those sectors, respectively. We note that sectoral heterogeneity in terms of supply and demand pressures is very similar to the no lockdown scenario.

5.3.3 The Role of External Finance in Sectoral Cost

In the previous sub-section, we calculated the economic costs of COVID-19 for each sector. There is heterogeneity among these sectors regarding their external finance needs. Although we have shown that the role of foreign demand is substantial in those sectoral estimates, we want to also identify the role of external finance needs in the calculated economic costs.

To do this, we consider a regression specification at the sector-level. Specifically, we regress the economic cost in each sector onto its I-O link as well as the capital needs in that sector. For sector economic costs we will use both the costs calculated under no lockdown scenario and the ones calculated under full lockdown scenario. We proxy for the sector-level external finance needs by

generating an interaction term that captures the degree to which each sector is open to capital flows. This sector-level proxy is computed as a weighted sum of net I-O trade of country-sector pairs where the weights are country specific capital flows divided by the number of countries.[35,36]

A priori, we expect tradable sectors to be hit harder from the COVID-19 shock because they are exposed to adverse foreign demand shocks in addition to domestic shocks. However, via I-O links, even a non-tradeable sector can get hit hard and hence we capture both of these channels via our I-O trade variable. Furthermore, the more a particular sector relies on external borrowing, the larger should be the economic costs during COVID-19 crisis due to increased risk aversion.

In order to test these hypotheses, we run the following regression:

$$\Delta Y_i = \beta_0 + \beta_1 \text{I-O Trade}_i + \beta_2 \text{I-O Trade Finance}_i + \varepsilon_i \tag{37}$$

where ΔY_i stands for the economic cost of the COVID-19 shock for sector i for $i = 1, \ldots, K$, that we estimate under no lockdown scenario in which no policy action is taken against the pandemic. We measure the sector-level economic cost as the percentage change in overall economic activity (proxied by output (Y_i) or value added (VA_i), where value added equals total production minus intermediate inputs i.e., $VA_i = Y_i - INT_i$.) for a given sector during pandemic relative to its pre-pandemic level. I-O Trade$_i$ is the I-O trade linkage for sector i and I-O Trade Finance$_i$ is the sector-level proxy variable that captures the interdependence between trade linkages and external finance needs.[37]

In equation (37), β_1 captures the impact of I-O trade linkages on COVID-19 related economic losses; β_2 captures the impact of interdependence between trade linkages and external finance needs on COVID-19 related economic losses; and $\beta_1 + \beta_2$ captures the total impact of being a small economy linked to production networks and borrowing externally to finance those links.

As a robustness check, we add sectoral FX debt (measured as the ratio of foreign currency debt

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[35]We calculate the sector-level proxy as follows: I-O Trade Finance$_i = \sum_{c=1}^{n} (((\text{Exports}_{c,i} - \text{Imports}_{c,i})/\text{Output}_i) \times$ Capital Flows$_c)/n$ where Exports$_{c,i}$, Imports$_{c,i}$ and Output$_i$ refer to final goods and intermediate goods made in sector i to be sold in the corresponding country c, final goods and intermediate goods that are bought from the corresponding country c to be used in sector i, and total output produced in sector i, respectively.

[36]The related data on capital flows is obtained from BIS and it is publicly available at https://stats.bis.org/statx/srs/table/A6.2?c=TR&p=20194&m=. Capital flows data of Turkey from 26 countries refers to data on Turkish banking sector external liabilities vis-a-vis those countries for 2019-Q4. We normalize flows by GDP as of 2019.

[37]See the footnotes 38 and 39 for further details on the calculation of this variable.

Table 1: Sector-level Regressions

Scenario	No Lockdown				Full Lockdown			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	Output Loss	Output Loss	VA Loss	VA Loss	Output Loss	Output Loss	VA Loss	VA Loss
I-O Trade	15.9829**	16.4862**	16.0273**	16.5283**	1.7337	2.0190	1.1996	1.4767
	(6.402)	(6.426)	(6.388)	(6.412)	(1.688)	(1.576)	(1.919)	(1.847)
I-O Trade Finance	34.7770*	35.6340**	34.9502*	35.8033**	5.4198	5.9057	4.8717	5.3435
	(17.351)	(17.256)	(17.331)	(17.234)	(4.593)	(4.218)	(5.274)	(4.988)
FX		0.1579**		0.1572**		0.0895***		0.0869**
		(0.076)		(0.076)		(0.023)		(0.034)
R^2	0.12	0.2	0.12	0.2	0.007	0.16	0.004	0.11

NOTES: Table 1 reports the results of estimation of equation (37) for two alternative scenarios. No Lockdown: No action is taken against the COVID-19 pandemic; Full Lockdown: A lockdown is put into practice between the 91st and 131st days of the pandemic and is fully effective with zero reproduction number. Dependent variable is defined as sector-level economic cost of the COVID-19 shock that is measured as the percentage change in overall economic activity for a given sector during pandemic relative to its pre-pandemic level. In Columns (1)-(2); (5)-(6) economic activity is proxied by output, and by value added in Columns (3)-(4); (7)-(8), respectively. Heteroskedastic-consistent standard errors are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

in total debt as of 2016) to equation (37) as an additional explanatory variable. This variable also captures domestic borrowing in foreign currency in each sector as opposed to only international borrowing that the I-O Trade Finance variable captures. I-O Trade Finance variable might be skewed towards tradeable sectors, while FX debt variable also captures the domestic foreign currency borrowing of non-tradeable sectors such as construction as reflected in Figure 2.

The regression results are highly consistent with our expectations. The positive and highly significant coefficient estimates in the first columns of Table 1, confirm the importance of international linkages on sectoral COVID losses under no lockdown. The results suggest that sectors with stronger I-O links suffer from larger COVID-19 related losses. They further suggest that sectors who finance these stronger production links through capital flows and sectors with higher FX exposure suffer even more, highlighting the additional adverse impact of COVID-19 on EMs with high external debt and domestic FX debt.

Interestingly, when we use the sectoral COVID losses that we estimate under full lockdown scenario on the left hand side in columns (5) to (8), the strong relation between sectoral output losses and I-O trade and finance linkages disappear. This is because now there is almost no sectoral variation on the left hand side that can be linked to open economy linkages. The coefficient on FX debt

stays positive and significant with a similar magnitude as this debt is mostly borrowed domestically and hence still linked to the sectoral variation in COVID losses as higher FX debt sectors are also the ones with close proximity jobs and hence higher COVID losses. The sectoral breakdown of the Turkish inflation data as of June 2020 provides an early confirmation of these findings. It is observed that the service sectors that are hit the hardest from COVID, such as transportation, food and accommodation, or arts and entertainment are the ones that experienced the highest monthly price increases. Given the substantial withdrawal of demand in these sectors, the increase in the price level reflects supply side pressures because these sectors have high external debt, domestic FX debt, and I-O linkages.

5.4   Taking Stock

When we take a look at the experiences of the countries over the course of the pandemic, we note that there are several paths adopted by different countries:

  (i) **Full lockdown:** Greece, New Zealand and Denmark provide good examples for an effective full lockdown. Our analysis indicates that this is the policy that minimizes economic costs by containing the pandemic in the most effective way.

 (ii) **No lockdown:** Very few countries considered no lockdown since the beginning of the pandemic. No lockdown approach might yield lower economic costs but the death toll is significantly higher. The economic costs are mostly dependent on the changes in demand.

(iii) **No lockdown followed by a full lockdown:** At the beginning of the crisis, UK adopted a no lockdown approach. However, this approach was abandoned later on due to public pressure as the death toll rose. UK then adopted a full lockdown policy to contain the pandemic. Our analysis indicates that if the lockdown was not delayed, there would be less mortality and the economic costs would be lower because the lockdown would begin with a smaller number of infections.

(iv) **Partial lockdown followed by full lockdown:** Many countries followed this route including Italy, France, Germany, Spain, Iran, Russia among others. Several of these counties recently

announced that they will gradually lift restrictions. The duration of full lockdown is longer than it could have been, had it been implemented earlier. In Italy, for example, a full lockdown went into effect on March 10, and the restrictions are announced to be removed by May 4, after approximately two months under full lockdown.

(v) **Enhanced Partial lockdown:** Turkey started with immediate partial lockdown measures which were enhanced over the course of the pandemic. Schools were closed on March 16 and the businesses were encouraged to work remotely where possible. On March 21, a curfew was imposed for people above the age of 65 and those with chronic diseases. The curfew was extended to those younger than 20 on April 5, effectively putting close to 40% of the population under full lockdown. Furthermore, a full lockdown was implemented on weekends and national holidays starting on April 9 in 31 largest cities which constitute approximately 87% of the population.[38] After about 45 days since the beginning of enhanced partial lockdown measures, R_0 is reduced below 1 and the number of new patients is lower than the number of recovered patients as of the last week of April.

Where does this take us? Our analysis indicates that a full lockdown at the early stages of the crisis can bring the pandemic under control relatively quickly. There are countries who implemented this successfully but also countries such as India, who tried an early full lockdown but did not succeed. The individual performance of the country depends on several factors that affect the recovery and the infection rates. An evaluation of Turkey's performance, two months after the introduction of lockdown measures indicates that Turkey did reasonably well. Potential reasons for the superior performance are the remarkable ICU capacity, young population, less care homes, as well as the generally compliant population where government decrees are not challenged. [39] If an enhanced partial lockdown is already in place, which is successful in lowering R_0 below 1, then the need for full lockdown may not be imminent. However, our results reflect that the duration of the lockdown would have been shorter if more restrictive measures were adopted right away.

An emerging question at this stage is the removal of restrictions once the pandemic is taken un-

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[38]These cities include the 30 metropolitan municipalities and Zonguldak, which constitute close to 79% of the population. On top of these, the age-based restrictions are intact in the rest of Turkey, which increases the number close to 87%.

[39]See https://blogs.lse.ac.uk/covid19/2020/06/04/how-has-turkey-done-in-its-fight-against-covid-19-the-jury-is-still-out/ for a detailed evaluation of Turkey's performance based on our framework

der control. As the duration of lockdown increases, policy makers get anxious about opening up their economies. In this paper, we model demand as a function of the number of infections and combine this with actual spending decline during COVID-19, measured in the data with credit card purchases. Thus, our framework implies that demand would not normalize by the mere attempt of removing the restrictions, so long as the number of infections are sizable. What is worse is that the number of infections would increase again as businesses open. In the model, we do not explicitly incorporate expectations about infections and implicitly assume that the two are highly correlated. Meanwhile, one can imagine a forward looking demand curve, which could be a function of infection expectations rather than the actual number of infections. In this case, leaders might be able to affect expectations about the number of infections and revive demand by removing the restrictions. To the extent that leaders can successfully convey a more optimistic outlook, the negative demand effect that we model in this paper may weaken and the economic costs of prematurely ending a lockdown might decline.

Another imminent issue is the potential second wave once the restrictions are removed. This is particularly a problem for those countries that adopted a full lockdown at the early stages of the crisis and controlled the pandemic in their own countries. If they open their borders, there is the risk of a second wave. If they do not open their borders, then they cannot fully normalize and suffer from an extended partial lockdown given the importance of the amplification effects on economic costs for open economies. The takeaway at this stage is that if a second wave of the COVID-19 virus hits, then an immediate and potentially *global* lockdown would work in the most effective way.

6 What are the policy options for EMs?

The previous sections illustrate the economic costs of the pandemic due to a fall in the GDP given the large supply and demand shocks for a small open economy. A lockdown increases the short-term costs but increases the long-term gains by leading the way to a faster recovery. One of the shortcomings of the model is that it does not incorporate the damage to the productive capacity that are caused by company closures. We simply assume that the productive capacity remains intact and the companies jump back to production once the pandemic is over. This is an overly optimistic

assumption and in the absence of a comprehensive support program, the liquidity issues would turn into solvency issues. This could lead to unnecessary bankruptcies, a deeper recession and a sluggish recovery.[40] Indeed, this is exactly why our estimates in the previous section should be interpreted as the lower bound costs of a stimulus package that is necessary to offset the damages of the COVID-19 crisis and keep the economic units alive.

A quickly implemented stimulus package that compensates the income loss due to the lockdown and enables a faster recovery would minimize the long term damage in the production capacity. If the stimulus packages are delayed, on the other hand, more companies would fail, more workers would be laid-off, and demand would decline further. This would then feed into more bankruptcies and elevate the economic costs that quickly become unmanageable. In fact, just as a drowning person needs immediate help or else her organs start to fail, the economy needs immediate help before the companies start to fail. Fiscal transfers can help to ensure that the supply chains are not destroyed, the economic units are functional and ready to go back to production once the pandemic is contained and demand returns. Fortunately, many governments around the world took decisive action. In the case of EMs, however, policy options are limited given the limited fiscal space. As put by former Colombian finance minister, Mauricio Cardenas:[41] "We do not live in whatever it takes region, we can do whatever we can." Thus, we next discuss the possible ways to finance the economic costs related to COVID in EMs.

6.1 Quantitative Easing or Debt Monetization? What is the difference?

The buzz-word in advanced countries for the funding needed to deal with the crisis is "helicopter money." In economists' jargon, this is called monetary financing where the central bank prints money and transfers resources to firms and households either directly, as in the Federal Reserve's recent policy of purchasing commercial paper and corporate debt, or indirectly by purchasing government bonds and enabling the government to use the proceeds to deal with the crisis.

In the process of monetary financing of the debt, the central bank's balance sheet will enlarge, either through direct loans to institutions or through large scale asset purchases (i.e. the so called

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[40]See Kalemli-Özcan et al. (2018), Gourinchas et al. (2020), and https://voxeu.org/article/proposal-negative-sme-tax
[41]The Economist, May 25, 2020.

"quantitative easing" (QE) programs). In a QE, the central bank prints money and buys sizeable amounts of government bonds. In the recent history, this was observed after the Great Recession both in the US and in Europe. The advantage of direct lending is that the liquidity is drained more easily when the loans are paid back.

How is debt monetization different? A central bank typically purchases securities through open market operations to meet the liquidity needs, consistent with its goal of price stability. The technical difference between money printing through an open market purchase and monetizing the debt is slim (Mishkin, 2007). Thus, one might argue that QE policies are effectively debt monetization (Orphanides, 2017). The Federal Reserve begs to differ and argues that debt monetization refers to a "permanent" source of funding for the government by the central bank and separates QE policies from debt monetization.[42, 43] So as long as the central bank commits to inflation targeting and normalizes its balance sheet when inflationary pressures kick in, asset purchases in the form of QE are not considered debt monetization (Andolfatto and Li, 2013). Based on this nuance, one can argue that QE and debt monetization are "observationally equivalent" in the short run, and the difference becomes apparent in the long run, with the central bank's ability to shrink its balance sheets to counteract inflationary pressures. Hence, using the Federal Reserve's usage of the term, the criterion for bond purchases to be considered debt monetization is whether the central bank fails to drain the money effectively later on and the money remains in the system permanently such that it leads to inflationary pressures.

In advanced economies, the distinction between QE and debt monetization can be easier to ascertain where the inflation rate is well-anchored and central bank credibility is well established. In fact, the inflation rate has not exceeded the 2 percent target in the US or Europe in the aftermath of large scale quantitative easing policies after the Great Recession. The distinction between QE and debt monetization can get blurry in EMs, however, particularly for those with a history of high inflation and weak credibility.

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[42]In the FAQs prepared by the Federal Reserve Board (https://www.federalreserve.gov/faqs/money_12853.htm), it is noted that "The term "printing money" often refers to a situation in which the central bank is effectively financing the deficit of the federal government on a permanent basis by issuing large amounts of currency. This situation does not exist in the United States."

[43]In response to a question from the lawmakers on June 3, 2009, then-chairman Bernanke had noted that the "Federal Reserve will not monetize the debt": https://www.c-span.org/video/?c4546512/user-clip-bernanke-debt-monetization

The key to a successful QE is policy credibility. A badly managed QE would erode credibility of the monetary policy making and de-anchor inflation expectations. This would only escalate the existing crisis by pushing the inflation rate on a higher trajectory and causing sharp depreciations in domestic currency. Hence, if it is not executed properly and the money is not drained from the system at the right time, QE can turn into inflationary debt monetization. In that respect, QE is far more challenging for EM central banks with weaker track records who need to be extra careful to clearly communicate their QE policies for policies to be credible.[44]
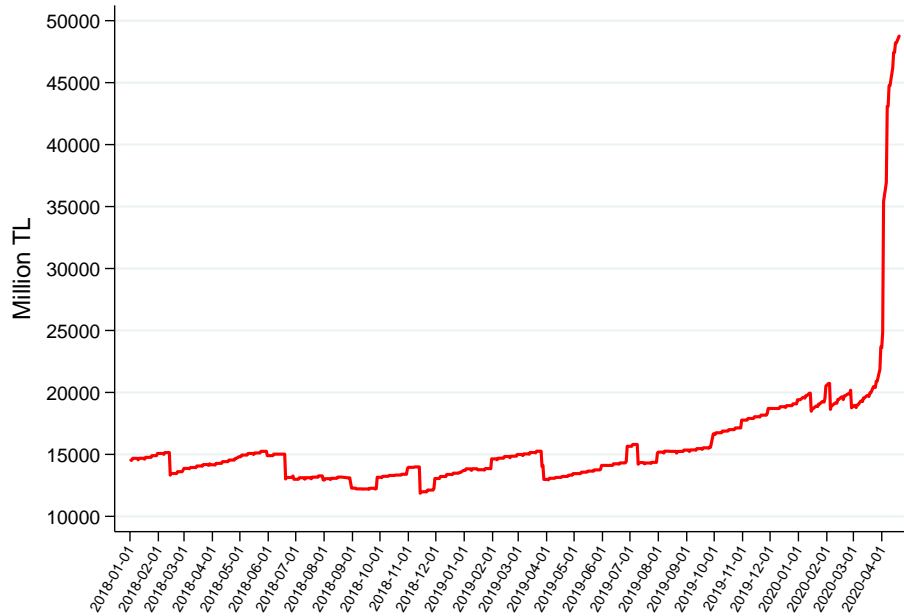
How does this apply to Turkey? There is a rapid increase in CBRT's bond holdings (Figure 16), which reflects sizable balance sheet expansion. Although the the size of purchases is currently limited to 10% of CBRT's balance sheet, the statement on March 31 suggests that these limits might be adjusted as needed. Thus, even though the data on purchases is publicly available, there is not yet an announcement of an explicit QE program with a clear exit strategy as is typically done in the advanced economies. We argue that transparent communication on this issue will be even more important going forward and hence rather than the absolute limit on the purchases, how foreign investors' sentiments change with these purchases is more important. If the limits announced can be data driven and tied to economic conditions in the country in question, they will be more transparent. [45]

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[44]Foreign investors sentiments are aligned with this view, see https://www.ft.com/content/6a63d700-3a59-4e3f-8092-4c818ffaa9d8.

[45]See https://www.ft.com/content/6a63d700-3a59-4e3f-8092-4c818ffaa9d8.

Figure 16: CBRT's Holdings of Government Bonds

NOTES: This figure plots the holdings government bonds of the CBRT. Source: Turkey Data Monitor

If you face a 1.5 percent inflation rate as in the US, and a deep recession is on its way, inflationary consequences of QE may not be imminent. This is because the public does not expect inflation to get out of control despite these excessive measures. There is still belief that the Fed will drain the money from the system at the right time and establish price control. Furthermore, because market participants do not expect the US government to default on its debt, there will not be a sharp decline in demand for US government bonds, which will keep interest rates under control. Turkey has been missing its 5 percent inflation target for some time now and the market sentiment is such that policy credibility eroded over the course of years (see Cakmakli and Demiralp (2020). [46]

The ultimate goal is to convince the market participants that QE will not turn into inflationary debt monetization. A detailed bond purchase calendar can be communicated with spending targets and the conditions under which the money will be drained from the system.[47] One way to increase

[46] See e.g. https://www.ft.com/content/a2a178f8-a109-11e9-974c-ad1c6ab5efd1 or https://www.wsj.com/articles/turkish-lira-falls-after-central-bank-defiantly-leaves-rates-unchanged-1532433561 for the unfavorable perception of credibility in alternative media outlets

[47] See Unsal, Papageorgiou and Garbers, 2020 on central bank communication for unconventional policies.

the transparency of QE could be through a Special Purpose Vehicle (SPV). An SPV would allow central banks to buy government bonds through this entity and separate these COVID-19 related bond purchases from the daily maintenance of monetary policy. The extent of monetary expansion that is solely due to COVID-19 crisis could be easily trackable in this manner. In turn, the money that is generated through this program should be spent in targeted sectors and announced by the government.

While a transparent and well executed QE could provide immediate funding that is necessary to deal with COVID-19 crisis, it would likely be insufficient. The case of Turkey, as several other EMs, requires a joint thinking of fiscal needs and capital flows given foreign financing needs. In the next section, we discuss the magnitude of external funding needs in Turkey.

6.2 External Funding Needs, Capital Controls, and the Role of External Anchor

Considering the facts that (i) the total amount of external debt that needs to be paid or rolled-over in 2020 is 23 percent of GDP and (ii) the current open FX position of the entire corporate sector as of January 2020 (which is -$175 billion) is almost 25 percent of GDP, Turkey has serious external funding needs. Our analysis in the earlier sections highlighted that those sectors with stronger trade linkages and higher external funding needs are more vulnerable during COVID-19 crisis. In order to get a sense of the economic outlook for these sectors and highlight the potential risks, this section investigates the external funding needs for the Turkish economy in the post COVID-19 world.

The rapid increase in the risk premium (Figure 3) shows that cost of external borrowing is getting higher for most EMs, which will make it harder to rollover external debt. News reports reflect that the investor sentiment is deteriorating given the large short-term external debt of the banking sector.[48] Many EMs are in a similar spot where the largest capital outflow so far was observed in Brazil with 12 billion USD outflow from the stock market and 19 billion USD outflow from the bond market before May 2020. Investors cited "fear" not only about the pandemic but also about the uncertainty surrounding the economic policies.[49] These sizable numbers for large EMs such as Turkey and Brazil suggest that several out-of-the-box policies may be needed.

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[48]See https://www.reuters.com/article/turkey-banks-funding-idUSL8N2DF21S.

[49]See Financial Times, June 2, 2020, Brazil Record Outflows.

In terms of policy alternatives for Turkey, a rate hike to compensate for the risk premium could be an option. Nevertheless, even in the absence of a large demand shock such as COVID, tight monetary policy may not be fully effective under a large risk-off shock, as shown by Kalemli-Özcan (2019). During risk-off shocks, raising policy rates to defend the currency and to bring back the capital flows backfires based on historical experiences, especially in countries with low policy credibility and high risk premia. In addition, given the large negative demand shock, the necessary accommodation can only be provided by loosening the monetary policy as many EMs, including Turkey, have done so far. On the other hand, EMs with high external debt cannot rely on rate cuts entirely either and need to find the balance between supporting domestic demand and limiting the volatility of their domestic currencies.[50]

A swap agreement with the Federal Reserve or another international institution[51] can help to address the liquidity needs arising from COVID-19 crisis, but this may not be enough on its own if the pandemic extends and weakens the businesses ability to remain in operation and service their debt, given the size of the domestic fiscal needs and external financing needs.[52] On May 20, Turkey announced that the existing swap line with Qatar is expanded to $15 billion. However, no swap arrangements with G20 countries with whom Turkey has sizable trade relationships has been announced yet. It should also be noted that the Federal Reserve did not expand the list of countries that are eligible for a swap line since the GFC. Because Turkey was not it the original list during GFC, it is rather unlikely that a swap line can be arranged with the Fed at this time.[53]

Yet another alternative is to introduce capital controls to trap both residents' and non-residents' foreign currency assets in Turkey, which in turn will limit the TL depreciation. Notice that, while capital controls on inflows during a boom might reduce the future probability of a sudden stop and protect financial stability,[54] capital controls on outflows during a large risk-off shock might have unintended consequences.[55] Historically, capital controls on outflows have not been very effective (see Loungani and Mauro (2000)). Most likely, what EMs need is more capital inflows, not controls on

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[50]See , Basu et al. (2020) who models optimal policy mix for EMs that will allow them monetary policy autonomy.

[51]The average emergency swap agreement granted by the IMF is about $11bn, https://www.imf.org/en/News/Articles/2020/04/07/sp040920-SMs2020-Curtain-Raiser, and the total outstanding amount granted by the Federal Reserve's international swap lines is $18.9 bn as of April 14, https://apps.newyorkfed.org/markets/autorates/fxswap.

[52]https://blogs.imf.org/2020/03/16/policy-action-for-a-healthy-global-economy/#.Xm9rH3Oc-7A.twitter

[53]https://yetkinreport.com/en/2020/05/11/would-the-fed-establish-a-swap-line-with-turkey/

[54]Mendoza (2010), Basu et al. (2020).

[55]Bartolini and Drazen (1997).

outflows. If EMs breach contracts, they might face legal action by private creditors, which compromises their future access to capital markets. Especially when there is significant foreign investment in local currency bonds of EMs, a panic by foreign investors would put even more pressure on local currency and inflation. As a result, such controls might further erode the policy credibility and scare foreign capital during the recovery phase when it will be most needed, especially for a country like Turkey who is already heavily dependent on external funding.[56] Hence, going back to our previous analogy, one might try to keep horses in the barn but needs to be also careful about not scaring the horses that can scar them for a longer time.

Since the beginning of COVID-19 outbreak, Turkey took certain steps that were perceived as as mild forms of capital control by the markets, mostly on domestic residents.[57] Such steps took the form of limiting TL supply in international swap markets, notifying the government regarding sizable FX transfers abroad, or restricting the TL transactions of large custodian banks. More recently on May 24, the tax on exchange rate and gold transactions has been increased from 0.2 percent to 1 percent. These measures deter foreign investors not only because they limit their ability to move their capital around but also because they give the impression of random changes in the legislation. Unpredictable changes in regulations that are viewed as interventions to the free market mechanism have the potential to discourage future capital inflows and damage policy credibility.[58] If the global recovery takes longer than a few years, interest rates would remain low in advanced countries and foreign investors would likely be willing to invest in riskier EM assets driven by search for yield motives similar to the period after 2007-2009 crisis. In that case, costs of too early capital controls might be not accessing finance in the medium term since it is well known that once capital controls on outflows put in place, it takes a long time to remove them.[59] In terms of their benefits, it could be argued that capital controls would prevent further dollarization that might be triggered by the TL liquidity injected through the QE program. Nevertheless, dollarization can also be prevented without capital controls if there is enough policy credibility to keep inflation expectations anchored.

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[56]These arguments reflect the views of foreign investors. See e.g. https://www.reuters.com/article/turkey-banks-funding-idUSL8N2DF21S.

[57]See, e.g., Financial Times article on February 9 https://www.ft.com/content/8eb51526-4bd5-11ea-95a0-43d18ec715f5 or on April 30 https://www.ft.com/content/06c85177-39ae-42fd-90cb-1d6bc6cbb11a

[58]See a nice summary of restrictions during COVID-19 period by Avci, 2020: https://yetkinreport.com/en/2020/05/14/will-turkey-attract-foreign-investments-after-covid-19/

[59]For example, it took Iceland 10 years to lift the controls put during the 2007-2008 crisis. See https://voxeu.org/article/capital-controls-21st-century.

One final alternative is a debt moratorium on foreign lenders. However, since foreign lenders are private creditors (and not official creditors), this would involve complicated debt default and debt restructuring. Unless private creditors offer the moratorium in a synchronized way as suggested by Rogoff and Reinhart (2020), a disorderly one would again hamper the medium to long-term credibility.

While there are still significant uncertainties regarding the future course of the pandemic, the alternatives that we laid out in this section aim to provide a better sense of potential scenarios if the crisis lengthens and global financial conditions tighten. If the external financial needs cannot be met through the market mechanism, then granting FX liquidity through arrangements with international institutions seem to be the optimal solution that would minimize future risks and speed up economic recovery. Our estimates in this paper suggest that those sectors that rely more on external borrowing are hit harder during COVID-19. Thus, keeping the flow of FX credit is particularly important for these sectors to maintain their production capacities.

Although EMs did not observe a crisis similar to COVID-19, their history is full of crises, where different stabilization policies were employed. Turkey's own historical experience involves a transparent QE program to meet the immediate liquidity needs combined with guaranteed external finance through an international institution in the aftermath of 2001 crisis. This was a combination of banking crisis, sovereign debt crisis and a balance of payments crisis. During that time, Turkey employed a sizable asset purchase program under an IMF program, keeping inflation expectations in check with a transparent inflation targeting framework. We lay out the details of this episode in the next section.

7 Lessons from History: Bond Purchases under an IMF program

When the financial crisis hit in February 2001, Turkey already had a standby agreement with the IMF, ongoing since December 1999.[60] State banks and Savings Deposit Insurance Fund (SDIF) experienced significant losses during the 2001 crisis, which elevated their liquidity needs. In order to meet their liquidity needs and recapitalize these institutions, government securities were trans-

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[60]The history of lending arrangements with the IMF are available at the following link: https://www.imf.org/external/np/fin/tad/extarr2.aspx?memberKey1=980&date1key=2008-03-31.

ferred to these institutions. The securities were then sold to the CBRT to receive cash to cover their liquidity needs. The size of securities purchases reached approximately 8 percent of GDP during that time. In turn, the CBRT drained the excess liquidity gradually through conventional methods (i.e., either through reverse repos or through its overnight borrowing facility) in order to prevent an unintended decline in market rates (see Statement of Intent, 2001).[61] When the ongoing 1999 program was deemed to be insufficient, a new and more comprehensive standby agreement was signed in 2002 which particularly aimed at lowering inflation expectations by strengthening policy credibility.[62]

The asset purchases that were undertaken in the post-2001 period took place at the same time Turkey started a new regime to take inflation under control. An amendment to the Central Bank Law (no: 1211) in 2001 granted operational independence. In the same amendment, it was stated that direct bond purchases from the government would continue until November 2001. The bond purchase program (debt monetization) was acknowledged in the 2002 agreement as well.[63] Figure 17 displays the overall size of CBRT's total assets in real terms. We observe that CBRT's total assets increased about 122 percent, from January 2000 to November 2001. To provide perspective, the Federal Reserve's balance sheet increased 100 percent after four rounds of QEs from December 2008 through October 2014.
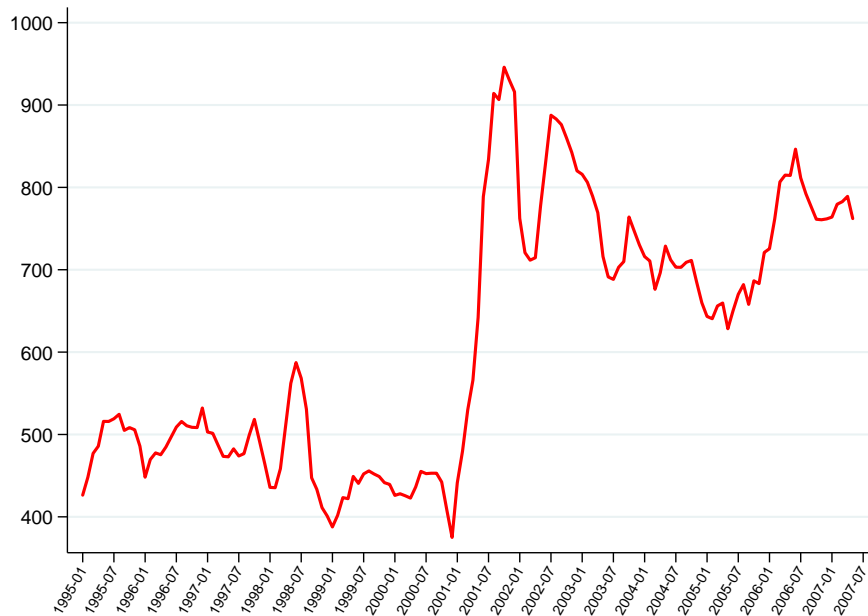
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[61]https://www.imf.org/external/np/loi/2001/tur/02/index.htm

[62]As stated in Statement of Intent, 2001: "This program is a continuation of the one initiated in late 1999, with the support of a stand-by arrangement with the International Monetary Fund. It shares the same strategy: disinflate the Turkish economy, strengthen the fiscal accounts, and reform the structure of the Turkish economy as a condition for setting economic growth on a sustainable basis and moving Turkey closer to its goal of joining the European Union. However, the program's policies have been significantly strengthened, in response to the recent crisis that led to the float of the Turkish lira on February 22, 2001, including through increased emphasis on transparency, accountability, and good governance in both the private and public sectors. In support of our strengthened program, we request that the arrangement be augmented by the equivalent of SDR 6.3624 billion and that the purchases scheduled through end-2001 be rephased and would consequently be subject to reviews which are expected to be completed during May, June, July, September, and November 2001."

[63]https://www.imf.org/en/Publications/CR/Issues/2016/12/30/Turkey-2002-Article-IV-Consultation-and-First-Review-Under-the-Stand-By-Arrangement-Staff-15925

Figure 17: Total Assets of CBRT

The 2002 standby agreement with the IMF not only met the external funding needs but it also provided the much needed credibility to boost confidence in the program and prevent excessive depreciation in the local currency. The comprehensive package of reforms that was supported by the standby agreement was instrumental in limiting domestic funding needs. In turn, this restricted the volume of asset purchases, taking the pressure off inflation expectations. Once the liquidity needs subsided, the liquidity was drained from the system promptly and transparently. As a result of these coordinate efforts, there was a successful disinflation performance as shown below in the absence of volatility in the exchange rate (Figures 18a and 18b).

An essential part of disinflationary policies in the post crisis period involved lowering inflation expectations. The program anchored inflation expectations by ensuring that large scale bond purchases would not turn into debt monetization. In order to prevent bond purchases from causing a substantive increase in inflation expectations and restore investor confidence in the program, public

finance and debt management laws were introduced to improve fiscal transparency and accountability. Furthermore, the budgetary impact of the additional funds needed to restructure the banking system was offset by increasing public savings in other areas to keep the overall budget under control. This step limited the extent of public borrowing and prevented market interest rates from rising further.

Figure 18: Inflation Rate and Exchange Rate

(a) Inflation Rate   (b) USD/TL Exchange Rate
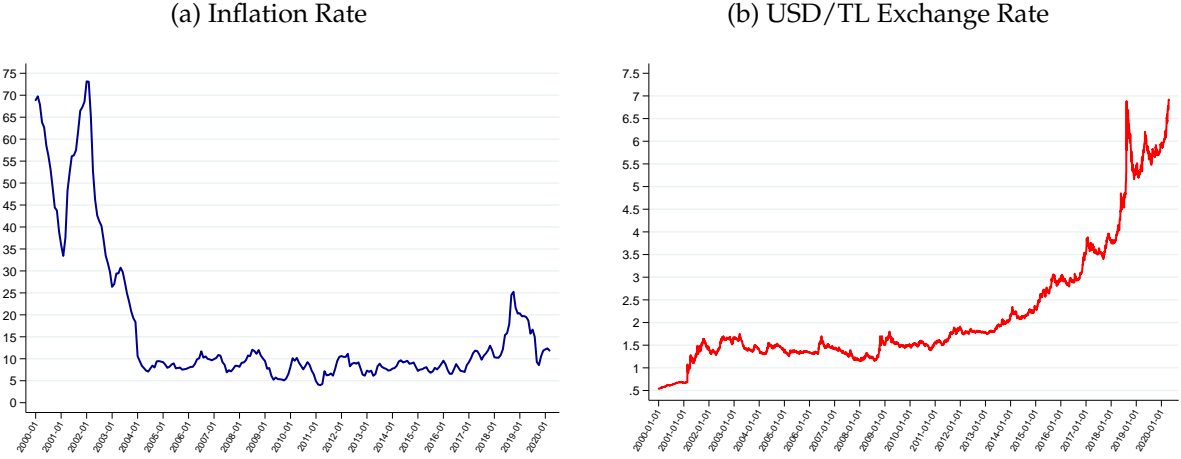
NOTES: (a) This figure plots inflation rate for Turkey, which measured as year-on-year change of CPI. (b) This figure plots USD/TL nominal exchange rate for Turkey. Source: Turkey Data Monitor

8 Conclusion and Policy Implications

Containing the pandemic as soon as possible is an urgent obligation to save human lives. Nevertheless, we have to act now also to deal with the economic fallout from the pandemic as the economic costs can be substantial. As put by the IMF (2020), this is "a crisis like no other" with potentially far more disastrous implications for emerging markets and developing economies relative to advanced economies.

We develop a small open economy SIR-multi-sector-macro model and calibrate it to Turkey using real time data. The annual cost of the COVID-19 crisis that we estimated ranges between 5.8 percent (full) and 11 percent (partial) of the Turkish GDP depending on the effectiveness and the duration of the lockdown. We estimate that the most cost effective full lockdown scenario implies a quarterly

GDP contraction of 17 percent. Delays in full lockdown, prematurely ending the lockdown, or a combination of full lockdown with partial lockdown increases the toll. While the numbers are rather scary and unforgiving, we take comfort in our prologue that "Best safety lies in fear" and urge caution in removing the lockdown restrictions, not only to save more lives but also to minimize the economic toll. Large economic costs do not come from lockdowns but rather from the fear factor, which can only go down once the disease is under control.

To understand the policy options for EMs, we have to be aware of their key characteristics. Large EMs are part of global supply chains and they have domestic and external debt, both denominated in local currency and in foreign currency. They generally have lower policy credibility relative to advanced economies. Most are heavily dependent on capital inflows to meet the demand in their fast growing economies, where these inflows also finance the supply chains. EMs learned their lessons from the crises of 1990s and early 2000s in the sense that they have manageable fiscal deficits and better capitalized banking systems as they face the COVID-19 crisis. Nevertheless, they will still operate with low fiscal space during their response to the COVID-19 shock given the size of the shock, domestic health needs and capital flow reversals that lead to increasing external finance gaps.

In terms of policy implications, EMs are in a position of difficult trade-offs. For a typical EM, a large part of its external debt is in the form of domestic banks borrowing from global banks and hence debt relief from official lenders will not help.[64] If domestic banks cannot rollover their external debt due to increased borrowing costs and insolvency risks of domestic firms, then there is a potential threat not only to domestic financial stability but also to global financial stability from elevated stress in such EMs. The risk of a deep recession could be reduced under a targeted and transparent asset purchase program by EM central banks, accompanied by external funding granted by an international institution in the absence of any financing from international capital markets. The literature shows that asset purchases programs require policy credibility to keep inflation expectations under control so that such programs do not turn into long term monetary financing of government debt.[65] With rising country risk premia under COVID shock, the perceptions of global investors and the market sentiment will be key determinants of capital flows.[66] In this context, international financial

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[64]Avdjiev et al. (2017), Bruno and Shin (2015).

[65]See https://www.brookings.edu/wp-content/uploads/2019/12/Bernanke_ASSA_lecture.pdf for Chairman Bernanke's ASSA lecture and the references therein.

[66]Rey (2015) and Kalemli-Özcan (2019).

institutions and central banks of reserve currency countries such as the Federal Reserve, can play a key role in assuring global investors and changing the risk perceptions so that EMs will have access to international financial markets.

Turkey has large external financing needs, with an upcoming external debt payment in 2020 as large as 23 percent of the GDP ($169 bn). Given these numbers, it seems rather challenging for Turkey to rollover its foreign currency debt and finance its domestic debt solely through a QE-type program unless monetary policy is transparent and communicated clearly similar to the QE policies of advanced countries. A well-designed and comprehensive package of macroeconomic and structural reforms will increase policy credibility and reduce external borrowing costs and spreads. Funding from international institutions would further signal support for the policy package and help to cover the financing gap in international markets. This would further lower the external finance premium and ease financial strains faced during the pandemic.

There are still substantial uncertainties ahead of us regarding the course of the pandemic.[67] In the absence of global coordination, countries that successfully contain the virus struggle about how to enable international trade and travel with the fear of a second wave. In this paper, we highlight that the role of global coordination is essential for open economies with international I-O linkages. If the lockdown could be implemented with global synchronization, demand would return to pre-pandemic levels faster and the economic costs of the pandemic could be kept at a minimum level. As this is not done so far, all the policy options should be on the table for EMs given the dynamic nature of this crisis with new information arriving every day. Looking ahead, should a second wave hit, a globally coordinated full lockdown would allow for the fastest global recovery.

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[67]See Baker et al. (2020) and Ludvigson et al. (2015) on the role of uncertainty shock linked to COVID-19.

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A APPENDIX

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Figure A.1: The Structure of OECD Inter-Country Input-Output Table

|	Intermediate use	Final Demand	Output
	country 1 x industry 1 [...] country 69 x industry 36	country 1 x fd 1 [...] country 69 x fd 7	
country 1 x industry 1 country 1 x industry 2 … … country 69 x industry 1 … country 69 x industry 36	(Z)	(F)	(Y)
Value added + taxes - subsidies on intermediate products	(VA)		
Output	(Y)		

NOTES: This table illustrates the structure of OECD Inter-Country Input-Output Table (ICIO), which represents the breakdown of output corresponding to 36 industries and 69 countries, giving us a matrix of 2484×2484 entries. In any industry-country combination, the output (Y) equals intermediate use (Z) plus final demand (F) of 36 industries in 69 countries. Industry list can be found in Table A.2. Further, in any industry-country combination, final demand sums the following components of expenditures over 69 countries. fd1: Households Final Consumption Expenditure (HFCE); fd2: Non-Profit Institutions Serving Households (NPISH); fd3: General Government Final Consumption (GGFC); fd4: Gross Fixed Capital Formation (GFCF); fd5: Change in Inventories and Valuables (INVNT); fd6: Direct purchases by non-residents (NONRES); fd7: Statistical Discrepancy (DISC).

Table A.1: FISCAL RESPONSES TO THE COVID-19 SHOCK IN THE G20 COUNTRIES

Country	% GDP	Explanation
Argentina	3	Adopted measures (totaling about 3.0 percent of GDP, 1.2 percent in the budget and 1.8 percent off-budget, based on authorities' estimates)
Australia	10.8	Total expenditure and revenue measures of A$194 billion (9.9 percent of GDP). The Commonwealth government has committed to spend almost an extra A$5 billion (0.3 percent of GDP). State and Territory governments also announced fiscal stimulus packages, together amounting to A$11.5 billion (0.6 percent of GDP)
Brazil	6.5	The authorities announced a series of fiscal measures adding up to 6.5 percent of GDP. Public banks are expanding credit lines for businesses and households, with a focus on supporting working capital (credit lines add up to over 3 percent of GDP), and the government will back a 0.5 percent of GDP credit line to cover payroll costs.
Canada	8.4	Key tax and spending measures (8.4 percent of GDP, $193 billion CAD).
China	3.8	An estimated RMB 2.6 trillion (or 2.5 percent of GDP) of fiscal measures or financing plans have been announced. The overall fiscal expansion is expected to be significantly higher, reflecting the effect of already announced additional measures such as an increase in the ceiling for special local government bonds of 1.3 percent of GDP.
France	19	The authorities have announced an increase in the fiscal envelope devoted to addressing the crisis to €110 billion (nearly 5 percent of GDP, including liquidity measures), from an initial €45 billion included in an amending budget law introduced in March. A new draft amending budget law has been introduced on April 16. This adds to an existing package of bank loan guarantees and credit reinsurance schemes of €315 billion (close to 14 percent of GDP).
Germany	31.6	The federal government adopted a supplementary budget of €156 billion (4.9 percent of GDP). The government is expanding the volume and access to public loan guarantees for firms of different sizes and credit insurers increasing the total volume by at least €757 billion (23 percent of GDP). In addition to the federal government's fiscal package, many state governments (Länder) have announced own measures to support their economies, amounting to €48 billion in direct support and €73bn in state-level loan guarantees (Authors: Another 3.7% of GDP).
India	1.1	Finance Minister Sitharaman on March 26 announced a stimulus package valued at approximately 0.8 percent of GDP. These measures are in addition to a previous commitment by Prime Minister Modi that an additional 150 billion rupees (about 0.1 percent of GDP). Numerous state governments have also announced measures thus far amount to approximately 0.2 percent of India's GDP.
Indonesia	2.8	In addition to the first two fiscal packages amounting to IDR 33.2 trillion (0.2 percent of GDP), the government announced a major stimulus package of IDR 405 trillion (2.6 percent of GDP) on March 31, 2020.
Italy	26.4	On March 17, the government adopted a €25 billion (1.4 percent of GDP) 'Cura Italia' emergency package. On April 6, the Liquidity Decree allowed for additional state guarantees of up to €400 billion (25 percent of GDP).
Japan	21.1	On April 7 (partly revised on April 20), the Government of Japan adopted the Emergency Economic Package Against COVID-19 of ¥117.1 trillion (21.1 percent of GDP)
Mexico	0.7	to request additional resources from Congress, that could reach up to 180 billion pesos (0.7 percent of 2019 GDP). AND The week of April 19 the President further announced an austerity program for public expenditures including wage reductions and a hiring in order to free up 2.5 percent of GDP to finance additional health expenditures and priority investment.
Republic of Korea	10	Direct measures amount to 0.8 percent of GDP (approximately KRW 16 trillion. On March 24, President Moon announced a financial stabilization plan of KRW 100 trillion (5.3 percent of GDP). This was augmented by a further KRW 35 trillion (1.8 percent of GDP) on April 22 through additional measures. On April 22, President Moon announced a key industry stabilization fund would be established for KRW 40 trillion (2.1 percent of GDP)
Russian Federation	2.1	The total cost of the fiscal package is currently estimated at 2.1 percent of GDP.
Saudi Arabia	5	A SAR 70 billion ($18.7 billion or 2.8 percent of GDP) private sector support package was announced on March 20. they will reduce spending in non-priority areas of the 2020 budget by SAR 50 billion (2.0 percent of GDP) to accommodate some of these new initiatives within the budget envelope. on April 3, the government authorized the use of the unemployment insurance fund (SANED) to provide support for wage benefits, within certain limits, to private sector companies who retain their Saudi staff (SAR 9 billion, 0.4 percent of GDP). On April 15, additional measures to mitigate the impact on the private sector were announced, including temporary electricity subsidies to commercial, industrial, and agricultural sectors (SAR 0.9 billion) and resource support to the health sector was increased to SAR 47 billion.
South Africa	0.2	https://www.globalpolicywatch.com/2020/04/south-africas-economic-response-to-the-covid-19-pandemic/
Spain	11.7	Key measures (about 1.6 percent of GDP, €18 billion; depending on the usage and duration of the measures the amount could be higher). In addition, the government of Spain has extended up to €100 billion government guarantees for firms and self-employed. Other measures include additional funding for the Instituto de Credito Oficial (ICO) credit lines (€10 billion); introduction of a special credit line for the tourism sector through the ICO (€400 million);
Turkey	5	A TL100 billion package was announced. This consists of TL75 billion ($11.6 billion or 1.5 percent of GDP) in fiscal measures, as well as TL 25 billion ($3.8 billion or 0.5 percent of GDP) for the doubling the credit guarantee fund. Gradually, this package increased to be 5% of GDP.
United Kingdom	18.8	Policy measures adding £86 billion in 2020-21. Coronavirus business interruption loan scheme and the Covid Corporate Financing Facility: the business interruption loan scheme was announced as up to £330 billion of support for businesses. Source: https://obr.uk/coronavirus-reference-scenario/
United States of America	13.6	US$484 billion Paycheck Protection Program and Health Care Enhancement Act . An estimated US$2.3 trillion (around 11% of GDP) Coronavirus Aid, Relief and Economy Security Act ("CARES Act"). US$8.3 billion Coronavirus Preparedness and Response Supplemental Appropriations Act and US$192 billion Families First Coronavirus Response Act . They together provide around 1% of GDP.

NOTES: This table reports the COVID-19 relief packages (as percent of GDP) by the G20 countries along with the details of the fiscal packages. Source: IMF Policy Tracker unless otherwise noted. Access Date: April 29, 2020.

Figure A.2: Sovereign Bond Issuance in Turkey

Turkey
Rollover risk, bonds issued, bonds due
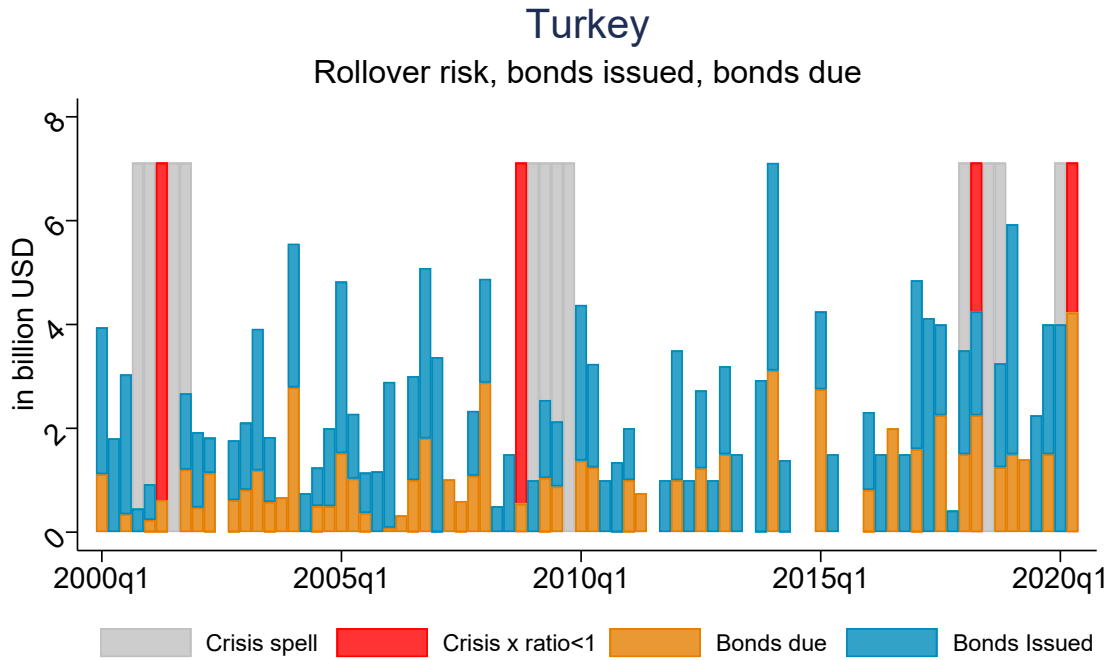
Note: The graphic shows external bonds issued against bonds due on a quarterly basis between 2000q1 and 2020q2. Crisis spells, i.e. periods of severe currency and financial crises, are highlighted in grey. Red areas (2001q2, 2008q4, 2018q2, 2020q2) represent periods during which Turkey experienced a financial crisis and the rollover ratio fell below 1.

Table A.2: PROXIMITY INDEX AND TELEWORKABLE SHARE ACROSS INDUSTRIES

OECD ISIC Code	Definition	Proximity Index	Teleworkable Share
01T03	Agriculture, forestry and fishing	0.86	0.06
05T06	Mining and extraction of energy producing products	1.08	0.32
07T08	Mining and quarrying of non-energy producing products	1.06	0.14
09	Mining support service activities	1.21	0.20
10T12	Food products, beverages and tobacco	1.12	0.13
13T15	Textiles, wearing apparel, leather and related products	1.09	0.20
16	Wood and products of wood and cork	1.03	0.15
17T18	Paper products and printing	1.08	0.22
19	Coke and refined petroleum products	1.11	0.22
20T21	Chemicals and pharmaceutical products	1.06	0.25
22	Rubber and plastic products	1.10	0.18
23	Other non-metallic mineral products	1.08	0.18
24	Basic metals	1.09	0.14
25	Fabricated metal products	1.08	0.21
26	Computer, electronic and optical products	1.03	0.54
27	Electrical equipment	1.07	0.29
28	Machinery and equipment, nec	1.06	0.29
29	Motor vehicles, trailers and semi-trailers	1.09	0.19
30	Other transport equipment	1.06	0.31
31T33	Other manufacturing; repair and installation of machinery and equipment	1.07	0.32
35T39	Electricity, gas, water supply, sewerage, waste and remediation services	1.08	0.29
41T43	Construction	1.21	0.19
45T47	Wholesale and retail trade; repair of motor vehicles	1.13	0.37
49T53	Transportation and storage	1.18	0.21
55T56	Accomodation and food services	1.26	0.10
58T60	Publishing, audiovisual and broadcasting activities	1.11	0.69
61	Telecommunications	1.07	0.58
62T63	IT and other information services	1.01	0.88
64T66	Financial and insurance activities	1.02	0.79
68	Real estate activities	1.10	0.54
69T82	Other business sector services	1.09	0.46
84	Public admin. and defence; compulsory social security	1.16	0.39
85	Education	1.22	0.86
86T88	Human health and social work	1.28	0.35
90T96	Arts, entertainment, recreation and other service activities	1.18	0.34

NOTES: This table provides the physical proximity index along with the share of those who can work remotely for the industries. To obtain these two industry-level values, we calculate the weighted average of the values corresponding to the occupations in each industry using the Occupational Employment Statistics (OES) provided by the U.S. Bureau of Labor Statistics (BLS). OES data follows four-digit NAICS codes to classify the industries. In order to convert the proximity data to OECD ISIC codes, we make use of the correspondence table between 2017 NAICS and ISIC Revision 4 Industry Codes, provided by the U.S. Census Bureau. We obtain the physical proximity values at the occupation level from the O*NET datase. O*NET collects the physical proximity information through surveys with the following categories: (1) I don't work near other people (beyond 100 ft.); (2) I work with others but not closely (e.g., private office); (3) Slightly close (e.g., shared office); (4) Moderately close (at arm's length); (5) Very close (near touching). We divide the category values by 3 to make category (3) our benchmark. Specifically, a proximity value that is larger than 1 indicates a closer proximity than the "shared office" level, and a proximity value that is smaller than 1 corresponds to sparse working conditions. We create a single physical proximity value for each occupation by taking the weighted average of the normalized category values. We calculate the proximity values at the industry level after removing the teleworkable portion of the employees. We use Dingel and Neiman (2020)'s list of teleworkable occupations to capture the proportion of employment that can be fulfilled at remote locations in each industry.

Table A.3: DEMAND CHANGES ACROSS INDUSTRIES

OECD ISIC	Definition	Change	Explanation
01T03	Agriculture, forestry and fishing	100%	Based on projections on the manufacturing sector using data on credit card spending from the database of CBRT and computations using historical data.
05T06	Mining and extraction of energy producing products	100%	Based on projections on the manufacturing sector using data on credit card spending from the database of CBRT and computations using historical data.
07T08	Mining and quarrying of non-energy producing products	100%	Based on projections on the manufacturing sector using data on credit card spending from the database of CBRT and computations using historical data.
09	Mining support service activities	100%	Based on projections on the manufacturing sector using data on credit card spending from the database of CBRT and computations using historical data.
10T12	Food products, beverages and tobacco	100%	Based on projections on the manufacturing sector using data on credit card spending from the database of CBRT and computations using historical data.
13T15	Textiles, wearing apparel, leather and related products	50%	Based on estimates using data on credit card spending from the database of CBRT.
16	Wood and products of wood and cork	90%	Based on projections on the manufacturing sector using data on credit card spending from the database of CBRT and computations using historical data.
17T18	Paper products and printing	90%	Based on projections on the manufacturing sector using data on credit card spending from the database of CBRT and computations using historical data.
19	Coke and refined petroleum products	75%	Based on estimates using data on credit card spending from the database of CBRT.
20T21	Chemicals and pharmaceutical products	90%	Based on estimates using data on credit card spending from the database of CBRT.
22	Rubber and plastic products	90%	Based on projections on the manufacturing sector using data on credit card spending from the database of CBRT and computations using historical data.
23	Other non-metallic mineral products	90%	Based on projections on the manufacturing sector using data on credit card spending from the database of CBRT and computations using historical data.
24	Basic metals	90%	Based on computations using historical data and sectoral reports, https://tr.steelorbis.com/celik-haberleri/guncel-haberler/abd-ham-celik-uretimi-haftalik-181-dustu-1141735.htm
25	Fabricated metal products	90%	Based on computations using historical data and sectoral reports.
26	Computer, electronic and optical products	100%	Based on estimates using data on credit card spending from the database of CBRT.
27	Electrical equipment	90%	Based on projections on the manufacturing sector using data on credit card spending from the database of CBRT and sectoral reports, https://www.ibisworld.com/industry-insider/media/4637/covid-19-special-report.pdf
28	Machinery and equipment, nec	90%	Based on projections on the manufacturing sector using data on credit card spending from the database of CBRT and computations using historical data.
29	Motor vehicles, trailers and semi-trailers	70%	Based on other countries' experiences and sectoral reports, https://edition.cnn.com/2020/04/01/business/car-sales-coronavirus/index.html https://econsultancy.com/how-coronavirus-is-impacting-sales-marketing-in-the-automotive-industry/
30	Other transport equipment	70%	Same as automobiles.
31T33	Other manufacturing; repair and installation of machinery and equipment	90%	Based on projections on the manufacturing sector using data on credit card spending from the database of CBRT and computations using historical data.
35T39	Electricity, gas, water supply, sewerage, waste and remediation services	100%	No change.
41T43	Construction	75%	Based on computations using historical data and sectoral reports, https://www.ft.com/content/3c27d23e-befe-4a53-be52-325adacdb929
45T47	Wholesale and retail trade; repair of motor vehicles	110%	Based on estimates using data on credit card spending from the database of CBRT.
49T53	Transportation and storage	80%	B ased on other countries' experiences and sectoral reports, https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Risk/Our%20Insight/COVID%2019%20Implications%20for%20business/COVID%2019%20March%2030/COVID-19-Facts-and-Insights-April-3-v2.ashx
55T56	Accomodation and food services	25%	Based on estimates using data on credit card spending from the database of CBRT.
58T60	Publishing, audiovisual and broadcasting activities	85%	Based on estimates using data on credit card spending from the database of CBRT.
61	Telecommunications	100%	Based on estimates using data on credit card spending from the database of CBRT.
62T63	IT and other information services	100%	Based on other countries' experiences and sectoral reports, https://www.reuters.com/article/us-heatlh-coronavirus-technology/coronavirus-may-cut-global-corporate-tech-spending-4-1-in-2020-survey-idUSKBN21I38C https://www.fiercetelecom.com/telecom/coronavirus-flushes-it-spending-to-a-2-7-decline-idc
64T66	Financial and insurance activities	100%	Based on estimates using data on credit card spending from the database of CBRT.
68	Real estate activities	60%	Based on estimates using data on credit card spending from the database of CBRT.
69T82	Other business sector services	85%	Based on estimates using data on credit card spending from the database of CBRT.
84	Public admin. and defence; compulsory social security	125%	Median Package size 5%. Public spending is close to %20 of GDP.
85	Education	85%	In line with other business services.
86T88	Human health and social work	100%	Based on other countries' experiences and sectoral reports, https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/NationalHealthAccountsHistorical https://www.fairhealth.org/publications/briefs
90T96	Arts, entertainment, recreation and other service activities	25%	Based on other countries' experiences and sectoral reports, https://www.nytimes.com/interactive/2020/04/11/business/economy/coronavirus-us-economy-spending.html

NOTES: This table provides the demand changes at the sectoral level along with the explanations. We use publicly available data and the credit card spending data from the Central Bank of Republic of Turkey (CBRT) to calculate the estimated demand change during the pandemic in each industry, which is categorized based on OECD ISIC Codes.

Table A.4: LIST OF THE LOCKDOWN SECTORS

Panel A: Lockdown Sectors

NACE Rev. 2	Definition
01	Crop and animal production, hunting and related service activities
1071	Manufacture of bread; manufacture of fresh pastry goods and cakes
1811	Printing of newspapers
1920	Manufacture of refined petroleum products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
35	Electricity, gas, steam and air conditioning supply
36	Water collection, treatment and supply
4646	Wholesale of pharmaceutical goods
4730	Retail sale of automotive fuel in specialised stores
4773	Dispensing chemist in specialised stores
4774	Retail sale of medical and orthopaedic goods in specialised stores
4920	Freight rail transport
4941	Freight transport by road
5224	Cargo handling
53	Postal and courier activities
60	Programming and broadcasting activities
61	Telecommunications
639	Other information service activities
75	Veterinary activities
86	Human health activities
87	Residential care activities

Panel B: Additional Sectors

NACE Rev. 2	Definition
10	Manufacture of food products
1722	Manufacture of household and sanitary goods and of toilet requisites
463	Wholesale of food, beverages and tobacco
4711	Retail sale in non-specialised stores with food, beverages or tobacco predominating
472	Retail sale of food, beverages and tobacco in specialised stores
4781	Retail sale via stalls and markets of food, beverages and tobacco products

NOTES: This table provides the list of the lockdown sectors. We use the decree issued by the Turkish Ministry of Interior on April 10, 2020 to identify these industries. This lockdown was effective for only two days and cover those given in Panel A. We supplement the list with those available in Panel B.

Table A.5: CBRT Credit Card Spending Titles Corresponding to OECD ISIC Sectors

CBRT	Definition	OECD ISIC Code
1	Total	
2	Car Rental	69T82
3	Car Rental-Sales/Service/Parts	45T47
4	Petrol Stations	19
5	Various Food	10T12
6	Direct Marketing	45T47
7	Education/Stationary	45T47
8	Electric & Electronic Goods, Computers	26
9	Clothing and Accessory	13T15
10	Airlines	49T53
11	Service	58T60 & 68 & 69T82
12	Accomodation	55T56
13	Club/Association/ Social Services	55T56
14	Casino	55T56
15	Jewellery	45T47
16	Marketing and Shopping Centers	45T47
17	Furnishing and Decoration	31T33
18	Contractor Services	41T43
19	Health/Health Products/Cosmetics	20T21
20	Travel Agencies/Forwarding	69T82
21	Insurance	64T66
22	Telecommunication	61
23	Building Supplies, Hardware, Hard Goods	25
24	Food	55T56
25	Government/Tax Payments	84
26	Private Pensions	64T66
27	Others	
28	E-commerce Transactions	62T63
29	Mail or Phone Shopping	
30	Customs Payments	84

NOTES: This table provides the concordance that we use to match the titles used in the CBRT's credit card spending data with the OECD ISIC Codes.

Table A.6: List of the Active Sectors in Public Administration during full lockdown

Type	Size	Source
Public (All)	2820095	http://www.sbb.gov.tr/kamu-istihdami/
Security	273000	https://tr.wikipedia.org/wiki/Emniyet_Genel_M%C3%BCd%C3%BCrl%C3%BC%C4%9F%C3%BC
Gendarmerie	150000	https://www.jandarma.gov.tr/jandarma-genel-komutanligi-2019-yili-faaliyet-raporu
Health	642184	https://www.saglik.gov.tr/TR,11588/istatistik-yilliklari.html
Share	37.77%	

NOTES: This table provides the list of occupations in Public Administration that work during full lockdown, together with the number of people within those occupations. The data sources are provided as well. The share of the active sub-sectors in the entire sector is 37%.