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JEL Classification: E61, F00, C51

Keywords: Globalization, infections, external finance, I-O Tables, sectoral heterogeneity

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This paper is previously circulated under the title: “An Epidemiological Multi-Sector Model for a Small Open Economy with an Application to Turkey".

COVID-19 and Emerging Markets:

A SIR Model, Demand Shocks and Capital Flows*

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"Best safety lies in fear."
– William Shakespeare

1 Introduction

The COVID-19 pandemic may trigger the biggest emerging market (EM) crises of modern times, which will have global implications due to potential spillback effects to advanced countries (AEs). Soon after the onset of the pandemic, EMs observed a collapse in domestic and external demand, capital outflows, higher external borrowing costs, a commodity bust, and depreciating currencies. EM governments, in a similar fashion to AEs, increased domestic borrowing via unconventional policies to assemble fiscal resources to fight the pandemic.

Traditionally, domestic and external borrowing go hand-in-hand in EMs, most often culminating in crises. During COVID-19 pandemic, however, the so-called twin deficits of fiscal and current account deficits can be a blessing by providing funding for the hardest hit sectors. On the other hand, high fiscal deficits can also act as a deterrent for foreign investors because too much domestic borrowing by the government increase the external finance premia. We argue that EMs have to increase both domestic and external borrowing to fight the pandemic effectively. In order to determine the extent of funding that is necessary to offset the economic drag from the pandemic, we estimate COVID-19 related economic costs for a small open economy at the sectoral level. We show that the sectors that are hardest hit domestically are also the ones that rely on more foreign finance.

We utilize an epidemiological Susceptible-Infected-Recovered (SIR)- multi-sector-macro model.[1] The key properties of our framework are as follows. The ability to work from home determines the size of the supply shock in non-essential sectors. 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 infections increase and the lowest point is calibrated using real time credit card purchases. Our methodology is for the short

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

run to estimate first-round effects, where the output is demand determined with fixed prices.

Our approach has the advantage of being simple and easily mapped to real time data. The model is calibrated to Turkey by using Turkey's international linkages to 65 other countries through 35 sectors. 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 sectoral economic costs for Turkey stem from lower external demand. In addition, we document a strong correlation between the sectoral output loss and capital flows of that sector.

Our work differs starkly from the rapidly growing COVID-19 literature that put the epidemiology at the center but focus on closed economies.[2] Although our supply side is similar to these closed economy models, we differ by emphasizing sectoral heterogeneity in terms of the spread of the disease. This leads to (i) differential sectoral supply shocks at home and (ii) differential foreign demand for that sector's output. These two features are not the focus of closed economy models. Given the importance of demand shocks under COVID-19, we believe that incorporating foreign demand is key to estimate the proper pandemic related costs for the emerging markets.

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.

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 domestic and external demand shocks. Our findings are consistent with recent findings of Goolsbee and Syverson (2020) for the US, 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

[2]The two exceptions that consider the open economy dimension seriously are Arellano et al. (2020) who focus on sovereign default risk under COVID shock with a SIR and sovereign debt model; and Antràs et al. (2020), who analyze the interplay between globalization and pandemic via trade-induced personal interactions.

[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).

cost of containing the 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). 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. Hence, they reach much smaller losses compared to us (See Barrot et al. (2020), Bonadio 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. In this framework, even if the supply channels remains unrestricted, demand drags the equilibrium output down and elevates the size of economic costs so long as the health issues are not resolved both at home and abroad.[5]

[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) does 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.

[5] Closed economy version of this result is emphasized by Chetty et al. (2020), who uses real time data to show that tra-

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 threat of multiple waves after reopening. 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 Turkey, Mexico, and South Africa. These countries present examples for all three lockdown scenarios: South Africa imposed full lockdown in the second quarter with only vital sectors remaining open. Turkey, on the other hand, imposed an enhanced partial lockdown with an intensive partial lockdown accompanied by periods of curfews. Meanwhile, Mexico can be taken as an example of a country that did not implement any lockdown measures. Our model implies that in the short run, the severity of

ditional 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

the lockdown measures will be immediately reflected to the economic costs of the pandemic because business shut downs will constrain economic growth. Thus, the costs of a full lockdown are higher than a partial lockdown. In the long run however, this order is reversed. Because a successful full lockdown contains the pandemic the fastest, economic costs will be lowest in full lockdown, followed by partial lockdown. In terms of long run annual costs, we estimate 5.8 percent, 11.6 percent, and 10.9 percent cost attributable to COVID shock in full lockdown, partial lockdown, and no lockdown scenarios respectively. Focusing on the short run picture, our model implies a 17% reduction in the quarter in which the lockdown is imposed, compared to the previous quarter in this scenario. These numbers are similar to the figures in South Africa, which experienced a 16% decline in the second quarter compared to the first quarter. For the partial lockdown scenario, our model suggests a 9% decline relative to the first quarter. Turkey, as an example similar to this case, experienced an 11% reduction in the second quarter GDP compared to the first quarter. The difference in the growth rates could potentially be explained by the hybrid approach adopted by Turkey that followed more stricter measures than the typical partial lockdown. Finally, for the case of no lockdown, we estimate a 15% percent reduction compared to the GDP of the first quarter. Mexican GDP declined 17% percent in the second quarter compared to the first quarter.

We organize the remainder of the paper as follows: Section 2 touches upon 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. Section 5 presents our quantitative results, 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.

2 COVID-19 Literature and Our Contribution

The literature on understanding the economic impact of COVID-19 pandemic has resulted in an ever-growing list of papers. To capture the infection dynamics, many studies use SIR models or its extensions. 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.

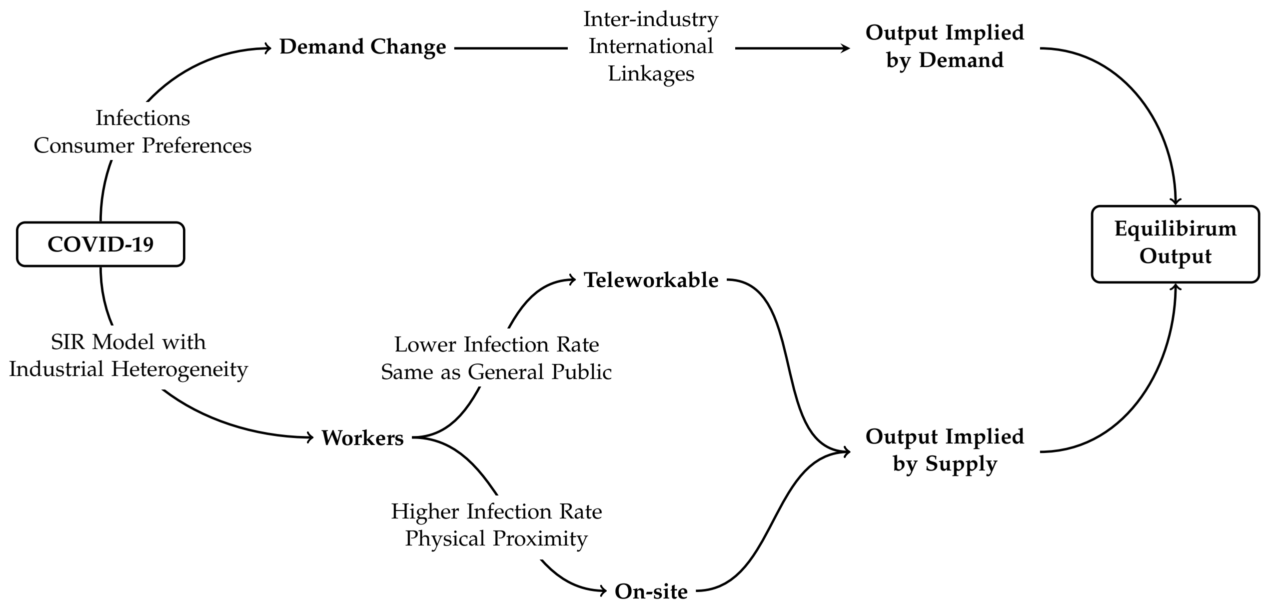
The above cited literature do not feature sectoral heterogeneity for demand and supply shocks together. However, the recent empirical evidence shows the magnitude of the demand shock to be very large and vary by sector, as we model. Specifically, using granular data, Chetty et al. (2020) analyzed the consumer spending during the first month of the pandemic in the United States and found that the spending declined by 39% for consumers in the top-quartile and 13% in the bottom quartile of the income distribution. The observed decline exhibits heterogeneity across sectors, with drastic decreases in industries requiring in-person interactions. 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 contracting the disease fuels the observed declines in spending. Similarly, by tracking the mobility patterns of individuals using cell phone data, Goolsbee and Syverson (2020) document that the consumer traffic decrease by 60%. Yet, merely 7% of this decline be attributed to the government restrictions. The authors speculate that the alterations in consumer behavior is likely to be explained by the fear of infection. In sum, these results highlight the importance of incorporating the sectoral demand changes into the model.

Our paper is one of the first papers to incorporate supply and demand shocks at the sectoral level for an open economy operating within the international production network, making full use of international I-O linkages.[7] 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.

Our theoretical framework is illustrated in Figure 1. While we explicitly model inter-sectoral linkages, we illustrate our framework for a single industry for simplicity. 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. Depending on whether the employees work on-site or remotely, the rate of transmission of the virus will be determined. 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. For the on-site professions, we assume that the transmission rate depends on the physical proximity needs at the work place. A worker in an on-site profession can catch the virus either at or outside work. Using the telework-

[7] del Rio-Chanona et al. (2020) consider demand and supply shocks at the sectoral level as well, with an extension in Pichler et al. (2020). They consider an open economy, focusing on the UK. Domestic demand shocks are added based on a CBO report from 2006, which considers predictions of a potential influenza pandemic.

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, essential industries are open while the non-essential sectors remain closed. When there is a lockdown, production declines immediately through the supply channel because the workers in the non-essential sectors cannot report to work. Meanwhile demand will be affected in a positive way once the lockdowns decrease the number of infections and reduce the need for voluntary social distancing.

able 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 remains 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. 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).[8] 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 such that the number of infections cause deviations from normal demand patterns in a reduced form function. The number of infections have an immediate impact on the demand profiles. As the lockdowns reduce the number of infections, they have a positive impact on demand. 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.

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.

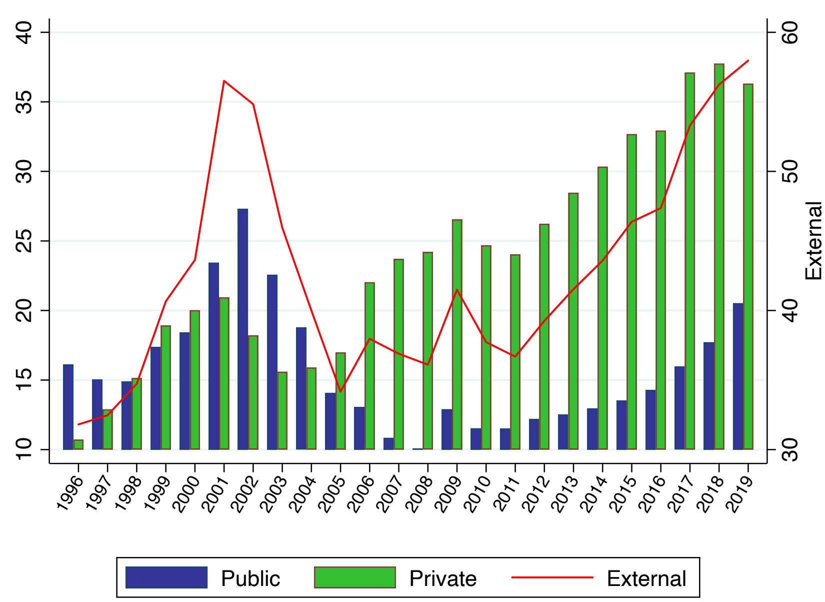
[8] Similarly, Andersen et al. (2020a) use transaction-level customer data from the largest bank in Denmark to estimate consumer responses to the COVID-19 pandemic and the partial shutdown of the economy, see also Carvalho et al. (2020) who uses similar data from BBVA for Spain.

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.

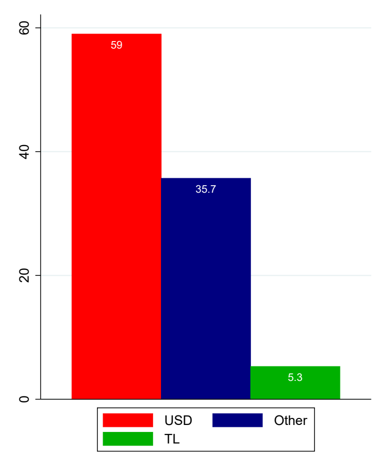
Capital outflows by non-residents during COVID-19 led to a wave of depreciation in TL, which required FX interventions and brought FX reserves to low levels. As of July 17, 2020, *net* reserves of Central Bank of the Republic of Turkey (CBRT) stood at $31 billion, of which over $55 billion was obtained 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.[9] 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 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.[10] 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.[11]

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

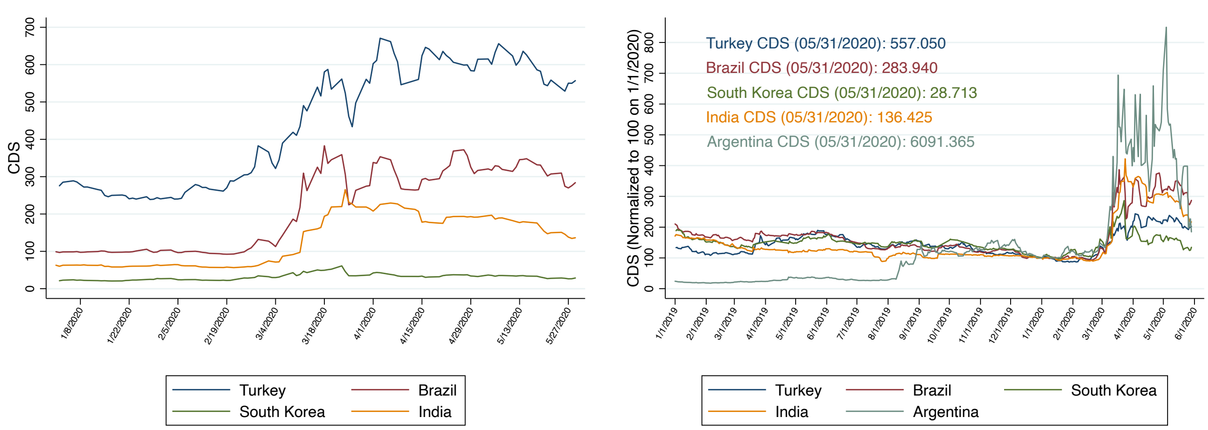
[10] We use the annual GDP of 2019 to express the January 2020 values as a percentage of GDP in this section.

[11] 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

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.[12] 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 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.

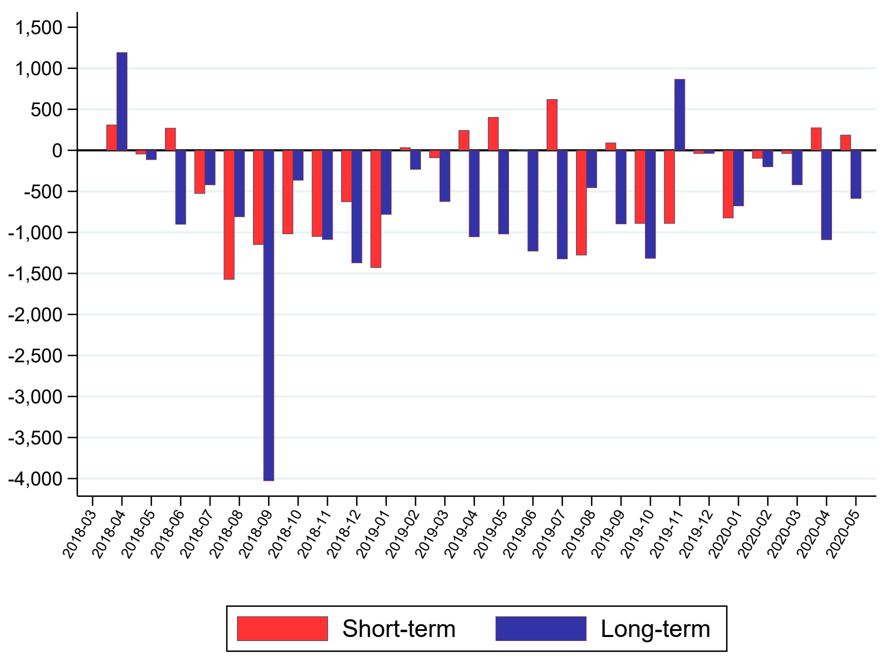
In addition to bonds and equities held by non-residents, more than 1/3 of total external funding is obtained through bank loans in Turkey, which is almost all in FX. These loans finance the foreign

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.1 in Appendix based on Stoppok and Trebesch (2020).

[12] 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).

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.[13] 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.

Figure 4: Rollovers of External Loans by Turkish Banks



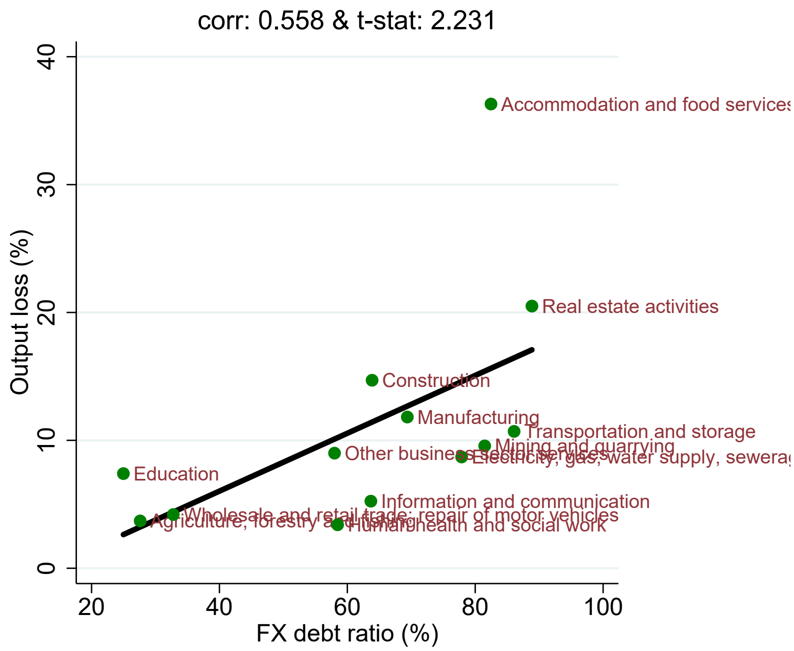
NOTES: This figure plots rollovers of external loans belonging to Turkish Banks. Loan rollovers refer to monthly-net values expressed in terms of millions of USD. Source: Turkey Data Monitor.

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 coun-

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

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.

try 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 action 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."[14] 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.[15] 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.[16] 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.

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

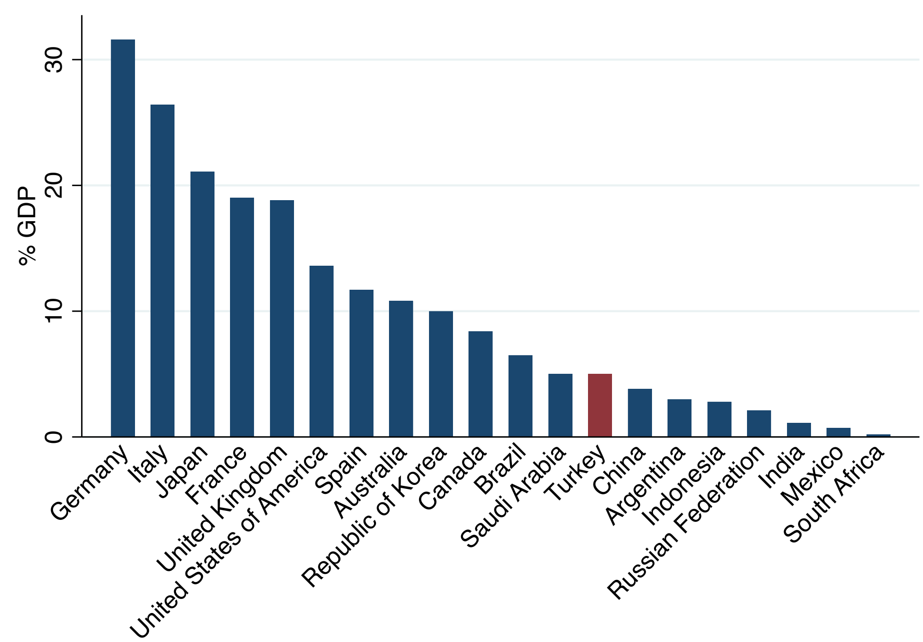
[15] https://www.bloomberg.com/news/articles/2020-04-18/turkey-announces-new-regulation-to-boost-lending-bond-purchase and https://www.reuters.com/article/health-coronavirus-turkey-banks/turkeys-banking-watchdog-sets-deposit-ratio-to-boost-loans-idUSL8N2C607I

[16] 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

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 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 use the workhorse model of the pandemic, the Susceptible-Infected-Recovered (SIR) model, which has been heavily used in epidemiology (see Allen (2017) for a primer). According to this model, the population (denoted by N) can be split into three disjoint groups, namely the Susceptible (S_t), Infected (I_t) and Recovered (R_t) individuals at any time t. The individuals in the susceptible group can contract the disease from the individuals in the infected group. Those who develop immunity to the disease (either by going through the disease or by vaccination) constitute the recovered group. At any given time, the number of susceptible individuals decreases and the number of people in the recovered group increases. The severity of the pandemic is related to the size of the infected group. We quantify the progression of the pandemic using certain assumptions. An interaction between a susceptible and an infected individual can occur with a probability proportional to $S_t \times I_t / N$, where N serves as the normalization constant. The disease would be transmitted with a ratio of β during this interaction. On the other hand, among the infected individuals, a ratio γ recovers from the disease.[17] Combining these ideas into a mathematical formulation, we arrive at the following equations that govern the law of motion of the pandemic at any given time:

$$
\begin{aligned}
\Delta S_t &= -\beta S_{t-1} \frac{I_{t-1}}{N} \\
\Delta R_t &= \gamma I_{t-1} \\
\Delta I_t &= \beta S_{t-1} \frac{I_{t-1}}{N} - \gamma I_{t-1}
\end{aligned} \tag{1}
$$

Since $S_t + I_t + R_t + N$, the summation of the differences, i.e., $\Delta S_t + \Delta R_t + \Delta I_t = 0$, is always zero.

Conventional SIR models treat interactions between the individuals as homogeneous. In real life, however, interaction patterns exhibit a great degree of variation among different industries. For instance, a dentist needs to work in close proximity to others to perform her job whereas a computer programmer does not require physical proximity. Because each industry employs a variety of occupations, the physical proximity requirements of occupations would create sectoral heterogeneity in different work-spaces. In turn, this sectoral heterogeneity leads to different infection dynamics and

[17] We do not model mortality here. Please see 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) for models with mortality.

trajectories. We assume that the industries that require a greater degree of physical proximity would be more prone to infections.[18]

We incorporate the heterogeneity in infection dynamics stemming from sectoral composition into the SIR model. First, we distinguish between working and non-working populations, where the latter is denoted by N_{NW}. We assume that the economy consists of K sectors, which are indexed by $i = 1, \ldots, K$, each with L_i workers. During the pandemic, if a worker can do her job remotely, she does not need to show up to the work site. We classify these workers as "teleworkable." We calculate the teleworkable share of employment from Dingel and Neiman (2020)'s list of teleworkable occupations. The remaining workers need to be on-site to fulfill their tasks. The number of teleworkable employees in industry i is denoted by TW_i and on-site workers are denoted by N_i, such that:

$$L_i = TW_i + N_i. \tag{2}$$

In terms of disease susceptibility, teleworkable employees and non-working population can be lumped together because they are both assumed be "at-home." We use $i = 0$ to represent the at-home group where the size of this group is:

$$N_0 = N_{NW} + \sum_{i=1}^{K} TW_i. \tag{3}$$

We assume that the at-home group is the least susceptible group and has an infection rate of β_0. Being at the job site increases the risk of contracting the disease and this increase is intimately related to the hetereogenity of physical proximity requirements of industries. Therefore, we define the infection rate within industry i to be:

$$\beta_i = \beta_0 \text{Prox}_i \qquad \text{for} \quad i = 1, \ldots, K \tag{4}$$

where Prox_i captures the proximity requirement of industry i. We calculate the physical proximity requirements for occupations using the O*NET dataset (see Section 4.5 for details). One caveat with this approach is that during the pandemic the physical proximity requirements of industries could

[18] In a report analyzing the effects of the pandemic on its members, DISK labor union in Turkey claims that the infection rate increases three times among workers compared to rest of the society: http://disk.org.tr/2020/04/rate-of-covid-19-cases-among-workers-at-least-3-times-higher-than-average/

be adjusted downwards (Eichenbaum et al., 2020). Here, we do not endogenize this decision in our model and consider the proximity measure as exogenous.

Because infection dynamics show sectoral heterogeneity, we track the on-site workers of industry i's susceptible, infected and recovered groups separately, which are denoted by $S_{i,t}$, $I_{i,t}$ and $R_{i,t}$, respectively. At any given time, the sum of individuals in these groups give $S_{i,t} + I_{i,t} + R_{i,t} = N_i$, number of on-site workers in industry i. This specification also holds for the at-home group ($i = 0$). We assume that the individuals in the at-home group could contract the disease from all infected individuals:

$$\Delta S_{0,t} = -\beta_0 S_{0,t-1} \frac{I_{t-1}}{N} \tag{5}$$

where $I_t = \sum_{i=0}^{K} I_{i,t}$ is the number of infected people in the entire society.

An on-site worker in industry i, can either contract the disease from the general population like at-home individuals, or she can contract it from the work site. We assume that the infection rate on work site is β_i, defined in Equation 4. Hence, the size of the susceptible individuals for on-site workers in industry i evolves according to the following equation:

$$\Delta S_{i,t} = -\beta_i S_{i,t-1} \frac{I_{i,t-1}}{N_i} - \beta_0 S_{i,t-1} \frac{I_{t-1}}{N} \tag{6}$$

We assume that the recovery rate is the same for any type of infected individual:

$$\Delta R_{i,t} = \gamma I_{i,t-1} \tag{7}$$

The change in the number of infected individuals is related to the changes in the size of susceptible and recovered individuals in group i:

$$\Delta I_{i,t} = -\left(\Delta R_{i,t} + \Delta S_{i,t}\right) \tag{8}$$

We would like to use the most realistic parameters to capture the infection dynamics. To that end, we first gather information about the parameters in Equation 1 that dictate the simple SIR model from the literature. The γ parameter captures the mean recovery time. Here, we rely on a report by the World Health Organization (WHO),[19], which mentions a median recovery time of two weeks for mild cases. We use $\gamma = 1/14 \approx 0.07$ to obtain a mean recovery time of two weeks, acknowledging the fact that the mean recovery time could exceed the median recovery time. Nevertheless, we prefer to err on the optimistic side. Another parameter that controls the disease progression is R_0, which is the average number of individuals infected by an already infected individual. In the simple SIR model, $R_0 = \beta/\gamma$. In the same WHO report, the range for R_0 is estimated to be between 2 and 2.5. Once again, we use the optimistic alternative and set $R_0 = 2$, which gives $\beta = 0.14$. These values agree with the parameters estimated by 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. The readers should be reminded at this early stage that our choice of more optimistic parameter values might imply a shorter duration for the pandemic and underestimate the total economic costs, should the pandemic follow a more pessimistic path.

For our multi-sector SIR model, we match the weighted average of each individual group i – i.e., β_i– to the β of entire population. Here, weights are the shares of the sectoral population in total population. For an on-site worker of industry $i = 1, .., K$, the normalized rate of infection is $(\beta_0 + \beta_i)$.[20] For an at-home individual, the infection rate is only β_0. The relationship between β_i's and β_0 is given in Equation (4). Therefore:

$$\beta_0 \frac{N_0}{N} + \sum_{i=1}^{K} (\beta_0 + \beta_i) \frac{N_i}{N} = \beta_0 + \beta_0 \sum_{i=1}^{K} \text{Prox}_i \frac{N_i}{N} = \beta \tag{9}$$

We can write β_0 as a function of population β, industry size, and the industry proximity levels as:

$$\beta_0 = \beta \left(1 + \sum_{i=1}^{K} \frac{\text{Prox}_i N_i}{N} \right)^{-1} \tag{10}$$

with $\beta = 0.14$ is estimated from the WHO report.

[19] https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf

[20] According to the report cited in Footnote 18, the infection rate is estimated to be 3 times higher for on-site workers compared to the non-working population. Here, we take a more optimistic stance and select the infection rate to be 2 times higher on average .

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:[21]

$$Y_i = Z_i L_i \tag{11}$$

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. For each industry i, we have two groups of workers, teleworkable, whose size is TW_i and on-site, with size N_i. Number of infected individuals among on-site workers is $I_{i,t}$. Teleworkers are considered to be as a part of at-home group, whose size is N_0 with active infections of $I_{0,t}$. Hence, the total number of available workers at time t will be:

$$\tilde{L}_{i,t} = (N_i - I_{i,t}) + TW_i \left(1 - \frac{I_{0,t}}{N_0}\right) \tag{12}$$

Since we assume a linear production function, the output in industry i decreases due to the ongoing pandemic with the levels at:

$$Y^S_{i,t} = Z_i \tilde{L}_{i,t} = Y_i \frac{\tilde{L}_{i,t}}{L_i}. \tag{13}$$

4.3 Demand

During the pandemic, the daily routines and priorities change drastically to avoid the risk of getting infected. This voluntary social distancing, or put differently, the ”fear” of getting infected, leads to substantial changes in consumer preferences. In addition to the fear of getting infected, there is also the fear of transmitting the virus to the others. The risk of transmission is particularly high for the asymptomatic cases. This fear factor is closely related to the severity of pandemic, which in turn,

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

depends on the number of active infections in the society. Supporting this view, as we highlight in Section 2, Chetty et al. (2020) and Goolsbee and Syverson (2020) show that the alterations in consumer behavior is most likely to be tied with the fear of infection.

Another factor that affects aggregate expenditure is the uncertainty shock and the turbulence brought about by the pandemic. The uncertainty is abounding, most notably, at the onset of the pandemic, when the course of the pandemic cannot be foreseen. As the precautionary savings soar in times of high ambiguity, aggregate expenditures are reduced in response. 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.

The changes in preferences and the following demand changes evolve as the pandemic progresses. We assume that the demand transitions from the 'normal' to a worst case scenario during the brunt of the pandemic. Specifically, we consider two demand profiles, representing the normal times and the turbulent times. To calibrate these profiles, we track the consumption data from the national accounts and the credit card spending data. While the first dataset is of low frequency and published with a delay, the latter is available timely at the weekly frequency. Therefore, it provides us with useful information on the changes in demand structure over the course of pandemic. We complement the credit card data with sector specific information in industry reports and expert opinions if the spending in a sector is not often done with credit cards.[22] We specify a smooth function that transition gradually between these two demand profiles depending on the number of infections. 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 assume that a representative agent allocates her income among different final goods optimally by maximizing her utility function in terms of expenditures on these goods. Here, we use a Cobb-Douglas specification for the utility function of the representative agent in line with the literature on input-output analysis (e.g., Acemoglu et al. (2012), among others). Specifically, we use the following utility function:

$$U(e_1, \ldots, e_n) = \prod_{i=1}^{n} e_i^{\alpha_i}, \tag{14}$$

[22] We present these demand changes and related data resources in Table A.3 of the Appendix.

where e_i is the expenditure spent on the final good of industry i and α_i refers to industry i's share in total expenditure together with $\sum_{i=1}^{n} \alpha_i = 1$ and $0 < \alpha_i < 1 \forall i = 1, \ldots, n$. As a natural consequence of the Cobb-Douglas formulation, α_i represents the share of expenditures on the final good i in the budget of the representative agent. Suppose that the income (wage) of the representative agent is w. Then the expenditure in industry i can be written as $e_i = \alpha_i w$.

The pandemic alters the demand profile and expenditure shares. We assume that the demand is affected through two distinct channels during the pandemic. The first channel is the effect of the pandemic on the priorities, and thus, on preferences. In this case the sectoral weights in the budget changes following the changes in preferences. The utility function changes through the weights as follows:

$$\tilde{U}(e_1, \ldots, e_n, I) = \prod_{i=1}^{n} e_i^{\tilde{\alpha}_i(I)}, \tag{15}$$

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 context, we set $\bar{I}$ to 50,000 to capture a relevant range for the number of infections (see below for our simulations). This limit implies that the untility 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, $\delta_i(I)$, that depends on the number of infections. The numerator shows the level of expenditure when the number of active cases is I, while the denominator shows the level of expenditure when there is no infection at all. 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:

$$\delta_i(I) = \frac{\tilde{\alpha}_i(I)\eta(I)}{\alpha_i}. \tag{16}$$

When the number of infections is small, the demand ratio approaches 1. When the number of infections soars, the preferences change dramatically with the heat of the pandemic. We specify the limiting cases for $\delta_i(I)$ using this ratio corresponding to the brunt of pandemic. We further assume that the demand remains unaffected for a small number of infections, $0.1\bar{I}$, when the society believes that the pandemic is contained. This implies that for $I \leq 0.1\bar{I}$, $\delta_i(I) = 1$.[23] At the brunt of the pandemic when the number of infections soars, $\lim_{I\to\infty} \tilde{\alpha}_i(I) \equiv \bar{\delta}_i = \frac{\bar{\alpha}_i\bar{\eta}}{\alpha_i}$. For the specific sectors, such as the airline industry, the demand might completely stall due to travel restrictions. For these sectors, $\bar{\delta}_i = 0$. On the contrary, the demand might remain intact for the other sectors, such as the food industry. In this case $\bar{\delta}_i = 1$. To sum up, $\bar{\delta}_i$ is sector specific and it reflects the lower bound for the change in demand for the industry's final good at the peak of the pandemic.

Because we assume that the demand evolves gradually with the active number of infections in the society, we need to specify a functional form reflecting this smooth transition between $\bar{\delta}_i$ and 1, representing the two limiting cases. We use an inverse hyperbolic functional form to achieve this

[23] We use the number of infected individuals 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 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.

property:[24] as:

$$\delta_i(I) = \begin{cases} 1 & \text{if} \quad I \leq 0.1\bar{I} \\ \bar{\delta}_i \frac{1+(I/\bar{I}-0.1)}{\bar{\delta}_i+(I/\bar{I}-0.1)} & \text{if} \quad I > 0.1\bar{I}. \end{cases} \tag{18}$$

The advantage of using this functional form is that it allows the marginal impact of the number of infections to change inversely with the number of infections. As a result of the tuning parameters $\bar{I}$ and δ_i which can change the limits and the slope of the function, we can specify sector specific fear factors that we estimate from the data.

With industry specific $\delta_i(I)$ values in hand, we can now estimate the output of industries that would satisfy these demand levels. Let's show the final demand levels (expenditures) of industry i in country c with $F_{c,i}$. During the pandemic, when the number of infections is I, the final demand can be written as:

$$\tilde{F}_{c,i}(I) = F_{c,i}\delta_i(I) \tag{19}$$

where the demand during the pandemic is represented by $\tilde{F}_{c,i}(I)$.

We map the changes in the final demand for each sector to the output level in each industry using 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).

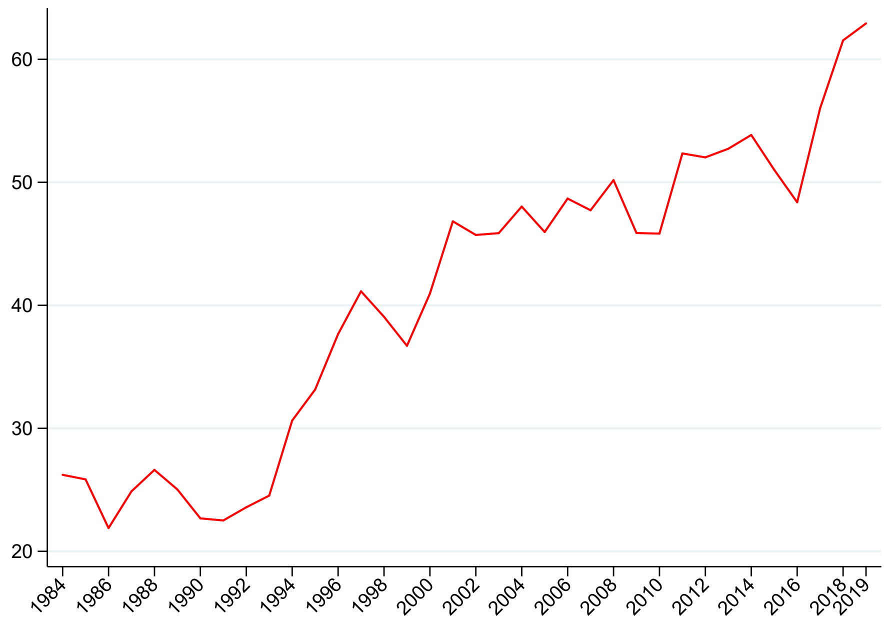
We account for the international linkages to fully capture the impact of final demand on production with OECD Inter-Country Input-Output (ICIO) Tables.[25] ICIO provides us with inter-industry input usages of industry i in country c from other industries form any country as well as final us-

[24]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 flexibly in this specification 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 following functional forms for $\eta(I)$ and $\tilde{\alpha}_i(I)$ for $i = 1, \ldots, n$ lead to the smooth function in Equation 18

$$\begin{aligned} \eta(I) = 1 \quad &\text{and} \quad \tilde{\alpha}_i(I) = \alpha_i & \text{if } I \leq 0.1\bar{I} \\ \eta(I) = \bar{\eta}\frac{1+(I/\bar{I}-0.1)}{\bar{\eta}+(I/\bar{I}-0.1)} \quad &\text{and} \quad \tilde{\alpha}_i(I) = \frac{\bar{\alpha}_i}{\alpha_i}\frac{\bar{\eta}+(I/\bar{I}-0.1)}{\bar{\delta}_i+(I/\bar{I}-0.1)} & \text{if } I > 0.1\bar{I} \end{aligned} \tag{17}$$

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

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.

age of this industry. ICIO consists of 36 industries and 69 entities (corresponding to 64 countries and another entity representing rest of the world). The input-output portion of ICIO is a matrix of 2484×2484 entries. The final demand vector has 2484 entries for each industry in every country. We calculate the direct requirements matrix $\mathbf{A}$ by dividing the rows of IO matrix with the total output of industry. The direct requirement matrix reflects the need from each intermediate input to make $1 worth of output. For any industry, its output is either used as a final good or an intermediate input. We can write this relationship in a matrix notation as:

$$Y = F + \mathbf{A}Y \tag{20}$$

where Y captures output vector of size 2484×1 and F is the final demand vector. For both of these vectors, each entry corresponds to a country industry combination of (c, i) combinations.[26] Solving

[26]In our formulation, with a slight abuse of the notation, variables missing a subscript refers to vectors or matrices.

for output in terms of the final demand yields: satisfy the final demand as:

$$Y = (\mathbf{I} - \mathbf{A})^{-1} F \tag{21}$$

where $(\mathbf{I} - \mathbf{A})^{-1}$ is the well-known Leontief inverse. Hence, the total output of country c is:

$$Y_c = \sum_{i=1}^{n} Y_{c,i} \tag{22}$$

During pandemic, with infection level of I_t, the expenditures on the final demand changes according to Equation (19). Therefore, the output to satisfy this final demand can be calculates using Equation 21:

$$Y_t^D = (\mathbf{I} - \mathbf{A})^{-1} \tilde{F}(I_t). \tag{23}$$

where Y_t^D denotes the output implied by the demand and $\tilde{F}(I_t)$ represents the altered demand vector due to infections at t. This relationship pins down the output as a function of infections due to the demand changes.

4.4 Equilibrium

We calculate the output implied by supply using Equation 13 and the output implied by demand using Equation 23. We take the minimum of these outputs to calculate the equilibrium. Formally, the output is calculated as:

$$Y_t^{EQ} = \min(Y_t^S, Y_t^D) \tag{24}$$

where the min is element-by-element minimum function for two output vectors corresponding to outputs implied by supply, Y_t^S, and demand, Y_t^D.

In practice, we are interested in calculating the GDP declines associated with the pandemic. We assume that value added shares of industries do not change during the pandemic. Let $VA_{c,i}$ denote the value-added in industry i in country c. Then, value added during the pandemic can be written as::

$$VA_{t,c,i}^{EQ} = Y_{t,c,i}^{EQ} \frac{VA_{c,i}}{Y_{c,i}} \tag{25}$$

GDP of a country is the sum of the value-added from all its industries:

$$GDP_{t,c}^{EQ} = \sum_{i=1}^{n} VA_{t,c,i}^{EQ} \tag{26}$$

4.5 Data

In our analysis, we use OECD ICIO Tables for 2015. OECD employs an aggregation of 2-digit ISIC Rev. 4 codes to 36 sectors as industrial classification. We follow this practice in our analysis, and use this classification labeled as OECD ISIC Codes. The list of industries can be found in Table A.2.

Our infection dynamics is governed by the share of teleworkable workers and physical proximity measures at the industrial level. These measures are readily available at the occupational level and we utilize occupational structure of industries to calculate industrial measures. Recently, Dingel and Neiman (2020) identify a set of occupations where remote working is feasible. We use this set for calculating the share of teleworkable workers in each industry.

Since the remaining workers keep working on-site, they can get infected at varying degrees depending on the working conditions. Physical proximity in the workplace is one of the main factors contributing to contagiousness of the virus. For computing this physical proximity conditions at sectoral level, we consult on the self-reported Physical Proximity values, which is provided in the the Work Context section of the O*NET database.[27] For physical proximity, O*NET data is gathered through surveys, which ask workers their occupations and whether their occupation requires physical proximity by selecting one of these 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).

[27] https://www.onetcenter.org/database.html. Accessed 1 April 2020. Dingel and Neiman (2020) also use several measures from O*NET to identify which occupations are teleworkable.

We take category 3 as a benchmark and divide the category values with 3 as our proximity measure of an individual. We take the weighted average of individual responses to create a single occupation proximity value. For an occupation, a proximity value higher than 1 would indicate a denser physical proximity compared to a shared office. To convert occupation level teleworkability and proximity values to industry-level, we use the information on occupational composition of industries from the the Occupational Employment Statistics (OES) by the U.S. Bureau of Labor Statistics (BLS). OES uses NAICS classification at four digit level and we map these into OECD ISIC codes using the concordance table provided by the U.S. Census Table between NAICS codes and ISIC Rev. 4 industry classification. We report OECD ISIC level teloworkable share and proximity values in Table A.2 of the Appendix.

We use the 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 of Turkey.

We heavily rely on publicly available credit card spending data from the CBRT to compute the industry specific changes in demand structure if consumers use credit cards in the sector. We provide the mapping between CBRT industry codes and OECD ISIC industries in Table A.5. Since credit card is not the main means of payment in a number of sectors, the data is not available for these sectors. For these sectors, we extensively make use of report from the sectoral associations, similar experiences from those sectors of other countries and historical records of these specific sectors and the manufacturing sector as a whole. These are provided in Table A.3 of the Appendix together detailed information on the sources of data and together with the list of OECD ISIC industries. As a result, the implied aggregate demand shock corresponds to 23% when we consider the sectors with credit card spending data. The implied aggregate demand shock is is 16% when we consider all sectors. Therefore, our results are qualitatively not sensitive to the coverage of sectors with credit card data among.

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 the industries that remain active during lockdowns. Turkish full lockdowns are typically on weekends and holidays and, thus, the list does not include some critical sectors. We supplemented the list with the food sector as well as household and sanitary goods. The list of the sectors that are active during the lockdowns is given in Table A.4 of the Appendix. The list is given in 2 to 4 digit ISIC REV 4 classification. To transform what proportion of each OECD ISIC industry is active during the lockdowns, we use the detailed employment data at 4 digit level. Finally, we estimate the share of public workers that continue working during 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.

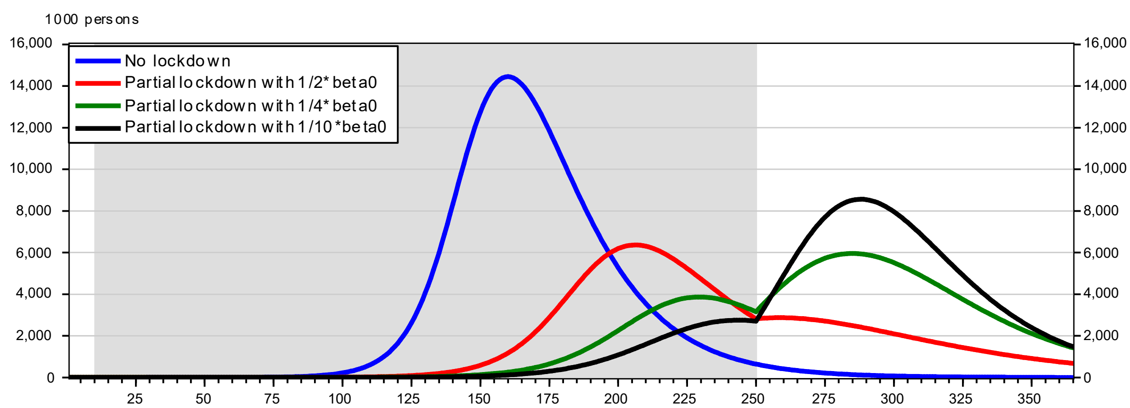
We assume that the pandemic is successfully contained if the number of total infections declines to 5000 after observing the peak. These simulations allow us to calculate the economic costs of alternative lockdown scenarios. [28]

We start with the no lockdown scenario and compare it to partial lockdown where certain restric-

[28] 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.

tions 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 10^{th} day and remains active until the 250^{th} day.

Figure 8: No lockdown versus Partial Lockdown Scenarios



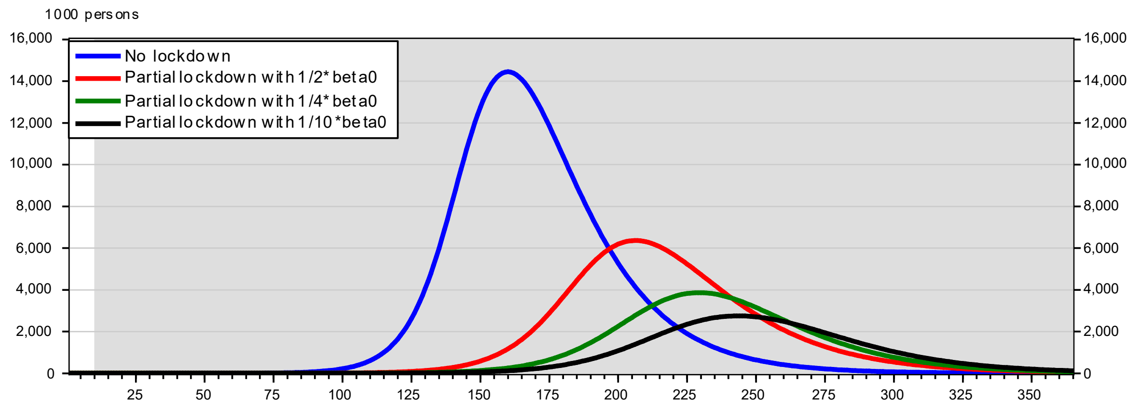
As can be seen from the figure, in case no action is taken against the COVID-19 pandemic, which is shown with the blue line, the pandemic advances at a rate implied by the benchmark reproduction rate of $R_0 = 2$. This implies that the pandemic reaches its peak around the 150^{th} day with a total toll 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 infection 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, however, 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.

Compared to Figure 8, we observe that the main advantage of an extended partial lockdown is

Figure 9: Alternative Scenarios under Partial Lockdown for Full Year

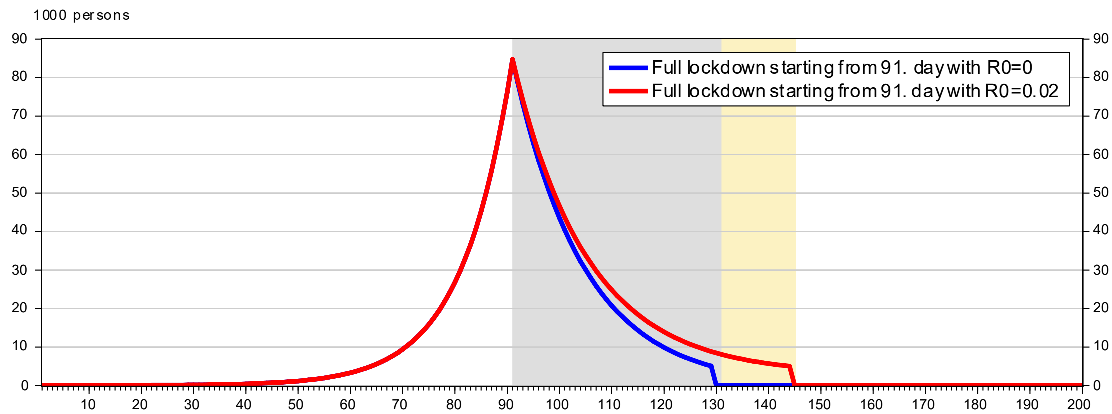


that it flattens the curve by spreading the number of infections over time and allowing for a larger recovery rate. In terms of the economic costs, the additional economic costs of the longer partial lockdown hover around 0.5 percent of the GDP. The added costs despite the extended duration of the lockdown 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.

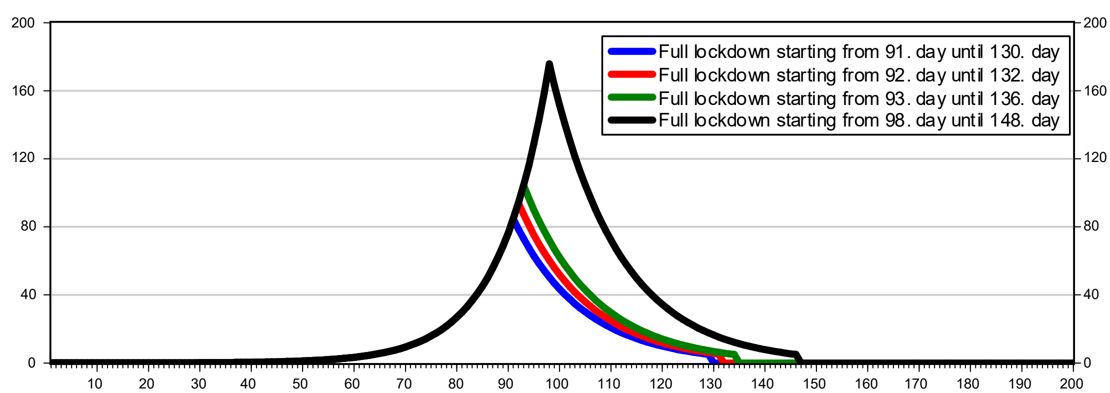
The costs of delaying full lockdown are shown in Figure 11. The benchmark scenario that is illustrated in Figure 10 is shown with the blue line. If the lockdown is delayed by only one day, the number of infections increases by more than 10,000. In the model, we assume that the number of infections increases 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

Figure 10: Alternative Scenarios under Full Lockdown



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:

$$F_{c,i} = \sum_{c'} F_{c,c',i} \tag{27}$$

where $F_{c,c',i}$ denotes goods or services produced by industry i in country c' and consumed in country c. Following Equation 19, we write the final demand in country c in industry i at the peak of the pandemic as:

$$\bar{F}_{c,i} = F_{c,i}\bar{\delta}_{c,i} \tag{28}$$

Different than Equation 19, in this section we allow for country specific demand shocks. The corresponding output to satisfy this final demand level is obtained by:

$$\bar{Y} = (\mathbf{I} - \mathbf{A})^{-1}\bar{F} \tag{29}$$

Using this relation, the total output for the country c can be computed as:

$$\bar{Y}_c = \sum_{i=1}^{n} \bar{Y}_{c,i} \tag{30}$$

The share of value-added in the output is computed using the industry specific portion of the value added when there is no infection. The total value-added (GDP) in country c can thus be written as:

$$\overline{GDP}_c = \sum_{i=1}^{n} \bar{Y}_{c,i} \frac{VA_{c,i}}{Y_{c,i}}. \tag{31}$$

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

$$\overline{INT} = \mathbf{A}\bar{Y}. \tag{32}$$

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:

$$\overline{\text{imports}}_c = \sum_{c' \neq c} \sum_{i=1}^{n} \left(\bar{F}_{c,c',i} + \sum_{i'=1}^{n} \overline{INT}_{c,i,c',i'} \right) \tag{33}$$

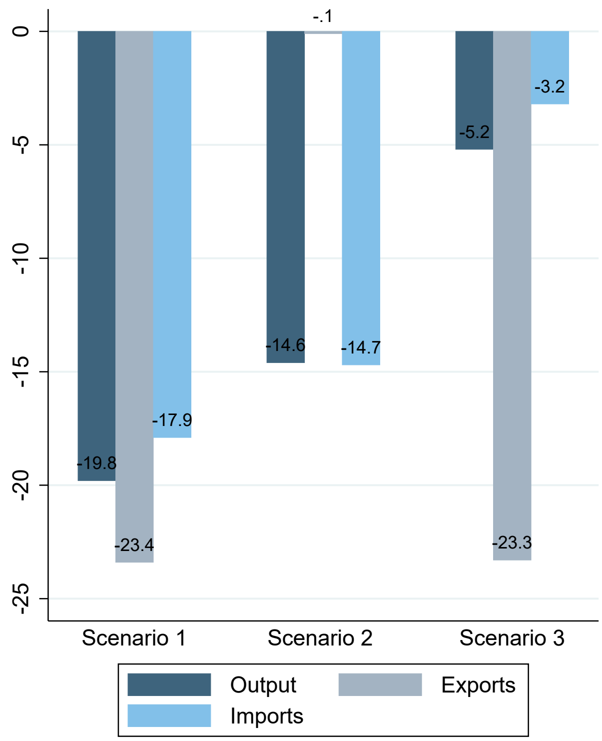
Similarly the total exports by country c is:

$$\overline{\text{exports}}_c = \sum_{c' \neq c} \sum_{i=1}^{n} \left(\bar{F}_{c',c,i} + \sum_{i'=1}^{n} \overline{INT}_{c',i',c,i} \right) \tag{34}$$

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 28 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).

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.

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 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 output. Notice that we run these scenarios under no lockdown policy in the absence of any policy action.[29]

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.

[29]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.

5.3.1 The Role of Trade Linkages in Sectoral Costs

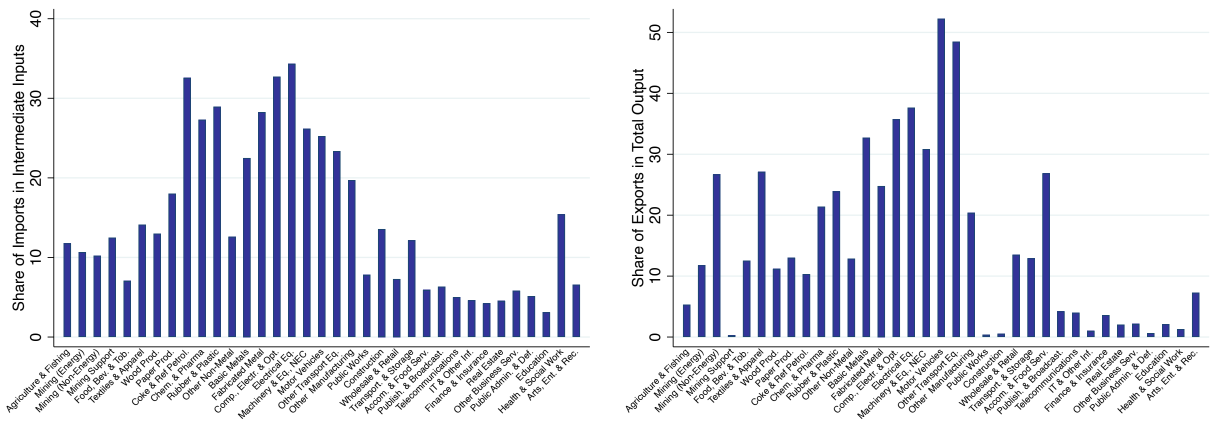
In this section, we investigate the role of international linkages in determining sectoral costs. International linkages would affect economic costs through trade relationships as well as capital inflows. Those sectors that are more closely connected to international value chains as well as those sectors 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 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 findings, 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).

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.

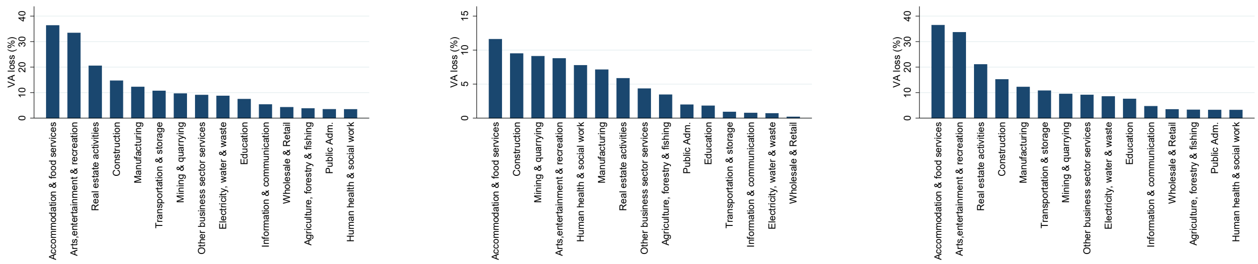
To interpret the findings present in this figure, we consider three benchmark scenarios: Panel (a)

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 91^{st} and 131^{st} days of the pandemic and is fully effective with zero reproduction number; (c) A partial lockdown is put into practice between 10^{th}-250^{th} 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.

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 .

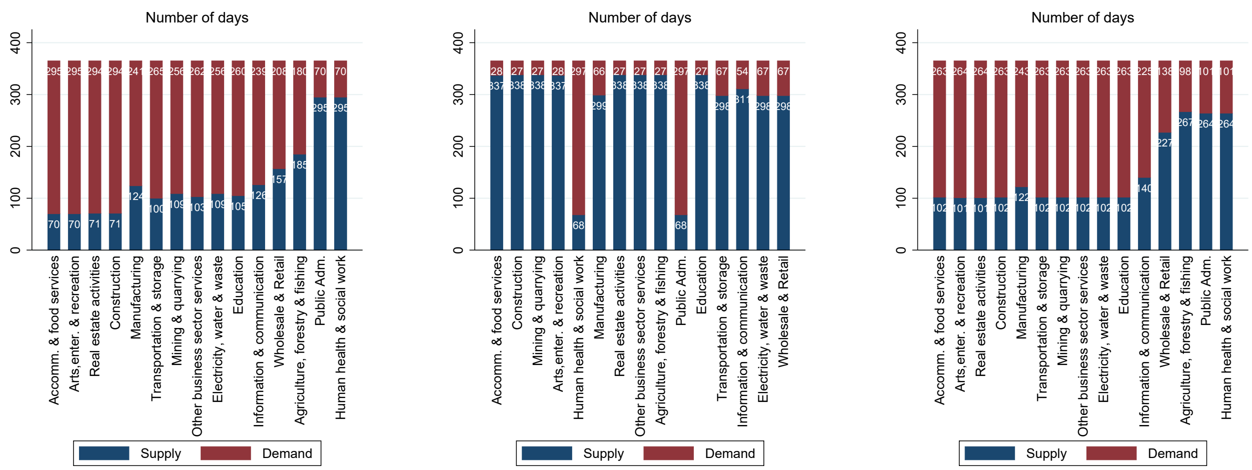
Under full lockdown scenario, the supply channel drives output due to the closure of all non-

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 91^{st} and 131^{st} days of the pandemic and is fully effective with zero reproduction number; (c) A partial lockdown is put into practice between 10^{th}-250^{th} 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.

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 10^{th}-250^{th} 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.[30,31]

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

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[30] We calculate the sector-level proxy as follows: $\text{I-O Trade Finance}_i = \sum_{c=1}^{n}(((\text{Exports}_{c,i} - \text{Imports}_{c,i})/\text{Output}_i) \times \text{Capital Flows}_c)/n$ where $\text{Exports}_{c,i}$, $\text{Imports}_{c,i}$ 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.

[31] 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.

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:

$$\Delta Y_i = \beta_0 + \beta_1 \text{I-O Trade}_i + \beta_2 \text{I-O Trade Finance}_i + \varepsilon_i \tag{35}$$

where $\Delta \mathrm{Y}_i$ 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.[32]

In equation (35), 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 in total debt as of 2016) to equation (35) 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

[32]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 (35) 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 91^{st} and 131^{st} 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.

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.[33] 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. [34] 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 under 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.

[33]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%.

[34]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

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.[35] 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

[35] See Kalemli-Özcan et al. (2018), Gourinchas et al. (2020), and https://voxeu.org/article/proposal-negative-sme-tax

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:[36] "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 "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

[36] The Economist, May 25, 2020.

from debt monetization.[37, 38] 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.

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.[39]

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 lim-

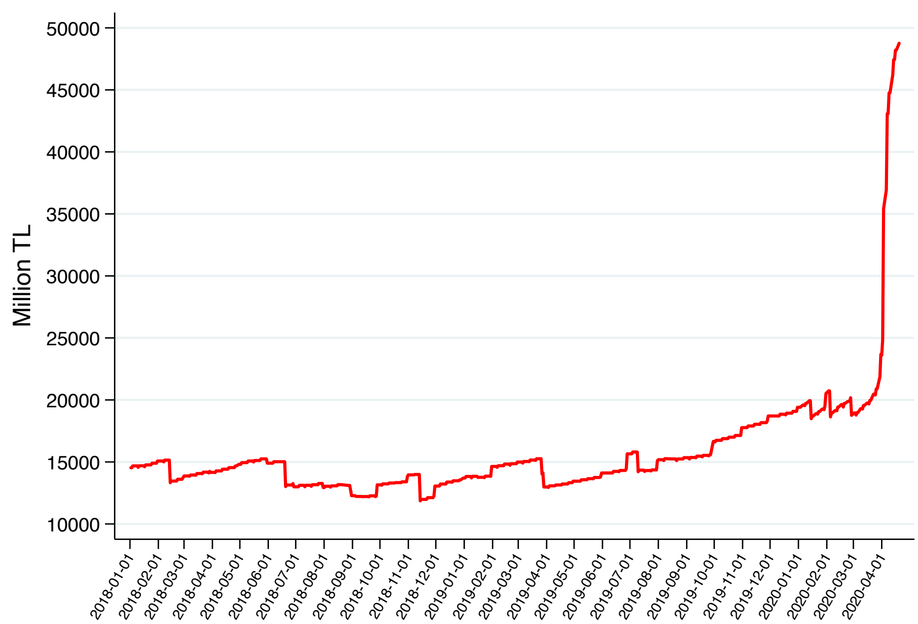
[37] In the FAQs prepared by the Federal Reserve Board (https://www.federalreserve.gov/faqs/money_12853.htm), it is noted that "The term "printing money" often refers to a situation in which the central bank is effectively financing the deficit of the federal government on a permanent basis by issuing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

[38] 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

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

ited 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. [40]

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

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

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). [41]

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.[42] One way to increase 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

[41] 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

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

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.[43] 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.[44] These sizable numbers for large EMs such as Turkey and Brazil suggest that several out-of-the-box policies may be needed.

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.[45]

A swap agreement with the Federal Reserve or another international institution[46] 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.[47] 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

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

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

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

[46] 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.

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

GFC, it is rather unlikely that a swap line can be arranged with the Fed at this time.[48]

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,[49] capital controls on outflows during a large risk-off shock might have unintended consequences.[50] 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 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.[51] 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.[52] 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.[53] If the global

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

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

[50] Bartolini and Drazen (1997).

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

[52] 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

[53] 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/

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.[54] 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.

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

[54]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.

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.[55] 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 transferred 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).[56] 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.[57]

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.[58] Figure

[55] 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.

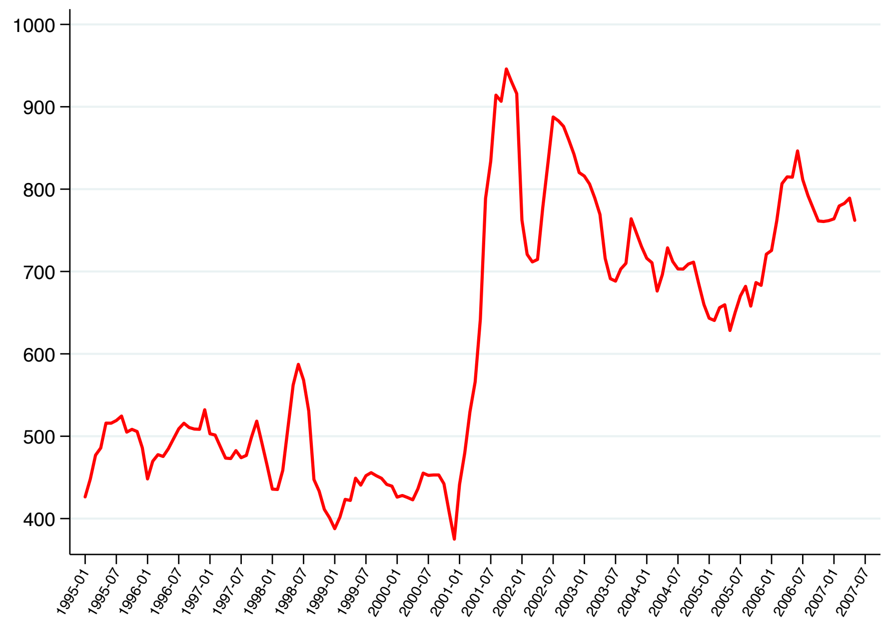
[56] https://www.imf.org/external/np/loi/2001/tur/02/index.htm

[57] 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."

[58] https://www.imf.org/en/Publications/CR/Issues/2016/12/30/Turkey-2002-Article-IV-Consultation-and-First-

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.

Figure 17: Total Assets of CBRT



NOTES: This figure plots total assets of CBRT in real terms, normalized by CPI. The figure ends prior to 2007-2009 global crisis. After this date, CBRT's balance sheet expanded again thanks to capital inflows in the post-crisis environment. Source: Turkey Data Monitor.

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).

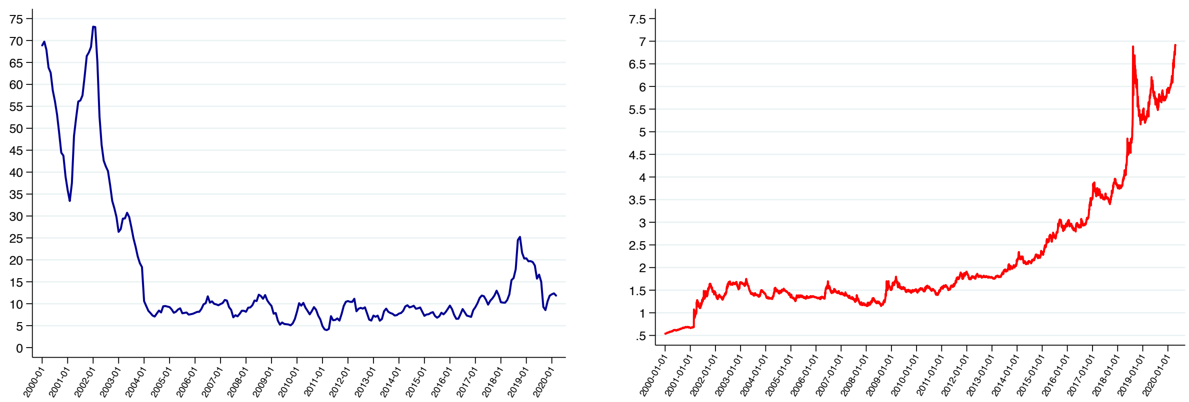
Review-Under-the-Stand-By-Arrangement-Staff-15925

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 framework that combines a SIR model with data on international and inter-sectoral linkages for an emerging market, Turkey. The role of external demand is critical for the amplified losses in a small open economy. 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, both at home and abroad. This leads to a decline in domestic and external demand. Thus, the recovery with demand normalization is only possible once the disease is under control.

In terms of policy implications, EMs are in a position of difficult trade-offs. Large EMs are part of global trade and production networks and already have sizable domestic and external debt. A large part of external debt is in the form of domestic banks borrowing from global banks and hence debt relief from official lenders will not help.[59] If domestic banks cannot rollover their external debt due to increased fiscal spending and hence higher external borrowing costs, then there is a potential threat not only to domestic financial stability but also to global financial stability. 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. With rising country risk premia under COVID shock, the perceptions of global investors and country specific sentiments will be key determinants of capital flows.[60] In this context, international financial 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.

There are still substantial uncertainties ahead of us regarding the course of the pandemic.[61] In the absence of global coordination, countries that successfully contain the virus will still struggle

[59] Avdjiev et al. (2017), Bruno and Shin (2015).
[60] Rey (2015) and Kalemli-Özcan (2019).
[61] See Baker et al. (2020) and Ludvigson et al. (2015) on the role of uncertainty shock linked to COVID-19.

as long as the others do not contain it. The ongoing pandemic in other countries will imply low external demand and international travel. If the lockdowns could be implemented with global synchronization, global demand would return to pre-pandemic levels faster and the economic costs of the pandemic could be kept at a minimum level.

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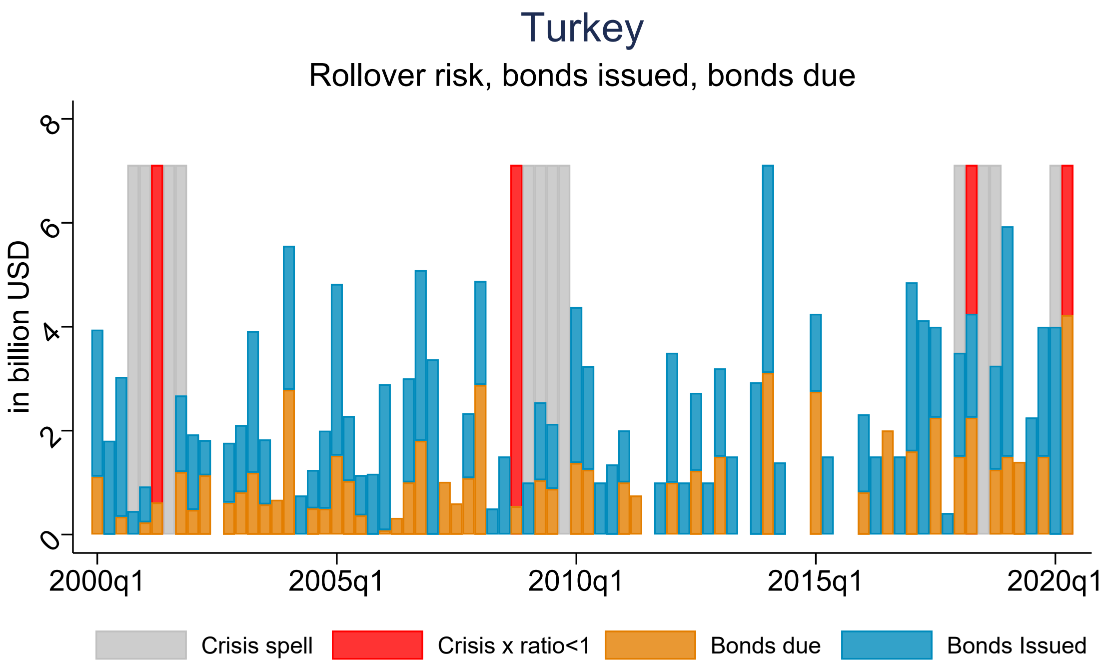
A APPENDIX

List of Figures and Tables:

Figure A.1: Sovereign Bond Issuance in Turkey



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.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.

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. Both these measures are first obtained at the occupational level and we utilize occupational structure of industries to calculate industrial level measures. For computing this physical proximity conditions at sectoral level, we consult on the self-reported Physical Proximity values, which is provided in the the Work Context section of the O*NET database.[62] For physical proximity, O*NET data is gathered through surveys, which ask workers their occupations and whether their occupation requires physical proximity by selecting one of these 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 take category 3 as a benchmark and divide the category values with 3 as our proximity measure of an individual. We take the weighted average of individual responses to create a single occupation proximity value. For an occupation, a proximity value higher than 1 would indicate a denser physical proximity compared to a shared office. To convert occupation level teleworkability and proximity values to industry-level, we use the information on occupational composition of industries from the the Occupational Employment Statistics (OES) by the U.S. Bureau of Labor Statistics (BLS). OES uses NAICS classification at four digit level and we map these into OECD ISIC codes using the concordance table provided by the U.S. Census Table between NAICS codes and ISIC Rev. 4 industry classification. Industry level proximity values are calculated after removing the employees whose occupations are teleworkable. Dingel and Neiman (2020) identify a set of occupations where remote working is feasible. We use this set for calculating the share of teleworkable workers 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%.