Forecasting the Impact of the COVID-19 Shock on the Mexican Economy

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Abstract

We forecast the short-term evolution of the Mexican economy after the COVID-19 shock. We take into account the fact that there is no similar shock observed in contemporaneous data. We combine an econometric procedure with a basic SIR model of the pandemic. To make the forecasts we first calculate an estimate of the shocks that hit the economy starting in March 2020. We then produce several forecasts in which we make variations on two dimensions: introducing a path for the pandemic or not, and if we do, we consider three scenarios. The introduction of paths of the pandemic in which new cases fall has a positive effect on the economy. The main results are the following. First, the shocks that hit the economy starting in March 2020 have the potential to produce a slow recovery of economic activity. In a forecast not conditioned on any path for the pandemic, the annual growth rate of the economy recovers positive values in the second quarter of 2021. Second, in our baseline scenario that includes a pandemic path based on the SIR model, the recovery is faster, having positive growth rates in the first quarter of 2021. To maximize the benefits of a fall in new cases, policy makers should reduce persistent effects of the initial shock that hit the economy. Otherwise economic activity would tilt towards a longer recession.

JEL classification codes: C11, C32, E27, E66

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Disclaimer: The views expressed in this paper are exclusively those of the author and do not necessarily reflect those of ITAM.

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1 Introduction

The COVID-19 pandemic is proving to be a very difficult test for Latin American economies, and for Mexico in particular. At the time of writing the curve for new cases in Mexico probably reached its peak. The curve for new deaths shows a plateau at approximately 600 per day. The Institute for Health Metrics and Evaluation (IHME) at the University of Washington recently predicted 118,810 COVID-19 deaths by December 1, 2020.

At the same time there was a sudden and large impact on economic activity. The government implemented a social distancing program on March 23. The program included the suspension on non-essential activities. One of Mexico's main economic indicators, the Global Economic Activity Indicator (IGAE in Spanish), showed in March a decline of 1.3% with respect to to February (with the deseasonalized series provided by INEGI, Mexico's national statistical institute). Then in April the indicator displayed a fall of 17.3% relative to March. Comparing April 2020 to April 2019, the fall was 19.6%.

These events lead to crucial questions. How persistent will be the fall of economic activity? Will there be a quick rebound? Will the liquidity crisis, due to lower sales in many sectors, become a solvency crisis? Will the crisis generate very persistent negative effects?

The objective of this paper is to forecast the short-term evolution of the Mexican economy after the COVID-19 shock. To construct the forecast we combine the procedure in Primiceri and Tambalotti (2020) with a basic SIR model of the pandemic.

In contrast to Primiceri and Tambalotti (2020), who calculate a forecast for the U.S. economy with three non-model-based scenarios for the pandemic, we use a simple version of the SIR model of Kermack and McKendrick (1927) to produce a path of the pandemic. Afterwards, with this path in hand, we then feed into the econometric model alternative paths based on what the SIR model produced.

Primiceri and Tambalotti (2020) analyze how to solve the problem of producing forecasts given the novel characteristics of the COVID-19 shock. As we have seen recently, many economic variables have suffered changes starting in March 2020 and especially afterwards. The problem that we face as econometricians is to produce a forecast of the impact of COVID-19 based on contemporaneous data, which exclude COVID-19-type crises.[1] Below we will describe the assumptions made by Primiceri and Tambalotti (2020) to produce a forecast of the effect of the COVID-19 shock.

To make the forecasts we first calculate an estimate of the shocks that hit the economy starting in March 2020. We then produce four forecasts in which we make variations on two dimensions: introduce a path for the pandemic or not, and if we do, we consider three scenarios. The introduction of paths of the pandemic in which new cases fall has a positive effect on the economy.

The first result is that the shocks that hit the economy starting on March 2020 have the potential to produce a slow recovery of economic activity. In a forecast not conditioned on any path for the pandemic, the annual *growth rate* of the economy reaches positive values in the second quarter of 2021. This implies that the recovery of the economic activity *level* pre March 2020 would take even longer.

[1] Most of our time series start in the 1990s, and a few of them only in the 2000s.

The second result is that, in our *baseline* scenario that includes a pandemic path based on the SIR model, the recovery is faster. In this case the annual growth rate takes positive values in the first quarter of 2021.

An additional result that permeates all forecasts is the slower recovery of investment. In all our forecasts the annual growth rate of investment lags the recovery of overall economic activity. From the point of view of aggregate demand components, our predicted recoveries are driven by consumption, not by investment. This prediction points to a negative impact on potential output and on long-term growth. The crisis then would have a negative long-term impact.

Finally, we want to highlight the increase in the volatility of the consumption growth rate. It falls as much as the overall economic growth rate, and tracks its recovery. The large variations in consumption growth over time would have a negative impact on welfare.

The rest of the paper is organized as follows. Section 2 presents a literature review of recent COVID-19 research documents making special emphasis in Mexico. Section 3 presents the data description for each of the variables used in the model. In Section 4 we present our baseline specification, along with the Primiceri and Tambalotti (2020) approach for dealing with the pandemic shock. We also present the simple SIR model used to obtain our scenarios. Section 5 presents the main results while Section 6 concludes.

2 Literature Review

Following the start of the COVID-19 pandemic, economists have contributed to understanding the nature of the shock, its transmission channels to the real and financial sectors, and possible measures to mitigate the severity of the observed contraction. There is a growing literature on the impact of COVID-19 on the Mexican economy.

First of all, in terms of methodology, there is a literature that analyzes econometric estimation and forecasting for the U.S. economy in the presence of COVID-19 shocks. As mentioned earlier, Primiceri and Tambalotti (2020) propose a set of assumptions to forecast the evolution of the U.S. following the outbreak of COVID-19. Lenza and Primiceri (2020) illustrate how to handle the sequence of extreme observations when estimating a vector autoregression, showing that the ad hoc strategy of dropping these observations may be acceptable for the purpose of parameter estimation. However, disregarding these recent data is inappropriate for forecasting the evolution of the economy because it underestimates uncertainty.

A set of papers uses econometric methods to measure the impact of COVID-19 on Mexico. This is the case of Jiménez Gómez et al. (2020) who, using cointegration, find that 205,863 jobs of permanent workers insured by the Mexican Social Security Institute (IMSS in Spanish) would be lost by each percentage point that Mexican GDP drops in 2020 as a consequence of the quarantine.[2] According to the authors, if GDP drops 8.2% in 2020, about 1.69 million of this kind of jobs would be lost. Compared to our work, these authors use data up to 2019. We estimate the model with data up to February 2020, and use data for March, April and May to measure the COVID-19 shock, analogously to Primiceri and Tambalotti (2020). ECLAC (2020) argues that the COVID-19 pandemic has hit Latin America and the Caribbean in a period of economic weakness and macroeconomic vulnerability. This work projected a contraction of

[2]IMSS is the public health institute that insures workers in the formal sector of the economy.

6.5% of GDP in 2020 for Mexico. Sampi and Jooste (2020) use the Google Mobility Index to nowcast monthly industrial production growth rates in selected economies in Latin America and the Caribbean, including Mexico.

Another group of papers uses general equilibrium models (GE) to measure the effect of COVID-19. McKibbin and Fernando (2020) explore seven different scenarios of how COVID-19 might evolve in the coming year using a hybrid DSGE/CGE general equilibrium model. They produce results for 20 developed and developing countries, including Mexico. Bekkers et al. (2020) develop three scenarios for the impact of the COVID-19 pandemic: a V-shaped, a U- shaped and an L-shaped recovery scenario. These authors use a dynamic CGE model. They analyze a group of developed and developing countries, including Mexico. It is important to say that there are GE models, aimed at studying the case of the U.S., that model explicitly the dynamics of the SIR model. One such model is, for example, Eichenbaum et al. (2020) who extend the SIR model to study the interaction between economic decisions and epidemics.

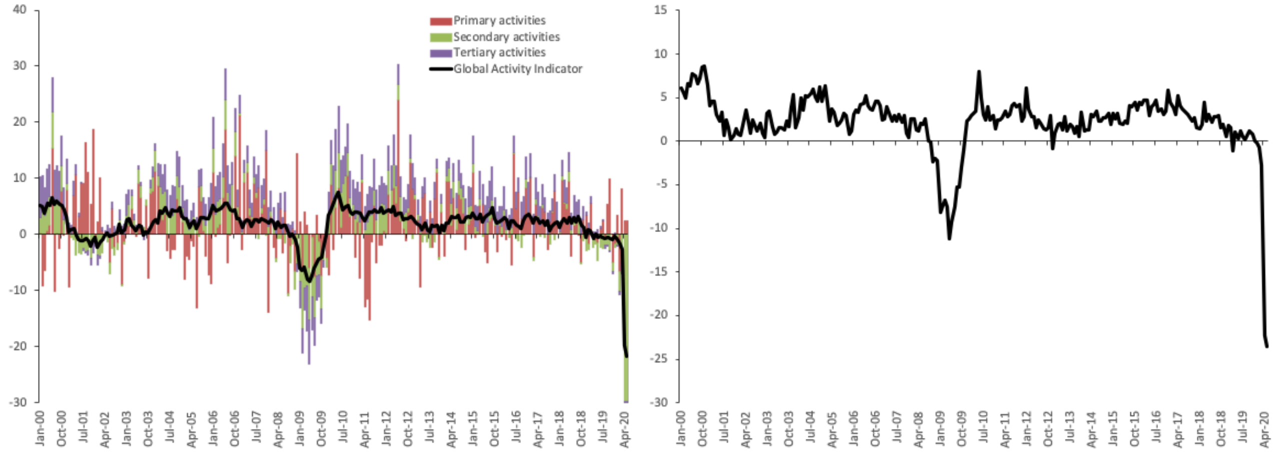
Our contribution to this literature is twofold. First, to the best of our knowledge, we are the first ones to include explicitly, in a simple way, the implications of a SIR model of the evolution of the pandemic to forecast the behavior of economic activity in Mexico. Jiménez Gómez et al. (2020) do not include any assumption on the evolution of the pandemic. Nor do, according to our reading, Sampi and Jooste (2020). ECLAC (2020) does have an assumption on the re-opening of the economy, which would be a reflection of the behavior of the pandemic. Second, we analyze and forecast the impact of the pandemic at a basic level of sectoral disaggregation. We forecast the behavior of the components of the Global Economic Activity Indicator for primary, secondary and tertiary activities. We find heterogeneous effects across sectors, with the primary one reacting less than the others. We also forecast the behavior of employment in those three sectors, with similar results.

3 Data Description

We use monthly data to calculate annual percent growth rates of twelve variables that measure real economic activity: the Global Economic Activity Indicator (IGAE in Spanish), the Economic Activity Indicator for the Primary, Secondary and Tertiary Activities, the Private Consumption in the Domestic Market Monthly Indicator (IMCPMI in Spanish), the Gross Fixed Capital Formation Indicator (IMFBCF in Spanish), the Capital Formation Indicator for Machinery and Equipment, the Capital Formation Indicator for Construction, the total number of insured workers associated with permanent or temporary urban jobs registered by the Mexican Social Security Institute (IMSS in Spanish), and its decomposition into workers in the primary, secondary and tertiary sectors. The IGAE index closely tracks real GDP. The IMSS data is considered a measure of formal employment, in a country with a large, low-productivity, informal sector. From now on we will refer to these variables as, respectively, Global Economic Activity (GEA), Primary Sector, Secondary Sector, Tertiary Sector, Consumption, Investment, Machinery and Equipment, Construction, Total Employment, Employment: Primary Sector, Employment: Secondary Sector, and Employment: Tertiary Sector. Due to availability of IMSS data the sample covers the period January 2000 to May 2020. The IMSS series had a seasonal component and were filtered using X-12-ARIMA. The other variables were deseasonalized by the source, Mexico's National Statistical Institute (INEGI in Spanish).

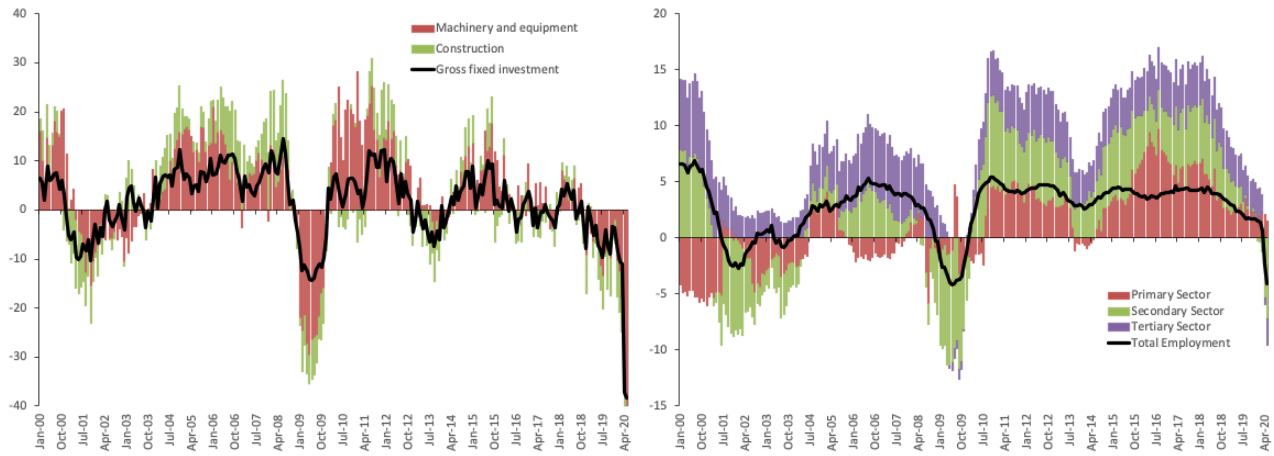
The impact of COVID-19 is sudden and large. Figure 1a displays the evolution of GEA, and its components. Figure 1b plots the evolution of the annual percent variation of Consumption. Figure 2a displays the dynamics of the annual percent variation of Investment and its components. Finally, Figure 2b presents the annual percent variation of employment and its components.

Figure 1. Annual % variation



(a) Economic Activity, Global and Disaggregated (b) Consumption

Figure 2. Annual % variation



(a) Investment, and Disaggregated (b) Employment, Total and Disaggregated

Table 1 presents descriptive statistics using a pre COVID sample and the complete sample. We compute the statistics using the annual percent variation of all variables using as pre COVID sample January 2000 to February 2020. The post COVID sample uses the period January 2000 to May 2020. The COVID-19 shock generated a new minimum in the time series analyzed, it increased the variance of the time series, and reduced the average percent growth rates. Primary activities, both output and employment, are insensitive to crisis episodes such as the dot-com crisis in 2001, the 2008 financial crisis, and the novel COVID-19 crisis.

Table 1: Descriptive statistics

Variable	Mean		Min		Std. Dev.	
	Pre COVID	Post COVID	Pre COVID	Post COVID	Pre COVID	Post COVID
Global Economic Activity	1.99	1.78	-8.29	-21.65	2.52	3.25
Primary Sector	2.15	2.17	-15.17	-15.17	6.27	6.24
Secondary Sector	0.86	0.59	-10.59	-29.69	3.10	4.15
Tertiary Sector	2.64	2.46	-8.13	-19.06	2.46	3.06
Consumption	2.41	2.19	-11.21	-23.53	2.71	3.55
Investment	1.82	1.45	-14.36	-38.41	6.24	7.20
Machinery and Equipment	4.18	3.72	-29.53	-43.76	10.44	11.23
Construction	0.71	0.39	-13.85	-36.29	5.72	6.54
Total Employment	2.81	2.75	-4.15	-4.15	2.35	2.40
Employment: Primary Sector	1.19	1.20	-6.04	-6.04	3.62	3.60
Employment: Secondary Sector	1.89	1.81	-10.00	-10.00	4.26	4.30
Employment: Tertiary Sector	3.60	3.55	-0.92	-2.35	1.47	1.54

Sources: Authors' calculations using information from INEGI and IMSS.

4 Bayesian VAR

To analyze the COVID-19 shock to the Mexican economy we use a Bayesian VAR. The econometric specification is

$$\mathbb{Y}_t = c + \sum_{p=1}^{P} A_p \mathbb{Y}_{t-p} + \varepsilon_t, \quad \varepsilon_t \sim \mathcal{N}(0, \Sigma) \text{ and } t = 1, \dots, T, \tag{1}$$

where $\mathbb{Y}_t$ is the (12×1) vector of endogenous variables that we listed above, c is a (12×1) vector of constants, and ε_t is a (12×1) vector of error terms following a multivariate normal distribution. As mentioned earlier we use annual percent growth rates of each variable. The estimation sample covers the period January 2000 to February 2020. The number of lags used is 12 months and we use the Minnesota prior. Our reference for the model is Dieppe et al. (2016).

As in Lenza and Primiceri (2020) we remove from the sample the observations of March, April and May 2020 to avoid explosive dynamics. Notice that by incorporating the last three observations, which are extreme values, we might turn into non-stationary some of the variables in the model. In fact, we confirmed that adding the information of March, April and May 2020 made each time series non-stationary. We also confirmed that the BVAR did not satisfy the stability condition after including those data points. We also compared the impulse-response functions between the sample up to February 2020, and the one ending in May 2020, finding explosive dynamics in the latter.

4.1 Modeling the COVID-19 shock

Primiceri and Tambalotti (2020) propose a set of assumptions, in the context of a Bayesian VAR, to estimate the effect that the COVID-19 pandemic would have on economic activity for the United States. We briefly describe their points here. The idea is to make a "synthetic" shock representing COVID-19 since there are no contemporaneous dynamics of macroeconomic fundamentals like the ones recently observed. The assumptions are: i) the COVID-19 shock is the main source of variation in macroeconomic variables in March-May 2020 (they used data only for March and April), ii) the shock will propagate in the following months through the economy like a combination of shocks previously observed in the history of macroeconomic variables, and iii) the propagation of the shock takes into account the diffusion path of the pandemic. In their paper, scenarios are generated regarding its evolution. Below we apply their procedure to Mexican data, using the codes they provided online. We add one element. We use a simple SIR model to predict a path for the pandemic. Based on this path, we construct scenarios for the pandemic, and produce forecasts.

Based on Primiceri and Tambalotti (2020) we describe the dynamics of an $(n \times 1)$ vector $\mathbb{Y}_t$ using the following two equations

$$\mathbb{Y}_t = G(L)\eta_t, \tag{2}$$

$$\eta_t = F(L)\varepsilon_t. \tag{3}$$

The first expression relates the evolution of $\mathbb{Y}_t$ to a vector of exogenous variables η_t and their lags, and the second expression states that η_t is a moving average of an $(n \times 1)$ vector of shocks, whose variance-covariance matrix is normalized to the identity matrix. $G(L)$ and $F(L)$ are lag polynomial matrices, of suitable dimensions and of potentially infinite order, that describe the endogenous and exogenous propagation of ε_t, respectively. The authors assume that $\mathbb{Y}_t$ and ε_t are of the same dimension so that matrices $G(L)$ and $F(L)$ imply a fundamental representation of $\mathbb{Y}_t$ as a moving average of ε_t.

Using both expressions we get the Wold representation of equation (1) in terms of past errors

$$\begin{aligned} \mathbb{Y}_t &= \Theta(L)G_0\varepsilon_t, \\ \Theta(L) &\equiv G(L)F(L)G_0^{-1}, \\ \Theta_0 &= I_n. \end{aligned}$$

To account for the effects of the pandemic the authors modify the previous expression to incorporate a virus shock ν_t such that

$$\mathbb{Y}_t = \Theta(L)G_0\varepsilon_t + \underbrace{\theta(L)r(L) \odot r_0\nu_t}_{\substack{\text{COVID-19} \\ \text{effect}}}, \tag{4}$$

where $\odot$ denotes the element-wise product of two vectors, $\theta(L) \equiv I_{n\times n} + \sum_{i=1}^{\infty} \theta_i L^i$ is an $(n \times n)$ lag polynomial matrix, $r(L) \equiv 1_{n\times 1} + \sum_{i=1}^{\infty} r_i L^i$ is an $(n \times 1)$ lag polynomial vector, r_0 is an $(n \times 1)$ vector, and ν_t is the COVID-19 shock. This shock is zero in all time periods except for the month in which COVID-19 started affecting the Mexican economy, March 2020.

In terms of symbols, assumption ii) is stated as $\Theta(L) = \theta(L)$. This is interpreted as, absent $r(L)$, the pandemic shock ν_t would propagate as shocks ε_t. Under the assumption that $\Theta(L) = \theta(L)$, the COVID-19 effect can be written as $G(L)F(L)G_0^{-1}r(L) \odot r_0\nu_t$. Let $f(L) \equiv F(L)G_0^{-1}r(L)$. $f(L)$ characterizes the propagation of $r_0\nu_t$. We expect that the size and duration of the contraction of economic activity will depend on the evolution of the pandemic. To incorporate this idea into the model, assumption iii) plays a crucial role. The main idea of the third assumption is to impose restrictions on the coefficients of vector $f(L)$ that characterize the evolution of the pandemic. Scenarios below will be specified in terms of paths for $f(L)$.

4.2 The SIR model and Scenarios for Mexico

To make three possible scenarios of the evolution of the virus in Mexico we use the *simplest* SIR model introduced by Kermack and McKendrick (1927). It consists of a differential equations system that characterizes the evolution of a pandemic by taking into account the number of susceptible people $S(t)$, the number of infected people $I(t)$, and the number of recovered people $R(t)$ for a given population of size $\bar{N} = S(t) + I(t) + R(t)$. The differential equations system is

$$\frac{dS(t)}{dt} = -\beta S(t)I(t), \tag{5}$$

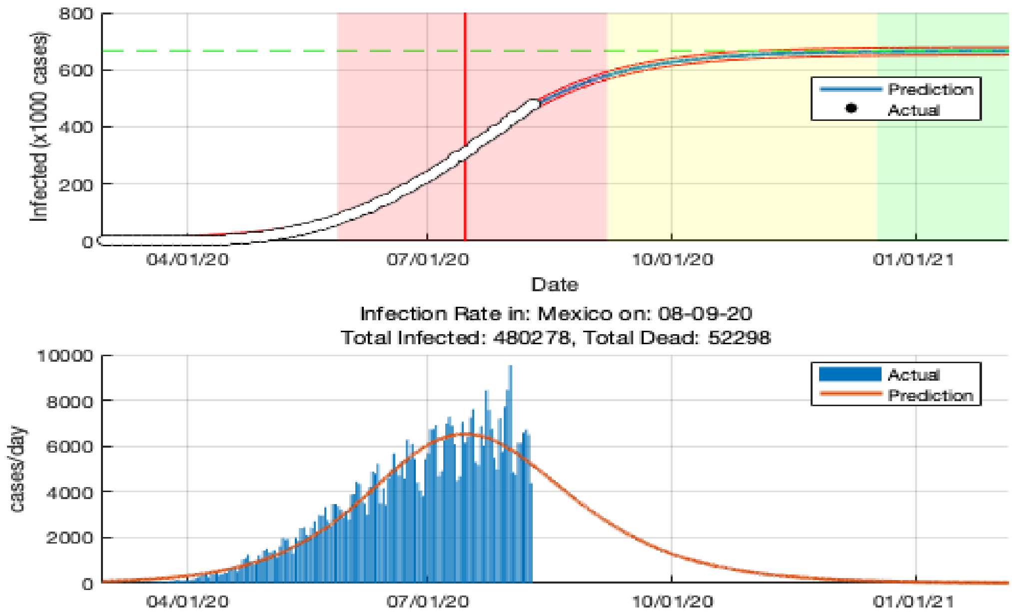
$$\frac{dI(t)}{dt} = \beta S(t)I(t) - \gamma I(t), \tag{6}$$

$$\frac{dR(t)}{dt} = \gamma I(t), \tag{7}$$

where β represents the transmission rate and γ is the recovery rate. We used the codes from McGee (2020) to compute the model-based prediction of the pandemic. Figure 3 presents the evolution of the virus for Mexico using $\beta = 16.8\%$ and $\gamma = 12.6\%$. As of August 9, 2020, the estimate is that new cases would have started falling in the second half of July 2020. The pandemic would end at the end of December 2020.

This clearly represents an optimistic prediction since the actual data, i.e. the blue bars in Figure 3, show a possible flattering of the curve for new cases only at the beginning of August 2020.

Figure 3. Evolution of pandemic in Mexico according to SIR model

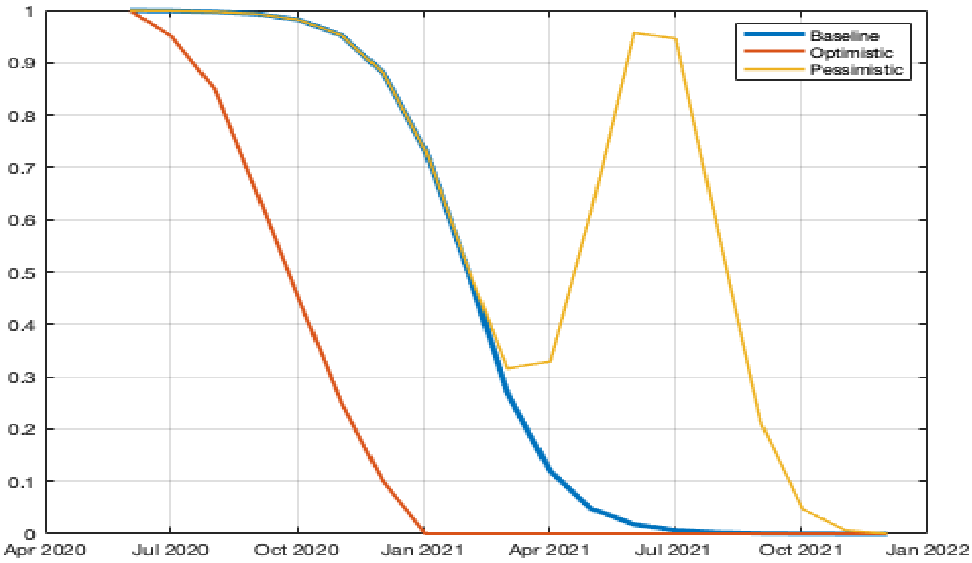


Given this prediction we define three possible scenarios of the evolution of the pandemic. As in Primiceri and Tambalotti (2020), the scenarios are specified in terms of $f(L)$. Figure 4 presents the evolution path of the pandemic in Mexico for each scenario. The date of the first point in each scenario is June 2020. Notice that the possible paths start at values close to 1. Afterwards they fall to zero. The interpretation is that the virus shocks disappear at changing speeds over time.

The paths for each scenario are:

- **Optimistic scenario:** this one is based on the prediction of the SIR model. The pandemic in Mexico began easing in mid-July 2020 and will end in January 2021, following

FIGURE 4. PANDEMIC EVOLUTION PATH FOR EACH SCENARIO



the path

$$[f_2^{Mex}, f_3^{Mex}, f_4^{Mex}, f_5^{Mex}, f_6^{Mex}, f_7^{Mex}, f_8^{Mex}] = [1, 0.95, 0.85, 0.65, 0.45, 0.25, 0.10] f_1^{Mex}, \quad \text{with } f_j^{Mex} = 0_{(n \times 1)} \ \forall j \geq 9.$$

- **Baseline scenario:** in this scenario we take the prediction of the SIR model and shift it to the right, using a functional form for the evolution of f. This function is based on Primiceri and Tambalotti (2020). We are assuming that new cases will peak in August 2020 and that the pandemic in Mexico will end by July 2021, following the path

$$f_j^{Mex} = \frac{1}{1 + \exp(j - 9)} f_1^{Mex}, \ \forall j \geq 2.$$

- **Pessimistic scenario:** there is a second wave of the virus starting in April 2021, with a maximum on June 2021, and ending in December 2021, following the path (also based on Primiceri and Tambalotti (2020))

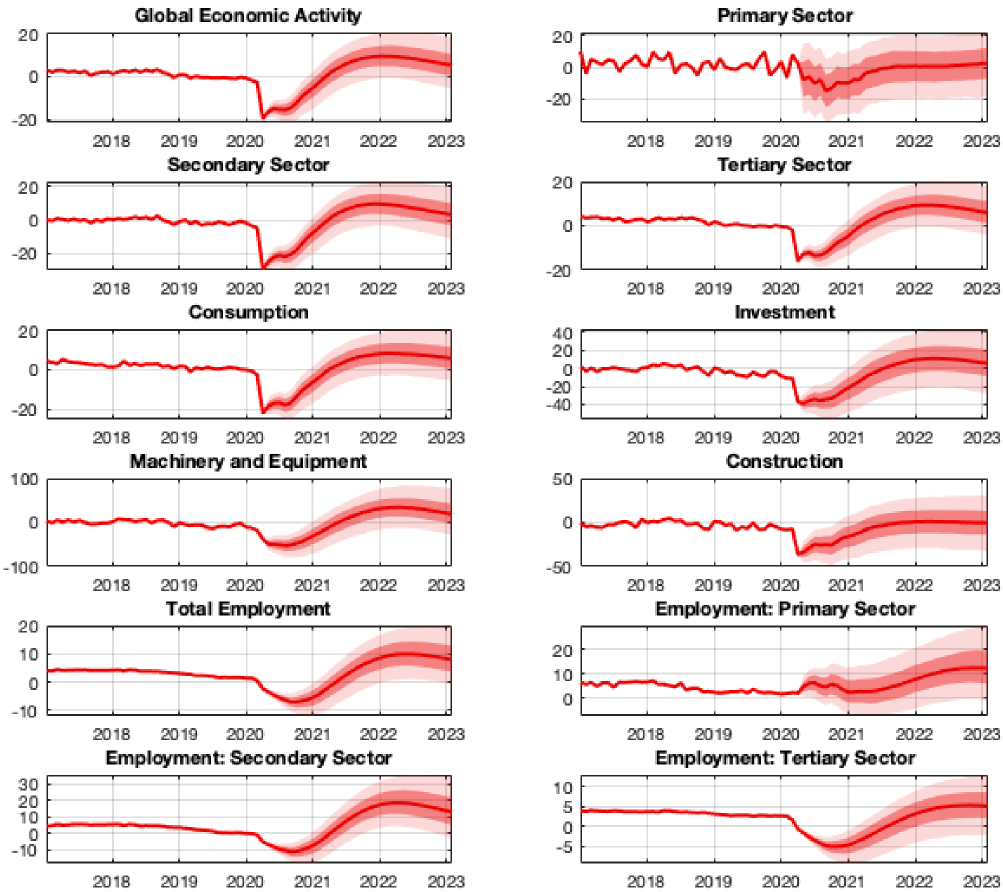
$$f_j^{Mex} = \left[\frac{1}{1 + \exp(j - 9)} f_1^{Mex} + \exp\left(-\frac{1}{4}(j - 13.5)^2 \right) \right] f_1^{Mex}, \ \forall j \geq 2.$$

This scenario is important as we are currently observing a second wave in Europe. In this particular scenario for Mexico the second wave of the pandemic rises sharply and also falls quickly. A smaller persistence in the second wave would be associated with a faster recovery of the economic activity. In the real world the initial negative shock on economic activity came from the lockdown. There is a lot of uncertainty on what response the government would undertake in case of a second wave. We interpret our assumption as a partial lockdown (or weaker compared to the first one).

5 Results

We first compute an unconditional forecast finding that the negative impact on the economy would be persistent. This forecast excludes any path for the pandemic evolution. It simply uses the observed shocks for March, May and April 2020 recovered from the data, and parameter values estimated with data between January 2000 and February 2020. The forecast starts in June 2020. Results are shown in Figure 5.

Figure 5. Unconditional Forecast



Note: The unconditional forecast does not inlcude any evolution path of the pandemic shock. The solid red line represents the actual data until May 2020, and the posterior median of the predictive density afterwards. The shaded area correspond to the 68 and 95 percent posterior credibility regions, respectively.

In this forecast Global Economic Activity (GEA) shows positive annual growth rates until the second quarter of 2021, after falling approximately 20% in April 2020. This implies that it would take several more months for this important indicator, highly correlated with GDP, to reach the *level* it had in December 2019.

Another interesting result is that Investment starts to show positive annual growth rates until the second half of 2021, after falling 37.1% in April 2020. This prediction has negative implications for Mexico's potential output, i.e. for long-term growth.

An additional interesting result is related to Consumption, which shows positive annual growth rates until the second quarter of 2021, following closely the behavior of GEA. The 22.2% fall in April 2020, and the persistent fall in the consumption growth rate, would produce a large negative effect on welfare.

Regarding other variables, we start with the behavior of the Primary, Secondary and Tertiary Sectors. The COVID-19 shock had a large impact on the Secondary and Tertiary sectors, given that several industries, restaurants, entertainment and transportation (partially in that case) shut down. The Secondary Sector, contracting 29.7% in April 2021, suffered both because of the fall in economic activity in the U.S., as both economies are closely linked by trade agreements, and because of the shut-down in Mexico. The Tertiary Sector fell 15.9% in April 2020. Under this forecast, the Secondary and Tertiary sectors show positive growth rates until the second quarter of 2021. The Primary Sector, more volatile than the others before the COVID-19 Crisis, contracts in response to the shock. This contraction is smaller than in the other sectors on impact. Afterwards the Primary Sector displays positive growth rates in the first half of 2021.

In terms of the components of Investment, Machinery and Equipment has a larger fall than Construction. Both falls are very large in April 2020. Machinery and Equipment fell 38%. Construction fell 36.3%. Machinery and Equipment has a faster recovery, showing positive growth rates in the second quarter of 2021. Construction has positive growth rates only until the second half of 2021. The rates for this type of investment are only slightly above zero, suggesting a very weak recovery.

In terms of the unconditional forecast for Total Employment and its decomposition into Primary, Secondary and Tertiary sectors, we find heterogeneous results regarding the size and duration of the contraction. After several months of negative growth, Total Employment has positive rates in the second quarter of 2021. The Primary Sector does not show a contraction on impact, and it displays positive growth rates throughout the forecast.[3] On the other hand, employment in the Secondary and Tertiary Sectors shows larger falls on impact. Afterwards, the Secondary Sector shows positive growth rates in the first half of 2021. Employment in the Tertiary Sector displays a slower recovery, having positive growth rates until the second half of 2021.

The fact that the predicted recovery is slow is reminiscent of Primiceri and Tambalotti (2020). They argue that producing a forecast *excluding* a path for COVID-19, with fewer cases over time, would yield a Depression. The reason behind this fact is that shocks in the data are associated with hump-shaped dynamics that imply slow recoveries.

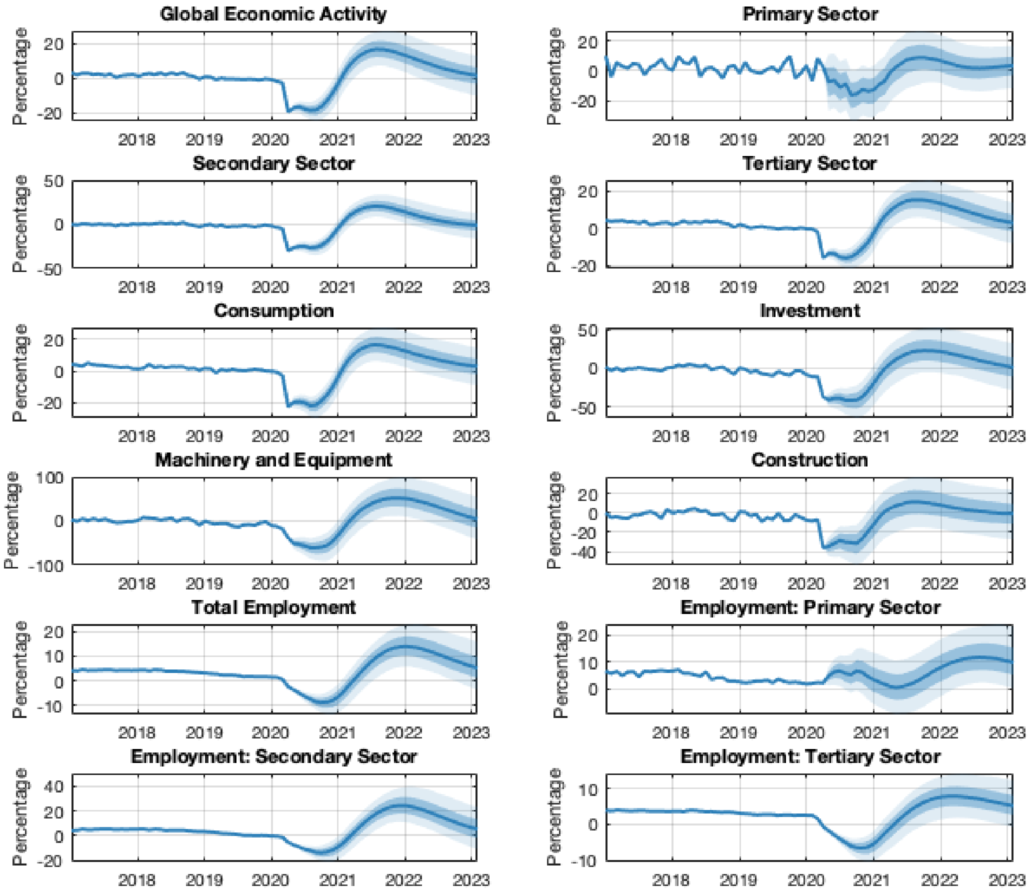
In contrast, our forecast that includes a baseline scenario for the pandemic produces a much faster recovery, because there is a positive effect on the economy coming from the fall in new cases (see Figure 6). More intuitively, it comes from a re-opening of the economy. GEA shows positive growth rates in the first quarter of 2021. These rates are bigger than those observed in the unconditional forecast. In spite of those bigger growth rates the forecast implies a recovery of December 2019 values at the end of 2021.[4]

Investment shows positive growth rates in the second quarter of 2021. But remarkably, the projected positive annual growth rates are smaller, in absolute terms, than those observed in the contraction (although the positive rates last for longer in our horizon). This suggests that Investment will not recover its pre pandemic values in the short-term. In levels, the forecast for investment does not recover its December 2019 values at the end of our forecast horizon, which is February 2023. Therefore, even taking into account the positive effect of the decrease

[3] In these data, employment in the primary sector is a small fraction of the total, approximately 3%.

[4] To obtain the levels we proceeded in two steps. First, we obtained the prediction in levels using the annual growth rates. Second, we used a simple exponential filter to smooth this forecast since we observed a pattern. It is common in forecasting to observe patterns when going from predicted growth rates to levels or when there are unknown trends. For example, see Holt (2004) and De Gooijer and Hyndman (2006).

Figure 6. Forecast for Baseline Scenario



Note: The COVID-19 shock follows the baseline path showed in Section 4. The solid blue line represents the actual data until May 2020, and the posterior median of the predictive density afterwards. The shaded area correspond to the 68 and 95 percent posterior credibility regions, respectively.

in new cases, the outlook for investment, potential output, and long-term growth remains very negative.

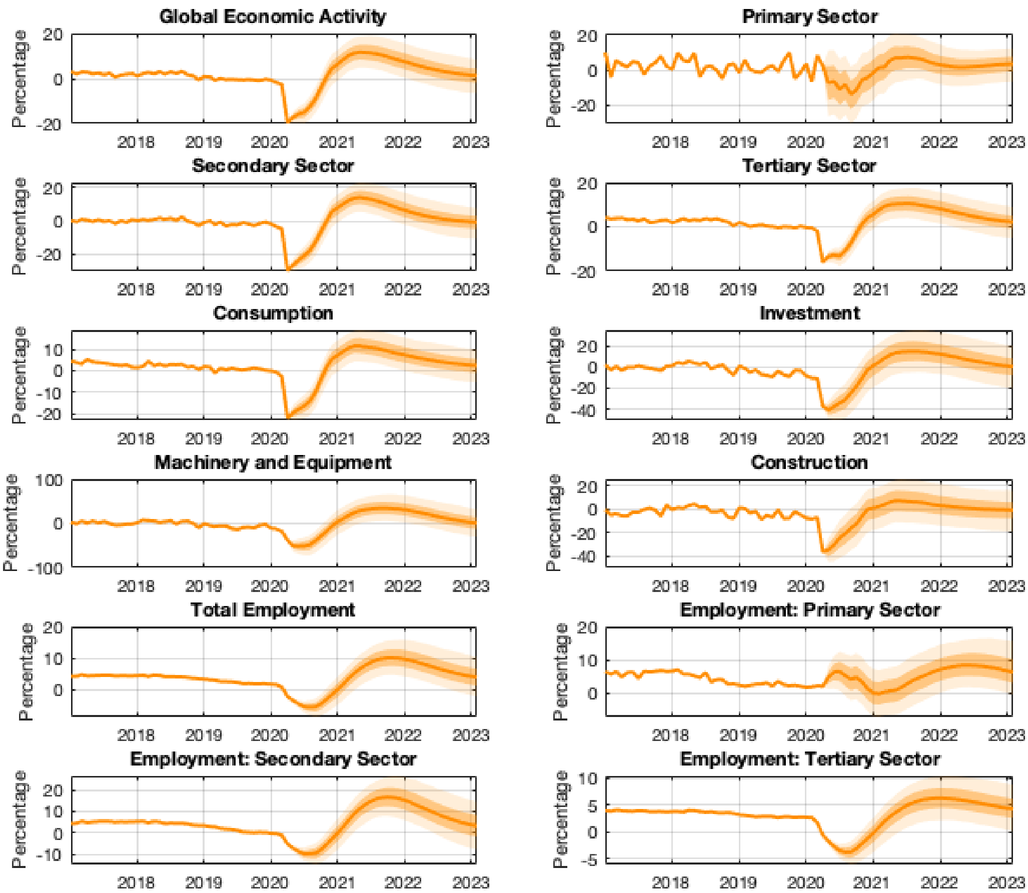
Consumption behaves in a similar way as GEA. It shows positive growth rates in the first quarter of 2021. In this baseline scenario for the pandemic, the implied welfare cost would be smaller than in the unconditional forecast.

In the case of total employment, we observe positive growth rates in the second quarter of 2021. As in the previous forecast, there is a heterogeneous behavior across sectors, with employment in the primary sector being affected much less. The other sectors show bigger contractions, and positive growth rates in the second quarter of 2021. The forecast implies a recovery of the December 2019 values in mid-2021.

The optimistic scenario (see Figure 7), in which the fall in new cases is faster, yields a faster recovery. It predicts that GEA will have positive growth rates in the last quarter of 2020. One remarkable result of this forecast is that Investment has positive growth rates in the first quarter of 2021. In the case of the Consumption, it behaves similarly to GEA. Total Employment has positive growth rates in the first quarter of 2021.

The pessimistic scenario (see Figure 8) produces a slower recovery compared to the baseline. In this scenario, which has a second wave of the pandemic that peaks in June 2021, Global

Figure 7. Forecast for Optimistic Scenario



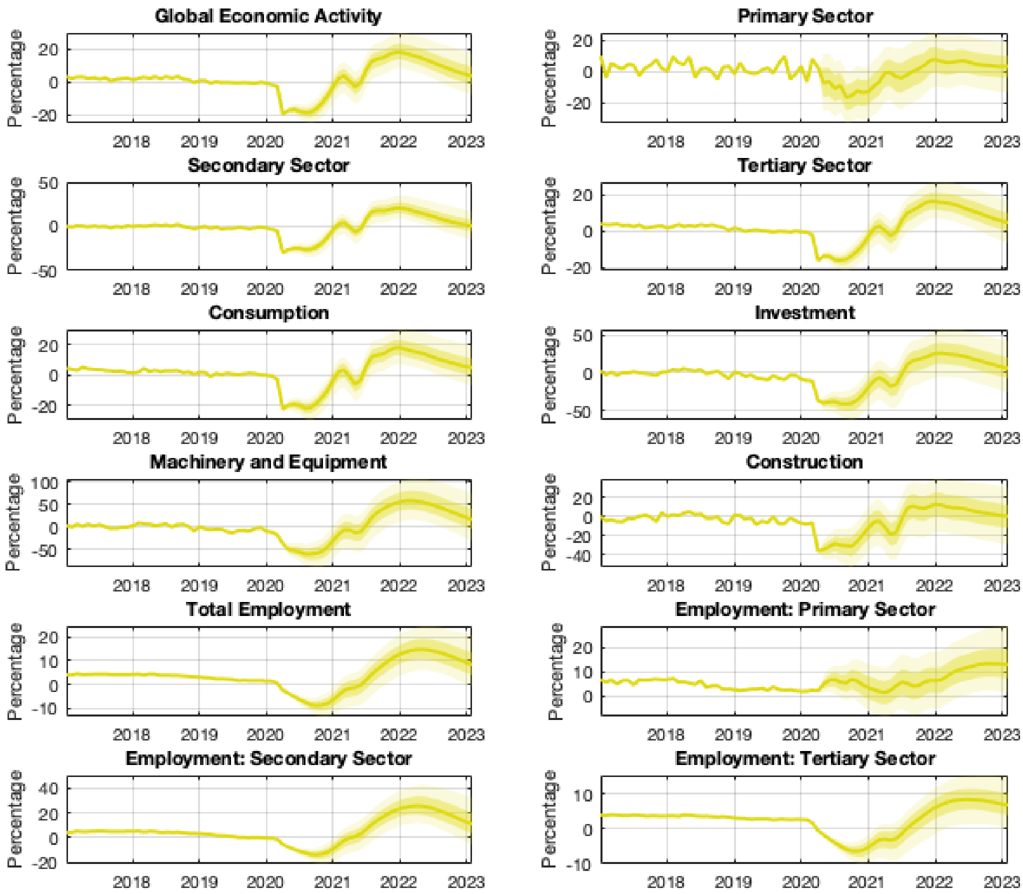
Note: The COVID-19 shock follows the optimistic path showed in Section 4. The solid orange line represents the actual data until May 2020, and the posterior median of the predictive density afterwards. The shaded area correspond to the 68 and 95 percent posterior credibility regions, respectively.

Economic Activity has positive growth rates in the first quarter of 2021. These rates are smaller than in the baseline scenario. The second wave produces negative growth rates in the second quarter of 2021. Investment displays a very negative behavior, with negative growth rates until the second quarter of 2021. Consumption follows closely the behavior of GEA. In terms of welfare, this path for consumption would generate a fall, not only because of the contractions in 2020 and 2021, but also because of the extra volatility caused by the sequence contraction-recovery-contraction. Total employment has a long sequence of negative growth rates which ends in second quarter of 2021.

5.1 Robustness

We estimated the model with variables in levels, as opposed to annual growth rates. We then computed the annual growth rates implied in this alternative estimation. Focusing on the baseline scenario, and on GEA, we find the following. First, the two forecasts have similar values and dynamics in the second half of 2020. Second, they differ in the recovery period between February 2021 and February 2022. In particular, the prediction using the estimation with levels has higher rates between April 2021 and February 2022. Third, after the latter month the growth rates become similar again. Fourth, the correlation between the two forecasts is 95%. We prefer our main estimation with annual growth rates, as in the alternative, recovery

Figure 8. Forecast for Pessimistic Scenario



Note: The COVID-19 shock follows the pessimistic path showed in Section 4. The solid yellow line represents the actual data until May 2020, and the posterior median of the predictive density afterwards. The shaded area correspond to the 68 and 95 percent posterior credibility regions, respectively.

rates during 2021 are asymmetrically large, i.e. higher in absolute value in the recovery than in the contraction, which we think is not plausible.

6 Conclusions

We combined an econometric procedure with a SIR model to answer the question of how the Mexican economy would evolve after the COVID-19 shock. We looked at the prediction of the simplest SIR model regarding the path of the pandemic for June 2020 and afterwards. Then we generated three scenarios based on that path. These scenarios are an input into the econometric forecast.

One important lesson is that the shocks that hit the economy have the potential to produce a long lasting recession. The unconditional forecast, in which we did not include a path for the pandemic with a fall in new cases, has that prediction. In this case economic activity would display positive growth rates until the second quarter of 2021.

On the other hand, in the baseline path for the pandemic, the fall in new cases has a positive effect on the economy. This forecast, conditional on a pandemic path based on the SIR model, yields positive annual growth rates in the first quarter of 2021.

The outlook for investment looks particularly bleak. In all our scenarios this variable takes many quarters to have positive growth rates. Such a behavior would imply a reduction in potential output and a fall in long-term growth. In turn, that would have implications for the rest of the economy: a lower growth rate of consumption, and a trend towards having current account surpluses because of the fall of domestic spending.

The model predicts different speeds of recovery for consumption, depending on the experiment. The fastest recovery to positive growth rates is realized in the optimistic scenario, taking place in the last quarter of 2020. But even in this case the initial fall in consumption is large. Consumption growth takes several months to recover. Therefore the COVID-19 shock would imply a fall in welfare. A second wave would amplify this cost, as a second large fall in economic activity would increase the volatility of the consumption growth rate, reduce income, and eventually spending.

We conclude that the outlook for the Mexican economy looks negative. At the time of writing, new cases (the speed of the pandemic) seem to grow more slowly. But there is obviously uncertainty about the evolution of the pandemic. To maximize the benefit of a fall in new cases, i.e. the gradual re-opening of the economy, policy makers should try to reduce persistent effects of the initial shock. There is already evidence that the initial liquidity crisis (the fall in sales) has caused a solvency crisis, both for the largest firms, and for micro businesses. An additional effort could be made to reduce insolvency. Otherwise economic activity would tilt towards a longer recession.

References

E. Bekkers, A. Keck, R. Koopman, and C. Nee. Methodology for the WTO trade forecast of april 8 2020. *Manuscript, WTO*, 2020.

J. G. De Gooijer and R. J. Hyndman. 25 years of time series forecasting. *International Journal of Forecasting*, 22(3):443–473, 2006.

A. Dieppe, R. Legrand, and B. Van Roye. The BEAR toolbox. 2016.

ECLAC. Measuring the impact of COVID-19 with a view to reactivation. *Special Report COVID-19, No. 2, ECLAC*, 2020.

M. Eichenbaum, S. Rebelo, and M. Trabandt. The Macroeconomics of Epidemics. *NBER Working Paper Series 26882, NBER*, 2020.

C. C. Holt. Forecasting seasonals and trends by exponentially weighted moving averages. *International Journal of Forecasting*, 20(1):5–10, 2004.

A. Jiménez Gómez, B. Martínez Carreño, and C. Absalón Copete. An Estimation of Jobs Lost in Mexico during 2020 as a Result of the COVID-19: a Cointegration Approach. *Brazilian Journal of Health Review*, 2020.

W. O. Kermack and A. G. McKendrick. A contribution to the mathematical theory of epidemics. *Proceedings of the Royal Society of London. Series A, Containing papers of a mathematical and physical character*, 115(772):700–721, 1927.

M. Lenza and G.E. Primiceri. How to estimate a VAR after march 2020. *Manuscript, Northwestern University*, 2020.

J. McGee. COVID-19 SIR Model. https://www.mathworks.com/matlabcentral/fileexchange/74676-fitviruscv19v3-covid-19-sir-model, 2020. Accessed: 2020-07-11.

W. J McKibbin and R. Fernando. The Global Macroeconomic Impacts of COVID-19: Seven Scenarios. *Report, The Brookings Institution*, 2020.

G. E. Primiceri and A. Tambalotti. Macroeconomic Forecasting in the Time of COVID-19. *Manuscript, Northwestern University*, 2020.

J. Sampi and C. Jooste. Nowcasting Economic Activity in Times of COVID-19. *Policy Research Working Paper 9247, World Bank Group*, 2020.