Covid Lockdown Effects on Inequality

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Abstract

In this work I will analyze distributional consequences of the Covid-19 shock interpreted as a supply shock generated by a decrease in the labor supply. To model this I will use an incomplete markets economy and the shock will be introduced by increasing the probability of getting a part-time job or getting unemployed. The results show that in the short term the shock increases savings inequality. Also, the duration of the shock matters and the longer the periods the longer the inequality generated. However, the shock does not have long term implications since it is not a permanent shock.

1 Introduction

Since the COVID-19 epidemic emerged it has become in the center of the research agenda to try to understand its consequences and to produce policy responses. Overall, it seems the epidemic generated a negative supply shock by forcing the economic activity to stop or reduce (OECD,2020) [1]. Furthermore, the epidemic seems to affect different agents in different ways, generating room for unequal consequences on the households.

The viral shock seems to be affecting labor supply through two main channels. The first is the health component of individuals that might become infected. The second is the lockdown consequences that restrict the economic activity. In this work I would like to capture the inequality consequences of a production shock in the economy as a consequence of a decrease in the labor supplied to the economy because of the lockdown policies. The emerging literature on the current epidemic has tried to tackle this problem with new models combining epidemiological spread models and economic models. However, in this work I will not consider the spread of the virus and I will just focus on the lockdown consequences.

To model this situation I will present different scenarios. I will start with a complete market environment to see what are the overall consequences of the lockdown. The lockdown will be understood as reducing the labor supply. However, since those environments do not allow for individual heterogeneity it is not sufficient to understand inequality dynamics. For this reason, I will focus most of my analysis in an incomplete market economy à la Aiyagari (1994) where agents face uninsurable income shocks. Here, the introduction of the shock becomes more computationally difficult and my work tries to tackle this issue the best I can. In a first environment I face an economy with two possible states, full-time worker or part-time worker. The idea is that the shock will increase the probability of being a part time worker, reducing the amount of labor provided to the economy. Ideally I will introduce unemployment. For this reason I present another environment where there are 3 possible states, full-time working, part-time working and unemployment. Under this environment the shock increases the probability of being unemployed. Furthermore, different duration of the shock will be considered. The results will show that the Covid-19 shock will always increase inequality.

My work is structured as follows. In the next section I provide a brief justification of the use of an incomplete markets model together with a review of some of the current literature on COVID-19. Section 3 provides the analytical framework with the two different environments, complete market and incomplete markets. Section 4 concludes the work reviewing the most important results.

[1] Visit: https://www.oecd.org/economic-outlook/march-2020/

2 Related Literature

In this part of the work I will focus in analyzing the most relevant literature in the two most important issues of this paper, inequality and COVID.

2.1 Inequality Literature

I will briefly justify the use of an incomplete market model to study wealth inequality dynamics in a heterogeneous agent economy with stochastic productivity and introducing a shock simulating the COVID-19 lockdown.

It is a well known fact that the deterministic neoclassical growth model is insufficient to study inequality dynamics. The conclusion is simple, its simple version does not consider heterogeneity. Furthermore, even when heterogeneity is present Chatterjee (1994) showed that any initial distribution of wealth will self-perpetuate over time. Therefore, the deterministic model of growth is not a wise choice to study inequality dynamics.

This leads myself to models on which households do not have access to insurance against shocks, also known as incomplete markets economies. This models have the ability to generate inequality as well as to measure precatuionary savings. The family of models is called Aiyagari-Bewley-Hugget-Imrohoroglu Economies. The first theory was developed by Bewley (1977) and was later further expanded by Huggett (1993) , Imrohoroğlu (1989) and Aiyagari (1994). In this model there is a mass of ex-ante identical agents that after the realization of an income shock become heterogeneous. This models are useful to generate wealth inequality but they can be improved to achieve higher inequality levels, closer to nowadays society. It is important to mention that this models describe the distribution of wealth given the distribution of earnings. If we where to analyze the distribution of earnings we would need a human capital model, but this is not the intention of this work.

2.2 Covid-19 Literature

As we have experienced, the current COVID-19 crisis has generated a lot of research interest on economist, generating a boom on the papers published on this topic. There is a big part of the studies that have combined an economic environment together with an epidemological spread models. The aim of those papers is mostly to determine what should be the optimal lockdown policy a country must do. Among those for example we have that of Alvarez et al. (2020) that studies the optimal lockdown policy of a social planner that wants to minimize the output cost of a lockdown combining a SIR epidemology model and a linear economy. Similarly Acemoglu et al. (2020) study lockdown in a multi-group SIR model with different groups facing different parameters. Other papers that established a epidemological enviroment are Atkeson (2020), which was one of the very first, and that of Eichenbaum et al. (2020), where the authors find that the competitive equilibrium is not socially optimal.

Another part of the literature focuses on the empirical evidence of the COVID-19 responses. In Andersen et al. (2020) the authors use Denmark data to estimate the change in consumer spending caused by the COVID-19 pandemic. Another empirical work is that of Carvalho et al. (2020) that uses transaction data from the BBVA to determine COVID-19 implications in Spain, finding a strong consumption reaction. In a similar spirit and also using bank account data, Cox et al. (2020) measures also the impact of the COVID-19 epidemic on consumer behavior finding a expenditure decline in the first months after the pandemic.

However, even if the previous literature is important and worth mentioning, in this work I am interested in analyzing the consequences of a labor supply shock generated by the lockdown in the distribution of the economy. In this family of papers focusing on modeling the implications of the shock there are also different studies using different models and approaches. In Fornaro & Wolf (2020) the authors are concerned about the negative supply shock generated by the factories lockdown and the effect on global supply chains. To model this situation they use a standard New Keynesian model to incorporate a negative shock on the growth rate of productivity. Following the New Keynesian approach but using a DSGE model FariaeCastro (2020) analyze the pandemic effects and the fiscal policy response. The model allows for incomplete markets. In fact, as explained in Guerrieri et al. (2020) incomplete markets make Keynesian supply shocks more likely to occur. The paper of Guerrieri et al. (2020) presents a theory of Keynesian supply shocks that trigger changes in aggregate demand larger than the shock themselves. Before analyzing the effects in a multi-sector economy the authors consider a single sector economy under complete and incomplete markets environments and analyze simple dynamics. The fact that the authors uses an incomplete market model à la Aiyagari (1994) makes this work similar to the one here. In fact, another work using and incomplete market environment à la Aiyagari (1994) to analyze distributional consequences is that of Clemens & Heinemann (2020). In their work, the authors uses a two sector incomplete market economy calibrated with German data to characterize the welfare and distributional consequences of the COVID-19 lockdown.

Having presented the current literature on the epidemic implications is time to move to the analytical part of this work, where I will present my approach to tackle this issue. In that sense, my paper will contribute to the literature discussion of Guerrieri et al. (2020) and Clemens & Heinemann (2020) since I will also use an incomplete market economy.

3 Model

To analyze the coronavirus supply shock I will use an incomplete markets model based on Aiyagari (1994) but with fewer states for computational simplicity. However, before going to the incomplete market economy I will first analyze what are the consequences of a supply shock on a complete market economy following Guerrieri et al. (2020). This will provide intuition for the future sections. The supply shock that will be introduced here corresponds in a reduction in the supply of labor. This reduction in the supply of labor is a consequence of the lockdown implemented by the governments. However, at least in the complete market economy, the effect will be very similar to an unexpected temporary labor productivity reduction.

In this model and following the standard procedures I will assume agents have a CRRA preferences of the form:

$$U(c) = \frac{c^{1-\sigma} - 1}{1 - \sigma}$$

I will assume that agents are endowed with l units of labor. Furthermore, agents do not receive any utility from leisure and therefore they inelasitcally supply all their labor.

3.1 Complete Market Economy

Following the standard model there is a mass of agents with measure one that face an infinite horizon. So the agent has the standard problem. I will solve the problem of the social planner to find the steady state level of capita. Then I can see what is the effect of introducing a shock in production. The problem of the social planner is:

$$\max_{\{k_{t+1},c_t\}_{t=1}^{\infty}} \sum_{t=0}^{\infty} \beta^t U(c_t)$$

subject to:

$$c_t + i_t = y_t$$

$$y_t = k_t^{1-\theta} l_t^{\theta}$$

$$i_t = k_{t+1} - (1-\delta)k_t$$

I will normalize the labor endowment of agents to $l = 1$ for simplicity. In fact, after the shock $l = (1 - \phi)$. Substitution we get that the problem is:

$$\max_{\{k_{t+1}{}_{t=1}^{\infty}} \sum_{t=0}^{\infty} \beta^t \frac{\left(k_t^{1-\theta} + (1-\delta)k_t - k_{t+1}\right)^{1-\sigma} - 1}{1-\sigma}$$

And now if we solve for capital using the First Order Condition and we impose stationary we get the usual result:

$$k_{ss} = l \left(\frac{1-\theta}{\frac{1}{\beta} - 1 + \delta} \right)^{\frac{1}{\theta}}$$

Where l is the inelastically supplied level of labor. Notice that since under a complete market economy the problem of the social planner and the competitive equilibirum are identical, I can now compute the interest rate at the steady state using the FOCs of the firm under competitive market.

$$r = (1-\theta)k^{-\theta}l^{\theta} - \delta$$

So in the steady state we get that:

$$r_{ss} = \frac{1}{\beta} - 1$$

So the the first result is that under a complete market economy the steady state interest rate will be the same no matter the shock level. This is a well known result but I want just to stress this. However, we can still determine interest rate changes after the shock.

My intention is to now compute what is the effect on the economy when a shock to production is introduced. Following Guerrieri et al. (2020) suppose that agents now face an unanticipated labor shock, such that a fraction $\phi \in [0, 1]$ is unable to provide its labor endowment. This is the same as the representative agent just supplying a fraction $(1 - \phi)l$ of labor. I will now present the results found in a simulation of this model. My results will consider two situations both starting with the economy at the steady state. The fist one assumes that the covid lockdown shock remains there a considerable amount of periods until the economy converges to a new steady state. The second and more realistic situation assumes the covid lockdown shock will only last 2 periods.

For the parametrization of the economy I will establish $\alpha = 0.33$, $\theta = 0.67$, $\rho = 0.06$ and $\delta = 0.08$. Remember $\beta = \frac{1}{1+\rho}$. An improvement of this work can be to do a better calibration.

3.1.1 Steady State Transitions if Covid-19 Shock is Permanent.

In this environment I will establish a COVID-19 shock that represents a 20% reduction in the supply of employment. As a further expansion of the work, a more accurate calibration can be done. The main results are displayed at Figure 1 and Figure 2.

Notice that in this environment I am assuming the COVID-19 shock is a permanent shock. This is not a realistic assumption. However, the consequences would be that the economy will move towards a new steady state level. Notice that Figure 2 shows that the interest rate first decreases. This is a direct consequence of the fact that labor supply has unexpectedly decreased, making the marginal productivity of capital decrease. However, period after period it recovers its previous level while capital decreases towards a new steady state level. The fact that the interest rate in steady state is independent of any shock was showed in the previous section and the results found are consistent with that result.

Figure 1 shows an economy that is at the initial steady state for 10 periods and then the permanent shock on labor supply is introduced.

Figure 1: Transition to the new steady state

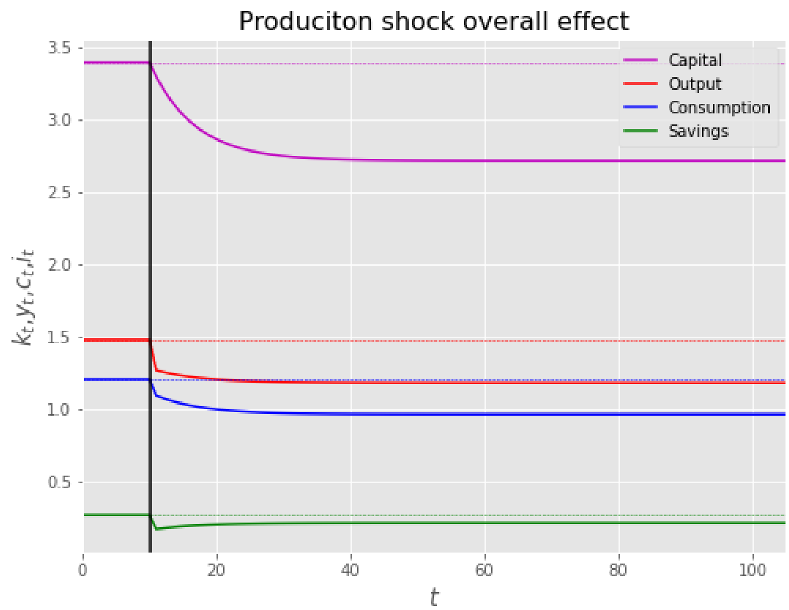
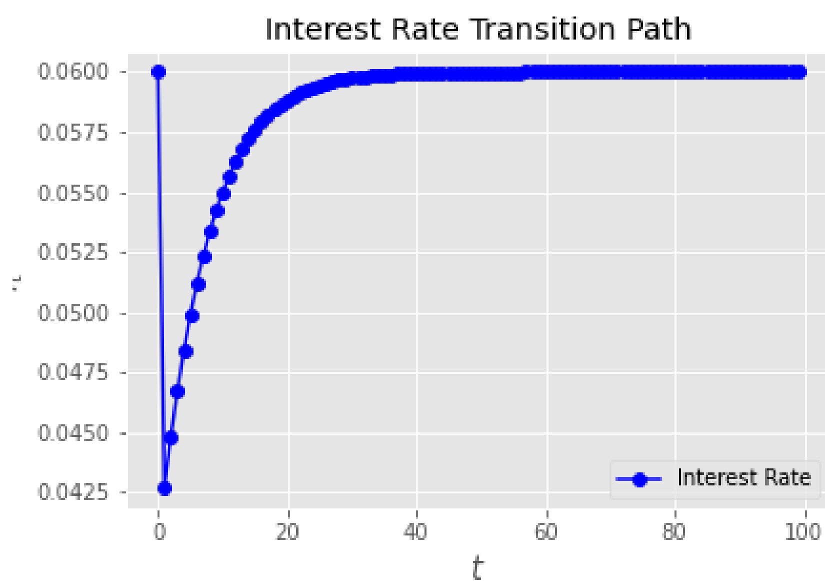


Figure 2: Transition of the interest rate



3.1.2 Steady State Transitions if Covid-19 Shock is Transitory.

I will now assume that the COVID-19 is a MIT shock. In that sense it produces a decrease on the labor supplied to the economy at one periods,and in the next period the economy recovers. As before, the economy starts at the steady state and it is distortionated with the shock. Results are displayed at Figure 3 and Figure 4.

As expected, the shock has no long term implication, since transitory shocks do not matter for the steady state. However, it does have implications in the short term since the economy is distorted. Figure 3 shows an economy that is for 10 periods at the steady state, then faces a shock and in the inmediate next period the shock disappears. An important remark is that the implication of the shock is the same of a productivity decrease of the size of the unemployment generated.

Figure 3: Transition to the new steady state under MIT shock

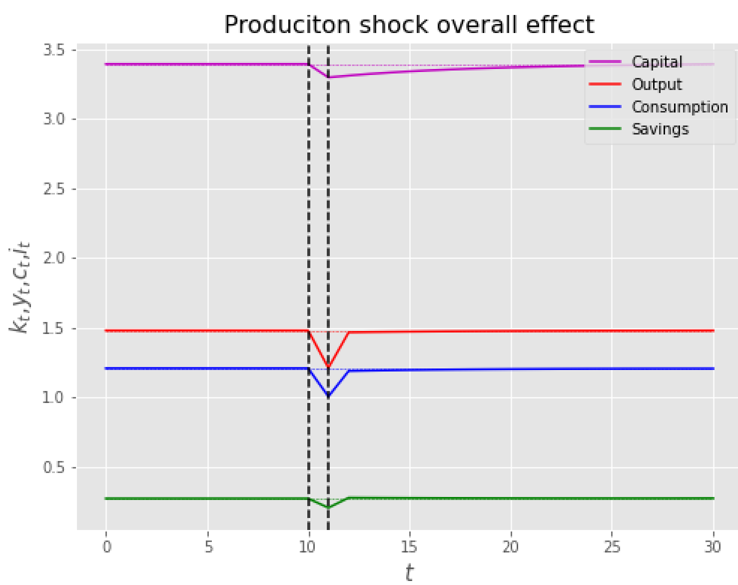
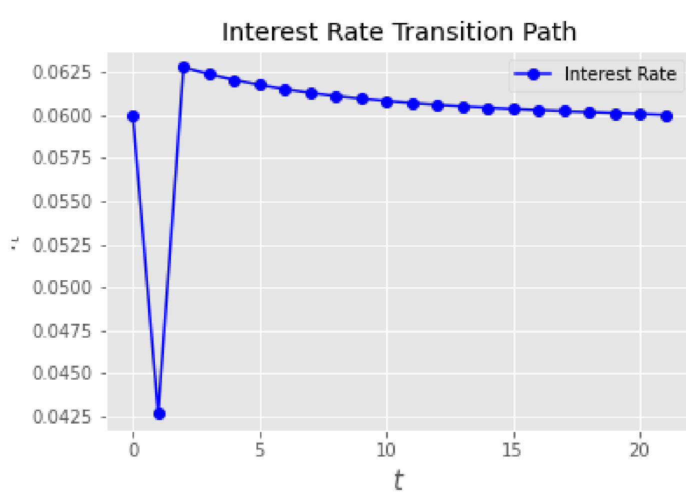


Figure 4: Transition of the interest rate under MIT shock



3.2 Incomplete Markets Economy

The results found in the previous section are interesting but they don't tell anything about inequality dynamics. I will now move to the incomplete market economy with uninsurable income shocks. As mentioned before, this environment allows to measure wealth inequality dynamics and therefore becomes useful to understand inequality dynamics under covid lockdown. In this model I will consider the economy has only one sector. However, further expansions can be done to introduce two sectors as in Clemens & Heinemann (2020) or Guerrieri et al. (2020). In fact, a potential expansion of this work is introducing more sectors.

The first important remark is that in this group of models the competitive equilibrium problem is not the same as the social planner, a result found in the complete market case. For this reason, I will now proceed by solving the competitive equilibrium problem. Once I can characterize the competitive equilibrium I will show how the stationary equilibrium distribution changes once the shock is introduced. I will also analyze some shock dynamics under partial equilibrium enviroment.

The model here will be the simple wealth model used in problem set 4 for programming simplicity. Later an expansion is done to allow for 3 states and unemployment. However, a potential expansion of this work is increasing the complexity of the model with more states or more sectors. The agent maximizes the sequence of consumption:

$$\max_{\{c_t\}_{t=0}^T} \mathbb{E}\left(\sum_{t=0}^{T} \beta^t u(c_t)\right)$$

The budget constraint for the household is the usual:

$$c_t + a_{t+1} = w_y y_y + (1 + r_t) a_t$$

where r_t is the interest rate that will be exogenous in the partial equilibrium case. I will also assume that agents are not allowed to borrow in this economy, therefore I will include the constraint:

$$a_{t+1} \geq 0$$

Furthermore, if I have time I can do an expansion allowing agents to borrow up to the natural borrowing limit described in Aiyagari (1994). In that case, the constraint would be:

$$a_{t+1} \geq -y_{\min} \sum_{s=0}^{T-(t+1)} (1 + r)^{-s}$$

The risk of the model comes because the individual faces a stochastic endowment process $\{y_t\}_t^T$. The stochastic process will vary in the two environments generated. Each process will be presented when explaining the model.

Under this situation the introduction of a shock is increase the probability of being unemployed and reduce the probability of finding a job. Let's now analyze the dynamic under those environments.

3.2.1 2 States Simple Wealth Economy

In this specification there are only two only states and this endowment follows a Markov process with variance σ_y and a transition matrix:

$$\begin{pmatrix} \frac{1+\gamma}{1-\gamma} & \frac{1-\gamma}{2} \\ \frac{1-\gamma}{2} & \frac{1+\gamma}{2} \end{pmatrix}$$

The income can then be $Y = [y - \sigma_y, y + \sigma_y]$. Notice that the main difference between this model and the usual incomplete markets is that here labor productivity is normalized to one. What varies is the amount of labor that individuals are allowed to supply. For this reason the two different states are a full employed individual and a partial employed individual. The interpretation is the same as if labor is normalized to one and productivity varies.

Partial Equilibrium

I will now analyze some dynamics to illustrate the effect of increasing the probability of getting partial-employment. This will translate into a less amount of hours supplied to the economy reducing the total amount of labor supplied. To solve this problem I will use Value Function iteration, the corresponding policy functions and Value Functions can be found at the appendix.

In the first graphs I will characterize the impact of a COVID-19 shock simulating 45 periods of life of an individual that is infinitely lived. This is important since the individual will do his decisions considering that he will live forever. Later I will consider the same path but for an individual that dies at T=45.

Figures 5, 6 and 7 show the average simulation over 1000 agents facing an stochastic process at each period through which they can either get full employed or partial employed. As we can see at period T=20 the agents face the COVID-19 lockdown shock distorting their trends. The calibration of this model is the following: $\sigma = 2$, $\gamma = 0.8$, $\sigma_y = 1$, $\rho = 0.06$, $r = 0.04$, $y = 1$ and the amount of initial assets in the simulation is 5. Furthermore, when the shock is introduced those partial employed have probability 1 of remain unemployed and those full employed have probability 0.5 of becoming partial employment. This will increase the number of agents partial employed in that period, reducing the total amount of working hours provided to the economy.

Figure 5: Average Lifecycle Path

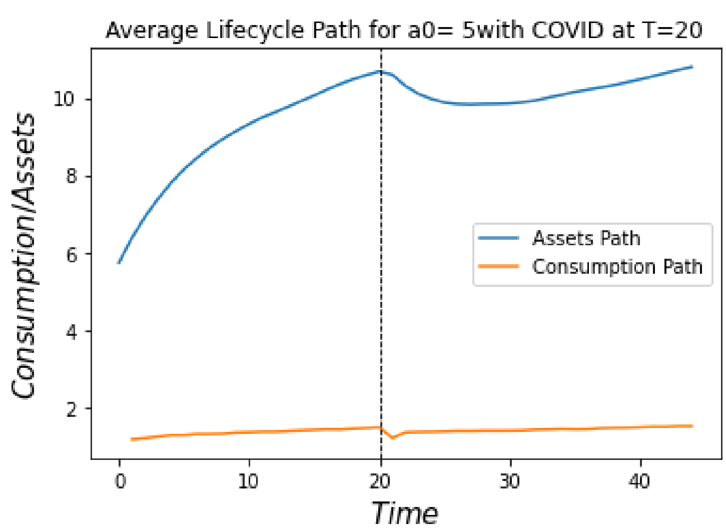


Figure 6: Average Assets Path with/without COVID

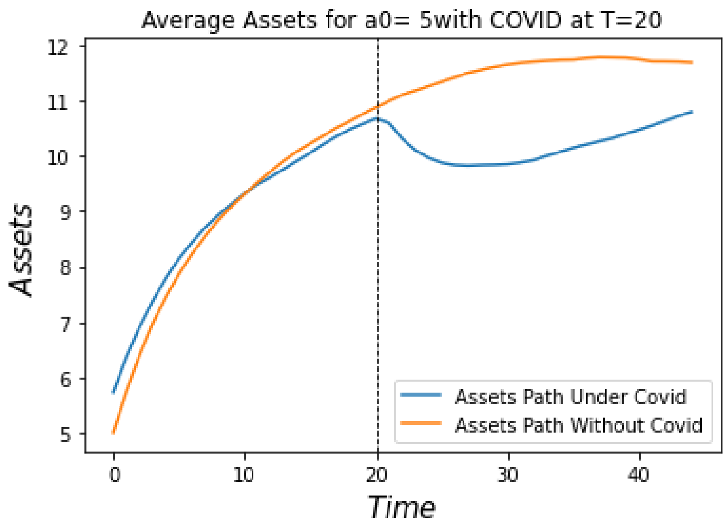
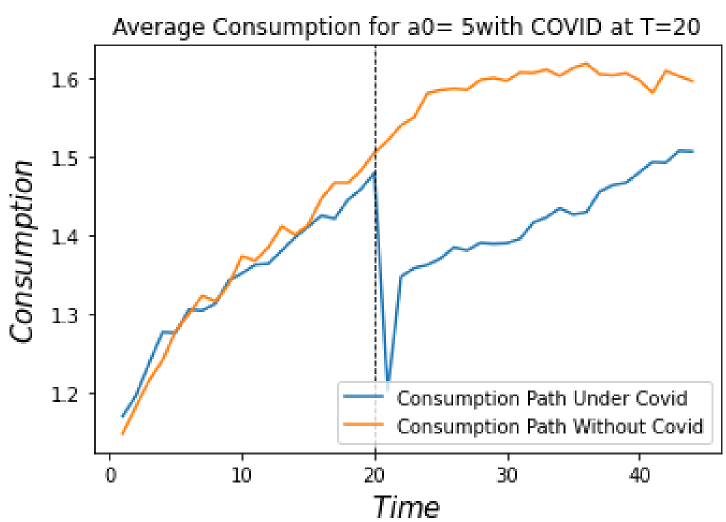


Figure 7: Average Consumption Path with/without COVID



Suppose now the case of a life-cycle economy where the agent knows he will die at period T=45. Under this economy there is a Value Function and a Policy function for each period, for this reason I will not introduce the plots here. However, they can be found at the code of this work. In this economy the agent knows he will die at period 45 and therefore his decision over a simulation of 45 periods will be different than that of the infinitely lived agent.

The results of this simulation can be shown at Figures 8, 9 and 10 which shows the comparison between the average path of an agent that has initial assets equal to 5, dies at period 45 and faces a COVID-19 shock at period 20. The average is computed among 1000 individuals simulation and the COVID-19 shock corresponds in increasing the probability of getting a partial employment. As we can see, the agent tries to smooth consumption by changing his asset level but the unexpected covid shock reduces the assets and the consumption and then recovers.

Figure 8: Life-cycle Path with/without COVID-19

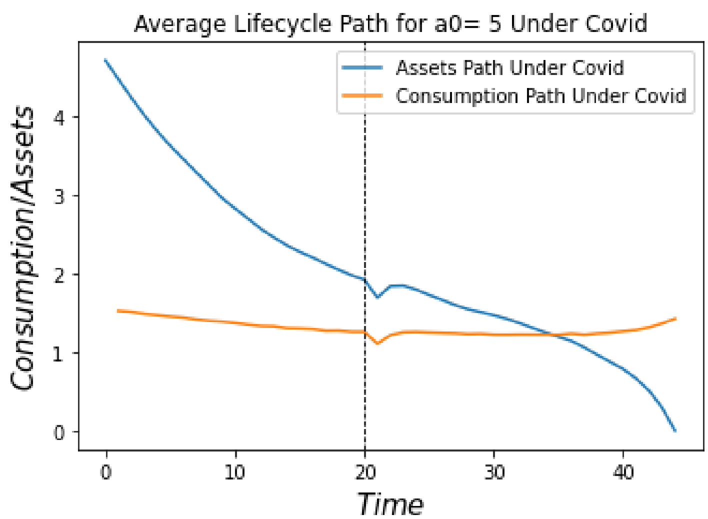


Figure 9: Life-cycle Assets Path with/without COVID-19

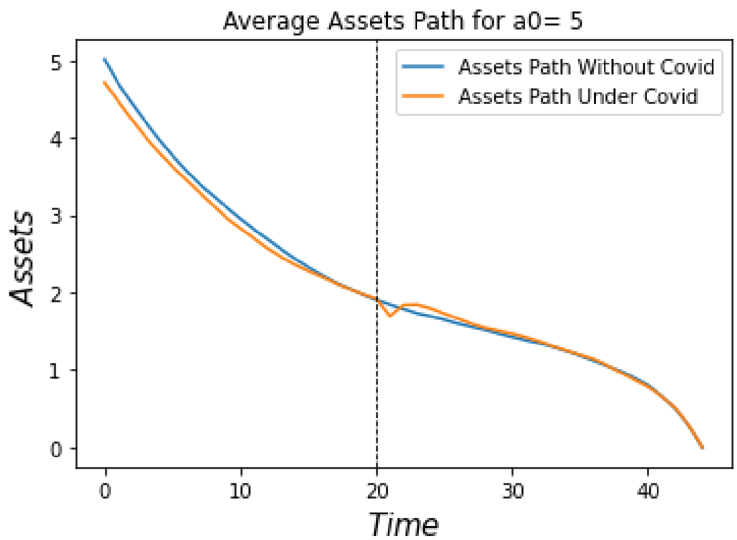
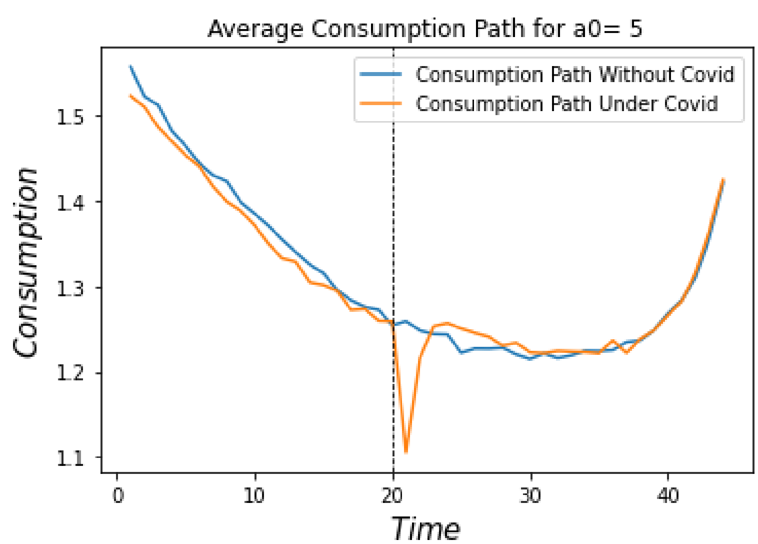


Figure 10: Life-cycle Consumption Path with/without COVID-19



In Figures 11, 12 and 13 we can see the same simulation but with initial assets equal to 0. As we can see the agent increases savings during his first life-cycle to later reduce them and finish his life with 0 assets. All this is to smooth consumption. The unexpected covid shock distortions one period but is recovered fast.

So the conclusion extracted here is that as long as the COVID-19 shock is interpreted as a one period transitory shock there will be negative effects on consumption and assets in that period, but the agents will recover fast. However, the effect was a bit stronger in the infinitely lived agent simulated over 45 periods. In that case the effect of the shock remained there for some periods.

Figure 11: Life-cycle Path with/without COVID-19

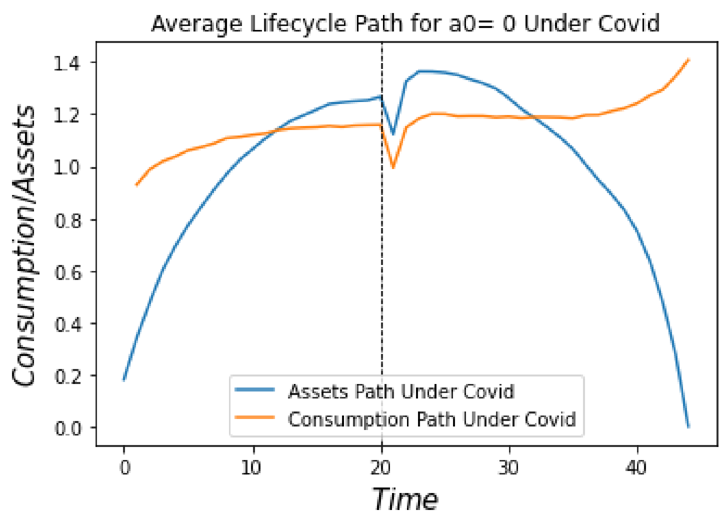


Figure 12: Life-cycle Assets Path with/without COVID-19

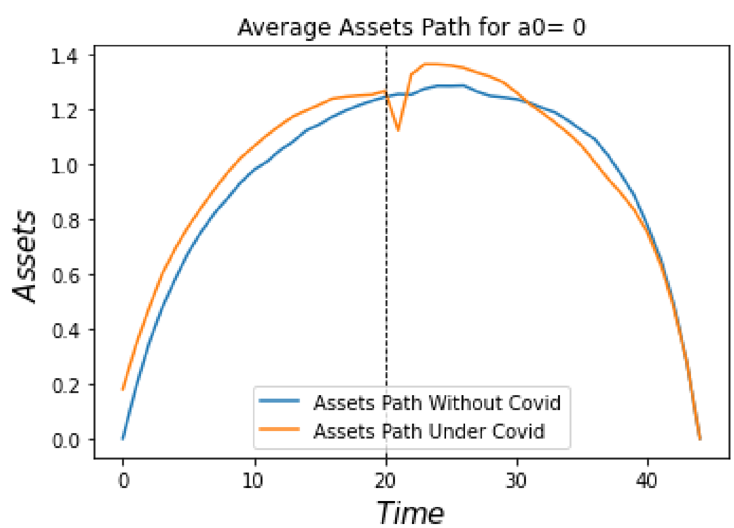
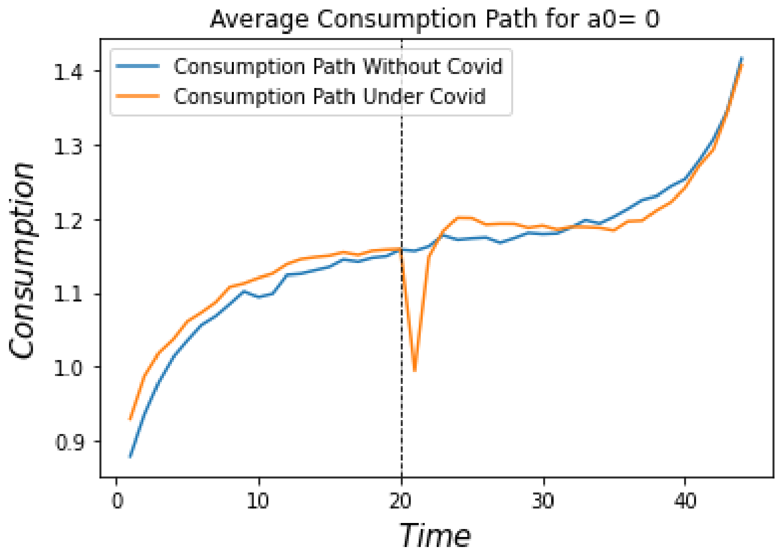


Figure 13: Life-cycle Consumption Path with/without COVID-19



General Equilibrium

In this section I will characterize the general equilibrium of the economy to characterize the recursive stationary equilibrium. Then, starting from that equilibrium I will introduce a COVID shock and this will allow to analyze inequality consequences of the shock. I will repeat this process for two different calibrations of the model. The reason is to see the reaction under different types of economies. I will now describe the different calibrations to later refer to them.

- Calibration 1. The parameters are:

σ	σ_y	y	γ	δ	α	ρ
2	0.8	1.2	0.8	0.08	0.33	0.06

- Calibration 2. The parameters are:

σ	σ_y	y	γ	δ	α	ρ
2	0.4	1.2	0.3	0.08	0.33	0.06

I will start by the Calibration 1. Figure 14 shows the evolution of the supply and demand of capital for a given interest rate. This graphs replicates the result found in Aiyagari (1994) Figure IIb. The point at which both curves cross represents the assets market equilibrium and is the point where the stationary recursive equilibrium is found. In this particular case, the interest rate that clears the market has a value $r = 0.0148$. Having found the interest rate that clears the market I can now compute the equilibrium stationary distribution of assets of the economy.

To compute the stationary distribution of the economy I iterate 2000 individuals over 2000 periods. It can be increased but the results won't change, this shows that stationary is found. This is shown in Figure 15. The interesting result is that the majority of the agents is at 0 savings levels. Another important remark is that inequality is much smaller than in reality.

I will now introduce a Covid-19 shock to see how this distribution changes. The procedure is the following, I will start at the stationary distribution and I will introduce a one period shock. The new distribution will be that one after the shock. Remember that in this environment the Covid-19 shock corresponds in increasing the probability of having a partial-employment. The results are displayed in Figure 16.

Figure 14: Supply vs Demand of Capital. Figure IIb Ayagari

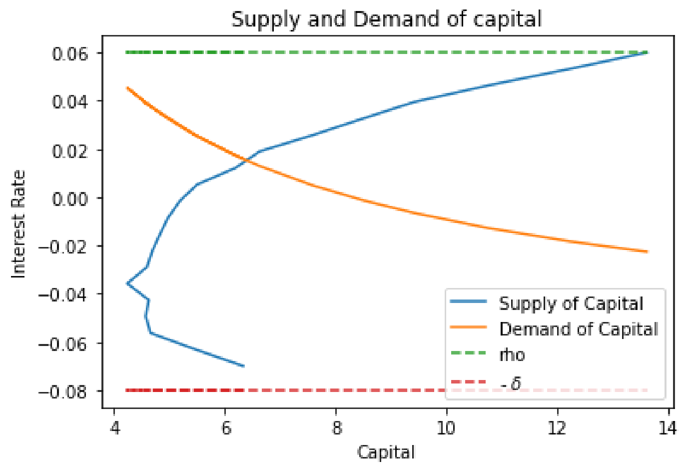


Figure 15: Stationary Distribution of Assets in the Economy

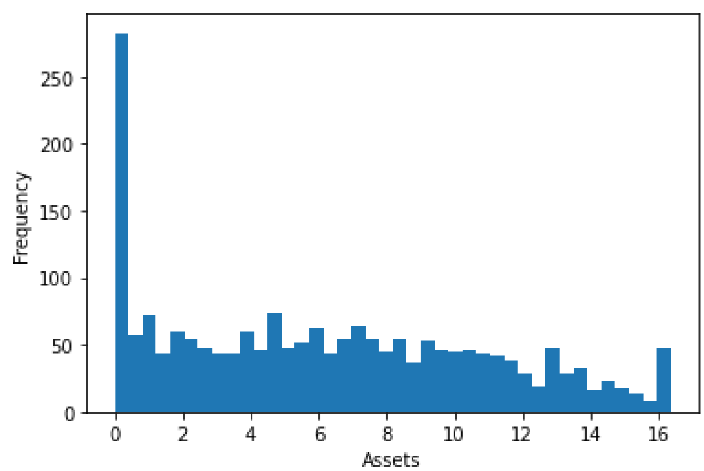
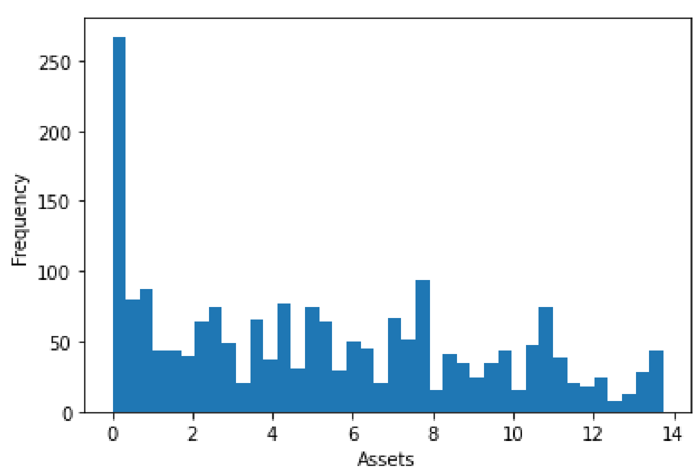


Figure 16: Distribution of Assets in the Economy after Covid-19



Even if there is a clear difference, the inequality consequences of this shock are no so clear. For this reason I will compute a table presenting the main stats on the wealth distribution, which can be seen at Table 1. However, I will also compute the distribution if the Covid-19 shock is not a one period shock and instead it last 3 periods. Under such a case the distribution is displayed at Figure 17. Interestingly, more individuals concentrate at the low asset level in the distribution.

Figure 17: Distribution of Assets in the Economy after 3 periods Covid-19

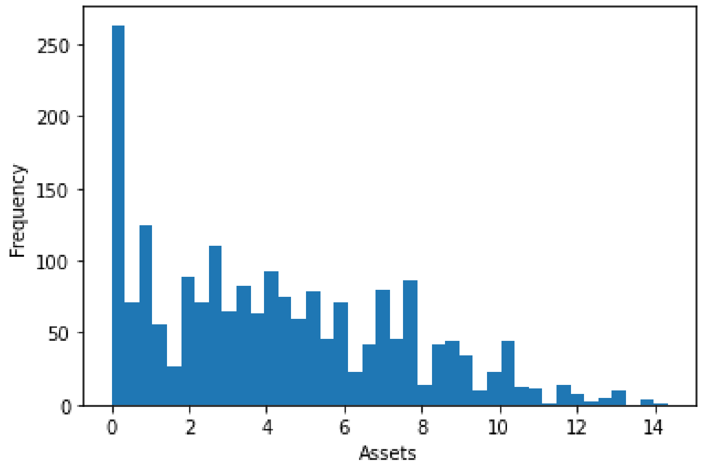


Table 1: Percentage of Wealth Owned by each Income Group

Income Group	No Covid	One Period Covid	Three Periods Covid
Top1%	2.63%	2.79%	3.1%
Top10%	23.48%	24.56%	25%
Bottom50%	18.25%	17.12%	17.32%
Q1	1.0%	0.86%	0.99%
Q2	8.99%	8.28%	8.62%
Q3	18.9%	18.22%	17.9%
Q4	28.76%	28.72%	28.21%
Q5	42.36%	43.92%	44.28%

From Table 1 we can see that after the Covid-19 shock the distribution of assets has changed, increasing inequality. In that sense the share of wealth owned by the Top 1% , Top 10% and Q5 has increased with respect to the stationary distribution of the economy. On the other hand, the share owned by the Bottom 50% and by the Q1,Q2,Q3 and Q4 has decreased, providing evidence of an increase in inequality. Furthermore, the inequality consequences are worse when the duration of the shock increases. Therefore, the longer the Covid-19 shock the worse its inequality consequences in the economy. As an improvement of this work a comparison to the current data could be done. However, I have faced time restrictions. Another improvement can be calibrate the model better. For this reason, I will now consider a different calibration of the model to see how results change.

Under Calibration 2 the results of the equilibrium interest rate determination can be seen at Figure 18. Furthermore, the stationary distribution of the economy and how it changes after the Covid-19 shock can be seen at Figures 19 and 20 respectively. Under such enviroment the equilibrium interest rate is found at $r = 0.055$. The results found are similar than those found before, a part from the fact that the interest rate level in equilibrium is now about 3 times higher.

Following the strategy developed before I will now compute the distribution of the economy if the Covid-19 shock least 3 periods. See Figure 21. Notice that when I refer to the Covid-19 shock I just increase the probability of getting a partial job, and therefore reduce the total amount of hours worked in the economy.

Figure 18: Supply vs Demand of Capital. Figure IIb Ayiagari

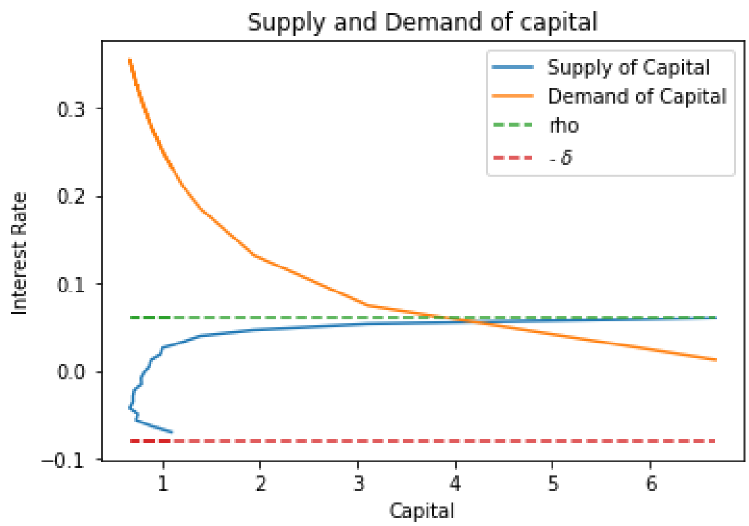


Figure 19: Stationary Distribution of Assets in the Economy

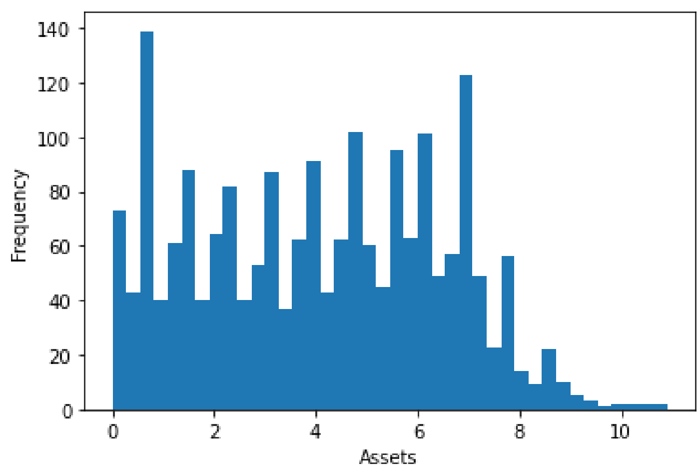


Figure 20: Distribution of Assets in the Economy after Covid-19

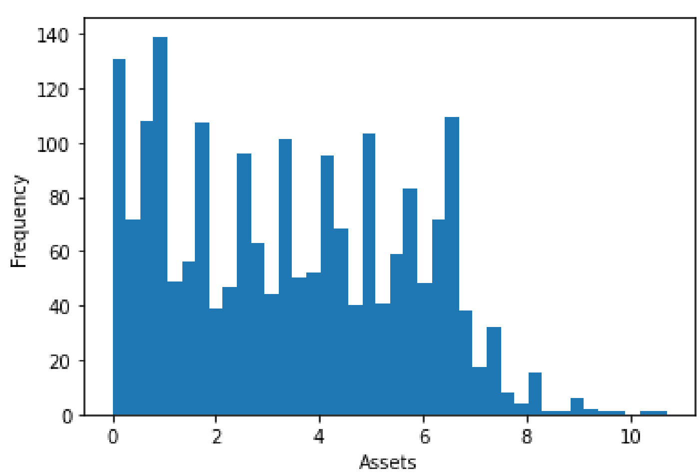
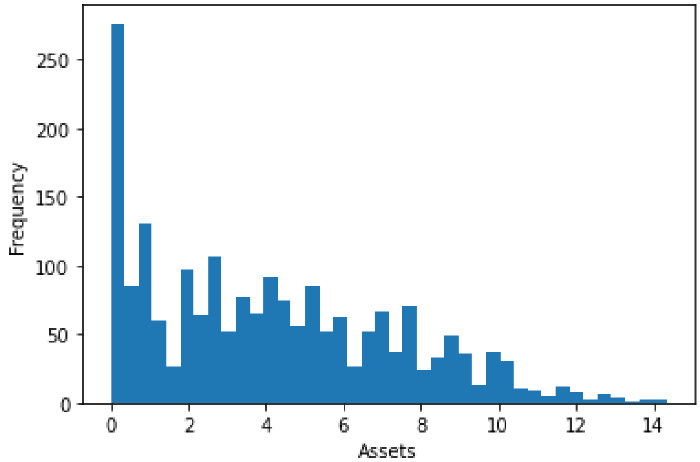


Figure 21: Distribution of Assets in the Economy after 3 periods Covid-19



As before, it can be clearly seen that the distribution has changed, but to really understand what are the inequality consequences let's take a look at the changes into different income groups. Those results are displayed at Table 2. As we can see the pattern is the same as before, the shock in labor supply increases inequality and the longer the shock, the longer its inequality consequences.

Table 2: Percentage of Wealth Owned by each Income Group

Income Group	No Covid	One Period Covid	Three Periods Covid
Top1%	2.37%	2.63%	2.71%
Top10%	19.54%	21.08%	22.17%
Bottom50%	24.59%	21.05%	19.8%
Q1	3.69%	2.56%	2.56%
Q2	11.78%	9.92%	9.17%
Q3	20.26%	19.5%	18.79%
Q4	27.96%	28.88%	29.0%
Q5	36.31%	39.15%	40.49%

Having presented all this results I can conclude that the Covid-19 shock understood as an increase in the probability of receiving a partial-employment and therefore supply less hours implies an increase in inequality in the shock period. Since a transitory shock does not matter for long term dynamics, the economy will recover from the shock and move back to the stationary distribution of the economy. Therefore, the consequences of the shock have short term implications but do not matter in the long run for the overall economy. I will now expand this model to allow agents to fail into unemployment and therefore supply 0 labor and receive 0 income from labor. This will be the 3 states environment.

3.2.2 3 States Simple Wealth Economy

In this specification I will allow the model to have three possible states. Those are: unemployed, partial employed or full employed. Under unemployment the agent will supply 0 units of labor and therefore will receive only income from the returns of savings. So the income now is:

$$Y = [0, y - \sigma_y, y + \sigma_y]$$

Here the endowment also faces a Markov process but the transition probabilities are now:

$$\begin{pmatrix} (1-\theta_1) & \frac{\theta_1}{2} & \frac{\theta_1}{2} \\ \theta_2 & \frac{1+\gamma}{1-\gamma} - \frac{\theta_2}{2} & \frac{1-\gamma}{2} - \frac{\theta_2}{2} \\ \theta_2 & \frac{1-\gamma}{2} - \frac{\theta_2}{2} & \frac{1+\gamma}{2} - \frac{\theta_2}{2} \end{pmatrix}$$

where θ_1 is the probability of finding a job given that you are unemployed. Similarly θ_2 corresponds to the probability of losing your job given that you are either full-employed or partial-employed-. Notice that for the transition matrix to be well defined not all combinations of γ and θ_2 are acceptable. Only those such that $1-\gamma \geq \theta_2$. In my mode the calibration is

σ	σ_y	y	γ	δ	α	ρ	θ_1	θ_2
2	0.8	1.2	0.4	0.08	0.33	0.06	0.5	0.3

The most important modification is that in this environment the Covid-19 will actually increase the probability of being unemployment, since we have unemployment as a possible state. An important remark is that my general equilibrium code for this environment does not provide satisfactory results and for this reason I will focus the analysis in a partial equilibrium set up taking the interest rate $r = 0.04$ as given. Under such scenario, the stationary distribution of the economy under partial equilibrium can be seen at Figure 22. Figure 23 shows the distribution after the Covid-19 shock and Figure 24 shows the distribution after the Covid.19 shock when it last 3 periods. The inequality statistics are reported at Table 3.

The introduction of the shock will imply that unemployment becomes an absorbing state, so unemployed individuals will remain there. Furthermore, under the Covid-19 the both the partial employed and the full employed individuals face a 60% probability of loosing their job. This is how the shock is introduced. The model generates less inequality than the previous ones, so in that sense it is less realistic. However,the results are the same, Covid-19 labor supply shock increases inequality. The duration of the shock matters since the longer the shock the more inequality it seems to genereate. The benefit of this model is that it allows for unemployment. However, the inequality of the model is not realistic.

Table 3: Percentage of Wealth Owned by each Income Group

Income Group	No Covid	One Period Covid	Three Periods Covid
Top1%	1.45%	1.5%	1.6%
Top10%	13.96%	14.21%	14.51%
Bottom50%	39.6%	39.06%	38.79%
Q1	12.73%	12.41%	12.37%
Q2	17.13%	17.01%	16.9%
Q3	20.2%	20.0%	19.82%
Q4	23.17%	23.37%	23.28%
Q5	26.76%	27.14%	27.63%

Figure 22: Stationary Distribution of Assets Partial Equilibrium

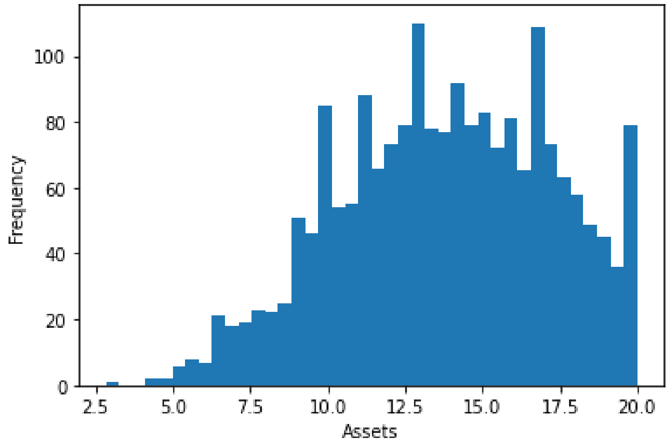


Figure 23: Distribution of Assets Partial Equilibrium after Covid-19

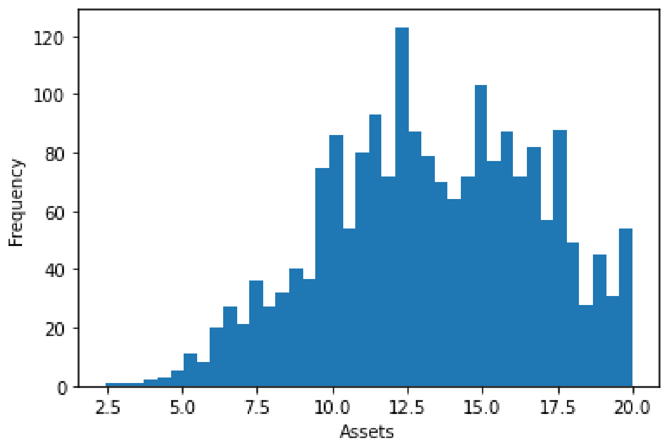
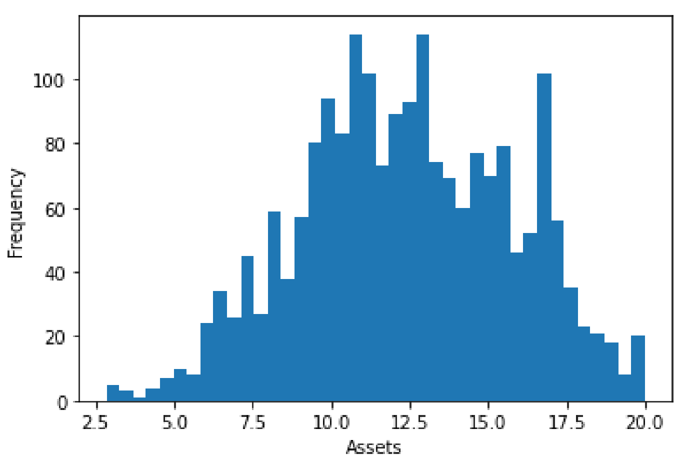


Figure 24: Distribution of Assets Partial Equilibrium after 3 periods Covid-19



4 Conclusions

Overall my work has shown that if we understand the Covid-19 shock as a supply shock caused by a reduction in the labor supply, it will have consequences to the distribution of assets in the economy. To model this shock I have increased the probability of being unemployed or getting a part-time employment to reduce the total amount of labor supplied in the economy.

From the complete market set up it can be seen that the Covid-19 shock alterates the steady state level of the economy but if we assume the shock is a MIT shock that last one period, the economy will recover relatively fast. The problem here is that it does not show inequality dynamics and for this reason I moved to an incomplete market economy.

The incomplete market economy showed that during the life-cycle of a consumer, a transitory shock like the Covid-19 will produce on average a decrease in the savings and in the consumption in the period of the shock, but the agent trend will recover very fast. However, in terms of inequailty dynamics I showed that the Covid-19 shock increases inequality and the duration of the shock matters, since the longer the shock remains the higher inequality it generates. To show this I used two models. The first has two possible states, partial-employed or full-employed, and the Covid-19 shock is modeled as an increase in receiving a part-time job and therefore reduce the amount of labor supplied. Since this model did not allow for unemployment I use a second model where a third possible state is introduced, unemployment. Under this second model the Covid-19 shock is modeled as an increase in the probability of getting unemployed together with a decrease in the probability of finding a job.

Overall, the results showed that the Covid-19 shock has important distributional consequences in the short run. However, in the long run the economy will recover to its previous stationary level since a transitory shock won't change the long term distribution. Another thing will happen if the Covid-19 is understood as a permanent shock, which is not the case.

As a further expansion of this work, more states can be introduced to the incomplete market economy, together with a better calibration more consistent with the new available data on Covid-19. However, given the time restriction I have not been able to explore all the empirical part of the Covid-19 shock.

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5 Appendix

Policy Functions Partial Equilibrium 2 States

Figure 25: Value Function for 2 states

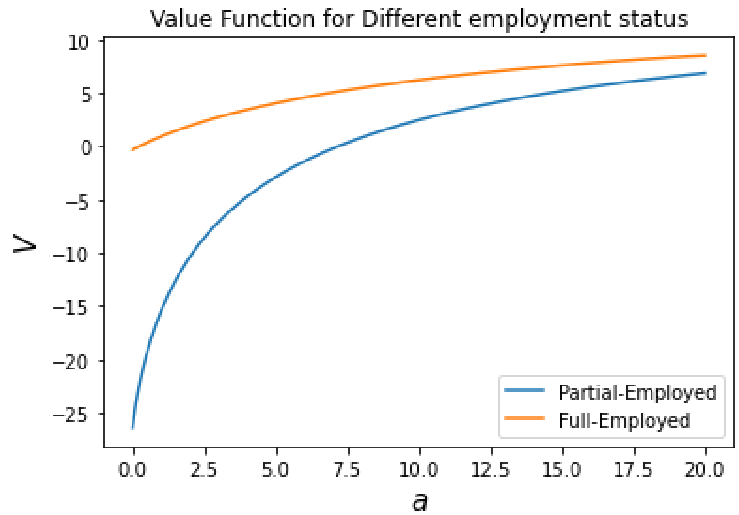

Figure 26: Assets Policy Function for 2 states

Figure 27: Consumption Policy Function for 2 states