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Fiscal Policy in the Economic Recovery after Covid-19 Epidemic

A Data-Driven Comparison between Theory and Practice

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For as a man that goith in pilgrimage, clepide hise seruauntis, and bitook to hem hise goodis; and to oon he yaf fyue talentis, and to another tweyne, and to another oon, to ech after his owne vertu; and wente forth anoon. And he that hadde fyue besauntis, wente forth, and wrouyte in hem, and wan othere fyue. Also and he that hadde takun tweyne, wan othere tweyne. But he that hadde takun oon, yede forth, and dalf in to the erthe, and hidde the money of his lord.

But after long tyme, the lord of tho seruauntis cam, and rekenede with hem. And he that hadde takun fyue besauntis, cam, and brouyte othere fyue, and seide, Lord, thou bytokist to me fyue besauntis, loo! Y haue getun aboue fyue othere. His lord seide to hym, Wel be thou, good seruaunt and feithful; for on fewe thingis thou hast be trewe, Y schal ordeyne thee on manye thingis; entre thou in to the ioye of thi lord. And he that hadde takun twey talentis, cam, and seide, Lord, thou bitokist to me twey besauntis; loo! Y haue wonnen ouer othir tweyne. His lord seide to him, Wel be thou, good seruaunt and trewe; for on fewe thingis thou hast be trewe, Y schal ordeyne thee on many thingis; entre thou in to the ioie of thi lord.

But he that hadde takun o besaunt, cam, and seide, Lord, Y woot that thou art an hard man; thou repist where thou hast not sowe, and thou gederist togidere where thou hast not spred abrood; and Y dredynge wente, and hidde thi besaunt in the erthe; lo! thou hast that that is thin.

His lord answeride, and seide to hym, Yuel seruaunt and slowe, wistist thou that Y repe where Y sewe not, and gadir to gidere where Y spredde not abrood?

Therfor it bihofte thee to bitake my money to chaungeris, that whanne Y cam, Y schulde resseyue that that is myn with vsuris.

Therfor take awei fro hym the besaunt, and yyue ye to hym that hath ten besauntis. For to euery man that hath me schal yyue, and he schal encreese; but fro hym that hath not, also that that hym semeth to haue, schal be taken awey fro him. And caste ye out the vnprofitable seruaunt in to vtmer derknessis; ther schal be wepyng, and gryntyng of teeth.

Matthew, 25, 14:30, Wycliffe 1385

Abstract

The present thesis presents some analysis on macroeconomic data for the World economies about the Covid-19 crisis and the subsequent evolutions. It offers evidence on recovery, also about the "recovery shape", of output. Analyses shortly the completely different landscape that appears about unemployment. It presents the importance, in the current crisis, of the unprecedented economic effort, in particular in fiscal policies, fielded by most economies in the World. It presents two theoretical models: the first is an epidemic spreading model with macroeconomic components, the second is an agent-based model tuned on the present crisis, with fiscal policies. While the first allows to understand the relation between health and economy, and the importance of social and economic intervention to pursue the best global utility, the second allows for interesting considerations about the impact of the policies. The qualitative intuitions built with the two models and the preceding considerations are then compared with actual data, studying correlations between factors, evidencing how better performing countries, on medium-term forecasts, are more likely to have implemented fiscal policies and more intense, with different behaviours and linear factors between advanced and low income countries.

CONTENTS

INTRODUCTION

> While expanding economies are all alike, every contracting economy is contracting in its own way.
>
> Lev Tolstoj?[1]

Among the recessions that have happened after the World-War II, Covid-19 recession is quite unique in its dynamics. Instead of a financial shock, it was triggered by a global epidemic that – besides a serious death toll – forced many people to remain at home, thus making demand and production contract abruptly.

This recession has, then, a quite unusual nature, making it difficult to approach it looking at past recessions, since they are totally different, as totally different is the response that most of advanced states have fielded to counter the crisis.

In this thesis we try to evaluate the present situation, eighteen months after the acme of the global crisis, through a look to the data, through some model-based considerations, through a brief survey of significant economic policies fielded by the states.

The first chapter starts with a series of considerations on the actual data we have about Gross Domestic Product and unemployment. These indicators are quite updated and granular, so I can perform some qualitative study on them. It is to be noticed that the availability of data, given the time proximity, has been quite an issue, and for many economies no sufficient data are provided, and for others there are deep discrepancies between different data sources.

The "problem" of the shape of the Covid-19 crisis and subsequent recovery is presented in light of the GDP data and official forecasts, and in fact allows to trace the evolution to some main cases (and, even more, to two basis cases: a relatively full recovery is forecast, or not). Unem-

1 Actually the Tolstoj-like quote comes from Benjamin Friedman's discussion of Schultze and Perry 1993 paper "Was This Recession Different? Are They All Different?"

ployment data shows, instead, a total difference in behaviour, since it depends more on social protection and on labour market characteristics in the state. We will analyse also the particular case of Italy, in which there seems to have been a drop in unemployment, together with the drop in output, against any possible intuition, arguing also about the relative reliability of these indicators.

An exam of the policies put in place by the World states (accounting, together, to the greatest economic effort to overcome a crisis that the history records) is made in second chapter. The analysis of the argued effects of the different types of policies, their importance in the first response and their shaping to favour a full and healthy recovery are contained in the second chapter. In it, it is contained also a brief survey of the policies adopted by most World states, highlighting with it the different approaches between states and among groups of states.

The "shapes" observed in the first chapter are modelled in the third, in which two theoretical frameworks, chosen to be very different among them and to cover different aspects of the epidemic crisis, are presented and confronted with actual data. The first one is a "SIR-macro" model, that inserts an economic factor into an epidemiological Susceptible-Infected-Recovered model.

This way, we can link a bigger or smaller loss in output and in labour with more or less steeper economic curves, and, more importantly, giving a first, and simpler, form to the strong optimal necessity of public intervention, in containment and in corresponding economic support.

The second model, instead, focuses on what happens *after* the epidemics outbreak, and in general after a certain period of consumption and production negative shock. It is a Mark-0 agent-based model, thus made to be solved numerically and with the contraindications of this type of "black-box" frameworks, but it allows to simulate with a good grade of qualitative reasonability the effects of the policies that a government puts in place.

The model considers three types of policies: monetary, "helicopter money" and credit sustain, simulating combinations of the last two and examining the impact they should have to avoid an L-shaped recession.

The fourth chapter is devoted to some specific case study, in light of what was previously exposed, highlighting the conflicts between theory and practice, but also presenting some correlations and apparent consequences, in the qualitative light offered by models. Given the fragmented economic landscape, the variety of cases, and the particularity of the usable data (that, even had it the cardinality of all states, would not allow for significant statistics), no robust result could be found, but some correlations, for the adherence to what previewed by the theory, are arguably not result of chance.

In this light, some final considerations are then offered in the Conclusion.

1 THE IMPORTANCE OF BEING IN GOOD SHAPE

Covid-19 crisis has hit strongly most of the states of the world. Every state has responded differently to the epidemics, and is looking differently to the sanitary and economic recovery. In view of evaluating the 'best' approaches to the crisis, who writes has firstly conducted a survey on recovery paths of several macroeconomic data for many states.

Data have been taken from the statistics libraries of the Organization for Economic Cooperation and Development (OECD)[28, 29] and of the International Monetary Fund [20, 31, 30].

I focused firstly on data on real Gross Domestic Product for fourty-nine significant economies in the world, plus some aggregates (including the world economy), for which the data availability, at a quarterly level, allows us to study economic evolution in this short time after the crisis outbreak, particularly confronting actual data, forecasts at the end of 2019 and forecasts at May 2021.

For each state I obtained thus three time series:

1. The actual data series, till first or second quarter of 2021.
2. The quarterly projection of GDP forecast at November 2019. The original OECD time series end was Q4-2021, and it was prolongued, given the yearly forecast, in a linear way, to Q4-2022.
3. The quarterly projection of GDP forecast at May 2021.

To evaluate the effectiveness of the policies of the states to counter the crisis, I studied the difference between real GDP forecasts in 2019 and 2021, aligning them through an inflation-correction factor, and normalizing on Q4-2019.

Obviously, these data are subject to a certain range of inaccuracy: economy is a stochastic process and the forecasts of an economic indicator should be taken with relative confidence. Moreover, unavoidable adjustments were made to confront the data: from normalization of the time series on Q4-2019 (that could lead to a distortion if in this quarter

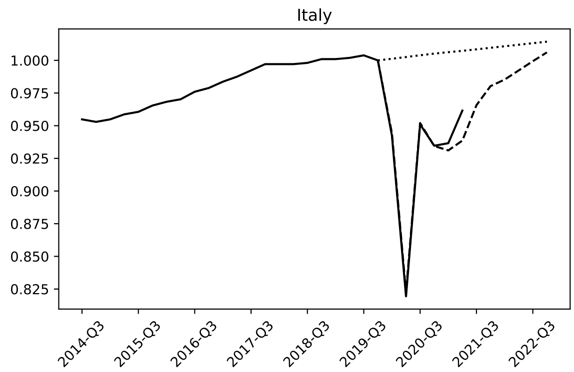


Figure 1: The actual GDP evolution (in solid line) along with current forecast (dashed) and the forecast before the Covid-19 crisis (dotted)

there is a significant deviation) for each state, to the linear quarterly projection of 2019 forecasts for the 2022.

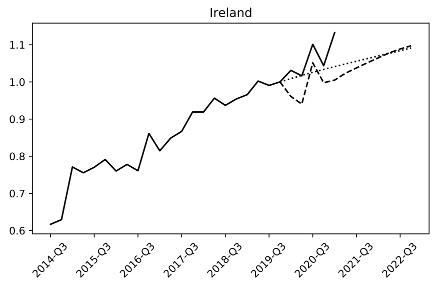
Since, however, the purpose is a qualitative evaluation, to relate it to policies put into effect by states, this issue is not really relevant.

1.1 A LITERAL RECOVERY

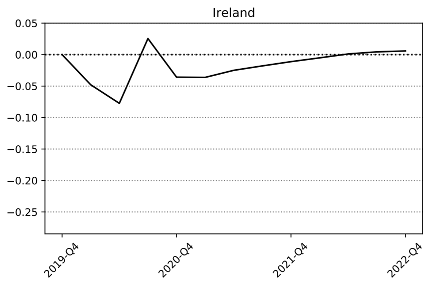
A key study in qualitative evaluation of a crisis is the *shape* of it. After the recession, with a decline of the economic indicators (such as real GDP, real income, employment, industrial production and retail sales), the economy will reopen and start growing again, and the shape this process assumes in the plot of economic indicators is an important categorization of the recession.

Usually this categorization is made using the alphabet letters: firstly "V", "U", "L", but also "Z", "W", "K", following the time path traced by the indicator – its "shape" – [27, 32, 34]. As we will see, however, this classification leaves space to overlaps between different types.

Z-SHAPED RECOVERY The most optimistic case is when the economy, after the recession, "bounces" back *above* the level of the pre-crisis baseline: the GDP lost during recession period is fully recovered is simply delayed. The only state that shows a similar dynamic in 2020 seems to be Ireland (fig. 2), even if its case shows immediately the weakness of this type of classification: despite the strong recovery, its case falls in a sort of dual economy (that falls under the case of "K-shaped" recovery), with technology and pharmaceuticals multinationals, based in Ireland for EU market, that have boomed with pandemics, and the domestic businesses that struggle [3]. Furthermore, the second wave of epidemics put Irish recovery on a W-shaped path.



(a) GDP evolution: actual (solid line), 2019 forecasts (dotted line), 2021 forecasts (dashed line)

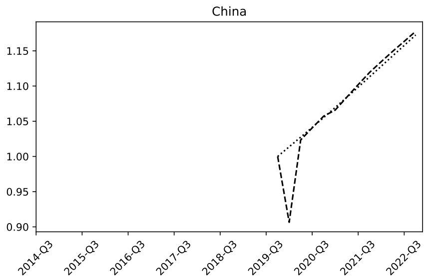


(b) Difference between 2021 and 2019 forecasts

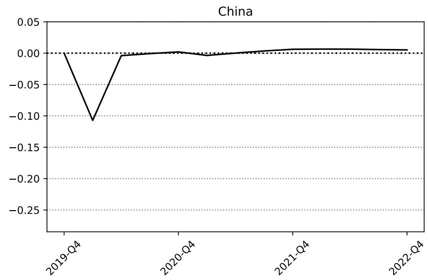
Figure 2

V-SHAPED RECOVERY The "classic" shock of the real economy has a "V"-shape: after the end of the recession, the recovery is strong and fast, and the economy returns back to the path it had before the crisis. It loses the production that would have occurred without the pandemic, but just for the period of recession. In light of Covid-19 crisis this should be the shape when the containment of the epidemics is fully effective and after a lockdown period (with momentaneous loss of supply and demand) the policies implemented allow the economy to return to business as usual. In the present case, a good example of it seems to be China (fig. 3), with a real GDP recovery in Q3 and Q4 of 2020 that covers the loss for the first two quarters of the year.

U-SHAPED RECOVERY (AND THE "NIKE SWOOSH") This case is when recovery is not so well defined as in V-shaped case: there is not a full recovery in short time, but at the end, after several periods, the economy returns to the previous path. In fig. 4, the forecasten evolution for United States GDP, that reflects this type of recovery: even if there is a strong recovery in 2020-Q3, after the reopening of the economy, the

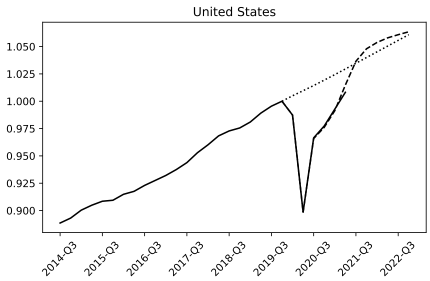


(a) GDP evolution: 2019 forecasts (dotted line), 2021 forecasts (dashed line)

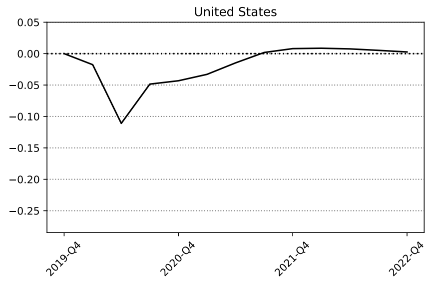


(b) Difference between 2021 and 2019 forecasts

Figure 3



(a) GDP evolution: actual (solid line), 2019 forecasts (dotted line), 2021 forecasts (dashed line)



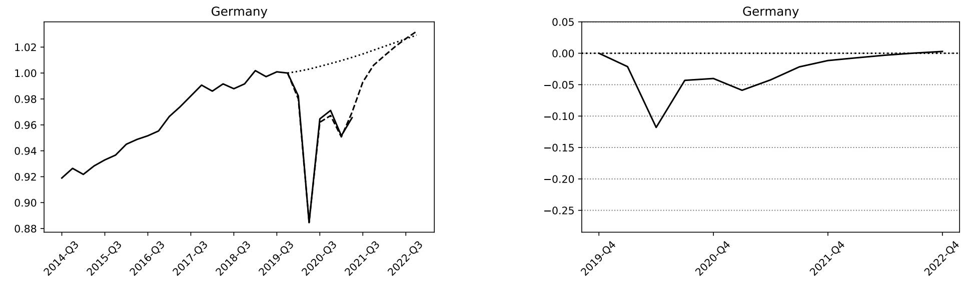
(b) Difference between 2021 and 2019 forecasts

Figure 4

2021 recovery proceeds at far slower pace. This shape is sometimes described as a ”Nike-swoosh”.

W-SHAPED RECOVERY This happens when after a rapid recovery there is a second period of decline. In Covid-19 crisis this hit many states, for the outbreak of a second wave of epidemics, with consequent lockdown and its effect on the economy. Germany (fig. 5) shows, as many other European countries, this type of recovery.

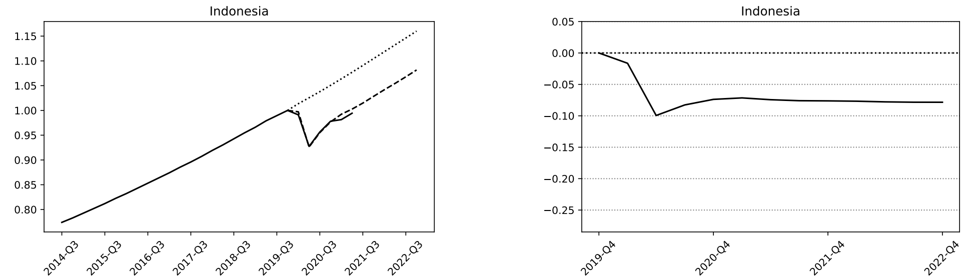
L-SHAPED RECOVERY When there is an ”L-shaped recovery”, no fast-growth recovery takes place and after the recession the growth proceeds at normal expansionary rates (or it proceeds strongly for some time, but without recovering), having then a permanent effect on the economy,



(a) GDP evolution: actual (solid line), 2019 forecasts (dotted line), 2021 forecasts (dashed line)

(b) Difference between 2021 and 2019 forecasts

Figure 5



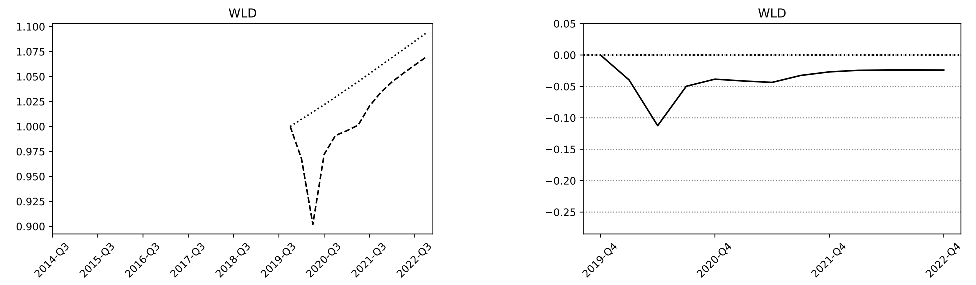
(a) GDP evolution: actual (solid line), 2019 forecasts (dotted line), 2021 forecasts (dashed line)

(b) Difference between 2021 and 2019 forecasts

Figure 6

since it will grow along a permanently lower trend path than if the recession had not occurred. This is the case of Indonesia (fig. 6), with a permanent loss of around 8% GDP (respect 2019) in long term, or also of the World GDP (fig. 7), that, even after a sharp recovery in 2020 and a flatter one in 2021, is forecasten to be 3% lower in long-term, that what was considered before the crisis.

K-SHAPED RECOVERY With Covid-19 crisis, a particular dynamic could be observed: different sectors proceed in different ways, and some economists refer to this as a "K-shaped" recovery. While sectors as e-commerce and information technology have boomed, others, like tourism-related sectors and retails, have plummeted.



(a) GDP evolution: 2019 forecasts (dotted line), 2021 forecasts (dashed line)

(b) Difference between 2021 and 2019 forecasts

Figure 7

1.2 WHAT MILTON SAYS

> *Monetary theory is like a Japanese garden. It has esthetic unity born of variety; an apparent simplicity that conceals a sophisticated reality; a surface view that dissolves in ever deeper perspectives. Both can be fully appreciated only if examined from many different angles, only if studied leisurely but in depth. Both have elements that can be enjoyed independently of the whole, yet attain their full realization only as part of the whole.*
>
> — Milton Friedman

An interesting light on these ”shapes” is offered by the so-called ”plucking model” described by Milton Friedman [15, 14]. It comes after a series of studies on business cycles, and correlation between recessions and expansions, in the view of money as a major factor in explaining business fluctuations.

The study of the systematic correlation between the amplitude of an expansion and the amplitude of the subsequent contraction, shows that, surprisingly, there appears to be no connection. On the other side, if we start with a contraction and see how its amplitude is related to that of the succeeding expansion, the results are very different: a large output contraction tends to be followed on the average by a large expansion, and a mild contraction by a mild expansion. An updated study on these correlation is made for several economies in Friedman’s update [14], and for U.S. in [27], whose summary results are in table 1.

	sample correlation	z-statistic
Entire expansion, subsequent recession	8%	0.2
Recession, entire subsequent expansion	-19%	-0.6
Recession, subsequent recovery	-68%	-3.8

Table 1: Correlations between output growth in consecutive phases of postwar business cycles. (Note: Output growth is measured using 100 times natural log differences for U.S. real GDP. The sample period is 1947Q2 to 2001Q4 for the first correlation and 1948Q4 to 2007Q4 for the second and third correlations. For the purposes of the correlations reported here, ”entire expansion” is defined as trough to peak as identified by the NBER, ”recession” as peak to trough, and ”recovery” as the first four quarters following a trough.) Source: [27]

Here there is a distinction between expansion (whose correlation with a preceding recession is not very statistically significant) and recovery, which, confirming previous Friedman's studies, has a high correlation and is statistically significant.

> Consider an elastic string stretched taut between two points on the underside of a rigid horizontal board and glued lightly to the board. Let the string be plucked at a number of points chosen more or less at random with a force that varies at random, and then held down at the lowest point reached. The result will be to produce a succession of apparent cycles in the string whose amplitudes depend on the force used in pluckin the string. The cycles are symmetrical about their troughs; each contraction is of the same amplitude as the succeeding expansion. But there is no necessary connection between the amplitude of an expansion and the amplitude of the succeeding contraction. [...] To complete the analogy, we can suppose the board to be tilted to allow for trend and the underside of the board to be irregular to generate variability in the peaks. [15]

In Friedman's metaphor, the output bumps along the upper board, that is ”the ceiling of maximum feasible output”, the upper limit set by available resources and technologies. Sometimes, however, output is plucked down – by a contraction that can be small, as in cyclical contractions, or big, as in recent Covid-19 crisis – and it tends to bounce back.

1.2.1 Is it so simple?

Definitely, in the real World, Friedman's perspective does not take into consideration the disruption of economy by the crisis,that can take also the form of a Keynesian supply shock, with demand shortages [24], with the consequence of lowering the potential output – and then with a "bounce" far smaller than what would have been needed to return to previous theoretical output. This is the cause for "L-shaped" recoveries, when the output, and the economy in general, takes another path, worst than that on which it was.

In fact, for many smaller scale recessions, in particular those caused by monetary policies or those associated with financial crises, there is usually a rapid recovery [4], but this is not true for bigger scale crises: 20s Great Depression, the U.S. recessions in the 90s or the Great Recession of 2007.

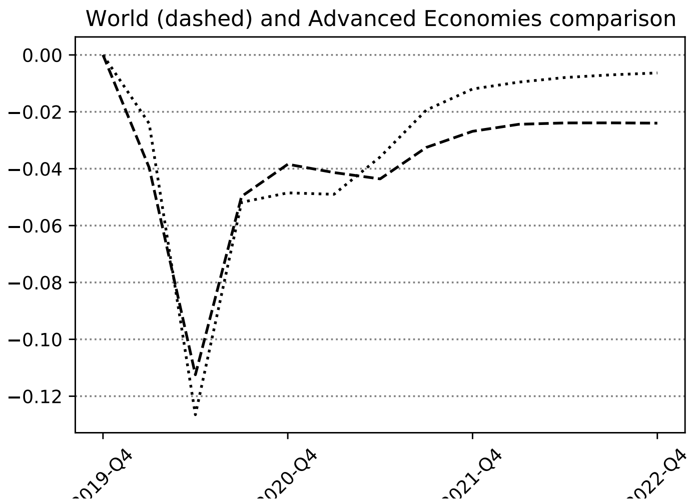


Figure 8

Covid-19 crisis is different for many reasons from the crises usually considered: it is in fact the double shock of supply and demand resulting from the collapse of production and consumption, and this has different effects given the economic conjunture in which it happens. We have seen a full palette of scenarios among the states, and the (optimistic) purpose of this thesis is to examine the relation between policies, effectiveness of them and "shape" of the recovery.

For the fifty-five states or aggregates whose data on quarterly GDP and forecasts I could study we can see that advanced economies[1] are forecasten to recover better and faster than the the World economy as a whole (fig. 8). We expect this is due to the possibility for advanced economies to put in place more thorough, effective and powerful policies.

1.3 WHAT ABOUT EVOLUTION OF EMPLOYMENT?

Dynamics between output and employment are well studied, and, in general, we expect the fall in output in Q2-2020 should be linked with an increase in unemployment.

This is in general true: for the 176 economies of which I have unemployment yearly data there is on average a raise in unemployment rate of 1.139%, or 17% higher unemployment rate in 2020 respect to 2019.

Using the three classifications used by World Bank – Advanced Economies, Emerging Markets, and Low Income Developing Countries –, we see that advanced economies have seen a higher relative increase than the other two groups (tab. 2).

	2019 U-rate	2020 U-rate	Increase	Relative increase (in %)
AE	5.36	6.53	1.16	21.71
EM	8.38	9.90	1.52	18.13
LIDC	5.70	6.28	0.58	10.14
World	5.37	6.47	1.10	20.45

Table 2: Unemployment rate change between 2019 and 2020 for the three World Bank groups of economies (in average per economy) and for the World economy.

We can see, however, in figure 9, that there is a very labile relation between the size of GDP loss and unemployment increase. Moreover,

1 The definition of advanced economies follows IMF's World Economic Outlook [30]

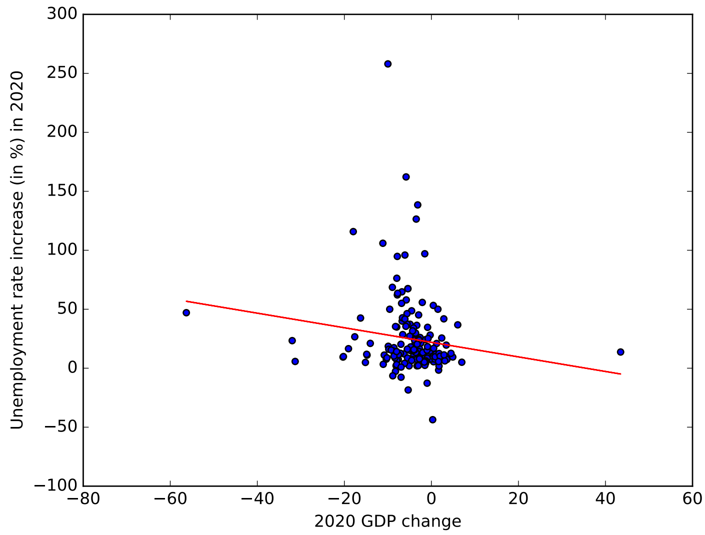


Figure 9: Scatter plot of unemployment rate relative increase against the change in yearly GDP for 174 economies.

limiting the analysis for advanced economies, and focusing on quarterly GDP loss, there is also an unexpected inverse relation trend (even if really light and without statistic significance) (cfr. fig. 10).

This can be due to the fact that heavily hit countries with a strong economic structure, reacted, to avoid worsening of the crisis on economic and social plan, giving extraordinary defence to workplaces, via various policies, while, at the same time, inactive people number increased substantially.

While we have seen that the output has followed for most countries similar shapes, unemployment, even if, on yearly basis, has had however an heavy impact from crisis and lockdowns, many different "shapes" can be seen in the dynamics (fig. 11).

An interesting example of the "countercyclical" dynamics, among the big economies, is Italy [9]. Although its economy has had a record contraction, the effects of Covid-19 crisis on employment levels have been limited. Lay-offs have been suspended for months, and the short-time work programs (the Cassa Integrazione Guadagni) has been an important labour cushion. This way, many economic and social short-term effects of Covid-19 have been avoided.

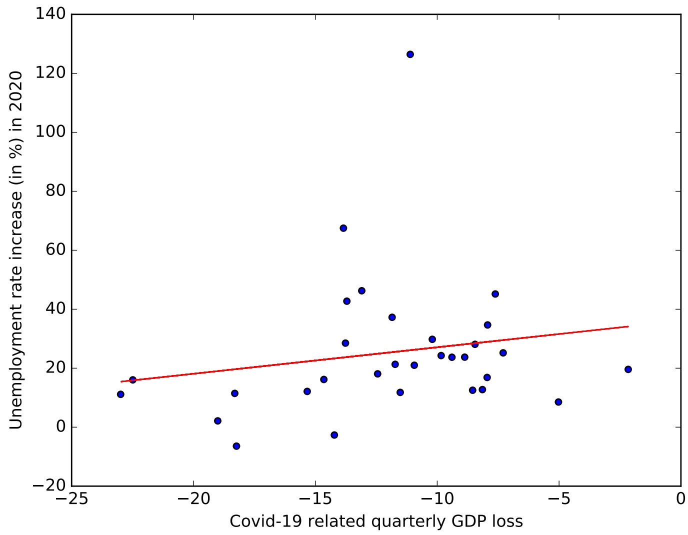


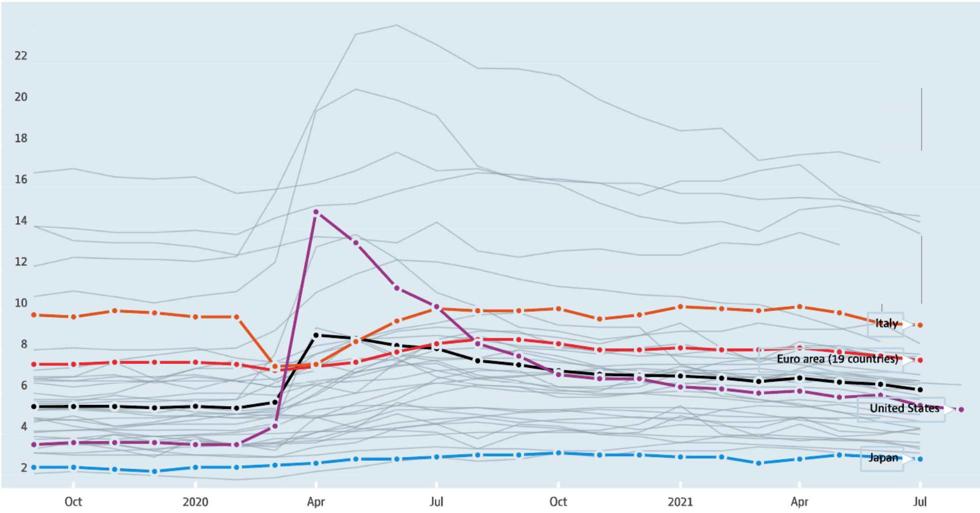
Figure 10: Scatter plot of unemployment rate relative increase against the loss of GDP, for advanced economies. The OLS trend, drawn with the red line, shows an unexpected positive slope.

However, in 2020, unemployment rate in Italy has declined, but mostly due to the drop in the number of active people (fig. 12). Social safety nets, however, have strongly limited the effects, so that, at the present moment, unemployment rate is lower than at the end of 2019 (fig. 13).

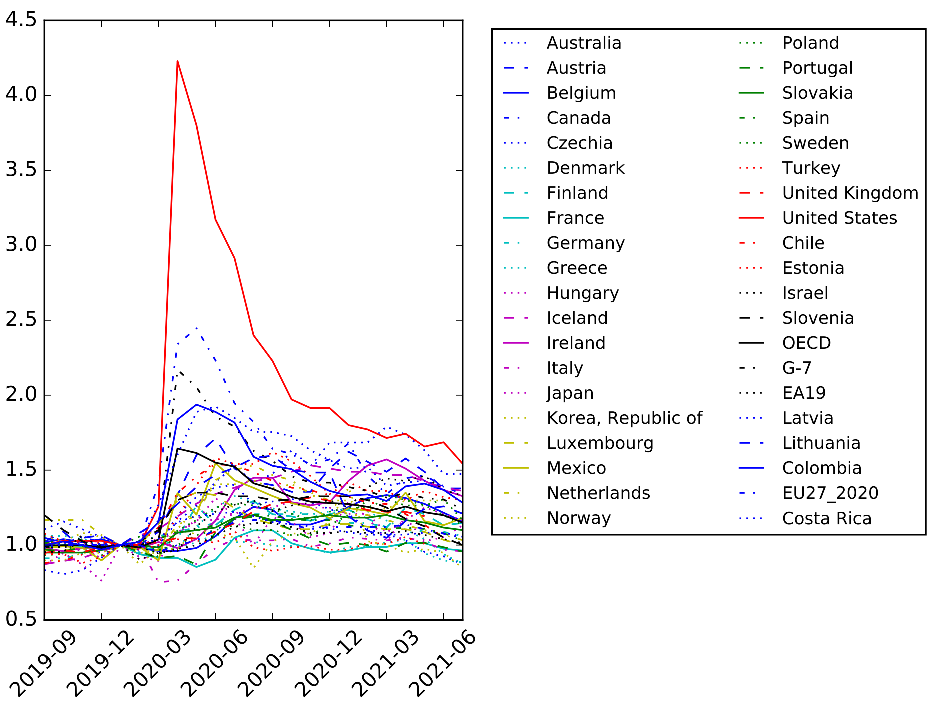
On the opposite side, United States, that have structurally a very elastic and liquid labour market, despite extraordinary measures to provide "safety net" programs, have seen unemployment rate in the worst moment of the crisis to reach 4.2 times the pre-crisis level, declining right after, but maintaining, still now, an unemployment rate far higher than pre-crisis level.

In light of what said before, it is clear due to the fact that unemployment is very much dependent on labour policies implemented by the country. In Euro area, where diffused safety nets were already in place and were deployed to protect employment during crisis, the increase of unemployment has been marginal and less sharp than in United States or in other country with lower labour protection (cfr. [11]).

This monthly analysis is made on a set of mostly advanced economies, members of the Organization for Economic Co-operation and Development, that can arguably field social policies of labour defence. But if we look to the yearly evolution of unemployment, we have already seen (in table 2 and in figure 9) that the relation is weak. So, short term evolution of unemployment, as we can observe now, is not a significant proxy for the severity of the crisis, but it must be integrated with additional considerations.



(a) Monthly unemployment for thirty-six OECD countries and four aggregates, September 2019 to last available data. Highlighted are US (purple), Italy (orange), Euro Area (red), OECD (black) and Japan (blue). (Source: data.oecd.org)



(b) The same graph, normalized to December 2019. While, on average, in the first months of 2020 there is an increase in unemployment rate, its evolution proceeds without a clear general pattern.

Figure 11

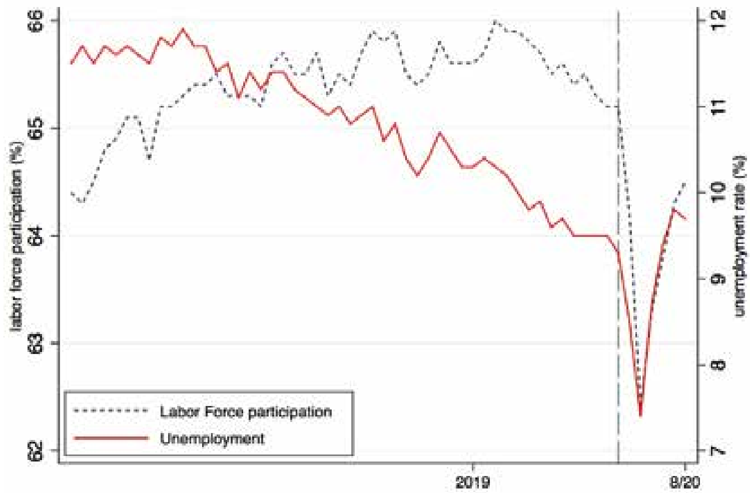


Figure 12

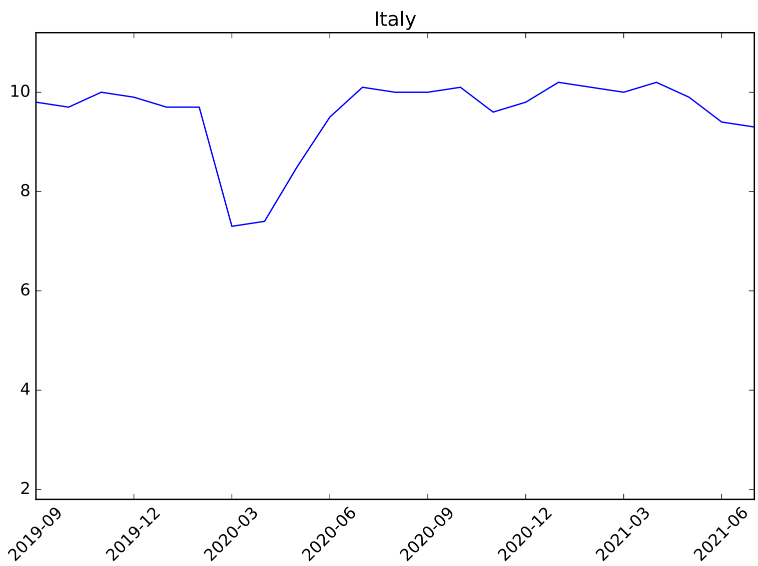


Figure 13

2 FISCAL POLICIES AND OTHER REMEDIES

> Policy is like a play in many acts, which unfolds inevitably once the curtain is raised. To debate the merit of the play is an absurdity. The important question is whether the curtain should be raised, because once the curtain is raised, the play will be completed, either by the actors or by the spectators who mount the stage.
>
> Klemens von Metternich, quoted by Henry Kissinger, *A World Restored* (1957)

2.1 FISCAL POLICIES AS THE FIRST RESPONSE

In a epidemic crisis like the present one, fiscal policies are the first and most powerful weapons government can use to respond fast and accurately. During the epidemics outbreak, with the consequent lockdown, a key priority is the spending on health and emergency services, assuring at the same time generous sustain to households which are affected by a contraction of income and by unemployment, and to firms which are subject to a contracted demand and at the same time are subject to a productivity shock, to prevent bankruptcies and guarantee liquidity.

At the same time, the crisis is global, and has unprecedented characteristics, as it carries a global shock of supply, demand and confidence. Inequalities across countries bring also an asymmetric development, subject to many facts: equatorial countries, and poorer countries with a more sedentary and younger population are far less subject to health consequences, that have hit hard countries with older population and more fast social dynamics. At the same time, however, the crisis has hit the demand for raw materials and has slowed supply chains, hitting also developing countries.

Focusing on advanced economies, they have responded in unprecedented way: one month after the epidemics, G20 countries had allocated more fiscal support in percentage to GDP than it had happened between 2008 and 2010 to counter the Great Recession [19]. The present crisis has hit hard during a long period of low growth for many advanced economies, when there was recent memory of 2008 Great Recession and the 2011 EU Sovereign-Debt Crisis, which have been overcome only through a generous expansive economic policy: it was then immediately clear that to avoid a deep crisis "whatever it takes"[1] was needed.

Timing is precious, and the economic reaction changes with the evolution of the epidemic and the crisis phases. Since, beyond the abstract modelling, there is a deep connection between economic activities and spread of the disease, following the words of 2020 IMF's Fiscal Monitor [19], "the main policy goal during the virus containment and mitigation phases is not to boost demand but rather to preserve the web of economic relationships between employers and employees, producers and consumers, and lenders and borrowers."

2.2 SEEKING A RECIPE FOR RECOVERY

The fiscal stimulus becomes really important and truly effective after the virus is contained and people return to work, to consume and, in general, to perform economic activity, in particular since the world comes from a decade of low growth and investment, a series of adverse shocks, and low inflation and interest rates, which prevent a substantial use of a broad range monetary policies, due to zero-lower bound of inflation rates for most advanced economies.

However, the low-for-long interest rates present an opportunity for quality public investment, aimed to boost growth, doing it in a "healthy"

1 From the speech given by Mario Draghi, then President of European Central Bank, on 26 July 2012, that announced strong monetary policies to overcome Sovereign Debt Crisis

way: through infrastructure, low-carbon technologies, health care, education and research. And this is true for both the advanced economies, and for emerging markets and developing countries, which have the opportunity to make a step forward.

Moreover, ”discretionary fiscal policies can have larger fiscal multipliers when policy rates are at the effective lower bounds and economic slack and fiscal space exist, because the policies can lead to a virtuous cycle that spurs private consumption and investment through higher inflation expectations and lower real interest rates.” [19]

At the beginning of the crisis (in April 2020), International Monetary Fund advised for three main directrices in policy responses: investment in the future, discretionary measures, and enhancement of automatic stabilizers.

PUBLIC INVESTMENT In some areas of high return-on-investment, particularly infrastructure, low-carbon technologies, health care, education and research, public investment could be the passport to a future sustainable, resilient, and inclusive economic growth, in particular for low income developing countries, whose infrastructure, production, enterprise and economic structure gap are impediments to long-term growth. A shock like the Covid-19 crisis make emerge the urgency of a such approach, targeting the Sustainable Development Goals (SDG) of the United Nations[2] as an instrument of alignment of growth and human development.

In this light, however, it is important the efficiency of investment. In fig. ??[3] it is presented the difference in macroeconomic impact for efficient and inefficient public investment, at a Global Level and focusing on European Union. It can be seen that an inefficient spending would lead to moderate impact in short term, not improving in the long term, and with a heavy detrimental effect on public debt/GDP ratio,

2 Fight poverty and hunger, promote healthcare, education, gender equality, provide sanity and clean water, affordable and clean energy, promote work and growth, pursue innovation and infrastructural and industrial development, reduce inequalities, aim to sustainable cities and communities, a responsible production and consumption cycle, take action against climate change, protect life below water and on land, promote peace, justice, and global cooperation.

3 The model used is a IMF version of Traum and Yang 2015

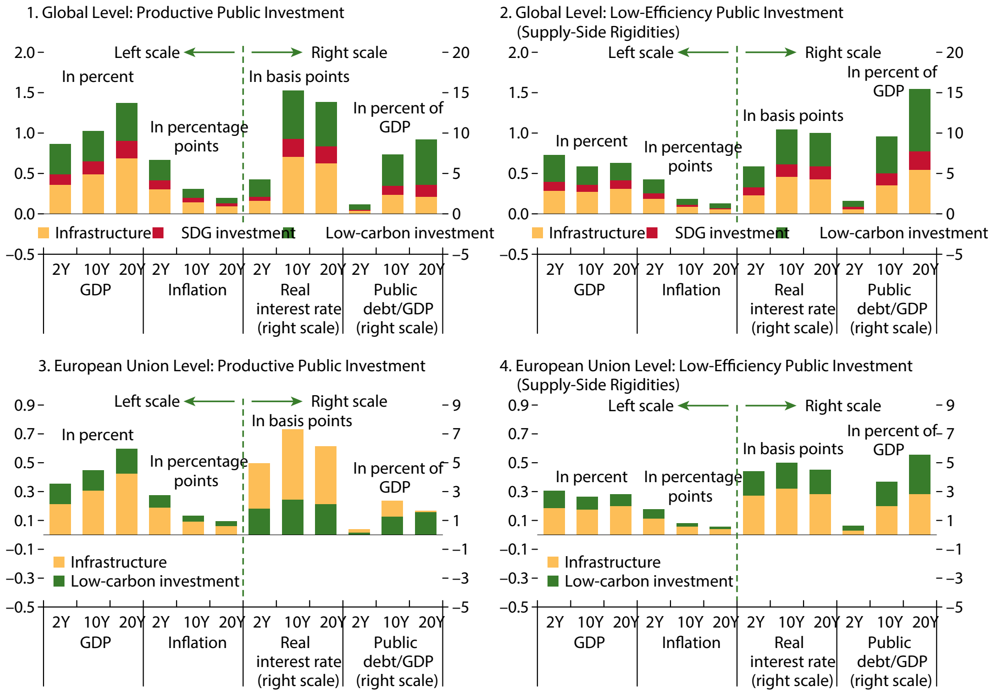


Figure 14: Simulated Macroeconomic Effects of a Public Investment Push. The two right side scenarios assume inefficient investment.

DISCRETIONARY MEASURES IMF stress the importance of such measures that can be deployed contingent upon a particular state of the economy, particularly during shocks and recessions. To promote resilient economy, it is important to identify discretionary measures to be used during deep and prolonged downturns, where it is not sufficient the social support through existing automatic stabilizers and safety nets, but a fiscal stimulus would be needed. IMF promotes automatic activation of such measures, according to certain threshold, for example, in unemployment, or in duration of downturns, so that the measures are timely and can act promptly as stabilizers, in a countercyclical way.

The urgency of measures for Covid, in this light, should give space also to these views, since public investment has a long lead time and it is useful to have a ready-to-implement plan to be deployed, and since the Covid-19 crisis, despite the broad vaccination campaign, is having subsequent waves.

ENHANCING AUTOMATIC STABILIZERS Automatic stabilizers are measures built into government budgets that raise spending and reduce taxes when the economy slows, and vice versa when the economy expands. Primarily they are the various mechanisms of progressive income taxes (even though the positive impact and the "right" measure of progressivity are debated topics) and, on the spending side, the various social safety nets, including emergency income and unemployment benefits [8].

Measuring the fiscal stabilization as the sensitivity of the overall budget balance to the output gap, these measures account for more than one-half of economic stabilization in most advanced economies. Actually, during downturns, they are a large and timely response [11]: during the Great Recession, they accounted for about 2 percent GDP recovery in US and EU.

So, it is natural that it is desirable to make this impact more effective, during the present crisis, in particular for those countries in which there is less protection for workers, in which, then, households would be able to smooth their consumption more effectively under income shocks.

2.3 POLICY ALL AROUND THE WORLD

Principal sources for the data used in this chapter are the IMF's Policy Tracker [21], that summarizes the key economic and social policies taken by 197 economies up to July 2021 (at the time of the writing of this thesis), and the IMF's Fiscal Policies Database [17], that summarizes the fiscal measures fielded by 191 economies. This last distinguish between the various types of fiscal intervention, and includes taken and announced policies between January 2020 and July 2021.

In [17] are presented and quantified, in local and international currency and in terms of GDP percentage, key fiscal measures governments have announced or taken between January 2020 and June 2021 in response to the Covid-19 pandemic, that have been implemented or are being implemented in 2021 and beyond.

The database categorizes different types of fiscal support with different implications for public finances.

Authors advice that, for the variety of the responses, in the country-specific context, it is not meant to be used for comparison or classification, even though, in the following part, some data-driven consideration will be made.

It focuses on government discretionary measures that supplement existing automatic stabilizers. These existing stabilizers differ across countries in their breadth and scope.

Although [17] allow for a first comparison at a glance, the differences in reporting, circumstances, measures, have to be considered, especially in relation with social policies and monetary intervention. For this purpose it is more effective a comparison with what registered in [21], that offers a broader range of information, though less specific.

Even considered the necessary caution in confronting data, due to different country-specific context, it is to be noted the huge variability that there is in the fiscal policy expense, and in the allocation of this expense, even between similar economies. In general, advanced economies have destined to fiscal policies far more than emerging countries, and these more than developing countries (fig. 15).

In the following lines, I will present how the fiscal policies are hierarchically classified by IMF,[4] with some quantitative considerations on the use by the countries of these policies:

- **Above the line measures**: increases in government expenditures and reductions in tax revenues, with the aim of directly impacting economic activity via fiscal multipliers.
  - **Additional spending on health**: The most immediate discretionary fiscal measure has been, arguably, the investment in health sector, to monitor, contain and mitigate epidemic and its effects. The vaccine development and the vaccination campaign have also been an important target of fiscal sustain, since, given the situation ”global vaccination may well be the public project with the highest return ever identified” [18].
  - **Non-health additional spending or foregone revenues**: apart the additional health expenses, they are investments and subsidies (even in the form of reduction in tax revenues) to

4 Different classification are used in other reports, such as the nature of ”above” or ”below the line” measure for tax deferrals.

sustain consumption and economic recovery after the contraction. On average, advanced economies have spent between 8 and 10% of their GDP in these measures, with the United States investing in additional spending more than 20% of their GDP, mostly on stimulus payments, unemployment benefits and social relief.

- **Accelerated spending or deferred revenue**: Most countries have postponed taxes as a measure of relief, accounting less than 2% of GDP; few countries, and among the advanced economies just Denmark (with 13.7 % GDP), Sweden and Luxembourg, have used the tax postponement as a true economic policy instrument.

- **Liquidity support**: to sustain enterprises in a liquidity shortage moment, many countries have demanded to liquidity support a strong role in countering the crisis effects and in allowing a subsequent recovery. Among the advanced economies, Italy is the country that has destined the most, respect to GDP. This is due to the intrinsic fragility of the economic texture of Italy, based mostly on small and medium enterprises, evidently more subject to liquidity issues.
  - **Below the line measures**: equity injections, loans, asset purchase or debt assumptions. Usually confined to a low percentage of GDP (below 2% average for advanced countries, lower for others), mostly for funding state-owned and strategical companies, also in this case Denmark alone pursuits eclectic policymaking, destining more than 12% GDP to direct loans, through government agencies, instead of providing guarantees.
  - **Contingent liabilities** (guarantees and quasi-fiscal operations): especially advanced economies have given an important sustain to credit, providing guarantees – also through state-controlled agencies (thus, in the form of "quasi-fiscal operations"), as in Japan, accounting for 25% GDP.

In general, around 17 trillions USD, or 16% of World GDP, are at the present moment destined to fiscal policies to recover the economy. It is an unprecedented effort to overcome the epidemic shock, and avoid a generalized recession.

Around 1.4% of the World GDP has been directed to health measures, and this could have a disruptive effect, in particular towards poorer countries with worst access to healthcare.

Around 8.2% of the World GDP has been destined to other discretionary spending measures, and around 6.2% to liquidity support.

Also in the distribution of these spendings there is a gap between the three country groups (table 3)

Even with the difference in intervention in distribution between countries, the effort fielded is in general an hapax, that is presumably going to change the economic history and the global approach to fiscal policy intervention.

	Total Discretional Spending	Health Additional Spending	Other subsidies and investments	Liquidity Support
AE	10.66	1.49	9.44	8.59
EM	4.32	0.94	3.48	3.37
LIDC	3.17	0.87	2.02	0.66
World	9.70	1.40	8.20	6.20

Table 3

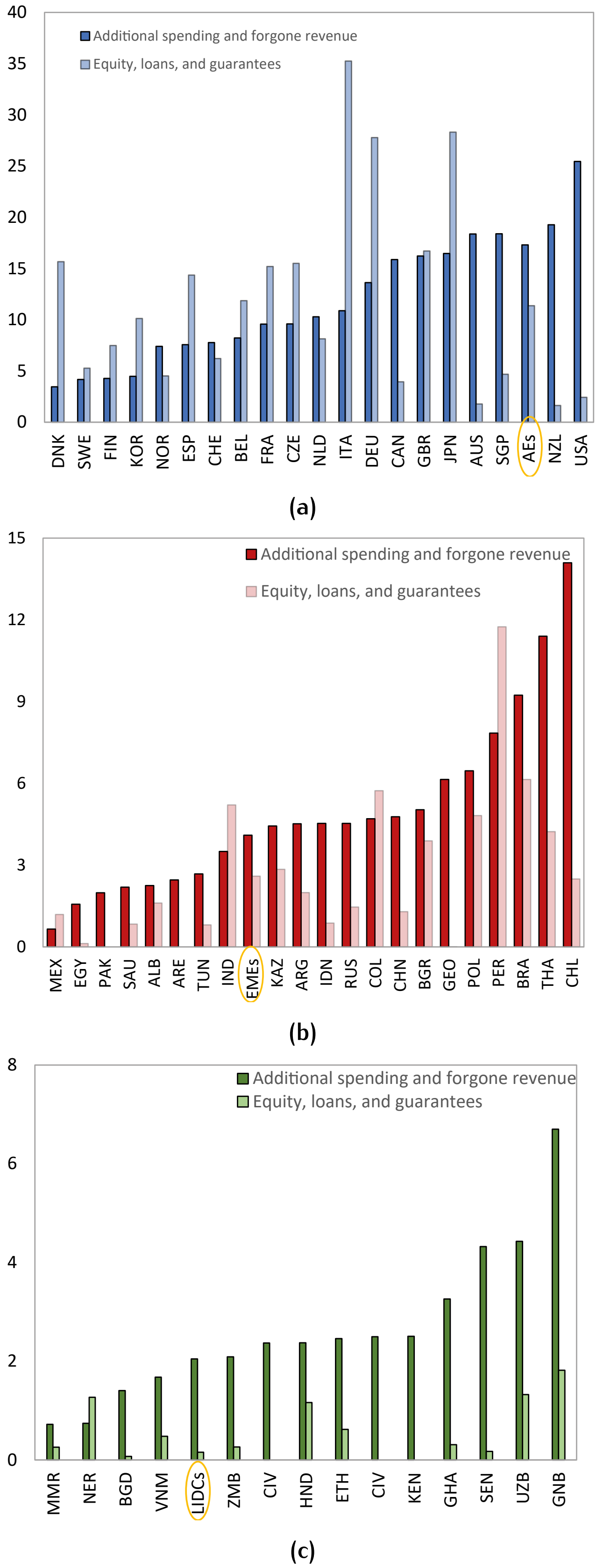


Figure 15: Discretionary Fiscal Response to the Covid-19 Crisis, in percentage of GDP, for some economies belonging to the three classifications: (a) Advanced Economies; (b) Emerging Markets; (c) Developing Countries.

3 THE IRRESISTIBLE FASHION OF MODELLING

> I am not a fan of economic models because they have all proven wrong when you have a paradigm change.
>
> David Davis
> UK Secretary of State
> for Exiting the European Union

While studying a complex phenomenon, subject to a big number of stochastic variables, depending arguably to a deep and not always transparent net of endogenous relations – such as an economic crisis – there is always a trade-off between simple and rational models and more fitting, complex and empirically driven treatments of the present data.

The lasts, even with a perfect description of the present reality, are easily subject to overfitting, with a detrimental effect on forecasting the future, and, worse, are less understandable, not allowing for qualitative analysis and, thus, for testing different futures.

On the other side, the simple and "textbook" models can oversimplify, missing necessary components, and it can involve also sophisticated models that on these oversimplifying assumptions are built, such as the Computable and Dynamic Stochastic General Equilibrium models (CGE and DSGE) that are usually used by Central Banks – that, however, could not predict the Great Recession of 2007.

Since my purpose, however, is not so ambitious, but still seek to evaluate qualitatively the influx of policies on the economic recovery, I will present two models, chosen in light of reasoning differently and appreciating different aspects of the current epidemics dynamics.

---

0 While I am concluding this work (september 2021) it appears a working paper by European Central Bank, presenting interesting results in a US economy framework: [7]

Despite the big difference in concept, purpose, results, both evidence an important aspect: without a sizeable government intervention through policies, an epidemic crisis outcome is destined to be harsh.

3.1 THE MACROECONOMICS OF EPIDEMICS

Martin S. Eichenbaum, Sergio Rebelo and Mathias Trabandt [13] propose a model, deriving from SIR epidemiological model, to include the equilibrium interaction between economic decisions and epidemic dynamics. According to this model, there is clearly an inverse correlation between contraction of the aggregate consumption and death toll (the, so called, health-wealth trade-off),[1], even if with a steep fall in consumption in any case. Authors highlight however, and using different approaches, that a global utility-based optimum passes through an important containment policy (joined with a government intervention associated with it).

3.1.1 The basic model

The economy before the epidemic

Before infection, the economy is based as follows:

1. The objective function for the population is

$$U = \sum_{t=0}^{\infty} \beta^t u(c_t, n_t),$$

where β is the discount factor, c_t and n_t are respectively consumption and work hours per unit of time. For simplicity, authors assume momentary utility function as

$$u(c_t, n_t) = \ln(c_t) - \frac{\theta}{2} n_t^2$$

.

1 A vast literature has flourished on the potential health-wealth trade-off, with different approaches and different results. An interesting statistic-based view is offered in [6] and interesting results about perception and choice are in [25].

2. The representative person has budget constraint

$$(1 + \mu_t)c_t = w_t n_t + \Gamma_t \tag{1}$$

   where w_t is the real hourly wage, and Γ_t denotes lump-sum transfers from government.

3. μ_t is a Pigouvian tax rate on consumption, that works, in this model, as a proxy for containment measures aimed at reducing social interactions, and is defined as a containment rate.

4. There is a rate A in which hours worked are transformed by a representative firm into consumption goods, according to technology

$$C_t = AN_t.$$

5. The firm obtains time-t profits Π_t

$$\Pi_t = AN_t - w_t N_t$$

   choosing hours worked to maximize them.

6. The government budget constraint is given by

$$\mu_t c_t = \Gamma_t.$$

Then, the first order condition for the representative person's problem is (from 1-3)

$$(1 + \mu_t)\theta n_t = c_t^{-t} w_t$$

In equilibrium we have that

$$n_t = N_t \text{ and } c_t = C_t.$$

The epidemic

Authors use a SIR model[2], that is, an epidemiological model based on three compartments (plus one):

S_t The number of **S**usceptible individuals, that can contract the disease;

2 About the original formulation, see [26]

I_t The number of **I**nfectious individuals, that have been infected and are capable of infect S individuals;

R_t The number of **R**emoved individuals from the pool: individuals that have been infected and are now recovered, and have developed a resistance, or have been vaccinated;

D_t The number of **D**eceased people.

The number of newly infected people is denoted by T_t.

A fundamental modification respect the classic model is that the infection probability depend on people's economic decision. Susceptible people can become infected in three ways:

- They meet infected people while purchasing consumption goods, becoming infected with probability parameter π_1. The number of newly infected people is given by

$$\pi_1(S_t C_t^s) \cdot (I_t C_t^i)$$

(the apex s or i refers the consumption (and in next point the hours worked) respectively to susceptible and to infected people).

- They meet infected people whie being at work, becoming infected with probability parameter π_2. The number of newly infected people is given by

$$\pi_2(S_t N_t^s) \cdot (I_t N_t^i).$$

- They meet infected people in other activities, not directly related to consuming or working, becoming infected with probability parameter π_3. The total number of newly infected people in this case is

$$\pi_3 S_t I_t.$$

We have then the total number of newly infected people as

$$T_t = \pi_1(S_t C_t^s) \cdot (I_t C_t^i) + \pi_2(S_t N_t^s) \cdot (I_t N_t^i) + \pi_3 S_t I_t.$$

We have, then, that at each time $t + 1$:

- the number of susceptible people decreases of T_t,

- the number of infected people increases of T_t and diminishes of $(\pi_r + \pi_d)I_t$, that is the number of people that recover (with probability π_r) or die (with probability π_d),
- the number of recovered people increases of $\pi_r I_t$,
- the number of deceased people increases of $\pi_d I_t$,
- and so the total population decreases of $\pi_d I_t$.

Writing in equations:

$$\begin{cases} S_{t+1} = S_t - T_t, \\ I_{t+1} = I_t + T_t - (\pi_r + \pi_r)I_t, \\ R_{t+1} = R_t + \pi_r I_t, \\ D_{t+1} = D_t + \pi_d I_t, \\ Pop_{t+1} = Pop_t - \pi_d I_t. \end{cases} \tag{2}$$

We normalize population at time zero, $Pop_0 = 1$ and assume that a fraction ϵ is initially infected (and so $I_0 = \varepsilon$ and $S_0 = 1 - \varepsilon$).

We introduce now a productivity parameter ϕ^j for the wage, that is 1 if the person is susceptible or recovered ($\phi^s = \phi^r = 1$) and 0 if she is infected ($\phi^i < 1$), thus rewriting equation (1) for a person j as

$$(1 + \mu_t)c_t^j = w_t n_t^j \phi^j + \Gamma_t. \tag{3}$$

The purpose of this constraint is to avoid the pooling of the risks associated with infection.

We define then the probability that a susceptible person becomes infected as

$$\tau_t = \pi_1 c_t^s (I_t C_t^i) + \pi_2 n_t^s (I_t N_t^i) + \pi_3 I_t \tag{4}$$

that, as we see, increases with work and consumption, creating a trade-off between the utility deriving from economic activities and the utility of not becoming infected.

SUSCEPTIBLE PEOPLE A susceptible person has then a lifetime utility as follows:

$$U_t^s = u(c_t^s, n_t^s) + \beta[(1 - \tau_t)U_{t+1}^s + \tau_t U_{t+1}^i] \tag{5}$$

that has first-order conditions for consumption c_t^s, hours worked n_t^s and probability of infection τ_t

$$\begin{cases} u_1(c_t^s, n_t^s) - (1+\mu_t) \cdot \lambda_{bt}^s + \lambda_{rt}\pi_1(I_t C_t^i) = 0 \\ u_2(c_t^s, n_t^s) + w_t \cdot \lambda_{bt}^s + \lambda_{rt}\pi_2(I_t N_t^i) = 0 \\ \beta(U_{t+1}^i - U_{t+1}^s) - \lambda_{rt} = 0 \end{cases} \tag{6}$$

with λ_{bt}^s and λ_{rt} Lagrange multipliers relative respectively to constraints (3) and (4).

INFECTED PEOPLE The lifetime utility of an infected person U_t^i is, as follows,

$$U_t^i = u(c_t^s, n_t^s) + \beta[(1 - \pi_r - \pi_d)U_{t+1}^i + \pi_r U_{t+1}^i] \tag{7}$$

(assuming that there is null utility for a deceased person, $U_t^d = 0$), with first-order conditions

$$\begin{cases} u_1(c_t^i, n_t^i) - (1+\mu_t) \cdot \lambda_{bt}^i = 0 \\ u_2(c_t^i, n_t^i) + \phi^i w_t \cdot \lambda_{bt}^i = 0 \end{cases} \tag{8}$$

RECOVERED PEOPLE For a recovered person, the lifetime utility U_t^r is

$$U_t^r = u(c_t^r, n_t^r) + \beta U_{t+1}^r, \tag{9}$$

that has first-order conditions

$$\begin{cases} u_1(c_t^r, n_t^r) - (1+\mu_t) \cdot \lambda_{bt}^r = 0 \\ u_2(c_t^r, n_t^r) + w_t \cdot \lambda_{bt}^r = 0 \end{cases} \tag{10}$$

GOVERNMENT BUDGET CONSTRAINT The government budget constraint is

$$\mu_t(S_t c_t^s + I_t c_t^i + R_t c_t^r) = \Gamma_t(S_t + I_t + R_t). \tag{11}$$

EQUILIBRIUM In the equilibrium maximization problem is solved for each person, under government budget constraint and goods and labour markets clearing:

$$\begin{cases} S_t C_t^s + I_t C_t^i + R_t C_t^r = AN_t \\ S_t N_t^s + I_t N_t^i + R_t N_t^r = N_t \\ c_t^j = C_t^j \; j = s, i, r n_t^j = N_t^j \; j = s, i, r. \end{cases} \tag{12}$$

3.1.2 More sophisticated modeling

The cited paper discusses analytically other assumptions, in particular introducing the possibility of vaccines and medical treatment and the impact of the number of infections on the efficacy of the health care system, calling the model with these assumptions "benchmark model".

We have then

- Vaccines: a vaccine is discovered with probability δ_v per period and immediately provided to all susceptible people, making them becoming recovered. The lifetime utility of a susceptible person becomes then

$$U_t^s = u(c_t^s, n_t^s) + (1 - \delta_v)(\tau_t)\beta U_{t+1}^s + \delta_v(1 - \tau_t)\beta U_{t+1}^r + \tau_t \beta U_{t+1}^i. \tag{13}$$

- Treatments: an effective treatment is developed with probability δ_c, that cures infected people transforming them into recovered people. The lifetime utility of an infected person becomes

$$U_t^i = u(c_t^i, n_t^i) + (1 - \delta_c)[(1 - \pi_r - \pi_d)\beta U_{t+1}^i + \pi_r \beta U_{t+1}^r] + \beta \delta_c U_{t+1}^r. \tag{14}$$

- Medical preparedness: the case fatality increases with the number of infected people, following the saturation of the health care system:

$$\pi_{dt} = \pi_d + \kappa I_t^2$$

  where $\kappa > 0$.

3.1.3 Economic policy

An immediate observation is that in every case, the competitive equilibrium is far from Pareto optimum. For each atomistic person, the maximum utility is reached while contributing to spread of infection, thus affecting heavily susceptible people. So, we study the corresponding Ramsey problem, with the policy instrument μ_t, that we have defined as a Pigouvian tax on consumption, and that is designed to summarize the various containment measures.

In numeric way we can find a sequence $\{\mu_t\}_t$ that maximizes social welfare U_0, defined as the weighted average of the lifetime utility of different people. The optimal sequence is the best simple containment policy.

The Pigouvian tax could seem a Byzantine way of modelling containment policies, and for this reason the authors compute numerically also the best policy using a planning problem in which the government chooses consumption and hours worked for all under the same rate, in order to maximize the social welfare (Simple Command).

In fig. 16 (that applies the numeric values recalled in the footnote), the competitive equilibrium evolution of the different parameters (in solid blue) is compared to that under the optimal policy following simple containment (in dashed red) and following simple command containment.[3]

Another containment policy modelling is called by authors "Smart containment". It is the solution to a social planning problem in which the planner directly chooses different levels of consumption and hours

3 We list the numeric values authors set to run the numeric simulations. For clarifications about sources and robustness tests, we invite to see the original paper.

1. The case fatality rate at 0.5%, for a weekly average duration of infection of 18/7, so $\pi_d = 0.19\%$;
2. From various sources, taking into consideration surveys on time spending and on social interactions in various context,

$$\pi_1 = 7.8408 \times 10^{-8},\ \pi_2 = 1.2442 \times 10^{-4},\ \pi_3 = 0.3901,$$

   respectively the probabilities of becoming infected for consumption hour per week, for worked hour per week and the weekly probability for becoming infected in other ways;
3. $A = 39.835$ (28 hours worked per week on average) and $\theta = 0.001275$ (weekly income of \$58,000/52);
4. $\beta = 0.96^{1/52}$;
5. $\phi^i = 0.8$;
6. $\kappa = 0.9$ and $\delta_c = \delta_v = 1/52$ for medical preparedness model;
7. $\mathcal{R} = 1.45$, for basic reproduction number, the statistic of the total number of infections caused by one infected person in her lifetime in a population in which everybody is susceptible.

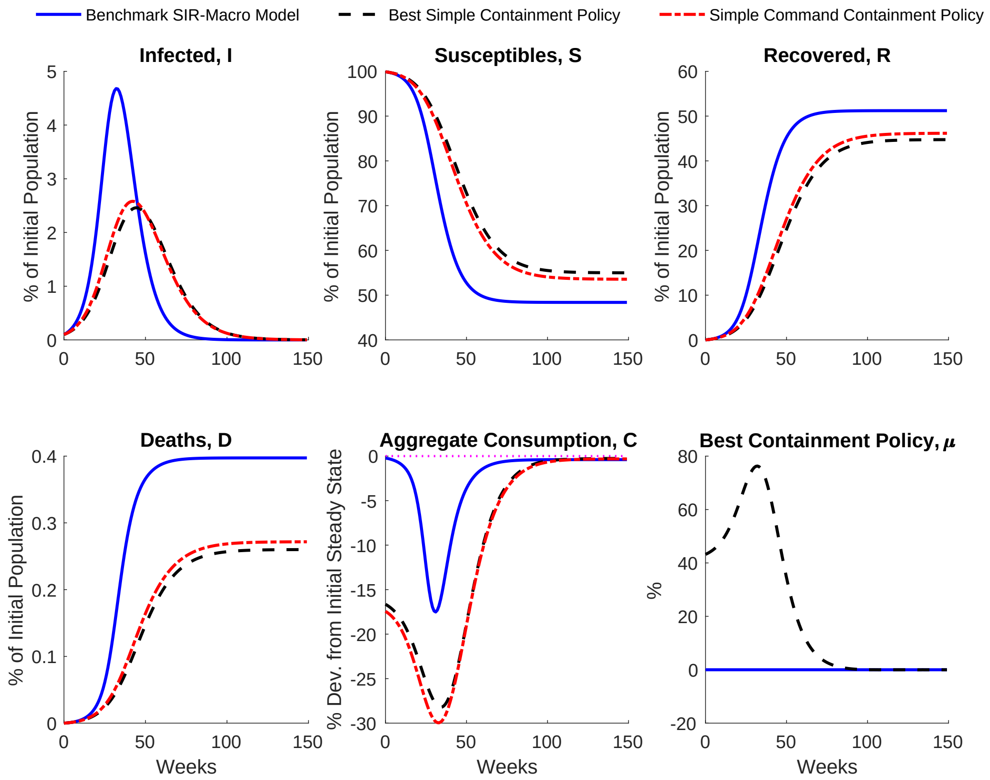


Figure 16: Evolution of parameters in the SIR-macro model with vaccines, treatment and medical preparedness

worked for the three groups of people, thus defining C_t^s, C_t^i, C_t^r, N_t^s, N_t^i and N_t^r for all t to maximize U_0.

The lifetime utilities for the three groups are then:

$$\begin{cases} U_t^s = u(C_t^s, N_t^s) + (1-\delta_v)(1-T_t)\beta U_{t+1}^s + \delta_v(1-T_t)\beta U_{t+1}^r + T_t\beta U_{t+1}^i \\ U_t^i = u(C_t^i, N_t^i) + (1-\delta_c)[(1-\pi_r-\pi_d)\beta U_{t+1}^i + \pi_r\beta U_{t+1}^r] + \beta\delta_c U_{t+1}^r \\ U_t^r = u(C_t^r, N_t^r) + \beta U_{t+1}^r \end{cases} \tag{15}$$

Simplifying, infected people do not work, then susceptible people can work without fear of becoming infected.

It is to say that while this model can represent significantly the epidemiological dynamics linked to economic activities, an important aspect, that will be evaluated using different instruments, can not be thoroughly studied: fiscal policy.

In Eichenbaum model, in fact, we have a government budget constraint (equation 11), in which the government transfer Γ_t corresponds quantitatively to the Pigouvian tax income, representative of containment measures, and on average compensates people for the biggest cost of consumption.

In practice, we have seen, states intervention acts on different levels not taken into consideration. Thinking of the fiscal policies of many countries to overcome the economic crisis linked to drop in consumption, we imagine that a state could provide a great liquidity support, to avoid contraction of consumption.

3.2 AN AGENT-BASED MODEL TO EVALUATE POLICY IMPACT

Are we so sure that the economic system by itself can recover from a rapid drop of supply and demand, followed by a quick return to normal, taking into account the fragility of the production system?

In [33], authors study the impact of a Covid-19-like shock on a simple model economy, however sufficiently sophisticated to include these aspects, based on a Mark-0 Agent-Based Model [23] (fig. 17) with a Central Bank. They evaluate then the impact of a Covid-19-like crisis, and, more importantly, the different impact of the policies on the economic recovery.

3.2.1 The model[4]

The Mark-0 economy is composed by interaction of firms producing goods, households consuming these goods, a banking sector and a central bank. Households and the banking sector are described at the

4 For simplicity in exposition, I apply, already in the model presentation, some strong simplifying assumptions that are used by authors in the numeric evaluation and that are argued to not significantly influence qualitative results, specifically: a zero-expected inflation, a zero-target inflation, a constant consumption propensity, the fact that firms' financial fragility does not affect their hiring/firing rates, and a zero base interest rate. This aspects are omitted from the equations – that can thus differ from those presented in [33] – and from the comment.

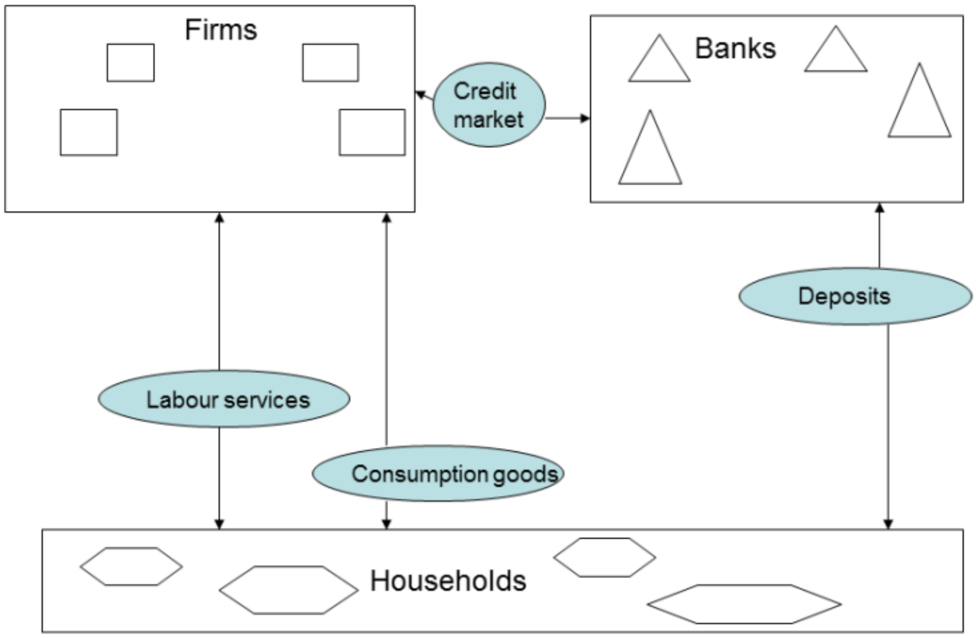


Figure 17: A simple scheme showing the agents in Mark-0 ABM and their interactions, from [10].

aggregate level by, respectively, a "representative household" and a "representative bank".

The model is defined in discrete time, where the time unit t is considered expressed in months. Each firm i produces a quantity $Y_i(t)$ of perishable goods that it attempts to sell at price $p_i(t)$, paying a wage $W_i(t)$ to its employees.

- $Y_i(t)$: quantity of perishable good produced by i at time t;
- $\mathcal{E}_i$: cash balance of firm i (if negative, then debt)
- $p_i(t)$: unitary objective price of the good produced;
- $N_i(t)$: employees at firm i;
- N total number of workers;
- $W_i(t)$: wage paid by i to its employees;
- $W(t) = \sum_i W_i(t)N_i(t)$: total wage;
- $D_i(t)$: demand for the good produced by i;

- $\rho^l(t)$ and $\rho^d(t)$: interest rates respectively on loans and on deposits;
- $\Delta(t)$: dividends received from firms profit;
- $C_B(t)$: consumption budget for the household, determined as a fraction of the household savings;
- $S(t)$: household saving;
- c_0: consumption propensity

For simplicity, it is assumed a linear production function, depending only on labor, with a productivity constant ζ such that

$$Y_i = \zeta N_i. \tag{16}$$

Unemployment is defined as

$$u(t) = \frac{\sum_i N_i(t)}{N} \tag{17}$$

provided $u(t) \geq 0$.

Instantaneous inflation rate $\pi(t)$ is defined as

$$\pi(t) = \frac{\overline{p}(t) - \overline{p}(t-1)}{\overline{p}(t-1)} \tag{18}$$

with $\overline{p} = (\sum_i p_i Y_i)/(\sum_i Y_i)$, production weighted average price.

Similarly, it is defined $\overline{w} = (\sum_i w_i Y_i)/(\sum_i Y_i)$, as the production-weighted wage.

The inflation that affects households and firms (named "realized inflation") is a smoothed average value of the instantaneous inflation:

$$\pi^{ema}(t) = \omega\pi(t) - (1-\omega)\pi^{ema}(t-1). \tag{19}$$

The agents

HOUSEHOLDS

- **Household savings** evolve according to

$$S(t+1) = S(t) + W(t) + \rho^d(t)S(t) - C(t) + \Delta(t). \tag{20}$$

- The **total consumption budget** is given by

$$C_B(t) = c[S(t) + W(t) + \rho^d(t)S(t)]. \tag{21}$$

- The **actual consumption** $C(t) \leq C_B(t)$ depends on the matching of production and demand:

$$C(t) = \sum_i p_i \min\{Y_i, D_i\}. \tag{22}$$

- The **demand** for good D_i is modeled in the following way:

$$D_i(t) = \frac{C_B(t)}{p_i(t)} \cdot \frac{\exp(-\beta p_i(t))}{\sum_j \exp(-\beta p_j(t))}. \tag{23}$$

FIRMS

- Firms have **financial fragility**, defined as the ratio between debt and payroll:

$$\Phi_i = -\frac{\mathcal{E}_i}{W_i N_i}. \tag{24}$$

- There is a threshold parameter Θ, that models the maximum leverage in the economy and the risk-control policy of the banking sector.

- **Default mechanism**: if $\Phi_i \geq \Theta$, the firm i defaults, and the costs burden on the banking sector. The defaulted firm is substituted by a new one, initialized at random, under the rate ϕ.

- **Production update**: firm i updates at each period its production following the following rules ("rules of thumb"):

$$\begin{aligned} &\text{If } Y_i(t) < D_i(t) \ \Rightarrow Y_i(t+1) = Y_i(t) + \min\{\eta_i^+(D_i(t) - Y_i(t)), \zeta u_i^*(t)\} \\ &\text{If } Y_i(t) > D_i(t) \ \Rightarrow Y_i(t+1) = Y_i(t) - \eta_i^-[Y_i(t) - D_i(t)] \end{aligned} \tag{25}$$

with $\eta_i^\pm \in [0,1]$ hiring/firing rates, $u_i^*(t)$ the maximum number of unemployed workers available to the firm i at time t, depending on the wage as follows:

$$u^* = \frac{\exp(\beta W_i(t)/\overline{w}(t))}{\sum_i \exp(\beta W_i(t)/\overline{w}(t))} \tag{26}$$

- **Price update**: the price update follows a random multiplicative process, influenced by the production-demand gap of the previous time step and the competitiveness of price (thus: price higher if it is lower than the average and there is more demand and vice versa):

$$\text{If } Y_i(t) < D_i(t) \Rightarrow \begin{cases} \text{If } p_i(t) < \overline{p}(t) \Rightarrow & p_i(t+1) = p_i(t)(1+\gamma\xi_i(t)) \\ \text{If } p_i(t) \leq \overline{p}(t) \Rightarrow & p_i(t+1) = p_i(t) \end{cases}$$
$$\text{If } Y_i(t) > D_i(t) \Rightarrow \begin{cases} \text{If } p_i(t) > \overline{p}(t) \Rightarrow & p_i(t+1) = p_i(t)(1-\gamma\xi_i(t)) \\ \text{If } p_i(t) \geq \overline{p}(t) \Rightarrow & p_i(t+1) = p_i(t) \end{cases} \tag{27}$$

  with $\xi_i(t)$ independent uniform $U[0,1]$ random variable and γ the relative price adjustment parameter.

- **Wage update**: wages follow the choices made for price and production. It is to be noted that productivity ζ does not depend on wages, that have an effect just on hiring. At each step the wages evolve as follows:

$$W_i^T(t+1) = W_i(t)[1+\gamma(1-u(t))\xi_i'(t)] \quad \text{if} \quad \begin{cases} Y_i(t) < D_i(t) \\ \mathcal{P}_i(t) > 0 \end{cases}$$
$$W_i(t+1) = W_i(t)[1-\gamma u(t))\xi_i'(t)] \quad \text{if} \quad \begin{cases} Y_i(t) > D_i(t) \\ \mathcal{P}_i(t) < 0. \end{cases} \tag{28}$$

  If profit ($\mathcal{P}_i$) is positive and demand excess supply, then theoretical wage W_i^T increases proportionally to inverse of unemployment rate and to a independent uniform random variable $\xi_i'(t) \sim U[0,1]$. If $W_i^T(t+1)$ implies $\mathcal{P} < 0$, then $W_i(t+1)$ is set to allow $\mathcal{P} = 0$. Otherwise $W_i(t+1) = W_i^T(t+1)$.

  If profit is negative and supply excess demand, wage is reduced proportionally to unemployment rate and to the uniform random variable.

- **Profits**: Profit is defined as the sales, minus the wages, plus (positive or negative) interests on cash balance:

$$\mathcal{P}_i = p_i(t)\min\{Y_i(t), D_i(t)\} - W_i(t)Y_i(t) + \rho^d \max\{\mathcal{E}_i(t), 0\} - \rho^l \min\{\mathcal{E}_i(t), 0\}. \tag{29}$$

- **Dividends**: A fraction δ of cash balance $\mathcal{E}_i$ is paid to the representative household if both cash balance and profit are positive:

$$\Delta(t) = \delta \sum_i \mathcal{E}_i(t) \cdot \theta(\mathcal{E}_i(t)) \cdot \theta(\mathcal{P}_i(t)) \tag{30}$$

with $\theta(x) = 0$ if x negative and 1 if x positive (Heaviside step function).

BANKING SECTOR It is composed by a "representative bank" and a central bank which sets baseline interest rates, following also an inflation targeting mandate.

- **Interest rates**: banking sector tunes interest rates following the total cost of defaulting firms ($\mathcal{D}(t) = -\sum_j \mathcal{E}_j(t)$ for j firms defaulted), the firms' total positive cash balance ($\mathcal{E}^+ = \sum_i \max\{\mathcal{E}_i, 0\}$) and the firms' total debt ($\mathcal{E}^- = -\sum_i \min\{\mathcal{E}_i, 0\}$), as follows:

$$\begin{aligned} \rho^l(t) &= f\frac{\mathcal{D}(t)}{\mathcal{E}^-(t)}, \\ \rho^d(t) &= (f-1)\frac{\mathcal{D}(t)}{S(t) + \mathcal{E}^+(t)}. \end{aligned} \tag{31}$$

The parameter f determines how much the impact of defaults is divided between lenders and borrowers.[5]

- **Constant circulation money**: the sum of savings ($S(t)$), firm deposits ($\mathcal{E}^+(t)$) and firm debts ($-\mathcal{E}^-(t)$) is constant:

$$M = S(t) + \mathcal{E}^+(t) - \mathcal{E}^+(t) \tag{32}$$

3.2.2 A Covid-like shock

In this toy economy, how does an economic shock such as that induced by Covid-19 change the game? As we have seen in [13] model, the two main effects are a sudden drop in productivity of firms, $\zeta \longrightarrow \zeta - \Delta\zeta$, and in consumption propensity of household, $c \longrightarrow c - \Delta c$.

The length of time T in which these effects are in place (reflecting a lockdown period or, in general, a period of uncertainty and restrictions)

5 Since the simplifying hypotesis that the baseline interest is zero, deposit interests are negative.

is an important parameter in the evaluation of the effects of the crisis. As we can see in figure 18, the "green area" (that reflects milder effects on output and unemployment) reduces significantly with longer crises, being subject to lower consumption and production shocks.

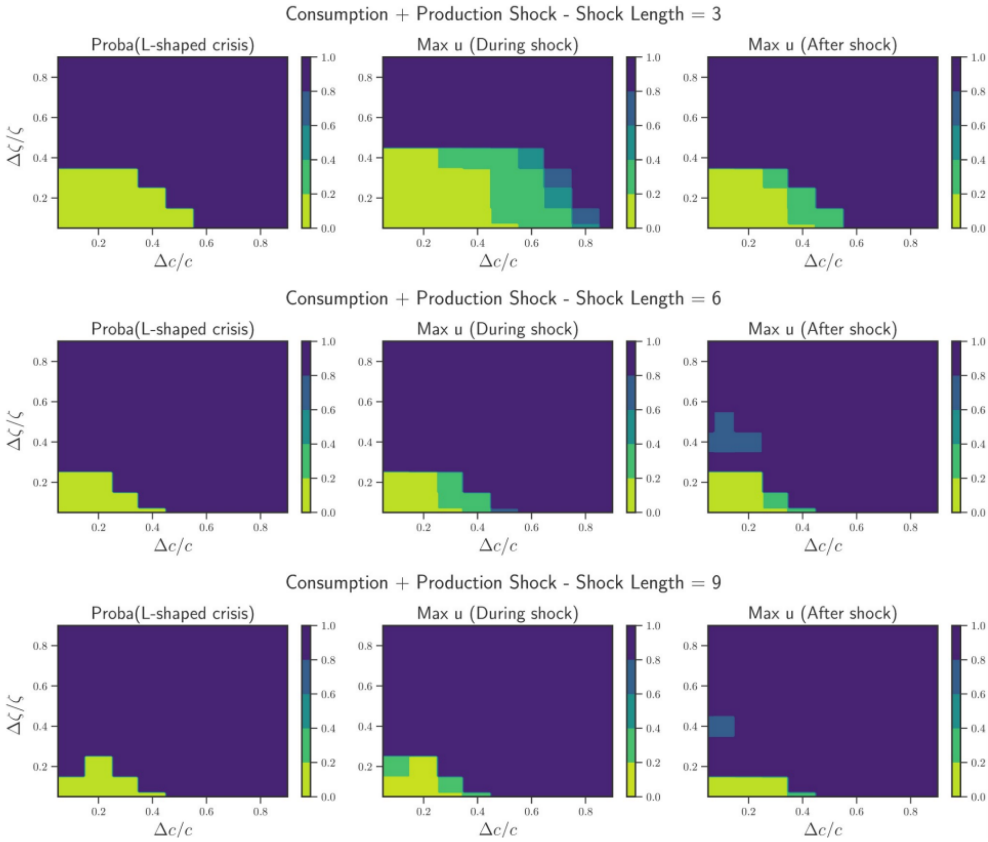


Figure 18: The phase diagrams, obtained with 500 independent simulations for each pair $\Delta c/c$—$\Delta\zeta/\zeta$, as presented in [33], for probability of an L-shaped crisis, maximum unemployment during shock and maximum unemployment after shock, for three different shock lengths – 3, 6 and 9 months

A relevant feature of this Agent-Based Model is the possibility of simulating the policies that a government can put in place to overcome the crisis. in figure 19, it can be seen that under a severe shock, a robust government intervention makes the difference between an L-shaped crisis, with a prolongued loss in output (in red) and a recovery (in black, dashed).

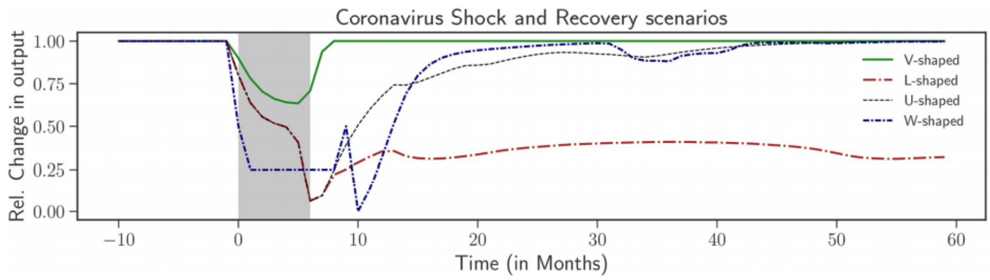


Figure 19: The change of output as function of the time, respect the no-shock scenario, for various type of shocks, according to [33]. In green a mild shock ($\Delta c/c = 0.3, \Delta\zeta/\zeta = 0.1, T = 6$) in which the economy contracts but quickly recovers (V-Shaped recovery). A more severe shocks over the same time period ($\Delta c/c = 0.3, \Delta\zeta/\zeta = 0.2$) causes a permanent loss in output (L-shaped scenario, in dot-dashed red). But in the same case, an increase in consumption propensity of 40% respect pre-crisis level, due to a massive intervention of "helicopter money" could restore the output after a longer period (U-shaped recovery, in dashed black). Long-term effects can be seen in case of severe shocks ($\Delta c/c = 0.3, \Delta\zeta/\zeta = 0.5$), with a second downturn many months after the shock and the subsequent recovery due to strong government policies.

The policies that are discussed, that are coherent with the intervention put in place by the states, are:

- Monetary policy: direct interest rate cuts, or quantitative easing. Since the current situation for most advanced economies, however, sees very low interest rates, the zero-lower bound could cause a liquidity trap, thus leading to a fail in the possibility of intervention. It is however an important tool for longer-term scenarios (as highlighted in [22]).
- Easy-credit access to firms;
- "Helicopter money"

Following [33], and since they are the most important instrument used actually by states during the current crisis[6], a thorough study is devoted to the latter two.

6 In fact, they roughly correspond respectively to non-health above-the-line measures and to contingent liabilities in IMF Fiscal Policy Database [17].

easy-credit access to firms In the exposed model, granting easy-credit access to firms corresponds to allow firms to get indebted more, without fear of bankruptcy, that is, to increase the bankruptcy threshold Θ virtually to ∞, not allowing firms to go bankrupt during crisis.

A fundamental policy decision is however the way in which to reduce Θ after the end of the shock. One of the most interesting results of this paper numerical simulation is the fail of the "naive" approach that set Θ to the normal level abruptly. The firms, that have accumulated debt, are more fragile, and a mass bankruptcy could happen when credit is tightened, leading the economy to a recession as if no policy were applied.

The alternative possibility, called "adaptive", sets Θ progressively to the previous level (Θ_0), tuning it following the average fragility, with a "tolerance parameter" θ:

$$\Theta = \max(\theta\langle\Phi\rangle, \Theta_0).$$

So, only the most indebted firms, whose fragility exceeds $\theta\langle\Phi\rangle$ will go bankrupt.

"helicopter money" Government can also take a more active role, with a money expansion and distribution. To avoid the banking trap, in which the money remain in the banking sector without going to consumption, it is considered the direct money distribution by the state, already described by Milton Friedman in [16].

> Let us suppose now that one day a helicopter flies over this community and drops an additional $1000 in bills from the sky, which is, of course, hastily collected by members of the community. Let us suppose further that everyone is convinced that this is a unique event which will never be repeated.

It is (or, it was before the Covid-19 crisis and its extensive use) usually considered a taboo policy, for the fear it could be strongly inflationary. However, taking apart more articulated and supporting views, as [5], already Friedman and Keynes[7], to name two, highlighted that this money that "rains down from heaven" could be useful to face deflation and drop in demand.

Since the examined case is precisely when an "helicopter money" drop could be useful, even since it is a one-time policy driven by an extraordinary case, we study, in light of this simplified model, its possible effects. We assume that government increases linearly household savings by a factor $\kappa > 1$: $S \longrightarrow \kappa S$.

The imagined effect is to raise the consumption propensity so to make it return, as soon as the shock is ended, to previous value.

The results of the simulations can vary under the different parameters. In figure 20, there is however an arguably comparison of different policy approaches, in the case of a 9-months production and consumption shock. Similar results are obtained tuning the different parameters: the most beneficial policy in terms of stability is the credit sustain, that diminishes gradually after the end of the shock.

7 Cited by Ben Bernanke in a speech in November 2002: "[Keynes] once semi-seriously proposed, as an anti-deflationary measure, that the government fill bottles with currency and bury them in mine shafts to be dug up by the public."

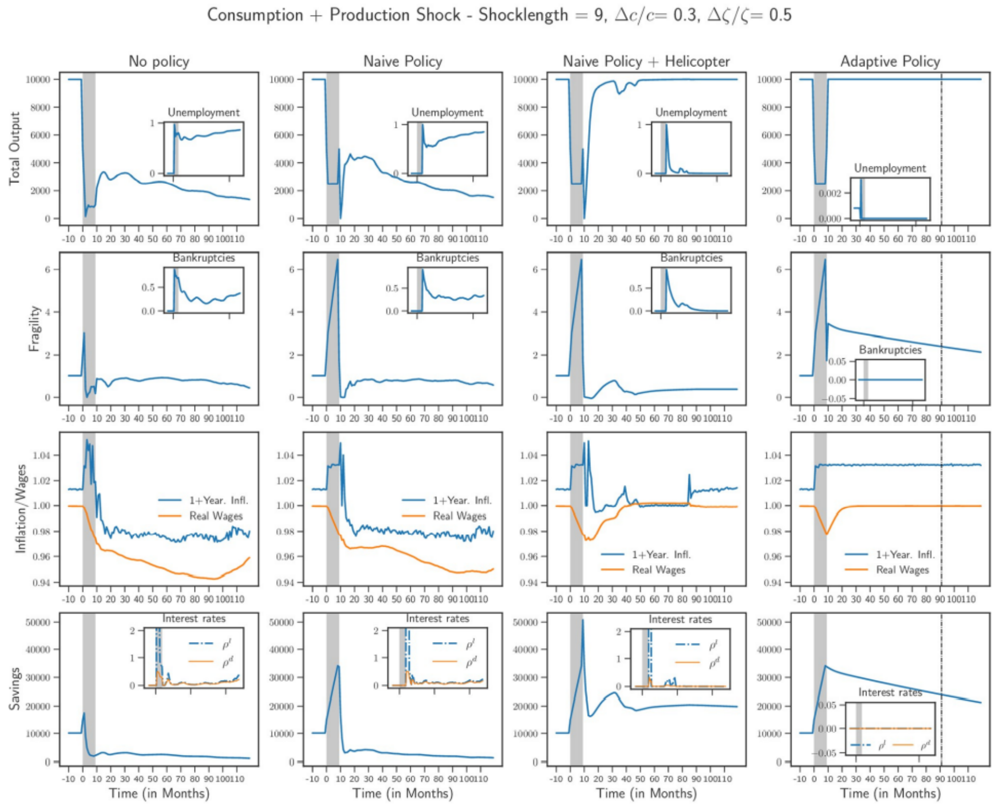


Figure 20: An example simulation from [33] model: there is a consumption and production shock, that lasts for nine months, and diminishes the consumption by 30% and production by 50%. The policies that are compared are: no policy, the policy that offer credit support just during the crisis and not after, the same, but with helicopter money, and the adaptive policy, that diminishes gradually the credit. This last seems the perfect choice.

4 COMPARING THEORY AND PRACTICE

In section 3.1, a simple epidemiological model is integrated with the fact of increased disease spreading through economic activities. Approaching this in a game-theoretical way, it can be seen that an individual limitation of the economic activity is a dominated strategy, and a Nash equilibrium exists precisely in a "lockdown-free" state, even if this is very far from Pareto optimum. Two different ways to set a Planner's problem in the model show that a containment and consumption compensation policy have a better outcome, with less deceased, but also a worse fall of consumption.

But people are not perfectly rational agents, and it is better so: introducing a reduction in social interaction dependent on epidemics spreading, as in [2], there is a sort of automatic containment, that, even if not "optimal", in the sense we have given, gives similar dynamics between countries that have implemented strict lockdown and countries that have not (in figure 21 the comparison of the two modeling approaches for United States). And this prescinding, in real policy-making, to changes in lockdown measures depending on the epidemic spread, that is an important feature of the model presented in 3.1, and that can be focused via the study of marginal analysis, so to tune the best policy [12].

Similar considerations are to be made on economic questions, in particular about the argued trade-off between health and economy, and the effective need of a lockdown-based containment policy (even with economic compensation), with its heavy economic and social impact (for a thorough study, see [1]).

Moreover, looking at the data, there seems to be not a trade-off between deaths and GDP loss. On the other side, looking at the linear regressions between deaths per million and GDP change, it appears that a greater deceased index correlates with greater losses in GDP in 2020. Examining advanced countries, and specifically the Q2-2020

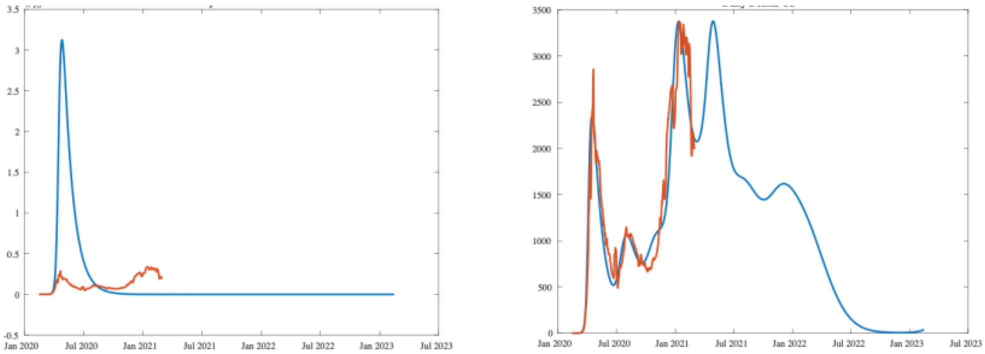
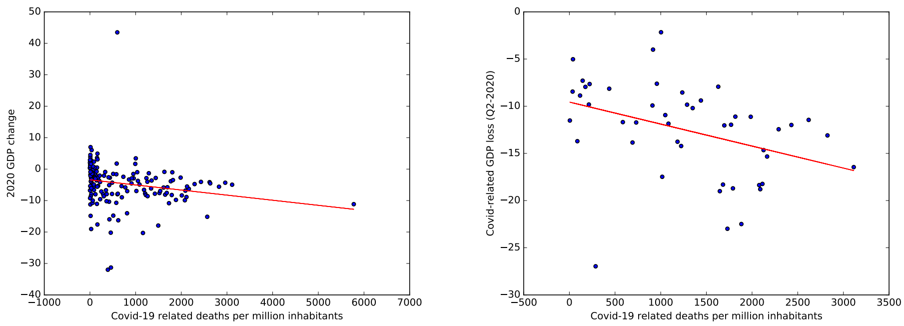


Figure 21: Predicted and Actual Daily Deaths for United States, where very limited lockdown was implemented. On left, using a SIR model. On right using [2] model, that includes a behavioural component.

Covid-related GDP difference respect to end 2019 forecasts, the slope is more pronouced and the result is more robust (fig. 22 e tab. 4).



(a) (b)

Figure 22: Deaths per million and GDP change respect forecasts, for 2020, for 174 economies (on the left), and for 57 advanced economies (on the right)

For what said in chapter 1, we will focus on the relation between policy intervention and evolution of GDP, for reasons of data availability, relative reliability and the fact that is a raw but effective instrument to evaluate the state of an economy, and in particular a post-crisis economic recovery.

We expect, from intuition and from models, that a greater investment correlates with better recovery. Actually, very partially it is so.

const	-3.4087***
	(0.6769)
DPM	-0.0016***
	(0.0006)
R-squared	0.0403
R-squared Adj.	0.0345

	GDPloss
const	-9.5605***
	(1.2666)
DPM	-0.0023***
	(0.0008)
R-squared	0.1475
R-squared Adj.	0.1285

Table 4: The linear regression summaries, in function of deaths per million due to Covid-19, on GDP change in 2020 for 174 economies (on the left) and on GDP change in Q2-2020 for 57 advanced economies (on the right).

Firstly, we can see the arguable fact that, for advanced economies, a greater loss in GDP due to Covid-19 in the second quarter of 2020 correlates with a greater investment in fiscal policies (figure 23). When the economy goes bad, an advanced economy has the instruments to react with a strong intervention, that can be a stabilizer (such as unemployment benefits) or an investment measure.

Unluckily, available data do not allow to distinguish promptly between these two main measures, that have, obviously, very different macroeconomic expected effects. It is to be noticed that most advanced economies have very low interest rates, and for zero-lower bound, and for what already said in chapter 2, it is not a surprise that strong fiscal intervention takes the place of main intervention measure, against monetary policy.[1]

After the first shock, looking at the consequent policy reaction, we could infer a correlation between the GDP recovery in the second part of 2020 and the fiscal spending. This in light of the previous argumentations, does not seem product of chance (figure 24).

Looking at yearly data, that I have available for most countries in the World, I can follow a similar analysis, on longer periods. As previously, in chapter 1, I study, more than the absolute value and the absolute dynamic, the difference in pro capite real GDP forecasts between the World Economic Outlook of IMF issued just before the Covid-19 crisis (end of 2019) and the last one, reindexing the first one to expected

1 For not advanced economies, the previous result could not be really compared, since the response has been mostly monetary, and only for a few of not advanced economies, reliable quarterly data, needed to perform a similar analysis, are available.

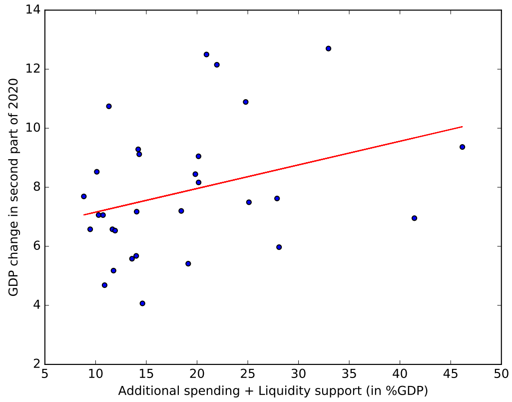


Figure 23: The sum of additional spending and liquidity support in percent of GDP, and the GDP loss in Q2-2020 for 30 advanced economies

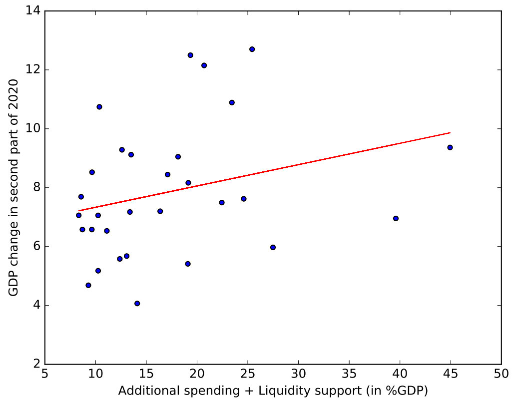


Figure 24: The sum of additional spending and liquidity support in percent of GDP, and the GDP recovery in the second part of 2020 for 30 advanced economies

inflation, to align the currency, and normalizing on 2019. In this way we can readily observe and compare different countries in their response to Covid, applying the – naturally simplifying assumption – that forecasts take into account every other characteristics, apart the epidemics and the relative economic reaction.

So, performing a linear regression between the total spending in fiscal policies and the GDP evolution for the next years, I obtain for advanced economies the results in table 5. Statistics are quite disappointing, but however I read that on average 1 additional point of GDP spent in 2020 on discretionary spending would result on 0.16 points of GDP more in 2022,0.19 points of GDP more in 2023 and 0.21 points of GDP more in 2024. Not so bad, for a mature economy.

The 2024 regression and the relative scatter plot are in figure 25.

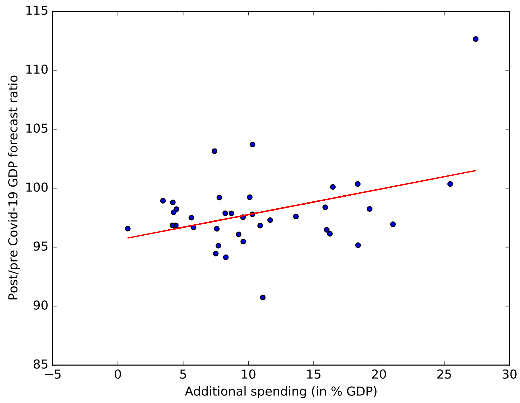


Figure 25: The sum of additional spending and liquidity support in percent of GDP, and the GDP recovery in the second part of 2020 for 30 advanced economies

	2022	2023	2024
const	95.1996***	95.5432***	95.6142***
	(0.8959)	(0.9674)	(1.0604)
TotSpending	0.1619**	0.1894**	0.2145**
	(0.0718)	(0.0776)	(0.0850)
R-squared	0.1267	0.1456	0.1538
R-squared Adj.	0.1017	0.1212	0.1297

Table 5: The linear regression results of discretionary spending as fiscal policy after the Covid-19 crisis, and the ratio (in percent) between 2019 forecast (adjusted to inflation) and 2021 forecast for 37 advanced economies. (Standard errors in parentheses. *: p<.1, **: p<.05, ***: p<.01)

While for emerging markets the regression is far less statistically robust (even below the – already non optimal – dimension we have seen), for low income developing countries this results appears again (table 6).

Interestingly, in this light, 1 additional point of GDP spent in 2020 on discretionary spending, on average, is forecasted to result on 0.87 points of GDP more in 2022, 0.98 points of GDP more in 2023 and 0.94 points of GDP more in 2024.

	2022	2023	2024
const	89.9294***	89.6726***	89.6279***
	(1.1084)	(1.2985)	(1.3994)
TotSpending	0.8711***	0.9834***	0.9485***
	(0.2767)	(0.3242)	(0.3494)
R-squared	0.1503	0.1411	0.1163
R-squared Adj.	0.1351	0.1258	0.1005

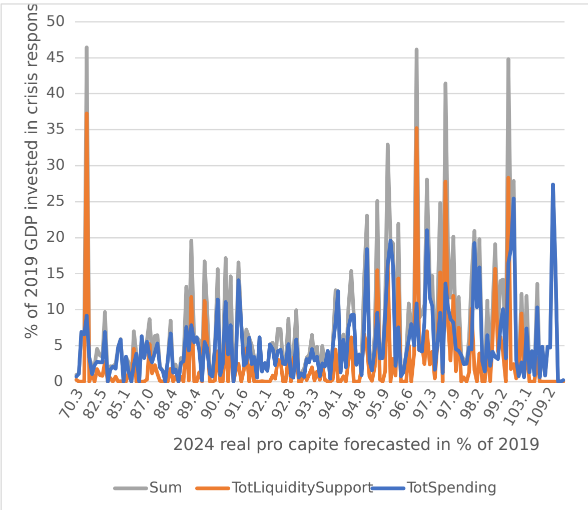
Table 6: The linear regression results of discretionary spending as fiscal policy after the Covid-19 crisis, and the ratio (in percent) between 2019 forecast (adjusted to inflation) and 2021 forecast for 58 low income developing countries. (Standard errors in parentheses. *: p<.1, **: p<.05, ***: p<.01)

As a concluding visualization of the impact of the presence of fiscal policy intervention on GDP recovery, I studied the frequency and the quantity of fiscal policy, in the list of economies ranked on improvement (or less worsening) of GDP forecasts for 2024 (figure 26a). It can be seen that countries, that in 2024 are forecasted to have a GDP greater than 94% of the 2024 forecast in 2019, have spent on average far more than countries that are forecasted to not recover. A similar result can be seen reordering the ranking on the difference between 2024 and 2020, imagining that the true effect of the fiscal intervention can be seen from 2021 on.[2] As it can be seen in figure 26b the trend of having greater investment on the right side remains.

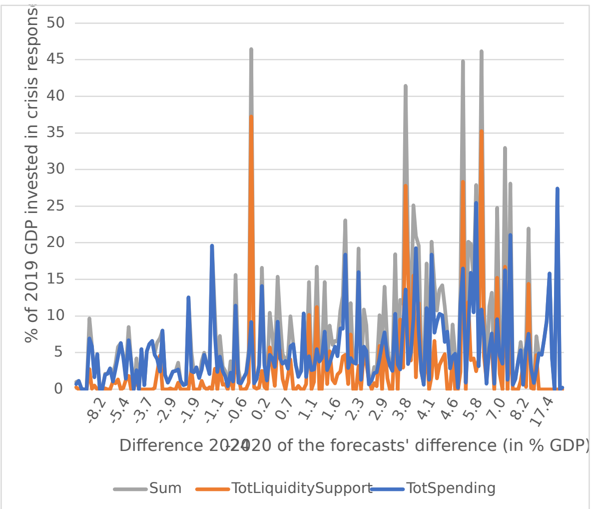
As a conclusion for this short survey of statistic argumentation, I want to shortly report that I tried with more sophisticated approach than the simple linear, too, but I obtained very low significant and consistent results, arguably due to the heterogeneity of the countries (of which I could not consider many features), and of the policies.

In light of what we have seen, in the case of an epidemic crisis like that we are living, intervention policies appear necessary to avoid an "L-

2 Naturally, many fiscal policies have had a first role in containing the shock, or have their effect right on the following months.



(a)



(b)

Figure 26: The level of fiscal intervention on 190 countries ranked by: (a) improvement of 2024 GDP forecast between 2021 and 2019, (b) difference in GDP change between 2024 and 2020. In both, the rightmost countries show, on average, highest levels of fiscal interventions.

shaped" crisis, and even under generous intervention, a net long-term loss of GDP is possible. Obviously, there is not only Covid in moving World economy: in the scores for highest-ranked countries in the last scales I have considered, there are Oil discoveries (as in French Guyana) and geopolitical factors (as in Libya and in Liberia), and among the lowest the reasoning is the same. But Covid has been a true World-impacting event, and most of the GDP change between 2019 and 2020 for most countries in the World is due to it.

5 CONCLUSION

We have seen that a recovery path can be inferred already now, eighteen months after the general outbreak of pandemic, and that can be useful to evaluate the right response to crisis.

We have considered, in this light, the Friedman's view of "plucking string"-like natural return of the output to its potential, discussing it, then, to face the actual loss in potential output that a serious shock can cause.

We have seen that unemployment is, for difference in society, for its dependence on policy-based factors and for discrepancies in accounting, a bad indicator for the evolution of the crisis.

We have then examined the particular role that fiscal policies have in addressing an epidemic crisis like the present one. In particular, their role in the "first aid" to the economy, to prevent plummeting and to safeguard a social and economic basis on which to build the recovery.

We have then considered the fiscal policies in their role of investment for the future, to build and consolidate a sustainable growth.

We have then studied two, very different, models, that have allowed us to think qualitatively on the different effects that a government intervention could have.

We have finally compared this qualitative results with actual data, finding some interesting consistence on the importance of economic intervention in the reshaping of the economy after the crisis.

It is however very optimistic to search for a direct link between policy and economic indicators on an heterogeneous landscape, as the whole world, with uncontrollable and various factors. Moreover, strong are the endogeneities: between policy and effects on short time evaluation it is easy to confound cause with effects.

It is then more interesting to focus on qualitative effects, and try to learn, even if only in economic terms, how to know right from wrong.

BIBLIOGRAPHY

[1] Douglas W. Allen. *Covid Lockdown Cost/Benefits: A Critical Assessment of the Literature*. 2021.

[2] Andrew Atkeson. *A Parsimonious Behavioral SEIR Model of the 2020 Covid Epidemic*. NBER Working Papers 28434. National Bureau of Economic Research, Inc, Feb. 2021. URL: https://www.nber.org/papers/w28434.

[3] Arthur Beesley. "Ireland's economy forecast to grow despite Covid shock". In: *Financial Times* (17th Dec. 2020).

[4] Michael D. Bordo and Joseph G. Haubrich. "Deep recessions, fast recoveries, and financial crises: Evidence from the American record". In: *Economic Inquiry* 55.1 (2017), pp. 527–541.

[5] Willem H. Buiter. "The Simple Analytics of Helicopter Money: Why It Works — Always". In: *Economics* 8.1 (2014), p. 20140028. DOI: doi:10.5018/economics-ejournal.ja.2014-28. URL: https://doi.org/10.5018/economics-ejournal.ja.2014-28.

[6] Bernard H. Casey. "Covid-19: Is there a trade-off between economic damage and loss of life?" In: *EUROPP – European Politics and Policy, London School of Economics* (18th Dec. 2020). URL: https://blogs.lse.ac.uk/europpblog/2020/12/18/covid-19-is-there-a-trade-off-between-economic-damage-and-loss-of-life/.

[7] Jagjit S. Chadha et al. *Monetary and fiscal complementarity in the Covid-19 pandemic*. Working Paper Series 2588. European Central Bank, Sept. 2021. URL: https://ideas.repec.org/p/ecb/ecbwps/20212588.html.

[8] Darrel S. Cohen and Glenn R. Follette. "The automatic stabilizers: Quietly doing their thing". In: *Federak Reserve, Finance and Economics Discussion Series (FEDS)* (2000).

[9] Tommaso Colussi. *IZA COVID-19 Crisis Response Monitoring - Italy*. Apr. 2020.

[10] Domenico Delli Gatti. "Agent Based Macroeconomics: An Introduction".

[11] Mathias Dolls, Clemens Fuest and Andreas Peichl. "Automatic stabilizers and economic crisis: US vs. Europe". In: *Journal of Public Economics* 96.3 (2012), pp. 279–294. ISSN: 0047-2727. DOI: https://doi.org/10.1016/j.jpubeco.2011.11.001. URL: https://www.sciencedirect.com/science/article/pii/S0047272711001642.

[12] Cam Donaldson and Craig Mitton. "Health economics and emergence from COVID-19 lockdown: the great big marginal analysis". In: *Health Economics, Policy and Law* (2020), pp. 1–5. DOI: 10.1017/S1744133120000304.

[13] Martin S Eichenbaum, Sergio Rebelo and Mathias Trabandt. *The Macroeconomics of Epidemics*. Working Paper 26882. Revised in April 2021. National Bureau of Economic Research, Mar. 2020. DOI: 10.3386/w26882. URL: http://www.nber.org/papers/w26882.

[14] Milton Friedman. "The 'Plucking Model' of Business Fluctuation Revisited". In: *Economic Inquiry* 31.2 (1993), pp. 171–177. DOI: https://doi.org/10.1111/j.1465-7295.1993.tb00874.x. eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1465-7295.1993.tb00874.x. URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1465-7295.1993.tb00874.x.

[15] Milton Friedman. "The Monetary Studies of the National Bureau". In: *The Optimum Quantity of Money and Other Essays*. Macmillan, 1969. Chap. 12, pp. 261–284. URL: http://abdet.com.br/site/wp-content/uploads/2014/12/Optimum-Quantity-of-Money.pdf.

[16] Milton Friedman. "The Optimum Quantity of Money". In: *The Optimum Quantity of Money and Other Essays*. Macmillan, 1969. Chap. 1, pp. 1–50. URL: http://abdet.com.br/site/wp-content/uploads/2014/12/Optimum-Quantity-of-Money.pdf.

[17] International Monetary Fund. *Fiscal Monitor Database of Country Fiscal Measures in Response to the COVID-19 Pandemic*. July 2021. URL: https://www.imf.org/en/Topics/imf-and-covid19/Fiscal-Policies-Database-in-Response-to-COVID-19.

[18] International Monetary Fund. *Fiscal Monitor: A Fair Shot*. Apr. 2021. URL: https://www.imf.org/en/Publications/FM/Issues/2021/03/29/fiscal-monitor-april-2021.

[19] International Monetary Fund. *Fiscal Monitor: Policies to Support People During the COVID-19 Pandemic*. Apr. 2020. URL: https://www.imf.org/en/Publications/FM/Issues/2020/04/06/fiscal-monitor-april-2020.

[20] International Monetary Fund. *IMF Data*. URL: https://data.imf.org/%22.

[21] International Monetary Fund. *Policy Tracker*. July 2021. URL: https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19.

[22] Stanislao Gualdi et al. "Monetary policy and dark corners in a stylized agent-based model". In: *Journal of Economic Interaction and Coordination* 12.3 (2017), pp. 507–537. ISSN: 1860-7128. DOI: 10.1007/s11403-016-0174-z. URL: http://dx.doi.org/10.1007/s11403-016-0174-z.

[23] Stanislao Gualdi et al. "Tipping points in macroeconomic agent-based models". In: *Journal of Economic Dynamics and Control* 50 (2015). Crises and Complexity, pp. 29–61. ISSN: 0165-1889. DOI: https://doi.org/10.1016/j.jedc.2014.08.003. URL: https://www.sciencedirect.com/science/article/pii/S0165188914001924.

[24] Veronica Guerrieri et al. *Macroeconomic Implications of COVID-19: Can Negative Supply Shocks Cause Demand Shortages?* Working Paper 26918. National Bureau of Economic Research, Apr. 2020. DOI: 10.3386/w26918. URL: http://www.nber.org/papers/w26918.

[25] Shaun P. Hargreaves Heap et al. "COVID-19 and people's health-wealth preferences: Information effects and policy implications". In: *Available at SSRN 3605003* (2020).

[26] William Ogilvy Kermack and Anderson G. McKendrick. "A contribution to the mathematical theory of epidemics". In: *Proceedings of the royal society of london. Series A, Containing papers of a mathematical and physical character* 115.772 (1927), pp. 700–721.

[27] James Morley. “The Shape of Things to Come”. In: *Macroeconomics’ Advisers, Macro Focus* 6 (4 Apr. 2009).

[28] OECD. *Quarterly GDP*. 2018. DOI: https://doi.org/https://doi.org/10.1787/b86d1fc8-en. URL: https://www.oecd-ilibrary.org/content/data/b86d1fc8-en.

[29] OECD. *Real GDP forecast*. Tech. rep. 2019. DOI: https://doi.org/https://doi.org/10.1787/1f84150b-en. URL: https://www.oecd-ilibrary.org/content/data/1f84150b-en.

[30] I.M.F. Research. *World Economic Outlook, April 2021*. World Economic Outlook. International Monetary Fund, Apr. 2021.

[31] I.M.F. Research. *World Economic Outlook, October 2019*. World Economic Outlook. International Monetary Fund, Oct. 2019.

[32] David Rodeck. *Understanding the Shape of a COVID-19 Recession*. 16th July 2020. URL: https://www.forbes.com/advisor/investing/covid-19-coronavirus-recession-shape/.

[33] Dhruv Sharma et al. “V-, U-, L- or W-shaped economic recovery after Covid-19: Insights from an Agent Based Model”. In: *PLOS ONE* 16.3 (Mar. 2021), pp. 1–22. DOI: 10.1371/journal.pone.0247823. URL: https://doi.org/10.1371/journal.pone.0247823.

[34] Louise Sheiner and Kadija Yilla. “The ABCs of the post-COVID economic recovery”. In: *Brookings Insitution* 4 (4th May 2020).