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Guillermo Peña *

* Department of Economic Analysis and IEDIS, University of Zaragoza, Spain

E-mail: gpena@unizar.es

Raising Interest Rates for Improving Income[1]

Abstract: This paper illustrates a case where an increase of the interest rates improves the economic activity and reduces income inequality. This theoretical exercise deals with a simple model of disequilibrium with accountant identities of budget constraints. In addition, and following previous models, the effect of the COVID-19 shock is considered, by reflecting asymmetric repercussions that increase income inequality. A simple empirical exercise confirms some of the previous results. The proposed explanation is that, for the euro area, this shock has affected more middle-income households such as the retailers harmed by the compulsory lockdown who have increased their debts.

Key words: Monetary policy, Income inequality, Financial sector, Black Swan, COVID-19, Unemployment.

JEL Code: E52, E25, E58, G21.

1. Introduction

The interest on the study of the main determinants of economic activity has increased in the last decades, especially since the beginning of the Great Recession, and even more after the "Great Lockdown" crisis derived from the COVID-19

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pandemic, which may lead to a *deglobalization* phenomenon (Zharikov, 2022). Just only the impact of negative nominal interest rates on the economy was a poorly studied issue until recent decades. This paper aims to explain the effects of an initial shift in initial zero-rated nominal interests and its effects on income inequality and economic growth. So, a simple model of one initial period and two alternative others are used. According to these results, there is a potential existence of a "reversal-rate" (Brunnermeier and Koby, 2019) of interest, maybe above zero, below which an increase of the official interest rate leads to a rise in the economic activity and a reduction in income inequality.

The existence of empirical evidence on the correlation between credit and economic inequality in association with a banking crisis is well-known (Perugini, Hölscher and Collie, 2015), previous to economic recessions. These authors find a positive association between distribution of income and private sector indebtedness, while Bordo and Meissner (2012) observe no relationship. Linking income inequality with monetary policy using empirical data, Lenza and Slacalek (2019) find that the European Quantitative Easing did not increase inequality in the euro area. According to them, it reduced income inequality, reduced the unemployment rate for low-income people and increased the wages of employed. Morset (2013) adapts a Ramsey-Cass-Koopmans model to incorporate wealth hoarding and price behaviour on assets. Through this, a negative correlation of inequality with real interest rates is obtained in the steady state, with a potential presence of asset bubbles.

Regarding the literature about negative interest rates, Abo-Zaid and Garín (2016) find the optimality of negative nominal interest rates in a New Keynesian model with money demand and financial frictions. Some other papers support the benefits of negative interest rates (Buiter, 2009). Nonetheless, Angrick and Nemoto (2017) show that this kind of policies have led to significant impacts on markets, financial conditions and expectations. They draw attention to potential adverse effects of the interaction of negative interest rates with the tight standards of liquidity and capital adopted since the Global Financial Crisis (GFC). In fact, negative nominal yields of Treasury bonds also appeared after other crises, such as the Great Depression during the 1930s (Cecchetti, 1987) or after the dotcom crisis in 2003 (Fleming and Garbade, 2004). Arce, García-Posada, Mayordomo & Ongena (2018) also advise about the adverse effects of negative interest rates on banks with low capitalization. On the other hand, they do not find evidence of a potential "reversal rate" that constrains the supply of credit. Yazdani and Nikzad (2021) also point that GDP losses can be decreased by monetary policies.

According to Borio and Gambacorta (2017), monetary policy is less effective in stimulating the growth of bank loans when interest rates reach a very low level. Going forward, Brunnermeier and Koby (2019) propose the existence of a reversal rate. As they state, in many models the economy enters into a liquidity trap due to assuming zero as a lower bound, but some central banks as the Bank of Japan have led money at negative market rates, getting into negative territory for a long period, without a relevant stimulus for the economy. They suggest the existence of a reversal interest rate, as the effective lower threshold in monetary policy, in which a decrease below it depresses rather than stimulates the economic activity. Heider, Saidi & Schepens (2019) confirm this fact through empirical analysis, in which negative rates in Europe after June 2014 induced banks with more deposits to lend rather to riskier borrowers, leading to a higher volatility and a reduction in lending. It would confirm the presence of a reversal rate.

In this paper we suggest that this reversal rate could be positive, and that an increase below this reversal rate could even increase the economic activity. Indeed, empirical evidence as Taylor (2009) or Peña (2017) suggests that in some advanced countries a raise in the interest rates before the GFC would have reduced the likelihood of banking crises, and their repercussions to the economic activity.

Amzallag, Calza, Georgarakos & Sousa (2019) suggest a justification for a possible pass-through of rate changes to negative interest rates for deposits by the banks, especially when they are well-capitalized, using European banking data. The next section will show that negative interest rates could lead to withdrawals of deposits, which would lead to a contractive effect of economic activity. Arce et al. (2018) also alert on the adverse effects of negative interest rates on low capitalized banks. On the other hand, they do not find evidence that the reversal rate hurts the supply of credit.

Chetty (2007) shows that, in a context of uncertainty and low interest rates, raising the interest rate increases investment by raising the cost of delay in the acquisition of information. Even without uncertainty, investment could raise with an increase in interest rates below the reversal interest rate. Other papers have highlighted the importance of risk in the context of negative rates. Basten and Mariathasan (2018) analyse the effect of negative monetary policy rates on Swiss banks, finding their high fee and interest income to compensate adverse consequences, but there is an increase of credit and interest rate risk, which reduces capital and liquidity. Nucera, Lucas, Schaumburg & Schwaab (2017) also find that policy rate cuts of negative sign trigger different bank's propensity to become undercapitalized in a financial crisis than an earlier cut to zero. Furthermore,

low interest rates can affect the sensitivity of profits to interest rates, as Claessens, Coleman & Donnelly (2018) show empirically and theoretically. In the case of low interest rates, usual prices policies are less effective, but Quantitative Easing (QE) may be a good substitute (Kiley, 2018). Some authors have considered the viability of an optimal positive quantity of money issue by central bankers (Friedman, 1969, Gomis-Porqueras & Sun, 2020).

Recently, Lee and Werner (2022) have put into question the well-known interest rate thesis that holds that lower interest rates are associated with a higher economic growth. They perform a time-varying dynamic analysis of the conditional correlation between both variables within a GARCH model, also analysing the direction of the statistical causation for 19 high-income and emerging countries. The results of their exercise show no evidence for the aforementioned thesis, they observe, in fact, the opposite relationship in both exercises. So, lowering interest rates can damage economic activity when trying to reactivate the real economy. Furthermore, Deryugina, Guseva & Ponomarenko (2022) have found that natural interest rate may tend to increase before a credit cycle peak and decrease afterwards. These empirical exercises add some doubts to recent theoretical models. The present paper provides an example of basic framework for explaining raising interest as a possible stimulus for the economy in low-interest rates environments, in contrast to the wide theoretical framework in which this possibility is not usually allowed.

The article is divided as follows. Section 2 develops a theoretical model that analyses the fact of rising interest rates for improving income. Section 3 analyses previous results and incorporates the COVID-19 shock and studies its effects, which results are discussed in Section 4 and, in addition, a simple empirical exercise is proposed. Finally, Section 5 ends the paper with some concluding remarks.

2. The dynamic exogenous model

This section develops a new theoretical framework, fundamentally based on Peña (2021), who develops a set of models for fiscal policy after an exogenous shock, but adapted to monetary policy and expanded in some questions, and additionally simplifying other issues that are not so relevant for this paper. Peña only studies the effects on the economy of a "black swan", an extraordinary and unpredictable effect like COVID-19, by studying its effects on economic activity and income inequality, showing an economic crisis and the raise of income inequal-

ity. The model proposed here assumes similar hypotheses as in Peña (2021),[2] but reflects the effects of a shift of real interest rates from zero to negative and positive and its effects on income inequality and economic activity. It is one of the first frameworks, if not the first one, that finds that an increase on the real interest rates could increase the economic activity in a theoretical model in which negative interests are considered and where results are empirically confirmed with real-timely data.

Following Peña (2021), consumers, which are families or households, provide capital to firms and banks, since they are the owners of the banks (household/consumers type 1, who work in the firm), and firms (household/consumers type 2, who work in the bank). The capital income for the households also follows the specification of Peña, as will be seen later, and depends on the pure interest rate, interest without fees, which is related to the reference interest rate. This capital has the banking sector as intermediary, which reallocates it between the bank itself and the firm in the form of investment. Banks also provide deposits to households 1, loans to consumers 2, in addition to the investment to the non-financial firm. The initial endowments of capital, credit and savings in the form of deposits are provided at the beginning of the initial period. The initial wages for households 1 and 2 are the same. At the end of period t=0, consumers "1" own the next budget constraint:

$$BC_0^1 = w_0^1 l^1 + R \cdot S^1 + \varepsilon_0 A^1 - C^{P1} = 0 \tag{1}$$

Being BC_t^i the budget constraint of the consumers i in period t, where no period in any variable indicates the variable remains constant on time. The wages and salaries are represented by w, the labour hours by l, the interest rate of the savings that the consumers obtain at the beginning of the period $t = 0$ is R, where S^i is the initial deposit amount of the savings of household i. The interest rate of the bonds A_t^i is equal to ε, and C^{Pi} is the real consumption of goods by household i. Assets from households 1 and 2 are bonds. Consumers 2 own the next constraint in their economic budget:

$$BC_0^2 = w_0^2 l^2 - r \cdot D^2 + \varepsilon_0 A^2 - C^{P2} = 0 \tag{2}$$

[2] The main assumptions following this author are, first, nobody is seeing their budget constraints reduced thanks to the financial sector, maintaining their purchasing power. Second, only monetary policy as government instrument is followed in the proposal, in contrast to Peña (2021), who only takes into account fiscal policy. Finally, an asymmetric shock of the COVID-19 between households is considered.

being D^2 the debt (credit/loan) permitted to borrow by the financial institution to consumers 2. They have to return loan interests with a lending rate at *r*. Next, the profits of the non-financial businesses are shown, which fulfil the following equation all periods:

$$\Pi_2^f = \Pi_1^f = \Pi_0^f = C^{P1} + C^{P2} - iK - w_0^1 l^1 = 0 \tag{3}$$

The investment of the firm is equal to the capital (*K*) purchased to banks by an interest of *i*. Hence, firms behave the same way during all periods. The financial sector faces the next equation of profits:

$$\Pi_0^b = r \cdot D^2 - \varepsilon_0 BM + iK - R \cdot S^1 - w_0^2 l^2 = 0 \tag{4}$$

On the other hand, the public sector fulfils the next equation, *BM* being the monetary base:

$$\varepsilon_0 A^1 + \varepsilon_0 A^2 = \varepsilon_0 BM \tag{5}$$

On this first period $t = 0$, income inequality is, assuming that $A^1 < A^2$ and zero real interest rates:

$$\begin{aligned} &t = 0 : \varepsilon_0 = 0 \Rightarrow \varepsilon_0 A^1 = \varepsilon_0 A^2 \Rightarrow \\ &\phi_0 = \left(w_0^1 l^1 + R \cdot S^1 + \varepsilon_0 A^1 - w_0^2 l^2 + r \cdot D^2 - \varepsilon_0 A^2 \right)^2 \\ &= \left(R \cdot S^1 + r \cdot D^2 \right)^2 > 0 \end{aligned} \tag{6}$$

Income inequality is defined with ϕ_t as the square of the difference between income of both households at the current period.

At period $t = 1$, real interest rates are shift to negative, and banks benefit from less funding costs, obtaining profits (P_1) and rising the wages of household 2 (w_1^2):

$$\Pi_1^b = r \cdot D^2 - \varepsilon_1 BM + iK - R \cdot S^1 - w_1^2 l^2 = P_1 \tag{7}$$

Banks allocate the reduction of cost because of the decrease on the official interest rates by giving dividends to the owners (household 1) and increasing the wages and salaries in the same amount (household 2).

Consumers 1 are the owners of the bank, and then they receive the profits from the bank, keeping their purchase power. They afford this budget constraint in period $t = 1$:

$$BC_1^1 = w_0^1 l^1 + R \cdot S^1 + \varepsilon_1 A^1 + P_1 - C^{P1} = 0 \tag{8}$$

It can be seen that $P_1 = \varepsilon_0 A^1 - \varepsilon_1 A^1$. Households 2 deposit all the increase of asset gains on the bank, reaching this constraint in the current period:

$$BC_1^2 = w_1^2 l^2 - r \cdot D^2 + \varepsilon_1 A^2 - C^{P2} = 0 \tag{9}$$

Where $\Delta w_1^2 l^2 = \varepsilon_0 A^2 - \varepsilon_1 A^2$.

Therefore, income inequality remains positive but is reduced.

$$\begin{aligned} &t = 1 : \varepsilon_1 A^1 > \varepsilon_1 A^2, \left(\left|\varepsilon_1 A^1\right| < \left|\varepsilon_1 A^2\right|\right) \Rightarrow \\ &\phi_1 = \left(w_0^1 l^1 + R \cdot S^1 + \varepsilon_1 A^1 + B_1 - w_1^2 l^2 + r \cdot D^2 - \varepsilon_1 A^2\right)^2 \\ &= \left(R \cdot S^1 + \varepsilon_1 A^1 + r \cdot D^2 - \varepsilon_1 A^2\right)^2 < \phi_0 \end{aligned} \tag{10}$$

In the next period, $t = 2$, public sector increases official interest rates from zero. Due to the increase in real interest rates, households earn more income, and both of them save the difference in order to maintain the same purchase power. According to that, household 1 faces to:

$$BC_2^1 = w_0^1 l^1 + R \cdot S^1 - S_2^1 + \varepsilon_2 A^1 - C^{P1} = 0 \tag{11}$$

On the other hand, consumers 2 reach this other budgetary constraint:

$$BC_2^2 = w_0^2 l^2 - r \cdot D^2 + \varepsilon_2 A^2 - S_2^2 - C^{P2} = 0 \tag{12}$$

At period $t = 2$, the profits for the banking sector are:

$$\Pi_2^b = r \cdot D^2 + S_2^1 + S_2^2 - \varepsilon BM + iK - R \cdot S^1 - w_0^2 l^2 = 0 \tag{13}$$

Due to the rise in interest rates, income inequality in this period is:

$$\begin{aligned} &t = 2 : \varepsilon_2 A^1 < \varepsilon_2 A^2 \Rightarrow \phi_2 = \left(w_0^1 l^1 + R \cdot S^1 + \varepsilon_2 A^1 - w_0^2 l^2 + r \cdot D^2 - \varepsilon_2 A^2\right)^2 \\ &= \left(R \cdot S^1 + \varepsilon_2 A^1 + r \cdot D^2 - \varepsilon_2 A^2\right)^2 < \phi_1 < \phi_0 \end{aligned} \tag{14}$$

which is the lowest one at this period:

$$\phi_2 < \phi_1 < \phi_0 \tag{15}$$

Following on the previous equations, the Gross Domestic Product (GDP) expressions for each period are formulated and compared. These expressions are calculated by summing the income of households 1 and 2:

$$GDP_0 = w_0^1 l^1 + R \cdot S^1 + \varepsilon_0 A^1 + w_0^2 l^2 - r \cdot D^2 + \varepsilon_0 A^2 \tag{16}$$

$$\begin{aligned} GDP_1 &= w_0^1 l^1 + R \cdot S^1 + \varepsilon_1 A^1 + P_1 + w_1^2 l^2 - r \cdot D^2 + \varepsilon_1 A^2 \\ &= w_0^1 l^1 + R \cdot S^1 + w_0^2 l^2 - r \cdot D^2 = GDP_0 \end{aligned} \tag{17}$$

$$GDP_2 = w_0^1 l^1 + R \cdot S^1 + \varepsilon_2 A^1 + w_0^2 l^2 - r \cdot D^2 + \varepsilon_2 A^2 > GDP_1 = GDP_0 \tag{18}$$

As observed, the highest GDP is achieved in period 2, confirming that the raising of interest rates from a zero bound may increase economic activity.

3. Comparative statics and COVID-19 effects

The main questions that are debated in this section are, first, the impact of an additional increase of interest rates on GDP, second, the same effect but on income inequality. Finally, following previous literature, the next derivations show the effect on income inequality of prices-based (on the interest rate) monetary policies after the COVID-19 pandemic, and the asymmetric impacts on the different agents.

The main assumptions for these analyses are the following. First, the economy is currently static at period 2. Second, initial reference interest rates are positive, but close to zero. Third, and derived from this, there is a rigidity in financial prices, lending and deposit interest rates, due to reference rates close to zero, with a decrease that is small in amount.

The set of comparative statics begins with the analysis of the impact of the pure interest rate ε_2 on GDP (equation 18), so the derivative of the national income respect to the reference rate is provided:

$$\frac{\partial GDP_2}{\partial \varepsilon_2} = A^1 + A^2 > 0 \tag{19}$$

It is clearly positive, so an increase on the reference rates "always" leads to a rise in national income, given the previous conditions. It is worth to remark that this is a case in which the interest rate is close to zero. In addition, a rigidity on lending and deposit rates is considered, feasible with the small shift of the rates. This rigidity of prices leads them to be considered as independent from the reference rate, which is the reason for their derivatives respect to the rate to be zero. If there were no rigidity on prices, the impact would be, analytically:

$$\frac{\partial GDP_2}{\partial \varepsilon_2} = \frac{\partial R}{\partial \varepsilon} \cdot S^1 + A^1 - \frac{\partial r}{\partial \varepsilon} \cdot D^2 + A^2 >< 0 \tag{20}$$

It is also clear that, for instance, if the interest rate were even higher, and therefore it is realistic to consider un-rigidity of these prices in this case, the effect of reference rates on income would not be so clear as in (19), with the possibility of changing the conditions for the variables in order to reach a positive or negative impact of rates on income, as in the previous expression (20). It is possible to achieve a negative sign in this case after taking into account at least two appreciations. First, loan amounts are usually higher than deposit ones, and second, it can be also considered that, after an enough positive increase of the reference rates, the increase of lending interest rates may be even higher. It is also remarkable to point that it is quite probably that the effect of pure interest rates was higher on lending interest rates than on deposit rates.

The same case is for the impact on income inequality, with the last variable given in expression (14). Under the same hypotheses and assumptions, the derivative of reference interest rates on income inequality would be given by:

$$\frac{\partial \phi_2}{\partial \varepsilon_2} = 2\left(w_0^1 l^1 + R \cdot S^1 + \varepsilon_2 A^1 - w_0^2 l^2 + r \cdot D^2 - \varepsilon_2 A^2\right)\left(A^1 - A^2\right) < 0 \tag{21}$$

The reason is that the factor after the scalar "2" is positive and that the household type 2 is the owner with the highest endowment of assets. The same additional comments can be made respect to the rigidity of lending and deposit rates.

The second part of this section considers the potential effects on income inequality of monetary policy during the current economic crisis provoked by the lockdown and the black swan of the COVID-19. The asymmetric effects of the COVID-19 in the different agents are based on the capital shocks of the simple model developed in Peña (2021). In this model, an endowment shock of the black swan is reflected as the capital income plus a negative shock u_2, which is the same for all the agents and an asymmetric shock, γ_2^i, which is different for each agent i and is negative, between minus one and zero.

So, now income inequality of period 2, after a shock like the COVID-19 with a lockdown of the economic activity, leads to:

$$\begin{aligned} \phi_2 &= \left(R \cdot S^1 + \varepsilon_2\left(1 + \gamma_2^1 + u_2\right)A^1 + r \cdot D^2 - \varepsilon_2\left(1 + \gamma_2^2 + u_2\right)A^2\right)^2 \\ &= \left(R \cdot A^1 + \varepsilon_2\left(1 + \gamma_2^1 + u_2\right)A^1 + r \cdot A^2 - \varepsilon_2\left(1 + \gamma_2^2 + u_2\right)A^2\right)^2 \end{aligned} \tag{22}$$

In the previous expression, the equality $A^2 = D^2, A^1 = S^1$ is assumed for the sake of simplicity. So, after simplifying and establishing groups:

$$\phi_2 = \left(\varepsilon_2\left[\left(1+\gamma_2^1+u_2\right)A^1 - \left(1+\gamma_2^2+u_2\right)A^2\right] + R\cdot A^1 + r\cdot A^2\right)^2 \tag{23}$$

Next, the derivative of income inequality respect to the pure interest rate is obtained in order to theoretically suggest the relationship between both variables when reference rates are positive but not so big in amount, and the increase is also small:

$$\frac{\partial\phi_2}{\partial\varepsilon_2} = 2\cdot\Theta\left(\varepsilon_2\cdot\Theta + R\cdot A^1 + r\cdot A^2\right) \tag{24}$$

Where $\Theta = \left(1+\gamma_2^1+u_2\right)A^1 - \left(1+\gamma_2^2+u_2\right)A^2$, and the impact is positive ($\partial\phi_2 / \partial\varepsilon_2 > 0$) in this case with the exception of being negative if, and only if:

$$\frac{\partial\phi_2}{\partial\varepsilon_2} < 0 \Leftrightarrow \left(1+\gamma_2^1+u_2\right)A^1 < \left(1+\gamma_2^2+u_2\right)A^2 \wedge \varepsilon_2\cdot\Theta < R\cdot A^1 + r\cdot A^2 \tag{25}$$

The second condition is always fulfilled, but the first condition leads to the following expression:

$$\frac{\partial\phi_2}{\partial\varepsilon_2} < 0 \Leftrightarrow \frac{1+\gamma_2^1+u_2}{1+\gamma_2^2+u_2} < \frac{A^2}{A^1} \tag{26}$$

Both sides of the inequality are higher than one if $\left|\gamma_2^1\right| < \left|\gamma_2^2\right|$. This case, which we will denominate as case A, is when a black swan affects more to the households that are not the ones with the lowest income (they are middle-classes, for instance) but they have to borrow, so they are the tenants of the loans. The case B is going to be seen right now.

Next, it is considered that the agents with the lowest income, households 1, are the borrowers instead of consumers type 2, and the last ones are now the depositors. So, equations (11) and (22) would change into:

$$\begin{aligned}\phi_2' &= \left(-r\cdot D^1 + \varepsilon_2\left(1+\gamma_2^1+u_2\right)A^1 - R\cdot S^2 - \varepsilon_2\left(1+\gamma_2^2+u_2\right)A^2\right)^2 \\ &= \left(-R\cdot A^1 + \varepsilon_2\left(1+\gamma_2^1+u_2\right)A^1 - r\cdot A^2 - \varepsilon_2\left(1+\gamma_2^2+u_2\right)A^2\right)^2\end{aligned} \tag{27}$$

with the derivative or expected impact being as follows:

$$\frac{\partial \phi_2'}{\partial \varepsilon_2} = 2 \cdot \Theta \left(\varepsilon_2 \cdot \Theta - R \cdot A^1 - r \cdot A^2 \right) \tag{28}$$

The impact is negative ($\frac{\partial \phi_2}{\partial \varepsilon_2} < 0$) by the given conditions with the exception of being positive if, and only if:

$$\frac{\partial \phi_2'}{\partial \varepsilon_2} > 0 \Leftrightarrow \left(1 + \gamma_2^1 + u_2\right) A^1 < \left(1 + \gamma_2^2 + u_2\right) A^2 \tag{29}$$

So, the previous expression can be formalized as:

$$\frac{\partial \phi_2'}{\partial \varepsilon_2} > 0 \Leftrightarrow \frac{1 + \gamma_2^1 + u_2}{1 + \gamma_2^2 + u_2} < \frac{A^2}{A^1} \tag{30}$$

This result is positive always that $\left|\gamma_2^1\right| > \left|\gamma_2^2\right|$, because the second term on the right side of the inequality is higher than one, and the first one would be lower than one in this case. This is denominated as case B, where the consumers with the lowest income are the most affected by the crisis and they have to borrow. In this case, raising reference interest rates would lead to higher inequality (Piketty, 1997).

4. Discussion of the results and empirical evidence

Traditional economic crises are located in the case B because the group of people more affected by the crisis is usually a low-income class who have to borrow. Nonetheless, in the COVID-19 pandemic, and mainly due to the lockdown, the case A could be considered to be in force, because the most affected people were middle-income people as small entrepreneurs of retail that were forced to close for a while, and then, to borrow in order to keep their businesses. So, during the COVID time, rising interest rates could have led to an improvement in the income inequality indicator.

For empirically analysing these facts, data from the Central Bank Data Warehouse[3] is used, concretely, the monthly interest rate of deposits and lending for 16 European countries during the period 2006M1 to 2021M1, also using data of unemployment rate and inflation for the same source, countries and period. Table 1 presents the sample and Table 2 summarizes the main statistics of the variables.

[3] https://sdw.ecb.europa.eu/

Table 1: Data sample

Countries (16) from 2006M1 to 2021M1		
Austria	Belgium	Germany
Estonia	Spain	Finland
France	Ireland	Italy
Lithuania	Luxembourg	Netherlands
Portugal	Slovenia	Slovakia
	Greece	

Table 2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
epsilon	2896	2.415665	1.353059	-0.0605835	5.966942
unem	2880	9.156764	4.918861	2.963582	28.95177
hicp	2896	1.697617	1.786929	-2.9	12.7

The empirical exercise consists on studying the empirical correlations of the variables with the reference rate, estimated according to López-Laborda and Peña (2018):

$$\varepsilon_0 = \frac{2 \cdot r \cdot R}{r + R} \tag{31}$$

The empirical models employ the OLS techniques and the panel data pool and Fixed Effects (FE) models. Additionally, a Granger-causality test is performed in order to see which variables lead to each other. The *epsilon* variable is the reference rate estimated following the "pure" interest rate (rate without fees for risk) of expression (31), *unem* is the unemployment rate, and *hicp* is the harmonized consumer prices of the European Union.

Results of the econometric models are shown in Tables 3-5. The methodology is the following: three models (OLS, pool and FE) are estimated for the next cases: first, the impact of the reference rate on unemployment (Table 3) and inflation (Table 4) is assessed, and after that the impact on inflation on unemployment (Table 5) is studied. For achieving this target, the sample has been divided into the full sample and the COVID-19 sample (since 2020M03, when the lockdown started in most countries).

Table 3: Results for unem as dependent variable

Methodology	OLS	Pool	FE	OLS	Pool	FE
Dependent variable	*unem*	*unem*	*unem*	*unem*	*unem*	*unem*
Sample	Full	Full	Full	COVID19	COVID19	COVID19
Epsilon	0.220***	0.031	0.030	-1.844***	-1.427**	-1.365**
p-value	0.001	0.498	0.508	0	0.016	0.032
Constant	8.625***	9.068***	9.080***	9.311***	9.006***	8.896***
p-value	0	0	0	0	0	0

Note: Significance at 1% ***, 5% **, 10% * levels.

Table 4: Results for hicp as dependent variable

Methodology	OLS	Pool	FE	OLS	Pool	FE
Dependent variable	*hicp*	*hicp*	*hicp*	*hicp*	*hicp*	*hicp*
Sample	Full	Full	Full	COVID19	COVID19	COVID19
Epsilon	0.575***	0.607***	0.608***	0.362**	0.682**	1.139**
p-value	0	0	0	0.013	0.038	0.025
Constant	0.309***	0.232	0.229***	-0.278*	-0.555	-0.951**
p-value	0	0.155	0	0.059	0.126	0.031

Note: Significance at 1% ***, 5% **, 10% * levels.

Table 5: Results for unem as dependent variable and hicp as explanatory

Methodology	OLS	Pool	FE	OLS	Pool	FE
Dependent variable	*unem*	*unem*	*unem*	*unem*	*unem*	*unem*
Sample	Full	Full	Full	COVID19	COVID19	COVID19
hicp	-0.371***	-0.533***	-0.533***	-1.698***	-0.151	-0.122
p-value	0	0	0	0	0.134	0.224
Constant	9.788***	10.049***	10.064***	7.794***	7.770***	7.718***
p-value	0	0	0	0	0	0

Note: Significance at 1% ***, 5% **, 10% * levels.

The coefficient and the p-value appear in each table. Results of Table 3 show that the reference rate usually positively impacts on unemployment, but not always being statistically significant. Nonetheless, this impact turns into negative when the COVID-19 sub-sample is considered, and it is always significant. This means that, while in general the official interest rates hurts the employment of the economy, during the COVID times an increase in the interest rates would reduce un-

employment, and then, help to reduce inequality because they are proxies (Cysne, 2009; Peña, 2021). According to this, it is empirically checked that rising reference rates could improve the economy during the COVID-19 pandemic, as in the B case of equation (29), because the most affected people in this pandemic have been small businesses that had to borrow, at least at the beginning, instead of the lowest-income people.

In addition, Table 4 shows that in the crisis, when there was low inflation, or even sometimes deflation, a rise in the interest rates could increase inflation towards the usual rates, as the positive and significant sign of the coefficient of epsilon shows in all the models. Finally, it is worth to highlight that, in the lax period that we are analysing (since 2006) and including the COVID times, a slight increase in inflation may improve unemployment (and, consequently, income inequality) as the negative and significant sign of the coefficient of *hicp* over *unem* shows in Table 5.

The results of the Granger-causality are shown in Table 6, which analyse whether the null hypothesis of one variable leading to another can be rejected according to the p-value, but also the presence of interferences as Peña (2020) proposes: it takes the lowest p-value for each country between the two directions of the causality, and expresses the average. Furthermore, a "single interference" is analysed but taking the lowest p-value of the interferences between the two studied periods: full lax period of the sample or only COVID-19 pandemic times. The results are conclusive: there are interferences among inflation, unemployment and reference rates, in the two samples for the interferences between inflation and reference rates, in unemployment and rates for the full sample and for unemployment and inflation during the COVID-19 times. This means that in both samples the impact of the rates on inflation can be considered as immediate and direct, while the impact on unemployment (and hence, on income inequality) may be considered as direct for the full sample and indirect via inflation for the COVID-19 times.

Table 6: Results of the Granger-causality test

	eps GC unem		unem GC eps		Interferences		Single Interferences	
	p-value	Reject?	p-value	Reject?	p-value	Reject?	p-value	Reject?
Full sample	0.164	0.625	0.247	0.500	**0.056**	**0.750**	**0.030**	**0.875**
COVID-19 sample	0.348	0.375	0.260	0.313	0.150	0.625		
	eps GC hicp		hicp GC eps		Interferences		Single Interferences	
	p-value	Reject?	p-value	Reject?	p-value	Reject?	p-value	Reject?
Full sample	0.203	0.625	0.122	0.625	**0.059**	**0.813**	**0.017**	**0.938**
COVID-19 sample	0.342	0.188	0.285	0.500	**0.098**	**0.688**		
	unem GC hicp		hicp GC unem		Interferences		Single Interferences	
	p-value	Reject?	p-value	Reject?	p-value	Reject?	p-value	Reject?
Full sample	0.460	0.302	0.427	0.271	0.389	0.719	**0.047**	**0.750**
COVID-19 sample	0.342	0.188	0.285	0.500	**0.098**	**0.688**		

Note: the term "Reject?" refers to the number of countries with rejection over the countries of the sample

5. Concluding remarks

Traditional economic crises are located in the aforementioned case B, where low-income consumers are the most damaged by the economic crisis and they have to borrow. Nonetheless, in the COVID-19 pandemic, and mainly due to the lockdown, we refer to the above case A where the economic crises do not hurt the highest- or lowest-income households. It is worth reminding that the denominated case A is when an exogenous shock as a black swan affects more to the middle-income rather than lowest-income households but they are new tenants of the loans since they have to borrow. This case could be considered to be in force during the pandemic crisis in most countries, because mainly the most affected people are middle-income people as small entrepreneurs of retail that have been forced to close for a while, and then, to borrow in order to keep their businesses. So, during the COVID times, raising interest rates could lead to an improvement in the income inequality indicator.

This paper provides theoretical support to recent empirical evidence that lowering interest rates is not always associated with, or not always Granger causes, higher economic growth. In fact, raising reference interest rates may lead to an improvement of economic activity and income inequality via unemployment in some cases in the low-interest rates environment, as the proposed model shows. Concretely, this works for economic crises as the one provoked by the lockdown

during the recent COVID-19 pandemic when middle-income people, the small retail owners, had to close their businesses for a while and borrow in order to maintain their jobs and way of life.

The paper first shows an initial status quo of low (zero) interest rates as are recently applied in most countries. Results show how a shock on real interest rates different than zero can reduce income inequality and this reduction in income inequality is higher if the turn is up, when there is a rigidity in financial prices. When real interest rates increase to positive, GDP (t=2) is the highest. Furthermore, a reduction of the interest rate to negative leads to a decrease in income inequality, but lower than a shift to positive; and the same level of economic activity as the zero rate, as the equality of GDP on t=0 and t=1 expresses in equation (18).

Second, the paper analyses the impact of the COVID-19 crisis on the main variables when there is no rigidity of prices. This leads to a situation where income inequality raises by rising real interest rates and whether the most affected group by the crisis applies for a loan and it is not the group with the lowest income. This happened during the recent COVID-19 crisis, when many small retailers, not the lowest-income people, have been the most affected agents by the economic crisis in developed countries, asking for credit. This last situation is confirmed with monthly data from the European Central Bank from 2006M01 to 2021M01 for 16 European countries and it is shown that, during the COVID-19 times, rising reference interest rates is correlated with reducing unemployment and lower disinflation than the contemporary excessive low inflation. After applying the Granger test, interferences are observed between the reference rates and the rate of unemployment via inflation.

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