**Appendix: Pandemic recession, helicopter money and political pressure**

What happened in Venice in the period 1629-31 can be also described using a model, applying and modifying the theoretical settings introduced in Masciandaro and Passarelli (2019), Masciandaro (2020) and Favaretto and Masciandaro (2021).

*1. The policymaker*

The economy consists of a population of inhabitants, and a policymaker that controls both fiscal and monetary policies. In the case of Venice, the Senate represents the incumbent policymaker. Initially we use the standard assumption that the policymaker is a benevolent player (Acemoglou *et al.* 2020; Argente *et al.* 2020; Brotherhood *et al.* 2020; Glover *et al.* 2020). This assumption will be modified later. All players are rational and share the same information; they maximize their utility in a simultaneous and one-shot way. Moreover, the population size is one, so total and per-capita amounts are the same for all the variables.

Since the population size is one, maximizing the utility of the average representative inhabitant amounts to maximizing social welfare. Without macroeconomic shocks, fiscal monetization is not needed. In Venice in normal times the Republic produced systematic fiscal surpluses. If a pandemic and/or famine occurs, the policymaker sets their economic policies to maximize social welfare. Venice was hit by an adverse macroeconomic shock from April 1629 – when a famine started – to September 1631 – when an outbreak of bubonic plague ended.

A pandemic shock triggers a special recession, because inhabitants’ incomes can be hit in a heterogeneous way for three reasons. First, the effects of both the disease and the corresponding public policies are unequally distributed (Glover 2020; Bloom et al. 2021). Second, the less the policymaker is involved in supporting the economy during the pandemic recession through fiscal transfers, the more likely are negative second-round effects on the well-functioning of the economic and financial system after the pandemic (pandemic externalities) (Acharya and Steffen 2020; Anderson *et al.* 2020; Deb *et al.* 2020; Bloom *et al.* 2021). Third, the fiscal policy financing introduces the possibility of monetary stability risks (monetary externalities). Therefore the policymaker will choose their economic policy design maximizing a welfare function with three terms (Masciandaro and Passarelli 2019; Masciandaro 2020):

$V\left(β,δ,τ\right)=U(β,δ,τ)-F \left(β\right)-M\left(β,δ\right)$ (1)

Where U(β,δ,τ), F(β) and M(β,δ) are respectively the inhabitants’ utility, the pandemic externalities and the monetary externalities, while τ, β, and δ represent the key economic policy variables: taxation, fiscal spending and fiscal monetization. Then the first step is to explore how inhabitants behave.

*2. The Inhabitants*

We assume that inhabitants are risk neutral, and they maximize their overall utility from consumption and disutility from effort. In our setting inhabitants’ utility is associated with heterogeneous resources (Krishnamurthy and Vissing-Jorgensen 2012; Masciandaro and Passarelli 2019; Glover *et al.* 2020; Gertler 2020; Masciandaro 2020; Reis 2020), and these sources are combined to consume a single final good (Masciandaro and Passarelli 2019; Glove *et al.* 2020).

Inhabitants expect that when a pandemic occurs their incomes can be hit. Containment measures save lives, but in parallel impose limitations on several economic activities. People suffer because lockdown measures and quarantines reduce their incomes and expenditures (Baker *et al.* 2020a; Carvalho *et al.* 2020; Cox *et al.* 2020). At the same time, inhabitants expect that the policymaker will help those who are suffering with an injection of a lump-sum fiscal transfer to mitigate the pandemic costs (Acemoglou *et al.* 2020; Argente *et al.* 2020; Brotherhood *et al.* 2020; Glover *et al.* 2020).

As much as inhabitants’ losses due to the pandemic can be heterogeneous, the same will be true for the distribution of the fiscal transfers (Bayer *et al.* 2020; Glover *et al.* 2020). The pandemic shock and the consequent fiscal transfer policy influence inhabitants’ welfare in an unequal way, producing a special case of income heterogeneity (Auerbach *et al* 2020; Bayer *et al.* 2020; Gertler *et al.* 2020; Glover *et al.* 2020; Kaplan *et al.* 2020).

Given the risk that an activity may be frozen during a pandemic due to the containment policies – pandemic or ‘quarantine shock’ (Bayer *et al.* 2020) – we can distinguish between safe activities and risky activities. Occupations that do not suffer losses during a pandemic produce safe incomes, while risky earnings are associated with activities that are negatively influenced when a pandemic occurs (De Vito and Gomez 2020; Elenev *et al.* 2020). Safe incomes can be taxed. As extreme examples of the two situations during the 1630 pandemic, consider on the one hand the second-hand clothiers who were involved in risky activities, being systematically hit by blockades and closures, and on the other hand the Arsenal workers with their safe occupation and secure salaries, due to the Senate subsidies.

Therefore the representative inhabitant’s utility is:

$l\left(1-τ\right)-U\left(l\right)+θ(r)$ (2)

Assuming a normalized productivity to one, the first term is the after-tax income, while the second term is a standard increasing and convex effort function. Given taxation, the inhabitant chooses their optimal effort. The optimal condition yields inhabitants’ labour supply, decreasing in taxation, and this rate represents their elasticity to tax distortion. Since both population size and productivity are equal to one, the labour supply represents the total safe income.

The third term represents the risky earning utility. There is only one risky activity, and it is measured using the variable *r*,which parameterizes the risk that the inhabitants bear. The return of the risky activity is θ(r), with θ’(r)>0 and θ’’(r)<0. We normalize this return to one. If a pandemic occurs, with probability *p*, lockdown and quarantine are implemented. The inhabitants know that the value of the risky activity will fall – for simplicity to zero – and they will bear the full cost. At the same time, the inhabitants expect that the policymaker will design a fiscal transfer policy to address their losses, in a proportion β of such losses, and with a corresponding monetization δ.

Safe incomes and risky earnings finance consumption. The overall budget constraint of the representative average inhabitant will be:

$c=l\left(β,δ,τ\right)+θ\left(β,δ\right)$ (3)

With risky earnings being the only source of heterogeneity among inhabitants, such a metric allows us to highlight in the clearest and simplest way the redistributive effects of the fiscal transfer and its monetary financing. Given that the economic policy design influences the inhabitants’ welfare, we now return to the policymaker’s choices.

*3. The economic policy design*

When a pandemic breaks out, the policymaker designs a containment policy, facing an unpleasant dilemma between two public goals (Baldwin and Weder di Mauro 2020). The policymaker needs to protect public health by implementing a containment policy with the aim of minimizing the expected loss of life. In parallel, containment policies save lives, but, given the interactions between economic decisions and epidemics (Eichenbaum *et al.* 2020), any containment policy has short-term economic and financial costs (Deb *et al.* 2020; Ludvigson *et al.* 2020). These costs simultaneously affect aggregate supply (Del Rio-Chanona *et al.* 2020; Koren and Peto 2020) and aggregate demand (Andersen *et al.* 2020; Del Rio-Chanona *et al.* 2020).

The policymaker can address the pandemic recession by implementing an extraordinary fiscal transfer policy using a lump-sum distribution (Bloom *et al.* 2021; Glover et al. 2020), with the aim of mitigating the negative effects of containment measures (Beck 2020; Bénassy-Quéré *et al.* 2020; Brunnermeier *et al.* 2020; Deb *et al.* 2020; Drechsel and Kalemli-Ozcan 2020; Gros 2020a; Kahn and Wagner 2020; Segura and Villacorta 2020). The fiscal transfer can come in many forms: as income subsidies, work insurance, equity injections, or loan guarantees (Céspedes *et al.* 2020; Didier *et al.* 2020; Elenev *et al.* 2020). Transfer payments can be unconditional (Kubota *et al.* 2020) and/or conditional on the inhabitant’s status (unemployed and/or liquidity or credit-constrained individuals) (Bayer *et al.* 2020). In Venice the Senate systematically implemented fiscal transfer policies during the pandemic recessions. Then two questions arise.

First, how large should this fiscal policy be? Two opposite options arise. At one extreme, the policymaker is completely absent, and inhabitants suffered income losses. At the other extreme, the fiscal expansion helps the suffering inhabitants. The policymaker injects resources into the economy, and the metric of this fiscal action is a proportion, β∈(0,1) of the inhabitants’ losses, which is the policy variable that parameterizes fiscal policy.

Second, how can such a fiscal policy be financed? The policymaker can raise taxation (Bloom *et al.* 2021; Eichenbaum *et al.* 2020) and issue debt or money. The policymaker defines the optimal fiscal transfer policy, \*, and this policy can be financed by issuing new debt, charging a regressive lump-sum tax  on the safe income for servicing the issued debt, and through monetization. Assuming no default risk, the policymaker’s budget constraint is:

$βθ\left(1+i\left(1-δ\right)\right)=τl$ (4)

where is the lump-sum tax, *l* is the safe income of the inhabitants before taxes,  is the interest paid on the public bond and  is the fiscal monetization where . For any unit of debt issued, the policymaker repays . The cost of debt, , is negatively associated with the degree of fiscal monetization. When a higher monetization is implemented (i.e. higher ), a lower portion of funded debt will be sold to inhabitants.

Therefore fiscal transfer and its monetization influence inhabitants’ consumption. But the pandemic policy can have long-standing effects on inhabitants’ welfare. So we introduce the possibility of monetary and pandemic externalities, internalizing future negative spillovers due to the economic policy action that can affect the economy when the pandemic ends.

First, fiscal monetization is not a free lunch: it may create monetary externalities. Monetary externalities can depend on the association between central bank seigniorage and monetary stability risks. The more traditional channel is the relationship between seigniorage and inflation tax (Buiter 2007), which increases both national inflation (Friedman 1969; Aizenman 1992) and, via exchange rate devaluation, international inflation (Hamada 1976). Moreover, monetary externalities can also include banking (Bianchi 2010) and financial (Stein 2012; Cesa Bianchi and Rebucci 2017) imbalances, or more generally it is a device to take into account the risk of monetary policy multiple equilibria and their costs (Gliksberg 2009; Airaudo and Bossi 2017).

Fiscal monetization threatens the monetary stability goal in the post-pandemic period, as was the case during the 1630 pandemic recession. The costs of monetary instability, $M=M(β,δ)$, are quadratic in the degree of monetary accommodation :

$\frac{Φ}{2}δ^{2}βθ≡M(β,δ)$ (5)

The monetary externality aversion – i.e. the parameter Φ – is homogeneous among inhabitants. With this assumption that it will be evident that it is sufficient to have just two sources of heterogeneity among inhabitants – fiscal transfer and its bond financing – to have a multiple equilibria setting in terms of political consensus. With further heterogeneity sources the results should be even stronger.

Second, the less the policymaker is involved in supporting the economy, the more likely are negative second-round effects on the well-functioning of the economic and financial system after the pandemic (Acharya and Steffen 2020; Anderson *et al.* 2020; Deb *et al.* 2020). The absence of active public policies can have adverse economic effects that spread out over time and into the longer term, as a reduction in return to human capital or negative structural changes in terms of trading patterns and stalling development (Bloom *et al.* 2021). In this respect, and notwithstanding the public action, the 1630 pandemic recession was a crucial negative turning point in the history of the Most Serene Republic.

To capture in the simplest way this channel, let the pandemic externality function be:

$\frac{ε}{2}\left[(1-β)θ\right]^{2}≡F(β)$ (6)

The pandemic externalities are increasing and convex in the amount of losses, and they are lower the higher the fiscal transfers, . Also the pandemic externality aversion – the parameter ε – is homogenous among inhabitants, for the same motivations above expressed.

*4. The optimal helicopter money*

Inhabitants and the policymaker simultaneously optimize their choices. The average representative inhabitant, optimizing the goal function (2), and given their elasticity to tax distortion, *η*, identifies the optimal effort, *l\** and the optimal risk assumption, *θ\**. The corresponding safe incomes and risk earnings finance consumption. This assumption is particularly relevant during a pandemic: shutdowns and quarantines or lockdowns produce material deprivation and households can draw on all their net available resources to address the shock (Baker *et al.* 2020a; Carvalho *et al*. 2020; Cox *et al.* 2020). Moreover the available resources depend on the design of taxation, fiscal transfer and income from bond financing. Equation (3) becomes:

 $c=l^{\*}\left(1-τ\left(β,δ\right)\right)+βθ^{\*}\left(1+i\left(1-δ\right)\right)≡C\left(β,δ\right)$ (3’)

The policymaker maximizes the social-welfare function (1), setting their strategy on taxation, , fiscal transfer, , and fiscal monetization policy, . Being a social plan in action, fiscal and monetary policy are optimally coordinated (among others, from Abel 1987 to Bianchi *et al.* 2020), including the degree of fiscal monetization (among others, Chari and Kehoe 1999; Punzo and Rossi 2019). Regarding the institutional setting, we have here a fiscal dominance regime (Sargent and Wallace 1981): monetary policy is not independent. Focusing on the optimal level of fiscal monetization, , its social optimal value is:

 . (7)

The optimal level of monetization, , will increase: (a) the more taxation is distortionary; (b) the more the cost of debt servicing is high; (c) the more monetary externality aversion is low.

Given the decision in terms of fiscal monetization, the final step is its implementation. Here a central bank – or a state bank issuer, the Venice Giro Bank, in the case of Venice – comes in as a public institution with its goal, which comes from somewhere or someone (Reis 2013) – the Venice Senate. The central bank, taking into account its resource constraint, *ξ* , technically implements the policy choice, using case by case the more effective tool (Castillo Martinez and Reis 2021). Focusing on helicopter money policies, two options are available (Galì 2020a; Benigno and Nisticò 2020): changes in central bank liabilities (soft helicopter money) and/or changes in the central bank net-worth (hard helicopter money). The overall macroeconomic effects of these policies are disputed (Bernanke 2003 and 2016; Woodford 2012; Turner 2013; Perotti 2014; Muellbauer 2014; Borio *et al.* 2016; Di Giorgio and Traficante 2018; Bartsh *et al.* 2019; Galì 2020a; Benigno and Nisticò 2020; Bartsh *et al*. 2020). For our purposes it is sufficient to assume that the central bank defines its optimal helicopter money action, discounting its effects on monetary externalities:

$ξ=f(δ^{\*})$ (8)

*5. Political pressure and helicopter money*

Now, we can see what happens if the policymaker is not benevolent. If politicians are in charge and at the same time inhabitants are heterogeneous, different monetization policies have associated redistributive effects, and at the same time such policies can have political effects if the political consensus depends on inhabitants’ economic preferences (Masciandaro and Passarelli 2019; Masciandaro 2020; Favaretto and Masciandaro 2021).

The net transfers implied by social optimal policies can be positive for some and negative for others. Moreover, if a policy task has distributional effects, politicians would like to control those effects (Alesina and Tabellini 2007): the redistributive effects are relevant as long as the politicians care about the inhabitants’ preferences. For example, one way to build consensus in favour of containment policies is to use fiscal retributive policies to reduce the costs to those whose resources are threatened by shutdowns and quarantines (Glover 2020). Therefore, we need to explore the inhabitants’ preferences regarding the policy mix designed by the policymaker. Two different dimensions are relevant: inhabitants may or may not be subsidy-recipient individuals, and/or they may or may not be monetization-prone agents.

Which are the subsidized inhabitants? Let us consider any inhabitant *j*, being$θ+θ^{j}$ the amount of risky earnings in her balance sheet. With $θ^{j}>0$ inhabitant *j* will be a subsidized inhabitant relative to the average inhabitant (subsidization gain). Let $L(θ^{j})$ be the distribution of the subsidized inhabitants across the population. With risky earnings being a proxy for the fiscal transfer, these resources in the balance sheet of the median inhabitant tell us whether the subsidized inhabitants represent the majority or a minority of the population.

What about monetization propension? Inhabitants may be heterogeneous also as funded debt holders. In this case, the more a inhabitant *j* is a debt holder, the more they will be monetization adverse, given that more monetization implies lower interest rates. Let $(β+b^{j})(1-δ)θ$ be the amount of bonds in inhabitant *j*’s balance sheet. With $b^{j}<0$ inhabitant *j* will be a monetization-prone individual relative to the average inhabitant (monetization gain). The bond holding of the median inhabitant signals whether the monetization-prone inhabitants represent the majority or a minority of the population. Therefore, given the general individual utility function (1) and the above definitions of $θ^{j}$ and $b^{j}$, the inhabitant *j*’s utility is:

$V^{j}(β,δ)=V(β,δ)+βθ^{j}+b^{j}θi(1-δ)$ (9)

where the last two terms on the right-hand side account for the two forms of heterogeneity of individual *j* relative to the average inhabitant. Each inhabitant’s preferences can differ from those of the benevolent policymaker because of these two terms. Focusing on monetization preferences, the optimal fiscal monetization for inhabitant *j* is:

$V\_{δ}^{j}=V\_{δ}-b^{j}θi\leq 0$ (10)

Assuming equation (10) holds as an equality, solving it yields:

. (11)

By comparing equation (7) with the social optimal monetization (11), it is evident that, given a fiscal policy , a political distortion can arise between a inhabitant’s preferred policy and the social optimal monetization:

$δ^{j}-δ\*=-\frac{b^{j}}{β}\frac{i}{Φ}$ (12)

The political distortion  will reflect inhabitants’ preferences. The direction of the political pressure depends on who the median inhabitant is. For example, we can assume that financial asset/wealth holdings are very skewed, concentrated among a small segment of the population: the rich. Therefore monetary policy, influencing asset returns, produces redistributive effects that benefit the holders of such assets (Krishnamurthy and Vissing-Jorgensen 2011; Brunnemeier and Sannikov 2014).

We interpreted the monetary stance in Venice in early modern times as an extraordinary ‘hard helicopter money’ with redistributive effects. Then a question arises: which inhabitants like fiscal monetization? Among all the possible equilibria, all Venetian subsidized inhabitants like helicopter money, but only when they were monetization-adverse individuals. In parallel, all monetization-prone inhabitants like helicopter money, but only when they are not subsidized inhabitants. In other words, uncertainty is present in cases without a clear-cut net benefit, such as subsidized merchants that are also bond holders.

But how relevant are the median inhabitant’s preferences for the incumbent policymaker? Taking inspiration from Passarelli and Tabellini (2017) and Favaretto and Masciandaro (2021), we assume that the monetary policy decisions are associated with political consensus, because consensus depends on the median inhabitant’s preferences through economic and psychological group-thinking mechanisms. The risks of political unrest can influence incumbent policymakers, and these risks can be motivated by facts and emotions. If the policymaker considers the median inhabitant’s preferences as a relevant proxy for riot risks, political pressures may be relevant in shaping fiscal monetization choices. The link between inhabitants’ preferences, political pressure and political choices can emerge also in an oligarchy of merchants, as the Venice Republic was at that time. In fact, ordinary Venetians used collective actions to influence patrician choices, especially during crisis periods.

This situation is captured in the simplest way assuming that the actual monetary policy decision $δ\_{A}$ is such that:

$δ\_{A}=χ\left|\overset{}{δ^{j}-δ^{\*}}\right|$ (13)

where $0<χ<1$ represents the relevance of the political pressure. In Venice, the 1630 extraordinary monetization over-expansion created inflation and currency depreciation. In parallel, the population expected ‘whatever it takes’ myopic fiscal policies, and the politicians tended to please inhabitants’ preferences, given the threat of riots. Political pressure and helicopter money were likely to be two sides of the same coin.

*6. Further steps*

The analysis can be enriched in several directions:

(a) Monetary externality sensibility and inhabitants’ heterogeneity: monetary instability is assumed to be a homogeneous social cost. But inhabitants can be heterogeneous in their ability to address such risks through hedging, with some individuals facing – or feeling that they face – higher costs due to monetary instability (i.e. *inflation-adverse* citizens). In other words, we could explicitly take into account the redistributive effect of inflation, that has long been recognized in the traditional literature (Keynes 1923; Bresciani-Turroni 1937; Friedman and Schwartz 1963), and discussed again recently (Doepke and Schneider 2006; Colbion *et al.* 2012). Also in early modern Venice the ruling elites constantly demanded a stable currency (Al-Bawwab 2021). Allowing for this kind of heterogeneity would lead to a straightforward prediction: the smaller the mass of inflation risk-adverse citizens, the stronger the political pressure to engage in fiscal monetization.

Moreover, we could introduce heterogeneity in the propensity to consume, which can influence the effect of the fiscal transfer in stimulating consumption (Andreolli and Surico 2021). This change could help to explain the empirical estimates of the marginal consumption propensity during a pandemic (Baker *et al.* 2020b; Chetty *et al.* 2020; Coibion *et al.* 2020; Karger and Rajan 2020; Kim and Lee 2020; Kubota *et al.* 2020). Finally, we can assume heterogeneity in inhabitants’ marginal propensity to take risk (Kekre and Lenel 2021), and also this heterogeneity can influence the distribution of the fiscal transfer effect.

(b) Taxation and inhabitants’ heterogeneity: safe income taxation has been assumed to be the same for all individuals. In the presence of taxation heterogeneity, the distributional effects are likely to increase. For example, given the decisions regarding the fiscal policy and its monetization, if richer inhabitants are likely to have higher tax burden, all else equal, they would prefer lighter fiscal policies. The income and/or taxation heterogeneity can be relevant in strengthening or weakening political pressure in favour or against the fiscal monetization.

(c) Public debt and interest rates: public debt is only issued to address the pandemic-related recession and the interest-rate level remained constant. Assuming an initial debt, or interest rate endogeneity depending on the debt stock, would exacerbate the policy trade-offs and, consequently, the relevance of the political distortions.

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