The Fiscal Channel of Quantitative Easing*

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Abstract

This paper is a theoretical examination of the role of fiscal distortions in shaping the effects of Quantitative Easing (QE). The presence of deadweight losses from taxation breaks Wallace's neutrality since QE influences the level and volatility of such losses. Under some conditions, QE can stimulate demand by removing tax distortions, but it increases the risk premium. This differs from the standard view that QE stimulates demand precisely by lowering risk premiums due to the relaxation of financial frictions. A Central Bank must strike the right balance between the efficiency gain of more QE against the additional risks it entails. By exploiting the risk premium from capital ownership, QE emerges as an alternative to costly taxation, suggesting an efficiency-risk trade-off for public finances.

Keywords: Quantitative Easing, Fiscal-Monetary Interactions, Risk premium.

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1.- Introduction

This paper is a theoretical examination of the role of fiscal distortions in shaping the effects of Quantitative Easing (QE). The presence of tax deadweight losses breaks Wallace (1981)'s irrelevance, making asset purchases capable of influencing aggregate demand and risk premiums but in a different way than commonly thought. Our goal is to uncover this fiscal channel and study its consequences for the conduct of QE.

Fiscal policy is paramount to determining the Central Bank's ability to affect the economy via asset purchases (Wallace (1981), Leeper and Leith (2016), Benigno and Nisticò (2020)). This is because asset purchases originate gains and losses that enter the consolidated budget constraint of the State and must be balanced out by movements in other fiscal or monetary items. How fiscal variables react determines then the autonomy degree of monetary policy and the ultimate effects of asset purchases.

Following Wallace (1981), a common assumption in the literature is that fiscal policy offsets QE gains/losses by using lump-sum taxes. Thus, the differences in interest earnings implied by QE are paid out in the form of taxes to the asset-holders that participate in the QE program. In this way, the allocation of resources is unchanged; the same agents get the same flow of resources, although under a different cover -a fiscal transfer instead of an asset payoff. As a result, the change in the public portfolio does not affect the competitive equilibrium. In other words, full fiscal support (in the sense of Del Negro and Sims (2015)) implemented via lump-sum taxes makes QE irrelevant.

Some papers deviate from Wallace's fiscal policy by assuming that fiscal deficits do not react to QE flows.[1] Without fiscal adjustment, there is a reallocation of resources and risk between the private and public sectors that impacts the equilibrium. For instance, in the event of a loss that is transferred to a Treasury with a given path of deficits, public debt must buffer it out, representing a wealth transfer to the private sector and a potential need for an alternative monetary policy path to stabilize the debt, both factors inducing inflation.[2] The role of

[1]This is the case, for instance, of some active fiscal policy, in the sense of Leeper (1991). However, active fiscal policy does not break neutrality by itself, as there exist fiscal rules that qualify as active but still fully react to QE flows, as shown by Benigno and Nisticò (2020).

[2]Alternatively, the loss can be kept within the Central Bank, perhaps as a deferred asset. This can be simply viewed as another form of public debt, backed by seignorage. If the debt is big enough, it might need an alternative monetary policy to be stabilized, breaking neutrality. Given this equivalence, in the paper, we assume full fiscal support;

sticky taxes in shaping QE outcomes has been studied in detail by Benigno and Nisticò (2020) and also in Hollmayr and Kühl (2019); and has been used to study issues such as debt sustainability (Elenev et al. (2021)) or QE's exit strategies (Airaudo (2022)).[3]

Nonetheless, what if the Government fully support the Central Bank but finds it easier to cut spending rather than to raise taxes in the event of a loss? Or to finance a targeted public program instead of transferring the resources back to the investors? What if, despite wanting to pass the gains or losses to the asset-holders that participated in the program, lump-sum taxes are not available? If public spending is adjusted and the public goods financed or defunded are not perfect substitutes for the private consumption of the asset-holders, QE ends up causing a reallocation of resources between the public sector and the investors. Besides, adjustments in costly taxes can influence tax deadweight losses, factor allocations, etc. Both adjustments imply the non-neutrality of asset purchases. They are the focus of this paper.

To study these cases, we use a two-period endowment stochastic economy, with a Lucas tree, a society of identical investors and an institutional framework characterized by: i) an independent Central Bank that is fully supported by the Government, in the sense of Del Negro and Sims (2015); ii) a Government that uses costly taxes to finance valuable public goods. We abstract from inflation and nominal variables, such that all the adjustments are in terms of goods. This, along with the risk-free nature of the public debt, implies a passive fiscal policy.[4] The Central Bank can only choose its balance sheet, that is, it chooses the holdings of the private risky asset financed by issuing risk-free public liabilities.[5] The independence of the Central Bank is reflected in the timing; it is a Stackelberg leader that decides its balance sheet policy in the first period. Given that policy, investors save and consume, and later, in the second period, the Government

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see Benigno and Nisticò (2020) for deviations from this.

[3] Elenev et al. (2021) is the only that considers distortionary taxes. As a result, there is a fiscal channel of QE since it affects debt, taxes and then the allocation of labour. However, they don't really explore this channel, which operates together with several financial frictions and changes between active-passive regimes. We do the opposite, focusing exclusively on this channel.

[4] Our mix of passive fiscal policy and full fiscal support is one of the examples of neutrality used by Benigno and Nisticò (2020). We show how non-neutrality can emerge even within this setup, which, for instance, closely follows the institutional arrangement in the UK.

[5] This particular definition of QE facilitates some of the derivations. However, it is not crucial at all for our results, which holds as long as the Central Bank finance the program by issuing liabilities that are less riskier than the assets it acquires.

chooses taxes and spending in a discretionary way, after observing the gains or losses originated by QE.

The setup differs from the literature in one key dimension. Instead of imposing an exogenous public spending and forcing tax adjustments or, alternatively, conjecturing some ad-hoc fiscal rules, we endogenously derive the fiscal reaction functions by asking the Government to achieve the best possible equilibrium. Thus, fiscal policy functions depend on the structure of the economy in a precise way. To make this problem interesting, we add two important ingredients. First, tax deadweight losses. Following Bohn (1992), we use a reduced-form formulation whereby some resources are lost in taxation, alluding to various possible reasons such as collection costs, allocation distortions, resources devoted to tax evasion activities and the likes. Second, public goods are valuable. This introduces a trade-off between costly taxation and desirable spending that might resemble the one actually faced by governments.

A new non-neutrality result emerges in this economy, related to the effects triggered by fiscal adjustment to QE.[6] Consider a QE program originating some gains. A rational government facing costly taxes and certain demand of public goods would rationally choose to react to the gains by lowering taxes and increasing spending, with an intensity depending on the severity of tax costs. Lower taxes reduce the tax deadweight losses; this efficiency gain is distributed between private and public spending, increasing ex-post welfare in the last period.

What are the consequences for period-1 variables? Forward-looking investors adjust their expectations on future consumption, becoming more optimistic, which leads to an increase in first-period consumption due to a consumption smoothing motive. On the downside, the efficiency gain increases the exposure of future consumption to output fluctuations; this generates a precautionary savings motive. Depending on the relative strength of each effect, QE can stimulate or depress the private goods demand and then deflate or inflate asset prices. Finally, the risk premium is also affected since QE increases the covariance between private consumption and the asset payoff. Thus, if QE deflates asset prices, the higher covariance would deflate risky prices further, widening the risk premium. Altogether, QE moves the economy to a new equilibrium with a higher mean-

[6]Note this is different from an active tax rule that does not react to QE flows and forces monetary policy to act. Here fiscal policy acts and this action triggers the effects in the model. In this sense, this is a fiscal transmission channel of QE, rather than a monetary policy channel induced by fiscal inaction.

variance consumption profile, with effects on aggregate demand, asset prices and risk premiums.

This channel implies a boost (dampening) of aggregate demand, asset price deflation (inflation) and risk premium widening (narrowing) simultaneously. This differs strongly from standard views of QE, whereby the reduction of long-run interest rates (and risk premiums) cohabits with higher aggregate demand. In fact, popular models conjecture that QE reduces risk premiums due to market segmentation or other financial frictions, boosting then aggregate demand (e.g., Gertler and Karadi (2011), Vayanos and Vila (2021)). On the contrary, in our model, aggregate demand is stimulated by removing tax distortions from the economy, but at the cost of increasing the risk, which eventually affects the risk premiums. In this sense, the fiscal channel is a complementary transmission channel that might counteract some of the effects of the financial channels, perhaps helping to understand the lasting uncertainty about QE's effects. Additionally, the relevant dimension of QE is the stock rather than the flow, as in Harrison (2017), due to its relation with the level of tax deadweight losses.

If swapping risk-free for riskier assets impacts the competitive equilibrium simply due to the presence of costly taxation and valuable public goods, a natural question is: How much QE should be done? We answer the question by asking the Central Bank to choose the quantity Q of risky asset purchases to maximize the expected social welfare taking into account the optimal reactions of all the other agents to its policy. It turns out that under linear tax costs, the efficiency gain always dominates the higher risk. More QE is always better: less distortions without too much additional risk ($Q^* = 1$). On the contrary, introducing quadratic costs delivers a $Q* < 1$. The key factor is the marginal productivity of tax cuts. With linear costs, it was constant; every additional unit of QE generates the same efficiency gain such that it always dominates the additional risk brought up by a larger QE program. With quadratic costs, however, the efficiency gains are decreasing with QE such that, at some point, QE begin to deteriorate the mean-variance consumption equilibrium.

All in all, QE emerges as an alternative way of collecting resources for the State: exploiting the risk premium from capital ownership rather than imposing costly taxes on households. In this vein, it shares with Farhi (2010) the exploration of capital ownership as an optimal alternative to taxation. In our economy, ownership is more efficient but at the price of increasing risk-taking. Thus, the paper suggests an efficiency-risk trade-off for public finances.

Practically, fifteen years of widespread QE employment (or more than twenty for Bank of Japan) has opened up the prospect of a more permanent or conventional use of QE. As *normalization* of monetary policy takes hold, there is a reasonable challenge regarding which of the unconventional measures may end up in the conventional monetary toolkit of the future. This paper provides a rationale and goal for a more conventional use of QE. Looking ahead, we show how QE can be used to finance valuable public goods, complementing the view described in Reis (2017). This has sometimes been called the "Fiscal QE" (Selgin (2020)). Recent targeted QE programs, such as Bank of England's and ECB's Green Corporate Bond Programs or the ECB's Transmission Protection Instrument, can be seen as examples of this use.

The rest of the paper is structured as follows. Section 2 sets out the model and solves the fiscal and savings-consumption problems. Section 3 deals with the Central Bank problem.Section 4 concludes pointing out some promising extensions.

2.- QE and Fiscal Policy

In this section, we describe a two-period model economy and use it to study QE. The model abstracts from all sorts of frictions considered in the QE literature, and focuses on fiscal elements that allude to tax collection costs and the utility of public goods. QE consists of purchasing risky private assets by issuing risk-free public assets.[7] The problem is set in two stages and solved backwards. In the last stage, the consolidated government observes QE gains or losses and decides how to adjust taxes and spending to satisfy the budget constraint. In the second stage, investors solve a consumption-savings problem before knowing QE gains or losses but anticipating how the government would eventually react to them. We analize the cases that make QE (non-)neutral and uncover a fiscal channel related to the efficiency gain of QE due to the removal of tax deadweight losses.

[7]We assume QE buys risky private assets instead of long bonds, but the results go through with long-term public bonds as well. We key is to buy an asset with a higher mean-variance profile.

2.1.- The model

The economy is populated by a continuum of measure 1 of identical investors. They last for 2 periods, indexed by t = 0, 1, 2. There is a single perishable good in the economy that also acts as the numeraire of the economy. There exist two assets: a single risky asset, call it "stock" S, in fixed supply in the form of a contract that delivers D_t goods each period and is marketable at an uncertain price P; a safe public bond B, that is issued at discount 1/R and delivers 1 unit of goods with certainty. When the time starts, each investor is endowed with one unit of the stock ($S^i_{-1} = 1$). Payments D_t are exogenous and stochastic, following a Normal distribution with mean μ and standard deviation σ. This is the only source of risk in the economy.

Financial markets are competitive but incomplete, as output D can materialize in a continuum of outcomes, but there are only two assets available. The goods market behaves also competitively. Investors possess full information about the economy's structure and are rational.

We consider a State that participates in the economy by determining monetary and fiscal variables. In particular, it is in charge of public spending G_t; costly taxes T_t with an associated tax cost function $H : T \to \mathbb{R}$ with $0 < H'(T) < 1$ such that the government has to collect 1+H(T) units of goods from the private sector to be able to spend 1 unit with $H(T) = \alpha T$ for $\alpha > 0$;[8] risk-free government debt B; and purchases of risky assets QE. Assume that the economy starts without debt. Thus, the State budget constraints read as:

$$G_0 + QP = T_0 + \frac{B}{R} \tag{1}$$

$$G_1 + B = T_1 + D_1 QE \tag{2}$$

These constraints can be collapsed into this intertemporal constraint

$$\underbrace{Q\left(P - \frac{D_1}{R}\right)}_{\text{QE losses}} = \underbrace{T_0 + \frac{T_1}{R} - G_0 - \frac{G_1}{R}}_{\text{Primary Surplus}} \tag{3}$$

that points out that the present value of the primary surplus must offset QE

[8]This is a reduced form for distortionary taxes that simplifies some computations. Bohn (1992) shown its equivalence with labor income taxes. It can also be broadly related to the Okun's "leaky bucket", whereby resources spent by the government are less than the ones collected, due to all sort of potential inefficiencies, distorted decisions, etc. The reduce-form remains silent about the sources of such inefficiencies.

losses. Note this model implies there is fiscal support in the sense of Del Negro and Sims (2015) and fiscal policy is passive since it adjusts surpluses given the actions of the Central Bank. In the literature, typically (G_0, G_1) are exogenous, for instance $(0, 0)$, such that passive government must adjust taxes. On the contrary, we allow the government to choose G, giving rise to infinitely many possible combinations of taxes and spending adjustments satisfying the intertemporal budget constraint.

Private investors solve a standard savings-consumption problem. We assume welfare depends on current consumption and a convex combination of utility derived from future consumption and public spending, with y denoting the weight attached to the utility derived from consumption. Utility is given by a CARA function $u(x) = \frac{-1}{\gamma} exp(-\gamma x)$, with γ being the parameter of absolute risk aversion.

Competitive Equilibrium. Given $S^i_{-1} = 1$, a Competitive Equilibrium is a vector of non-negative asset prices $\{P, 1/R\}$ and allocations $\{C^i_0, C^i_1, S^i, B^i\}$ indexed by an economic policy made of a fiscal policy $\{G_0, G_1, T_0, T_1\}$ and a balance sheet policy $\{B, QE\}$ that satisfies:

1. Investor's Euler Equations for stocks and bonds.
2. Investor's budget constraints.
3. The State's intertemporal budget constraint.
4. Assets market clearing conditions

$$\int_0^1 S^i di + QE = 1; \quad \int_0^1 B^i di = B \tag{4}$$

There are 12 endogenous variables and 7 optimality conditions. It follows that economic policy needs to target 5 variables out of $\{G_0, G_1, T_0, T_1, B, QE\}$. Without loss of generality, assume there is no public spending and tax collection in period 0. QE is defined as the vector $\{B/R, QE\} = \{QP, Q\}$. The remaining two fiscal variables, T_1 and G_1, will be set optimally by the government to absorb the flows originated by QE.

2.2.- The fiscal problem

QE originates a flow of funds in the government's consolidated budget constraint. Let $X = Q(D_1 - PR)$ be such flow. Standard practice is to assume $G_1 = 0$ such that the period-1 budget constraint would impose $T_1 = -X$. Instead, we allow the government to select how to react to QE rationally once all the outcomes have been observed. The rational response, call it T^* and G^*, is given by

$$T^*, G^* = arg \max_{\{T,G\}} yu(C_1) + (1-y)u(G) \tag{5}$$

subject to

$$G + B = T + QD_1 \tag{6}$$

$$C_1 + T + H(T) = SD_1 + B \tag{7}$$

Given $S = 1 - Q$, $B = QPR$, P and R. Thus, fiscal policy exhibits no commitment; it is selected to maximize ex-post social welfare subject to period-1 restrictions and taken as given period-0 equilibrium outcomes.

The FOC determining optimal taxes is equal to:

$$y(1+\alpha)exp\{-\gamma C_1\} = (1-y)exp\{-\gamma G\} \tag{8}$$

Manipulating this expression a bit using investor's and gov's budget constraints:

$$ln[y(1+\alpha)] - ln(1-y) = -\gamma(G - C_1) = -\gamma(X + T - D_1 + X + T(1+\alpha)) = -\gamma(2X + (2+\alpha)T - D_1) \tag{9}$$

Solving for T:

$$T^* = \frac{1}{2+\alpha} D_1 - \frac{2}{2+\alpha} X - \underbrace{\frac{ln[y(1+\alpha)] - ln[(1-y)]}{\gamma(2+\alpha)}}_{\equiv a} \tag{10}$$

In words, taxes should increase with output D_1, decline with QE gains X (as QE gains are an alternative way of financing G), decline with distortions α (the more costly taxation is, the less it should be used) and increase with the social weight on public goods $(1-y)$. Using the government's budget constraint:

$$G^* = X + T^* = \frac{1}{2+\alpha} D_1 + \frac{\alpha}{2+\alpha} X - a \tag{11}$$

It is optimal for the government to raise spending to offset part of the QE gains, but less than one-to-one (as $\alpha > 0$). If taxes are costless ($\alpha = 0$), $\partial T^*/\partial X = -1$ and $\partial G^*/\partial X = 0$ as in Wallace (1981) and the literature following him. If public spending is useless ($y = 1$), the government would not spend anything before QE, and then all the adjustments would go through taxes as well.[9]

2.2.- The investor's problem

The representative investor solves the following consumption-savings problem at period-0 (superindex i has been eliminated to save notation):

$$\max_{\{C_0,C_1,S,B\}} u(C_0)+\delta\mathbb{E}_0\{yu(C_1)+(1-y)u(G)\} \tag{12}$$

subject to

$$C_0+PS+\frac{B}{R}=(P+D_0)S_{-1} \tag{13}$$

$$C_1+T+H(T)=D_1S+B \tag{14}$$

Optimality conditions boil down to two Euler Equation for bonds and stocks.

$$\frac{1}{R}=\delta y\mathbb{E}_0\left(\frac{exp\{-\gamma C_1\}}{exp(-\gamma C_0\}}\right) \tag{15}$$

$$P=\delta y\mathbb{E}_0\left(\frac{exp\{-\gamma C_1\}}{exp(-\gamma C_0\}}D_1\right) \tag{16}$$

In equilibrium, individual and aggregate consumption coincide such that $\{C_0, C_1\} = \{D_0, C_1^*\}$. Given the rational reaction of the government in period-1,

$$C_1^*=D_1-G^*-\alpha T^*=\frac{1}{2+\alpha}D_1+\frac{\alpha}{2+\alpha}X+a(1+\alpha) \tag{17}$$

Equilibrium consumption grows with output, and QE gains. Notice there is a constant gap between private and public consumption determined by $C_1^*-G^*=(ln[y(1+\alpha)]-ln[(1-y)])\gamma^{-1}$. Intuitively, the gap increases with both the private consumption weight and the cost of taxation. Apart from that, consumption and public spending react symmetrically to output and QE gains.

Using this expression in the Euler Equations and operating, it can be shown that equilibrium asset prices are given by

$$\frac{1}{R^*}=\delta yexp\Big\{-\gamma\Big(a(1+\alpha)+\frac{\mu}{2+\alpha}+\frac{\gamma\sigma^2}{2(2+\alpha)^2}(\alpha^2Q^2-1)-D_0\Big)\Big\} \tag{18}$$

[9] Imagine that for some reason, $G_1=\bar{G}$ before QE and $y=1$. In this case, QE losses would be optimally absorbed by cutting G, and QE gains by lowering T.

and

$$P^* = \frac{\mu - \gamma\left(\frac{1+\alpha Q}{2+\alpha}\right)\sigma^2}{R^*} \tag{19}$$

From these expressions, we can evaluate the effect of QE on demand, asset prices and the risk premium. To begin with,

$$\frac{\partial 1/R^*}{\partial Q} = \delta y exp\Big\{-\gamma\Big(a(1+\alpha) + \frac{\mu}{2+\alpha} + \frac{\gamma\sigma^2}{2(2+\alpha)^2}(\alpha^2 Q^2 - 1) - D_0\Big)\Big\}\Big(-\frac{\gamma\sigma^2\alpha^2 2Q}{2(2+\alpha)^2}\Big) < 0 \tag{20}$$

The effect of QE on bond prices is unambiguously negative. To understand the reason behind it, rewrite the bond price as

$$\begin{aligned}\frac{1}{R} =& \delta y \mathbb{E}_0\left(\frac{exp\{-\gamma C_1^*\}}{exp(-\gamma C_0^*\}}\right) = \delta y exp(\gamma D_0)\mathbb{E}_0\left(exp\{-\gamma(C_1^*)\}\right) \\ =& \delta y exp(\gamma D_0) exp\{-\gamma\mu_c + \frac{\gamma^2\sigma_c^2}{2}\}\end{aligned} \tag{21}$$

Hence, the effect of QE on bond prices is transmitted through its effects on consumption mean and variance. How is this effect? Using the equilibrium period-1 consumption (17), it turns out

$$\mathbb{E}(C_1^*) \equiv \mu_c = \frac{\mu}{2+\alpha} + \frac{\alpha\gamma\sigma^2 Q(1+\alpha Q)}{(2+\alpha)^2} + a(1+\alpha) \tag{22}$$

$$\mathbb{V}ar(C_1^*) \equiv \sigma_c^2 = \Big(\frac{1+\alpha Q}{2+\alpha}\Big)^2\sigma^2 \tag{23}$$

QE pushes the mean-variance consumption equilibrium up. A higher mean pushes bond prices down, as higher future consumption leads to reduce savings today (consumption smoothing). On the contrary, a higher variance pushes bond prices up due to a boost in precautionary savings. Which effect does dominate? It turns out the distance between the mean and the risk-weighted variance that determines the QE effect on bond prices increases with Q:

$$\frac{\partial(\mu_c - \gamma\sigma_c^2/2)}{\partial Q} = \frac{\alpha^2\gamma\sigma^2}{(2+\alpha)^2}Q \tag{24}$$

Therefore, a larger QE increases the expected future consumption more than its risk, with the net effect of reducing savings and asset prices in period 0.

Behind the increase in mean consumption, there is a reduction in the tax deadweight loss αT. This is easy to check since $C_1^* = D_1 - G^* - \alpha T^*$, and the dividend mean and the gap between consumption and public spending are both unaffected by Q. A lower tax deadweight loss implies investors and government enjoy a larger amount of goods, becoming both more exposed to goods' volatility.

To understand the effect of QE on stock prices, equation (19) can be rewritten as

$$P = \frac{1}{R^*}\mu - \mathbb{C}ov(exp\{-\gamma(C_1 - C_O)\}, D_1) \tag{25}$$

with

$$\mathbb{C}ov(exp\{-\gamma(C_1 - C_O)\}, D_1) = \frac{\gamma\left(\frac{1+\alpha Q}{2+\alpha}\right)\sigma^2}{R^*} \tag{26}$$

Thus, the effect of QE on stock prices can be decomposed into two terms. First, stock and bond prices comove positively such that QE deflates stock prices for the same reasons it reduces bond prices. Additionally, the stock price decreases more than the bond price with Q because QE increases the covariance between consumption and the asset payoff. The asymmetric asset price deflation leads to a widening of the risk premium.

All the previous derivations can be summarized in the following two results:

Result 1: QE non-neutrality with tax deadweight losses. If $\{C_0, C_1, B, S, P, 1/R\}$ is an equilibrium for the policy $\{G_0, G_1, T_0, T_1, B/R, QE\} = \{0, G, 0, T, QP, Q\}$, then $\{C_0, C_1, \hat{B}, \hat{S}, P, 1/R\}$ is an equilibrium for the policy $\{0, \hat{G}, 0, \hat{T}, \hat{Q}P, \hat{Q}\}$ only if $\alpha = 0$ (*Neutrality with lump-sum taxes*). For $\alpha > 0$, $\{0, \hat{G}, 0, \hat{T}, \hat{Q}P, \hat{Q}\}$ implies a different equilibrium $\{\hat{C}_0, \hat{C}_1, \hat{B}, \hat{S}, \hat{P}, 1/\hat{R}\}$ (*Non-neutrality with tax collection costs*).

Result 2: The fiscal channel of QE. A program of asset purchases Q financed by issuing risk-free public debt $B/R = QP$ in an economy where collecting taxes is costly ($\alpha > 0$) and public goods are of some utility ($y < 1$) has the following consequences:

- Efficiency gain. QE reduces the tax deadweight loss, increasing expected future consumption. This increases consumption at time 0 due to a consumption smoothing motive.

- Higher risk. The gain in efficiency increases the consumption exposure to output fluctuations; this generates a precautionary savings motive at time 0.

- Private demand stimulus. The efficiency gain dominates the higher risk, and its distance increases with Q. The increase in consumption dominates the precautionary savings motive.

- Asset price deflation. The precautionary savings motive is dominated.
- Risk premium widening. QE increases the covariance between consumption and the asset payoff.

3.- The Central Bank problem

The previous section showed that swapping risk-free for riskier assets impacts the competitive equilibrium in the context of costly taxation. A natural question is: with that knowledge, how much QE should be done? We answer the question by posing an optimal policy problem for the agency determining QE. It turns out that linear tax collection costs lead to a corner solution. We then explore the question with quadratic collection costs, which poses a true trade-off for QE.

3.1.- Linear tax collection costs

Assume $H(T) = \alpha T$, as in the previous section. In this context, a public agency (typically, a Central Bank) would choose the optimal QE, call it Q^* such that

$$Q^* = arg \max_{Q} \mathbb{E}_0\{yu(C_1) + (1-y)v(G_1)\} \tag{27}$$

given the equilibrium policy functions C_1^*, G^*, T^* and the equilibrium pricing functions P^*, R^*. In words, the Central Bank chooses Q to maximize the expected welfare in the last period taking into account the optimal reactions of all the other agents to its policy.

From the previous section, we know that both C_1^* and G^* are normally distributed as they depend only on D_1. The mean and variance of equilibrium consumption are given by () and (). Likewise, for public spending they read as

$$\mathbb{E}(G^*) \equiv \mu_g = \frac{\mu}{2+\alpha} + \frac{\alpha\gamma\sigma^2 Q(1+\alpha Q)}{(2+\alpha)^2} - a = \mu_c - a(2+\alpha) \tag{28}$$

$$\mathbb{V}ar(G^*) \equiv \sigma_g^2 = \Big(\frac{1+\alpha Q}{2+\alpha}\Big)^2 \sigma^2 = \sigma_c^2 \tag{29}$$

Note that maximizing

$$-\frac{y}{\gamma} exp\Big\{-\gamma\mu_c + \frac{\gamma^2\sigma_c^2}{2}\Big\} - \frac{1-y}{\gamma} exp\Big\{-\gamma\mu_g + \frac{\gamma^2\sigma_g^2}{2}\Big\} \tag{30}$$

is equivalent to maximize

$$
\begin{aligned}
&-\frac{y}{\gamma}\Big(-\gamma\mu_c+\frac{\gamma^2\sigma_c^2}{2}\Big)-\frac{(1-y)}{\gamma}\Big(-\gamma\mu_g+\frac{\gamma^2\sigma_g^2}{2}\Big)\\
=&\mu_c-\frac{\gamma\sigma_c^2}{2}+(1-y)a(2+\alpha)
\end{aligned}
\tag{31}
$$

where the second line uses the equivalences between the mean and variances of C and G. Altogether, the Central Bank's problem boils down to choosing the Q that maximizes the distance between the consumption mean and variance, accounting for the level of risk aversion

$$
\begin{aligned}
Q^* =&arg\max_{Q}\mu_c-\frac{\gamma\sigma_c^2}{2}\\
=&arg\max_{Q}\frac{\gamma\sigma^2}{2(2+\alpha)^2}(\alpha^2Q^2-1)
\end{aligned}
\tag{32}
$$

where the last equality uses the expressions for μ_c and σ_c^2. Then, it is optimal for the Central Bank to do as much QE as possible; in our economy, $Q^*=1$ (since the total stocks in the economy are normalized to 1). The reason was apparent already in the previous section: the more the QE, the more the efficiency gain dominates the increase in risk-taking; the more the QE, the larger the risk premium so that the more the taxes can be reduced and the more efficient the economy gets. QE represents a more efficient way of funding public goods, trading a larger government's balance sheet with a lower tax economy.

3.2.- Quadratic tax collection costs

Consider $H(T)=\alpha T^2$, capturing the possibility that tax collection is increasingly costly, perhaps due to the complexity of managing a higher volume of resources. The introduction of quadratic costs makes the closed-form solution infeasible but enrich the properties of the model. The key factor is the marginal productivity of tax cuts. With linear costs, it was constant; every additional unit of QE generates the same efficiency gain such that it always dominates the additional risk brought up by a larger QE program. On the contrary, with quadratic costs, the efficiency gains are decreasing with QE such that, at some point, QE begin to deteriorate the mean-variance consumption equilibrium, reverting the sign of the effects summarized in *Result 2*; more QE increases precautionary savings, driving asset prices up and spreads down.

Figure 1 plots many of the model's variables as a function of Q, illustrating *Re-*

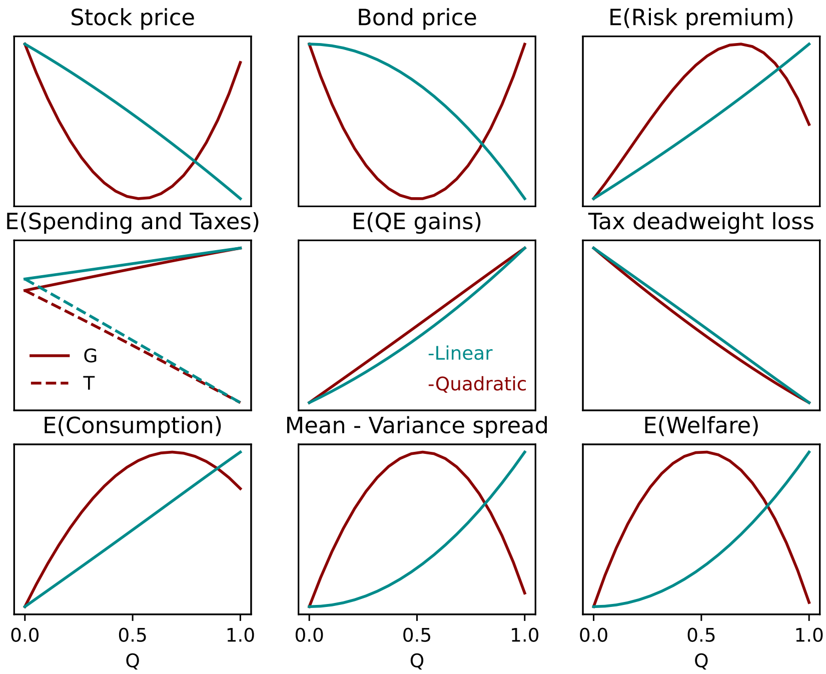

Figure 1: Effects of Quantitative Easing with Linear (blue) and Quadratic (red) tax collection costs.

sult 2 and its reversion with quadratic deadweight losses. As shown analytically for the linear case, Q^* is the one that delivers the best mean-variance equilibrium for private future consumption, balancing the gains from lower taxes against the . For quadratic tax collection costs, that point is reached for $Q^* < 1$, given the decreasing marginal gains from lower taxes. Interestingly, for the quadratic case, this point coincides with a minimum for asset prices but not with a maximum for the expected consumption and risk premium (that peak at $Q > Q^*$). In simulations, we found that Q^* decreases with the asset's payoff risk and the weight of private consumption on the welfare function but increases with the level of risk aversion.

4.- Conclusions

This paper explores the effects of public risky asset purchases financed by risk-free public liabilities in the context of fiscal distortions. These distortions break Wallace's neutrality even in the context of monetary dominance since the profits from these purchases affect taxes and their associated deadweight loss. However, the effects of asset purchases are different from the ones emerging from models with financial frictions. Typically QE relaxes some financial constraints, lowering risk premiums and then, boosting aggregate demand. Differently, through the fiscal channel, QE reduces tax distortions but increases the consumption risk, potentially boosting demand but also risk premiums.

The fiscal channel poses an efficiency-risk trade-off for QE: more QE removes inefficiencies from the economy but increases private risks. Central Banks can exploit this trade-off to deliver the optimal mean-variance equilibrium. From a broader perspective, QE can be viewed as an alternative to taxation to fund public goods, based on capital ownership and the exploitation of risk premiums.

We presented these arguments in a stylized two-period model that isolates the fiscal channel as much as possible. In this enterprise, we abstract from conventional monetary policy and all the intricacies of monetary economics. The presence of nominal variables and rigidities would introduce additional adjustment mechanisms, such as inflation or output, that might potentially change some of the outcomes. Additionally, an exploration of the interaction between the fiscal channel and other transmission channels seems pertinent towards a holistic evaluation of the possibilities of QE. Moreover, the model misses dynamics, which would make the game between Government and Central Bank more complex. Finally, from a public finance standpoint, the model raises questions for optimal debt management under QE as well as the right mix of capital taxes and capital ownership to fund public goods. We are currently exploring some of these issues.

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