ERASMUS UNIVERSITY ROTTERDAM
Erasmus School of Economics

Bachelor Thesis International Bachelor Economics and Business Economics

Tax-Based Parallel Payment Systems: An Inquiry Into Their Economic Feasibility

Stavros Kavvadias

425842

Supervisor: Dr. Bauke Visser

Second Assessor: Dr. Yao Chen

Date: July 4th, 2019

Abstract

This paper compares the potential of a tax-based parallel payment system as a solution to a shortage of liquidity in a highly leveraged country with the options of further debt assumption and sovereign debt default. A two-period game is used to analyze the best response of the state and the private sector and to identify under which conditions a tax-based parallel payment system would be preferred over foreign financing or default. The key variables affecting the decision of the state to implement or not the parallel payment system are, based on the model, the state of the economy, projected government expenditure, the cost of foreign financing versus domestic financing, the level of debt accumulated, the opportunity cost of current consumption of the private sector, and the subjective valuation of the future by the private sector. The private sector's decision in equilibrium depends ultimately on the opportunity cost of current consumption and the level of taxation in the first period. Further recommendations include the segregation of the private sector into its constituents, the extension of the model to **n** periods, and the introduction of tax evasion and morale.

Introduction

Nine years after the recession that hit the modern capitalist world with consequences of catastrophic proportions for the welfare state, the abolishment of the middle class, the increase in income inequality, and the desertification of business and entrepreneurial activity, Greece's labour and capital markets are ostensibly recovering, albeit at low rates of growth. Following its entry in the European Union in 1981 as one of the proponents of the united European community, Greece submitted its monetary authority to the European Central Bank, abandoning the archaic drachma and instating the common Euro currency distributed to all members of the Euro common currency zone in 2002. Following a period of financial growth, the Greek economy witnessed a decrease of 18.05% in GDP/capita over the years 2009-2012 and an abrupt increase in unemployment, peaking at 27.47% of the labour force in 2013 (OECD, 2019).

The liquidity crisis of Greece has its roots in the unpropitious practice of sustained government deficits coupled with a commensurate current account deficit and the continuous decline in the economy's competitiveness (Gortsos, 2017; Nelson, Belkin, & Mix, 2011; Repousis, 2015; Stournaras, 2016). In the wake of the international financial crisis of 2007, the Greek banking system was minimally exposed to securitized financial products issued by US banks and was not affected directly and significantly by the events that triggered the financial crisis. However, Greek domestic banks were heavily reliant on the Eurosystem and in the midst of strained financial conditions in the euro area had limited access to wholesale market liquidity. To make matters worse, interbank liabilities approaching maturity were pressuring the system's liquidity supply even further. Consequently, the adoption of a recovery program by the Greek government to bailout the banking system materialized in December 2008 (Gortsos, 2017). This program, which totaled €28 billion, consisted of bank bond guarantees, Greek government bonds, and preference stock issuance with a set annual return of 10%. This posed an additional risk component for the solvency of the state in an already bleak outlook of its budget balance, and led to severe fiscal imbalances in the year of adoption and forth. The accumulation of foreign debt throughout years of deficit spending in unison with the deterioration of the current account led to an upsurge in borrowing costs and risk premia on sovereign debt. The fiscal crisis of the state had important adverse spillover effects on the banking system via government bonds and

guarantees utilized as collateral. Greek sovereign debt was successively downgraded, which in turn downgraded the ratings of Greek credit institutions and led to the significant tightening of their liquidity position (Collins, 2015). A decline in bank deposits and repos, which hampers the extent of credit available for the economy, was estimated at 30% in the period 2009-2015 (Gortsos, 2017; Repousis, 2015). Inevitably, Greece was excluded from international capital markets and, in the absence of a sovereign mint, was financed by the European Central Bank, the International Monetary Fund, and the European Commission jointly for what was the first Greek government bailout package amounting to €110 billion in May 2010 (Gortsos, 2017). Even after the first package, the enfeebling recession made it progressively harder for households and Small & Medium Enterprises (SME) to service their debts, increasing the ratio of Non-Performing Loans (NPL) to Total Loans more than fourfold from 2010 to 2015, a crippling implication for the banking sector's liquidity (Gortsos, 2017, Repousis, 2015).

Greece came against serious complications when seeking finance from the newly instated European financial support mechanisms such as the European Financial Stability Facility (EFSF), European Stability Mechanism (ESM), European Financial Stability Mechanism (EFSM). The president of the Bank of Greece, Yannis Stournaras, admitted that Greece did not benefit from the asset purchase program of the ECB because Greek banks could not issue covered bonds or asset backed securities that met the criteria for admission to these mechanisms, in addition to Greek government bonds being considered as ineligible collateral for refinancing operations (Stournaras, 2016). Thus, another mechanism managed (for Greek banks) by the Bank of Greece called Emergency Liquidity Assistance (ELA) was introduced in order to finance private commercial banks by funds provided by the European central banks against a higher interbank rate than the other available mechanisms. Greece had to go through three rounds of recapitalization, the first in 2013 after a sovereign debt write-off and Private Sector Involvement of 48%, the second in 2014 as part of the Asset Quality Assessment by the ECB following its macroprudential policy measures, and the third in 2015 after a stress test conducted owing to the general uncertainty that prevailed in the first half of that year (Stournaras, 2016). Greece also underwent a period of recurrent bank resolutions, 14 in total from 2011 until 2016, and whose difference in assets and liabilities were financed by the Hellenic Financial Stability Fund.

After years of financial instability and political turmoil, Greece has reentered the international capital markets. It was Greek bank bonds first and subsequently Greek sovereign bonds which reentered the market and witnessed their credit ratings climb for the first time since 2010. After twenty years of sustained and consecutive government deficits, the Greek government achieved a positive balance on the National Ledger in 2015 with a balance of 0.49% of GDP and has maintained a positive balance ever since. In 2018 the government surplus was 1.08% of GDP whereas the highest deficit recorded was -15.14% in 2009 (OECD, 2019). However, due to the extensive borrowing for debt servicing and bank recapitalization, the government has accumulated debt further. In fact, Greece's debt to GDP ratio has recorded its highest value since 1995 at 188.7% of GDP in 2017, raising the possibility of another credit crisis due to unsustainable and non-performing debt (OECD, 2019). The government's leverage is important to the sustainability of the Greek banking sector because, as we saw, many of the securities and loans were issued on the premises of being guaranteed by the Greek state. Therefore, the sustainability of the sovereign debt depends on the fiscal policy and the implications that policy will have on the credit rating of the Greek government. Compared to 2010, when the first bailout package was administered, general government debt has risen by 46% (OECD, 2019), while the Gross Fixed Capital Formation growth rate (an indicator of investment and recycling of GDP into the economy through investment) has dropped significantly below 0 in 2018, reaching a low of approximately -12% (Hellenic Statistical Authority, 2019). In order to avoid another disastrous fiscal crisis threatening to contaminate the banking sector, a means to reducing government debt and therefore improving its credit capacity is required.

The purpose of this paper is to provide an analysis of a tax-based parallel payment system proposed by Varoufakis (2014) and examine under which conditions such a system is superior to foreign financing and/or sovereign default. The tax-based parallel payment system was proposed as an alternative solution to the problem of liquidity shortage and increased foreign financing dependency in the face of adverse credit conditions and excessive leverage position of the state instead of a sovereign default on debt. Perhaps the most vivid account of the system's feasibility is the following quote:

"Everyone who has obligations to the state will be willing to accept the pieces of paper with which he can settle the obligations, and all other people will be willing to accept

these pieces of paper because they know the taxpayers, etc., will accept them in turn."(Lerner, 1947, p.313).

The research question formulated is: "Under what circumstances is a tax-based parallel payment system preferred over foreign financing or sovereign default on debt as a solution to a liquidity shortage?"

Payment systems have existed in various forms throughout history, from bartering, to intermediaries, to more recently electronic payment systems and the blockchain. Their integrity and efficiency in completing payments is imperative to the stability of the financial system, as well as to the expansion of credit, economic growth, and confidence in the system. Diamond and Rajan (2006) examine how shifts in the demand for cash relative to deposits can adversely affect the amount of credit, a corollary of robust economic activity, leaving banks exposed to fluctuations in monetary conditions sustained by the banking system. They view banks as liquidity channels through which monetary policy can and should be conducted. In accordance with the previous concept, Merrouche and Nier (2012) posit that fluctuations in credit supplied are inversely associated with the general use of currency as payment medium, proposing that the banking system's viability depends on its capacity to successfully and reliably complete payment transactions. The authors discovered that the establishment of efficient, well-functioning payment systems was positively correlated with the acceleration of credit. Both papers point to the importance of a robust banking system and praise their role as mediums of monetary policy. When the government forfeits the authority to conduct monetary policy through the banking sector, it is unable to inject liquidity into the economy using conventional means. The case where this restriction is in effect and an inquiry into alternative tools of monetary policy and liquidity injections are not examined in the literature.

The expanding financialization of transactions and the prevalence of money as a medium of exchange and store of value necessitated the establishment of institutions that would legitimize a standardized system of transacting between economic agents. Therefore, the term "parallel payment system" defines an apparatus existing in tandem with the official system of settling obligations (i.e. the banking system). Parallel payment systems provide alternative routes, incentives, and capacities to "discharge liabilities incurred as a result of economic activity through transfers of monetary value"

(Summers, 1991, p. 82). The allure of these modes of transacting can be found in both legitimate and illegitimate purposes. The same system of settlement can be used to transfer remittances from migrants to their families at home where the banking sector may be underdeveloped or even absent in certain areas, as well as funding terrorist acts and laundering money generated from illegal operations (Zagaris, 2007). Such systems are prevalent in certain parts of the world even today. In Hong Kong, the underground banking system as represented by chop shops was estimated to be circulating between $10-$20 billion annually through the underground banking system (Trehan, 2003). In Middle-Eastern and Arabic countries the “hawala” and “hundi”, for example, are broker payment systems based on trust that work very similarly to debit/credit card systems of banks and clearing houses, clearing and settling a transaction without the actual physical transfer of funds by creating a claim between the two brokers, just as a debit card creates a claim by the payor’s bank to the payee’s bank. The payment system’s functioning depends on trust just as much as the established banking sector does. The difference is that legal tender and the credibility of the official banking institutions is supported by governments, whereas the aforementioned systems depend on cultural norms, fear of retaliation, and certain codes of honour (Trehan, 2003; Zagaris, 2007). The parallel payment systems examined by the literature so far have been ones employed by the shadow sector of the economy for the purpose of bypassing the legitimate channels of payment or taking up the role of the banking sector where it is absent. However, the case where a sovereign government seeks to bypass the banking sector for the sake of liquidity and implement an alternative way for settling obligations between economic agents has not been argued.

In the wake of globalization, it would be naïve to limit an application of an official parallel payment system in the context of a closed economy. Political connections play an important role in the global diplomacy game, and economic interests are a prime concern of all political governments and institutions. An open economy, however, does not predicate a failure of the parallel payment system, nor does the system itself threaten political stability and global order. The system could be a lucrative foreign investment opportunity for both greenfield and brownfield Foreign Direct Investment (FDI). In a common currency area like the Eurozone, the absence of an exchange rate and a sovereign monetary authority render a sovereignty incapable of

maintaining its competitive edge versus the rest of the members of the area without reducing tax rates and consequently, deterioration of tax revenue and public services.

The stability of the financial system has long been dependent upon sovereign power and ultimacy in order for confidence and trust to be maintained in it (Peacock, 2006; Summers, 1991). Nevertheless, governments are considered themselves economic agents and account for their economic activity using similar accounting principles as the rest of the economy's participants. When sovereign economic performance slumps and the finances of the state deteriorate, the credibility of governments as guarantors of loans and providers of collateral also dissipates. This can lead to financial crises whose severity depends on the degree to which financial products such as asset-backed-securities and high-value loans are exposed to the adversity of a reduction in sovereign credit rating (Mainelli & Manson, 2011). Under the circumstances of the Eurozone, where monetary authority has been unified but fiscal and political authority retained within the sovereignties, governments of member states are presented with two options when funding is scarce; either borrow at higher rates or embrace austerity to reduce the deficit. Austerity by itself is detrimental to the economy and evokes deflationary forces which hamper economic growth, especially when a sovereignty finds itself deeply and unsustainably indebted. Against the ostensible stalemate of austerity, a corollary of the sovereign debt and liquidity crisis in Greece in the context of the Eurozone, a national government seeks creative solutions as an ailment to the crumbling economy in order to safeguard the incomes and quality of life of its constituents. One such initiative was the proposal of a tax-based parallel payment system by Yanis Varoufakis, the minister of finance in Greece during the first half of 2015, which sought to settle internal debts in the Greek economy in order to alleviate part of the credit crunch and provide some degree of liquidity to the economy through the government and not the banks.

From an economics and systems theory perspective, fragmenting the banking sector and diversifying the means through which economic agents can complete transactions safely and efficiently reduces the risk of systemic failure (Mainelli & Manson, 2011). Schumacher (1973) challenged the benefit of consolidation and scale in the financial sector and supported that decentralization and regionalization would minimize the social dislocation of financial system breakdowns. Furthermore, the increasing interconnectedness of financial institutions attributable to globalization lead

to increased risk for systemic banks, consequently intensifying the threat of a financial crisis at a specific part of the complex compromising the resilience of the whole (Mainelli & Manson, 2011). Through the prism of systems theory, Mainelli & Manson (2011) argue that a failure in the financial sector should not bring about the systemic failure of the whole, should not create material losses for a large class of innocent individuals, and should not create a large direct loss to the government or taxpayers. These are objectives which a parallel payment system instigated by the government seeks to achieve. Having said that, the role of the government as an institution of fiscal regulation in providing liquidity and payment system efficiency when the conventional systems of payment and monetary authority are at a stalemate has sparsely been debated.

Some research papers have elucidated the long-term costs of a sovereign default. Kuvshinov and Zimmerman (2019) claim that the negative impact of a sovereign default on GDP is accentuated by cost of transitioning to autarky and a subsequent to the default banking crisis by means of drastically reduced investment and credit. In their analysis, the estimated cost of default peaks at 9.5% of GDP, and suggest to regulate and maintain domestic bank's financial robustness. Esteves and Jalles (2016) estimate that capital inflow reductions persist at a level above 70% five years past the default event, and identify the existence of credit rationing to the domestic sector by virtue of depressed foreign financing as a negative supply shock rather than lower demand for finance. Alonso-Ortiz, Colla, & Da-Rocha (2017) use a continuous time series model of government defaults to compare stock price trends and sovereign debt risk premiums to estimate the cost of default in terms of total factor productivity, which they evaluate at 5.88%.

In the following sections, a review of the relevant literature accompanied by a description of the proposed parallel payment system and its mechanics will be presented. Next, the framework and particularities of the model will be explicated, followed by a discussion on the results. The final sections of the paper address the conclusions and remark the limitations and recommendations for advancing the accuracy of the model in display.

Theoretical Framework & Methodology

Description of the Parallel Payment System

The parallel payment system, as conceptualized by Varoufakis (2014), was officially devised in November 2014 and submitted to public media in 2015.

The aims of implementing a parallel payment system are summarized in the following three prepositions:

1. The provision of liquidity to the public sector.
2. The provision of liquidity to the private sector via a new transaction mechanism in euro-denominated units accessible to all citizens and outside the direct influence of the banking system, involving zero transaction costs.
3. The minimization of the social repercussions of a potential abolition of the common currency and reinstitution of a national currency.

The technical and legal nature of the apparatus is a digital currency reserve account system existing on the platform of the tax authorities called TAXISnet. These unique taxpayer accounts allow for the following functions:

1. Partial or Full debt settlement of the public sector to private entities in accounting units called Future Tax Relief (henceforth FTR's) which correspond to €1 per FTR.
2. Debt settlement between private entities in FTR's, as well as from private sector to public sector.

A Future Tax Relief unit is defined as an accounting unit which is either bestowed (by the state) or bought by private entities against €1 each in period t, which can compensate tax or other debt obligations to the public sector of €$(1+\rho)$, where $0<\rho<1$ at the end of period t+1.

The reserves of the accounts will result from funds either transferred by the public sector to the respective private entity as settlement of due debt or purchased by private entities at the exchange rate of 1 FTR/€.

As an accolade for maintaining a positive balance in the particular taxpayer's account, the amount of "unused" FTR's yields a return of θ (is increased by $1+\theta$) at the end of year t+1 following the year of issuance t. For example, if there are 100 units of

FTR left unused the end of year t+1, that amount increases to $100 * (1 + \theta)$ at the beginning of t+2 and can be used to redeem either €$100 * (1 + \theta)$ by the end of t+2 or $100 * (1 + \theta)(1 + \rho)$ during t+3.

A private entity can choose to utilize its FTR reserves in three ways:

1. Use them directly or in the future to pay taxes to the state. These can be in the form of any tax, including fines.
2. Use them to settle debt obligations to third private parties (also taxpayers of the system) by crediting their current reserve account.
3. Maintain the balance as a financial investment.

In its very crude essence, this system transforms current promises to pay in both current and future promises to forego payments, or equivalently, current debt and interest expense to current and future foregone tax revenue.

A simplified example depicts how the parallel payment system encompasses an injection of liquidity within the real economy (Varoufakis, 2014).

The effectiveness and magnitude of the benefit to the public sector depends naturally on the propensity of private entities to use their reserves of FTR's for current period tax payments. To incentivize intertemporal substitution and retainment of FTR's for future use, the future tax payment discount factor ρ has been introduced i.e. 1 FTR today settles €(1+ρ) of tax payments the following year.

Below a numerical example of the system's interactions and effects to liquidity and tax revenue foregone is presented. The situation is as follows:

Suppose that the system involves the state, two business enterprises (A and B), two employees in the labour force of A and B (1 and 2 respectively), and a random citizen. The roles are indicative of the layers of economic activity in which debt outstanding has pervaded within the Greek economy. For simplicity, suppose that the public sector is indebted only to company A by an amount of €100.000 and that the sum of private debt does not exceed that of public debt.

- The Public Sector owes 100.000 to A.
- A owes 25.000 to B, 20.000 to the Public Sector, and 1.000 to Employee 1.

- B owes 24.000 to the Public Sector, and 1.000 to Employee 2.
- Employee 1 owes 150 to the Public Sector.
- Employee 2 owes 150 to the Public Sector, and 400 to the Citizen.
- The Citizen owes 400 to the Public Sector.

Table 1: *Entity Taxpayer Account Transactions in FTR.*

Company A	**Company B**	**Employee 1**	**Employee 2**	**Citizen**
+100.000 (from public sector)	**+25.000** (from A)	**+1.000** (from A)	**+1.000** (from B)	**+400** (from 2)
-25.000 (to B)	**-24.000** (taxes to public sector)	**-150** (taxes to public sector)	**-150** (taxes to public sector)	**-400** (taxes to public sector)
-20.000 (taxes to public sector)	**-1.000** (to 2)		**-400** (to Citizen)	
-1.000 (to 1)				
Balance = +54.000	**Balance = 0**	**Balance = 850**	**Balance = 450**	**Balance = 0**

(Varoufakis, 2014)

The Public Sector has therefore reduced its liquidity need by substituting current need for liquidity with future need for liquidity as a result of foregone tax revenue.

Table 2: *Public Sector Balance Sheet.*

Public Sector Account	
Liabilities/Owner's Equity	**Tax Debt Settlements**
100.000	**20.000** (A)
	24.000 (B)
	150 (1)
	150 (2)

	400 (Citizen)
Balance = 100.000	**Balance = 44.700**
Final Balance Transferred to Next Period = 100.000 – 44.700 = 55.300	

(Varoufakis, 2014)

Assuming that the involved parties accept the full amount of debt be settled in FTR, the public sector has reduced its liquidity need dramatically by 55.3%.

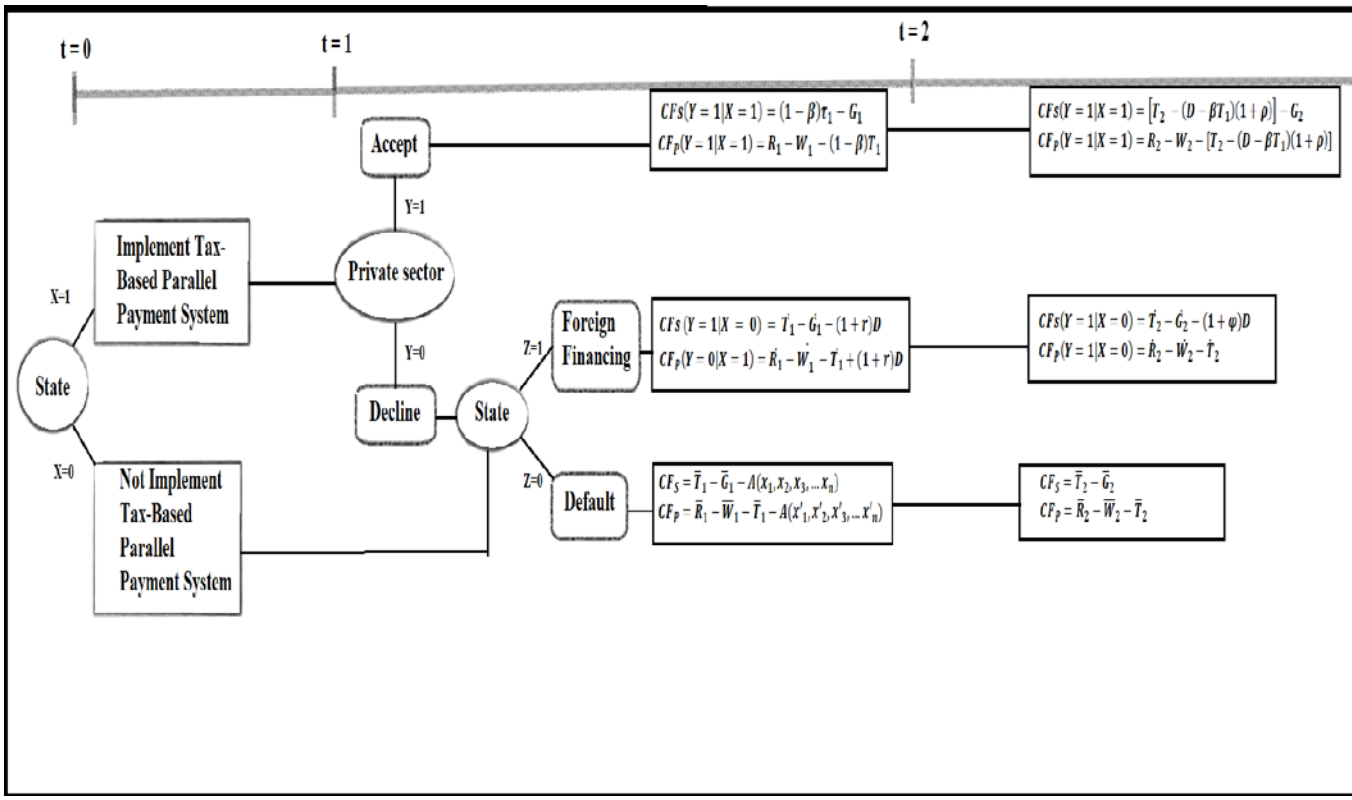
Description of the Model

The framework utilized is Game Theory and its application between the agents involved in the aforementioned transactions. The basic form of the model pertains to the interaction between the state and private sector in the context of compliance to tax authority under profit maximization and risk neutrality. Therefore, expected outcomes manifest in their nominal pecuniary valuations without initially taking into consideration risk premiums or management objectives (such as eradication of competition, lobbying, collusion towards monopolization, efficiency wages etc.) other than the maximization of profit. In addition, the outcomes are considered certain and therefore probability theory will not be utilized. As a consequence of initial simplicity, voluntary tax evasion is considered an impossible alternative.

The first model will be portrayed by a sequential two-period game. Consider two agents, the state (S), and the private sector (F). The state can choose between implementing the system (X=1) or not implementing (X=0). Subsequently, the private sector can either accept (Y=1) or decline (Y=0). In the case that the private sector declines, the state must finance expenditure by borrowing from abroad. If the state resolves to not implementing, it must seek foreign financing (Z=1) or default on its debt (Z=0). The state must make a decision at the beginning of year 1 (t = 0), after which the private sector decides on whether to accept or decline. A decision tree of the game is presented in Timeline 1.

The outcomes are determined at the end of year 1 (t = 1) and at the end of year 2 (t = 2) respectively. The objects of analysis are the cash flows of the state and private sector. Both actors are risk neutral. The debt component found in this model pertains to internal debt i.e. **(**D**)** is only held by the private sector. It is assumed that only two

periods, present and future, are relevant for the initial model with respect to expected outcomes. For the state, the cash flow consists of tax revenue T_i, government spending G_i, public debt due D_i, and interest rate on debt **r**. Furthermore, the most basic version of the model assumes that there is only one internal debt component of the state to the private sector due at the end of year 1 (t=1). In the event that foreign financing is chosen, the external debt liability appears as an outflow on the state's cash flow. The decision variables of the state are the choice to implement the parallel payment system or not i.e. X**,** the choice to seek foreign financing or default on its debt i.e. Z, the amount of tax revenue to be collected, T_i, and the percentage increase ρ in the value of tax euros a unit of FTR issued at $t = i$ can disburse at $t = i + 1$ i.e. 1 FTR issued at $t = 1$ is worth €(1+ρ) of taxes in $t = 2$. The private sector's decision variable is the choice to accept or reject i.e. Y and the percentage of taxes to be paid using FTR, β, with $0 \leq \beta \leq 1$. It is assumed that markets, including the labour market, are perfectly competitive, therefore in the pilot version of the model, revenues and expenses are considered exogenous i.e. prices are derived from the market.



Timeline 1. Decision tree of the game. The ellipses represent the players, the curved boxes represent choices made by the respective actors, and the solid line rectangles present the resulting cash

flows. The line above the tree represents time. The nodes and boxes within the distance between the boundaries of time periods occur in the period denoted by the left boundary.

The terms CF_S and CF_P represent the cash flows of the state and the private sector respectively. The dots above the variables indicate that the values of those variables are specific to the foreign financing scenario. Without the implementation of the parallel payment system, the state must choose between defaulting or seeking foreign financing the cash flow of the state at t = 1 is given by

$$CFs\ (Z = 1|X = 0)\ =\ \dot{T}_1 - \dot{G}_1 - (1 + r)D \quad (1)$$

after assuming foreign debt.

With implementation, the cash flow expression changes to

$$CFs(X = 1|Y = 1) = (1 - \beta)T_1 - G_1 \ (2)$$

if the private sector accepts payment in FTR and

$$CFs\ (Z = 1|Y = 0) = \dot{T}_1 - \dot{G}_1 - (1 + r)D \ \ (3)$$

if the private sector declines and the state assumes additional foreign debt for debt servicing.

Whether the state chooses foreign financing or default after its offer has been declined is ascertained by the same condition as when the system is not implemented. Likewise, the cash flows of the private sector for each scenario are given by the functions

$CF_P(Z = 1|X = 0) = R_1 - W_1\ \ - \dot{T}_1 + (1 + r)D$ (4) under foreign financing and

$$CF_P(Y = 1|X = 1) = R_1 - W_1\ \ - (1 - \beta)T_1 \ (5)$$

upon accepting or

$$CF_P(Y = 0|X = 1) = \dot{R}_1 - \dot{W_1}\ \ - \dot{T}_1 + (1 + r)D \ (6)$$

upon declining the FTR system,

where $\boldsymbol{R_i} = (R_i, \dot{R}_i)$ is revenue, $\boldsymbol{W_i} = \left(W_i, \dot{W}_i\right)$ is expenses, $\boldsymbol{T_i} = (T_i, \dot{T}_i)$ is the tax amount at t = 1, and **β** the percentage of tax paid using FTR.

At t = 2, the cash flow equations become

$$CFs(Z = 1|X = 0) = \dot{T}_2 - \dot{G}_2 - (1 + \varphi)D \quad (7)$$

as an outcome of foreign debt undertaking, while following implementation yields

$$CFs(Y = 1|X = 1) = \left[T_2 \ - (D - \beta T_1)(1 + \rho)\right] - G_2 \ (8).$$

With respect to the private sector,

$$CF_P(Z = 1|X = 0) = \dot{R}_2 - \dot{W}_2 - \dot{T}_2 \ (9)$$

after foreign financing, and

$$CF_P(Y = 1|X = 1) = R_2 - W_2 - [T_2 - (D - \beta T_1)(1 + \rho)] \ (10)$$

after the implementation of the FTR system.

With regards to the scenario of default, $A(x_1, x_2, x_3, \dots x_n)$ is a function exogenous to the model but determined by an array of socioeconomic, political, and ethical variables $x_1, x_2, x_3, \dots x_n$ and represents the total cost of defaulting on debt expressed in a subjective pecuniary amount. The clarification of the identities and values of these costs are beyond the scope of this paper.

The cash flows of both state and private sector in the event of a default are defined as

$$CF_S(Z = 0) = \bar{T}_1 - \bar{G}_1 - A(x_1, x_2, x_3, \dots x_n) \ (11),$$

$$CF_P(Z = 0) = \bar{R}_1 - \bar{W}_1 - \bar{T}_1 - A'(x_1, x_2, x_3, \dots x_n) \ (12) \text{ at t = 1 and}$$

$$CF_S \ (Z = 0) = \bar{T}_2 - \bar{G}_2 \ (3.2),$$

$$CF_P(Z = 0) = \bar{R}_2 - \bar{W}_2 - \bar{T}_2 \ (13) \text{ at t = 2.}$$

The tilde above the variables indicates that they are specific to the default on debt scenario.

The linear cash flow functions relevant to the scenario of the parallel payment system's implementation presented above are displayed in Figure 1. Higher values of β improve the cash flow of the private sector proportionately to how they worsen the cash flow of the state. To maintain the same level of cash flow, the state requires and the

private sector withstands higher values of T_1. The cash flows relevant to t = 2 for the FTR system are 4-dimensional functions and thus will not be displayed.

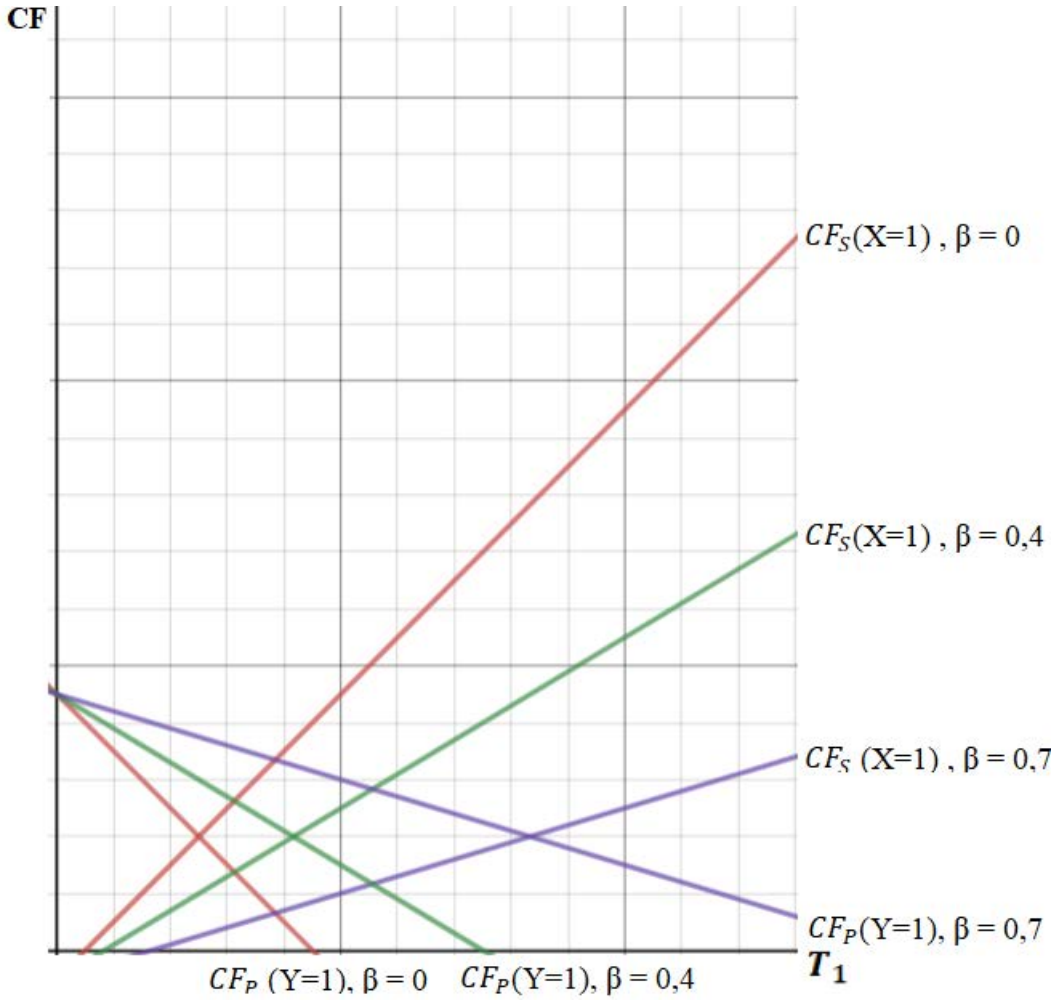


Figure 1: The cash flow functions with respect to T1 are linear. The downward sloping lines correspond to the cash flow of the private sector, whereas the upward sloping represent the cash flow of the state. The different pairs of lines that form with different values of β are displayed.

In order to examine when implementing the parallel payment system is better than foreign financing it is presupposed that the option of defaulting on debt is simultaneously inferior to foreign financing and to the tax-based parallel payment system. Therefore, the Intertemporal Cash Flows of the players in both FTR system and foreign financing must be greater than their Intertemporal Cash Flows (ICF) counterparts in the event of a default. The above conditions are satisfied by assumption in order to focus on the differences between the FTR system and foreign financing and how these would affect the final decision to implement or not by the state and to accept or not by the private sector. Therefore, I assume

Assumption 1. $\mathrm{CF}^{\mathrm{FTR}}_{\mathrm{P},\ t=2} * \mathrm{k} + \mathrm{CF}^{\mathrm{FTR}}_{\mathrm{P},\ t=1} > \mathrm{CF}^{\mathrm{DEFAULT}}_{\mathrm{P},\ t=2} * \bar{\mathrm{k}} + \mathrm{CF}^{\mathrm{DEFAULT}}_{\mathrm{P},\ t=1}$

Assumption 2. $\mathrm{CF}^{\mathrm{FTR}}_{\mathrm{S},\ t=2} * \mathrm{k_s} + \mathrm{CF}^{\mathrm{FTR}}_{\mathrm{S},\ t=1} > \mathrm{CF}^{\mathrm{DEFAULT}}_{\mathrm{S},\ t=2} * \bar{\mathrm{k}}_\mathrm{s} + \mathrm{CF}^{\mathrm{DEFAULT}}_{\mathrm{S},\ t=1}$

Assumption 3. $\mathrm{CF}^{\mathrm{F.F.}}_{\mathrm{P},\ t=2} * \dot{\mathrm{k}} + \mathrm{CF}^{\mathrm{F.F.}}_{\mathrm{P},\ t=1} > \mathrm{CF}^{\mathrm{DEFAULT}}_{\mathrm{S},\ t=2} * \bar{\mathrm{k}} + \mathrm{CF}^{\mathrm{DEFAULT}}_{\mathrm{S},\ t=1}$

Assumption 4. $\mathrm{CF}^{\mathrm{F.F.}}_{\mathrm{S},\ t=2} * \dot{\mathrm{k}}_\mathrm{s} + \mathrm{CF}^{\mathrm{F.F.}}_{\mathrm{S},\ t=1} > \mathrm{CF}^{\mathrm{DEFAULT}}_{\mathrm{S},\ t=2} * \bar{\mathrm{k}}_\mathrm{S} + \mathrm{CF}^{\mathrm{DEFAULT}}_{\mathrm{S},\ t=1}$

The variable *k* represents the subjective valuation of future flows as described by time discounting and preference (Frederick, Loewenstein, & O'Donoghue, 2002) by the private sector, and k_s the subjective valuation of future flows by the state. For simplicity, I assume that the state and the private sector value their existence in the present and in the future equally and across the different scenarios. Therefore,

Assumption 5. $\mathrm{k_s} = \dot{\mathrm{k}}_\mathrm{s} = \bar{\mathrm{k}}_\mathrm{s} = \mathrm{k} = \dot{\mathrm{k}} = \bar{\mathrm{k}} = 1$

The state also cannot finance its spending solely by borrowing and therefore needs to have some tax revenue both in the present and the future. Therefore

Assumption 6. $\mathrm{T}_2 > 0\ , \mathrm{T}_1 > 0, \dot{\mathrm{T}}_2 > 0\ , \dot{\mathrm{T}}_1 > 0.$

In order for the FTR system to be preferred over foreign financing and consequently accepted by the private sector, the ICF of the private sector under the tax-based parallel payment system must be greater than or equal to the sum of the ICF yielded by foreign financing. In other words, the state wishes to uphold the inequality

$$\{R_2 - W_2 - [T_2 - (D - \beta T_1\ )(1+\rho)]\}k + R_1 - W_1\ - (1-\beta)T_1$$

$$\geq$$

$$\{\dot{R}_2 - \dot{W}_2 - \dot{T}_2\}\dot{k} + \dot{R}_1 - \dot{W}_1\ - \dot{T}_1 + (1+r)D$$

Setting $\pi = (R_2 - W_2)k + (R_1 - W_1\ )$ & $\dot{\pi} = (\dot{R}_2 - \dot{W}_2)\dot{k} + (\dot{R}_1 - \dot{W}_1\ )$ and solving yields

Assumption 7. $\{T_2 k + T_1(1 + \beta[(1+\rho)k - 1]\} - (\dot{T}_2\dot{k} + \dot{T}_1) \leq (\pi - \dot{\pi}) + [(1+\rho)k - (1+r)]D$ (14),

For simplicity, it is also assumed that the state needs to be solvent in the future period (t = 2). Therefore

Assumption 8. $T_2 = G_2 + (D - \beta T_1)(1 + \rho)$ (4.2)(15)

$$\dot{T}_2 = \dot{G}_2 + (1 + \varphi)D \text{ (4.3)(16)}$$

Logic dictates that the amount paid in FTR in t = 1 cannot exceed the total amount of FTR in circulation.

Assumption 9: $\beta T_1 \leq D$

The state's objective is to implement the FTR system while at the same time satisfying the condition of acceptance of the FTR system by the private sector. Solvency in the future period is not strictly required in the broader version of the model, given the assumption that the default option is inferior to both parallel payment system and foreign financing and the state is not denied access to capital markets because of its leverage. However, the case of required solvency in t = 2 will be examined to illustrate the effect of β with greater clarity.

The ICF of the state under the FTR system is defined as $ICF_S^{FTR} = \left[T_2 \ - (D - \beta T_1)(1 + \rho)\right] - G_2 + \ (1 - \beta)T_1 - G_1$ (5.1)(17) whereas the ICF of the state after foreign financing is defined as $ICF_S^{F.F.} = \dot{T}_2 - \dot{G}_2 - (1 + \varphi)D + \dot{T}_1 - \dot{G}_1 - (1 + r)D$ (5.2)(18). It is assumed that the state's objective is to implement the FTR system (i.e. X=1). The state sets $T_1, T_2, \dot{T}_1, \dot{T}_2, \rho$ so that its expected intertemporal cash flow under the FTR system is greater than its intertemporal cash flow under foreign financing. If the above condition is unattainable given the variables that the state can influence, the state chooses not to implement the system (i.e. X=0) and subsequently proceeds to decide between foreign financing (Z=1) and default on debt (Z=0), an analysis which is beyond the scope of this paper. Therefore, the objective function of the state and the relevant decision variables are:

$$(ICF_S^{FTR} - ICF_S^{F.F.}) \geq 0 \ _{(\boldsymbol{T_1}, \boldsymbol{T_2}, \dot{\boldsymbol{T}}_{\boldsymbol{1}}, \dot{\boldsymbol{T}}_{\boldsymbol{2}}, \boldsymbol{\rho})}$$

$$\Leftrightarrow [T_2 + T_1(1 + \rho\beta)] - \left(\dot{T}_2 + \dot{T}_1\right) \geq (G_2 + G_1) - (\dot{G}_2 + \dot{G}_1) - (1 + \varphi + r - \rho)D \text{ (19)}$$

$$\text{subject to} \qquad T_2 > 0\,, T_1 > 0, \dot{T}_2 > 0\,, \dot{T}_1 > 0.$$

$$\rho \geq 0$$

$$T_2 = G_2 + (D - \beta T_1)(1 + \rho)$$

$$\dot{T}_2 = \dot{G}_2 + (1 + \varphi)D$$

$$\{T_2 k + T_1(1 + \beta[(1 + \rho)k - 1]\} - \left(\dot{T}_2 \dot{k} + \dot{T}_1\right) \leq (\pi - \dot{\pi}) + [(1 + \rho)k - (1 + r)]D$$

It is assumed that a negative cash flow is financed by liquidating capital.

The objective of the private sector is to maximize its ICF. However, since it is assumed that the private sector can affect the decision to accept or decline only by setting the variable β (i.e. the private sector cannot affect its cash flow under foreign financing) and that the state seeks to implement the FTR system, the objective function of interest is the ICF of the private sector under the parallel payment system scenario,

$$maxICF_P^{FTR}(\beta) = \max\{\pi - (T_2 k + T_1) - [(1 + \rho)k - 1]\beta T_1 + (1 + \rho)kD\} \quad (20)$$

Model Analysis

Future Period Solvency Requirement

By substituting equations (15) and (16) into inequalities (14), (19), and (20) we retrieve the following updated conditions

$$(1 - \beta)T_1 - \dot{T}_1 \geq G_1 - \dot{G}_1 - (1 + r)D \quad (21)$$

$$(1 - \beta)T_1 - \dot{T}_1 \leq (\pi - \dot{\pi}) - \left(G_2 k - \dot{G}_2 \dot{k}\right) - [(1 + r) - (1 + \varphi)k]D \quad (22)$$

$$CF_P^{FTR} = \pi - G_2 k - (1 - \beta)T_1 \quad (23)$$

The above expressions are shown as areas bound by the linear equations in Figure 2. The blue line and area represent inequality (22), while the red line and area represent inequality (21). The points of intersection on the x axis indicate the value T_1 must take when $\dot{T}_1$ is zero.

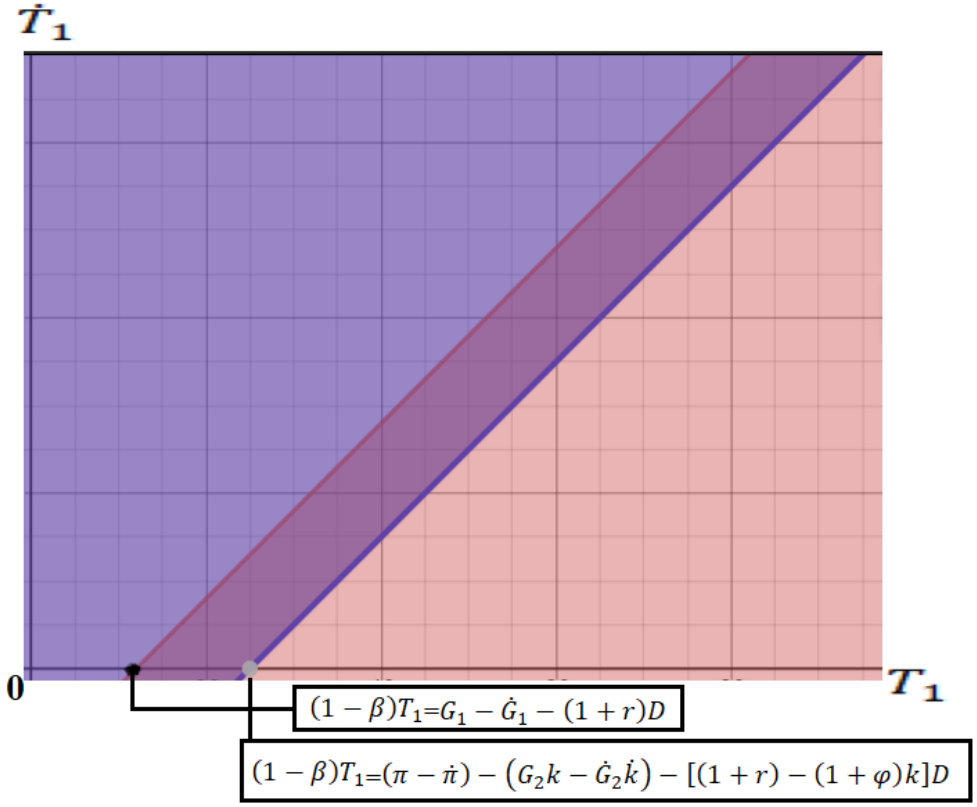


Figure 2. The highlighted areas depict inequalities (21) (red) and (22) (blue). The overlapping area depicts the combinations of T_1 and $\dot{T}_1$ for which both conditions are fulfilled. These particular lines correspond to a single value of β^*. For alternative values of β, the lines rotate on the point X (0, -$\dot{T}_1$)

These points are not achievable however according to assumption 6. The overlapped shaded area represents all possible combinations of T_1 and $\dot{T}_1$ for which the conditions are satisfied and therefore the parallel payment system is successfully implemented.

The term ρ is absent from the expressions, which leads us to the following lemma

Lemma 1. In the case of a requirement for solvency at t = 2, the effect of ρ is proportionately offset by an increase in T_2 to secure the condition of solvency. The units of FTR that the private sector does not use now will be siphoned by a higher tax rate in t = 2 to cover the lack of euro denominated tax revenues.

We observe that a higher value of β requires a higher T_1 to meet the state's objective function condition but at the same time a higher T_1 stresses the participation constraint of the private sector proportionately.

In the absence of intertemporal benefits (due to state solvency requirement) and consumption smoothing considerations, the private sector maximizes its objective function (23) by setting β = 1. This leads to the following proposition.

Proposition 1: If $(\pi - \dot{\pi}) - \left(G_2 k - \dot{G}_2 \dot{k}\right) - [(1 + r) - (1 + \varphi)k]D \geq G_1 - \dot{G}_1 - (1 + r)D$, then the state implements the system and the private sector accepts and sets β = 1.

This, however, renders the FTR system useless, since its effectiveness depends on FTR units being retained for future use. If there is no incentive to substitute current consumption for future consumption, then the private sector uses all of the stock of FTR immediately.

This predicament can be initially mitigated by introducing an intertemporal consumption smoothing incentive (Frederick, Loewenstein, & O'Donoghue, 2002; Wakai, 2013). It encompasses the tendency to "spread" consumption between periods in order to save some income for future consumption. In this particular case it means saving FTR now for use in the future to save euros for consumption and not for servicing tax liability. A cost function C(β) has the properties C′(β) > 0, C′′(β) > 0, 0 ≤ C(β) ≤ C(1) ∀ β $\in [0, 1]$ appended in the objective function of the private sector (23), which also appears on the right side of the participation constraint (22). (22) and (23) become:

$$(1 - \beta)T_1 - \dot{T}_1 \leq (\pi - \dot{\pi}) - \left(G_2 k - \dot{G}_2 \dot{k}\right) - [(1 + r) - (1 + \varphi)k]D - C(\beta) \quad (24)$$

$$CF_P^{FTR} = \pi - G_2 k - (1 - \beta)T_1 - \ \mathrm{C}(\beta) \quad (25)$$

Now, the optimal choice of β is given by setting the first order condition of (25) equal to 0.

Proposition 2: If and only if $(\pi - \dot{\pi}) - \left(G_2 k - \dot{G}_2 \dot{k}\right) - [(1 + r) - (1 + \varphi)k]D - C(\beta) \geq G_1 - \dot{G}_1 - (1 + r)D$, there exists an equilibrium where the state implements the FTR system. The private sector accepts and sets β^* such that $C'(\beta^*) = T_1$. The state sets T_1^* such that $(ICF_S^{FTR} - ICF_S^{F.F.}) \geq 0$ given the conditions under which the FTR system is preferred. Subsequently, depending on the disposition of the state, which can be to boost the private sector or to enhance the budget balance, this

problem can be either a maximization or a minimization problem of the above objective function. However, the objective of the state to implement the system is already achieved at this point. If the state wishes to boost the economy, it becomes a minimization problem with respect to T_1 where the state sets $T_1^* = T_1^{min}$ so that $(ICF_S^{FTR} - ICF_S^{F.F.}) = 0$. Thus, the surplus of $T_1^{max} - T_1^*$ is reaped by the private sector. If however the state wishes to support its budget, perhaps on the premises of future uncertainty of flows, it can choose $T_1^* = T_1^{max}$ whereby $(ICF_S^{FTR} - ICF_S^{F.F.}) > 0$ and the participation constraint of the private sector (24) is equal to 0. The surplus extracted by the private sector is graphically depicted as the horizontal distance of point $(T_1^*, \dot{T}_1^*)$ from the participation constraint curve (8.1). As a general rule then, T_1^* can float between $T_1^{max} \geq T_1^* \geq T_1^{min}$ depending on the state's underlying economic objective of balancing support for the private sector and support for its own finances.

The state can therefore directly affect the choice of $\beta^*$by setting T_1 accordingly. If for some reason the state has a target β^*, it can induce the private sector to select such a β^* by means of a particular $T_1^* = C'(\beta^*)$ and subsequently set $\dot{T}_1$ to satisfy (21) and (24). There may however be some limitation. Since $0 \leq \beta \leq 1$, there may be levels of T_1 high enough that lead to the selection of $\beta = 1$ by the private sector. This effect depends on the subjective form of the cost function C(β) which determines the relevant range of T_1 for which $\beta < 1$.

The effect of moving from β_1^* to β_2^* with $\beta_1^* < \beta_2^*$ is to rotate both participation constraint and objective function curves by the same degrees rightwards (see Figure 6 further below). The relevant range of the degrees within which the curves can rotate is from $0^o$when $\beta = 1$ to 45^o when $\beta = 0$. Therefore, $T_1^* = C'(\beta^*)$ also determines the optimum range of condition satisfying values of $\dot{T}_1$. Interestingly, both curves materialize after the announcement of T_1 and $\dot{T}_1$. This is because β affects the linear coefficient of the two lines, and β is determined by C´(β), which at optimum equals T_1.

Comparative Static Analysis

Inequalities (21) and (24) can be viewed as linear inequalities of the form $x - y \leq A$. What follows is an examination of the parametric composition of A and the effect of a change in one of those parameters, *ceteris paribus.*

$\boldsymbol{\pi}$: This is the aggregate measure the economy's expected performance under the FTR system**.** An increase in π leads to a rightward shift of the blue line to the position of the green line as shown in Figure 3 by the amount of Δπ and vice versa. Essentially, it relaxes the participation constraint of the private sector and allows for greater values of T_1 to be selected for given values of $\dot{T}_1$. The state's objective function curve remains unaffected.

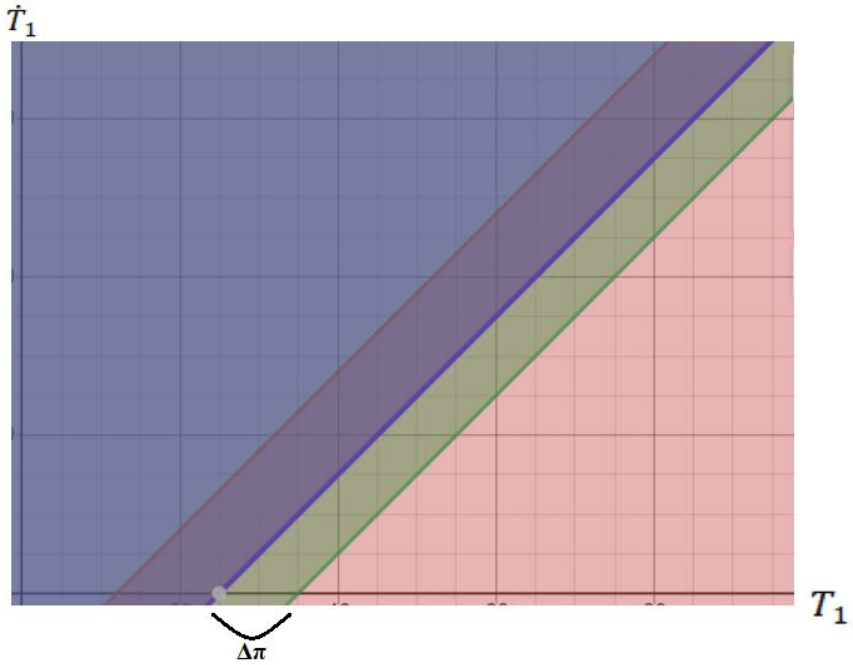


Figure 3. A rightward shift (from blue to green) of the participation constraint curve (24) caused by an increase in π of Δπ.

$\dot{\boldsymbol{\pi}}$**:** This is the aggregate measure of the economy's expected performance under foreign financing. A unit increase in $\dot{\pi}$ leads to a leftward shift of the blue line to the position of the green line by the amount $\Delta\dot{\pi}$, as shown in Figure 4. An increase in this parameter works conversely to its undotted counterpart, since it represents an improvement in the expected performance of the economy under foreign financing and thus constitutes an incentive towards declining a parallel payment system. The state's objective function curve remains unaffected.

$\boldsymbol{G_2}$: This is the expected government expenditure at t = 2 under the FTR system. A unit increase in G_2 leads to a leftward shift of the participation constraint curve from blue to green as shown in Figure 3. The only difference with the shift discussed above is that now the curve shifts by an amount of kΔG_2, and therefore the magnitude of the

particular shift depends on the valuation of future flows by the private sector under the FTR system, k. The state's objective function curve remains unaffected.

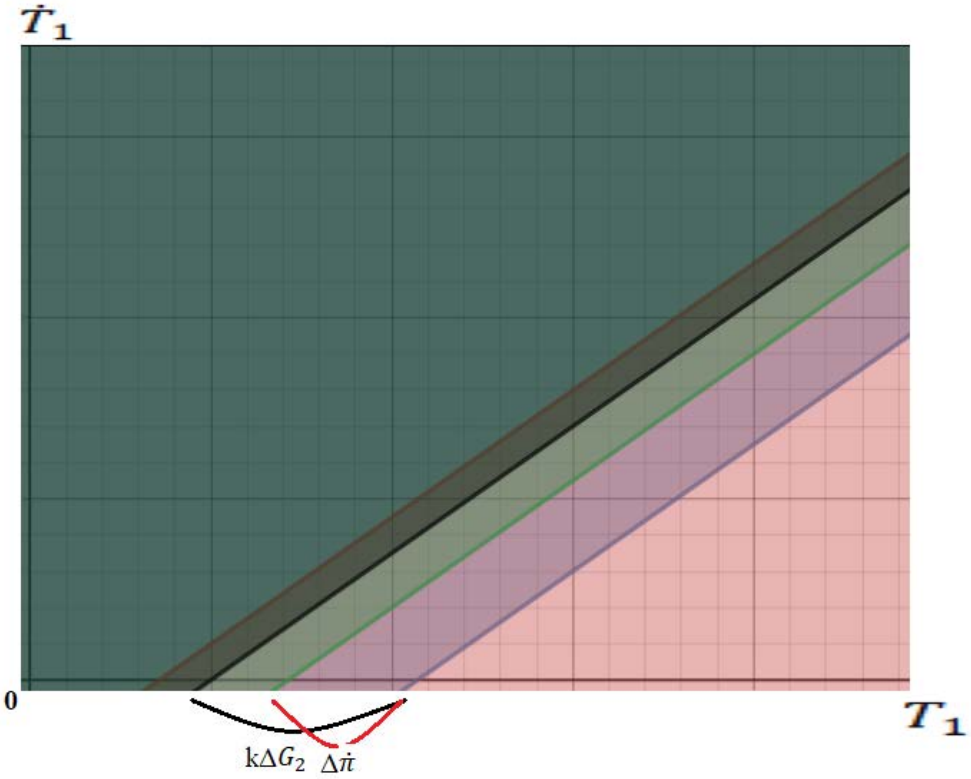


Figure 4. A leftward shift (from blue to green) of the participation constraint curve (24) as a result of an increase in $\dot{\pi}$ and a leftward shift (from blue to black) of the same curve as a result of an increase in G_2 with $k\Delta G_2 > \Delta\dot{\pi}$. The shift becomes rightward by $\dot{k}\Delta\dot{G}_2$ for a unit increase in $\dot{G}_2$ depicted as the shift from black curve to blue curve.

$\dot{G}_2$: This is the expected government expenditure at t = 2 under foreign financing. A unit increase in $\dot{G}_2$ leads to a rightward shift of the participation curve from black curve to blue curve similar to Figure 4. The distance of the shift is $\dot{k}\Delta\dot{G}_2$ and thus the magnitude of the shift depends on the valuation of future flows by the private sector under foreign financing. The state's objective function curve remains unaffected.

$\boldsymbol{G_1}$: This is the expected government expenditure at t = 1 under the FTR system. A unit increase in G_1 leads to a rightward shift of the state's objective function curve from the red line to the green line as shown in Figure 5. The magnitude of the shift is exactly proportional to ΔG_1. The private sector's participation constraint curve remains unaffected.

$\dot{\boldsymbol{G}}_{\boldsymbol{1}}$: This is the expected government expenditure at t = 1 under foreign financing. A unit increase in $\dot{G}_1$ leads to a leftward shift of the state's objective function curve from red to green by an exactly proportional amount to $\Delta\dot{G}_1$. The private sector's participation constraint curve is unaffected.

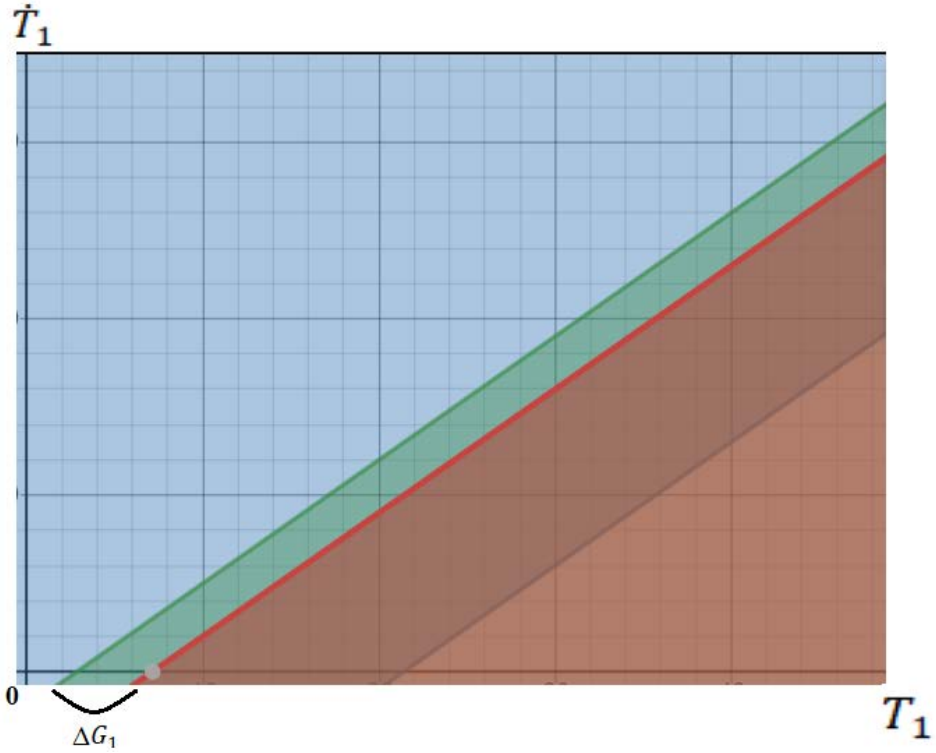


Figure 5. A rightward shift (from green to red) of the objective function of the state (21) as a result of a unit change in G_1.

D: This is the level of internal debt due at t = 1. A unit change in the value of D entails a double effect on both the participation constraint curve (24) of the private sector and the objective function curve of the state. First, a unit change in D leads to a leftward shift in the objective function curve (21) by an amount of $(1+r)\Delta D$. Second, a unit change in D leads to a shift of magnitude $\left[(1+r)-(1+\varphi)\dot{k}\right]\Delta D$ and of ambiguous direction. The direction depends upon the relative value of $(1+r)$ and $(1+\varphi)\dot{k}$. If $(1+r)>(1+\varphi)\dot{k}$, the shift is leftward. If $(1+r)<(1+\varphi)$, the shift is

rightward. Essentially, if the cost of foreign financing which is passed on to the private sector from the state in the form of higher taxes in t = 2 is greater than the benefit of receiving the owed debt plus interest in euros, then there is a greater incentive to accept the parallel payment system and vice versa. In addition, if the shift is parallel for both curves, an increase in D shifts (21) by a greater amount than (24), therefore increasing the total area of overlap between the two curves.

C(β): This is the opportunity cost of the private sector when using units of FTR now instead of the future. A unit increase in C(β) leads to a left and upward shift of the participation constraint (24) by a proportional amount. Since this opportunity cost is linked with β, then β also shifts the participation constraint curve (24) in addition to rotating it. The relevant shifts are depicted in Figure 6. This strains the conditions under which the parallel payment system is preferred over foreign financing.

The terms $\boldsymbol{k}$, $\dot{\boldsymbol{k}}$ are the current valuations of future outflows by the private sector and serve as weights on the key variables $G_2, \dot{G}_2, (1+\varphi)$. An increase in k leads to a leftward shift in the participation constraint curve (24) by an amount of $G_2 \Delta k$ and vice versa. On the contrary, an increase in $\dot{k}$ leads to a rightward shift of (24) by an amount of $[\dot{G}_2 + (1+\varphi)D]\Delta\dot{k}$.

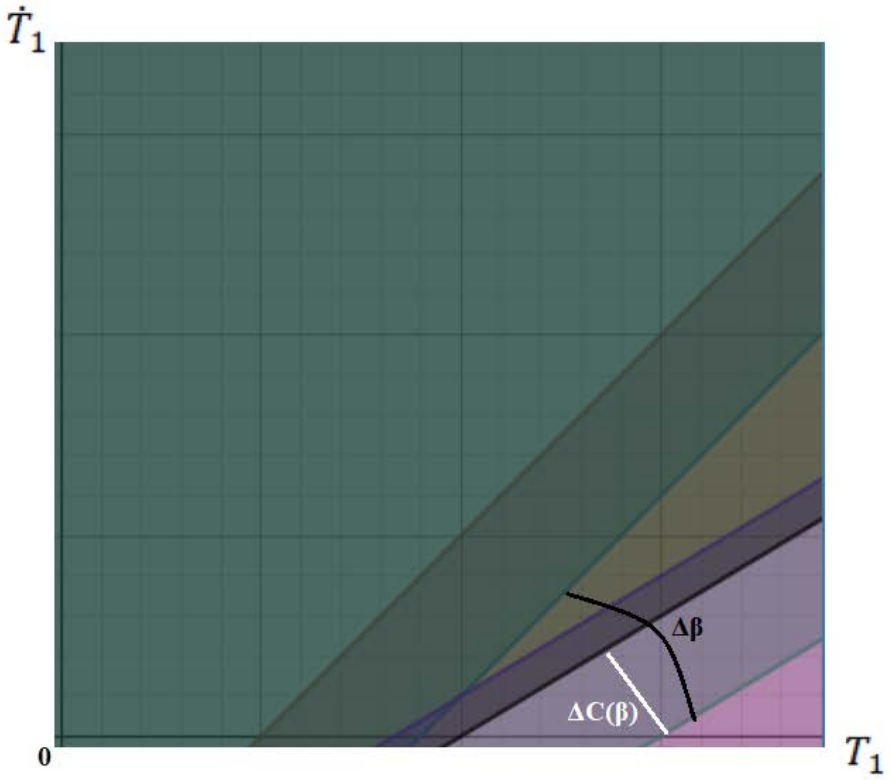


Figure 6: A change in β leads to a rightward rotation of the participation constraint (24) (green to green line) and the objective function of the state (brown to purple line) by the same degrees. Simultaneously, the participation constraint (24) shifts upward (from green to black line) by an amount ΔC(β) originating from the change in β.

Discussion on Results

To answer the research question, it was shown that in order for the tax-based parallel system to be preferred over foreign financing it must be that the condition of proposition 2 holds. In that case, the state can manipulate T_1 and $\dot{T}_1$ in order for the FTR system to be accepted by the private sector (Y=1). If proposition 2 is not satisfied, then the state chooses not to implement (X=0) and proceeds to the next decision node which entails foreign financing (Z=1) versus sovereign default (Z=0) The economic agents must have more positive expectations for the values of key exogenous variables, such as the business cycle π, under the parallel payment system than under foreign financing. Government expenditure must be expected to be adequately greater under foreign financing, and the cost of borrowing φ greater than internal debt interest rate *r*. Overall, if the expectations of economic conditions are more favourable under the parallel payment system (i.e. if implementation of the parallel payment system is expected to affect the economy more positively than foreign financing) and the outstanding internal

debt is sufficiently high, then it is better to implement the system to provide liquidity instead of borrowing from abroad.

The model allows for variation of variable values across scenarios since it is their relative values which determine the outcome. While the choice of β is made at t = 1, the variables pertaining to t = 2 represent the expectations of the players regarding the outcome values of those variables. For example, temporarily exogenous variables such as operational revenues, expenses, and government expenditure are estimated in t = 1. In further analysis, probabilities of realization could be appended to potential values of these variables.

The state can commit to values of T_1 and $\dot{T}_1$ **(**i.e. by setting tax rates accordingly) to uphold the inequality in favour of the FTR system based on its own estimations of future expenditure and the estimations of the private sector regarding the state of economy. Without perfect and symmetric information, the state can infer the variable k and $\dot{k}$ by observing the private sector's investment behaviour and attach a probability to the binary $k > 1$ and $k \leq 1$.

The level and cost of the debt component play a definitive role in shaping the outcome. The interest collected from the state, $\boldsymbol{r}$, is proportionately offset by the cost of foreign credit, $\boldsymbol{\varphi}$, which is also influenced by the future valuation parameter $\dot{k}$. Commonly, debt issued for the purpose of debt servicing, be it domestic or foreign debt, is priced higher than the outstanding debt because the price depends on the current leverage, debt to GDP ratio, and credit rating score given by rating agencies to gauge the credibility of the borrower. Therefore, it is expected that $\varphi \geq r$, suggesting that the economic rationality of borrowing to service debt lies in the subjective valuation of the future, $\dot{k}$. Higher values of $\dot{k}$ indicate a higher value weight on the future, therefore a greater return on debt $\boldsymbol{r}$ today would be required to offset the higher subjective cost of debt $\boldsymbol{\varphi}$ tomorrow. A potential reason for observing discrepancies in the rational valuation of the future is the moral hazard which occurs when the real cost of borrowing is not accounted for properly. A typical principal-agent problem arises, if we consider state officials and elected politicians to be agents of the state, which is the principal. The agent fails to internalize the cost of future fiscal contraction or overestimate their own political cost of not borrowing (Yeyati & Panizza, 2011). Agent's private valuations of the future might be significantly lower than that of the state as an entity,

especially when the cost of borrowing remains with the principal while the particular principal-agent contract is potentially terminated in a finite amount of time.

It is assumed that the values of both endogenous and exogenous variables e.g. $T_1 \neq \dot{T}_1$ differ between the scenarios of FTR system and foreign financing. What is the foundation for assuming that the value of such variables may differ depending on the implementation or not of the parallel payment system?

As Cooper (1999) demonstrates, a choice of labour income tax rate based on *ex ante* expectations of a tax revenue shortfall may lead to a self-fulfilling prophecy, as the private sector (or households) retract their supply of labour, consequently reducing the tax base. This complication leads to two Pareto-ranked equilibria, one being the inefficient high tax rate – low labour supply on the inefficient side of the Laffer curve. With regards to the model of this paper the private sector's revenues R, for example, may be affected by the expectations of the tax rate. If $\dot{T}_1$ is expected to be high, then according to Cooper (1999) this should lead to a diminution of the labour supply and consequently economic output, as proxied by the term $\dot{R}_1$.

Camous and Gimber (2018) demonstrate that accumulated public debt levels determine whether the state can adjust its debt position to achieve an efficient outcome. Furthermore, they argue that excessive public debt places a great burden on economic growth and threatens the stability of the economy, because then the tax-base effect (i.e. requirement of future solvency) of a fall in output outweighs the consumption smoothing effect which the issue of public debt allows. The sequence leading to the inefficient equilibrium begins with the households forming negative expectations about a high income tax rate and thus retracting their labour supply. The reduced labour supply in turn reduces the projected output, which induces the government to fulfill the pessimistic expectations of a high tax rate since new debt cannot be issued cheaply because of the already high leveraged position of the public sector. Camous and Gimber (2018) conclude that the threshold for public debt depends on current spending commitments (G**)**, future fiscal capacity, and the interest rate on borrowing. These prepositions support the idea that, since the FTR system affects inherited debt levels, the macroeconomic variables between the scenarios are very likely to differ.

Furthermore, the greater the debt D in absolute terms, the greater the impact of the cost-benefit differential (i.e. $r - \varphi$) of debt on the participation constraint and the

objective function of the state. If debt levels are significantly high, then it is more likely that the parallel payment system is preferable because the net benefit of not seeking foreign financing is greater in absolute value than with lower levels of debt. The interest earned (or paid) increases ad valorem with the level of debt, thus straining the economy further.

Parallel Payment System Threats

The parallel payment system has certain vulnerabilities. Firstly, in a multi-period model the value of β can fluctuate between periods depending on the other key variables. If the parallel payment system is adopted for continuous use and the supply of FTR is centrally administered (not a one-off issue of FTR units and circulation until they are all redeemed), then managing the system becomes similar to managing the money supply and entails greater risk depending on the volatility of β and the accurate selection of ρ. Estimations on government expenses and expected number of FTR to be redeemed need to be constantly matched in order to meet budget requirements and not fall short of tax revenues, consequently leading to further foreign financing. Therefore, bad management of the FTR supply could lead to another liquidity crisis. This also entails the implication of moral hazard in the sense that if debt could be commonly substituted for future tax reductions, then governments would have an additional incentive to borrow greater amounts and at greater frequencies from their constituents, increasing total leverage in the long run.

Secondly, if FTR are traded in a secondary market, this particular market could be subjected to market manipulation practices by speculators. Since its market capitalization would be relatively small, accumulating a considerable portion of the FTR and withdrawing it from circulation would spur the price of FTR and therefore yield a greater profit margin per unit. This however defeats the purpose of the FTR being circulated within the economy to alleviate the liquidity crisis by settling intra-private sector debts.

Thirdly, if there are foreign interests of economic and strategic importance, then a system which enables a state to achieve a higher degree of economic freedom is viewed with dismay from abroad. It could therefore lead to retaliation from the international institutions by means of sanctions for flouting international treaties

regarding the economic relations of states and their independent interventions in the economy.

Finally, a serious threat of a technical nature is security of information. Since the parallel payment system will also be a part of the digital world, it faces the dangers of data transmission interception and information theft. Although this system is overlooked by the government, the costs associated with a potential breach in security systems and a manipulation of its ledger could be significant.

Conclusion

This paper sought to answer the question under what circumstances would a tax-based parallel payment system be preferred over foreign financing and default on debt for providing liquidity to the economy and reducing general government debt. After setting the relevant intertemporal conditions, it became evident that the feasibility and attractiveness of the system depended on macroeconomic variables such as the state of the economy π, the projected government expenditure G_1, the subjective valuation of the future k, the inherited debt level D**,** the differential of domestic to foreign financing r – φ and the consumption smoothing cost function of using a unit of FTR C(β). It was shown that equilibrium exists only if the private sector's participation constraint i.e. $(\pi - \dot{\pi}) - \left(G_2 k - \dot{G}_2 \dot{k}\right) - [(1+r) - (1+\varphi)k]D - C(\beta)$ is greater than the objective function of the state i.e. $G_1 - \dot{G}_1 - (1+r)D$. The viability of the system depends on values of β selected by the private sector, which in turn are determined by the level of taxation T_1 and the subjective opportunity cost function of the private sector C(β). It was also shown how β affects the required $\dot{T}_1$ for the FTR system to be preferred over foreign financing; lower values of β had to be compensated with expectations of greater $\dot{T}_1$ i.e. the private sector must expect significantly greater taxes under foreign financing in order to compensate for the lesser taxes avoided by using FTR. The state can direct the optimal choice of β by setting T_1 according to the first derivative of C(β) in order to safeguard its fiscal stability and preserve preference in the FTR system. It was also shown that if the assumption of future solvency holds, then the variable ρ has no effect on the outcome. Discussion on the various determinants of the macroeconomic variables under scrutiny yielded that economic conditions and fiscal budget balance depend on the level of inherited debt and the ability of the state to take on additional debt at favourable rates in order for the beneficial

consumption effect to dominate the adverse reduction in the tax base i.e. how the burden of additional borrowing is smoothened across periods based on the terms of the foreign debt instruments. The importance of expectations and confidence was justified through their effect on realized economic output and valuations of future flows.

Limitations & Further Recommendations

The model presented above takes a rudimentary form in which only the discount factor ρ is considered. In order to include the "interest" factor θ it is required that a third period is incorporated into the model. This presupposes that the total amount of FTR is not utilized completely in $t = 2$, but is partially maintained as an investment for $t = 3$. The model can thus be gradually elevated to n periods to fully incorporate intertemporal substitution considerations of ρ and θ. In this two-period game, the prospect of the variable ρ (i.e. the return on FTR saved) being influential to the result is minimized by the two-period setup of the game. When including additional periods, however, the influential power of ρ comes into play.

The tax-based parallel payment system's viability is threatened by the relative values of ρ and β. Specifically, the future tax relief rate ρ is an incentive towards retainment of FTR units for future use and therefore a lower β (Varoufakis, 2014). However, a high future tax relief rate compromises the future tax revenue of the state and increases the risk of insolvency anew. This effect is absent in this model due to its limitation of examining only two periods under the assumption of future solvency. But the future solvency requirement posits a second complication, that of increased tax rates owing to the expectations of the tax authority for a high level of FTR redeemed. The greater the β and ρ, the higher the tax rate required to cover the budget given that FTR units will be redeemed.

In addition, the policy implications on the choice of the aforementioned opportunity cost $C(\beta)$ and its effect in unison with the factors of ρ and θ on the level of redeemed FTR units should be illuminated further.

Another assumption which could be loosened is that of the state having no due debts in future periods, therefore including the option of issuing extra FTR. The cases of both indebted and solvent firms could be considered, thus the private sector's debt due will be either considered due at t = 1 for the indebted firm, or t = 2 (and subsequently t = 3) for the solvent, thus providing insights regarding the decision-making of agents with solvency issues in comparison to agents who are not in direct need of liquidity.

The segregation of the private sector into businesses and households and the ability of those to settle both tax liabilities and private debts using FTR could also provide further insights into the policy implications of different tax instruments and the respective optimal induced values of FTR redeemed by each taxpayer category. Consequently, both entities can benefit from holding FTR now and in the future.

Outside options for allocating funds and sources of financing for the state could be considered by introducing a second decision-making stage in the game for the case of implementation (X=1) where the private sector evaluates investing in FTR (Y=0) or some other financial asset yielding constant y per year (Y=1), a decision made at t = 0 after knowing about the implementation or not of the parallel payment system.

Subsequently and as an auxiliary, the expansion of the game into an additional two stages of interaction, i.e. firms against households and households against the state, could render the analysis a multifarious, universal approach to understanding decision-making of all the categories of agents involved in the scheme. This would also allow for psychological dimensions and diverse management objectives to be embedded in the model and enhance the capacity of the study to suggest policy implications of wider applicability (Walsh, 2012).

Finally, tax evasion is a salient feature of the Greek economy. Integrating the concept of tax morale and the various dimensions of tax compliance would augment the model considerably in explaining real situations accurately, expanding the universal relevance of the model to economies with similar shadow sectors and demographics/psychographics. The standard model of cost-benefit analysis of tax evasion developed by Becker (1968) and Allingham and Sandmo (1972) could be used. Concepts such as evasion deterrence, social norms, fairness and trust, and the role of government, could provide ample interpretative power (Walsh, 2012).

Appendices

Appendix 1

Proof of Proposition 1: Given $0 \leq \beta \leq 1$ and Assumption 6, it is evident that the private sector's cash flow function is maximized with respect to β when the term $(1-\beta)T_1$ is minimized. The value range of this term with respect to β is $0 \leq (1-\beta^*)T_1 \leq T_1$. Therefore, (4.6) is maximized at β = 1, where the term $(1-\beta^*)T_1$ is minimized.

Proof of Proposition 2: If $(\pi - \dot{\pi}) - \left(G_2 k - \dot{G}_2 \dot{k}\right) - [(1+r) - (1+\varphi)k]D \geq G_1 - \dot{G}_1 - (1+r)D$, then there can be no pair of $(T_1, \dot{T}_1)$ that satisfies both (4.4) and (4.5) and foreign financing is the equilibrium outcome. On the other hand, the private sector seeks to maximize (4.7) with respect to β. Therefore it sets the first order derivative of its ICF to 0. This gives $-T_1 - \mathrm{C}'(\beta) = 0 \Leftrightarrow \mathrm{C}'(\beta^*) = {T_1}^*$.

Appendix 2

The algebra employed to reach the final form of (4.5) is henceforth presented.

In order for the private sector to prefer the FTR system over foreign financing, the following inequality must hold:

$$\begin{aligned}\{\boldsymbol{R_2 - W_2 - [T_2 - (D - \beta T_1)(1+\rho)]}\}\boldsymbol{k + R_1 - W_1 - (1-\beta)T_1} \\ \geq \{\boldsymbol{\dot{R}_2 - \dot{W}_2 - \dot{T}_2 + (1+r)D}\}\boldsymbol{\dot{k} + \dot{R}_1 - \dot{W}_1 - \dot{T}_1 + [(1+r) - (1+\varphi)\dot{k}]D}\end{aligned}$$

Subject to

$$\boldsymbol{T_2 - G_2 - (D - \beta T_1)(1+\rho) = 0}$$

$$\Leftrightarrow$$

$$\boldsymbol{T_2 = G_2 + (D - \beta T_1)(1+\rho)}$$

$$\boldsymbol{\&\quad T_2 - G_2 - (D - \beta T_1)(1+\rho) = 0}$$

$$\Leftrightarrow$$

$$\boldsymbol{T_2 = G_2 + (1+\varphi)D}$$

$$\Leftrightarrow$$

$$[(\boldsymbol{R_2 - W_2})\boldsymbol{k} + \ (\boldsymbol{R_1 - W_1})] - \ \{\left[\boldsymbol{G_2} + \left(\boldsymbol{D} - \ \boldsymbol{\beta T_1}\right)(\boldsymbol{1} + \boldsymbol{\rho})\right] - \left(\boldsymbol{D} - \ \boldsymbol{\beta T_1}\right)(\boldsymbol{1} + \boldsymbol{\rho})\}\boldsymbol{k} - (\boldsymbol{1} - \boldsymbol{\beta})\boldsymbol{T_1}$$

$$\geq$$

$$\left[\left(\dot{\boldsymbol{R}}_2 - \dot{\boldsymbol{W}}_2\right)\dot{\boldsymbol{k}} + \left(\dot{\boldsymbol{R}}_1 - \dot{\boldsymbol{W}}_1\right)\right] - \left[\dot{\boldsymbol{G}}_2 + (\boldsymbol{1} + \boldsymbol{\varphi})\boldsymbol{D}\right]\dot{\boldsymbol{k}} - \dot{\boldsymbol{T}}_1 + (\boldsymbol{1} + \boldsymbol{r})\boldsymbol{D}$$

$$\Leftrightarrow$$

Set $\boldsymbol{\pi} = [(\boldsymbol{R_2 - W_2})\boldsymbol{k} + (\boldsymbol{R_1 - W_1})]$,

$$\dot{\boldsymbol{\pi}} = \left[\left(\dot{\boldsymbol{R}}_2 - \dot{\boldsymbol{W}}_2\right)\dot{\boldsymbol{k}} + \left(\dot{\boldsymbol{R}}_1 - \dot{\boldsymbol{W}}_1\right)\right]$$

$$\Leftrightarrow$$

$$\boldsymbol{\pi} - \boldsymbol{G_2 k} - (\boldsymbol{1} - \boldsymbol{\beta})\boldsymbol{T_1} \geq \dot{\boldsymbol{\pi}} - \dot{\boldsymbol{G}}_2\dot{\boldsymbol{k}} - (\boldsymbol{1} + \boldsymbol{\varphi})\boldsymbol{D}\dot{\boldsymbol{k}} - \dot{\boldsymbol{T}}_1 + (\boldsymbol{1} + \boldsymbol{r})\boldsymbol{D}$$

$$\Leftrightarrow$$

$$(\boldsymbol{1} - \boldsymbol{\beta})\boldsymbol{T_1} - \dot{\boldsymbol{T}}_1 \leq (\boldsymbol{\pi} - \dot{\boldsymbol{\pi}}) - \left(\boldsymbol{G_2 k} - \dot{\boldsymbol{G}}_2\dot{\boldsymbol{k}}\right) - [(\boldsymbol{1} + \boldsymbol{r}) - (\boldsymbol{1} + \boldsymbol{\varphi})\dot{\boldsymbol{k}}]\boldsymbol{D}$$

Reference List

Allingham, M. & Sandmo, A., (1972). Income Tax Evasion: A Theoretical Analysis. *Journal of Public Economics*, 1(3-4), 323-338.

Alonso-Ortiz, J., Colla, E., & Da-Rocha, J. (2017). The productivity cost of sovereign default: Evidence from the european debt crisis. *Economic Theory*, 64(4), 611-633. doi:10.1007/s00199-015-0939-y

Becker, G. S. (1968). Crime and punishment: An economic approach. *Journal of Political Economy*, 76(2), 169-217.

Camous, A., & Gimber, A. (2018). Public debt and fiscal policy traps. *Journal of Economic Dynamics and Control, 93*, 239-259. doi:10.1016/j.jedc.2018.02.009

Collins, J. (2015, July 10). *Greece's Real Problem Is Financial System Illiquidity, Not Interest On Debt*. Retrieved from www.forbes.com

Cooper, R. (1999). *Coordination games: Complementarities and macroeconomics*. Cambridge: Cambridge University Press.

Diamond, D., & Rajan, R. (2006). Money in a theory of banking. *The American Economic Review, 96*(1), 30-53. doi:10.1257/000282806776157759

Esteves, R., & Jalles, J. (2016). Like Father Like Sons? The Cost of Sovereign Defaults in Reduced Credit to the Private Sector. *Journal of Money, Credit, and Banking, 48*(7), 1515-1545.

Frederick, S., Loewenstein, G., & O'Donoghue, T. (2002). Time discounting and time preference: A critical review. *Journal of Economic Literature, 40*(2), 351-401.

Gortsos, C. (2017). Safeguarding the Stability of the Greek Banking System Amidst the Fiscal Crisis in the Euro area: Arrangements Before and After the Establishment of the European Banking Union. *European Business Organization Law Review, 18*(3), 479-502. doi:10.1007/s40804-017-0083-1

Hellenic Statistical Authority, (2019, May 24). The Greek Economy. Retrieved from http://www.statistics.gr/documents/20181/14477706/greek_economy_24_05_2019.pdf/e64930d4-821b-4558-a81d-7b464c67b2dc

Kuvshinov, D., & Zimmermann, K. (2019). Sovereigns going bust: Estimating the cost of default. *European Economic Review*. doi:10.1016/j.euroecorev.2019.04.009

Lerner, A. (1947). Money as a creature of the state. *American Economic Review, 37*(2).

Mainelli, M., & Manson, B. (2011). Small enough to fail: A systems approach to financial systems reform. *The Journal of Risk Finance, 12*(5), 435-444. doi:10.1108/15265941111176163

Merrouche, O., & Nier, E. (2012). Payment systems, inside money and financial intermediation. *Journal of Financial Intermediation, 21*(3), 359-382. doi:10.1016/j.jfi.2012.01.002

Nelson, R., Belkin, P., & Mix, D. (2011). Greece's debt crisis: Overview, policy responses, and implications. *Current Politics & Economics of Europe, 22*(4).

OECD (2019). General government deficit. Retrieved from https://data.oecd.org/gga/general-government-deficit.htm#indicator-chart

OECD (2019). General government debt. Retrieved from https://data.oecd.org/gga/general-government-debt.htm

OECD (2019). Greece. Retrieved from https://data.oecd.org/greece.htm

Peacock, M. (2006). The Moral Economy of Parallel Currencies. *American Journal of Economics & Sociology, 65*(5). **https://doi.org/10.1111/j.1536-7150.2006.00491.x**

Repousis, S. (2015). Regulatory framework and deposit – investment guarantee fund in greece. *Journal of Financial Regulation and Compliance, 23*(1), 18-30. doi:10.1108/JFRC-07-2013-0023

Schumacher, E.F. (1973), Small is Beautiful: Economics as if People Mattered, Blond & Briggs, London

Stournaras, Y. (2016). *The impact of the Greek sovereign crisis on the banking sector – challenges to financial stability and policy responses by the Bank of Greece*. Retrieved from www.bis.org

Summers, B. J. (1991). Clearing and payment systems: The role of the central bank. *Federal Reserve Bulletin,* 77(2), 81-91.

Trehan, J. (2003). Underground and parallel banking systems. *Journal of Financial Crime*, *10*(1), 76-84. doi:10.1108/13590790310808628

Varoufakis, Y. (November, 2014). ΕΞΩΤΡΑΠΕΖΙΚΟ ΣΥΣΤΗΜΑ ΠΛΗΡΩΜΩΝ ΜΕΣΩ TAXISnet. Retrieved on April 16, 2018, from http://media.enikos.gr/data/files/525401_0b61ac46dc-b17bc725cdd84282.pdf

Wakai, K. (2013). Intertemporal utility smoothing: Theory and applications. *Japanese Economic Review, 64*(1), 16-41. doi:10.1111/j.1468-5876.2012.00587.x

Walsh, K., (2012). Understanding Taxpayer Behaviour – New Opportunitie for Tax Administration. *The Economic and Social Review*, 43(2), 451-475.

Yeyati, E., & Panizza, U. (2011). The Elusive Costs of Sovereign Defaults. *Journal of Development Economics, 94*(1), 95-105.

Zagaris, B. (2007). Problems applying traditional anti-money laundering procedures to non-financial transactions, "parallel banking systems" and islamic financial systems. *Journal of Money Laundering Control*, *10*(2), 157-169. doi:10.1108/13685200710746866