

CREDIT EXPANSION, THE PRISONER'S DILEMMA AND FREE BANKING AS MECHANISM DESIGN

LUDWIG M.P. VAN DEN HAUWE*

Resumen: A pesar del carácter distintivo del enfoque austríaco de las «microfundaciones para la macroeconomía», la literatura sobre la banca libre contiene algunos argumentos que recurren a los conceptos y modelos de la teoría de juegos tales como el conocido modelo Dilema del Prisionero. A pesar de que no puede existir una presunción *a priori* sobre la posible utilidad de conceptos de la teoría de juegos para las teorías austríacas, en el contexto del debate sobre la banca libre tales conceptos y modelos han sido manejados con distintos grados de perspicacia. Un ejemplo elaborado en el documento comenta la configuración de interacción entre los bancos independientes en un sistema de banca libre con reserva fraccionaria, que a veces ha sido modelado como un juego de Dilema del Prisionero *One-Shot*. Esta conceptualización no ofrece suficientes argumentos para la tesis de la sobreexpansión *in-concert*, ni para la tesis de que un sistema de banca libre con reserva fraccionaria tendería a la creación de un banco central. El autor abandona la asunción implícita de que existe una correspondencia de uno a uno entre la matriz de resultado y la matriz de utilidad. Al reconocerse que los bancos en un sistema de banca libre con reserva fraccionaria no deben adoptar necesariamente una perspectiva «miope» y egoísta, pero pueden reconocer la armonía de intereses a largo plazo entre el sector bancario y la sociedad en general, surgen una conceptualización y representación de la matriz distintas.

Palabras clave: Diseño de mecanismo económico; Teoría del ciclo económico; Dilema del Prisionero; Banca libre.

Códigos JEL: D01, E31, E32, E42, E52, E58, E66, G18, K39.

Abstract: Despite the distinctive character of the Austrian approach to «microfoundations for macroeconomics», the literature on free banking

* Ludwig van den Hauwe received his Ph.D. from the Université Paris-Dauphine.

contains a number of arguments which make use of game-theoretic concepts and models such as the well-known Prisoner's Dilemma model. While there can be no general *a priori* presumption against the possible usefulness of game-theoretic concepts for Austrian theorizing, in the context of the debate on free banking such concepts and models have been used with varying degrees of perspicacity. One example which is elaborated in the paper is concerned with the interaction configuration between independent banks in a fractional-reserve free banking system, which has sometimes been modeled as a One-Shot Prisoner's Dilemma game. This conceptualization does not provide a sufficient argument for the in-concert overexpansion thesis, nor for the thesis that fractional-reserve free banking will tend to lead to the establishment of a central bank. The author drops the implicit assumption that there exists a one-to-one correspondence between the outcome matrix and the utility matrix. When it is acknowledged that banks in a fractional-reserve free banking system need not necessarily adopt a «myopic», self-regarding perspective but may recognize the long-run harmony of interests between the banking sector and society at large, a different conceptualization and a different matrix representation emerge.

Key words: Economic Mechanism Design; Business Cycle Theory; Prisoner's Dilemma; Free Banking.

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I. INTRODUCTION

1. The institutional turn in business cycle theorizing

Different causal explanations of the business cycle typically lead to different sorts of policy advice. Whereas the new classical economists had essentially made a case against discretionary policy activism and in favour of rules, based on a set of arguments including the policy ineffectiveness proposition, the Lucas critique and time inconsistency, thus providing a sustained challenge to the monetarist as well as the Keynesian orthodoxies, the new Keynesian school has provided rigorous microfoundations to explain why markets may fail to clear due to wage and price stickiness, thus accounting for involuntary unemployment as

an equilibrium phenomenon and providing a rationale to justify interventionist policies to stabilize the economy.

Remarkably none of these better known paradigms has provided a fundamental criticism of the prevailing monetary-institutional framework. Among the various conceptualizations of business cycle phenomena and the concomitant policy and/or reform proposals only the Austrian paradigm occupies a unique place on account of the truly radical character of its proposals for institutional reform.

Since on the Austrian account of boom and bust, the bust is simply the market's recognition of the unsustainability of the previous credit-induced boom, the Austrians' policy advice to the central bank would consist of prevention rather than cure: do not engage in credit expansion in the first place.¹ But since abiding by this imperative is notoriously difficult both politically and technically, what is apparently needed is fundamental reform rather than policy prescription. Beginning with Hayek's 1976 *Denationalisation of Money* several attempts have been made, by Austrian economists and fellow travelers, to provide theoretically possible and consistent alternatives to existing central banking regimes. While some degree of variation can be discerned among the different proposals, the common thread in these proposals consists is an argument to the effect that nothing less than a thoroughly decentralized banking system, one in which the market rate of interest is an unbiased approximation of the natural rate, may be the ultimate solution to the problem of boom and bust.

The search for institutional alternatives to prevailing central banking regimes has thus led to a closer examination of the hypothetical working characteristics and the internal dynamics of possible systems of «free» banking, that is to say decentralized and non-hierarchical monetary systems in which banks would engage in the competitive supply of money. According to one such proposal, developed by, among others, L. White (1989; 1995),

¹ For a short introduction to capital-based macroeconomics, see Garrison (2005). For an extensive comparison of capital-based macroeconomics with other macroeconomic paradigms, see also Garrison (2001).

G. Selgin (1988) and L. Sechrest (1993), in the free banking system market mechanisms would move each of the unprivileged private banks which would engage in the unrestricted competitive issue of specie-convertible money, as well as the banks as a group, toward equilibrium and would so restrain them from over-issuing. Monetary instability and business cycles as they typically result from central-bank activity would disappear.

The superiority of a fractional-reserve free banking system is perceived as being related to the speed with which the self-correcting mechanism operates to reverse an over-issue by any single bank. Under the free banking system of multiple competing note issuers, the check against over-issues by any single bank is more rapid and direct, because of the negative feedback provided by interbank clearings. Under a central banking system of a single monopoly note issuer, the check against excessive note issue is attenuated; the corrective process is likely to take more time before it exercises its discipline on the central bank. In the meantime the central bank may have sufficient time to generate an artificial boom through the injection of new money. (White 1995) Accordingly credit expansion would be more limited and kept within narrower boundaries under fractional-reserve free banking than may be the case under central banking.

The proposal of a system of fractional-reserve free banking has been challenged, however, by authors who advocate a return towards a 100 per cent reserve requirement in banking. According to these authors the alleged advantages of fractional-reserve free banking are largely if not entirely illusory. It is claimed by these authors that fractional-reserve free banking would be inherently unstable, foster credit expansion and thus «inevitably» lead to the introduction or the re-introduction of a central bank. The only mechanism which can render the monetary system proof against recurring boom-bust cycles is a 100 per cent reserve requirement.

In order to better understand the rationale of various proposals of free banking as well as the radical nature of the proposals for institutional reform which have been proposed within the Austrian paradigm, we have to appreciate the causal role of credit expansion within the Austrian account of boom and bust.

2. How credit expansion creates an unsustainable mix of incompatible market forces

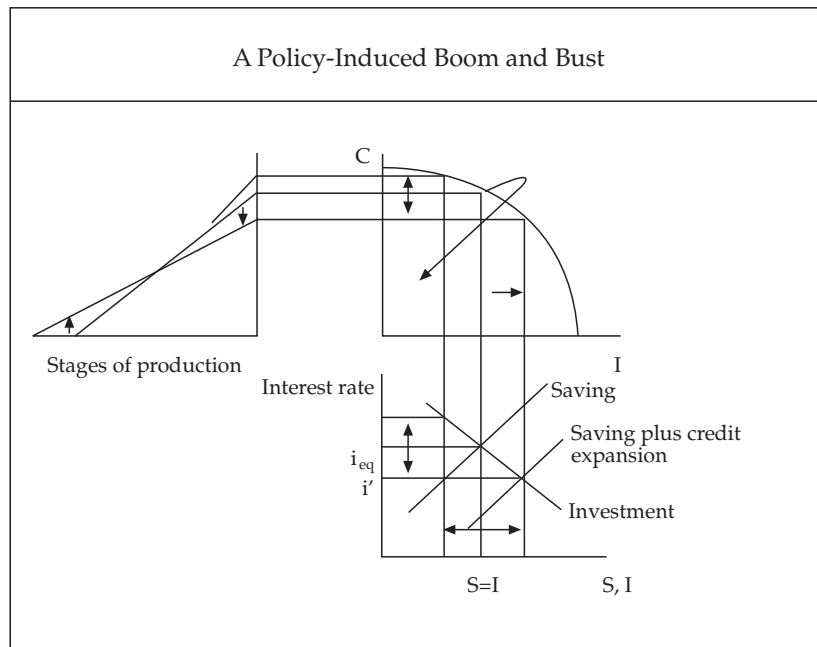
Despite its considerable explanatory power and its relevance for the comprehension of real-world phenomena, the Austrian theory of the business cycle had remained comparatively unknown until quite recently. In conventional overviews of developments in business cycle theory since Keynes' *General Theory*, the theory was on occasion mentioned in an introductory section devoted to the «History of Business Cycle Theory», or Hayek was mentioned in an appendix explaining «The Over-investment Theory» (see e.g. Arnold 2002). Since some time this situation has begun to change. As a result of the important contributions of R.W. Garrison (among others), it is today no exaggeration to assert that in the global macroeconomic landscape the Austrian macroeconomic school has acquired a respectable place among the various other macroeconomic schools and paradigms, and that it is there to stay.

In the capital-based account of the business cycle, credit expansion figures prominently as a causal factor underlying the boom-bust sequence. According to the Austrians, the market is capable of allocating resources in conformity with intertemporal preferences on the basis of a market-determined (natural) rate of interest. It follows, then, that an interest rate substantially influenced by extra-market forces will lead to an intertemporal misallocation of resources. The capital-based theory of the business cycle is thus a theory of boom and bust with special attention to the extra-market forces that initiate the boom and the market's own self-correcting forces that turn boom into bust.

In the case of an artificial boom, the change in the interest-rate signal and the change in resource availabilities are at odds with one another. To the extent that the central bank pads the supply of loanable funds with newly created money, the interest rate is lowered just as it is with an increase in saving, but in the absence of an actual change in time preferences, no additional resources for sustaining the policy-induced boom are being made available. In fact, facing a lower interest rate, people will save less and spend more on current consumables. Seemingly

favourable credit conditions encourage the initiation of long-term investment projects at the same time that the resources needed to see them through to completion are being consumed. Consumers and investors become engaged in a tug-of-war. The central bank's credit expansion drives a wedge between saving and investment. It results in an incompatible mix of market forces. The artificial boom is thus characterized by *malinvestment* and *overconsumption* (Mises 1998). In terms of a familiar device introduced by Hayek and often used in expositions by Austrian macroeconomists, we can say that the triangle is being pulled at both ends against the middle. The now familiar graphical depiction of a policy-induced boom-and-bust cycle combines the Hayekian triangle and the simple analytics of the loanable funds market with the Garrisonian production possibilities frontier. It is displayed in Figure 1.

FIGURE 1



The wedge driven between saving and investment in the loanable funds market and the tug-of-war that pulls the economy beyond its production possibility frontier are manifested in the economy's capital structure as clashing triangles. In the case of a saving-induced capital restructuring, the derived-demand effect and the discount effect work together to reallocate resources toward the earlier stages. In the case of credit expansion, the two effects work in opposition to one another.

The time-discount effect, which is strongest in the early stages, attracts resources to long-term projects. These excessive allocations to long-term projects are called *malinvestment* in the Austrian literature. The derived-demand effect, which is strongest in the late stages, draws resources in the opposite direction so as to satisfy the increased demand for consumer goods. The malinvestment is therefore accompanied by *overconsumption*. In the end real resource constraints remain binding, however, and a bust is the eventual but inevitable resolution to the problem.

3. The search for adequate micro-foundations

It is today commonplace to point out that macroeconomics should be grounded in choice-theoretic microfoundations. Whereas the new classical approach had put a strong emphasis on underpinning macroeconomic theorizing with neoclassical choice-theoretic microfoundations within a Walrasian general equilibrium framework and had thus basically consisted in adapting macro theory to orthodox neoclassical market-clearing microfoundations, the new Keynesian theorists, while they agree that macroeconomic theories require solid microeconomic foundations, have also recognized the importance of a whole variety of real-world imperfections. Problems associated with asymmetric information, heterogeneous agents and imperfect and incomplete markets etc., are not assumed away. They have thus basically preferred to adapt micro to macro theory.

These relatively recent developments should not blind us to the fact that, as regards the recognition of the need for macroeconomic theories to be grounded in microeconomic foundations, the Austrian economists were clearly precursors. Methodological individualism

and a rejection of excessive macro-economic formalism have been constant themes in Austrian methodological writings.² While Austrian macroeconomists in general thus do not question the now mainstream consensus regarding the need or at least the desirability of providing macroeconomic theories with adequate choice-theoretic foundations, this stance has often been accompanied by the proviso that their own variant of microeconomics—designated as Mengerian or as praxeological—should be clearly distinguished from the neoclassical variant. Austrians have thus on occasion highlighted the peculiar character of their own approach to the issue of «microfoundations for macroeconomics».

It should immediately be noted, however, that this stance has not always been consistently maintained. For instance while various argumentative strategies have been used in the context of the debate on free banking, the advocates as well as the opponents of fractional-reserve free banking, in their attempts to scrutinize the actual incentives toward credit expansion that the banks would face within a fractional-reserve free banking system, have on occasion resorted to arguments drawn from game theory and in particular to the interaction configuration known as the Prisoner's Dilemma. The fact that the same game-theoretical model is used by participants on both sides in a debate in order to support divergent conclusions—in casu concerning the working characteristics of fractional-reserve free banking—is sufficiently remarkable in itself to warrant a closer examination of the respective arguments. Is it true that game theory, and in particular

² In particular L.M. Lachmann had been especially critical of the style of thought he characterized as *macro-economic formalism*. We may speak of formalism whenever a form of thought devised in a certain context, in order to deal with a problem existing there and then, is later used in other contexts without due regard for its natural limitations (Lachmann 1973, 16). The schools that adopt the macro-economic approach are tempted to regard as «macro-variables» what are in reality the cumulative results of millions of individual actions. Since these micro-economic actions are not necessarily repeated from day to day, even less from year to year, we have no reason at all to believe in the aggregative constancy of the macro-variables over time (Lachmann 1973, 23). Macroeconomics is safely used only by economists who are constantly aware of the substructure of individual choices and decisions. It is unsafe in the hands of economists who think it *replaces* the substructure.

the Prisoner's Dilemma model, are basically «a gun for hire», which can be used almost *ad libitum* for various purposes, as some have claimed, or is it possible to unambiguously distinguish between correct applications of the Prisoner's Dilemma and incorrect ones in this connection? In the remainder of this paper it will appear that Prisoner's Dilemma game type of arguments have been used with varying degrees of perspicacity.

4. The multifarious uses of the Prisoner's Dilemma model in economics

The applications in theoretical and applied economics of the interaction configuration which is known in game theory as the Prisoner's Dilemma are varied and numerous. Formally, a game with two or more players is a Prisoner's Dilemma if each has a unique dominant strategy and an inefficient outcome results when each plays his or her dominant strategy (Campbell 2006, 47). The Prisoner's Dilemma is the paradigmatic example of self-interested, rational behavior *not* leading to a socially optimal result (Mas-Colell et al. 1995, 237). A conventional representation of the pay-off structure of the Prisoner's Dilemma game is depicted in Figure 2.

The outcome matrix represents a Prisoner's Dilemma if and only if Player A's preference ordering of the outcomes is $P > Q > R > S$, and Player B's preference ordering is $S > Q > R > P$.

The Prisoner's Dilemma is not an Austrian invention, however.³

In view of the Austrians' more or less outspoken preference for Mengerian microfoundations, the recurrent use of Prisoner's Dilemma type of arguments in Austrian writings may at first seem somewhat remarkable. On occasion one finds in the work of one

³ For a semi-popular account of the history of the Prisoner's Dilemma, see Poundstone (1992). Puzzles with the structure of the Prisoner's Dilemma were first devised and discussed by Merrill Flood and Melvin Dresher in 1950, as part of the Rand Corporation's investigations into game theory, which Rand pursued because of possible applications to global nuclear strategy. See also: Stanford Encyclopedia of Philosophy, *op. cit.*

FIGURE 2

		Player B	
		C	D
Player A	C	Q: 3, 3	S: 1, 4
	D	P: 4, 1	R: 2, 2

and the same author a defense of Austrian and in particular Mengerian microfoundations as well as explicit arguments invoking a game-theoretical model such as the Prisoner's Dilemma. An example is provided by Horwitz' (2000) *Microfoundations and Macroeconomics*. Despite his endorsement of a Mengerian approach to microeconomics as the foundations for macroeconomics and of a Mengerian conception of the competitive process, this author repeatedly invokes the Prisoner's Dilemma in his explanation of why economy-wide changes in prices necessitated by monetary disequilibrium are problematic.

Each individual seller would like to cut prices when faced with slackening sales, but none is willing to do so without some assurance that other sellers will do the same. The result is therefore sub-optimal: no one cuts prices when everyone should (e.g. Horwitz 2000, 145). The falling price level is a public good of sorts and each actor wishes to reap the benefits of the needed decline, but no one is able to bear the cost of starting the process. With everyone trying to free ride off the desired result, it never occurs. No individual has an interest in doing what would, if done collectively, benefit all. This, Horwitz argues, is a classic Prisoner's Dilemma (ibid. 158).

The major advantage of fractional-reserve free banking, Horwitz pursues, is precisely that it does adjust the nominal quantity of money to equilibrate potentially devastating monetary disequilibria rather than leaving that burden to the price level. One central shortcoming of 100 per cent reserve banking, according to this author, is that it is unable to do this and that it relies on the price level to bear the burden of adjustment (ibid. 229). Clearly in this instance the Prisoner's Dilemma model is used in an attempt to *justify* credit expansion by the fractional-reserve free banking system.

It is doubtful whether this argument is supported by conventional price theory and whether the underlying hypothesis of pervasive price stickiness, even in the absence of institutional barriers to price flexibility, is indeed descriptive of real-world situations. Besides these obvious reservations, it should be clear why Horwitz's *who-goes-first* argument, especially when considered as an argument for the superiority of a fractional-reserve free banking system in comparison with a system based on a 100 per cent reserve requirement, is not convincing.

According to monetary disequilibrium theorists such as Horwitz, not the price rigidities *per se* but deflationary pressures constitute the originating factor of depressions. Excess demands for money and not price rigidities are the originating factor of depressions. Furthermore, the monetary disequilibrium theorists argue that excess demands for money need not lead to depression and unemployment, *if* the monetary system responds quickly to such excesses by creating additional nominal supplies of money. There are several problems with this view.

A first objection consists in pointing out that *if* there exists something like a *who-goes-first* problem, a policy of accommodating excess demands for money might worsen it because of a moral-hazard type of problem.

Furthermore the conclusion of Horwitz, considered as an argument against the 100 per cent reserve requirement in banking, is clearly flawed for the following reasons. When monetary disequilibrium theorists like Horwitz refer to downward pressures upon the general price level due to excess demands for money they mostly implicitly have in mind the kind of special circumstances

as they prevail in a fractional-reserve banking system when excess demands for money actually trigger a decline—or a collapse—of the money supply because of a phenomenon known as multiple deposit contraction. It is indeed the multiple-contraction effect that actually accounts for the generalized nature of the phenomenon. A particularly dramatic instance of this phenomenon relates to the financial difficulties prevailing at the time of the onset of the Great Contraction and significantly Horwitz himself mentions this example.⁴

In Chapter 5 of his (2000) *Microfoundations of Macroeconomics*, entitled *Monetary equilibrium theory and deflation* (141-175), and to which he refers on page 228 when criticizing 100 per cent reserve banking for not offering a satisfactory solution to Prisoner's Dilemma problems due to excess demands for money, Horwitz writes:

«(...) prior to the Great Depression, the US economy was able to avoid significant unemployment for any real length of time precisely because wages were relatively free to adjust downward when needed. The Great Depression brought an end to that policy, as bad economic ideas and the self-interest of labor and politicians

⁴ These were very well described by Milton Friedman and Anna Schwartz in their *A Monetary History of the United States*. ([1963] 1993). As they explain:

«The deposit-currency ratio has been of major importance primarily during periods of financial difficulties. In each such period, the public's loss of confidence in banks led to an attempt to convert deposits into currency which produced a sharp decline in the ratio of deposits to currency and strong downward pressure on the stock of money. The establishment of the Federal Reserve System was expected to deprive such shifts in the deposit-currency ratio of monetary significance by providing a means of increasing the absolute volume of currency available for the public to hold, when the public desired to substitute currency for deposits, without requiring a multiple contraction of deposits. In practice, it did not succeed in achieving that objective. The most notable shift in the deposit-currency ratio in the 93 years from 1867 to 1960 occurred from 1930 to 1933, when the ratio fell to less than half its initial value and in three years erased the secular rise of three decades. Though the absolute volume of currency held by the public rose, it did so only at the expense of a very much larger decline in deposits, the combined effect being a decline of one-third in the total stock of money.» (Friedman and Schwartz 1993, pp. 684-85).

led to calls for maintaining nominal wages in the face of a 30 percent decline in the money supply. It is of little surprise that the result was 25 percent unemployment, a failure of one-third of US banks, and widespread business bankruptcies.»(ibid. 164).

However, these kinds of special circumstances would never and can never occur under a system of 100 per cent reserve banking. Under 100 per cent reserve banking a 30 per cent decline in the money supply could never have happened in the first place. Therefore Horwitz's attack upon the advocates of 100 per cent reserve banking is flawed. It will be recalled what the charge against 100 per cent reserve banking is. The criticism starts from a distinction, connected with the so-called productivity norm, between falling prices necessitated by declines in income velocity unmatched by increases in the nominal money supply and falling prices caused by increases in factor productivity in specific areas of the economy. The latter are perfectly easy to explain precisely because they occur in specific times and places and are consistent with the profit-seeking interests of the entrepreneurs in question, or so the argument goes. Downward movements in the general price level due to excess demands for money present Prisoner's Dilemma problems that changes in factor productivity do not. The claim is that fractional-reserve free banking can cope much more satisfactorily with the kind of problem posed by excess demands for money and accompanying Prisoner's Dilemma's than a system subject to a 100 per cent reserve requirement.

Now Horwitz, and other monetary disequilibrium theorists who hold similar views, clearly commit a fallacy known as *petitio principii*. Horwitz's argument against 100 per cent reserve banking, namely that such a system is incapable of coping with a particular kind of problem, presupposes or assumes what it ought to prove—or at least render plausible—in the first place, namely that this type of problem could possibly occur under a regime of 100 per cent reserve banking. Stated differently, the type of problem which Horwitz identifies can be expected to occur exclusively under a monetary regime that is *not* based on a 100 per cent reserve rule. It is a type of problem that is indeed particularly likely to occur under a regime of fractional-reserve

banking. But it makes little sense to blame a particular type of monetary regime, such as a 100 per cent reserve system, for not being able to cope with a particular type of problem, if under such a regime such problems would, by virtue of the very nature of that regime, be prevented from arising in the first place.

In view of such obviously fallacious uses of arguments involving the Prisoner's Dilemma model, the question can be raised of whether game theory may indeed serve as «a gun for hire». A similar phenomenon has been observed in other contexts, for instance in political theory (See e.g. Pellikaan 1994). Depending upon the situation to which a game-theoretical model such as the Prisoner's Dilemma is to be applied or depending upon the political or ideological agenda of the author who wants to use arguments of a game-theoretical nature, arguments of this sort may at first appear as flexibly adaptable. Whereas, say, an advocate of government intervention may want to choose a one-shot Prisoner's Dilemma in order to illustrate how individual rationality «inevitably» leads to a collectively undesirable result, an author who to the contrary wants to defend free markets will choose a repeated Prisoner's Dilemma in order to demonstrate how cooperation can emerge without central authority (Axelrod 1984 [1990]), thus illustrating the marvelous achievements of spontaneous orders.

On the other hand, the fact that *some* uses of game-theoretical arguments are obviously questionable or fallacious, is no sufficient reason for rejecting such arguments generally. There can be no general *a priori* presumption that Austrians could never make a profitable use of game-theoretical arguments (Foss 2000).⁵ An

⁵ Foss' (2000) main conclusion, namely, that Austrians should approach and make use of game theory in economics can be granted. This author emphasized the relevance of the literature on iterated Coordination Games which is indeed of potential interest to Austrians.

With the proviso provided in the text, we believe that the same is of true of the literature on Prisoner's Dilemma games. Whether a Coordination Game model or Prisoner's Dilemma game model will have to be used will depend upon the underlying situation to be modeled. The classic contrast between Coordination games and Prisoner's Dilemma games makes perfect sense since it is illustrative of the fact that whereas surely some forms of cooperation are easy to reach, others remain prohibitively costly. There is a sense in which *every* industry faces a Prisoner's Dilemma: firms within an industry could all earn higher profits if they colluded to raise their prices but individual firms

illuminating example of a correct use of Prisoner's Dilemma reasoning in the context of business cycle theorizing is provided by Carilli and Dempster (2001). These authors have used the Prisoner's Dilemma framework to model the profit maximizing behavior of bankers and the investors under uncertainty when the market rate of interest is below the underlying rate of time preference, thus questioning the standard account of Austrian business cycle theory which posits that central bank manipulations of interest rates fool bankers and investors into believing that there has been an increase in the real supply of loanable funds available for capital investment.

In the next sections I take a further critical look at several uses of the Prisoner's Dilemma model which have been made in the context of the ongoing debate about free (decentralized) banking, with the purpose of examining in greater detail the incentives of the banks in a fractional-reserve free banking system to engage in credit expansion.

II.

DOES FRACTIONAL-RESERVE FREE BANKING EXEMPLIFY THE 'TRAGEDY OF THE COMMONS'?

Horwitz' *who-goes-first* argument invoking the Prisoner's Dilemma game is not the only example of game-theoretical Prisoner's Dilemma reasoning in the context of the debate on free

earn more if they continue to compete. It is not difficult to see why this must be true: consumers prefer low prices to high prices. If all the other firms collude to charge exorbitantly high prices, the profits of the deviant firm that undercuts them rise. The difference between a Coordination Game and a Prisoner's Dilemma game is reflected in the difference between standardizing products and fixing prices for instance. These kinds of business cooperation bear little resemblance to each other and in fact are radically different. It is confusing to conflate them under the generic heading of «collusion». As long as consumers want a uniform product, adhering to industry standards is self-enforcing. As long as consumers prefer low prices to high prices, price-fixing is not. Reaching the cooperative outcome in the former may be relatively easy, while reaching this outcome in the latter case may be costly and difficult. In the case of a price fixing cartel, the higher prices actually hurt the consumers and this fact is at the basis of the incentive of individual cartel members to deviate and continue competing.

banking. In the context of the discussion about the possibilities and limits of credit expansion within a system of fractional-reserve free banking, the Prisoner's Dilemma has been invoked both as supporting an argument in defense of the thesis that fractional-reserve free banking would exhibit endogenous tendencies toward concerted credit expansion and as supporting an argument against that thesis.

In his (2006) *Money, Bank Credit, and Economic Cycles* Huerta de Soto uses a Prisoner's Dilemma model in order to argue that fractional-reserve free banking will tend to evolve towards the establishment of a system of central banking, while claiming that what is actually involved is an application of Hardin's classic *tragedy of the commons* theory.⁶ The effect of permitting fractional-reserve banking is thus considered analogous to that of a *tragedy of the commons* (De Soto 1998, ch. 8). Therefore, Huerta de Soto concludes, a return to a banking system subject to a 100 per cent reserve requirement is to be recommended.

⁶ Hardin's chief insight was that open access resources will be unsustainably exploited unless *some* property rights regime is imposed for their protection. The question remains which property rights regime. Two general solutions are typically offered for resolving environmental problems and both of these are acknowledged by Hardin (1968, 1245): (1) specify property rights in environmental goods, that is, privatize them, or (2) control access to and use of environmental goods through governmental regulation. Therefore most mainstream economists would consider that the existence of a *tragedy of the commons* problem *per se* does not yet constitute an argument in favour of the first type of solution consisting of privatization, deregulation etc. Furthermore it should be noted that law-and-economics theorists have since long abandoned the idea that private-property rights have an absolute prerogative to being the efficient institutional form and have developed the concept of the *optimal commons* (e.g. Field 1989; also Papandreou 1994). Therefore critics might argue that it does not yet follow directly from any critique of fractional-reserve free banking that a 100 per cent reserve gold standard would be, *in over-all economic efficiency terms*, the obviously preferable alternative. The answer to that question would depend upon the cost of establishing and sustaining (protecting) the property rights structure consistent with a 100 per cent commodity standard. The latter may well remain a costly matter after all, even if on theoretical grounds there are good reasons to believe that the working properties of such a system have desirable characteristics in terms of efficiency, stability and predictability and even on political or ethical grounds, and even if the costs of a purely fiat standard have tended to be under-estimated until recently. Property rights themselves are costly, and sometimes too costly, to impose and protect. Therefore the evolution of property rights is seldom unidirectional, that is to say it does not *always* move in the direction of more sharply-defined private rights.

In the most general sense, the *tragedy of the commons* refers to the problem of common property. Inasmuch as property rights are not exclusive, privately perceived benefits and costs will differ from total gains and costs. As long as nominal owners and actual holders of rights to rival goods are not the same persons, the latter are able to use the nominal entitlements of the former as common property while imposing their use costs on the nominal rights holders. To the extent of the positive externality, demand for the resource exceeds the optimal level *because* others pay its price. The resulting problem of overexploitation of commonly owned resources may be viewed as the central problem of property rights economics. Using the terminology of standard public goods theory, overexploitation is to be expected to occur whenever the consumption of an asset is rival and non-paying users are not excluded from extracting benefits from it (Müller and Tietzel 1999, 42-3).

Commonplace examples of overuse problems of resources to which no property rights are assigned are those of natural resources where formal rights are non-existent, such as air, fishing grounds, oil pools etc. Since Hardin in his celebrated (1968) article paradigmatically explored his example of a «pasture open to all», with many villagers driving on their cattle, the notion of a «tragedy of the commons» connotes all kinds of examples of resources with exclusive rights being absent. Each herdsman, as a rational non-altruist, will try to keep as many cattle on the commons as will meet his *individual* profit maximum. While the gains of his effort are strictly private, the associated costs are shared by all herdsmen, with himself bearing only a small fraction. Since a similar calculus holds for each individual, the villagers are locked into a dilemma where *collective* welfare, which is maximized at a lower than the individually optimal level of effort, is unattainable owing to individually rational behaviour.

Two questions can be distinguished in the present context. The first question is that of whether credit expansion, if it takes place on a more or less significant scale, indeed generates effects similar or analogous to those of a tragedy of the commons. The second question, which is more closely considered here, is whether the

internal dynamics of fractional-reserve free banking is such that effects of this sort would be endogenously generated under this arrangement. Are the effects of fractional-reserve banking indeed similar or analogous to the effects of the tragedy of the commons in the sense of Hardin (1968)?

As will be explained further, the interaction configuration between independent banks in a fractional-reserve free banking system can indeed be modeled as a Prisoner's Dilemma. It is less clear—and in fact not quite correct—that we should also model the *tragedy of the commons* in the sense of Hardin (1968) as a Prisoner's Dilemma. Anyway, it seems intuitively clear that we would want to conceive of the collectively undesirable outcome, that is to say the outcome which is inefficient *from the perspective of society as a whole*, as corresponding to the inefficient equilibrium in the game, that is to say the outcome of mutual defection (D-D) in the case of the Prisoner's Dilemma.

Huerta de Soto, however, conceives of the interaction pattern between (initially only two) banks in a fractional-reserve free banking system as a classic Prisoner's Dilemma in the manner depicted in Figure 3 (See also Huerta de Soto 2006, Table VIII-2 on page 667).

FIGURE 3

		Bank A	
		Does not expand	Expands
Bank B	Does not expand	R: Survival of both (reduced profits)	S: Failure of A Survival of B
	Expands	P: Failure of B Survival of A	Q: Large profits for both

In order to bring this representation into better agreement with conventional textbook representations of the Prisoner's Dilemma game, we here modify Huerta de Soto's representation along the following lines:

- 1) The positions of the two players are switched so that Player A becomes the row player.
- 2) It will be noted that in Huerta de Soto's representation the «inefficient» equilibrium of this non-cooperative game, which is the outcome in which both banks abstain from expanding, that is to say the outcome which represents mutual defection from the standpoint of the banks (D-D outcome in the Prisoner's Dilemma game), is located in the upper left corner. According to the conventional matrix representation of the Prisoner's Dilemma game which can be found in most textbooks and which has already been provided previously, the efficient outcome is located in the upper left corner while the inefficient Nash equilibrium outcome (solution) is located in the lower right corner. Although the question of where to locate the respective —and in particular the main-diagonal— outcomes in the game is a conventional matter and does not concern the substance of the argument, for reasons of convenience we again modify the representation along more familiar lines by putting the mutually cooperative outcome in the upper left corner.
- 3) The «temptation» payoffs for the unilateral defector (A or B) are labelled «larger profits for (A or B)» in order to bring out the essence of the Prisoner's Dilemma game in which the off-diagonal outcomes act as attractors.
- 4) To the C-C outcome which supposedly would yield large profits to both banks in case this outcome were to occur in one way or another, the qualifier «in the short run» is added in order to highlight the fact that the banks apparently adopt a short run, «myopic» perspective in this case, as is explained further.
- 5) Furthermore, following Ludwig von Mises it is assumed that only the issuance of *additional* fiduciary media will affect prices and alter the structure of production. Once the effects

of these have been consummated the market will no longer be influenced by any movements generated from this past credit expansion. As Ludwig von Mises indeed wrote: «The total quantity of the fiduciary media as issued by the banks and absorbed by the cash holdings of their clients has altered the structure of prices and the monetary unit's purchasing power. *But these effects have already been consummated and at present the market is no longer stirred by any movements generated from this past credit expansion.*» (1998, 434, *emphasis mine*).

We adopt the following conventional notation in this respect: $\Delta CE_X > 0$ means that Bank X increases its level of credit expansion while $\Delta CE_X = 0$ means that Bank X maintains its current level of credit expansion. These modifications yield the representation depicted in Figure 4.

This conceptualization is intended by Huerta de Soto to elucidate the typical *tragedy of the commons* effect which is supposed to appear under fractional-reserve free banking:

FIGURE 4

Interaction configuration between independent banks			
		Bank B	
		$\Delta CE_B > 0$	$\Delta CE_B > 0$
Bank A	$\Delta CE_A > 0$	Q: Large profits for both (in the short run)	S: Failure of A Larger profits for B
	$\Delta CE_A > 0$	P: Failure of B Larger profits for A	R: Survival of both (reduced profits)

bankers face the almost irresistible temptation to be the first to initiate a policy of expansion, particularly if they expect all other banks to follow suit to one degree or another. In a Prisoner's Dilemma configuration comprising only two banks, if either bank expands credit alone, its viability and solvency will be endangered by inter-bank clearing mechanisms, which will rapidly shift its reserves to the other bank if the first fails to suspend its credit expansion policy in time. Furthermore, the situation in which both banks simultaneously initiate credit expansion—a strategy which yields the same large profits to both—represents the mutually cooperative outcome, while the situation in which neither of the banks expands and both maintain a prudent policy of loan concession represents the outcome of mutual defection.

In fact, there can be little doubt that the interaction configuration between independent banks in a fractional-reserve free banking system can indeed be conceptualized as a Prisoner's Dilemma, in the manner depicted in our modified representation and as also claimed by Huerta de Soto. Fractional-reserve free banker White correctly adopts a similar conceptualization (White 1995, 16; see further). White is not explicit about the game-theoretical structure of the interaction pattern he envisages, but he clearly believes that cooperation between independent banks in view of concerted expansion would not be a self-enforcing outcome, that is to say such an outcome is costly to enforce or, stated differently, the interaction pattern would be of the Prisoner's Dilemma game type rather than of the Coordination Game type of interaction (See also footnote 5). White's reference to the analogy with the breakdown of cartels reinforces this conclusion since in conventional price theory the breakdown of cartels is indeed considered perfectly analogous to the Prisoner's Dilemma (see e.g. Landsburg 2002, 399-403). Therefore I will further assume that White has indeed a Prisoner's Dilemma type of interaction pattern in mind in this context.

The interaction pattern between independent banks in a fractional-reserve free banking system can thus be represented in the aforementioned manner as a classic Prisoner's Dilemma. However, the ways in which Huerta de Soto incorporates this

conceptualization into his argument against fractional-reserve free banking and in favour of the alternative definition of free banking as being based on a 100 per cent reserve requirement, presents several anomalies:

- 1) *First*, it does not support the aforementioned author's conclusion that fractional-reserve free banking will tend to lead to the establishment or the re-establishment of a central bank. This author indeed argues that it follows from the aforementioned interaction configuration that the two banks will face a strong temptation to arrive at an agreement and, in order to avoid the adverse consequences of acting independently, to initiate a joint policy of credit expansion, and particularly, to urge authorities to create a central bank.

Huerta de Soto also writes:

«Therefore our analysis enables us to conclude the following: (...) (2) that the fractional-reserve banking system itself prompts bankers to initiate their expansionary policies in a combined, coordinated manner; (...)» (ibid. 670)⁷

However, and although the aforementioned author's conclusion may find some support in historical fact, without a more detailed description of how, in the absence of extra-market devices and interventions such as those of a central bank, the two banks will actually coordinate their courses of action upon the mutually cooperative outcome (in-concert expansion), the argument is not tight. Indeed, according to the logic of the Prisoner's Dilemma game all players will end up defecting so that no overexpansion will ensue. This is apparently the conclusion L. White (1995, 16) had in mind when he wrote:

«Concerted expansion by a multiplicity of independent banks is implausible for the same well-known reasons that the attempt to build a stable cartel arrangement among many firms is unlikely

⁷ It will be noted that this position contradicts that of Ludwig von Mises on the working characteristics of free banking. See further.

to be successful in any industry in the absence of a legal mechanism enforcing cartelisation. Any firm not abiding by the cartel agreement could capture whatever benefits the agreement is supposed to bring the industry to a greater extent than a firm adhering to the agreement.»

It may be useful to summarily remind of the role and nature of the interbank clearing mechanism in this context and its modus operandi in correcting over-issue by an individual bank. Under a system of fractional-reserve free banking over-issue by an individual bank will be corrected through what nineteenth-century writers referred to as a process of «reflux», the return of excess currency to the over-issuing bank. Nineteenth-century writers, when they spoke of the return of excess currency to the over-issuing bank as a process of «reflux», emphasized the potential for over-issue. The contemporary fractional-reserve free bankers believe that an equal amount of attention should be paid to the potential for under-issue too.

White's reconstruction of the «law of the reflux» (see e.g. White 1999, Chapter 3) is based upon the supposition that for any particular bank, there exists an equilibrium size of its currency circulation—the same is true for its deposits—that satisfies a set of equimarginal conditions. This size is the value of the public's desired holdings of currency issued by bank i , given the bank's operating costs, that is to say its optimizing expenditures on non-price competition.

Let us denote the value of the public's desired holdings of currency issued by bank i as N_{ip}^* , where the subscript p indicates the public for whom the currency is an asset, the subscript i denotes the issuing bank for whom it is a liability, and $*$ means that it is a desired value. It can now be explained how N_{ip} converges on N_{ip}^* as the public adjusts toward its desired portfolio of assets. Suppose that excess currency is introduced by means of loans. The borrowers spend the currency. The recipients of the spending now have balances of bank i currency in excess of their desired levels. A recipient individual q for whom $N_{iq} > N_{iq}^*$ can respond in any of three

ways. *Direct redemption* for reserves at the issuer's counter free bankers consider the least likely way since it is assumed that in a mature system little or no reserve money is held by the public. Clearly this would directly reduce the bank's reserves R_i —as well as in the first place but simultaneously N_i .

Deposit of the excess currency into another bank—the bank where q keeps his demand deposit account— would bring the currency-exchange mechanism into play, generating adverse clearings for the overissuer as the recipient bank presents the deposited currency claims for redemption at the clearinghouse. Settling the clearing balances entails a loss of reserves R_i just as direct redemption does. The volume of currency in circulation N_i is reduced by the return of the excess currency to bank i , unless the bank immediately reissues it. However, the reserve loss signals to bank i that reissuing the currency would lead to further haemorrhaging of reserves, so it should accept the reduction in its circulation. Deposit of the excess currency into bank i itself would not generate adverse clearings. However, it does mean a higher marginal interest cost of liabilities, and a higher liquidity cost, than before the expansion. An issuer that was maximizing profit before will thus find the expansion now unprofitable. *Spending* the excess currency transfers the excess to a new individual who also has the same three options. This new individual will directly redeem or deposit the currency, leading again to a reserve loss for bank i and a contraction of N_i . As a consequence of reserve losses, bank i finds its reserves lower than it desires ($R_i < R_i^*$). The marginal net benefit of holding reserves now exceeds the marginal net revenue from making loans or holding securities, prompting the bank to sell securities (or not roll over maturing loans) in order to increase its reserves. Reserves return to bank i from the rest of the banking system.

It would be correct to point out that even if it is true that the inter-bank clearing mechanism thus limits and puts a check upon isolated expansionary schemes—expansion by an individual bank—it does not serve to limit credit expansion in a fractional-reserve free banking system if most banks

«decide» to simultaneously expand their loans, that is to say to expand in unison. However, assuming a *laissez-faire* context consisting of a multiplicity of independent banks, hypothesizing a one-shot Prisoner's Dilemma configuration would of course not be a sufficient ground for arguing plausibly that the in-concert expansion scenario is *what will actually happen*.

From this perspective Huerta de Soto's argument apparently assumes or pre-supposes what it sets out to demonstrate in the first place, namely the emergence or the existence of a central bank or of a similar device intent upon orchestrating the in-concert credit expansion by all the banks in the system. Again the argument seems to involve a *petitio principii* of sorts.

The breakdown of cartels is indeed perfectly analogous to the Prisoner's Dilemma. If a cartel is to succeed, it needs an enforcement mechanism, that is to say a way to monitor members' actions and a way to punish those who cheat (see also Landsburg 2002, 399ff.).

As a model of a *tragedy* of any sort caused by concerted credit expansion, the use of the Prisoner's Dilemma model in the aforementioned manner is not a convincing representation. According to this very representation, *no tragedy* will take place at all. If the two banks play their unique dominant strategy, the «inefficient» outcome, here characterized by the absence of credit expansion, will ensue. In this sense the aforementioned conceptualization is a correct representation of precisely the opposite of what it claims; it is a correct representation of the *absence of any tragedy*.

Therefore the aforementioned one-shot Prisoner's Dilemma configuration does not support the conclusion that fractional-reserve free banking will tend to lead to the establishment of a central bank. Different—or at least additional—assumptions would be needed to draw this conclusion. Under *laissez-faire*, which is the hypothesized institutional context, mutual defection—characterized by the *absence* of concerted credit expansion—is and remains the unique equilibrium.

- 2) *Second*, the outcome which is inefficient from the standpoint of the banks in the Prisoner's Dilemma game, is the outcome

which is efficient from the perspective of the rest of society, or from the perspective of society as a whole, while the cooperative efficient outcome from the standpoint of the banks—which represents in-concert credit expansion by the entire banking system—is the outcome which from the standpoint of society must be considered a *tragedy*, that is to say sub-optimal.

In a conventional game-theoretic representation of a *tragedy of the commons*—or of any other tragedy for that matter—we would expect the efficient, cooperative outcome to be the outcome which represents the *absence of any tragedy*, as it may result, for instance, from the imposition of an adequate property rights regime but which, in the absence of any such property rights regime, remains the Pareto-efficient but unattainable optimum. In the absence of an adequate property rights regime, the non-Pareto-optimal (inefficient) *tragedy* will ensue in what we would consider an adequate representation from a more conventional viewpoint.

- 3) *Third*, the Prisoner's Dilemma modeling does not yet turn the interaction configuration into a *tragedy of the commons* in the sense in which this concept was introduced in Garret Hardin's popular 1968 paper.

In fact game-theoretically the tragedy of the commons in the sense of Hardin (1968) is not exactly modeled as a two-person Prisoner's Dilemma. The two-person tragedy of the commons is conventionally represented as a «Stag Hunt» game. In this representation the socially optimal situation corresponds to the C-C outcome in the game.⁸ Therefore apparently the expression «tragedy of the commons» is used in this context only in a metaphorical and not in a strictly literal sense, at least insofar as reference is to be made to Garret Hardin's 1968 use of this concept.

⁸ A common view is that Garret Hardin's popular «the tragedy of the commons» has the structure of a multi-player Prisoner's Dilemma game. This contention must be qualified, however. For the matrix representation of the two-person version of the tragedy of the commons game, see: Stanford Encyclopedia of Philosophy 2007. On the Stag Hunt, see also Skyrms (2004).

To the extent concerted credit expansion and its effects indeed present a genuine analogy with a tragedy of the commons, this analogy results from three circumstances:

- a) As the Austrian theory of the business cycle explains, credit expansion engineered by the banks causes large-scale intertemporal discoordination, misallocation of capital and thus a waste of resources.
- b) According to the advocates of a system of 100 per cent reserve banking, the deeper causes of this state of affairs can be explained in terms of an inadequate definition and/or enforcement of property rights.
- c) It is assumed that the «tragedy» can be cured by the imposition of a more adequate property rights regime, in particular a 100 per cent reserve requirement in banking.

In this sense it is indeed correct to hypothesize that concerted credit expansion by the banks in a fractional-reserve free banking system, if indeed it were to occur in one way or another, would constitute a real tragedy of sorts, somewhat analogous —although not strictly identical— to Hardin's well-known *tragedy of the commons*.

The aforementioned matrix representation, in which the cooperative outcome yields large profits for both banks, represents a short-run outcome only. We have noted, however, that under the assumption that the banks indeed adopt a myopic «self-regarding» perspective by trying to maximize their short-run profits from credit expansion, the banks are in virtue of the very logic of the Prisoner's Dilemma game, and in the absence of additional assumptions, unable to achieve this outcome since when both banks play their unique dominant strategy the «inefficient» no-expansion outcome results.

Moreover, if it is true that credit expansion by the banking system is a tragedy of sorts, then intuitively we would want to model this fact in such a manner that the «tragedy» is represented by the inefficient outcome in the game—in terms of a Prisoner's Dilemma game: the outcome «mutual defection»— and the absence of the tragedy by the Pareto-optimal efficient outcome

in the game—in terms of a Prisoner’s Dilemma game: the outcome «mutual cooperation». According to the aforementioned representation— which models the situation from the myopic perspective of the banks and not from the perspective of society at large—the «efficient» but unattainable outcome is concerted credit expansion, while the attainable but «inefficient» Nash equilibrium outcome is the situation in which both banks refrain from credit expansion. This latter outcome, however, represents the situation which is efficient from the perspective of society at large. From the perspective of society at large— but of course not from the short-run myopic perspective of the banks—one could read the aforementioned model as an argument in favor of fractional-reserve free banking, rather than as an argument against fractional-reserve free banking.

III.

AN ALTERNATIVE MATRIX REPRESENTATION

The assumptions underlying the previous matrix construction are not compelling, however. Supposing a purely *laissez-faire* context with no central bank or lender of last resort, the banks may well acknowledge the fact that their long-run interests essentially coincide with those of society at large. If they act imprudently by over-expanding there will be no central bank to come to their rescue and bail them out.

As is well explained by the Austrian theory of the business cycle, the huge profits yielded by credit expansion are only a short run phenomenon and in fact—one could argue— illusory when considered from a perspective that takes into account the more remote consequences of credit expansion. The credit expansion engineered by the banking system will set in motion spontaneous market processes which reverse the distorting effects of the expansion. Huerta de Soto himself offers an essential clue to better insight into these matters since he explains in detail in several chapters of his book how these reversion processes will cause systematic crises in the banking system. In this sense, while in the short run in-concert credit expansion may yield

huge profits to the banks, the more remote effects of such credit expansion will, in the absence of a central bank or similar device, be detrimental to the banks themselves.

If we drop the assumption that the interaction configuration should be modeled from a myopic «self-regarding» perspective of the banks and if we reformulate the model from the perspective of society at large by placing the dominant no-expansion outcome in the upper left corner and by re-labeling this outcome as one of «Sustainable Economic Growth», the result depicted in Figure 5 ensues.

In this representation the expansive course of action of the individual banks no longer means «Cooperation» and the prudent course of action of an individual bank no longer means «Defection». From the standpoint of society at large, it can indeed be considered efficient that an individual bank which acts imprudently by unilaterally over-expanding goes bankrupt, and that an individual bank which acts prudently by restraining from credit expansion survives and prospers in the long run. Therefore the expansive strategy is the defective one and the non-expansive strategy is the cooperative one. The outcomes in which one of the banks defects while the other bank cooperates

FIGURE 5

		Player B (Bank)	
		Does not expand	Expands
Player A (Bank)	Does not expand	R: Sustainable Economic Growth	S: Failure of B Survival of A
	Expands	P: Failure of A Survival of B	Q: Tragedy

are represented by the off-diagonal elements in the matrix. However, these off-diagonal outcomes no longer function as attractors towards the now mutually defective (D-D) outcome—as is the case in a Prisoner's Dilemma game—since we drop the assumption that the banks myopically pursue the aim of maximizing short-run profits from credit expansion but instead assume that the banks recognize the dangers inherent in credit expansion and thus adopt a perspective that is more in agreement with the long-run interests of society at large. In this sense one could say it is assumed that the banks choose «morally» or act in accordance with a «social norm».

Obviously this matrix construction no longer represents a Prisoner's Dilemma. Under the previous representation, where it was assumed that the expansive strategy is the cooperative one and that the banks choose «egoistically» and «myopically», Player A's preference ordering was indeed $P > Q > R > S$ and Player B's preference ordering was $S > Q > R > P$. These were indeed the orderings which characterize the pay-off structure of the Prisoner's Dilemma game.

Under the modified conceptualization where the banks are assumed to choose «morally» and to act in accordance with the «social norm», the mutually defective outcome is the outcome in which both banks choose the expansive strategy and it is labeled «Tragedy». The efficient cooperative outcome is the one in which both banks choose the cooperative strategy by refraining from credit expansion and it is labeled «Sustainable Economic Growth». It is the outcome which is efficient both from the perspective of the long-run interests of the banks and from the perspective of society at large. This latter efficient outcome is precisely the outcome that, under suitable assumptions, will be realized by a free banking system. This representation illustrates the fact that free banking is an *effective mechanism for avoiding the tragedy resulting from generalized credit expansion*. As we have seen, this conclusion was also implicit in the previous matrix construction. The modified matrix representation is different, however, in that the no-expansion outcome is now considered efficient *even from the standpoint of the banks themselves*.

Player A's preference ordering is now, say, $R > P > S > Q$, while Player B's ordering is $R > S > P > Q$. Clearly this is no longer a Prisoner's Dilemma game. This fact illustrates that a modification of the assumptions about the motives of the players, for instance by assuming that they choose «morally» or in accordance with the «social norm» rather than «myopically» and in a purely «self-regarding» manner, radically changes the structure of the game.

In the modified representation it is assumed that the mutually cooperative outcome in the game represents the situation in which the banks exercise some restraint by refraining from credit expansion, a course of action which involves foregoing some profit opportunities in the short run and which in the short run imposes an opportunity cost upon the banks in the form of foregone short-run profit opportunities. Still it is the outcome which is in the long run interests both of the banks and of society at large. Indeed in the longer run the interests of the banks coincide with those of society at large and it is not too unrealistic to assume that the banks might conceivably recognize this possible harmony of interests in the longer run.

The outcome in the upper left corner is conceptualized as the cooperative outcome, not only because it is the efficient outcome from the long-run perspective of the banks themselves but also and foremost because it is the outcome which ensures a long-run harmony of interests between the banking sector and its allies on the one hand and the rest of society on the other. By refraining from credit expansion the banks act in a manner which serves both their own longer-run interests and the interests of other market participants. Of course throughout a *laissez-faire* context is assumed, without central banks or similar devices.

In our modified outcome matrix, the outcomes, when considered in «physical» or objective terms, are identical to the outcomes in Huerta de Soto's matrix on page 667 of his (2006) book. Under the modified representation the outcomes are re-labeled in accordance with their true significance from the standpoint of society; it is no longer assumed that the actors in the game will «automatically» perceive the outcome matrix as a Prisoner's Dilemma. By abandoning the assumption that

the actors —*x hypothesi* the banks in a fractional-reserve free banking system— are motivated by myopically «self-regarding» considerations, the assumption that the actors will necessarily attach to the objective outcomes the preference ordering of a Prisoner's Dilemma game has been abandoned. Which motives motivate the actors and which preference ordering they adopt with respect to the objective outcomes, now becomes a matter for empirical investigation. The implicit assumption that there exists a one-to-one relationship between the outcome matrix and the utility matrix, or between a particular outcome matrix and a particular preference ordering with respect to the outcomes in that matrix has been dropped. Whenever the banks myopically attempt to maximize their short-run net gains from credit expansion, the preference orderings adopted by the players (banks) correspond to those of a Prisoner's Dilemma: $P > Q > R > S$ for the row player. But whether a bank in a fractional-reserve free banking system actually adopts a perspective embracing this preference ordering is an empirical matter. If it is assumed to the contrary, as we have done, that the banks may adopt a long-run free market perspective, which leads them to perceive their own interests as being basically coincident with those of society at large and to choose «morally» or act in accordance with a «social norm», the preference ordering effectuated with respect to the outcomes will no longer be that of a Prisoner's Dilemma. For Player A, it may now be, for instance: $R > P > S > Q$.

Modeling the outcome characterized by the absence of global in-concert credit expansion as the efficient outcome in the game is also in better agreement with our intuitions about what is and what is not desirable for society. It is the outcome which will result if banks take an essentially long-run perspective, knowing that when they get in trouble there will be no lender of last resort to come to their rescue. Replacing the *laissez-faire* context by a different institutional setting —or lobbying for such a replacement— is simply not an option for the banks under this hypothesis.

The representation exclusively from the «myopic» short-run perspective of the banks delivers the intuitively paradoxical result that the mutually cooperative, Pareto-optimal outcome in the game represents the outcome which is actually *worst from*

the perspective of society as a whole since, as the Austrian theory of the business cycle explains, credit expansion by the entire banking system will distort the productive structure and provoke widespread, inter-temporal discoordination in the economy. But since the inevitable reversion effects of the credit expansion process will also hit the banking sector this outcome is not even efficient from the perspective of the interests of the banks themselves once a longer time perspective is adopted. It is indeed far from obvious that, especially from a longer-run perspective, the outcome consisting of concerted credit expansion by all the banks is in the interest of the banks themselves since the reversion processes which will necessarily be provoked by the credit expansion will also hit the banking sector.

The question remains: What is the institutional mechanism to be imposed to make the efficient outcome the outcome which will actually be realised? Advocates of the 100 per cent reserve requirement in banking will contend that obviously this outcome can be achieved by legally imposing a 100 per cent reserve requirement upon the banks, assuming that such a requirement can be effectively enforced. Advocates of a fractional-reserve free banking system to the contrary can reply that it seems doubtful *from the perspective of economic theory* whether a 100 per cent reserve requirement is a strictly necessary condition —although it is probably sufficient— for obtaining the desired result, since even under the pessimistic hypothesis that the short-term interaction configuration between the banks is to be modeled as a Prisoner's Dilemma, the (from the standpoint of society) efficient no-expansion outcome is the Nash equilibrium solution of the game.

From this perspective imposing a 100 per cent reserve requirement appears as an instance of *regulatory overshooting* so to speak, since, as we have seen, in a fractional-reserve free banking context the inter-bank clearing mechanism by itself constitutes a sufficient mechanism to guarantee the desirable outcome. This does not yet mean, of course, that there may not exist good independent reasons or arguments of an ethical or of a legal-theoretic nature in favor of the imposition of a 100 per cent reserve requirement. We are here only concerned with economic logic.

My conclusion concerning the internal dynamics of fractional-reserve free banking comes thus quite close to that of Ludwig von Mises. Ludwig von Mises believed that «[o]nly free banking would have rendered the market economy secure against crises and depressions (...)» (ibid. 440) since under free banking «a limit is drawn to the issue of fiduciary media.» (ibid. 435)⁹ Moreover Ludwig von Mises apparently found no juridical or moral anomaly in fractional-reserve free banking either. This accords with his general rejection of considerations grounded in natural law.¹⁰

⁹ Mises explicitly distinguished the problem of the business cycle from the argument concerning the limitation on the issuance of fiduciary media, and seems to have related the former predominantly to the hypothesis of *in-concert* expansion. He wrote: «The catallactically most important problems of the issuance of fiduciary media on the part of a single bank, or of banks acting in concert, the clientele of which comprehends all individuals, are not those of the limitations drawn to the amount of their issuance. We will deal with them in Chapter XX, devoted to the relations between the quantity of money and the rate of interest.» (1998, 433) In chapter XVII on *Indirect Exchange* Mises is only concerned with the problem of the coexistence of a multiplicity of independent banks: «Independence means that every bank in issuing fiduciary media follows its own course and does not act in concert with other banks. Coexistence means that every bank has a clientele which does not include all members of the market system.» (ibid. 433)

¹⁰ See e.g. Mises (1998, 716) where he wrote: «There is (...) no such thing as natural law (...)» Advocates of 100 per cent reserve banking might conclude that Ludwig von Mises does not seem to have sufficiently appreciated the importance of the legal-theoretical issues and distinctions involved. Mises apparently believed that fractional-reserve banking is fully justified from a «juristic» point of view since he wrote: «It is usual to reckon the acceptance of a deposit which can be drawn upon at any time by means of notes or checks as a type of credit transaction and juristically this view is, of course, justified; (...)» (Mises 1981, 300) Significantly he did not link his analysis of fractional-reserve banking to his important remarks concerning external effects and the imperfections in the positive or actual definition of property rights, «loopholes» as he called them. (Mises 1998, 653) As he wrote: «It is true that where a considerable part of the costs incurred are external costs from the point of view of the acting individuals or firms, the economic calculation established by them is manifestly defective and their results deceptive. But this is not the outcome of alleged deficiencies inherent in the system of private ownership of the means of production. It is on the contrary a consequence of loopholes left in the system. It could be removed by a reform of the laws concerning liability for damages inflicted and by rescinding the institutional barriers preventing the full operation of private ownership.» (1998, 653) Clearly an advocate of 100% reserve banking could argue that the failure to impose and/or to enforce the 100% reserve rule constitutes a loophole of this sort.

Advocates of a 100 per cent reserve requirement in banking might still question whether the game-theoretical representation indeed captures the essential characteristics and elements of the interaction pattern between the banks, thus questioning the conclusion that the interbank clearing mechanism constitutes a sufficient check upon in-concert credit expansion by the banks. One such possibility is explored in Hülsmann (2000). This author conceives of a possible expansive scenario in the following terms. If it is possible to bring *some* extra money title into circulation then this represents an opportunity for other banks to expand *their* issues. A bank that receives from one of its customers a money title from another bank can, rather than present the title to its issuer for redemption, issue more of its own money titles and «back» them with nothing but the title of the other bank. This in turn permits other banks—for example, the issuer of the original «excessive» title—to do the same thing. By this sort of zigzag process, all the banks can increase their title issues at virtually zero cost. Of course it is not possible for an individual bank to issue huge quantities of uncovered money titles at once and all on its own. But over time and in concert with other banks it can do this through a zigzag process of the sort described (Hülsmann 2000, 10). As Hülsmann contends, under fractional reserves, the cost of currency issue for any given bank is not independent of the decisions of the other banks. The more titles a bank chooses to hold, the more titles it can issue, and this permits other banks to do the same thing. In doing this bankers reduce the title-issue costs of their fellow bankers to virtually zero. *All* bankers have a strong incentive to do this since they all gain from the fractional-reserve business at the expense of the other market participants.

One could add to this account that on Selgin's and White's own account of the working properties of a fractional-reserve free banking system, this scenario is indeed rather likely to happen since on this account an increase in the demand to hold on to bank liabilities must lead to an increase of title issues. This feature of the system is even seen as one of its main advantages and virtues. Consider the case of an individual bank *i* experiencing a rise in demand to hold its currency. (For simplicity the following analysis

is in terms of currency, but the analysis applies equally to deposits.) An increase in the demand to hold bank *i*'s currency, unmatched by an increase in the supply, creates the reverse of an overexpansion. As the fractional-reserve free bankers see it, the actual circulation then *falls short* of the desired circulation. Suppose the bank customers, whose demand for *i*-currency has risen, hold on to more *i*-currency instead of spending it. Less *i*-currency enters the clearing system, and bank *i* enjoys positive clearings. As a result, bank *i* finds its reserves greater than desired, and is prompted by the profit motive to expand its loans and securities holdings, increasing its interest income and ridding itself of undesired reserves. In the new equilibrium reserves are returned to (or nearly to) their old level, with a larger volume of *i*-currency in circulation and a larger portfolio of earning assets. This is the sense in which according to the fractional-reserve free bankers the supply of money is *demand-elastic*: bank *i* finds it profitable to respond to a rise in the «desired» level of circulation by raising the actual circulation, and the reverse for a fall.

However, from the standpoint of the individual banker, it is not *prima facie* clear how to distinguish between a situation in which the *public* holds on to more of its titles and a situation in which *other banks* hold on to them, instead of presenting them for redemption, in view of expanding their own issue. Thus as soon as, say, bank *A* holds on to some titles issued by bank *B* instead of presenting them for redemption this fact will have for *B* the same appearance as an increase in the demand of the public to hold on to its currency and this fact will thus induce *B* to issue more titles. Now this fact allows *A* to issue more of its own titles with no cost in terms of anticipated reserve losses. So the point is that each issue of a title not backed by money represents an additional opportunity for other banks to expand their own uncovered issues. Each bank discovers how many uncovered titles it can issue at any point in time; and these issues change the conditions for the other banks, which can now discover that they can go a little further with their own issues, and so forth. Since all the banks as well as their clients have at least a short run incentive to engage into this sort of in-concert expansion

process, it is not obvious anything will restrain this process from running its course. Hülsmann is not explicit about whether this scenario can be modeled game-theoretically, and if so, how it should thus be modeled.

Hülsmann seems to *assume* that *all* banks would obviously be willing to participate in the expansion. No bank is interested in choosing the strategy «unilateral defection». The situation would then probably be better modeled as a Coordination Game. This is an issue upon which further research on the topic of free banking along the lines suggested by Hülsmann might focus closer attention. In any case, and while there is probably no need to deny that Hülsmann's scenario is a *possible* scenario in the short run, it is not immediately clear why, in a purely *laissez-faire* context, and in the absence of a central bank or similar devices, this scenario should be supposed or assumed to *necessarily* occur in the real world. The assumption that «obviously all banks will be willing to participate in the expansion», thus manifesting a preference for short-run gains from credit expansion and neglecting the more remote harmful consequences of credit expansion, is no more than that: an assumption. It is not logically contradictory to make this assumption but whether it actually obtains in a historical context is a matter for empirical investigation in every particular case.

Moreover, as Mises reminds us (1998, 433), free banking is *defined* by the fulfillment of *two* conditions: *coexistence* and *independence* of a multiplicity of banks. If it is simply assumed, however, that no bank would be interested in taking a course of action which is independent of that of the other banks, the latter condition is simply assumed away. Again the argument seems to pre-suppose or to assume what it sets out to demonstrate in the first place. Therefore, contrary to Hülsmann, we assume independence of the banks and thus also the possibility of unilateral defection on the part of any of the individual banks. But then White's objection, quoted above, still applies.

In case it is assumed that the interaction configuration is indeed best modeled as a Prisoner's Dilemma, a more obvious way to try to counter White's objection would seem to consist in modeling the interaction pattern as a *repeated* Prisoner's

Dilemma game. Game-theoretical experiments and arguments have contributed to the understanding of the conditions under which cooperation will be induced by rational self-motivated behavior in repeated Prisoner's Dilemma games (See e.g. Axelrod 1984 [1990]).¹¹

All of the foregoing is of course not intended to deny that the introduction of a lender of last resort in the form of a central bank radically changes the interaction pattern and the incentives of the players. In fact it is only the introduction of a central bank which leads to the *institutionalization* of generalized credit expansion. Independence of the individual banks is no longer assumed. All the banks participate in the expansion in coordinated fashion. In any matrix representation the off-diagonal outcomes lose their significance. The only remaining choices are those between *more* and *less* expansion. The tragedy is unavoidable, but it still makes sense to distinguish between *more* or *less* severe instances of the process. Depending upon the volume of the expansion and the velocity of the process, the ultimate effects might appear *later* or *sooner*. The dilemma which arises in this context is the following: if the monetary authority stops its expansionary policy, the boom will come to an end and current financial stability may be endangered; if the monetary authority keeps monetary policy expansionary, this may help to continue the boom for a somewhat longer period, but only at the cost of a greater recession later (see also Bagus 2007).

An approximate matrix construction might then rather yield something like the pay-off structure depicted in Figure 6. The whole process is orchestrated by the central monetary authorities. In this situation in which the banking system will extract huge amounts of wealth from the rest of society, clearly the interests of the banking system no longer coincide with those of society at large.

¹¹ See also Kreps et al. (1982) who actually prove that, given a small but positive probability that one of the players is not really a rational player but is instead a machine that always plays the *tit-for-tat* strategy, if there is a large number of periods then the players will cooperate in every period until they are close to the terminal period. For a classic and excellent summary of most of the game-theoretic concepts and arguments, see also Myerson (1991).

FIGURE 6

		Bank B	
		More expansion	Less expansion
Bank A	More expansion	Tragedy (recession) arrives later but is more severe	X
	Less expansion	X	Tragedy (recession) arrives sooner but is less severe

IV. CONCLUSION

We can concur with Foss' (2000) conclusion that Austrians ought to explore ways to incorporate game theoretic reasoning into their analyses, despite their otherwise highly distinctive and unique approach to the topic of «microfoundations for macroeconomics».

An examination of various attempted uses of the well-known Prisoner's Dilemma model has also led us to conclude, however, that the introduction of game-theoretical models into Austrian analyses should always proceed with great caution. In particular in the context of the ongoing debate on free banking the Prisoner's Dilemma model has been used with varying degrees of perspicacity.

As regards in particular the use of the One-Shot Prisoner's Dilemma configuration in the context of an argument against fractional-reserve free banking, it has appeared that this argument does not support the in-concert overexpansion thesis and that different—or at least additional—assumptions would be needed to support this thesis. Nor does it support the thesis that fractional-reserve free banking will tend to evolve towards central banking. When modeling the interaction configuration between

banks in a fractional-reserve free banking system, we have abandoned the implicit assumption that there exists a one-to-one correspondence between the outcome matrix and the utility matrix. When it is acknowledged that banks in a fractional-reserve free banking system need not necessarily adopt a «myopic», self-regarding perspective but may recognize the long-run harmony of interests between the banking sector and society at large, a different conceptualization and a different matrix representation emerge.

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