

OPTIMAL PRUDENTIAL REGULATION OF THE BANK RISK-TAKING

Regulación Prudencial Óptima de la Toma de Riesgo Bancario

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Fecha de recepción: 8 de noviembre de 2021

Fecha de aceptación: 9 de mayo de 2022

Resumen: Es probable que la pandemia de 2020 resulte en incumplimientos crediticios masivos. Los reguladores nos aseguran que los bancos son suficientemente estables. Sin embargo, los opositores afirman que la regulación es laxa, que debe ser más estricta y que se necesita de manera vital un regulador supranacional. Para resolver este debate, volvemos a los fundamentos del sistema bancario moderno. Analizamos la evolución de la regulación micro y macroprudencial, en especial el riesgo sistémico. Encontramos la solución en la intersección de la teoría del requisito de reserva total para depósitos a la vista de von Hayek (1929) y la teoría de policentricidad de Ostrom (2009), que resulta más eficiente para utilizar de manera óptima los recursos comunes. Desarrollamos las recomendaciones basadas en cuencas hidrográficas de Selmier (2016) para gobernar los mercados financieros y las extendemos a una analogía de flujo de tráfico. Concluimos con recomendaciones operativas para la revisión de la regulación bancaria prudencial existente. Proporcionamos una justificación adicional para la necesidad de un sistema completo de reserva. Esto permite abandonar los sistemas estatales de seguro de depósitos con déficits presupuestarios crónicos.

Palabras clave: patrón oro; comité de Basilea; encaje legal; regulación; tráfico.

Clasificación JEL: G28; G32; E58; R41.

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Author acknowledges the anonymous referees for the useful feedback.

Abstract: The 2020 pandemic is likely to result in massive credit defaults. Regulators assure us that banks are sufficiently stable. However, opponents claim that regulation is lax, that it must be tightened and a supranational regulator is vitally needed. To resolve this debate, we return to the basics of the modern banking system. We analyze the evolution of micro- and macroprudential regulation, particularly touching on systemic risk. We find the solution at the intersection of von Hayek's (1929) theory of full reserve requirement for sight deposits and Ostrom's (2009) theory of polycentricity, which proves more efficient to optimally use common-pool resources. We elaborate on Selmier's (2016) watershed-driven recommendations to govern financial markets and extend them to a traffic flow analogy. We conclude with operational recommendations for existing prudential banking regulation revision. We provide additional justification for the need of a full reserve system. This allows to abandon state deposit insurance systems with chronic budget deficits.

Keywords: gold standard; Basel committee; reserve requirement; regulation; traffic.

JEL classification: G28; G32; E58; R41.

"...men's fatal striving to control society — a striving which makes him not only a tyrant over his fellows, but which may well make him the destroyer of a civilization which no brain has designed, but which has grown from the free efforts of millions of individuals."

von Hayek (1974)

"Externally imposed regulation that would theoretically lead to higher joint return "crowded out" voluntary behavior to cooperate."

Ostrom (2009)

1. Motivation

In January 2020, *The Economist* predicted that the coronavirus-induced 2020 financial turbulence may result in a cascade of up to

25% of companies defaulting all over the world outside China. This is the credit risk early warning indicator (EWI). As a follow-up, Aramonte & Avalos (2020) demonstrated an unprecedented rise in default correlation on July 1st. They argue that during the world financial crisis of 2007-09, default correlation was 40%, having been approximately 10% in 2017 and having risen during the pandemic of 2020 up to 60%. This means that joint individual credit risks' realization amounts to something larger with devastating consequences. This is a systemic risk EWI. Such a probable hike in losses from credit and systemic risks have triggered discussions of delays in regulatory novelties' implementation and actual delays. For instance, the use of new IFRS 9 loss accounting standards may be shifted (Véron, 2020), and the derivative-related regulation of Basel III was postponed (BCBS, 2020).

Such events impacted people's opinions. Probably because of this, Pettifor (2020) evaluated the existing regulation as too lax on June 25. Her statements echo Calomiris & Haber (2014). They both assess the modern financial system as fragile by design. If Calomiris & Haber (2014) relate such fragility to politics-driven causes, Pettifor (2020) thinks that its origin dates back to 1944, when the Bretton-Woods system was abandoned. As a solution, she repeats the proposal of Dewatripont, Rochet, & Tirole (2010). They were first to suggest the creation of supranational banking regulator. Such calls for regulatory tightening resemble those raised immediately after the world financial crisis of 2007-09. At that time *The Financial Times* (2010) and particularly Admati & Hellwig (2013) asked for an increase in the number of agents policing the financial system. They stated that such a rise in supervisory extent would pay off. However, if this crisis is different, as Reinhart & Rogoff (2009) suggested and as Borio (2020) proves it to be, it is not clear why we need tighter regulation and another supranational regulator today.

Pettifor (2020) particularly contradicts the stance of official regulatory body representatives—for instance, the head of the Basel Committee on Banking Supervision (BCBS). Coen (2018) claimed that BCBS sufficiently tightened regulation after the world financial crisis of 2007-09. As a result, he evaluates modern banks as stable as ever. Particularly, they have enough capital to absorb potential losses. Borio (2020) supports his statement. He claims

that banks utilize their accumulated capital well, making them adequately stable. Interestingly, Borio delivered his speech within a week of Pettifor's article.

A research question naturally arises: Do we actually need any reform of modern banking or financial market regulation? More specifically, do we indeed need a supranational regulator, or BCBS with an enlarged mandate? Answering these questions is the objective of the current paper. We have at least two broad sets of options available to us. The first option is to wait and see. We may see whether the abovementioned credit or systemic risk triggers lead to actual losses. The second option is to act without waiting. Here we are also at a junction. We may follow Pettifor's (2020) suggestion and further enlarge the building of modern banking prudential regulation. Perhaps the BCBS may change its role from a standards-setter to a sort of "last resort regulator," i.e., the regulator (not a cooperative or representative body) of central banks all over the world. Keep in mind, as we will show later, the foundations of modern financial regulation are rather large already. On the other hand, we may choose different actions. To design those, we need a truly interdisciplinary study. We need to account for quite different streams of economics ranging from the very quantitative econophysics to a more incentive-based institutional analysis and development (IAD) framework.

To achieve this goal, we proceed with the literature review in the second section. We will demonstrate why we need to focus on banking regulation and not on financial market regulation. By reading von Hayek (1929), we will discuss whether banks are indeed so specific and different from corporations. Then we explain our methodology in Section 3. Particularly, we extend the works by Selmier, Penikas, & Vasilyeva (2014) and Selmier (2016) to apply the study of commons to banking regulation. We will also show that cash is the basis for the goods topology in banking regulation. Von Hayek's works, forgotten by a majority of researchers, enable us to see how overuse of cash as a common-pool resource leads to a public bad of financial fragility. We introduce the analogy of traffic regulation to arrive at operational recommendations in the domain of prudential banking regulation. Selmier (2016) uses watersheds to introduce the strategic stewardship recommendations for the governance of the financial markets. He complains

that the watershed analogy does not work well, as it does not capture the rapid economic growth possible in financial markets well. We show that this is not a shortcoming of Selmier. We use a watershed analogy of our own with the traffic flow model, where both represent fluid dynamics concepts. Though econophysics does capture such rapid evolution, we show that it lacks the foundation laid by von Hayek. In fact, the failure of fluid dynamics concepts to capture rapid evolution helps to illustrate the artificial and distorting nature of growth expansion that originates from the over-use of cash. We present our findings in Section 4, explicitly highlighting the recommendations that contradict those introduced by the BCBS. We conclude in Section 5.

2. Literature Review

We wish for a broader audience to understand the essence of this paper's messages. That is why we structure the literature review in three distinct parts: a review of prudential banking regulation, the essence of banking description, and the polycentric solutions to social (community) dilemmas.

First, we briefly introduce prudential banking regulation from the high-level perspective. We will list the major pillars of such regulation, specifically the so-called microprudential and macroprudential ones. The former targets solo-level (entity-specific) credit risk, whereas the later focuses on the consolidated level, i.e., on systemic risk. We will also try to offer a flavor of modern regulation evolution.

Second, we discuss what banks are: why they are so special, why they tend to merge, why they form the foundations for rapid growth not well captured by fluid dynamics concepts. Here we will mention why econophysics is so suited to capturing these dynamics and why it is insufficient at explaining one.

The reader may challenge our order of presenting the regulations first and the regulatory subjects second. The reader is right—regulations should consider the specifics of the parties under regulation; thus, discussion of the regulated entities must follow. However, as we show, it seems that this is not the case. That is why

we wish to present banks second in order. As a summary, we list the reasons why data and modeling can't help us answering the question on how to transform modern banking regulation if it is needed.

Third, we cover the study of the commons, or the IAD framework. Its attractive feature is that it does not share the view that markets are the best solutions ever for resource allocation, consumption and production ever. It admits that markets may fail. However, it does not admit that hierarchical government structures are always efficient when failures happen, either. The framework suggests that people, often in localized communities, may decide more optimally than such a sort of a disinterested governmental central planner. We assert that the existence of many decision-making nodes (polycentricity) in such cases may be more efficient than a government-driven monocentricity. We may also recall the principle of subsidiarity in the Roman Catholic Church. It recommends solving problems and finding solutions at the lowest (at the most localized) level as possible¹.

2.1. *Review of prudential banking regulations*

"The prudential regulation refers to the set of laws, rules, and regulations which is designed to minimize the risks banks assume and to ensure the safety and soundness of both individual institutions and the system as a whole" (Polizatto, 1989, p. 2, footnote 4). There are seven high-level pillars of modern prudential banking regulation. To list them in historical order, they are as follows:

1. Obtaining bank charter
2. Minimum reserve requirement against deposited funds
3. Participation in the state deposit insurance (SDI) scheme
4. Minimum amount of own funds (capital) requirement
5. Proportionality treatment, including systemic risk consideration

¹ Author acknowledges the anonymous reviewer for pointing this out and referring to the following material: [https://en.wikipedia.org/wiki/Subsidiarity_\(Catholicism\)](https://en.wikipedia.org/wiki/Subsidiarity_(Catholicism))

6. Minimum amount of cash-equivalent funds (liquidity) requirement
7. Worldwide unification of requirements

Let us look at these pillars in more detail. The first one is the bank charter. The majority of people perceives banks as financial intermediaries. Their conventionally expected business model is the following. Banks borrow small sums for the short-term from individuals and lend large sums for the long-term to enterprises. Although borrowing and lending can be undertaken by anyone, banks have special charters (permits, licenses) to do this. We find that historically, all banks had charters (Hildreth, 1837). In Section 2.2, we will explain the reason for this by following von Hayek (1929) and Huerta De Soto (2006). For now, it is important to remember that the charter implies the possibility to run a bank business model and the necessity to follow regulatory requirements.

According to Huerta De Soto (2006), the reserve requirement was the first requirement to banks, going back several thousand years of human history. The regulator requires the bankers to hold a certain fraction of sight (demand) deposits in the form of assets that are quick and easy to liquidate without much loss in value. Such assets might be cash or securities (often government-issued ones). Recently the reserve requirement refers to all bank liabilities except their own funds (equity, capital). The introduction of the possibility to withdraw any deposit early (even timing a withdrawal with the loss of the interest accumulated, but by preserving the principal) led to such requirement scope expansion. The minimum reserve requirement became mandatory for banks around the world after the last days of the Bank of Amsterdam by 1820 (Gillard, 2004; Huerta De Soto, 2006). At that time, obtaining a bank charter became mandatory. The idea of holding cash-equivalent (mandatory) reserves against deposits suggests that all else being equal, *in normal times* the amounts of a mandatory reserve should be enough to cover the average needs of bank clients in cash. Huerta De Soto (2006) gives the popular example of a 10% fraction of the deposited funds as a benchmark reserve requirement since the 18th century (the times of Cantillon, Law and others).

However, fractional mandatory reserves are not sufficient to cover deposit withdrawal needs in crisis by definition when depositors are frightened and wish to collect all their deposited funds. The most destructive consequences of such a situation occurred during the Great Depression of 1929-1933. As a remedy, the US government established the world's first state deposit insurance (SDI) agency, the Federal Deposit Insurance Commission (FDIC). Prior to this, there were private deposit insurance schemes (Hogan & Johnson, 2016). However, for an insurance scheme to be efficient, it should encompass the entire set of potentially exposed agents. The SDI scheme suggests that every depositor of a failed bank is entitled to the lower of the minimum deposit coverage amount and the deposit amount. Diamond & Dybvig (1983) provided strong support in favor of the SDI scheme. After their paper's publication, countries all over the world started establishing SDI schemes for themselves. One example of SDI expansion was the remarkable rise in the minimum deposit insurance coverage amount by the FDIC from USD 100k to USD 250k in September 2008. This happened within a week of the Lehman Brothers investment bank collapse. It helped to prevent a panic, or bank run, among depositors during the world financial crisis of 2007-09 in the US. However, Hogan & Johnson (2016) present historical examples and show that banks in US states without state deposit insurance support took on board fewer risks than those participating in such schemes.

Nevertheless, regulators considered that the availability of liquid funds does not guarantee a bank's sustainability. The reason is that banks may still experience losses from credit risk. Borrowers may not pay back their loans from the bank. That is why regulators decided that in case a bank has sufficient funds of its own (equity, capital), it may survive without recourse to any financial assistance by the government. Thus, the BCBS introduced the capital adequacy ratio (CAR) in 1988. CAR implies that the amount of capital is enough to cover risks taken by the banks. Initially, BCBS considered only credit risk (the possibility to not be paid back in full and on time). BCBS considers this risk as a borrower-driven one. Then, it added market risk in 1996 (probable losses from common risk driver moves like interest rates, FX exchange rate, etc.). In

2004, BCBS augmented the risk list with the operational one. The operational risk may originate from failures in processes, technologies or systems, or people (including fraud activity). Since 1996, BCBS has allowed banks to define asset riskiness themselves. This is called internal models (internal models method [IMM] for market risk; internal-ratings-based [IRB] for credit; advanced measurement approach [AMA] for operational risk). Banks used the estimates for the denominator of the CAR. The use of the internal models might be obligatory, as it has been in the US since 2014, or voluntarily, as in the EU since 2007.

From one viewpoint, Dewatripont & Tirole (1994) supported the introduction of CAR as it limited recourse to public funds when a bank needed rescue. Dewatripont, Rochet, & Tirole (2010), and later Ordoñez (2018) argued that the minimum capital requirement is vital for banks. Otherwise, the mentioned authors unanimously claim that banks' capital would go to zero; i.e., the banks would tend to minimize its amount. These authors' claim is wrong for two reasons. First, historically investing has more often happened in the form of joint vehicles (i.e., via joint equity holdings). People have themselves designed the cooperation format—as noted in the epigraph by Elinor Ostrom (2009). To invest jointly, people always required co-investment, co-contribution by all members. People understand the fact that if a project manager has no personal stake in a project, he is not very efficient. Dewatripont & Tirole (1994) said that debt-holding is a positive feature for corporate governance as it disciplines bank managers not to spend a lot. Equity holding also disciplines the manager as when taking wrong risk, he himself is to lose. Spong & Regher (2012) and Gorton (2012) bring additional historical evidence. They demonstrate that banks operating without minimum capital requirements in fact had higher capital-to-asset ratios than those subject to such regulation. This contradicts Dewatripont, Rochet, & Tirole (2010) and Ordoñez (2018). Second, let us not think of banks as special entities. People run firms, just as they run banks. If Dewatripont, Rochet, & Tirole (2010) and Ordoñez (2018) were right, then firms would not have any equity of their own. However, we refer to several studies covering quite different times and geographical areas. Altman, Haldeman, & Narayanan (1977) showed that both failed

and non-failed US firms had some debt, but never nil equity. Izan (1984) showed the same thing for Australian firms. Acharya, Sundaram, & John (2004) covered 1990-2002 data for UK firms and showed that their average debt was about 30% of assets, and again equity was never nil. Later, we will explain why nothing disciplines banks in the modern banking system to have non-nil capital.

From another angle, Dewatripont, Rochet, & Tirole (2010) said that overly tight financial regulation (or a high CAR minimum) may prevent banks from undertaking their core intermediary functions for the economy. However, recent studies on firms' capital structure do not strongly support this. For instance, Seta, Morellec, & Zucchi (2020) argue that only holding long-term debt incentivizes firms to take lower risk. Inversely, they show that short-term borrowing—as is actually the case with the bank business model of financial intermediation introduced earlier—stimulates higher risk-taking by firms. This is an important consideration if we do not think of banks as special entities. If we look at banks as mere leveraged firms, the nature of their short-term borrowing stimulates higher risk-taking by them.

Conversely, Acharya (2009) claimed that tighter regulation is needed. He argued that there is systemic risk. Generally speaking, it is problematic when the joint impact of all risks is larger than the sum of entity-specific ones. Acharya introduced a theoretical framework to justify higher CAR requirements for larger banks. If Dewatripont & Tirole (1994) were proponents of microprudential regulation, Acharya (2009) operationalized macroprudential regulation. Combined with *The Financial Times'* (2010) appeal to regulators to tighten regulations, BCBS introduced Basel III (BCBS, 2017). One of its parts introduces definition of systemically important financial institutions (SIFIs) and requires them to hold up to a quarter more capital in relative terms compared to non-SIFIs, all else being equal. BCBS called this a proportionality requirement. Conceptually, the larger the entity contributes to the systemic risk, the more stringent regulation it has to follow.

The concept of systemic risk has captured the minds of researchers (Carey & Gordy, 2003; Acharya, 2009; Mayordomo, Rodriguez-Moreno, & Pena, 2014; Li & Marin, 2014; Tente, von

Westernhagen, & Slopek, 2019; Duprey & Ueberfeldt, 2020; Meuleman & Vennet, 2020; Fatica, Heynderickx, & Andrea, 2020) for the last twenty years. They offer different approaches to quantify it. However, we should keep in mind that systemic risk is unobservable (Ermolova et al., 2020). This means that we may think of it, but we cannot back-test any quantifiable model (test its goodness-of-forecast). This is what von Hayek (1974) said—that often in economics, we lack the data on the factors that really matter. For instance, in the case of Acharya (2009), we can verify his proposed approach to measure asset-return cross-correlations. But this will not be a systemic risk back-testing; that would be asset-return cross-correlation back-testing—Nothing more, nothing less.

There is another tool within the macroprudential measures list: the counter-cyclical capital buffer introduced as part of Basel III in 2010. Its idea is to raise the minimum CAR requirement during boom times and decrease it in crises ones. The former curbs credit acceleration, while the latter is thought to promote recovery after crises.

Though micro- and macroprudential policy measures are designed to mitigate excessive risk-taking by banks, regulators wish to investigate whether they were efficient or not (BIS, 2020). However, this raises the dilemma with econometric tools. When all the regulatory measures are applied to all agents, one cannot separate the affected (treatment) group from the unaffected (control) group. Additionally, if a measure was indeed efficient and prevented some bank failure or crisis, then the data does not signal this because of the following. The EWI triggered some measure introduction, but a negative event did not occur. However, if there was no measure in place, the event could occur. Then there was a desired sequence that a negative event occurred after the EWI signal. That is why the problem with econometric tools is that it relies on past information about observable events. If some sort of regulation was not already in place or we do not have sufficient data about it, econometrics cannot help. It cannot tell us about the measures' efficiencies as they are applied to all banks.

Though BCBS had already considered three types of risk (credit, market, operational), the collapse of the Lehman Brothers bank in

2008 canonically illustrated that this was insufficient. Although the bank met CAR and minimum reserve requirements, it was unable to meet all obligations. The liquidity risk is no less meaningful. This incentivized BCBS to explicitly introduce a minimum liquidity requirement in Basel III. Goodhart (2011) states that there were discussions to do this from the very enactment of the BCBS in the 1970s, but no one reached consensus. Everyone waited for 40 years for a world-scale failure like the Lehman one to arrive at the consensus. We may regard the minimum liquidity requirements (Mordel, 2018) as a sort of reserve requirement specification. The major novelty was the ratio of liquid funds to the expected short-term cash outflows from the deposits. Thus, a change to a reserve requirement was twofold. First, BCBS limited the numerator to short-term assets. Second, deposit account balances in the denominator are replaced with the expected (mathematically modeled) cash outflows.

Liquidity regulation followed the same path as capital regulation (CAR). Prior to BCBS standards, every country had its own regulation of these risks. Often the form was different. As for capital, some countries used risk-weighted ratios; others, risk-unweighted ones. As for liquidity, some regulators checked the ratios of assets to liability account balances, whereas some monitored cash flows. Nevertheless, BCBS took a long path for regulators from different countries to agree on a unified approach. For instance, it took 40 years to agree on a liquidity measure. It took eight years to agree on capital measures, from 1980 to 1988 (Goodhart, 2011), and also to agree on Basel III, from 2009 to 2017.

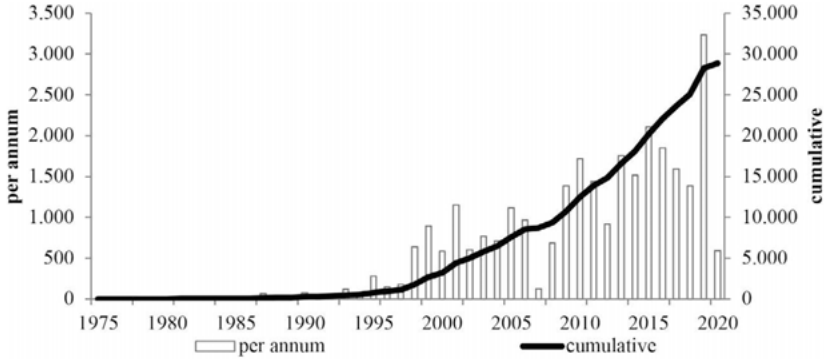
From its launch in 1974, BCBS acted as a cooperative—that is to say, consultative—body. It offered recommendations that local regulators may or may not implement. However, BCBS made a historical decision in 2013. By that year, the number of BCBS member countries had risen from 12 to 29. It decided to shift from recommendations to standards and guidelines. BCBS required local regulators to implement those guidelines no softer than originally stated. Any requirement leads to control. As a result, BCBS initiated a regulatory consistency assessment program (RCAP; BCBS, 2013) to evaluate whether a regulator in a given country of interest implemented standards no softer than stated. One of the most

noticeable, unexpected findings was the fact that BCBS considered the EU countries as materially noncompliant (BCBS, 2014). This led to significant prudential regulation changes in the EU since then. BCBS argues that such banking prudential regulation standards' unification is needed for at least two reasons. First, it provided a level playing field for international banks operating in different jurisdictions. Second, such unification implies that there are no "black holes" that may be sources of systemic risk proliferation. There are proponents of such unification (e.g., Gordy et al., 2015; Pugliese, 2016). However, there are also opponents. For instance, Avgouleas (2000) argues that the EU benefits from having regulations different from the BCBS standards. Lall (2012) claims that BCBS regulation (particularly on the use of mathematical models) favors larger banks. Jones et al. (2018) similarly claim that developed countries benefit from BCBS regulation more than developing ones.

The seven pillars described above seem logical and concise. However, they only form the top of the of the building of modern banking prudential regulation: BCBS produced much more granular regulatory requirements (see Figure 1). Overall in its 45 years of activity, BCBS has published approximately 900 documents worth 30k pages.

From one perspective, one may deem that such an amount of regulation is already large enough. Then one may doubt the statement by Pettifor (2020) that the regulation is lax. We may find at least two indirect justifications for such an amount, especially for such consecutive rises in regulatory requirements. First, Demsetz (1968) discussed the origins of regulation. He looked at utilities that groaned under the increased regulatory burden. However, he hypothesized that utilities are the direct and most important beneficiaries of such increases. The reason is that the rise in regulation implies increase in entry barriers for potential competitors. When the barriers rise, the utilities present at the market may sustain the targeted return on their investments. Second, almost 50 years later Shleifer (2012) claims that the legal and court systems inefficiency leads to the rise in regulation overall (not specifically banking regulation). He says that because of much uncertainty when in litigation, agents prefer to invest in regulation to avoid the stage of litigation.

FIGURE 1. NUMBER OF PAGES IN BCBS-PUBLISHED DOCUMENTS DEVOTED TO PRUDENTIAL BANKING REGULATION



Source: author manually collected and processed data from the BCBS website. Original idea from Haldane (2009). Penikas & Selmier (2013) first demonstrated proof of concept, and Penikas (2015) methodologically augmented it.

However, from another point of view, one may recall the chief economist of the Bank of England, Haldane (2009), gave an example of a CDO documentation page count. He determined that to properly understand the risks of the CDO squared, an average investor should have read one billion information memorandum pages. Such volume perplexed many and might have prevented them from reading. Besides, one may remember Hensarling (*The Economist*, 2016). He was a proponent of simpler regulation rules, as one may always gamble with the complex rules. Though the statements by Haldane and Hensarling are general ones, and disregarding the regulation requirements augmentation, several authors (Moosa, 2010; Dewatripont, Rochet, & Tirole, 2010; Lall, 2012; Cathcart, El-jahel, & Jabbour, 2017) argue that there were many cases of regulatory failures. From this point, Pettifor's (2020) claim seems reasonable. Let us now look deeper into the essence of banking.

2.2. *The essence of banking*

We started the previous section from the statement that many people perceive banks as financial intermediaries. However, von

Hayek (1929) has proven this is not true. One may recall the strange fact that banks required a Charter to operate, but anyone could borrow and lend. According to von Hayek (1929), the Charter is the certificate legalizing the illegal appropriation. This may sound odd to many readers. To explain, let us carefully solicit the arguments of von Hayek (1929) and rich examples from Huerta De Soto (2006).

The essence of illegality is the notion of the bank deposit, which is specifically delineated in the Civil Codes of all countries worldwide as an operation distinct to lending (borrowing) or storage. When the reader thinks of a bank deposit she likely has, she may fail to clarify whether it is a storage contract (equivalent to a safe box) or a lending contract (to a bank). One may say that the current account (sight/demand deposit) is a storage contract, and the time deposit is a lending one. However, a deeper inspection reveals no differences. If you remember, we said that any time deposit may be withdrawn early in the modern world. This means a time deposit may only differ from the sight one in the interest rate. From the withdrawal perspective, all bank deposit contracts are sight ones. Thus, the minimum reserve requirement refers to the total deposit base regardless of whether it is called a sight or time deposit.

If the contract is a demand one, one expects it is available any time. This availability is actually the feature of a storage contract. When you put an object into a safe box or put some liquid or dry bulk into a large reservoir, we expect you can take it or its equivalent at any time. You expect this because you did not transfer the property rights for the stored item. Remember, when you store, you pay for the storage.

When you lend, however, you transfer the property rights of the lent item (temporarily). The borrower may do whatever he wishes (including nothing). Regardless of his actions, he has the property rights for the borrowed item and must return the item and its property rights to its holder at the end of the borrowing (debt) contract period. The contract's interest rate is the lender's reward.

How does it happen then that the bank deposit is a storage contract, as it is available any time, but the depositor also receives an interest rate? According to von Hayek (1929), this occurs because

the depositor treats the contract as a storage contract and the bank as a debt one. When two parties treat a deal differently, it is void. All contract parties need concordance on the contract type for it to be effective. Thus, the bank deposit operation contradicts the very essence of legal system (Huerta De Soto, 2006). It legalized different contract treatment by parties. The bank charter grants the chartered entity the right to undertake a deal that would be illegal in other circumstances.

The key implication of introducing the bank deposit notion is the change in the banking business model. Someone operating storage contracts can't lend money, and someone negotiating debt contracts can act as an intermediary. However, one cannot lend more than was borrowed if the transaction is not a bank deposit. When the bank receives money for storage, it starts lending it. If the bank deposit notion was not legalized, it could not do so. When legalized, the bank may lend more than it borrowed.

Any economist reading this will probably recall the following. The amount of credit money created in the economy equals the amount of cash (monetary aggregate M0) divided by the reserve requirement fraction. For the mentioned fraction of 10%, the monetary base grows to ten times the amount of cash initially available in the economy. This happens because of the following bank accounting mechanics. To give a loan, a bank registers the needed lent sum of money on the borrower's current account within this bank. If the borrower did not have such an account, the bank opens it. The described monetary multiplication happens only if the loan stays within a bank—the lent cash does not leave the bank's auspices. This is feasible in two cases. Either the borrower uses bills, bank notes, or electronic money from a plastic (debit/credit) card or the borrower's counterparty (contractor, employee) also has a current account within the same bank. Why is credit creation lucrative for a bank? If we take a 10% reserve requirement, the bank may earn interest income 10 times larger than it must pay for the interest expense. It pays the latter on the deposited cash. It gains the former from a 10 times larger amount of money.

Huerta De Soto (2006) and von Hayek (1929) call this a process of (credit) money creation from nothing (*ex nihilo*). Thus, upon comparing the above incomes from the two activities, banking's true

business model is not financial intermediary, but creating money from nothing. For instance, creating money from nothing yields nine times more income than the financial intermediation of the original cash.

According to von Hayek (1929) and Huerta De Soto (2006), governments are the key beneficiaries of such an essentially illegal use of deposited cash. They say printing money is too obvious and is criticized by an enlightened public. Thus, governments legalized bank deposits so that banks would allocate part of the newly created money to the government by purchasing government debt. Here, you may start assessing the true reasons why regulators require banks to hold more cash-equivalents, including government bonds, as a part of the liquidity risk regulation.

If a reader is not convinced with the above legal analysis of the fractional reserve banking, we should recall the saying by (Mises, 1953, p. 60) that 'it is a mistake to deal with economic problems according to legal criteria'. He argued that economists should look deeper than the lawyers (jurists) and to see the economic substance under the legal form. Thus, we should mix the legally possible events (e.g., the existence of a bank deposit contract as it is present in the Civil codes) and the actually unaffordable ones (like the violation of property rights in the case of a bank deposit). Therefore, the given legal analysis is sufficient for us to proceed with the discussion of its economic implications.

Historically, von Hayek (1929) was the first to demonstrate the detrimental consequences of such an illegal appropriation of cash. He starts with a productive example of no credit involving a fisherman. He says that a fisherman can have technological progress, but he needs to sew a new net. To do this, he must abandon fishing for a time and store food in advance to survive. An entrepreneurial risk occurs; he might count the days wrong and not have enough food, or something else may prevent him from accomplishing the task. However, if he does as he planned, he will catch more fish or catch as much fish as before but relax more. This fisherman can go to the market. The demand side did not change, and the fish buyers have no triggers to change their budgets for purchasing fish. However, the fisherman can offer more fish, so the price per unit of fish goes down. The proponent of this process was von Hayek

(1929). He underlines that voluntarily saving is the driver for technological progress, and such progress is accompanied by deflation.

Von Hayek (1929) extends the fisherman's case to the whole economy, and Huerta De Soto (2006) illustrates this. When people voluntarily save, they sacrifice their current consumption, and prices for the end-goods go down (we just described the deflation process mechanics). When prices decrease, relative labor costs go up. The worker's quality of life improves because he can now afford more per unit of his salary. Labor becomes relatively more expensive than capital. Industries producing end-goods start decreasing their demand for labor and increase their capital use. The value chain overall becomes longer and more capital-intensive. Von Hayek (1929) stresses the importance of a flexible labor market at this point in the process. If there are no rigidities, labor easily flows from producing end-goods to new production stages that appear earlier in the value-creation chain. As a result, prices continue decreasing, technology progresses, and people's well-being improves. In such a financially stable situation, no economic crises occurs. This should be the government's objective. In fact, Huerta De Soto (2006) shows this was the case for the Netherlands in the 18th century when the Bank of Amsterdam (Gillard, 2004) forbade credit from nothing by imposing a 100%-reserve requirement for demand deposits.

However, when the government allows creating credit from nothing, things change. The money supply rises, which implies a rapid rise in the prices of goods, including asset quotes on stock exchanges. Thus, the relative cost of labor lowers compared to the capital. Entrepreneurs start employing people more, and there is no need for technological progress. The value chains become labor-intensive and shorter. Banks have abundant credit. To allocate this credit, they actively search for extra investment opportunities. To approve them, banks decrease underwriting standards and start offering more loans to riskier borrowers. Remember, labor's relative price is low, and the demand for labor rises from the existing industries and from newly launched projects. People become a scarce resource, and their wages rise. This seems a nice feature for employees, although prices for goods and services continue to rise, and

employees' net well-being diminishes. Nevertheless, people cannot join all the projects. Entrepreneurs cannot accomplish part of their projects. Defaults on bank loans start to mushroom, and banks start losing money. Depositors worry about the safety of their cash stored in banks, so they start running on the banks. Being hit from both loan- and deposit-sides, banks start defaulting. As a result, the financial crisis burns out the economy, leaving it with labor-intensive labor chains, high unemployment, and high prices (inflation).

High unemployment leads to lower wages. People start getting back to work and accumulating cash. With time, they recover trust in banks. They start depositing money with the banks again, and the cycle repeats. Von Hayek (1929) described such a cycle and predicted the Great Depression of 1929-1933 in advance. Huerta De Soto (2006) argues more generally that humans have had devastating financial crises every 5 to 10 years during the last two thousand years. Huerta De Soto (2006) also noticed that inflation continues to proliferate along with the crises because banks obtain interest income from loans and can increase the numerator for the credit expansion ceiling. Some people claim this is a natural "golden figure" of inflation of about 3%. However, von Hayek (1929) has shown that only deflation is natural and constructive, whereas inflation is not the cause of economic problems, but a consequence. To manage an economy, one must return to depositors their property rights on stored cash, so you do not need to worry about inflation driven by creating credit from nothing.

Thus, von Hayek (1929) is the true founder of the endogenous economic cycle that modern researchers claim to have invented (Blatt, 1983; Haxholdt, Kampmann, Mosekilde, & Sterman, 1995; Raybaut, 2014; Sunaga, 2017; Colacchio & Davanzati, 2017; Hasumi, Iiboshi, & Nakamura, 2018; Agliari, Böhm, & Pecora, 2020). They actually have started reinventing it based on Keynes (1936). However, the modern invention does not allow for such a cycle as explained by von Hayek (1929). Huerta De Soto (2006) provides evidence on the Keynes-Hayek communication; he shows how Hayek explained that Keynes is wrong. Keynes even agreed, although it was via private correspondence in the last days of Keynes' life. The important (and mostly forgotten) contribution of von Hayek (1929) is that he explains the crises' predefined origins embedded in the

modern banking system with a fractional reserve requirement. This means that no crisis happens awkwardly, as many claimed during the 2007-09 world financial crisis (Minsky, 1982). Minsky (1982) failed to explain the nature of crises and merely said that they occur unexpectedly. However, von Hayek (1929) has proven that crises occur expectedly.

We want to explain this seemingly forgotten principle of the endogenous economic cycle of modern banking systems via the fractional reserve banking revealed by von Hayek (1929). Only banks with the opportunity to illegally utilize the alien cash property drive such a cycle. Huerta De Soto (2006) adds that sometimes those drivers may also be insurance companies or pension funds from which clients can withdraw the allocated funds at any time. However, the major drivers for the cycle are banks, which is why we focus on banking regulation and not on financial markets or other financial institutions.

The nature of the endogenous economic cycle portrayed by von Hayek (1929) explains why fluid dynamics concepts failed to properly describe economic growth and contraction. For instance, Selmier (2016) complains that a watershed might not be an appropriate analogy for financial markets' governance as it does not capture the rapid economic growth.

Fluid dynamics comes from physics, but it has a substream that may be a separate interdisciplinary research domain called econophysics. Researchers de Area Leao Pereira, da Silva, and Pereira (2017) argue that this domain started prospering in 1990s when one found a substitution to the fluid dynamics (mechanics) theory. Schinckus (2018) states that the Ising model was a breakthrough. Physicists observed that the material features may drastically change with a change in temperature, producing a sort of nonlinear boom-bust effect. Econophysicists found a way to capture the path of a nonlinear economic expansion. However, they can't explain why this happens. It is insufficient to say we observe that something happens because the change of some unknown driver may drastically change the outcome as well. Thus, von Hayek (1974) criticized the appealing feature of applying the laws of physics (originating from quite a different environment) to economics. Nevertheless, it may be interesting to know that Ising discovered

his effect in physics in 1925, i.e., mostly in parallel to von Hayek's (1929) discovery in economics.

Let us recall the earlier statements of Dewatripont, Rochet, and Tirole (2010) and Ordoñez (2018). They claimed that banks always wish to minimize capital. Above, we said that this is true only if we consider banks as special entities in the modern banking system. In the current subsection, we investigated von Hayek's (1929) theory of how banks create money out of nothing. Now consider the following two cases. When you store something, you do not need a co-investment from the storage holder. Inversely, as we said, when one wants a long-term investment (particularly when one voluntarily lends to a bank her savings made by sacrificing her current consumption), one definitely requests a co-investment for strictly positive capital. Governments—having allowed clients to withdraw any deposit early (be it a sight or a time one)—made bank clients start treating all the deposits as storage contracts. Thus, governments have eliminated debt's disciplinary impact mentioned by Dewatripont and Tirole (1994). Bank clients think that all the deposits are a storage type and do not require any capital from a bank. A government tries to introduce some external (prudential) banking regulation to offset the consequences of its own deeds. This is the conventional “cobra effect” introduced by Siebert (2001). He refers to the West-Indian British Campaign when Englishmen wished to get rid of cobras. They offered remuneration for every dead cobra. Locals started breeding cobras, and the number of cobras quadrupled instead of shrinking. As a result, the Englishmen had to get rid of even more cobras. In fact, eliminating the first policy steps—keeping paying for cobras or allowing for early withdrawal of any deposit—may help revert the situation to its manageable origin.

Another notorious implication accompanies letting clients withdraw any deposit early. This incentivizes people to bring more cash to a bank than they would for voluntary savings. By allowing the early withdraw of any deposit, the credit expansion was fueled even more.

Besides, depositors' disinterest laid the groundwork for governments to claim that banks need a regulator because depositors cannot understand the complexities of banking. However, depositors

do not wish to do this—they think they stored cash and wonder where inflation comes from and why crises continue to bombard the economy.

The modern banking system's design with the fractional reserve requirement has three important implications. First, banks tend to merge, and the probability that a borrower counterparty has a current account with a borrower bank rises. Thus, less cash leaves the bank, so credit expansion is possible, and more profit can be earned. As a result, banks become larger and more systemically important. Such a process might be somewhat slower via the introduction of macroprudential tools. However, these tools do not revert the trend. Second, banks tend to argue for the benefits of electronic money and ignore that maintaining electronic systems (IT servers, electricity, and cyber-security measures) is not free. Plastic money gains its market share from the total transaction volume in a step-wise fashion. To accelerate it, banks and regulators offer novelties in form but not in substance, such as private and public digital currencies (Pfister, 2019). When cash is fully abolished, the creation of credit from nothing can reach its peak. Third, the more cash banks have, the more money banks can create from nothing. That is why financial inclusion is promoted. Yunus (2006) argues that having a current account with bank leads to economic prosperity, citing his case of Bangladesh. We now know that putting cash into a modern fractionally-reserved bank actually deteriorates the well-being of the poor, helping only the bank shareholders and the government via profit from the artificial credit expansion. For poor countries, increasing financial inclusion gives a short-term economic boost, but yields a more devastating crisis, higher unemployment, and higher inflation. Do we really think we help poor countries this way?

Von Hayek (1929) described the origin of modern banking fragility by identifying when governments and central banks allowed fractional reserve banking. We have shown his logic of how banks then tend to take more risks, but there is a room for improvement. Von Hayek (1929) did not investigate the proper governance structure—if any—needed for banks' risk-taking with a 100%-reserve requirement.

2.3. *Polycentric solutions to social dilemmas*

The hierarchical government units may fail. We already mentioned the cases of regulation failures. The IAD framework suggests that proper governance depends upon many factors.

To recall the goods topology used in IAD, see Table 1. There are two dimensions. The first is non-excludability—whether people may be excluded from consumption. Ostrom (2009) mentions it is more correct to call the second dimension “subtractability” rather than “rivalry,” as first used in Ostrom and Ostrom (1977). This second dimension means someone might be detached from simultaneous good utilization (consumption, production). She also notes that, instead of indicating the presence or absence of a feature from each dimension, it is better to indicate the degree of a present feature’s intensity.

Two features are important when looking at the goods topology. First, Ostrom (2009) gave peace and security as examples of pure public goods and theater as an example of a club good (service). Common-pool resources are rivers, forests, and air. The pure private goods are food, clothing, and automobiles. This gives an important hint for further research. A common feature of the three types of goods (except the pure public good) is tangibility. On the other hand, the pure public good is something vital but intangible, which does not mean that it cannot be proxied. For instance, one may compute the number of war conflicts to identify peace. Alternatively, one may ask experts to rank the peace level. However, no observably objective measure exists for the pure public good. Inversely, all other good types or services can be quantified in terms of volume and availability, such as the number of cars available for sale, the number of theater tickets sold, or the tons of water in the water basin. Such measurement might be imprecise (like water capacity) or manipulated (like the deficit for the theater ticket). However, we focus not on measurement or manipulation errors, but on the fact that omitting all the constraints may yield the true volume of goods available.

Second, Ostrom (2009) gave examples of various goods in each type. However, it might be interesting when the same good appears in different types. Selmer is the first researcher to academically

prove that financial risk and finance overall can be perceived via the topology matrix (Selmier, 2014; Selmier, Penikas, & Vasilyeva, 2014; Selmier, 2016). He suggests that financial risk might be a special good (bad) type depending on the amount. Thus, we wish to further investigate how a good in Selmier's (2016) words transmutes between types in the topology matrix.

TABLE 1. ORIGINAL GOODS TOPOLOGY ACCEPTED IN IAD.

		<i>Subtractability of Use</i>	
		<i>high</i>	<i>low</i>
Non-Excludability	high	Common-pool resource	[Pure] public good
	low	[pure] private good	Club good

Source: (Ostrom, 2009, p. 413).

Persons involved in decisions at the national and supranational levels regularly use such parallels, but for a single type of good. The IMF representative (Camdessus, 1999) seems to first identify financial stability as a public good. Then, representatives of central banks—Shirakawa (2012) and Demetriades (2012)—followed him. Pettifor (2020) is one of the most recent references. However, they explain neither the origins of their thought nor the implications for governance. Selmier (2016), however, introduces the watershed governance analogy to arrive at the financial market's governance implications. For instance, he claims that the "two sides of a coin" needed attention. On one side, more disclosure should be favorable. On the other side, there should be more monitoring, including of the disclosed data. He also suggests that adaptive management by a community, rather than by a sole leader, should be encouraged. We may treat it as a sort of support for counter-cyclical capital management. He adds that the fuzzy boundaries concept is useful. Such boundaries may relate to home–host supervision. This is an important issue as BCBS started from the need to resolve it. To do so, it published the first, seldom remembered, Concordat document stating principles for international cooperation when

resolving bank failure. It involved counterparties from several countries, as was the case with the failure of Herstatt bank in 1974 that triggered BCBS's creation (Goodhart, 2011).

However, two principal improvements are available when departing from Selmier's (2016) endowment. First, he deals with the human–nature interaction, but finance is a human–human interaction. As Ostrom (2009) stated, humans are particular because they possess complex motivational structures. Thus, we must search for a domain where humans interact with each other by some means (tools, contracts, etc.). According to Avgouleas and Cullen (2014), regulators in finance should consider human psychology, i.e. why and how people decide upon human–human actions. We should also remember that the basic decision to pay back the loan, i.e. whether credit risk results in a loss or not, depends upon two general sets of factors. First is the capacity, i.e. the funds available to pay back to banks. Second is willingness, i.e. whether the borrower wishes to pay. This concerns psychology. For instance, a borrower may have two loans but only funds available to pay for one. Thus, her willingness defines which bank scores profit and which one scores a loss. Second, the governance of a water basin as a common-pool may require a watershed (Selmier, 2016). However, finance is not limited to a single bank or to a single product. According to Selmier (2016) with reference to Stiglitz (2008), the abundance of often derivative products “polluted” the economy during the 2007–09 world financial crisis, which is why we want an analogy that permits a set of tools (contracts)—sometimes quite exotic ones.

Importantly, a recently popular tool is being used in econophysics (de Area Leao Pereira, da Silva, & Pereira, 2017) and in IAD frameworks (Ostrom, 2009): agent-based models (ABM). They can mimic the interaction between crowds of agents, but they heavily rely on assumptions the modeler incorporates. However, such effects—like the above “cobra one”—may not be foreseen by a modeler, which is why ABM may better quantify the impact of a well-studied event. Nevertheless, it does not add anything if not previewed by a modeler. Like econometrics, econophysics does not help anticipate unforeseen (often psychological) human reactions in economics.

To sum up, we may derive the following. Prudential banking regulation includes the appealing objectives of reaching and maintaining financial stability. The volume of regulation permanently grows, but regulation failures still occur. The existing prudential regulation may exacerbate the negative consequences of modern fractional banking system. The latter stimulates banks to merge, and regulators mirror this trend by tending to supranationally regulate banks. “Cheap talk” and informal rules are pulled off by such a government construct (Ostrom, 2009). Disinterest in cooperation and in disciplining banks is fueled by property rights violations that occur when people think of all bank deposits as storage contracts while they are debt. However, even with the full-reserve requirement, there is no sufficient investigation of banks’ risks, except in the work by Selmier (2016).

3. Methodology

To proceed further, we describe two facets of our methodology. First, we present the goods topology with respect to banking. Second, we introduce a traffic flow analogy to investigate how risk-taking is regulated therein.

3.1. *Cash as the basis of goods topology*

Selmier, Penikas, & Vasilyeva (2014) argued that the basis for financial risk is asset size. However, later Selmier (2016) presented various financial arrangements not solely differentiable by asset size. Take, for instance, option contracts, mutual funds and currency. We argue that Selmier (2016) was the first to coin the fundamental element of goods topology when studying financial stability; i.e., he denoted “currency.” We wish to elaborate on this idea more. In our view, it is indeed currency (cash, more specifically; as opposed to credit money) that underlies financial stability. As a private good, cash is the amount one can deposit (lend) or store. We already mentioned that such a simple transaction can be operated by any person or entity. Even full utilization of the *stored* cash by the storage

holder cannot impact the economy-wise financial stability. When several deposits in cash are collected by a single bank, the implications for the economy from the illegal property right use for a stored amount of cash are larger. However, as discussed earlier, the more banks are in the economy, the more often cash leaves the bank, the less detrimental is the negative impact of utilizing stored cash. Imagine we have an extreme situation that intentionally or subconsciously target banks and regulators. There is a single bank that has all the cash and all economic agents have current accounts with this behemoth. Then cash becomes a truly common-pool resource. Such a behemoth bank may well overuse cash—i.e., actually use the stored (deposited) cash with it. Financial stability indeed is then a purely public good. Its mirror counterpart (a public bad) is systemic risk. As with peace and national security (Ostrom, 2009), financial stability and systemic risk are both intangible. This means that neither financial stability nor systemic risk can be measured. Still, as discussed earlier, many attempt to proxy such variables and derive quantitative implications based on the proxies used. Table 2 summarizes the mentioned ideas.

TABLE 2. GOODS TOPOLOGY APPLIED TO BANKING REGULATION

		<i>Subtractability of Use</i>	
		<i>High</i>	<i>Low</i>
Non-Excludability	High	Common-pool resource: Total cash (M0)	[Pure] public good: Financial stability
	Low	[Pure] private good: Cash from a single deposit	Club good: Total deposits of one bank

Source: author’s proposal.

3.2. *Traffic analogy introduction*

We mentioned that Selmier’s (2016) analogy may be improved by considering human–human interactions, i.e., psychological effects of risk-taking, and by adding vehicles to the capital flow.

We may call these two enhancements a sufficient requirement for the analogy in question. The necessary conditions are the criteria that Selmier's (2016) watersheds satisfy. We suggest looking at a traffic flow analogy. Several people have already mentioned traffic flow parallels in a general way. For instance, Chang (2014) compares banks to cars, Ingves (2015) makes parallels between Basel II and the Vasa warship, and Byres (2012) treats bank managers like airplane pilots.

First, let us clarify the key points in the traffic flow analogy and then proceed to details. When comparing traffic flows to banking, banks form our unit of analysis and they equate to intersections and cars—to transactions (contracts). Chang (2014) uses the inverse comparison, treating banks as cars. As we show later, because of his assumption, he arrives at the wrong conclusions. Let us go deeper into the details.

Traffic flow has several attractive features as an analogy. First, it meets the minimum requirements of Selmier (2016). It is scalable as well as having watersheds. It also allows for a variety of users. Resources (cars, vehicles) can be tapped for many uses. We may map all traffic flow situations to all four good types. Different good types of traffic imply various governance arrangements. Generally, drivers as well as bankers tend to sustainably exploit resources. However, sometimes separate individuals may deviate from the optimal strategy. When this happens to nearly everyone due to their limited viewpoints, we end up either with congestion or a mass accident in the case of traffic and with illiquid markets or financial crises in banking. Due to the earlier introduced notion of cash as the underlier of financial stability, we now see that the latter might degrade because of the overuse of the former. The same happens with traffic. As mentioned, when many drivers take individual decision to be smarter, everyone ends up in an accident or at least in congestion. Thus, the traffic pure public good of driving comfort deteriorates (discharges).

Traffic flow has additional attractive features in this metaphor. First, traffic flow is primarily a human–human interaction by means of using particular vehicles (cars, trucks, etc.). Thus, it shares the core feature of transacting in banking (i.e., risk-taking). For instance, Adams (1985) calls drivers “deliberate risk-takers.” Second, the

presence of vehicles enables us to model the next steps on Selmier’s (2016) watershed analogy. Banking is not only a flow of cash (as the true intermediary function), but it also employs various vehicle types. For instance, an exotic option or CDO-squared is somewhat similar to an F-1 racing car. Table 3 provides more details on benchmarking the banking and traffic regulation domains.

Having mapped banking to traffic, let us derive the implications for the regulation of bank risk-taking.

TABLE 3. TRAFFIC FLOW REGULATION TERMS MAPPED TO BANKING RISK REGULATION

<i>Traffic Flow Regulation</i>		<i>Banking Risk Regulation</i>
Risk Taking as the Principal Activity		
1.	When one moves or turns, she risks crashing into another vehicle	When a banker offers a loan, she risks not getting it back.
Goods Typology		
<i>Private Good</i>		
2.	A vehicle on a road	Cash from a single deposit
<i>Club Good</i>		
3.	Vehicles at an intersection	Total deposits of one bank
<i>Common pool resource</i>		
4.	All movable vehicles in the region	Total cash (M0)
<i>Public Good</i>		
5.	Driving comfort	Financial stability
Regulatory Objectives		
6.	Minimize the number of accidents	Minimize the number of bank defaults
7.	Minimize consequences of an accident	Minimize expenses caused by bank defaults
8.	Minimize congestion	Minimize out-of-operation periods
9.	Maximize possible speed	Maximize the speed of a transaction

.../...

.../...

<i>Traffic Flow Regulation</i>		<i>Banking Risk Regulation</i>
Bank		
10.	Intersection	Bank
11.	Driver	Client, banker, or jointly
12.	Weather	Economy
13.	Other traffic participants	Other financial entities, stakeholders
14.	Obstacles	Regulatory limitations
15.	Crash, accident	Default, crisis, loss
16.	Probability of crash	Probability of default
17.	Injury in event of crash	Loss incurred upon default
18.	Congestion	Stop of transaction flow (liquidity risk)
19.	Infrastructure (intersection), flow size	Proportionality criteria
Transaction		
20.	Car	Transaction
21.	Formula-1 (F-1) racing car	Exotic derivative
22.	Speed limits	Internal risk assessment models
23.	Trial actions upon crash	Recovery and resolution planning (RRP)
24.	Side of road (left/right)	Approach to regulation (non-unification)
25.	Speed	Capital/liquidity risk
26.	Traffic lights	(Credit) deal acceptance criteria

Source: Prepared by the author.

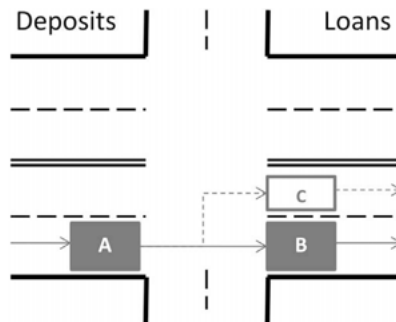
4. Principal findings

We group all the implications into five groups: the effects of exponential scalability, infrastructure design, speed limit control, approach to regulation unification, and insurance usage.

4.1. *Exponential scalability*

Prior to the use of the Ising model, Selmier (2016) and econophysicists complained that their models did not capture the explodable dynamics of rapid economic growth. The traffic analogy as a sort of fluid dynamics concept does not do this, either. However, the impossibility of capture is not a shortcoming of our approach, that of Selmier (2016) or those of early econophysicists. It underlines the problems of the modern economic system with a fractional reserve requirement (see Figure 2). Today, our economy functions like this intersection, where the approaching car A (one incoming deposit) multiplies into cars B and C (two outgoing loans).

FIGURE 2. HYPOTHETICAL TRAFFIC SCALABILITY



Source: Prepared by the author.

In modern economic systems, the capacities for multiplication are much greater than one-to-two. For instance, in the EU it is one-to-one hundred since January 2012². However, for the US it is one-to-infinity, as the reserve requirement has been set to zero since March 26, 2020³. It is easy to grasp that such an exponentially

² Website of the European Central Bank [accessed on July 18, 2020]: https://www.ecb.europa.eu/explainers/tell-me/html/minimum_reserve_req.en.html

³ Website of the US Federal Reserve System [accessed on July 18, 2020]: <https://www.federalreserve.gov/monetarypolicy/reservereq.htm>

scalable traffic system ought to soon end with absolute congestion when all the roads are invaded with artificially created clones of true vehicles. The key implication here is to abandon the fractional reserve requirement, disallow early withdrawal of time deposits, and restore the practice of the Bank of Amsterdam with a 100% (full) reserve requirement for sight deposits.

Of course, the full reserve banking does not prevent any financial crisis. The latter ones might be at least triggered by irresponsible actions of particular agents, including speculators, or by mere natural disasters like hurricanes, earthquakes etc. However, the full reserve banking system is times more stable than the fractional one. Operationally, full reserve banking does not require a gold standard, i.e., the necessary link between the money (money-substitutes) and its underlying guaranteed by the Government. Moreover, the undiscussed fragility of the gold standard is the inherent inflation. It comes from the fact that gold is constantly mined. As a result, its stock increases globally. Thus, it implies the inflation equal to the pace on newly extracted gold per annum. Thus, the paper money once printed and fixed in quantity is sufficient.

However, we should consider why (Mises, 1953, p. 19) wrote that 'Like all human creations, the gold standard is not free from shortcomings; but in the existing circumstances there is no other way of emancipating the monetary system from changing influences of party politics and government interference, either in the present or, so far as can be foreseen in the future'. This means that the once printed and fixed in quantity the amount of paper money is an equivalent of Pareto optimum for society. The challenge with Pareto is that it is often unstable and the social game falls into the Nash-equilibrium. And the Nash equilibrium is the increase in the amount of paper money. The gold standard with its inherent extraction-driven inflation is the second-best solution as it forces the imposition of an explicit boundary for human actions. Then the society has a choice either to have a monetary system with no gold standard and the possibility to print paper money in an unbounded fashion; or to have a gold standard with the limited inflation equal to the gold extraction rate. The latter one, hopefully, might end as all the extractable natural resources (unfortunately, it may happen in the very distant period).

4.2. *Infrastructure design*

Intersection design is the primary determinant for the regulations imposed at the crossroads on how two traffic flows intersect, on who has the priority to move first. Its analysis is important for banking regulation. Banks are intersections in this analogy. That is why banking regulation defines how many vehicles and at what speed a bank as an intersection may allow to pass (to negotiate).

Modern road traffic infrastructure has several types of road intersections: simple intersections with no traffic lights (uncontrolled intersection and priority intersection), roundabouts, intersections with traffic lights (or signal-controlled ones) and multilevel intersections (or grade-separated ones), using classification from Bird (2009). Generally, when the traffic flow increases, the intersection type evolves from the simplest to the most complicated. The objective of and need for evolution is twofold: to enable cars to cross the intersection at high speed, i.e., to avoid congestion (or to have the fewest lines and jams possible), and to minimize the risk of accidents where diverse flows intersect.

The mentioned intersection types vary. For example, simple intersections come into being mostly naturally, whereas grade-separated ones need significant investment and a large available surface to plan and erect. The simpler the intersection is, the more weight is attributed to rules that define the priority of crossing the road; the more complicated it is, the less weight is attributed to rules that define the priority of traffic to cross or pass the road. When the traffic flow intensity (its accident and congestion traits) is high enough, the traffic regulator decides to introduce a traffic light (i.e., the regulation) for a particular intersection. Thus, intersections with traffic lights are intermediate solutions: the presence of regulation is neither a starting nor a long-term state of affairs.

When reviewing the listed intersection types, one may easily note that regulation is in fact needed only for intersections with traffic lights. For the simplest intersection types, simple established rules are enough to guide drivers when they meet at the intersection. For grade-separated ones, regulation does not matter, as the intersection design guides the drivers. There are three implications with respect to who should be regulated and supervised in

normal and crisis times and whether specific prudential treatment is needed for financial monoliners (narrowly specialized financial entities) or universal banks (banking supermarkets).

With respect to banking risk regulation, the first observation implies that neither the smallest (or the simplest, i.e., monoprod-uct-based) financial entities, nor the largest (or the most complicated, e.g., universal banks, including SIFIs) should be regulated. Similar to the traffic flow approach, prudential treatment of a financial entity should change with the changes in its risk profile. This is called proportionality criteria in today's banking risk regulation parlance. It is prescribed to regulate larger entities more. This means that on one extreme, traffic flow regulation and its banking counterpart coincide, suggesting no regulation for the smallest intersections (banks), but contradict at another extreme. Key policy implication here comes to abandon regulation of the largest and most advanced institutions.

Second, traffic flow regulation suggests that the narrower the street, the faster the average flow speed. Alternatively, when an accident happens or a jam takes place, a regulator is invited to rule out the situation. Here, the implication for banking risk regulation is that in crises, regulation should be increased, not dampened. This also contradicts the recent proposals of banking risk regulation to decrease countercyclical capital buffer (Danielsson & Jonsson, 2005; BCBS, 2010; Repullo & Saurina, 2012; BCBS, 2019) or decrease the amount of dynamic provisions when in crisis (Ocampo, 2003; Fernandez de Lis & Garcia-Herrero, 2010; Agénor & da Silva, 2017; Saurina & Trucharte, 2017).

Third, infrastructure design experience suggests that where possible, traffic flows should be separated to increase flow speed and decrease the probability of accidents—particularly the most harmful ones (Button & Hensher, 2009; Kerner, 2009). Specifically, F-1 racing cars are forbidden from driving on general-purpose roads. As for banking, Titova, Penikas, & Gomayun (2020) show that trading derivatives results in much more risk for banks than the use of hedging derivatives. Adding traffic regulation experience to this fact implies the need to re-separate business lines, namely, corporate and investment banking. This would mean restoring the Glass-Steagall Act introduced in 1933 and abandoned

in 1999. The only possible allowed use can be of hedging derivatives for commercial banks.

Thus, traffic flow regulation experience implies that neither small nor large financial entities should be regulated or supervised. However, when crisis strikes, such regulation is worth introduction for both groups and should be tightened for the already-regulated entities. Overall, business models should not be mixed.

4.3. *Speed limit control*

Another domain of traffic flow regulation is speed limiting and monitoring. In banking risk regulation, speed is equivalent to the riskiness of an asset or transaction. Speed defines how many cars may pass the intersection. Risk weight defines which assets and/or transactions are taken on board as it straightforwardly enters the denominator for the CAR formula: the greater the risk weight is, the less the amount of particular asset allowed by the regulator is. Let us cover the traffic flow regulation experience in that domain.

There are three major works to consider: (Adams, 1985; Wells, 2012; and Blinkin & Reshetova, 2013). Adams (1985) makes the case that with improved brakes, drivers start driving faster and brake later. Blinkin & Reshetova (2013) mention the increased number of accidents from exceeding speed limits in the developing countries from overreliance on the new technological features of the car (e.g. improved brakes or anti-blockage systems). Opposite from car technology effects and investigations by Adams (1985) and Blinkin & Reshetova (2013), Wells (2012) presents a survey on the history of speed cameras' introduction in a developed country (the UK) in 2003. The cameras were designed to control the speed of cars passing by. The business model was to cover the maintenance costs and the expense of the new camera installations from fines due to speed limit violations. However, drivers adapted—as could have been foreseen from Adams (1985)—and slowed down prior to camera-located spots. Thus, the program did not get full country reach and its expansion was stopped in 2009.

Now let us shift to banking risk regulations. These allow banks to define the risk weights themselves (IMM, IRB, AMA) —i.e., the

speed of their cars—subject to passing the prudential validation. The most natural equivalent in traffic terms would be the following example. A car can pass an intersection subject to a higher speed limit if and only if the car owner or car producer proves that the car is technologically advanced.

Now consider the following situation. A regulator sets the limit for the number of cars that can pass the intersection per unit of time. The intersection's (bank's) profits proportionally depend on that number and the bank is allowed to set the speed by itself. Therefore, the bank's management motivation—remembering the psychological issues raised by Adams (1985) for traffic and by Avgouleas & Cullen (2014) for banking—might be expected to devalue the speed (the risk weight) assessment. This is particularly expected of traffic experiences in developing countries (Blinkin & Reshetova, 2013), though that might also be present in the developed ones. Remember the Volkswagen scandal when the automotive producer manipulated internal software—equivalent to speed measurement or a bank's risk-weight—to get its cars approved for sale in the US (Crete, 2016)?

The key implication here is that interested parties should exclude internal models from prudential treatment, as they are prone to manipulation by psychological and economic motives. This does not mean that mathematics should not be used in day-to-day banking business processes, but it should not be part of regulation. This echoes the message of Jones et al. (2018) who claim that the advanced approaches of Basel II (including internal models) are detrimental to financial stability.

Here we wish to specifically discuss the concepts of capital and liquidity that form the basis of banking. There are two types of liquidity: market and balance sheet (funding) ones. The former relates to the capability to quickly and with no material loss sell an asset on the stock exchange. The latter relates to a bank's ability to pay on its liabilities. It is subject to regulations discussed earlier. However, if we introduced 100% reserve requirement and forbade early withdrawal of time deposits, we by construction would have no balance sheet liquidity risk. Stored cash is always available. The lent cash is unavailable till contracts mature. If one doubts that a bank may fulfill its obligations in front of the

borrowers, it is only because of credit risk realization. This is also true for a stock asset. If you cannot sell it, it is illiquid, or equivalently, it has lost its value. That is why credit risk remains the only risk, corresponding to the true business model of banks as financial intermediaries.

4.4. *Approach to regulation unification*

Let us take a very basic concept that underlies traffic flow regulation, side of driving. Kincaid (1986) presents rare examples when countries historically changed the side of driving. Mostly this was related to the desire to erase the memory of being under British imperial rule. However, the dominant majority of countries stayed with the historically original side of driving, be it left or right. Discussions on the advantages and disadvantages seem to be permanent. For instance, Kincaid (1986) himself provides statistical evidence that right-sided (UK-style) driving is more secure. However, there is no global target to have a single side-of-driving standard. Moreover, one may easily notice that there are no purely international driving rules. All that such rules prescribe is to stick to local ones when driving in a given country.

As for banking regulation, the situation is different. We already mentioned that many years were taken to agree on minimum capital and liquidity standards, as well as the RCAP initiative to unify standards throughout all member countries.

That is why the key implication here is to avoid banking regulation harmonization globally, and at least abandon RCAP. This is in line with Greenwood & Roederer-Rynning's (2015) thoughts, as well as Jones et al. (2018), who observed discrimination against developing countries when banking risk regulation was unified along the single path of BCBS.

Like the absence of unified international driving rules, banking regulation—if ever needed—should be localized. There is neither need nor justification for any supranational regulator or for assigning BCBS with a larger mandate. This is why Ostrom (2009) said that “‘one-size-fits-all’ policies are not efficient” (p. 409).

4.5. *Insurance usage*

Mandatory third-party liability insurance is used to form a pool of funds to compensate for the losses of innocent traffic accident victims. Third-party liability insurance incentivized drivers to take on more risk similar to the introduction of improved brakes (Adams, 1985) or seat belts (Wells, 2012), as they knew that minor expenses in case of non-catastrophic accidents would be covered.

Financial institutions also have a type of third-party liability insurance that may have similar implications, known as deposit insurance (Hogan, Jones 2016). One may note that similarly to state deposit insurance, credit default swaps (CDS) incentivized equivalent shifts toward more risk-taking. With this came an illusory perception of lowered risk. In fact, one risk type was substituted by another (e.g., credit risk against counterparty A was changed to credit risk against counterparty B). Risk did not evaporate from the entire financial system; it still resides within the system, though a feeling of its absence at the level of a solo institution may be produced. Similar to car insurance, deposit insurance implies higher risk-taking at first, and as a consequence results in systemic budget deficits of the state deposit insurance agencies (Ingves, 2017). At the same time, there are private deposit insurance agencies. Actually, these represent themselves as a form of polycentric arrangement.

That is why the key takeaway is that state deposit insurance has to be abandoned. Private deposit insurance programs may continue existing, as people are able to cooperate themselves when no hierarchical government unit dominates.

5. **Concluding Remarks**

The 2020 pandemic has provoked challenges for banking prudential regulation revision. As a representative of one camp, Pettifor (2020) repeats the post-2007-09 slogans to tighten regulation and, as Dewatripont, Rochet, & Tirole (2010) suggested, to introduce a supranational regulator. Regulators, from their side, claim that banks have adequate capital and liquidity buffers to withstand

any losses, disregarding the unprecedentedly high levels of default correlation (Aramonte & Avalos, 2020).

In an attempt to resolve the controversy, we recall the brief history of prudential banking regulation. It has positive objectives of achieving and maintaining financial stability. However, as von Hayek (1929) first showed, there are fatal vulnerabilities of fractional reserve banking in modern economies, accelerated by the possibility to withdraw any bank deposit early. These vulnerabilities are exacerbated by requiring banks to hold minimum capital and liquidity. Indirectly, the situation has been worsened by the rush away from cash (promotion of digital currencies, as well as proliferating financial inclusion for those who do not have spare money for voluntary savings). As a result, booms and busts occur more often, being expected rather than unexpected as Minsky (1982) or Taleb (2007) claim.

In our search for an answer about the destiny of prudential banking regulation, we found that neither econometrics nor econophysics could help us. For instance, systemic risk is unobservable and immeasurable, though many try to proxy it and derive quantitative recommendation for regulation. Simulation models largely depend on assumptions and cannot by themselves model the observed “cobra effects” of people’s opposite actions to the targeted ones.

That is why we find remedy in an IAD framework. We depart from the Selmier’s (2016) work. He pioneered in offering governance implications for the financial markets. We look at the traffic flow analogy as an alternative. We stress that banks are intersections and not cars, as previous researchers expected. We demonstrate that this model has several advantages over the watershed one introduced by Selmier (2016). It allows for both capital flow and distinction among vehicles, as well as capturing human–human interaction by means of such vehicles.

Overall, getting back to the posed research questions: Yes, we are indeed striving for a reform of the existing prudential banking regulation. However, we do not need either a supranational regulator or a BCBS with an enlarged mandate. Instead, we need to undertake the seven following steps to revise existing prudential banking regulation:

1. We need a 100% reserve requirement and the impossibility to withdraw time deposits early. This should come instead of requiring banks to hold minimum capital and liquidity. By restoring the true debt nature of time deposits, depositors will become interested in disciplining banks. This is the foundation for polycentric arrangements, including private deposit insurance systems that are dampened by the predominance of hierarchical government (and proposed supranational) regulatory bodies.
2. The largest banks should not be regulated unless there are respective polycentric initiatives. In fact, when there is a 100% reserve requirement, banks will not merge very intensively. There will be more smaller banks. This would make polycentricity even more exercisable and efficient.
3. Only when a crisis occurs (such occurrences and their scale would be greatly limited by a 100% reserve requirement), then regulators might step in and remove the degrees of freedom for banks to regularize activity slowly. Any fast recovery leads to a crisis of no lesser magnitude, as the modern banking system with fractional reserve requirements demonstrates quite often.
4. Restore separation of investment and commercial banking activities, particularly operations with derivatives. Allow commercial banks to only use hedging derivatives. Restoring the true natures of sight and time deposits will help people to more responsibly take risks in investment banking and derivative transactions.
5. We already argued for the abandonment of minimum capital requirements. As a transitional step, internal models should be excluded from prudential treatment. This should initially be done in developing countries.
6. Any regulation that will be conceived as a needed one should not be unified on a greater scale. Local communities know much better what suits them. We cannot avoid fraud activities. Some banks may still try to overuse cash stored with them. But here, polycentricity solves the problem by most probably imposing sanctions at their own expense to punish the deviating banks (Ostrom, 2009).

7. Abandon mandatory participation in state deposit insurance schemes. This lower risk-taking frees up taxpayers' money. The tax dollars collected will no longer need to finance state deposit insurance agency budget deficits. The immediate implication is to lower taxes proportionately.

TABLE 4. SUMMARY OF CONTRADICTIONS
TO CURRENT POLICY IMPLICATIONS

No.	<i>Traffic Flow Regulation Domain</i>	<i>Existing Banking Risk Regulation</i>	<i>Implication from Traffic Flow Regulation</i>	<i>Proposal for Optimal Regulation</i>
1.	Exponential scalability	Fractional reserve banking accompanied by minimum capital and liquidity requirements	Traffic is nonscalable	Abandon minimum capital and liquidity requirements; instead reintroduce a 100% reserve requirement
2.	Infrastructure Design	Tighter regulation for large entities (incl. SIFIs)	Do not regulate the largest and the most sophisticated intersections	No regulation for large entities (SIFIs)
3.	Infrastructure Design	Soften regulation in crises (apply counter-cyclical capital buffer)	Tighten regulation in loose spots	Tighten regulation in crises
4.	Infrastructure Design	Allow merging corporate and investment banking; commercial banks can underwrite exotic derivatives	Separate traffic flows where possible; F-1 racing cars are not allowed on general-use roads	Restore separation of corporate and investment banking (one financial entity cannot do both); only hedging derivatives may be allowed for commercial banks
5.	Setting Speed Limits	Internal models can be allowed in all countries	Technologically advanced vehicles lead to higher accident rates in less-developed countries	Exclude internal models from the prudential treatment
6.	Approach to Unification	Banking risk regulation requirements should be no softer than the Basel ones (RCAP)	Do not target convergence internationally; there are no international driving rules, they are all local	Do not target unification of banking risk requirements internationally
7.	Insurance Usage	All banks need to participate in SDI programs	Third-party insurance induces more risk-taking by drivers	Abandon mandatory participation in state deposit insurance schemes

Source: prepared by the author.

Table 4 summarizes the findings by benchmarking them to the existing requirements. We have no data to prove our suggestions. However, we have the rich experience of peoples with complex motivational structures, cooperation, and ability to locally solve social dilemmas where hierarchical government units have failed. That is why we strongly believe that the proposed steps will indeed enhance financial stability and economize taxpayers' money from unjustifiable funding of regulatory and supervisory agencies.

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