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Analysis and impact of macroprudential policies on the stability of the global financial system.

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Academic year 2023.-2024
Dissertation for the master of
Ingénieur de gestion, à finalité spécialisée avec une majeur en International Finance
Daytime schedule

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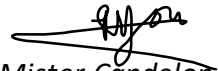

7/08/2024

Firstly, I would like to sincerely thank Mister Candelon, who was a great help to me with his advice, his knowledge and his availability during the writing of this thesis.

I would also like to thank my family for their support.

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Introduction

The financial crisis has inevitably led to catastrophes on an economic and social scale, resulting in sizeable output losses, drastic downturns in economic activity (due to the decline in the quantity of products and services produced), weakening of GDP growth, rising unemployment, unequal distribution of wealth, and so on (Ampudia et al., 2021b). This phenomenon has recently struck several nations, brought on by cycles of credit expansion followed by abrupt recession. That is the reason why so many countries have implemented macroprudential policies as their main tool for addressing these difficult circumstances and reducing the risk of financial instability on a global level (Vučinić, 2016).

In this thesis, we look at the effects that macroprudential policies can have on the stability of the global financial system. To do this, we will draw up with a literature review, considering the concepts, explanations, elements and theoretical models of numerous scientific articles. We'll start with the main objectives of macroprudential policies and the characteristics of these policies that make them effective in promoting financial stability. Conversely, we will then discuss the factors that promote financial instability, as well as the complexity of the financial system, which makes it difficult for macroprudential policies to intervene. Microprudential and monetary policies will also be discussed in terms of their influence on the effectiveness of macroprudential policies. To continue, we will tackle the importance of tightening and loosening these policies, which have a major effect on excessive credit growth, the latter having an impact on the SRISK, a measure of systemic risk.

To enrich this thesis, we will complement it with an empirical analysis oriented towards an econometric study. This analysis will help us understand whether there is a significant relationship between macroprudential policies and the stability of the financial system. We will see whether other factors, such as GDP, should be taken into account to study this link. The codes to enable us to obtain results will be generated by Rstudio using Excels files containing the data we need. There will be some theoretical elements which should have been included in the literature review section, but which have ended up in the empirical analysis section for reasons of text fluidity, clarity and comprehension. We will finish by deeply analyzing the interpretation of the results and stating the limitations. Finally, we will draw conclusions out of it.

Literature review

1. Objectives of a macroprudential policy

The term "macroprudential" originated in the 70s, at a meeting organized by the Cooke Committee (the current Basel Committee specializing in banking supervision), where one of the topics discussed was the precarious state of the financial system, linked to the drastic increase in lending, particularly in developed countries. Later in the year 2000, a reference was made to this term when speaking of the need to broaden the macroprudential dimension considered as the pro-cyclicality of the financial system to guarantee financial stability, which is a complement to the microprudential dimension (CHIRIACESC, 2013).

The ultimate objective of macroprudential policy is to safeguard financial stability (which contributes to sustainable economic growth), strengthen the resilience of the financial system and reduce the build-up of systemic risks[1] (Vučinić, 2016) while at the same time limiting the risks and the costs that may result from a financial crisis (CHIRIACESC, 2013). There are two characteristics that define financial stability: (1) the ability to withstand shocks (resilient) and (2) the capacity of the financial system to deal with transactions by avoiding interruptions or interventions (Alfi, A. F., 2014). Macroprudential policies also aim at moderating credit growth and real estate prices, which are two factors that must not to be overlooked considering that those have one of the highest probabilities among other variables to trigger a crisis (Biljanovska et al., 2023). Therefore, macroprudential policies set up several instruments to achieve this, but we'll discuss these in more detail later.

We can also regard macroprudential policy as predefined rules containing thresholds to respond to specific situations, which differentiates them from the rules previously implemented by regulators as the latter are discretionary in nature (i.e. based on the ad hoc judgment of policymakers) (Vučinić, 2016).

[1] The definition of systemic risk is "the risk of widespread disruption to the provision of financial services that is caused by an impairment of all or parts of the financial system, which can lead to serious negative consequences for the real economy" (Biljanovska et al., 2023).

Another crucial point stated by Stellinga (2021), is that macroprudential policies reinforce requirements (thanks to the instruments that are enabled by macroprudential authorities) during booms and relax them in periods of low level of risk. This encompasses the first dimension of systemic risk which is the time dimension. In other words, to address the vulnerabilities across the time dimension, these macroprudential tools aim to smoothen the boom-bust cycle of financial markets (fluctuation in financial cycle) (Stellinga, 2021) by reinforcing the resilience of banks, especially during periods of excessive credit growth that can trigger financial instability. The strengthening of bank resilience is done by boosting capital (meeting higher capital requirements during that period) before the downturn with the aim of minimizing the reduction of credit supply when the recession eventually happens (Yilla & Liang, 2020).

The boom-bust cycle phenomenon is backed by Minsky's hypothesis stipulating that the financial system oscillates between robustness and fragility, which constitutes the business cycle (see Figure 1). Minsky also developed a model constructed through his financial stability hypothesis which emphasizes the fact that the US have been going through three economic cycles (1981-1990, 1991-2001 and 2002-2009) where each one of them experienced a cycle where both borrowers and lenders fell under the assumption that they were prompt to increase financial risks. On top of that, each one of them also encountered another cycle marked by financial innovation and financial deregulation (i.e. removing government rules that monitor the operations of financial institutions). This eventually made financial instability increase because of growth in lending and risk tolerance. As a result, the solution that Minsky suggests avoiding financial instability would be to reinforce the supervisory and regulatory policies (CHIRIACESC, 2013). The features which make the macroprudential policy robust and effective to maintain financial stability will be discussed in section 2. We talked about the time dimension but there is also a second one which is the structural dimension (Stellinga, 2021). It addresses risk derived from a firm's shared exposure or systemic significance, simply put the interconnectedness of financial institutions. This can create shocks that can expand across financial markets and countries all around the globe (Altunbas et al., 2018). Consequently, the coordination of macroprudential policy on international level is also preponderant to mitigate the impact of cross border effect (Vučinić, 2016).

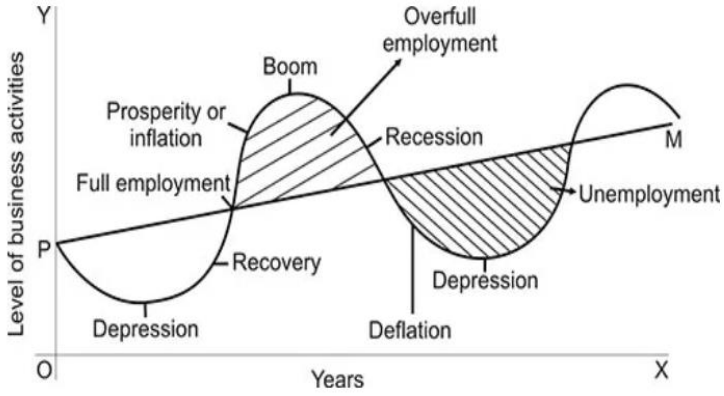

Figure 1. (Source : diversityecon.substack.com)

2. What makes macroprudential policies effective ?

2.1. Strong macroprudential framework

Several studies have shown that to strengthen the effectiveness of macroprudential policies in maintaining financial stability, it is necessary to opt for a strong institutional framework. This means that it must be supervised with clear policies and tools, while taking into account the impact that other economic policies (i.e. microprudential policies and monetary policies) have on these macroprudential policies, as well as the influence they may have on other non-bank sectors (i.e. shadow banking, etc.) (Vučinić, 2016). On top of that, we must consider in detail what constitutes a strong macroprudential framework. To begin with, there must be a focus on the wide range of policy tools. The policy toolkit should address most sources of systemic financial risk, surround all banks as well as other financial institutions and finally, take into consideration borrowers whose activities may be harmful. Another thing that makes a macroprudential framework strong would be that supervisors must have minimal constraints when it comes to protracted consultation (which requires feedback and approval to make relevant decisions) in order to activate tools to allow for prompt interventions in the right time (considering the delay between interventions and results) (Stellinga, 2021).

2.2. Supranationalization of macroprudential policies

A supranational approach for macroprudential policies must also be considered in order to let international predefined rules oversee countries' financial operations. For example, on the European level, this approach can strengthen competitiveness among domestic and foreign firms operating in each EU country (same rules applied to each one of them). It can also reaffirm its stable nature to prevent systemic risk since financial markets are heavily connected in the EU. A strong supranationalized macroprudential framework must therefore be the essential foundation for contributing to financial stability while maintaining the financial integration of countries. However, this would come at the price of national discretion, meaning that national supervisors have only limited power to take control of macroprudential decisions (Stellinga, 2021). For that reason, the assumption would be that a supranationalized framework would be suitable mainly for countries that share common financial regulation.

2.3. Trade-off between financial stability, financial integration and national supervision

It is important to note that the two characteristics "strong" and "supranational" go hand in hand, and that one without the other is not sufficient to maintain a good financial stability while considering the financial integrity and national supervision of member states. Stellinga (2021) came to a conclusion that there is some kind of trade-off between financial stability, financial integration and national supervision and mentions Schoenmaker (2011) who states that ‘‘[any] two of the three objectives can be combined but not all three; one has to give’’ which for Stellinga looks like a simplistic viewpoint that doesn’t acknowledge the complexity of the trade-off situation. The following conclusion seem credible in showing the interdependence and selective strategy of the 3 objectives that make up the trade-off, but the reality is actually much more subtle and compound: a strong decentralized framework could hinder the effectiveness of the single market which secures the free movements of goods, services and capital within the EU (*Single Market, Capital Markets Union | European Union*,

s. d.) . On the other hand, a weak supranational framework guarantees financial integration but negatively impacts financial stability and national discretion.

We can deduce that a weak non-centralized framework is clearly not sufficient to protect financial stability which is according to the European Commission, the European Parliament and the ECB privileged with financial integration over national discretion (Stellinga, 2021). However, to be more in touch with reality, we must consider the degree supranationalization which is a key indicator that indicates the extent to which macroprudential norms are harmonized.

3. Externalities favoring the procyclicality and the build-up of systemic risk

Many recent studies have shown that certain externalities coming from financial institutions favor procyclicality and the build-up of systemic risk. Those externalities have a huge impact on the other financial institutions due to their interconnectedness. The identified externalities are as follows (Claessens, 2015):

1) Externalities which arise from strategic interactions of banks as well as other financial institutions and agents that give rise to the materialization of vulnerabilities. Those externalities contribute to asset price volatility because the positive outcome from a definite strategy increases the number of agents adopting the same strategy. This in turn, increases competition that leads to the lowering of credit standards which in turn makes banks become less effective in assessing the borrower's ability to pay because it is driven to remain competitive with lower profits (less vigorous screening). These externalities are thus related to strategic complementarity that occurs during the expansionary phase (boom period) of a financial cycle.

2) Externalities arising from the liquidation of assets create a drastic decrease in asset prices (fire sales), deterioration of balance sheets of intermediaries and investors, restriction of credit and capital (credit crunch). The liquidation of assets is forced at a period when potential buyers are also vulnerable. The low amount of the asset is due

to the fact that the number of buyers is limited, meaning that other buyers have less access to finance which further leads to economic recession. There is another major problem that comes up when we consider that the decline in asset price makes it more difficult to use it as collateral for a financial institution but can nevertheless help fund its illiquid assets. These externalities linked to fire sales and credit crunches, occur during the contractionary phase of a financial cycle.

3) Externalities related to contagion, meaning there is a propagation of shocks derived from systemic institutions (the distress of one of them affects the other) or caused through financial markets or networks, i.e. contagion. They emanate from bilateral balances sheets, asset price movements and aggregate reactions for the real economy. These are externalities related to interconnectedness.

The various factors mentioned above are one of the reasons why the enormous costs derived from financial crisis has compelled policy makers to focus mainly on crisis prevention. Knowing that the system was complex, had the potential for shock amplification and that monetary policy as well as microprudential supervision had their limits, policy makers thought about changing their approach to financial stability by emphasizing the need for a strong macroprudential framework to tackle financial imbalances.

4. Complexity of the financial system, an issue for macroprudential regulation?

Before the 2008 crisis, a major problem was that the complexity and breadth of the financial system made it very difficult for policy makers to anticipate and identify risks and costs. The complexity of the financial system was due in part to the involvement of shadow banks in the financial markets and the fact that they were heavily linked with traditional banks, one of the major differences being that shadow banks are less regulated and centralized (Ampudia et al., 2021b). Strict enforced regulation has been one of the major causes of financial intermediaries, i.e shadow banks moving away from the perimeter of the banking sector. It

led to financial imbalances by increasing credit growth and leverage while failing to be monitored by macroprudential policies unlike banks

Another factor is the growing imbalances that caused a high demand for financial assets, which encouraged innovation and investment in assets with relevant risk but high return, which in turn enabled overborrowing and favorable financing conditions. Moreover, the interconnection between shadow banks and traditional banks increases the likelihood of shocks spreading through the financial system and pushes the financial system into a pro-cyclical phase leading to the build-up of systemic risk like mentioned before (Ampudia et al., 2021b). Asymmetric information and limited enforcement of contracts for example, shows a tendency to decrease risk aversion among private agents, accelerating also the build-up of systemic risk. This will inevitably create a negative impact on the financial system which would affect the real economy (Biljanovska et al., 2023).

5. Macroprudential policy, microprudential policy and monetary policy: links, complementarity and tensions

One of the major advantages of macroprudential policy is that they provide instruments as well as appropriate mandates, to strengthen the identification of systemic risk which are likely to have a positive impact on financial stability (Vučinić, 2016). Moreover, it is not only macroprudential policy that aims to maintain economic and financial stability. Monetary and microprudential policies are also used to achieve the same objectives, even if they are not as effective as macroprudential policy in addressing systemic risk. We can also add that not only does macroprudential policy contribute to financial stability, but it also contributes indirectly to sustainable economic growth thanks to the maintenance of a sound financial system that microprudential and monetary policies alone cannot guarantee (Vučinić, 2016).

5.1. Microprudential policy and macroprudential policy

One of the objectives of microprudential policy, like that of macroprudential policies, is financial stability. Microprudential policies contribute to maintaining the resilience of the system in general by keeping individual financial institutions “financially healthy” which is crucial for a resilient financial structure (Osinski et al., 2013).

What's important to remember is that both policies obviously use prudential policy instruments, but that microprudential policies (which tools can range from buffers to balance sheet restrictions) are only applied at the level of the individual firm. Thus, it does not fully consider the effects it has on financial markets, on the complex financial structure they are part of, and on the behavior of other financial institutions like the macroprudential policies are used to. In layman’s terms "Microprudential policy adjusts capital based on individual institutions’ risks, while macroprudential policy adjusts overall levels of capital based on the financial cycle and systemic relevance to guard against systemic risk buildup” (Osinski et al., 2013).

Risk is also different in nature and in source when we compare both policies prudential policies. Risk in a macroprudential viewpoint is endogenous, it is triggered by collective behavior and common exposures among the financial institutions. On the contrary, risk at microprudential level is regarded as exogenous, meaning that interconnections and common exposures between financial institutions is quite impertinent and insignificant (CHIRIACESC, 2013).

We noticed that both prudential policies are complementary and reinforce each other into pursuing financial stability as the major objective. However, there can be some tensions arising from the application of both prudential policies. First, we already mentioned that macroprudential policy has a countercyclical feature to counter the financial cycle for the purpose of reinforcing the resilience of the financial system. On the contrary, microprudential policy instruments can have a procyclical nature such as risk-based capital adequacy requirements. But majority of supervisors agree that macroprudential policy is better suited to gauge the vulnerabilities coming from the build-up of credit cycles, to evaluate the

interactions in the financial system as well as the interactivity of the financial system and the economy (Osinski et al., 2013).

There are several ways to ease the tensions between the two prudential policies. One way would be to set separate mandates for both policies, that must be explicit and well explained to define the objectives as well as the instruments that will be used. Defining mandates will help to maintain transparency and accountability and promote independence. The instruments would have to be assessed frequently knowing that systemic risk is always evolving (Osinski et al., 2013). Another way would be to comprehend the functions of both prudential policies to make coordination and consultation smoother between the two authorities overseeing their prudential policy. It can be done by promoting open communication, sharing of information and transparency. This will lead to reaching a common viewpoint on systemic risk and a better assessment approach which will in turn reduce the inducement for a difference in opinion and non-coordinated actions by both authorities (Osinski et al., 2013).

5.2. Monetary policy and macroprudential policy

Macroprundential policy and monetary policy are complementary but highly dependent on each other, which means that side effects can arise and compromise the effectiveness of either if the two policies are not used optimally. It can happen that sometimes macroprudential and microprudential tools are not as effective as expected due to several economic reasons to preserve financial stability, therefore, monetary policy can be used as a back-up if financial stability or some other objectives are not reached (Osinski et al., 2013).

Nevertheless, according to reports written by the IMF dating from 2013, it has been shown that strengthening the resilience of the banking system through calibrated macroprudenital policy instruments reduces the possibility of a strict monetary policy implementation. For example, the Counter-cyclical capital buffer can reduce the chances that the monetary policies will lower the interest rate to very low levels (Vučinić, 2016). A very low interest rate reduces

the cost of borrowing which increases the incentive of agents to contract loans to stimulate the economy during a bust, which should not be necessary if the Counter-cyclical capital buffers are able to absorb losses during the same period in order to boost economic activity.

Another situation will be that monetary policies are not effective if used alone to achieve financial stability objectives, because their instruments are too broad to tackle specific financial distortions such as dampening the asset price bubble which demands large variation in policy rates. Monetary policy also has a strong influence on risk-taking incentives and borrowing constraints which in turn influences leverage. Likewise, macroprudential policies may generate additional distortions while monitoring aggregate demand by putting unnecessary constraints. It is therefore essential and more rational for monetary policies to focus mainly on price stability and macroprudential policies on financial stability (Claessens, 2015).

6. Macroprudential instruments/tools

An interesting point about macroprudential tools is that they have been used even before the recent crisis occurred, and they can be divided into two categories aligned with the two dimensions of systemic risk (time and sectoral dimension): borrower-based tools and broad-based tools. We will not cover all of them because they are numerous, but we will talk about the most important ones.

6.1. Policy tools to limit the build-up of vulnerabilities

These policy tools comprise borrower-based instruments and aim at maintaining borrowing at sustainable levels. As a result, it restrains the risk of default and minimizes the probability of credit losses as a consequence of the default. These tools impose lending constraints on "new" loans, we mean by that loans that were not part of most of the loans which were already contracted. Therefore, it can create an effect on the bank's lending portfolio. Borrower-based instruments are frequently activated/reinforced early during a housing bubble (Valderrama, 2023). A housing bubble or housing boom is often characterized by an

increase in property prices which is caused by a number of factors, such as speculation, a very wide gap between supply and demand, etc.

The borrower-based tools are as follows:

- **LTV** (Loan-to-value) limits: their role is to keep losses to a minimum when the default materializes. If we take into account the "double trigger of default" hypothesis[2] and assume that it holds, LTV would have an impact on the default risk that financially stresses borrowers by decreasing the likelihood of them having a negative housing equity, meaning that the value of the house is lower than the amount of the mortgage that has been contracted. When activating LTV limits, supervisors frequently evaluate the level of house price overevaluation.

- **DTI** (Debt-to-income) /**DSTI** limits (Debt-service-to-income): these are both debt ratio tools which purpose is to restrict extreme lending by enforcing a cap on the borrower's overall mortgage debt reimbursement obligations. It decreases the probability that borrowers will become financially disadvantaged. DTI/DSTI limits typically react to variation in household debt levels, forecasted interest rates and loan maturity profile.

These borrower-based tools are complementary if they are well designed and calibrated by the macroprudential authorities to reach their objective of stability of the financial system and safeguard the resilience of banks and borrowers when the economy is subject to a downturn (Valderrama, 2023).

[2] The double trigger of default hypothesis stipulates that for the borrower, to enter the category of "not being able to pay their mortgage (default)", there are two conditions that must be fulfilled. The first one would be that the borrower experiences financial burden (negative liquidity or income shock) that restrains him from paying the mortgage. The second condition is when the borrower faces a negative housing equity. Therefore, if neither of those conditions are met, the borrower has a low probability of default (Cunningham et al., 2021).

On top of having an influence on housing prices and markets, it is also crucial to acknowledge that borrower-based have an impact on the number and magnitude of loans. The latter ineluctably refers to credit growth and decreases the chances to adopt a pro-cyclical tightening of credit conditions in which banks would restrain themselves from contracting more lending. The purpose of this is to regain their capital position that would possibly lead to a housing downturn[3] (Valderrama, 2023).

6.2. Policy Tools to Strengthen Bank Resilience

These tools' purpose is to compel banks to set up sufficient buffers with a view to absorbing potential future losses. They comprise capital-based requirements and loan provisioning requirements instruments. There are two known instruments that falls into the category of capital-based instruments which purpose is to counter the pro-cyclicality of the financial system (Valderrama, 2023):

- *Countercyclical capital buffers* (CCyB): they can be broad-based[4] or sectoral. They strengthen the resilience of the banking system in periods of excessive credit growth, which is diminished due to the implementation of CCyB, knowing that the cost of capital is higher than the cost of debt (Valderrama, 2023) especially when interest rates are low. Banks will also try to decrease their risk-weighted assets instead of increasing excessive equity capital to fulfill higher CCyb requirements, which can lead to the restriction of the extension of credit as well.

- *Systemic risk buffer* (SyRB): its goal is to tackle systemic risks that are not covered by other macroprudential tools such as capital requirements regulation, CCyB and other types of buffers (European Central Bank, 2024). The SyRB assist banks to hold enough capital to face future downturns. This tool also gives us an assessment of structural vulnerabilities within the financial system (*Advice on the Systemic Risk Buffer*, 2024).

[3] Period when house prices drop significantly for a period of time which happens frequently during an economic downturn.

[4] Applied to a large number of financial institutions

The particularity of this buffer is that there is no maximum limit for it. An authorization from the European commission must be required to activate the tool (European Central Bank, 2024).

- *Dynamic provisioning on real estate exposures*: this instrument has many countercyclical characteristics in common with the CCyB. Dynamic provisioning helps financial institutions to grow the provisioning (in the balance sheet) coming from retained profits, (i.e. part of the company's net income that was decided not to be distributed to shareholders but instead reinjected in the company to increase the provisions) during financial boom as to hedge against losses during financial distress. What dynamic provisions differs from the CCyB, is that its activation is connected to the bank's prudential behavior, meaning that it relies on the capability of the bank to put aside loan loss provision to handle future problem assets, rather than depending on the financial cycle characterized by the emergence of credit growth.

Finally, we could say that these instruments increase banks' resilience by raising capital requirements and provisions (depending on the tool activated) in periods of financial progress. They also minimize the risk of vulnerability if banks raise interest rates on mortgages to compensate for the higher cost caused by increased capital requirements. On the contrary, if banks do not have enough capital, they are forced to reduce their credit offer (limiting the availability of the loan contract provided) (Valderrama, 2023).

7. Tightening and loosening of macroprudential policies

We have already argued that broad-based tools assigned to financial institutions (capital and provisioning requirements) and liquidity tools (reserve requirements) have shown to have a significant impact in reducing the total credit growth. Although they are highly effective, their effect on the vulnerabilities of the financial system depends in part on the tightening or loosening of macroprudential tools. The former refers to more stringent measures being put in place, such as raising the threshold for capital requirements, while the latter reflects exactly the opposite, i.e. implementing less restrictive measures. Another definition of tightening of macroprudential policies is the involvement of "a substantial change in policy stance and has

to be differentiated from other milder types of policy interventions such as further recalibrations/adjustments of existing policy instruments" (Belkhir et al., 2022). Numerous studies suggest that tightening macroprudential policies have a greater effect than loosening and are therefore more statistically significant (Biljanovska et al., 2023).

The tightening of macroprudential tools (with the enforcement of macroprudential and microprudential tools combined) leads to a serious decrease (on average) in the total credit, a decrease that would not have had the same significance if only one of the two policies had been chosen to have an effect on the same economic indicator (i.e total credit growth). Regarding the borrower-based tools specifically, it appears that they are more relevant in the housing context and thus have much more influence on the dampening of household credit (part of the total credit growth). Seemingly, many studies have evaluated the substantial effect of borrower-based tools in decreasing borrower's likelihood of default as well as lender's loss linked to the probability of default of the borrower during periods of financial stress. Finally, like the broad-based tools, the tightening of these tools has a huge influence (on average) on the decline in housing credit (Biljanovska et al., 2023).

However, according to other researchers, the net benefits of macroprudential policy tools decreases with progressive tightening. Thus, the marginal benefit of reinforcing one tool is a downward slope because the excessive use of any tool could create distortions and trigger the incentives for circumvention (Biljanovska et al., 2023). Circumvention refers to the evasion of regulations done by financial institutions because of restrictive rules.

Additionally, the effects of macroprudential policy tools depend on the phases of the financial cycle. Some results suggest that these tightened effects are more impactful when financial vulnerabilities are building (periods before economic downturn). Many studies have shown that stricter macroprudential regulation (in other words its tightening) moderates the decline in GDP growth experienced by many countries as a reaction to adverse global financial shocks (Biljanovska et al., 2023). Having said that, we may assume that during periods of downturn, the loosening of macroprudential tools appears to be more beneficial than the tightening because it can stimulate the mortgage lending (McDonald, 2014).

8. Financial instability linked to excessive credit growth

8.1. Excessive credit growth

As was said before, a crucial macroprudential tool which aims at dampening the procyclicality of systemic risk and introduced by the Basel Committee on Bank Supervision, is the Countercyclical capital buffer (CCyB). This tool protects the banking system from periods of excessive credit growth, i.e, credit expansion that is ineluctably linked to the increase of systemic risk which is synonym of financial instability. CCyB does this by putting capital reserve aside that can be determinant for banks to continue to provide credits to other financial institutions, in that way it reduces the likelihood for the supply of credit to decrease during periods of recession (Gersl & Seidler, 2011).

Credit expansion is due to many factors implying both demand and supply of the credit market. Credit growth usually shows up at very low levels when the economy experiences a transition (procyclical behavior). There is also an assumption that a fast credit expansion in many developing economic countries for example doesn't necessarily mean excessive borrowing (which can increase the likelihood of risk to financial stability) but can but may refer to the fact that these extreme values converge towards values typical of western countries (more advanced economies). Several years before the 2008 crisis, there were tools introduced to limit credit growth. Their effectiveness at that time was shown through their ability to impose sufficiently hard administrative restrictions on credit portfolio growth. However, according to some recent studies, they are now considered as ineffective because it restrains credit expansion mainly during economic recession, but that restriction is very limited during periods of economic boom (Gersl & Seidler, 2011).

One way to perceive that excessive credit growth can harm macroeconomic stability is the overstimulating effect of the aggregate demand on loans (which is one way for immediate consumption) that induces the economy to overheat. This phenomenon is very serious

because it can have a large impact on inflation, current account deficit[5], interest rates and real exchange rates. We can also add that the financial institutions most able to lend, may be over-optimistic about their borrowers and their ability to meet their obligations, not hesitating to raise the interest rate on the loan to attract borrowers with a high risk of default. In addition, it was estimated by the IMF (2004) "that more than 75% of credit booms were followed by banking or currency crises". The prompt warning signals exacerbated by excessive credit growth can be regarded as one of the most credible indicators of the upcoming future vulnerabilities within the banking sector (Gersl & Seidler, 2011).

If we take the case of Central and Eastern European countries (CCE), we notice that many of their loans were contracted in foreign currency, as the interest rate in foreign countries was very low. Nevertheless, this had a negative impact on the banking sector, because if the domestic currency depreciates, the number of loans offered via the domestic currency increases[6], debt servicing costs increases which converts foreign exchange risk into credit risk. This leads to an increase in the risk of domestic banking sector having non-sufficient liquidity because loans are sought "outside of the border" (Gersl & Seidler, 2011).

8.2. SRISK, measure of systemic risk

Furthermore, a method proposed by the Basel Committee to calculate excessive credit growth is called the Hodrick Prescott (HP) filter, and it compares the actual credit-to-GDP ratio of a specific country with the same ratio but in the long term. If the difference in credit-to-GDP between the short-term and long-term exceeds five percentage points, it is then considered to be an indicator of excessive credit which may be a threat to the financial sector (Gersl & Seidler, 2011).

[5] A current account deficit happens when a specific country imports more goods and services than it exports.

[6] the value of foreign interest rate or debt increases when it is converted to domestic currency because the latter falls in value compared to the foreign currency

Another method is to consider that there is excessive credit growth when the financial sector has insufficient capital to cover market value losses when the economy experiences a downturn. The need to raise capital to address chocs coming from the financial crisis is called the capital shortfall. The measure of the capital shortfall which is in fact a measure of systemic risk is called the SRISK (Engle & Ruan, 2018). The SRISK is a crucial factor that will be covered in depth in the empirical analysis part that follows.

9. Does the tightening of macroprudential policies have an impact on the systemic risk (SRISK)?

We see from the results obtained by (Belkhir et al., 2022) that the probability of a systemic banking crisis is often decreased in advanced economies, due to the tightening of its macroprudential policies. This implies that these policies' direct effects are usually successful in lowering the probability of a crisis to occur and thus has a positive impact on financial stability (SRISK lowered). In other words, emerging market economies exhibit a more noticeable impact from tightening macroprudential policy compared to emerging economies, even though it significantly lowers the likelihood of a crisis in emerging markets.

Furthermore, more findings show that macroprudential tools (that includes DSTI and LTV limits, and capital requirements) when they are tightened can reduce the SRISK and that the impact on the latter is all the greater when the inflation target is used. It is mainly due to the fact, like partly mentioned in section 7, that tightening of macroprudential regulations is linked with lower bank credit growth, housing credit growth, and house price appreciation. Although the tightening of some macroprudential tools has a positive impact on SRISK, a very low SRISK is generally associated with the tightening of most macroprudential tools. Hence, we can conclude that tighter macroprudential policies are “conductive to financial stability” (Belkhir et al., 2022).

In the following part of this master thesis, we will examine the link between macroprudential policy intensity and SRISK from an econometric point of view. This will enable us to determine whether there is a significant link between the two.

Empirical analysis

1. Description of the data

Regarding the database for statistical analysis, to find a credible index for macroprudential policies and to represent its intensity (tightening or loosening), I based myself on the integrated Macroprudential Policy Database (iMaPP) database proposed by the IMF and originally constructed by Alam et al. (2019). This database provides dummy-type indices of tightening and loosening procedures of 17 macroprudential policy instruments and their underlying subcategories, implemented for most of the countries around the globe. If the macroprudential instrument has been tightened, the score is +1, and if it has been loosened, the score is -1. On the other hand, a score of 0 means that macroprudential policy is neutral (in between tightening and loosening). Concerning the other sub data proposed by the iMaPP database, we won't be taking them into consideration, as they contain a single indicator of regulatory limits for the LTV ratio, which can be very reductive in representing macroprudential policy.

The imaPP database provides data from 1990 to 2021. However, for our analysis, we will only focus on data from 2007 to 2021. This choice was made mainly because the database used to represent the Y variable (which we will detail below) only includes values from the year 2000 onwards. Nevertheless, data between 2000 and 2007 were missing for many countries, so it was decided to integrate the database from 2007 onwards into the empirical analysis.

As for the variable representing financial stability, it was difficult to find one that was validated by models and presented as credible and statistically effective by researchers. This is why we decided that our indicator of financial stability, or rather financial instability, would be referred to as SRISK, as we have already mentioned, as being a measure of excessive credit growth and thus systemic risk (Engle & Ruan, 2018). Excessive credit growth is known as a precursor to financial crisis and earlier in the literature review, we highlighted the fact that this factor was linked to financial instability. We can infer that there is excessive credit growth when the financial sector does not have enough capital to counterbalance the losses in

market value (assets) that occur during economic decline. This coincides with the fact that at the end of a credit cycle, too much risky credit is being issued and the ones that contracted these risky credits are mostly financial institutions which have to use excessive leverage to cover losses during economic decline and shows the transition from credit boom to credit bust (Engle & Ruan, 2018).

We deduce that the risk of triggering a financial crisis in a given country depends mainly on the total capital shortfall of the financial sector of the country. Therefore, the risk of a financial firm will not be considered as systemic unless it shares a large part in the financial sector. We reckon that any financial institution which implements action plans to reduce its capital shortfall will have a positive impact on the whole economy. The same applies to the impact of other countries' SRISK (aggregate SRISK) on a single country's risk, and vice versa. If one country strengthens its regulations (this can refer to macroprudential policies as well as other policies) then it will lead to other countries maintaining a stable financial position, which has a positive impact on the global economy and the financial system.

Furthermore, the estimation of the additional dollar amount of capital that a given financial firm needs to obtain (i.e. capital shortfall) in order to continue functioning normally if a financial crisis (which results from excessive credit growth) occurs by performing a regulatory stress test. This estimation is in other words the SRISK (Engle & Ruan, 2018). The SRISK is computed on a weekly basis and published on the NYU Stern's Volatility Laboratory (V-Lab) website. The most important financial firms (mainly banks) of each listed country provided by V-Lab is shown with its SRISK calculated in billions of US dollars (The Volatility Laboratory, s. d.).

2. Methodology

2.1. Choice of estimation method

For the empirical analysis, we will perform a linear regression analysis based on the generalized method of moments (GMM). The GMM is a method to estimate parameters of a

model using the assumptions about specific moments of random variables instead of assumptions about the entire distribution of the data (all the variables combined) like the Maximum Likelihood Estimation (MLE) (Econometrics, 2015). The latter is more likely to give estimates that are biased or inconsistent because the distribution is not precisely known and that is the reason why the GMM is more robust because it doesn't rely on the specification of the model distribution. Moments are all the measures that give indications about the shape of the distribution like the mean (first moment), the variance (second moment), etc. Moreover, the difference between GMM and the standard method of moments (MM) is that the GMM allows the number of moments conditions to be greater than the number of parameters and if that is the case, then we consider the estimator to be overidentified.

The GMM was also preferred to the most used conventional ordinary least squares method (OLS) for several reasons. The main problem that has to be addressed in this case, is the issue of endogeneity: as we developed earlier in section 4 of the literature review, risk from a macroprudential viewpoint, unlike the microprudential angle, is endogenous, since it is generated by the collective behavior of financial institutions, which means that there is interconnectedness. In econometric terms, endogeneity refers to a common problem arising when a model's explanatory (or independent) variables are correlated with the error (another variable) of the same model. The fact that these two variables are related to each other can lead to biased estimation of the coefficients to be determined from the linear regression. Knowing that the risk of one financial institution can affect another financial institution means that the risk is not isolated. We infer that each of the financial institutions involved in the financial system may face adverse shocks resulting from a common risk and that is the reason why it is considered endogenous.

To return to the econometric context, endogeneity can also make the estimates inconsistent (in many cases giving the wrong sign for the coefficient) and can lead to confusing conclusions with improper interpretations. This is why the GMM Model is the most appropriate model for this analysis because it provides unbiased estimates through its use of instrumental variables (Ullah et al., 2018). Although this explains the choice of GMM for the regression analysis, this method has several other essential features, which will be covered later to explain the results obtained.

2.2. Use and handling of data

The variable X, or in other words the explanatory variable, will be the macroprudential index. As we are studying the impact that the intensity of macroprudential policy has on financial (-in) stability represented by the SRISK, we will consider this variable to be the variable Y or dependent variable. We said previously that the regression is linear, but we can't assume that the link between variable Y and variable X are purely linear because according to Biljanovska et al. (2023), the effects of macroprudential policy are expected to be nonlinear and that nonlinearity means that the costs or the benefits of macroprudential measures depends on the magnitude (implicitly referring to its tightening or loosening) and direction of the policy change. It would therefore be preferable to establish a non-linear link between the variables X and Y, while retaining a linear regression function, since the latter is linear in its parameters (i.e. the coefficients) and not necessarily linear in its explanatory variables (Van Bellegem, 2022). To link X and Y non-linearly, we'll assume that the logarithm (base 10) of macroprudential policy intensity (Macroprudential index or MI) is related to systemic risk (SRISK):

$$Y_i = \beta_0 + \beta_1 log(X_i) + \varepsilon_i$$

$$\updownarrow$$

$$SRISK_i = \beta_0 + \beta_1 log(MI_i) + \varepsilon_i$$

$$\downarrow$$

$$\mathrm{E}(SRISK_i/MI_i) = \beta_0 + \beta_1 log(MI_i)$$

Other explanatory variables could have been taken into consideration, such as the inflation rate or a microprudential or monetary policy index, but it is preferable to depart from this initiative, for several reasons. The firs reason is that we could implicitly divert from the subject of this thesis by considering the involvement of factors other than macroprudential policy as being equally important for the development of this thesis, especially for the empirical analysis part. The second reason is that it would have made the linear regression more complex due to the behavior of these variables, which are very different in nature from the

macroprudential index. These variables and the macroprudential index variable may also present multicollinearity concerns, as mentioned above, since they are complementary and strongly linked.

Because in the ImaPP database, the scores (dummy type variables), +1 (tightening), -1 (loosening), 0 (neutral), are given monthly for each country with the respective year. To obtain a credible representation of the macroprudential index considering the SRISK as the variable Y, the monthly scores had to be converted into years and then averaged. This means that each monthly score was added together for their respective year, and the sum was then divided by twelve to return the result at the end of the given year. Annex 1 contains a table listing the selected countries and their associated macroprudential index scores for each year of the 2007-2021 period. But before dividing the scores by 12, it was important to make sure that none of the observed X variables did contain negative values, because as already mentioned, the fact that the model is non-linear has an impact on the treatment of the variables. If we use logarithmic or squared transformations of the X variable, the former will give us indeterminate results, while the latter will give us positive values, thus losing the negative effect that the X variable may have on the Y variable. To make all the values positive, we added up each macroprudential index score by 13, since the smallest value among the scores was -13. The table containing the average scores of the 64 listed countries is in Annex 2.

Furthermore, for the SRISK, the data provided by V-Lab concerns the SRISK of numerous financial institutions by country. The excel files proposed by the V-Lab only contain the SRISK of financial institutions for each day of the year. However, the data needed to perform the linear regression analysis needs to be the SRISK by country because it's very complex to compare financial institutions from one country to another. What's more, taking into account the SRISKs of each country enables us to make a comparative analysis of their values, as well as their respective SRISK growth or decline trends over time. The table displays the SRISK for each listed country in Annex 3.

3. Results and interpretation

For our first analysis, we will test the relationship between the macroprudential index and SRISK to see if it is relevant. The total number of observations is 855, and as the only explanatory variable is the macroprudential index, the number of coefficients to be estimated is 2 (if we count the intercept with). For the GMM function, in the R studio line code, ***e*** is the residual (gap between the values that are observed and the ones that are predicted). It is the first moment condition. The second moment condition is e*x which is the product of the residual and its associated x variable and finally for the third moment condition, we have the same calculation as the previous one, except that the x is squared. Using the two-step GMM method, we obtain the following regression (Annex 5):

$$E(Y/X) = 57.5633687 + 20.0188069 * \log(MI)$$

We note that in Annex 6, the output generated by the p-value of the coefficient β_1 is higher than 0.05. This means that the intensity of macroprudential policies represented by its index are statistically not significant at the 5% level under the null hypothesis (H_0: $\beta_1 = 0$). The null hypothesis should therefore not be rejected, and in this case the data can't provide us with sufficient evidence that there is indeed a relationship between the variables X and Y.

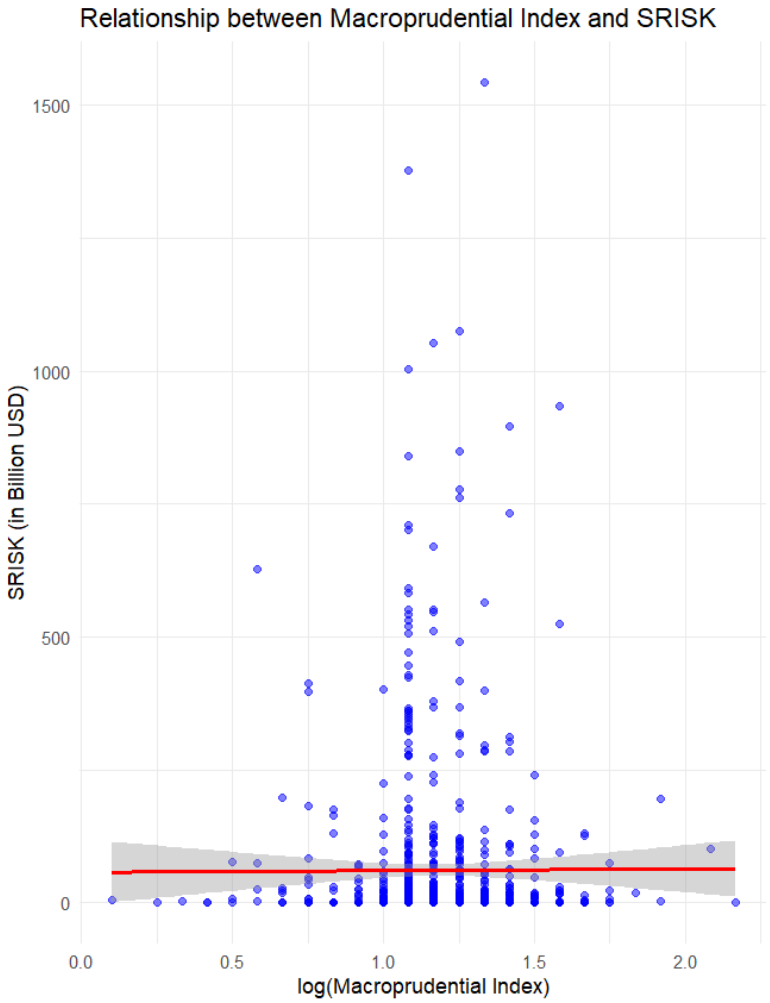

Figure 2.

If we plot the regression line on a graph with the scatter plot (see Figure 2.) representing the observed data, we notice that the relationship between the log(macroprudential index) and SRISK is almost a constant, as the inclination of the linear regression (slope) approaches that of a horizontal line, meaning that any change in macroprudential policies would not have a huge impact on the SRISK. We also observe that many points have a position very far from the regression line, suggesting that the deviation from the mean (E(Y/X)) for these same points is very high, and that some observations may be outliers.

Removing outliers from the statistical analysis is essential because these extreme variables can have a disproportioned impact on the outcome of the analysis. It will also have a strong influence on the behavior of the estimation and are therefore likely to bias the results, as they can "shift" the regression line away from the positions of the variables with the most similar

values and which recur most often, thus increasing the error in relation to the mean of the observed data. By considering this argument, it would make more sense to remove the outliers from the database. Let's see if there are any outliers we can extract from the database to "filter" our regression. We will first standardize the data to obtain their Z-score, which is the number of standard deviations from the mean. Data with a Z-score greater than 3 will be considered outliers (conventional threshold). 36 outliers were extracted from the database, so we now have 819 observations instead of 855 (Annex 7). After doing that, we apply the GMM with the two-step method and we get the following (Annex 8):

$$E(Y/X) = 45.6573893 - 27.2743559*\log(MI)$$

We observe now a negative relationship between the macroprudential index and the SRISK. However, we notice once more that in the output generated in Annex 9, the p-value of the coefficient beta1 is still higher than 0.05. The macroprudential policies represented are statistically not significant at the 5% level under the null hypothesis (H0 =B0). The null hypothesis is once again not to be rejected because the data (even with the outliers gone) can't provide us with sufficient evidence that there is indeed a relationship between the two variables X (macroprudential policies) and Y (financial stability).

The main issue is that in our database, we have many countries with a huge SRISK compared to others. Countries with a high SRISK are generally developed countries such as China, USA or Japan, and those with a low or very low RISK are less developed countries such as Poland or Turkey or developing countries such as Pakistan or the Philippines. We can therefore assume that developed countries have a greater impact on systemic risk than their less developed counterparts and therefore countries that are wealthier tend to have a higher SRISK.

As mentioned in the literature review, excessive credit growth is linked to the SRISK, and if we take the definition of systemic risk, it "can lead to serious negative consequences for the real economy". We can therefore conclude that a country's SRISK has a strong influence on its GDP, which is not only associated with a country's wealth but is also a relevant indicator for assessing economic health.

In the work by Engle and Ruan (2018b), they explain that there are several ways for a financial institution to reduce its systemic risk and thus mitigate the negative impact on the economic and financial health of other countries. One of these is that many countries wait until their GDP reaches a certain level before benefiting from a bail-out (financial aid granted to an institution if it is on the verge of collapse). This is the case if these companies decide to let the development of the economy do the work. This is why a natural measure of the magnitude of risk would be to normalize (divide) the SRISK by the GDP for each country. If this ratio is very high, this constitutes a major risk for the economy (mainly caused by the country's financial instability).

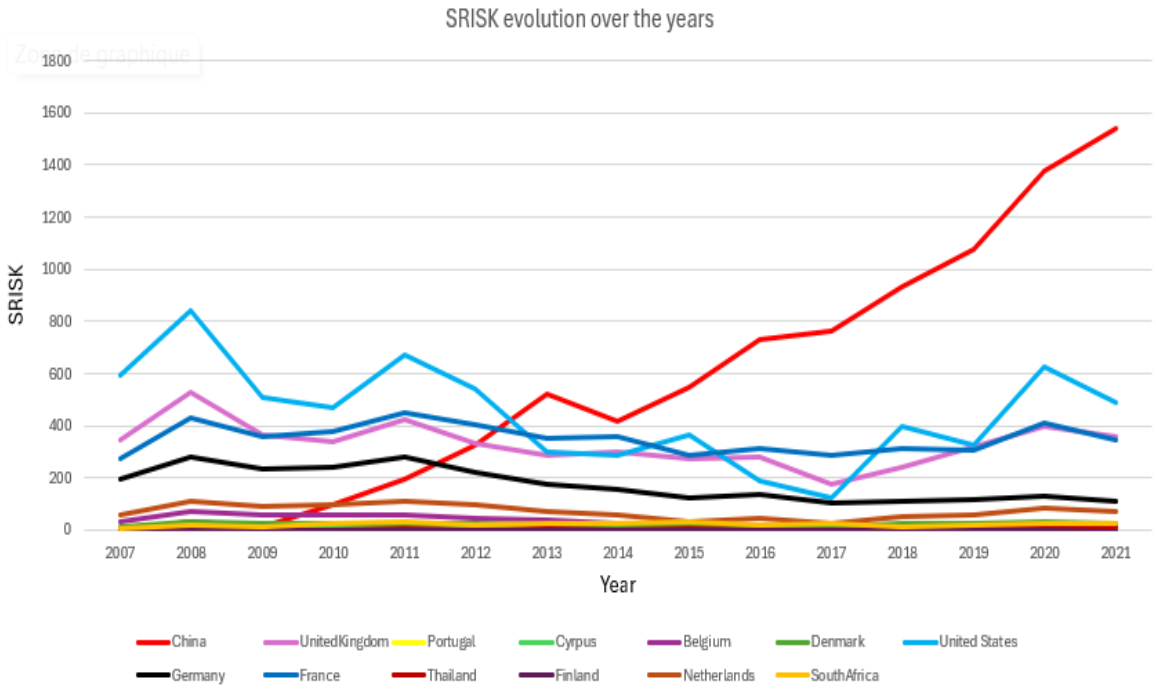

Figure 3.

Therefore, when assessing the impact of macroprudential policies on a country's financial (in)stability, it would be interesting to take its GDP into account. This involves calculating the relationship between the macroprudential index and SRISK, but relative to GDP. Figure 3[7] shows that the USA, the UK, France and Germany all have very high SRISKs, especially China, which by 2021 will have reached around $1,500 billion. Other countries with smaller economies have very low or even insignificant SRISKs compared with the “giants”.

[7] Only some of the countries in the database have been included in this graph simply to explain the comparison between their SRISKs and also for greater visual clarity.

But when we take their respective SRISK into account and divide them by the associated GDP, we realize that the trend is changing, and that some countries with smaller economies are approaching the value of SRISK (normalized by the GDP) of larger economies (see Figure 4). You'll find the table of the SRISK/GDP by country in Annex 4. Values are expressed as percentages for ease of reading

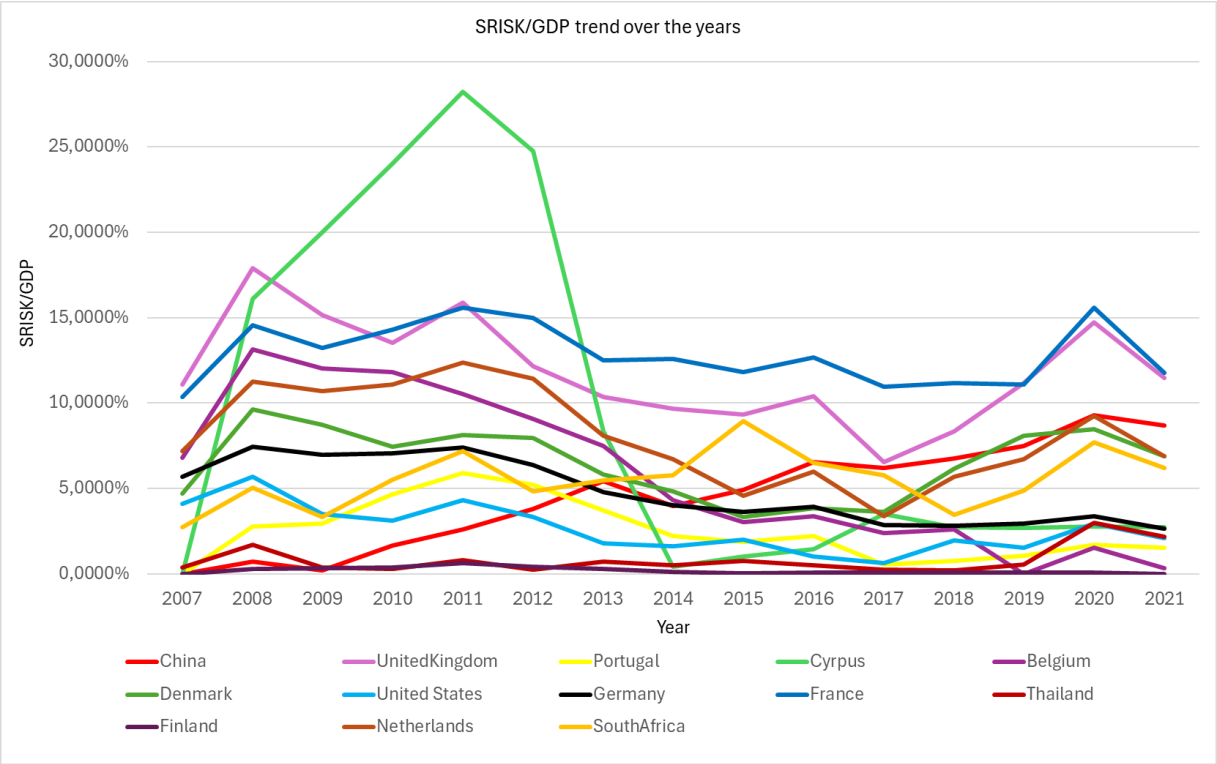

Figure 4.

For example, we see that in 2011, Cyprus reaches a SRISK per GDP close to 30%, and that China is for several years (from 2007 to 2014) below most of the countries on the graph, and below France and the UK over the entire period (2007-2021), even if it remains high in the most recent years. It is partly due to the fact that the country has been experiencing increasing development of its GDP, which is showing the same trend as its SRISK over the years. We also note that the value for SRISK/GDP is high for Denmark and the Netherlands, especially in recent years. However, for the USA, the value is very low over the whole period, due to a very high GDP. This means that the US economy is robust enough to stabilize the financial situation of its financial companies. Regarding France and the UK, their SRISK/GDP is enormous over

the period 2007-2021, and would therefore cause a very high bailout, putting a high burden on public finances and therefore increasing the financial instability and aggravating the economy linked to systemic risk.

That being said, we would now like to consider the impact of macroprudential policies on financial stability relative to the GDP. The dependent variable Y is SRISK/GDP, while the explanatory variable X is still the macroprudential index. Before applying the GMM function, we would like to extract outliers from this "alternative" database. We have the same number of data as before, but the country's SRISK is now normalized by the its GDP, so we still have 855 observations. After deleting the outliers, we have 829 observations. Once again, we perform a GMM with the two-step method on the filtered data and we get the following regression (annex 10) :

$$E(Y/X) = 0.032830 - 0.025061*\log(MI)$$

We see from the output in annex 11, that the p-value of the coefficient is above the level of 0,05 which induces that the null hypothesis should this time be rejected and thus the data provide us with enough evidence that there is indeed a "logarithmic" relationship between the macroprudential policies and the SRISK normalized by the GDP, thus financial stability.

If we go further down the output, we see that the J-test (or Hansen test) has been calculated for this regression. This test assesses the validity of the moment conditions used to estimate the parameters (coefficients among others) of the model and therefore also assesses the validity of the model specification. We know that there are a total of 3 moment conditions and that the number of parameters to be estimated is 2, giving us 1 degree of freedom for the J-test. There is therefore overidentification, which means that there are more restrictions than necessary to estimate the parameters. The J-test is thereof used to test the validity of this over-identification by assessing whether the additional moments condition is consistent (in agreement) with the parameters. The null hypothesis of the J-test is that the moment conditions are indeed valid. The p-value for this test gives us 0.37485, above the 5% level, so we can't reject the null hypothesis. In short, the model appears to be valid and well-specified, since the evidence provided by the data cannot contradict it.

When inspecting the graph (Figure 5), we find that the slope of the line is much steeper, thanks in part to the extraction of outliers and the relation between the logarithm of the macroprudential index and the SRISK/GDP.

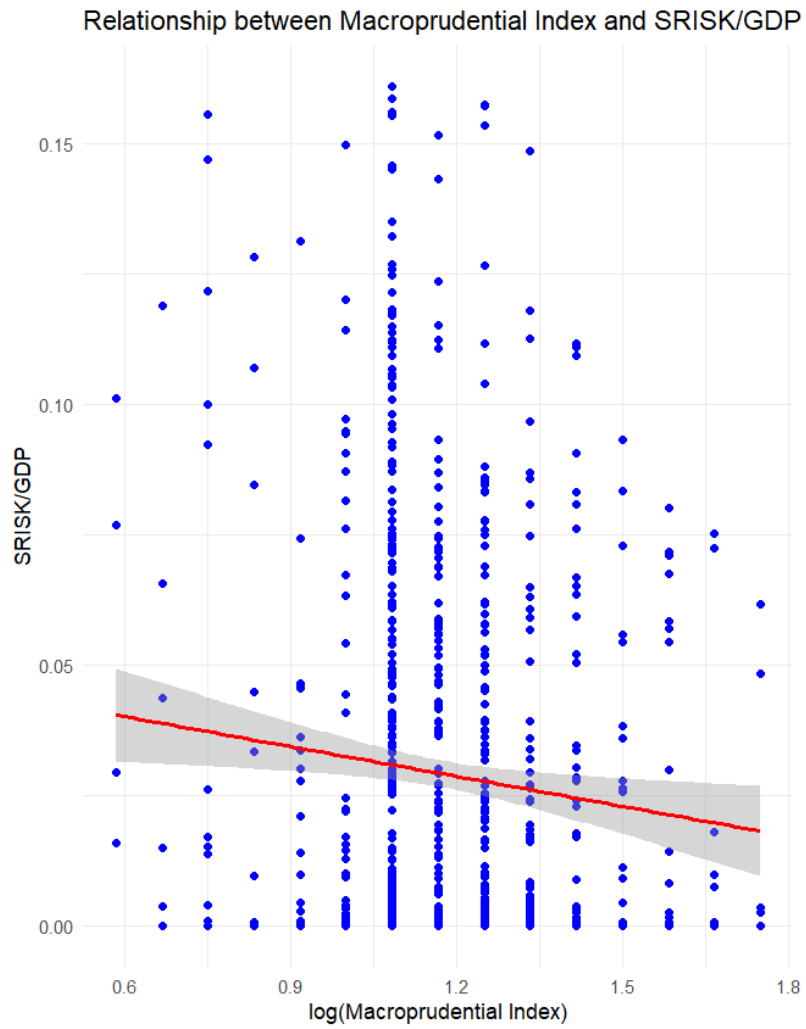

Figure 5.

If we return to the implication of the scores indicated by the dummy types, where +1 represents tightening, -1 loosening and 0 the neutrality of macroprudential policies (the processing of this data has already been discussed in the "Use and handling of data" section above). As we have added +13 to all scores and divided them by 12, a normalized score of (0+13)/12 (=1.0833) is equivalent to the average score for a neutral macroprudential policy. Any score below 1.0833 and approaching 0 is seen as loosening macroprudential policy, while a normalized score above 1.0833 is seen as tightening macroprudential policy. The maximum

value among the normalized scores is 1.75 (maximum intensity of macroprudential policies) and the minimum value is 0.5833 (minimum intensity of macroprudential policies). Extreme values are in fact higher but are no longer included in the database since outliers have been removed. If we calculate the predicted SRISK/GDP for each intensity level, we obtain the following results :

Maximum intensity (tightening) :

SRISK/GDP = 0.032830 + (- 0.025061)*log(1,75) = 0.032830 + (- 0.025061)*(0,243) = 0.0267

Neutral intensity :

SRISK/GDP = 0.032830 + (- 0.025061)*log(1,0833) = 0.032830 + (- 0.025061)*(0,0347) = 0.03

Minimum intensity (loosening) :

SRISK/GDP=0.032830 + (- 0.025061)*log(0,5833) =0.032830 +(- 0.025061)*(-0.2341)= 0.0386

We can therefore conclude that tightening macroprudential policies would have a positive impact on financial stability. Indeed, since the logarithm of all values above 1.0833 returns a positive number, and the coefficient of the "macroprudential index" variable in the last regression (the only robust regression with parameters having p-values below 5%) is of negative sign, this reduces SRISK/GDP and therefore financial instability. A value around 1.0833 would have an almost negligible impact on SRISK, as the logarithm of 1 is 0. We can also see that the neutrality of macroprudential policies has an almost negligible impact on financial stability, thus on the global economy. As for the loosening of macroprudential policies, it has a negative impact on financial stability, since the logarithm of any number between 0 and 1 gives a negative number. As this negative number is multiplied by the coefficient of X, which is also negative, this gives a positive number and would therefore increase the SRISK/GDP. We can conclude say that the intensity (depending on the tightening or loosening) of macroprudential policies has a significant impact on the global financial stability represented by the SRISK given the GDP.

4. Limitations

Many countries had to be excluded from the statistical database because their SRISK was calculated only very late (SRISK data only appear several years after 2007). This is the case for Georgia and Estonia, for example, where the information about the SRISK is only available from 2017 and 2019 respectively. Conversely, we have a few countries like Slovakia, which contains SRISK data from 2007 onwards, but no longer provides any data for much of the year 2021 up to the present day. This exclusion is justified by the fact that statistical analysis does not take empty data into account, and that it would be interesting to compare the SRISKs of several countries and their trends over the same period.

Additionally, some countries belonging to the list published by V-Lab have not been included because no information on the macroprudential index for these countries has been included in the 2019 ImaPP database. Conversely, countries that were not included in the list published by V-Lab had to be excluded even though the X (2019) database included their macroprudential index value. Other countries, such as Bosnia-Herzegovina and Afghanistan, were not included in the database because the ImaPP database was unable to provide information on their macroprudential index score.

Conclusion

In this thesis, we set out to explore the impact and importance of macroprudential policies on the stability of the global financial system. We have seen that macroprudential policies are preponderant to the safeguard of financial stability which is linked to sustainable economic growth and thus reduces the build-up of systemic risk. They are also crucial to limit excessive credit growth by encompassing the time (boom-bust cycle) and structural (interconnectedness) dimension of systemic risk.

A strong integrated macroprudential framework with clear and wide range of policy tools approved by experienced supervisors and a supranationalization of macroprudential policies (especially for countries that share common financial regulation) while considering financial integration, showed to be effective features in maintaining financial stability. On the contrary, externalities such as strategic complementarity, credit crunches, fire sales and risk of contagion are considered as harmful for the stability of the financial system because they favor procyclicality and hasten the build-up of systemic risk. In addition, we have seen that the complexity of the financial system can also be a trigger to the increase of credit growth and financial imbalances due to financial intermediaries other than traditional banks (i.e. shadow banks) that are less prone to macroprudential regulation.

Moreover, scientific literature mentioned the involvement of microprudential and monetary policies that serve as complements to macroprudential policies to reach the same financial objectives (bearing in mind that the degree of importance of these objectives depends on the policy used). However, it is proven that they are not as effective as macroprudential policies to address systemic risk which has negative consequences for the economy because it fails to consider the effects it has on financial markets but also fails to comprehend the complexity of the financial system. However, several tensions can arise from the application of macroprudential policies and monetary policies. Which is why supervisors agree that monetary should mainly focus on price stability and macroprudential policies on financial stability.

Furthermore, macroprudential tools (which are essential to implement macroprudential policies) can be divided into two categories. The first one involves borrower-based tools to limit the build-up of vulnerabilities in order to minimize the likelihood of credit losses such as LTV and DTI's. The second category involves policy tools to strengthen bank resilience (such as capital-based requirements) in order to drive them to use buffer for the purpose of absorbing future financial losses.

Regarding the intensity of macroprudential tools, results show that the tightening of these has more effect on systemic risk when financial vulnerabilities start to arise. Nevertheless, the loosening of macroprudential policies appears to be more effective during periods of downturn. Additionally, many studies suggest that excessive credit growth is synonym with systemic risk, or a measure that comes as close as possible, the SRISK which is a measure of capital shorfall (i.e. capital that needs to be raised to address chocs coming from the financial crisis). We can therefore infer that the SRISK gives us a representation of the overall financial instability.

That's why we decided it was a good index to represent financial stability in our empirical analysis, just like the average macroprudential index scores of the 64 countries selected for macroprudential policies. The level of intensity of macroprudential policies is crucial to analyze the impact on stability of the global financial system, because as previously stated, the effects of tightening and loosening macroprudential policies are different. As the effects of macroprudential policies on systemic risk are non-linear, we assumed that they were linked by a logarithmic factor in the regression function. The method to obtain the regression was done with the GMM because we consider the SRISK to be an endogenous variable. The results obtained by Rstudio showed a non-significant link between macroprudential policies and financial stability (even when outliers were removed), in contrast to the results obtained by (Belkhir et al., 2022). This is due to a high p-value for the coefficient of the "macroprudential index" variable.

This insignificance stems from the fact that we did not consider several parameters, such as GDP. Other variables could have been taken into account, such as monetary or microprudential policies, or even the inflation rate, but this would have complicated our

regression analysis, since we would not be calculating the direct link between macroprudential policies and financial stability, which is central to this thesis.

Furthermore, as already mentioned, systemic risk has adverse consequences for the economy. It is therefore essential to consider GDP, which is an economic indicator, in our regression. When we take SRISK and divide it by GDP, this enables us to measure the level of bail-out a country can benefit from thanks to its GDP. A high rate of SRISK/GDP in a country would mean that this country does not have a GDP high enough to cover the probability of a build-up of the risk systemic having a negative impact on financial stability and therefore also on the economy. We noticed that several advanced countries had a lower SRISK/GDP compared to some less developed countries, which means that the economies of these advanced countries are robust enough to maintain their financial situation at a stable level and thus reduce the probability of a build-up of systemic risk.

For this reason, we decided to include SRISK/GDP in the linear regression and replace it with SRISK in this case, while keeping the average macroprudential index intact. Taking care to remove outliers, we note that the link between macroprudential policy intensity and financial stability given GDP is significant due to a low p-value of the coefficients and a well-defined model confirmed by the J-test. We therefore conclude that tightening macroprudential policies has a positive impact on financial stability, as it reduces SRISK/GDP, while loosening would have a negative impact on overall financial stability conditional on the economic situation, as it would tend to increase SRISK/GDP.

Although most of this thesis focuses solely on the impact of macroprudential policies on the stability of the financial system, it would be enriching to also consider other factors such as the political context faced by some countries compared to others or the intensity of other economic policies used for financial stabilization purposes. This could provide a new perspective on the stability of the global financial system.

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Appendix

Annex 1 : Yearly macroprudential index score by country

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Argentina	-2	0	0	1	0	1	0	2	2	4	-1	8	3	6	0
Australia	0	0	0	1	0	0	0	1	4	6	1	0	0	-1	1
Austria	0	1	0	2	1	0	1	0	1	5	3	5	2	-5	0
Bahrain	0	0	0	0	0	2	1	0	0	0	0	3	0	-10	0
Bangladesh	0	1	-1	1	1	1	0	2	2	2	2	0	-1	-2	1
Belgium	0	-2	-1	0	0	-1	1	1	0	2	2	5	2	-4	1
Brazil	4	-2	0	5	3	-4	2	-1	3	1	-1	2	3	-5	-1
Canada	-1	3	0	2	2	5	1	1	1	8	4	7	5	-5	2
Chile	0	0	-1	0	0	1	0	0	1	0	0	0	1	1	2
China	13	3	1	12	10	0	6	2	1	4	2	6	2	0	3
Colombia	4	3	1	0	0	0	0	0	0	0	2	0	0	0	4
Croatia	1	-3	-3	-1	0	1	0	3	1	3	1	3	0	0	0
Curacao	0	0	0	0	0	0	0	0	1	0	-1	0	0	0	0
Cyprus	0	0	0	0	0	0	2	0	2	0	0	1	3	-2	3
CzechRepubli	0	0	0	0	0	0	0	2	3	3	4	4	2	-8	2
Denmark	1	0	-1	0	0	0	1	1	2	5	5	8	4	-3	2
Estonia	0	-1	-1	-2	-1	-1	0	3	4	0	0	3	2	-6	1
Finland	-1	0	0	2	0	-1	0	0	2	4	2	5	3	-3	4
France	0	0	0	1	0	-1	0	0	3	2	4	4	4	-4	0
Georgia	1	1	0	2	-1	0	3	1	0	0	3	6	8	-3	0
Germany	0	0	0	1	0	-1	0	0	2	3	4	4	3	-3	0
Greece	0	0	0	-1	0	-1	0	0	1	2	2	2	2	-2	1
HongKongSAR	-1	0	1	4	1	4	5	1	6	6	9	6	3	-4	0
Hungary	0	-1	0	6	-1	2	0	1	5	3	4	7	1	-5	0
Iceland	-1	-3	-1	0	0	0	1	2	1	5	6	1	2	2	2
India	6	0	1	5	0	-4	2	2	-2	2	4	4	1	-7	5
Indonesia	0	0	0	1	3	1	2	0	1	3	3	5	6	-4	-2
Ireland	1	0	0	0	0	-1	0	2	3	1	0	3	2	-2	1
Israel	0	0	1	2	4	1	6	0	4	3	4	3	0	-5	-3
Italy	1	0	0	0	0	-1	0	2	1	1	0	4	2	1	1
Jamaica	0	0	0	0	0	0	1	0	2	0	1	0	-1	1	-1
Japan	1	0	0	0	0	0	0	1	1	3	2	2	4	0	1
Jordan	0	1	0	0	0	0	0	0	0	3	1	0	1	0	1
Korea	3	-2	3	1	5	0	1	-2	3	2	6	7	5	-3	-4
Kuwait	1	-1	0	0	0	-1	1	4	1	2	1	0	2	-6	-3
Luxembourg	0	-1	0	0	0	0	1	1	1	5	3	4	2	-1	2
Malaysia	-1	-1	-2	2	8	3	4	1	1	2	2	3	2	-7	0
Malta	0	-1	0	0	0	-1	2	1	1	3	4	4	6	-4	1
Mexico	0	1	1	1	4	1	2	2	4	3	2	3	2	-13	0
Morocco	0	0	0	0	0	0	2	0	1	1	1	1	1	-2	-1
Netherlands	1	0	0	1	1	-1	3	2	2	2	4	3	1	-4	1
NewZealand	0	0	0	1	2	0	5	1	3	1	0	0	-1	-5	3
Nigeria	1	0	-1	5	4	2	1	4	1	0	0	1	1	0	0
Norway	-1	0	0	2	1	0	2	3	5	3	7	5	2	1	0
Oman	0	3	0	0	0	1	1	0	1	2	3	4	3	-5	0
Pakistan	1	2	2	0	0	1	1	4	7	5	1	3	-2	-9	-2
Peru	-1	3	-2	6	4	3	4	0	1	2	-7	-5	-2	-4	3
Philippines	1	-1	0	0	2	-1	0	4	1	0	1	3	3	-7	0
Poland	0	4	-1	2	3	0	-1	3	2	4	4	3	1	-1	0
Portugal	0	0	0	0	1	0	1	0	1	1	2	7	2	-1	1
Romania	-3	3	-4	0	1	2	0	0	1	5	1	6	3	-4	2
Russia	0	2	4	0	5	0	4	4	4	7	4	8	4	-4	-1
SaudiArabia	1	1	0	0	0	0	1	1	3	1	1	3	2	0	0
Singapore	0	0	1	4	3	2	10	0	2	2	0	6	3	-2	1
SlovakRepubli	0	0	2	0	0	2	0	3	1	1	5	4	3	-3	2
SouthAfrica	0	0	0	0	0	0	0	1	1	3	2	4	2	-6	1
Spain	0	2	-2	0	1	-1	0	0	1	2	2	4	2	-3	0
Sweden	0	0	0	1	0	0	2	3	2	3	2	3	2	-2	3
Switzerland	0	1	2	0	1	2	4	2	1	3	1	2	2	-6	2
TaiwanProvinc	3	-1	0	1	1	0	0	2	3	2	0	0	0	0	0
Thailand	-1	-1	0	1	2	2	0	0	0	2	3	3	3	6	1
Turkey	1	3	1	3	3	0	2	3	1	0	-1	7	-1	2	1
UnitedArabEm	0	0	0	0	2	1	1	0	1	1	1	2	3	-8	0
UnitedKingdor	0	0	1	0	0	0	0	3	1	2	4	5	2	-4	0
UnitedStates	0	0	0	0	1	0	0	3	2	2	1	3	0	-6	2

Annex 2 : Yearly macroprudential index positive score on average by country

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Argentina	0,917	1,083	1,083	1,167	1,083	1,167	1,083	1,250	1,250	1,417	1,000	1,750	1,333	1,583	1,083
Australia	1,083	1,083	1,083	1,167	1,083	1,083	1,083	1,167	1,417	1,583	1,167	1,083	1,083	1,000	1,167
Austria	1,083	1,167	1,083	1,250	1,167	1,083	1,167	1,083	1,167	1,500	1,333	1,500	1,250	0,667	1,083
Bahrein	1,083	1,083	1,083	1,083	1,083	1,250	1,167	1,083	1,083	1,083	1,083	1,333	1,083	0,250	1,083
Belgium	1,083	0,917	1,000	1,083	1,083	1,000	1,167	1,167	1,083	1,250	1,250	1,500	1,250	0,750	1,167
Brazil	1,417	0,917	1,083	1,500	1,333	0,750	1,250	1,000	1,333	1,167	1,000	1,250	1,333	0,667	1,000
Canada	1,000	1,333	1,083	1,250	1,250	1,500	1,167	1,167	1,167	1,750	1,417	1,667	1,500	0,667	1,250
Chile	1,083	1,083	1,000	1,083	1,083	1,167	1,083	1,083	1,167	1,083	1,083	1,083	1,167	1,167	1,250
China	2,167	1,333	1,167	2,083	1,917	1,083	1,583	1,250	1,167	1,417	1,250	1,583	1,250	1,083	1,333
Colombia	1,417	1,333	1,167	1,083	1,083	1,083	1,083	1,083	1,083	1,083	1,250	1,083	1,083	1,083	1,417
Croatia	1,167	0,833	0,833	1,000	1,083	1,167	1,083	1,333	1,167	1,333	1,167	1,333	1,083	1,083	1,083
Cyprus	1,083	1,083	1,083	1,083	1,083	1,083	1,250	1,083	1,250	1,083	1,083	1,167	1,333	0,917	1,333
CzechRepubli	1,083	1,083	1,083	1,083	1,083	1,083	1,083	1,250	1,333	1,333	1,417	1,417	1,250	0,417	1,250
Denmark	1,167	1,083	1,000	1,083	1,083	1,083	1,167	1,167	1,250	1,500	1,500	1,750	1,417	0,833	1,250
Finland	1,000	1,083	1,083	1,250	1,083	1,000	1,083	1,083	1,250	1,417	1,250	1,500	1,333	0,833	1,417
France	1,083	1,083	1,083	1,167	1,083	1,000	1,083	1,083	1,333	1,250	1,417	1,417	1,417	0,750	1,083
Germany	1,083	1,083	1,083	1,167	1,083	1,000	1,083	1,083	1,250	1,333	1,417	1,417	1,333	0,833	1,083
Greece	1,083	1,083	1,083	1,000	1,083	1,000	1,083	1,083	1,167	1,250	1,250	1,250	1,250	0,917	1,167
HongKongSAR	1,000	1,083	1,167	1,417	1,167	1,417	1,500	1,167	1,583	1,583	1,833	1,583	1,333	0,750	1,083
Hungary	1,083	1,000	1,083	1,583	1,000	1,250	1,083	1,167	1,500	1,333	1,417	1,667	1,167	0,667	1,083
India	1,583	1,083	1,167	1,500	1,083	0,750	1,250	1,250	0,917	1,250	1,417	1,417	1,167	0,500	1,500
Indonesia	1,083	1,083	1,083	1,167	1,333	1,167	1,250	1,083	1,167	1,333	1,333	1,500	1,583	0,750	0,917
Ireland	1,167	1,083	1,083	1,083	1,083	1,000	1,083	1,250	1,333	1,167	1,083	1,333	1,250	0,917	1,167
Israel	1,083	1,083	1,167	1,250	1,417	1,167	1,583	1,083	1,417	1,333	1,417	1,333	1,083	0,667	0,833
Italy	1,167	1,083	1,083	1,083	1,083	1,000	1,083	1,250	1,167	1,167	1,083	1,417	1,250	1,167	1,167
Japan	1,167	1,083	1,083	1,083	1,083	1,083	1,083	1,167	1,167	1,333	1,250	1,250	1,417	1,083	1,167
Jordan	1,083	1,167	1,083	1,083	1,083	1,083	1,083	1,083	1,083	1,333	1,167	1,083	1,167	1,083	1,167
Korea	1,333	0,917	1,333	1,167	1,500	1,083	1,167	0,917	1,333	1,250	1,583	1,667	1,500	0,833	0,750
Koweit	1,167	1,000	1,083	1,083	1,083	1,000	1,167	1,417	1,167	1,250	1,167	1,083	1,250	0,583	0,833
Luxembourg	1,083	1,000	1,083	1,083	1,083	1,083	1,167	1,167	1,167	1,500	1,333	1,417	1,250	1,000	1,250
Malaysia	1,000	1,000	0,917	1,250	1,750	1,333	1,417	1,167	1,167	1,250	1,250	1,333	1,250	0,500	1,083
Malta	1,083	1,000	1,083	1,083	1,083	1,000	1,250	1,167	1,167	1,333	1,417	1,417	1,583	0,750	1,167
Mexico	1,083	1,167	1,167	1,167	1,417	1,167	1,250	1,250	1,417	1,333	1,250	1,333	1,250	0,100	1,083
Morocco	1,083	1,083	1,083	1,083	1,083	1,083	1,250	1,083	1,167	1,167	1,167	1,167	1,167	0,917	1,000
Netherlands	1,167	1,083	1,083	1,167	1,167	1,000	1,333	1,250	1,250	1,250	1,417	1,333	1,167	0,750	1,167
NewZealand	1,083	1,083	1,083	1,167	1,250	1,083	1,500	1,167	1,333	1,167	1,083	1,083	1,000	0,667	1,333
Nigeria	1,167	1,083	1,000	1,500	1,417	1,250	1,167	1,417	1,167	1,083	1,083	1,167	1,167	1,083	1,083
Norway	1,000	1,083	1,083	1,250	1,167	1,083	1,250	1,333	1,500	1,333	1,667	1,500	1,250	1,167	1,083
Oman	1,083	1,333	1,083	1,083	1,083	1,167	1,167	1,083	1,167	1,250	1,333	1,417	1,333	0,667	1,083
Pakistan	1,167	1,250	1,250	1,083	1,083	1,167	1,167	1,417	1,667	1,500	1,167	1,333	0,917	0,333	0,917
Philippines	1,167	1,000	1,083	1,083	1,250	1,000	1,083	1,417	1,167	1,083	1,167	1,333	1,333	0,500	1,083
Poland	1,083	1,417	1,000	1,250	1,333	1,083	1,000	1,333	1,250	1,417	1,417	1,333	1,167	1,000	1,083
Portugal	1,083	1,083	1,083	1,083	1,167	1,083	1,167	1,083	1,167	1,167	1,250	1,667	1,250	1,000	1,167
Romania	0,833	1,333	0,750	1,083	1,167	1,250	1,083	1,083	1,167	1,500	1,167	1,583	1,333	0,750	1,250
Russia	1,083	1,250	1,417	1,083	1,500	1,083	1,417	1,417	1,417	1,667	1,417	1,750	1,417	0,750	1,000
SaudiArabia	1,167	1,167	1,083	1,083	1,083	1,083	1,167	1,167	1,333	1,167	1,167	1,333	1,250	1,083	1,083
Singapore	1,083	1,083	1,167	1,417	1,333	1,250	1,917	1,083	1,250	1,250	1,083	1,583	1,333	0,917	1,167
SouthAfrica	1,083	1,083	1,083	1,083	1,083	1,083	1,083	1,167	1,167	1,333	1,250	1,417	1,250	0,583	1,167
Spain	1,083	1,250	0,917	1,083	1,167	1,000	1,083	1,083	1,167	1,250	1,250	1,417	1,250	0,833	1,083
Sweden	1,083	1,083	1,083	1,167	1,083	1,083	1,250	1,333	1,250	1,333	1,250	1,333	1,250	0,917	1,333
Switzerland	1,083	1,167	1,250	1,083	1,167	1,250	1,417	1,250	1,167	1,333	1,167	1,250	1,250	0,583	1,250
TaiwanProvinc	1,333	1,000	1,083	1,167	1,167	1,083	1,083	1,250	1,333	1,250	1,083	1,083	1,083	1,083	1,083
Thailand	1,000	1,000	1,083	1,167	1,250	1,250	1,083	1,083	1,083	1,250	1,333	1,333	1,333	1,583	1,167
Turkey	1,167	1,333	1,167	1,333	1,333	1,083	1,250	1,333	1,167	1,083	1,000	1,667	1,000	1,250	1,167
UnitedArabEm	1,083	1,083	1,083	1,083	1,250	1,167	1,167	1,083	1,167	1,167	1,167	1,250	1,333	0,417	1,083
UnitedKingdor	1,083	1,083	1,167	1,083	1,083	1,083	1,083	1,333	1,167	1,250	1,417	1,500	1,250	0,750	1,083
UnitedStates	1,083	1,083	1,083	1,083	1,167	1,083	1,083	1,333	1,250	1,250	1,167	1,333	1,083	0,583	1,250

Annex 3 : SRISK score by country

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Argentina	0,12	0,92	0,21	0	0,5	0,47	0,04	0	0	0	0	0	0,17	0,11	0,1
Australia	7	69	41	59	89	45	48	35	35	18	23	37	56	74	50
Austria	2	17	14	10	23	18	16	17	7	11	7	12	12	19	15
Bahrain	0	0	0,13	0	0	0,1	0	0	0	0	0	0	0	0,13	0
Bangladesh	0	0	0	0	0	0	0	0,11	0,13	0,2	0,21	0,47	0,7	0,78	0,9
Belgium	32	68	58	57	55	45	39	23	14	16	12	14	0	8	2
Brazil	0	24	10	10	22	34	50	54	43	30	21	8	11	22	41
Canada	33	98	48	81	101	102	72	75	113	74	50	130	127	197	177
Chile	0	1	0	0	0	0	0,2	0,4	0,9	0,4	0,8	0	1,7	1,9	5,9
China	0	33	9	100	195	323	524	416	547	732	762	935	1076	1378	1543
Colombia	0	0	0	0	0	0	0	0	2,5	0	0	2,2	1,7	3	5,7
Croatia	0	0	0	0	0	0	0,04	0	0	0	0	0	0	0	0
Curacao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyprus	0	4,5	5,2	6,2	7,8	6,2	2	0,1	0,2	0,3	0,8	0,7	0,7	0,7	0,8
CzechRepubli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Denmark	15	34	28	24	28	26	20	17	10	12	12	22	28	30	28
Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	0	0,75	0,84	0,88	1,71	1,03	0,79	0,25	0,06	0,17	0,18	0,19	0,13	0,18	0
France	276	427	357	379	447	402	351	360	288	313	284	312	303	412	348
Georgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Germany	195	278	237	240	278	224	178	156	122	136	105	111	115	130	113
Greece	0	13	13	20	23	23	11	17	17	13	9	11	8	14	12
HongKongSAR	20	24	18	19	20	20	15	20	22	23	18	29	54	42	62
Hungary	0	0,27	0	0	0,49	0,12	0,1	0,38	0,03	0,03	0,01	0	0,05	0	0,4
Iceland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
India	2	36	15	19	64	48	79	57	71	73	64	62	72	77	84
Indonesia	0	1,43	0	0	0	0,04	0,81	0,52	1,06	0,79	0	0,2	0,73	0,94	1,1
Ireland	14	40	30	26	14	10	4	3	0	3	1	3	6	9	10
Israel	5	16	9	8	17	15	17	20	18	19	18	19	16	27	22
Italy	6	119	107	147	175	159	132	115	67	126	91	109	105	147	127
Jamaica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Japan	227	365	519	582	710	702	552	551	512	564	777	850	896	1003	1054
Jordan	0	0	0	0	0	0	0	0	0,1	0	0,03	0,05	0,14	0,4	0,61
Korea	5	38	25	27	48	78	77	69	89	114	95	125	154	176	182
Kuwait	0	0	0	0	0,16	0	0	0	0	0,24	0,8	1,37	1,04	1,72	1,37
Luxembourg	0	4,8	5	4,9	5,5	4,5	4,7	0	0	0	0	0	0	0	0
Malaysia	0,2	3,1	0,6	0,4	0,8	1,3	1,1	2,3	3,4	4,9	2	0,8	3,7	7,8	5,6
Malta	0,08	0	0	0	0	0	0	0	0	0	0	0	0,13	0,26	0,41
Mexico	0	1,1	0	0	1,1	0	0	1	2	2,7	2,5	3,2	3,2	4,5	1,4
Morocco	0	0	0	0	0	0	0	0	0	0	0	0	0,01	0	0
Netherlands	61	107	93	94	112	96	71	60	35	47	28	52	61	84	71
NewZealand	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nigeria	0	0	0	0	0	0	0	0,9	1,05	1,12	0,05	0,48	1,38	1,68	1,92
Norway	1	16	11	9	19	17	13	17	10	9	4	4	9	8	4
Oman	0	0	0	0	0	0	0	0	0	0	0	0,04	0	0,28	0,02
Pakistan	0	0,7	0	0	0,3	0,1	0	0	0,2	0	0,9	1,7	1,4	1,8	3,4
Philippines	0	0,91	0,1	0,11	0	0	0	0	0,05	0,07	0	0,01	0,49	1,17	1,05
Poland	0,2	0,7	0,7	0	1,1	0	0,1	0,4	0,9	1,2	0,9	1,1	1,8	9,4	1,3
Portugal	0	7,3	7,2	11,11	14,4	11,3	8,4	5,1	3,7	4,6	1,2	1,8	2,5	3,9	3,9
Romania	0	0	0	0	0,05	0	0	0	0	0	0	0	0	0	0
Russia	0	2	0	0	0	3	3	35	12	0	6	6	5	6	6
SaudiArabia	0	0	0	0	0	0	0	0,05	0,02	0	0	0	0	0	0
Singapore	0	7	0	0	11	2	3	2	7	12	0	1	7	16	6
SlovakRepubli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SouthAfrica	9	16	11	23	33	21	22	22	31	21	22	14	19	26	26
Spain	0	57	45	104	110	129	84	74	89	96	76	95	120	164	138
Sweden	18	37	27	23	31	24	14	10	11	9	13	9	20	25	23
Switzerland	95	139	85	93	122	108	64	62	38	59	38	53	60	75	63
TaiwanProvinc	13	17	15	13	13	13	13	33	40	46	46	51	54	71	48
Thailand	1	5	1	1	3	1	3	2	3	2	1	1	3	15	11
Turkey	0	3	0	0	3	0	9	3	8	11	8	14	11	12	24
UnitedArabEm	0	1,52	3,29	3,24	1,36	2,31	0	0	0	0	0	0,17	0,17	0,21	0,02
UnitedKingdor	343	530	367	336	423	329	288	297	273	281	175	240	319	397	361
UnitedStates	592	840	506	470	671	543	301	285	368	188	122	399	325	627	491

Annex 4 : SRISK/GDP by country

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Argentina	0,0417%	0,2531%	0,0628%	0,0000%	0,0948%	0,0811%	0,0065%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0381%	0,0286%	0,0205%
Australia	0,7368%	6,5297%	4,0960%	4,7020%	5,8727%	2,8658%	3,1575%	2,4012%	2,8351%	1,4242%	1,6635%	2,6073%	4,0340%	5,4216%	3,0160%
Austria	0,5138%	3,9351%	3,4885%	2,5472%	5,3289%	4,3939%	3,7192%	3,8401%	1,8324%	2,7797%	1,6782%	2,6362%	2,6988%	4,3708%	3,1275%
Bahrein	0,0000%	0,0000%	0,5667%	0,0000%	0,0000%	0,3252%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,3755%	0,0000%
Belgium	6,7944%	13,1459%	12,0150%	11,8303%	10,5114%	9,0640%	7,4741%	4,2948%	3,0278%	3,3618%	2,3876%	2,5757%	0,0000%	1,5214%	0,3327%
Brazil	0,0000%	1,4152%	0,5991%	0,4528%	0,8416%	1,3798%	2,0229%	2,1986%	2,3888%	1,6698%	1,0177%	0,4173%	0,5872%	1,4904%	2,4541%
Canada	2,2466%	6,3109%	3,4871%	5,0082%	5,6320%	5,5788%	3,8991%	4,1534%	7,2598%	4,8429%	3,0317%	7,5349%	7,2833%	11,8984%	8,8171%
Chile	0,0000%	0,5566%	0,0000%	0,0000%	0,0000%	0,0000%	0,0721%	0,1542%	0,3711%	0,1604%	0,2895%	0,0000%	0,6114%	0,7479%	1,8694%
China	0,0000%	0,7210%	0,1769%	1,6573%	2,6027%	3,7824%	5,4442%	3,9528%	4,9219%	6,5201%	6,2126%	6,7549%	7,5032%	9,2716%	8,6884%
Colombia	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,8518%	0,0000%	0,0000%	0,6584%	0,5262%	1,1097%	1,7895%
Croatia	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0672%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
Cyprus	0,0000%	16,0973%	19,9846%	24,0115%	28,2230%	24,7377%	8,3472%	0,4304%	1,0045%	1,4259%	3,4877%	2,7334%	2,6975%	2,7770%	2,7117%
CzechRepubli	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
Denmark	4,6960%	9,6219%	8,7161%	7,4535%	8,1395%	7,9474%	5,8210%	4,8159%	3,3039%	3,8324%	3,6131%	6,1652%	8,0808%	8,4563%	6,9019%
Finland	0,0000%	0,2625%	0,3317%	0,3525%	0,6206%	0,3985%	0,2911%	0,0909%	0,0256%	0,0706%	0,0704%	0,0689%	0,0484%	0,0663%	0,0000%
France	10,3724%	14,5735%	13,2322%	14,3162%	15,6040%	14,9700%	12,4826%	12,6019%	11,8060%	12,6604%	10,9474%	11,1739%	11,1023%	15,5748%	11,7635%
Germany	5,6918%	7,4235%	6,9551%	7,0538%	7,4160%	6,3467%	4,7672%	4,0102%	3,6332%	3,9206%	2,8459%	2,7916%	2,9566%	3,3465%	2,6394%
Greece	0,0000%	3,6530%	3,9281%	6,7257%	8,1288%	9,4970%	4,6042%	7,2181%	8,6866%	6,7324%	4,5051%	5,1851%	3,8972%	7,4338%	5,5863%
HongKongSAR	9,4526%	10,9450%	8,4093%	8,3100%	8,0478%	7,6153%	5,4408%	6,8620%	7,1109%	7,1682%	5,2744%	8,0170%	14,8730%	12,1760%	16,8043%
Hungary	0,0000%	0,1705%	0,0000%	0,0000%	0,3452%	0,0932%	0,0737%	0,2694%	0,0240%	0,0233%	0,0070%	0,0000%	0,0305%	0,0000%	0,2197%
India	0,1644%	3,0028%	1,1178%	1,1339%	3,5106%	2,6263%	4,2548%	2,7953%	3,3752%	3,1811%	2,4138%	2,2938%	2,5391%	2,8787%	2,6521%
Indonesia	0,0000%	0,2561%	0,0000%	0,0000%	0,0000%	0,0044%	0,0888%	0,0584%	0,1231%	0,0848%	0,0000%	0,0192%	0,0652%	0,0888%	0,0927%
Ireland	5,1830%	14,5234%	12,7018%	11,7066%	5,8546%	4,4393%	1,6799%	1,1550%	0,0000%	1,0051%	0,2966%	0,7755%	1,5038%	2,1015%	1,9465%
Israel	2,7164%	7,2546%	4,2363%	3,3485%	6,3574%	5,7052%	5,7117%	6,3676%	5,9460%	5,9197%	5,0388%	5,0646%	4,0035%	6,5577%	4,4925%
Italy	0,2711%	4,9411%	4,8691%	6,8761%	7,6266%	7,6139%	6,1626%	5,3178%	3,6476%	6,7144%	4,6402%	5,2081%	5,2199%	7,7534%	5,8897%
Japan	4,9566%	7,1475%	9,8119%	10,1058%	11,3907%	11,1920%	10,5903%	11,2518%	11,5187%	11,2717%	15,7580%	16,8621%	17,5069%	19,8394%	20,9350%
Jordan	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,2588%	0,0000%	0,0720%	0,1151%	0,3141%	0,9140%	1,3157%
Korea	0,4265%	3,6219%	2,6490%	2,3610%	3,8295%	6,1031%	5,6178%	4,6481%	6,0708%	7,6032%	5,8531%	7,2448%	9,3253%	10,7012%	10,0086%
Koweit	0,0000%	0,0000%	0,0000%	0,0000%	0,1039%	0,0000%	0,0000%	0,0000%	0,0000%	0,2194%	0,6629%	0,9912%	0,7498%	1,5998%	0,9663%
Luxembourg	0,0000%	8,1580%	9,1898%	8,7096%	8,9163%	7,5233%	7,2081%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
Malaysia	0,0987%	1,2813%	0,2832%	0,1547%	0,2647%	0,4076%	0,3355%	0,6708%	1,1282%	1,6265%	0,6267%	0,2230%	1,0132%	2,3114%	1,4980%
Malta	1,0014%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,8122%	1,7063%	2,2607%
Mexico	0,0000%	0,0947%	0,0000%	0,0000%	0,0895%	0,0000%	0,0000%	0,0733%	0,1648%	0,2428%	0,2100%	0,2547%	0,2452%	0,4015%	0,1066%
Morocco	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0078%	0,0000%	0,0000%
Netherlands	7,1878%	11,2423%	10,6826%	11,0840%	12,3742%	11,4360%	8,0941%	6,7235%	4,5713%	5,9961%	3,3590%	5,6864%	6,7011%	9,2403%	6,8908%
NewZealand	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
Nigeria	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,1583%	0,2132%	0,2768%	0,0133%	0,1138%	0,3080%	0,3912%	0,4350%
Norway	0,2484%	3,4415%	2,8352%	2,0879%	3,7897%	3,3153%	2,4714%	3,3882%	2,5763%	2,4262%	0,9957%	0,9095%	2,2019%	2,1761%	0,7946%
Oman	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0437%	0,0000%	0,3689%	0,0227%
Pakistan	0,0000%	0,3462%	0,0000%	0,0000%	0,1301%	0,0400%	0,0000%	0,0000%	0,0667%	0,0000%	0,2653%	0,4773%	0,4360%	0,5992%	0,9757%
Philippines	0,0000%	0,5027%	0,0568%	0,0528%	0,0000%	0,0000%	0,0000%	0,0000%	0,0163%	0,0220%	0,0000%	0,0029%	0,1300%	0,3234%	0,2664%
Poland	0,0466%	0,1312%	0,1592%	0,0000%	0,2098%	0,0000%	0,0194%	0,0742%	0,1888%	0,2555%	0,1715%	0,1868%	0,3020%	1,5681%	0,1908%
Portugal	0,0000%	2,7716%	2,9460%	4,6620%	5,8758%	5,2228%	3,7096%	2,2178%	1,8554%	2,2290%	0,5423%	0,7425%	1,0416%	1,7042%	1,5252%
Romania	0,0000%	0,0000%	0,0000%	0,0000%	0,0259%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
Russia	0,0000%	0,1124%	0,0000%	0,0000%	0,0000%	0,1369%	0,1311%	1,7083%	0,8845%	0,0000%	0,3809%	0,3630%	0,2949%	0,4032%	0,3255%
SaudiArabia	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0065%	0,0030%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%
Singapore	0,0000%	3,6154%	0,0000%	0,0000%	3,9376%	0,6778%	0,9754%	0,6352%	2,2727%	3,7611%	0,0000%	0,2653%	1,8572%	4,5781%	1,3821%
SouthAfrica	2,7055%	5,0554%	3,3214%	5,5114%	7,1941%	4,8343%	5,4880%	5,7713%	8,9424%	6,4916%	5,7695%	3,4560%	4,8812%	7,6879%	6,1903%
Spain	0,0000%	3,4933%	3,0204%	7,3071%	7,4302%	9,7315%	6,1965%	5,3929%	7,4397%	7,7845%	5,7892%	6,6791%	8,6054%	12,8415%	9,5395%
Sweden	3,6641%	7,1469%	6,1851%	4,6388%	5,3998%	4,3440%	2,3857%	1,7183%	2,1778%	1,7454%	2,4029%	1,6203%	3,7462%	4,5699%	3,5954%
Switzerland	19,3546%	24,5188%	15,3503%	15,5475%	17,0455%	15,7344%	9,0598%	8,5316%	5,4763%	8,5804%	5,4645%	7,3025%	8,3122%	10,1211%	7,7544%
TaiwanProvinc	3,1948%	4,0875%	3,8380%	2,9261%	2,6861%	2,6230%	2,5344%	6,1644%	7,4834%	8,4702%	7,7869%	8,3717%	8,8322%	10,5470%	6,2093%
Thailand	0,3803%	1,7160%	0,3550%	0,2932%	0,8090%	0,2515%	0,7137%	0,4910%	0,7476%	0,4838%	0,2191%	0,1973%	0,5515%	2,9972%	2,1728%
Turkey	0,0000%	0,3892%	0,0000%	0,0000%	0,3578%	0,0000%	0,9399%	0,3197%	0,9258%	1,2654%	0,9314%	1,7944%	1,4464%	1,6663%	2,9328%
UnitedArabEm	0,0000%	0,4818%	1,2976%	1,0793%	0,3769%	0,6006%	0,0000%	0,0000%	0,0000%	0,0000%	0,0000%	0,0398%	0,0407%	0,0601%	0,0048%
UnitedKingdor	11,0942%	17,9030%	15,1560%	13,5052%	15,8741%	12,1511%	10,3349%	9,6859%	9,3220%	10,4109%	6,5240%	8,3478%	11,1809%	14,7052%	11,4885%
UnitedStates	4,0900%	5,6873%	3,4949%	3,1231%	4,3014%	3,3407%	1,7831%	1,6186%	2,0115%	0,9997%	0,6221%	1,9316%	1,5101%	2,9405%	2,0810%

Annex 5 :

```
install.packages("gmm")
install.packages("readxl")
install.packages("writexl")
install.packages("plm")
install.packages("ggplot2")
install.packages("lmtest")
install.packages("tseries")


library(ggplot2)
library(gmm)
library(readxl)
library(plm)
library(lmtest)
library(tseries)


file_path <- 'C'
```

```
OK <- read_excel(file_path, sheet = 8)
CV <- read_excel(file_path, sheet = 9)

head(OK)
head(CV)

data_OK <- OK
data_CV <- CV


gmm_moments <- function(beta, data_OK){

  x <- log(data_OK$Imappmoy)
  y <- data_OK$SRISK
  e <- y - beta[1] - beta[2] *x
  m1 <- e
  m2 <- e * x
  m3 <- e * x^2
  m <- cbind(m1, m2, m3)
  return(m)
}

initial_model <- lm(y ~ x)
beta_init <- c(coef(initial_model)[1], coef(initial_model)[2])
gmm_result <- gmm(gmm_moments, x = data_OK, t0 = beta_init)
summary(gmm_result)


ggplot(data_OK, aes(x = Imappmoy, y = SRISK)) +
  geom_point(color = "blue", alpha = 0.5) +  # Scatter plot points
  geom_smooth(method = "lm", color = "red") +  # Regression line
  labs(title = "Relationship between Macroprudential Index and SRISK",
       x = "log(Macroprudential Index)",
       y = "SRISK (in Billion USD)") +
  theme_minimal()
```

Annex 6 :

```
Call:
gmm(g = gmm_moments, x = data_OK, t0 = beta_init)


Method:  twoStep

Kernel:  Quadratic Spectral(with bw =  2.27593 )

Coefficients:
             Estimate    Std. Error  t value     Pr(>|t|)
(Intercept)  57.5633687  19.9453813   2.8860500   0.0039011
x            20.0188069  18.0065963   1.1117485   0.2662463

J-Test: degrees of freedom is 1
                J-test   P-value
Test E(g)=0:    0.54297  0.46121

Initial values of the coefficients
(Intercept)           x
   59.11168    10.95019

#############
Information related to the numerical optimization
Convergence code =  0
Function eval. =  129
Gradian eval. =  NA
```

Annex 7 :

```
# Compute the Z-scores in order to identify the outliers
z_scores <- scale(data_OK[, c("Imappmoy", "SRISK")])

# Find the outliers above 3 or below -3
outliers <- which(abs(z_scores) > 3, arr.ind = TRUE)

outliers_rows <- unique(outliers[, 1])
data_outliers <- data_OK[outliers_rows, ]

# Delete the outliers from the dataset
data_cleaned <- data_OK[-outliers_rows, ]

head(data_cleaned)
print(data_cleaned)
print(data_outliers)
```

Annex 8 :

```
gmm_moments1 <- function(beta, data_cleaned){

  x <- log(data_cleaned$Imappmoy)
  y <- data_cleaned$SRISK
  e <- y - beta[1] - beta[2] * x
  m1 <- e
  m2 <- e * x
  m3 <- e * x^2
  m <- cbind(m1, m2, m3)
  return(m)
}

initial_model1 <- lm(y ~ x)
beta_init1 <- c(coef(initial_model1)[1], coef(initial_model1)[2])
gmm_result1 <- gmm(gmm_moments1, x = data_cleaned, t0 = beta_init1)
summary(gmm_result1)
```

Annex 9 :

```
Call:
gmm(g = gmm_moments1, x = data_cleaned, t0 = beta_init1)


Method:  twoStep

Kernel:  Quadratic Spectral(with bw =  2.78743 )

Coefficients:
             Estimate     Std. Error   t value      Pr(>|t|)
(Intercept)   45.6573893   15.0946039    3.0247491    0.0024884
x            -27.2743559   23.4984187   -1.1606890    0.2457684

J-Test: degrees of freedom is 1
                J-test   P-value
Test E(g)=0:    0.05280  0.81826

Initial values of the coefficients
(Intercept)           x
   43.99638   -24.51410

#############
Information related to the numerical optimization
Convergence code =  0
Function eval. =  133
Gradian eval. =  NA
```

Annex 10 :

```
# Compute the Z-scores in order to identify the outliers
z_scores <- scale(data_CV[, c("Imappmoy", "SRISKGDP")])

# Find the outliers above 3 or below -3
outliers_CV <- which(abs(z_scores) > 3, arr.ind = TRUE)

outliers_rows <- unique(outliers_CV[, 1])
data_outliers_CV <- data_CV[outliers_rows, ]

# Delete the outliers from the dataset
data_cleaned_CV <- data_CV[-outliers_rows, ]

head(data_cleaned_CV)
print((data_cleaned_CV))
print(data_outliers_CV)
```

```
gmm_moments2 <- function(beta, data_cleaned_CV){

  x <- log(data_cleaned_CV$Imappmoy)
  y <- data_cleaned_CV$SRISKGDP
  e <- y - beta[1] - beta[2] * x
  m1 <- e
  m2 <- e * x
  m3 <- e * x^2
  m <- cbind(m1, m2, m3)
  return(m)
}
```

```
initial_model2 <- lm(y ~ x)
beta_init2 <- c(coef(initial_model2)[1], coef(initial_model2)[2])
gmm_result2 <- gmm(gmm_moments2, x = data_cleaned_CV, t0 = beta_init2)
summary(gmm_result2)
```

```
ggplot(data_cleaned_CV, aes(x = Imappmoy, y = SRISKGDP)) +
  geom_point(color = "blue", alpha = 2) +  # Scatter plot points
  geom_smooth(method = "lm", color = "red") +  # Regression line
  labs(title = "Relationship between Macroprudential Index and SRISK/GDP"
       x = "log(Macroprudential Index)",
       y = "SRISK/GDP") +
  theme_minimal()
```

Annex 11 :

```
Call:
gmm(g = gmm_moments2, x = data_cleaned_CV, t0 = beta_init2)


Method:  twoStep

Kernel:  Quadratic Spectral(with bw =  0.5711 )

Coefficients:
             Estimate     Std. Error   t value      Pr(>|t|)
(Intercept)   3.2830e-02   5.3025e-03   6.1914e+00   5.9615e-10
x            -2.5061e-02   1.0547e-02  -2.3762e+00   1.7492e-02

J-Test: degrees of freedom is 1
                J-test   P-value
Test E(g)=0:    0.78752  0.37485

Initial values of the coefficients
(Intercept)           x
 0.03259228 -0.02290663

#############
Information related to the numerical optimization
Convergence code =  0
Function eval. =  59
Gradian eval. =  NA
```

Many countries around the globe have been affected by the financial crisis, which is why the decision to implement macroprudential policies is decisive in favoring financial instability by limiting the build-up of systemic risk. This thesis focuses on the impact of macroprudential policies on the stability of the global financial system. To answer this question, a scientific literature accompanied by an econometric empirical analysis was conducted to see whether this impact is significant.

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