References

[1] General government - General government debt - OECD Data.

[2] Central Bank of Iceland » Statistics » Statistic, October 2008.

[3] Viral Acharya, Itamar Drechsler, and Philipp Schnabl. A Pyrrhic Victory? Bank Bailouts and Sovereign Credit Risk. *The Journal of Finance*, 69(6):2689–2739, 2014. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/jofi.12206.

[4] Markus K. Brunnermeier, Luis Garicano, Philip R. Lane, Marco Pagano, Ricardo Reis, Tano Santos, David Thesmar, Stijn Van Nieuwerburgh, and Dimitri Vayanos. The Sovereign-Bank Diabolic Loop and ESBies. *American Economic Review*, 106(5):508–512, May 2016.

[5] Department of Finance Canada. Canada's COVID-19 Economic Response Plan: Support for Canadians and Businesses, March 2020. Last Modified: 2020-03-18.

[6] Agostino Capponi, Felix Corell, and Joseph E. Stiglitz. Optimal bailouts and the doom loop with a financial network. *Journal of Monetary Economics*, March 2022.

[7] Russell Cooper and Kalin Nikolov. Government Debt and Banking Fragility: The Spreading of Strategic Uncertainty. *International Economic Review*, 59(4):1905–1925, 2018. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/iere.12323.

[8] Emmanuel Farhi and Jean Tirole. Deadly Embrace: Sovereign and Financial Balance Sheets Doom Loops. *The Review of Economic Studies*, 85(3):1781–1823, July 2018.

[9] Andrei Hrebenciuc. Banking Union framework and the stability of the European Banking sector. *Theoretical and Applied Economics*, XXIV(1(610), Spring):291–298, 2017. Publisher: Asociatia Generala a Economistilor din Romania - AGER.

Financial Crises and the ’Doom Loop’ Amplification Mechanism

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1 Introduction

The onset of COVID-19 in the developed world came with it many complex challenges in regard to economic policy, though perhaps unexpectedly, financial stability was not one of them. In the absence of government intervention, we would have likely seen businesses and consumers struggling to repay loans in the face of falling income and hence, banks main asset streams drying up. However, instead, we witnessed an immediate response of governments which shouldered almost the entire macroeconomic impact themselves by extending large fiscal stimulus packages including direct transfers, business subsidies, and low-interest loans to the public [5]. Nearly all governments have employed some form of this resulting in some of the most striking Debt-GDP ratios in history [1]. Considering this massive transfer onto governments' balance sheets, it may be useful to look at some of the implications this could have for the financial sector, which has remained largely untouched so far. One mechanism for the propagation of financial crises which has become concerning since 2008 has been the 'doom loop'.

The 'doom loop' refers to a continuous amplification mechanism that arises due to the relationship between sovereign debt and the balance sheet composition of the domestic banking sector. Empirically, it is evident that banks usually hold a large amount of domestic sovereign debt. In March of 2011, during the height of the European debt crisis, the banking sector held about one-sixth of its risk-weighted assets in sovereign debt securities, 69% of which were issued by their own national government [3]. This home bias results in a banking sector that is very sensitive to fluctuations in the value of their own sovereign debt securities, and hence, to the macro-prudential policies of that government. More specifically, the literature on the doom loop is divided into two strands: the 'bailout loop' and the 'real economy loop'. The bailout loop refers to the following process:

1. A financial crisis or adverse shock impacts the financial sector, necessitating a bailout from the government.
2. The increased government debt levels from the bailout increase the probability of a sovereign default.
3. The value of sovereign debt falls putting further strain on banks' balance sheets and financial stability.

The real economy loop on the other hand functions through the "credit channel" and proceeds as follows:

1. Sovereign stress decreases the value of assets on banks' balance sheets.
2. This results in a credit crunch resulting in a reduction in economic activity.
3. As a result of decreased incomes, tax revenue is lower inducing further sovereign stress.

This 'doom loop' phenomenon was observed on multiple occasions during the European debt crisis with two especially prominent examples being Ireland and Greece. These two represent extreme cases as both resulted in the sovereign entity requiring bailouts from the IMF. Though we will focus on these examples, a full default is not a prerequisite for this mechanism, just the possibility of default is sufficient reason for concern.

In this paper, I will be exploring the literature related to the 'doom loop' and its implications for fiscal and macroprudential policy. There has been a lot of work related to the doom loop (e.g. [3], [4], [7], [8], [6]) but we will focus on Acharya et al. (2014) and Capponi et. al (2022) as I believe they are most interesting. We will begin with a review of the original model and empirical work done by Acharya et. al upon which much of the literature is built. Following this, we will look at how other literature built upon this and how Capponi et. al extended it to issues of financial contagion and the 'too big to fail' problem.

2 A Pyrrhic Victory? Bank Bailouts and Sovereign Credit Risk (Acharya et. al, 2014)

2.1 Background and Motivation

Acharya et. al provides a theoretic model and empirical evidence for both the bailout and real economy loops. Acharya uses Ireland as a case study for illustrating the doom loop and for good reason. In 2008, Irish banks were in severe financial distress due to the falling value of their MBS positions, eventually necessitating a bailout. In September, the government made an announcement that it would guarantee all bank deposits in Irish banks. This led to a 250-basis point fall in Irish bank credit default swaps (CDSs) overnight. Meanwhile, the CDS rate of Irish government debt moved in the opposite direction, eventually increasing by more than 300 basis points over the next 6 months.

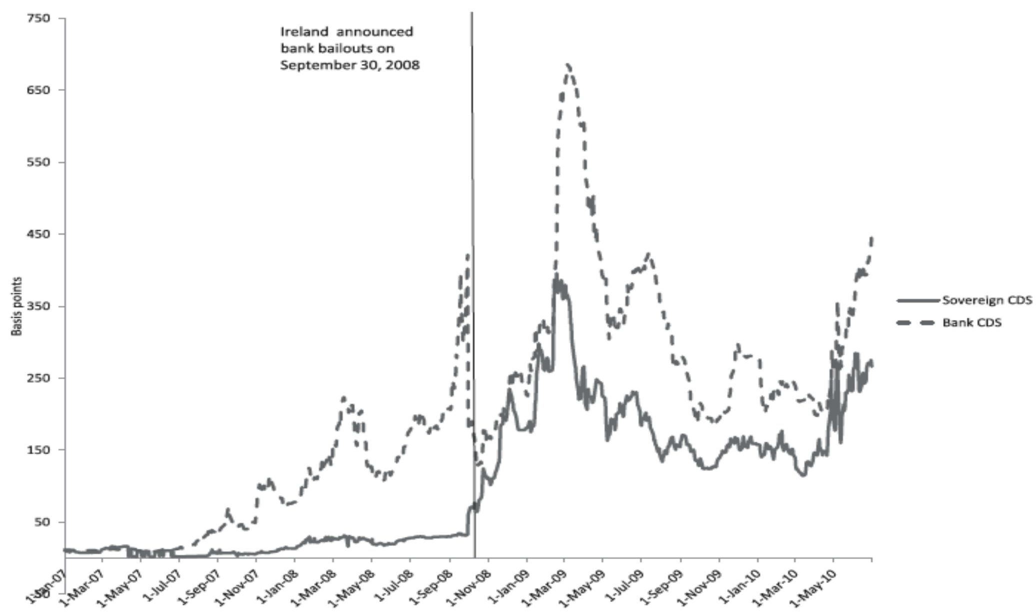


Figure 1: Sovereign CDS and Bank CDS of Ireland (Acharya et. al, 2014)

Several key empirical features are evident here that are essential to identifying doom loops. Firstly, we can that before the bailout, bank and sovereign debt CDS displayed little correlation. After the announcement of the bailout, we see an implicit transfer of bank risk onto the government's balance sheet and hence a co-movement between the bank and sovereign CDS rates. The underlying process through which this occurs is what motivated the authors' research questions:

1. Were financial sector bailouts influential in affecting sovereign credit risk?
2. What was the mechanism that caused the transmission of this risk?
3. Does sovereign credit risk feed back into the financial sector?

2.2 Model

The authors use a theoretical model of an economy which we will not explore in too much but we will cover the key assumptions and results. They model a theoretical economy over 3 period with 3 agents; the government, financial sector, and corporate (non-financial) sector (+ representative consumer). The figure below illustrates the decision making process:

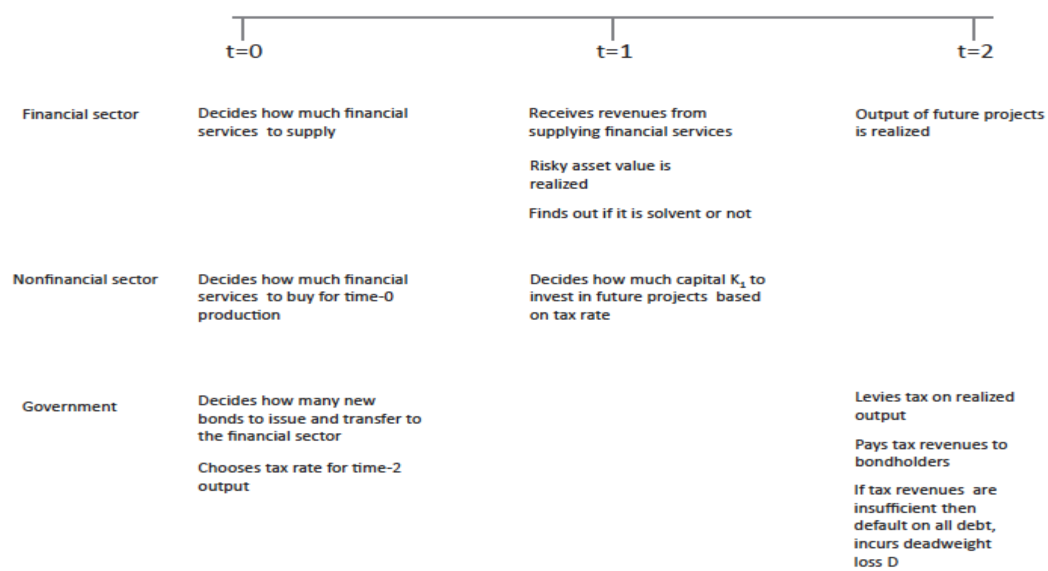


Figure 2: Timeline of Acharya model (Acharya et. al (2014))

The financial sector optimizes expected payoff by choosing an allocation of government bonds and other assets. The financial sector is assumed to be highly leveraged and sufficiently large relative to the size of the economy, such that sufficient debt overhang would necessitate a bailout. The corporate sector buys financial sector services from the financial to supply the real economy and decides how much to invest in period 1 based on a tax rate. The corporate sector assists in modelling the real economy side of the doom loop. Finally, the government chooses the optimal bailout for the financial sector as well as the optimal tax rate applied to the corporate sector to maximize welfare. The government finances spending by issuing new bonds and transferring them to the financial sector. In period 2, the government must use tax revenues to pay bondholders. If it fails to do so, it will default with an associated deadweight loss that reflects the damage to its international reputation.

In equilibrium, the model is characterized by 3 important relationships which describe the doom loop process:

1. There is a unique and optimal tax revenue choice and transfer which is increasing in financial sector debt and decreasing in the amount of existing government debt.
2. The net benefit of defaulting in t=2 is increasing in financial sectors debt and existing government debt but *decreasing* in the fraction of government debt held by the financial sector.
3. In the presence of uncertain future output, the optimal insolvency ratio (ratio of outstanding bond value to tax revenue) and expected tax revenues are increasing in the financial sector's debt overhang.

In a sequential format, this can be interpreted as the following. The government must make a transfer to the financial sector but the efficient means of doing so is dependent on the value of the financial sector debt and government debt. The government is also limited by the degree to which it can raise taxes without stimulating underinvestment in the non-financial sector as described by a Laffer curve. Therefore, there is a point at which the government will decide to accept a higher insolvency ratio, which decreases the value of its debt due to the possibility of default. This dilution also affects the financial sector, necessitating a larger bailout. Therefore, the effect on the value of sovereign debt is scaled by how far away the government is from having to increase this insolvency ratio and risk default. This is dependent on the initial value of government debt and the ability of the sovereign to levy taxes. The figure below illustrates the relationships described well.

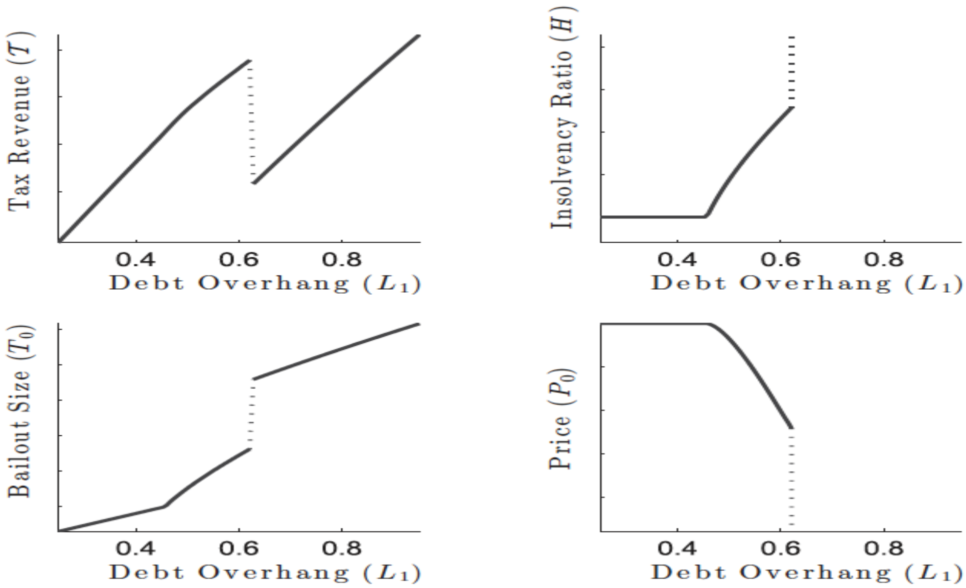


Figure 3: Comparative Statics for Debt Overhang (Acharya et. al, 2014)

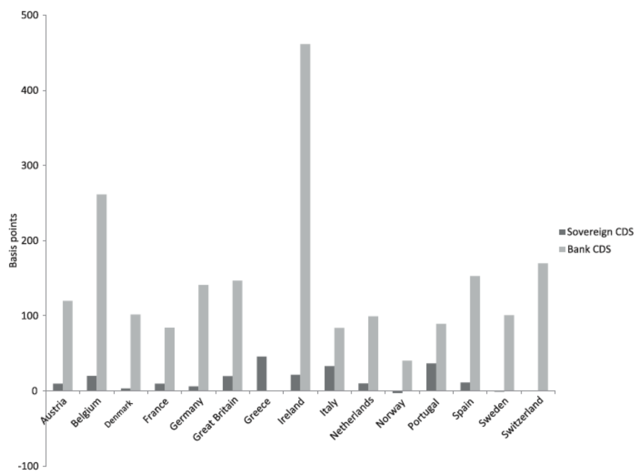
On the x-axis of the graphs, we see debt overhang, which essentially scales the size of the bailout required. Notice the breaking point in all relationships occurs at 0.6. This corresponds to the point at which default becomes the optimal strategy for the government. At this point, the government trades off the deadweight loss associated with a default, for the ability to increase the size of the bailout while lowering taxes to limit the burden on the real economy. This possibility is exactly what leads to the relationship between the value of sovereign and financial sector debt. This is what we observed in the Irish example after the bailout: a co-movement between financial and sovereign credit risk. The relationship should be especially valuable to policymakers as it means that the issue of bailouts does not stop at the long-term moral hazard issue, there is rather an immediate negative impact on financial stability that must be internalized.

2.3 Empirical analysis

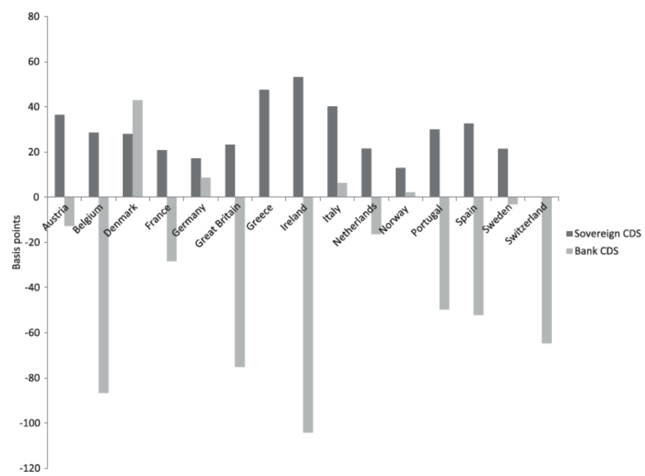
Given the results of the model, the authors wanted to test these results empirically. More specifically, they wanted to test if bank bailouts, like the Irish example, were a key factor in triggering the rise in sovereign credit risk in developed countries. This would confirm the first part of the loop, so they could move on to testing whether there is a feedback of sovereign credit risk into the financial sector and vice versa. These two results, if structurally identified, would confirm the presence of the doom loop.

Part 1: Emergence of Sovereign Default Risk

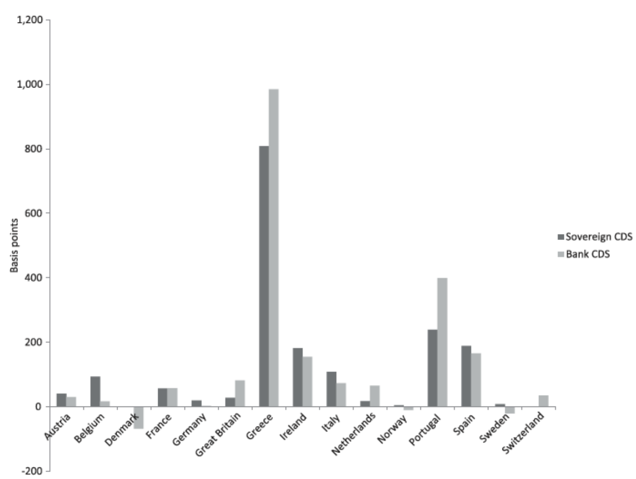
This part of the analysis used 2007-2011 data from Eurozone countries (+ Denmark, Norway, Sweden, Switzerland, and the UK) on bank and sovereign CDS rates. Within this period, each of the sample countries' governments announced some form of a bailout to the financial sector. They analyzed the average changes in CDS in the three timeframes; pre-bailout, bailout, and post-bailout. The results are very clearly demonstrated in the following three figures.



(a) Pre-bailout



(b) During bailout



(c) Post-bailout

Figure 4: Change in bank and sovereign CDS during various periods (Acharya et. al, 2014)

These figures demonstrate the following relationship. Before the bailout, the cost to insure the financial sector (CDS) was rising as the fault lines in the global financial system began to appear.

After the announcements, we see the cost to insure banks drop dramatically, whilst the CDS for sovereign debt rose dramatically. After the transfer of financial sector debt to the government and the issuance of new bonds by the government (absorbed by the financial sector) we see that financial and sovereign CDS move in the same direction. To further illustrate this point, the authors ran regressions and discovered that there is no relationship between the two assets before the bailout, whereas afterwards, we observe a strong positive correlation between the two. Unfortunately, this is not enough to identify a structural relationship as these variables may be subject to many unobserved/omitted variables.

Part 2: Sovereign Bank Feedback Loop

So how can we control for these unobserved variables? The authors use 3 sets of controls with the following regression specification:

$$\Delta log(\text{Bank CDS}_{ijt}) = \alpha_i + \delta_t + \beta \Delta log(\text{Sovereign CDS}_{jt}) + \gamma_i \Delta X_i jt + \epsilon_{ijt}$$

The set of controls included (i) day fixed effects to control for macroeconomic fundamentals that affect the entire financial sector (ii) foreign credit exposure and (iii) heterogeneity in banks' exposure as evidenced through bank-specific CDS movements and equity price. The results are displayed below and are precisely in line with the predictions of the model. No relationship in the pre-bailout period, a strong negative relationship during the bailout period, and a mildly positive relationship in the post-bailout period. The model predicts that a 10% increase in sovereign CDS results in a 0.9% increase in the average value of Bank CDSs, which is exactly in line with the percentage of sovereign debt that is typically held on banks' balance sheets. The impact on equity in this scenario is likely to be significantly amplified to leveraged nature of banks.

Therefore, from this paper, we can conclude that there is empirical evidence for a doom loop that is well described by the specified model. This model characterizes both the real economy loop, through the ability of the non-financial sector to freely operate as well as the bailout loop through the impact of sovereign debt dilution on banks' balance sheets. We can use this as a baseline of understanding as we move on to discuss the model employed by Copponi et. al (2022) which focuses exclusively on the bailout loop and the implications of financial market structure.

3 Optimal bailouts and the doom loop with a financial network (Capponi et. al, 2022)

Copponi et. al extends the theoretical literature on the doom loop to include financial market structure specifications. The motivation for this is to rectify two important areas of study; optimal bailout policy with an interconnected financial market and the doom loop literature. More specifically, the authors want to examine how a given network of bank liabilities will respond to an adverse shock that affects a subset of banks. The model assumes that, in the absence of government intervention, there will be a cascade of failures associated with this shock. Therefore, the optimal bailout policy is dependent not only on the financial situation of an individual bank but also on its creditors. The authors allow for a broad heterogeneity of balance sheets structure across banks, including a specified distribution of sovereign debt securities across banks in order to consider doom loop implications.

To get a sense of the kind of results the authors were looking for we can consider the following questions which I believe are implicitly defined in the paper:

1. How does the level and distribution of sovereign debt affect the optimal bailout policy?
2. How does centrality or the degree of interconnectedness of a given bank affect the optimal bailout policy?
3. How does this differ from the traditional literature on both the doom loop and optimal bailouts under financial contagion?

We will not cover the model they employed in significant depth (although it is very interesting) for the sake of time but I will attempt to highlight the key features. The authors model a 3-period economy where:

t=0: Exogenous unanticipated shock hits a subset of banks' cash assets resulting in insolvency (Liabilities>Assets).

t=1: Government can issue bonds and provide a bailout to insolvent banks.

t=2: All sovereign debt matures which is held by domestic banks and risk-neutral investors. The government may default or not.

They model a network of N banks, each with a stylized balance sheet of the following form (assuming solvency):

Assets	Liabilities
c^i	d^i
$(\Pi L)^i$	L^i
$q_0 b^i$	V_0^i

Figure 5: Stylized Balance Sheet

where on the asset side c^i = cash and other assets, $(\Pi L)^i$ = vector describing interbank assets, $q_0 b^i$ = sovereign bond holdings. On the liabilities side we have d^i = deposits (senior), L_i = total interbank liabilities, V_0^i = value of equity (=difference).

When a bank fails

A bank failure is characterized by the following process. Senior deposits are paid first (through a deposit insurance scheme), then each creditor is paid according to its share of the failed bank's interbank liabilities. We assume there is additional DWL associated with a bank failure (due to legal proceedings and impact on the larger financial network) that is scaled by β. This term reduces the total amount available to the creditors further and is increasing in the size of the bank.

Government

Governments react to the shock in t=1 by deciding on the optimal bailout. In this process, they trade-off the benefit of avoided DWL due to financial contagion with the liabilities that will be moved to the public balance sheet in the form of higher sovereign spreads (due to a higher probability of default). In the process of the bailout, the government essentially decides on a payment clearing vector which describes interbank settlements, the sum of which will be the size of the bailout. The feature that makes this interesting is that the optimal bailout is dependent on both the subset of banks adversely affected and the distribution and price of sovereign debt within the entire network. So, the government internalizes the effect of the bailout on the value of their own debt.

Default decision

In the final period, the government raises taxes to cover its obligations to its debt holders. The tax revenue is assumed to be a random process that is exogenously given. This is the structure that results in unique identification of the bailout loop, as we are not considering the effects on the real economy which would be reflected in tax revenues.

Equilibrium results: full and no bailout case

To avoid the complex math associated with non-degenerate distributions. We can first consider two corner solutions: full bailout and no bailout. The relative welfare benefits of each should help us characterize some broader results of the model. Under this specification, we observe several expected results as per the doom loop literature. Firstly, the welfare benefits of a bailout are decreasing in the proportional amount of sovereign debt held by the entire financial system, though we will see that there are caveats to this. This is because for a given amount of sovereign debt in the domestic financial system, the government internalizes a greater degree of the dilution impacts. Second, we observe that the effect of sovereign debt is scaled by the capital buffer of banks, therefore, a redistribution of the assets towards well-capitalized banks could increase the benefit of a bailout.

Equilibrium results: partial bailouts

If we allow for partial bailouts, it becomes much more difficult to derive globally optimal solutions therefore the authors approximate them by introducing a sequential structure. Governments look at each bank individually and calculate the welfare benefits associated with saving it; if it is positive, it is bailed out. An interesting feature here is that governments can consider the amplification effects. If we assumed that the base case is no bailout, then the welfare benefit of a bailout is scaled by $(1+\beta)$ for each interconnected creditor of the failed bank. The number of interconnected creditors is referred to as the 'node depth' or 'centrality' of the bank.

This parameter turns out to be very important and leads to some interesting results. The benefit of a bailout is scaled by (i) degree of centralization (ii) size of the capital buffer and (iii) sovereign debt holdings. Interestingly, however, the impact of sovereign debt holdings on the bailout is determined by the degree of centrality. Highly centralized banks with high sovereign debt are likely to be bailed out but sovereign debt actually decreases the probability of a bailout for periphery banks. It is exactly this result that has implications for the 'too big to fail' problem as centralized banks may have a strategic incentive to trade-off capital buffers for sovereign debt holdings as a protective mechanism for financial crises. Holding sovereign debt and capital buffers operate in the same fundamental way in the absence of a 'no bailout' clause by the government.

To summarize, this paper provides us with the following important results that we can take into the discussion section. The doom loop is weaker when banks hold little domestic foreign debt or if they have large capital buffers. Governments are more inclined to bail out banks that are centralized and have large sovereign debt positions. This implies that there may be benefits to strategic sovereign debt allocations for these banks. It is important to realize that the bailout loop is likely to be much more present in countries where sovereign default is actually a risk. Where this model might fall short is in the following assumptions: no real economy loop effects, no payouts at all in the event of a default, and an ability to raise taxes that is exogenous.

4 Discussion

The policy implications of the doom loop are very well illustrated in the Copponi paper yet there is still further research to be done to incorporate the effects of the real economy (as in Acharya et. al (2014)) as well as include the strategic behaviour of firms. This strategic behaviour could be also analyzed empirically to see if banks designated as globally systemically important (GSIBs) or domestically important banks trade-off capital buffers for sovereign debt holdings. Either way, there appears to be a lot of room for further research. In practice, the European Union has sought to ameliorate the impact of the doom loop with the establishment of the Banking Union [9].

To finalize, I would just like to highlight one special case of the doom loop which has sometimes been characterized as 'too big to save'. This phenomenon was specific to one country during the financial crisis; Iceland. The Icelandic banking sector was massive compared to its GDP with large subsidiaries in the UK and other European countries. The banking sector was so large that, at the height of the crisis, Iceland's external debt was 7 times the value of its GDP [2]. It was immediately evident that the government did not have the ability to bail out all creditors, therefore, it separated the domestic and foreign banking sectors and bailed out the domestic sector. The foreign creditors were given zero support. This resulted in a period of currency depreciation and hence inflation for several years and an increase in Iceland's CDSs of 1000 basis points. By March of 2011, however, Iceland's CDS rates were below that of Ireland, likely since it was not exposed to a comparable degree of the risk of their banking systems balance sheet. Therefore, we can conclude that the doom loop is not an ever-increasing concern in the size of the banking system, but the associated costs of not bailing out the banking sector may be.

I hope this literature review has provided an interesting insight into the ’doom loop’ phenomenon and the associated policy implications for dealing with them.