Information and Financial Crisis Policymaking

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Abstract

The degree to which governments intervene to contain financial crises varies considerably. We aim to understand why policymakers choose the level of intervention they do to contain financial shocks. In particular, we want to understand why policymakers may choose policies that create outcomes they do not want. We focus on a defining feature of financial crisis policymaking that has been largely unaddressed in the literature on policy responses to crises: policymakers lack good information about the health of their banking systems. So, they rely on their bureaucrats and other actors for necessary information. However, information providers may have different policy preferences. To understand the interactions between these actors and the implications for policy choice, we advance a signalling game of financial crisis containment. We use comparative statics and a case study of the recent Irish crisis to demonstrate how information asymmetries can have a significant impact on bailout choices.

Keywords: banking crisis, financial crisis policymaking, guarantees, Ireland, signalling games

1 Introduction

Governments in countries confronted with financial shocks face a severe trade-off. To contain a crisis they must announce a policy response that will restore confidence to the financial system. At the same time, such measures expose governments to significant possible fiscal costs which may threaten the solvency of the state itself. This was dramatically demonstrated by the Irish Government's 2008 decision to provide a blanket guarantee of bank liabilities.

Despite the size of the Irish response, which included guarantees that amounted to €365 billion, or almost 2.5 times GNP (Honohan, 2010, 19), decision-makers believed that it would end up costing very

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little as the guarantees were not likely to be redeemed. The financial sector was believed by many to be merely suffering a short-term liquidity crisis rather than a fundamental problem of insolvency. This sentiment was expressed by the Minister for Finance who shortly after the first round of banking system support was announced commented that it was "the cheapest bailout in the world so far".[1] But by Spring 2011 the bill had reached €70 billion, leading the central bank Governor to note that it had ended up being one of the costliest crises in history.[2] Irish policymakers seemed to have chosen exactly the containment level that they did not want. The recent Irish example motivates us to create a general way of conceptualising banking crisis policymaking so that we can understand counter-intuitive situations where decision-makers end up choosing crisis containment policies that lead to non-preferred outcomes.

Our article makes an important contribution to the growing literature on the political economy of public responses to banking crises (see Alesina and Drazen, 1991; Grossman and Woll, 2014; Keefer, 2007; Pepinsky, 2014; Rodrik, 1999; Rosas, 2006, 2009; Weber and Schmitz, 2011; Woll, 2014). We use a signalling game framework to understand how information asymmetries between political decision-makers and bureaucrats shape initial crisis responses. Specifically, we adapt seminal models of strategic information transmission (Crawford and Sobel, 1982; Gilligan and Krehbiel, 1987) by making domain specific assumptions about what information policymakers need, as well as what the ranges of their and their bureaucrats' preferences are.

Information poor decision-makers rely on financial bureaucrats for information about the proportion of non-performing loans (NPL) in their banking systems and the recovery value of these loans in the aftermath of shocks. These are important indicators of how much a given policy response is likely to cost. If information providers have different preferences from decision-makers, they are likely to give vague or even uninformative messages. This prevents decision-makers from choosing crisis responses that they prefer. The model also predicts situations where decision-makers receive accurate information: when decision-makers and information providers have closely aligned bailout preferences.

Information asymmetries have long been acknowledged as a cause of crises (e.g. Mishkin, 1990), and have been well-studied in the broader game theory literature (for a review see Sobel, 2013). However, research on policy responses to financial crises has not systematically explored information problems, instead implicitly assuming that decision-makers have perfect information about their banking systems. Rather than studying information asymmetries, previous work has focused on factors including differences between democracies and non-democracies, institutional weaknesses in emerging economies, and the number of veto players to explain policy choices.

These works have been shown to have poor explanatory power in light of the 2008 financial crisis

[1] Brian Lenihan to the Leinster Society of Chartered Accountants lunch in Dublin, October 23rd, 2008.
[2] Patrick Honohan, March 31st, 2011.

(Gandrud and Hallerberg, 2015*b*). The present state of the art has little to say about cases like Ireland's, as it is an advanced democracy with a developed economy, and (at least before the crisis) well regarded public and private financial institutions. Previous work suggests that the Irish crisis response should have been low cost, but it clearly was not. We show that bringing information asymmetries into the crisis policy response literature generates better explanations.

It is important to emphasise the external validity and generalisability of the environment we are modelling. Previous work has largely assumed that decision-makers in wealthier, and especially democratic countries are not as reliant on domestic public bureaucracies and banks themselves for information about banks' health as policymakers are in less wealthy and less democratic countries (e.g. Satyanath, 2006). It is assumed that bureaucratic actors in more advanced markets are more transparent and non-bureaucratic actors, including a free financial press and robust auditors, serve as independent sources of information. However, these may not be reasonable assumptions.

Financial bureaucracies, even in advanced economies can be relatively opaque. Gandrud and Hallerberg (2015*a*) document that only about a third of EU member states regularly release marginally detailed supervisory data on banks. In the data that is released it is difficult or impossible to get a real-time and accurate impression of the full extent of non-performing loans. This limits the independent information that the press and decision-makers can access. In some countries, such as Germany, confidentiality laws even prohibited law-makers from accessing bank-level supervisory information. Only after the 2007-09 crisis have German lawmakers gained some access to this information, though still within the confines of a special investigation.

There are many examples of information problems between bureaucracies from the recent crisis. For example, in September 2007 deliberations at the Bank of England about how and how much to support troubled lender Northern Rock it is clear that the now defunct Financial Services Authority (FSA) presented an overly rosy picture of the lender's health. The "FSA were clear that Northern Rock's problems were liquidity related there was not a solvency issue" (Bank of England, 2007, 53). It would turn out that the FSA was in fact providing unjustifiably positive information. After being provided with extensive public liquidity support, Northern Rock was nationalised in 2008.

Though, in general non-governmental actors are important sources of information, their ability to provide accurate information about quantities such as NPLs during the start of a crisis has been limited. Sikka (2009) shows that banks across Europe and the United States received clean bills of health from external auditors, often within a few months of their collapse in the 2007-09 crisis.

International or supranational institutions such as the International Monetary Fund, the European Commission, and the European Central Bank (ECB) may release their own information to governments and closely scrutinise domestic bureaucracies' information. However, they generally play a major role *after* a crisis has started.[3] Often they are brought in because a government's initial crisis response–what we are primarily trying to explain–ended up being unsustainable.

2 Previous Explanations of Banking Crisis Containment

When a country has widespread bank insolvencies it is in a banking crisis (Sundararajan and Baliño, 1991). "Because bank balance sheets are tightly integrated and bank capital is highly leveraged, the failure of a single insolvent bank may threaten to upset the entire banking system and have effects on the real economy" (Rosas, 2009, 6). If bank failures have potentially large and widespread negative externalities it is reasonable to assume that most actors–policymakers, bankers, the public–greatly prefer mitigating the impact of these crises with government intervention to inaction. Before developing our signalling game for how decision-makers choose crisis containment policies we critically discuss the state of the art literature attempting to explain how governments intervene.

Crony capitalism is possibly the most straightforward political economy approach to understanding why countries choose high levels of bank support to contain crises. Bankers prefer public to private losses as public losses in banking crises are wealth transfers to them. So, they push for high public guarantees to forestall insolvency, i.e. they gamble for resurrection (Downs and Rocke, 1994). Politicians with cronyistic ties to bankers are more likely to use bailouts at the expense of diffuse public interests such as taxpayers (Rosas, 2006). The crony capitalism theory expects decision-makers with close ties to the banking sector to pursue policies that maintain the solvency of banks even at substantial public expense.

Another major stream in the literature focuses on veto players. Opinion about how the number and polarisation of a country's veto players affects policy choices during banking crisis ranges considerably. On the one hand, Alesina and Drazen (1991) argue that as the number of veto players increases, we are less likely to expect them all to agree on a new policy. Therefore crisis responses in general will be slow and inadequate. Conversely, Rodrik (1999) suggests that having many veto players, if organised to manage conflicts, will result in more appropriate and quickly implemented crisis management policies.

Keefer (2007) argues that the number of veto players has no effect on crisis responses, but competitive elections encourage better crisis responses for the general public since they weaken policymakers' ties to banking interests and align them more closely with taxpayers. Similarly, Rosas (2009) argues that actors in democratic rather than authoritarian countries are more likely to use public cost reducing crisis responses, since electoral incentives push them to favour limiting public losses. Countries with competitive elections, regardless of the number of veto players, could be more likely to choose crisis response policies that limit public costs. However, working with updated data, Gandrud and Hallerberg

[3] An exception is the post-crisis ECB, which has direct supervisory responsibilities.

(2015*b*) find no difference in costs between countries with less and more competitive elections.

Choices may also be constrained or shaped by bureaucratic capacity (for a discussion of this type of argument see Satyanath, 2006, 18). Bureaucratic institutions do not have equal capacity across all countries. Higher capacity regulators, ministries of finance, and central bank officials with expertise are better able to implement complex policies, such as orchestrating sustainable bank mergers. For the same reasons, bureaucrats with lower capacities might be restricted in the policies they can plausibly enact and therefore have incentives to try (see Huber and McCarty, 2004). Policymakers may take this into account when choosing policy responses. Furthermore, high capacity bureaucracies may be able to obtain better quality information about the true health of the banking sector (Abonyi, 2005). How might bureaucratic capacity help us predict containment policy choices? One expectation would be that if a bureaucracy could be held accountable and could more accurately monitor banking activity then the country would accurately target support at solvent, though illiquid institutions, and so would be less likely to issue costly crisis containment support.

Through conditions on loans that countries in financial crises desperately need, international institutions may force countries to adopt certain policies (Vreeland, 2003). Receiving support from international institutions could result in policies closer to the preferences of these institutions.

Throughout previous work, when information asymmetries are discussed, they are generally believed to exist in less developed countries. Satyanath (2006), for example, examined how information asymmetries could affect developing countries' pre-crisis financial regulatory choices. However, he explicitly assumed that information asymmetries were not an important component of decision-making in more advance financial centres. Woll (2014)– argues that governments with one-to-one relationships with banks have costlier responses than those that interact with banking sectors capable of making collective commitments and thus private sector contributions to bailouts. She does briefly mention information asymmetries as an important factor in this process for the Irish bailout. However,– she includes– them in an *ad hoc* manner.

3 Signalling Game Setup

We aim to directly understand how information asymmetries and differences in preferences among government actors affect what containment policy level is initially chosen. To do this we build on seminal analysis by Crawford and Sobel (1982) and Gilligan and Krehbiel (1987) to advance a signalling game where the actor who makes the containment policy decision relies on information from information rich actors, primarily their financial bureaucrats. These actors have preferences about policy decisions and aim to influence them.

The general model and its generic conclusions are well-established in the game theory literature (Sobel, 2013). Our innovation is the creation and application of useful domain specific assumptions about what decisions policymakers are concerned with and what information they need to make these decisions. In so doing, we clarify this complex policy environment and derive a useful theoretical model allowing us to make novel predictions that were not previously possible in the banking crisis policymaking literature.

The Players We model banking crisis policymaking as the result of a game between two sets of actors. One set makes the containment policy decision. This could be, for example, a prime minister or president. We call her the decision-maker (DM). Before making her decision she needs to *receive* information *sent* by one or more signallers who are information rich. For convenience, we denote the information providers as the financial regulator (FR) and the minister of finance (MoF).

Field of Play: The Banking System Balance Sheet The environment within which our actors manoeuvre is a banking system. To demonstrate why a decision-maker must rely on signals from financial bureaucrats for a containment policy decision, we first model how a shock would generate changes to the proportion of NPLs. For both modelling simplicity and because we assume that the decision-maker is concerned with the effect of policy choices on the entire banking system, rather than individual banks, we focus on the balance sheet of an entire banking system. We characterise the balance sheet of the banking system in terms of assets (A), liabilities (L), and capital (C).

The asset side consists of a portfolio of assets. These can be loans to households or firms, for example. Assets have two broad types: performing (P) and non-performing (N). The value of assets that are performing is denoted A_P. This is simply the book value of the assets. While we use A_N for the value of *the same assets* when they are non-performing. Firms or mortgage holders may fall behind on their payments or default on their loans with probability γ and create non-performing assets. Non-performing assets always have a real value less than their book value.[4]

Banks play a fundamental role in the transformation of short-term deposits into long-term loans. However, this creates an asset-liability maturity mismatch. Banks rely on both traditional retail deposits and wholesale funding on the liabilities side to finance their assets. Deposits may be withdrawn and wholesale funding may not be rolled over. The banking system's balance sheet makes it vulnerable to liquidity risk. On the liability side of the balance sheet we have regulatory capital. This will often take the form of hybrid claims such as subordinated debt or preferred equity instruments which are considered as a buffer against losses that protects depositors. Building on Aghion, Bolton and Fries

[4] Non-performing assets may be liquidated and the bank will obtain j with probability β. Otherwise the assets will have a continuation value with a realised return π. Formally: $A_N = \beta j + (1 - \beta)\pi$.

(1999), we characterise the balance sheet of a banking system as:

$$\theta = \gamma A_N + (1-\gamma)A_P - (L+C). \tag{1}$$

A solvent banking system is one where the payoffs from performing and non-performing assets exceeds the value of liabilities issued to fund the assets and reserve capital at each point in time. Banks are solvent at all points in time when $A \geq L + C$. If $\gamma A_N + (1-\gamma)A_P < L + C$ then the banking system is insolvent.

Banks' asset portfolios are sensitive to macro-financial shocks. A shock can cause asset price declines and disruptions to the supply of credit, generating non-performing loans (Nkusu, 2011). To capture this we assume that the shock i changes the proportion of non-performing loans by μ_i, where $\mu_i \geq 1$. Therefore, following a shock the expected proportion of NPLs is given by:

$$\gamma_i = \mu_i \gamma. \tag{2}$$

For the time being, we'll assume that γ_i is from a uniform distribution between [0, 1] with mean $\bar{\gamma_i}$ and variance $\sigma^2_{\gamma_i}$. θ_i represents the net worth of the banking system as a result of shock i:

$$\theta_i = \gamma_i A_N + (1-\gamma_i)A_P - (L+C). \tag{3}$$

Information We assume that all information is common to the actors except the DM does not know the proportion of non-performing assets (γ_i) following the shock, so she does not know the recovery (r) value of assets in the crisis $A_{ri} = \gamma_i A_N + (1-\gamma_i)A_P$. This is primarily because of the opacity of loan valuations during a crisis. She does however know the distribution of A_r.[5]

Containment Policy Choices Policies used to respond to financial crises can be categorised by their use during two broad phases beginning with *containment* and followed by *resolution* (Honohan and Laeven, 2005). Here we focus exclusively on crisis containment policymaking in the initial period following the shock.

Useful extensions could examine how containment policy choices affect the set and desirability of subsequent resolution policies. It would be interesting to understand how the DM learns from initial policy choice outcomes. Nonetheless, it is important to note that containment policy decisions are not

[5] Currently we do not assume that gathering information is costly to signallers. One extension would be to apply Dewatripont and Tirole's (1999) model for understanding how to incentivise agents to gather information when doing so is costly. This could provide insights into how to structure financial regulatory institutional systems to gather information and convey it to decision-makers such that they can make preferred decisions. Ultimately, this would build on the model presented here, as once the information is gathered actors enter into a similar signalling game.

trivial. They have potentially large and long lasting effects. For example, once a government institutes a guarantee it can be difficult to remove it without undermining market confidence. Thus it is important to understand how they are made.

Governments have a range of containment policy choices to restore confidence in financial systems. These include liability and asset guarantees (e.g. supporting the value of certain assets held by banks), as well as liquidity assistance and recapitalisation which ensures their solvency. For simplicity, we assume that the DM is indifferent between the different containment policy types.

We conceptualise containment policies G as being from a unidimensional space. We choose to further conceptualise G as a proportion of the pre-shock book value of assets in the banking system A, and denote this g, where $g = \frac{G}{A}$. g is from the set $\{g_i, \ldots, g_n\}$. Focusing on containment policies as a proportion of assets is not necessary.[6] However, it is substantively meaningful for actors who care about containment costs. Assuming a best case scenario where containment costs can be recuperated up to the recovery value of banking system assets,[7] if support is equal to the recovery value of those assets the support will be 'costless'.[8]

In addition to providing support to the banking sector, politicians can require private sector participation or impose costs on the private sector by, for example, requiring haircuts and bail-ins. These policies effectively reduce the public costs of containment, and the public support provided to the banking sector. Therefore, we conceptualise g as net of publicly forced private sector participation and costs.

For a shock i we can express the assets' recovery value A_{ri} in terms of the assets' pre-shock book value A with α_i, where $\alpha_i = \frac{A_{ri}}{A}$. A costless containment policy g for a shock i is be one where $g - \alpha_i = 0$.

DM's Preferences If the DM has 'moderate' preferences in that she wants to ensure that the guarantee has no direct costs to the taxpayer she would choose guarantee g_k that equals the recovery value of the loans in the system α_i. This choice may calm the liquidity crisis and maintain banking system solvency, while ensuring that the state could recuperate the containment policy costs. It is not necessary to assume that the DM prefers $g_k - \alpha_i = 0$. She may be more concerned about financial system stability or protecting banks from losses and want some $g_k > \alpha_i$. Or she may be worried about the potential losses from the guarantees or the moral hazard containment policies could create and prefer some $g_k < \alpha_i$.

At this point, we assume that the DM has moderate preferences. In order to be re-elected, incumbents need to please taxpaying voters who have a preference for both financial stability (as instability is costly to them) and do not want to provide costly bailouts (see Keefer, 2007; Rosas, 2009). Aiming for $g_k - \alpha_i = 0$

[6] For example, we could think of them as a proportion of the banking system's total balance sheet value θ or indeed of liabilities.

[7] They would effectively be collateral either ex ante or ex post.

[8] This of course assumes there are no costs associated with acquiring, administering, and selling the assets as well as the costs of extending the support. However, including these costs would not fundamentally change our model.

allows the DM to balance these two preferences. DM's moderate containment policy preference can be enforced at the ballot box by voters. Nonetheless, it is important to note that we do not make a normative judgement when describing a preference for $g_k - \alpha_i = 0$ as 'moderate'. There may certainly be legitimate reasons to provide guarantees above or below this depending on how the actors weigh the relative importance of moral hazard, financial stability, and taxpayer costs. Of course, extensions of our work could easily examine situations and reasons for why DM's have other preferences.

Regardless, our information poor DM does not know the recovery value of banking system assets. She cannot choose the containment level that most matches her preferences without more information.

Signaller Preferences To learn the recovery value of the banking system's assets the DM must rely on signals from the other players. The DM does not have the resources to undertake the highly complex task of supervising banks herself. So she has delegated supervision to financial policy bureaucrats, e.g. central banks and/or financial supervisors, who can specialise and develop specific policy expertise. Though financial policy bureaucrats have their own containment policy preferences,[9] the DM relies on their information when a crisis strikes as she does not "magically find resources" (Epstein and O'Halloranx, 1999, 10) needed to make an independent assessment of the banking sector's health. Furthermore, given that most financial bureaucrats have lucrative careers awaiting them in the private sector even if removed from office, it is difficult for the DM to create incentive-compatible contracts (Dijkstra, 2010) ensuring that she receives accurate information.

It could be that the signallers' preferences are perfectly aligned with the DM's. Of course such a close alignment of preferences may not always be the case. In crony capitalist and other models of crisis containment policymaking, banking industry actors are often assumed to want high levels of support to forestall insolvency (Rosas, 2006, 2009). Public sector signallers may have cronyistic ties with the banking industry or be 'captured' by the industry. Capture may involve the regulator perceiving the interests of the banks to be the same as that of the state (Barth, Caprio Jr. and Levine, 2006). They may therefore prefer policies that ensure the continuation of financial institutions rather than prioritising the recovery value of bank assets to protect taxpayers (e.g. some $g_k > \alpha_i$). Even in countries with seemingly 'strong' institutions, an independent central bank governor, for example, may have a preference for financial stability over low costs to the state and as such prefer large containment policies (Honohan and Laeven, 2005). On the other hand other bureaucrats involved in the game, in departments of finance for

[9]Rather than having preferences about policy outcomes, signallers might be primarily concerned with their professional reputation as policy experts. See Ottaviani and Sørensen (2006) for a formal discussion of such situations. Though all financial bureaucrats are likely concerned with their reputations to some extent, it is clear that many–including those discussed in our case study below–have preferences about containment policy outcomes. For example, regulators may also be motivated by career concerns from within the finance industry, rather than as regulators per se, ideological beliefs, or conflicting statutory mandates. It could nonetheless be useful to extend the model to formally incorporate actors with reputational incentives to provide information.

example, may be more concerned with fiscal costs and/or moral hazard problems. They would therefore prefer that the state limit its containment policies (some $g_k < a_i$). Though many banks, especially troubled banks, may want a high containment level, preferences in the banking system may actually be heterogenous. Healthy banks, that believe they could weather a crisis, may prefer a lower containment level. They could believe that accepting public assistance would undermine market confidence in them, or that failures at weaker banks could be an opportunity to consolidate their presence in the market. This is all to say that signaller's containment policy preferences can be very heterogenous and certainly need not be the same as the decision-maker's.

In many countries central banks also gather supervisory information and have preferences about the government's crisis response. Central bankers, uniquely among financial bureaucrats, have the ability to respond to crises using considerable resources based on their own balance sheet–e.g. emergency liquidity assistance (ELA). This fact could influence their preferences as signallers. Though they can provide ELA, central banks may be particularly concerned about risks to their balance sheets, risks that could hinder their ability to achieve their other goals, primarily price stability. While they may want to assist financial institutions, and have the ability to do so, central bankers may still prefer that fiscal policymakers act. For example, during the height of the 2008 crisis the Bank of England requested that the Treasury indemnify–guarantee–emergency liquidity assistance it provided, thus transferring crisis response risks from the Bank to fiscal authorities.[10] These preferences could influence what signals they make and their inclusion in future work would be a direct extension of our model.

Sequence of Play The game has the following sequence of play:

- In t_0 there is a shock to the banking system i that creates a new proportion of non-performing assets. Hence α_i is created.
- In t_1 the sender observes α_i and sends a message m_α about the level of non-performing assets α_i to the DM. In games with more than one signaller, each sends their own message.
- In t_2 the DM receives m_α, updates her prior knowledge about α and decides g_k, the containment policy level.
- In t_3 the outcome $x_k = g_k - \alpha_i$ is realised.

[10]See Bank of England Committee of Court transcripts available at: http://www.bankofengland.co.uk/archive/Documents/archivedocs/codm/20072009/transactionscomm.pdf. Accessed August 2015.

4 The Game with Two Signallers

We develop the game with two signallers Please see the Annex for the single signaller version upon which the two signaller version builds.

Utilities Following Gilligan and Krehbiel (1987) the DM, FR, and MoF's preferences can be characterised as quadratic utility functions, whereby x_{MoF} and x_{FR} are the ideal outcomes for the MoF and FR respectively and x_{DM} is the optimal outcome for the DM. All players maximise their expected utilities and their utility functions are given by:

$$U^{MoF} = -\left(x_{MoF} - x\right)^2 \qquad U^{DM} = -\left(x_{DM} - x\right)^2 \qquad U^{FR} = -\left(x_{FR} - x\right)^2. \tag{4}$$

We assume that the MoF always has a preference for a lower containment level than the FR, except when they have the same ideal points. This is merely for notational convenience. Similar to the single signaller game, at t_1 the signallers (MoF and FR) observe the shock, infer accurately α_i, and send messages $m_{1\alpha}$ and $m_{2\alpha}$ from a set of feasible messages $M = \{m_{j1\alpha}, \ldots, m_{jn\alpha}\}$. At t_2 the DM observes $m_{1\alpha}$ and $m_{2\alpha}$ but not α_i and updates her prior. She selects a guarantee g_k. The outcome x_k is realised at time t_3: $x_k = g_k - \alpha_i$.

Equilibrium The equilibrium concept here is Perfect Bayesian. A Perfect Bayesian Equilibrium is a set of strategies $g_k^*(m_{1\alpha}, m_{2\alpha})$, $m_{1\alpha}^*(\alpha_i, m_{2\alpha}, g_k)$, $m_{2\alpha}^*(\alpha_i, m_{1\alpha}, g_k)$, and posterior beliefs, $h^*(\alpha_i; m_{1\alpha}, m_{2\alpha})$ such that four conditions are met. The FR's signalling strategy must maximise his expected utility given the DM's optimal choice of g_k and the MoF's optimal signalling strategy. The MoFs signalling strategy must maximise his expected utility given the DM's optimal choice of g_k and the FR's optimal signalling strategy. The DM's choice of g_k must maximise her expected utility given her posterior belief about the value of α. The DM's posterior belief must be consistent with the optimal strategies of the senders as per Bayes' rule. Building on Satyanath (2006, 43), as well as Crawford and Sobel (1982) and Gilligan and Krehbiel (1987), there exists a Perfect Bayesian Equilibrium with the following characteristics:

1. When α_i takes values outside of the range $\bar{\alpha} + 2x_{MoF}$ to $\bar{\alpha} + 2x_{FR}$, the two signallers send the true value of α_i to the DM. The DM then chooses $g_k = \alpha_i$ with the outcome $x_k = 0$.

2. When α_i takes values between $\bar{\alpha} + 2x_{MoF}$ and $\bar{\alpha} + 2x_{FR}$, the two senders send conflicting messages of the value of α_i. The DM then chooses $g_k = \bar{\alpha}$ with the outcome $x_k = \bar{\alpha} - \alpha_i$.

See the Annex for the proof.

5 Comparative Statics

We now illustrate the implications of the two signaller model's equilibrium in comparative statics with various levels of signaller polarisation. Comparative statics give us an idea of when accurate communication between the signallers and the DM breaks down, i.e. signals become uninformative. The further away the signallers' ideal points are from the DM's, the more often the DM will make non-preferred containment policy choices. Figure 1 shows the guarantee choices and outcomes made under the two signaller game from four scenarios using 1,000 random draws of α from a uniform continuous distribution with the range [0.65, 0.95] and mean of 0.8.[11] In other words the realisation value of the banking system assets following a shock ranges between 65 and 95 percent of the book value of the pre-shock assets. This is a more realistic range of values than [0, 1], though it represents a situation that is on average more dire than the Irish case discussed below.

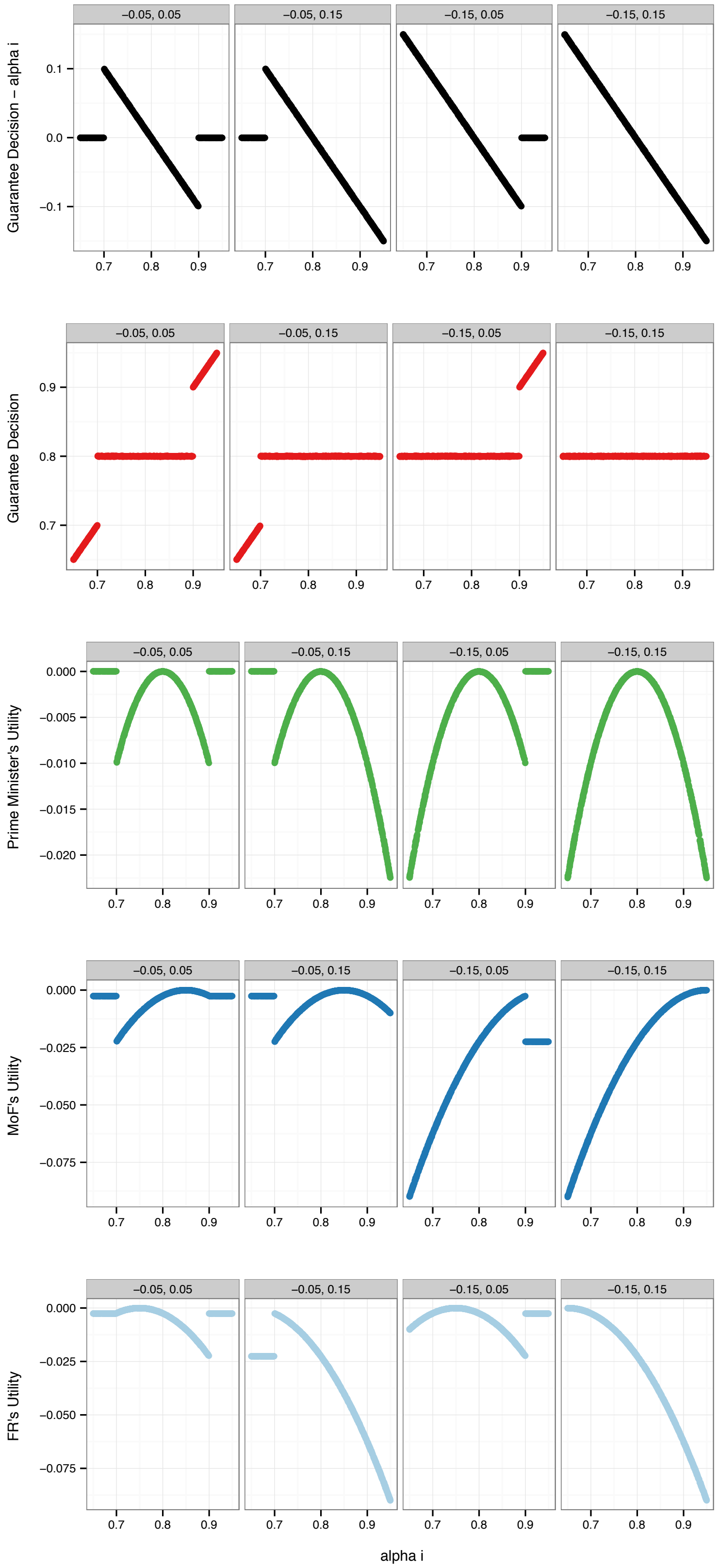
The first row of plots shows how relatively costly the containment policy is. In all of the scenarios we assume that the DM is moderate and so most prefers $g - \alpha = 0$. The first scenario (shown in the left-most column) is one where the signallers' ideal points are somewhat close to the DM's (the MoF's is -0.05 and the FR's is 0.05). One third of the values of α are outside of the range $[\bar{\alpha} + 2x_{MoF}, \bar{\alpha} + 2x_{FR}]$, i.e. [0.7, 0.9]. When this is the case both signallers signal α_i and the DM chooses $g_k = \alpha_i$. This is represented in the top-left most square by the 45 degree containment policy decision lines below 0.65 and above 0.85. The DM's payoff is 0 and the signaller's payoffs are both -0.0025. Only when $0.7 < \alpha_i < 0.9$ do signallers send conflicting messages. In these cases the DM chooses $g_k = \bar{\alpha} = 0.8$. The DM's payoff is less than 0 in all cases except when $\alpha_i = 0.8$, with decreasing utility the further away α_i falls from $\bar{\alpha}$. She chooses a lower containment policy than she ideally wants when $\bar{\alpha} + 2x_{MoF} \leq \alpha_i < \bar{\alpha}$. She chooses a higher level than she would like when $\bar{\alpha} < \alpha_i \leq \bar{\alpha} + 2x_{FR}$.

The right-most column of Figure 1 shows a situation where signallers have very polarised preferences and as a result are completely uninformative. The MoF's ideal point is -0.15, while the FR's is 0.15. The range $[\bar{\alpha} + 2x_{MoF}, \bar{\alpha} + 2x_{FR}]$ is greater than the range of α's distribution. So the FR and MoF only send conflicting signals and the DM always chooses a containment policy at $\bar{\alpha}$. This leads to only one situation where the DM chooses her ideal policy, when $\alpha_i = \bar{\alpha}$. Clearly, having signallers with containment policy preferences further away from the DM's leads to less preferred policies for the DM.

The two centre columns show asymmetrical signaller preferences around the DM's idea point. In the second column is a situation where $x_{MoF} = -0.05$ and $x_{FR} = 0.15$. In this case the FR and MoF send uninformative signals for all values of $\alpha > 0.7$. The reverse preference arrangement is shown in the third column with the reverse results, i.e. informative signals are sent at all values of $\alpha > 0.9$.

[11] Figure 1 can be reproduced using the Python and R scripts available at [WITHHELD FOR BLIND REVIEW].

Figure 1: Equilibrium from a Two Signaller Game with a moderate DM and various signaller ideal points.



Reminder: in the three lower rows of plots, actors' maximum utility is represented by 0.

In this application we see how slight differences in preferences can lead the DM to miscalculate their desired containment level, and could lead either to a non-preferred socialisation of bank losses or low containment level.

6 Case Study: Containment Policy Decisions in Ireland

To further demonstrate the usefulness of our model we apply it to understand the Irish Government's 2008 crisis containment policymaking. We first make a prediction about the chosen containment level based on our signalling game and the underlying health of the Irish banking system at the time. The prediction indicates that the Irish Prime Minister (PM)–the decision-maker–would choose a higher containment level than his ideal preference when preferences diverge.

The intuition behind this conclusion starts from the idea that signallers with conflicting preferences send conflicting signals. As such the PM will not know who to believe. So, he makes a 'best guess' that the crisis is average, there are relatively few NPLs, and so the real value of all bank assets is relatively high. Thus he provides generous guarantees believing that few will be called, while reestablishing stability. However, because there are many NPLs and so the assets' recovery value is very low, many of the guarantees are called upon at great public expense. Thus the PM chooses a much higher guarantee than he wanted.

The Signallers We find evidence using primary and secondary documentation, that the signallers can be placed into two groups. Civil service staff at the Department of Finance (DoF) expressed concern about the potential costs of public intervention given the size of the problem, and were reportedly against a full guarantee. Conversely, the Financial Regulator did not appear concerned with potential problems in the banks, instead preferred to restore financial stability, and so did not communicate that the recovery value of bank assets was relatively low. Bank officials also signalled that the recovery value would be high as part of a push for a full guarantee. The two groups thus sent conflicting signals. We further demonstrate the plausibility of our argument by comparing it to major alternatives from the political economy literature, many of which assume perfect information in this type of case.

Predictions Let's predict what containment policy level the Irish Prime Minister would choose assuming he relied on information from two signallers, one with a preference for a high level and one for a low level. Let's assume that the Prime Minister has a preference for a 'costless' containment in that $g_k - \alpha_i = 0$. We further assume that actors with a high containment preference, for example troubled banks with high proportions of non-performing loans, would like $g_k - \alpha_i = 0.05$. Because very troubled banks' individual balance sheets have more non-performing loans that are likely to have a lower recovery value than the banking system average, they needed the overall level of banking system support to be larger in order to prevent insolvency. $g_k - \alpha_i = 0.05$ is likely to be an underestimated preference for the most troubled banks. For example, Anglo Irish Bank had an NPL ratio of just under 15 percent in 2010 rising to almost 35 in 2012 (Fitch Ratings, 2013). We assume that other actors have a preference for a smaller containment policy such that $g_k - \alpha_i = -0.05$. As we will see, these preferences are more than far enough apart to lead to uninformative signals in the Irish case.

To understand this let's look at the last assumption we need to make: the range of the uniform distribution of the recovery value of Irish banking system assets. To determine the range, let's first consider the likely non-performing loans range. In the seven years before the crisis Ireland had a mean NPL ratio of 0.86 percent without much variation. We assume that this is the lowest end of the distribution. It would be a situation where the crisis was entirely a short-term liquidity crisis, where the realisation value of the banking system assets did not change. By 2012 the ratio increased to 18.7 percent (World Bank, 2013). We assume that 19 is the maximum NPL ratio as it is larger than the NPL ratios in almost every other Eurozone country in 2012 including Greece, Spain, and Portugal. Let's assume that the recovery value of non-performing assets is 50 percent.[12] So the range of the distribution of recovery values expressed as a proportion of the pre-crisis book value of assets is 0.905 to 0.9957 with a mean of 0.9537.

In a two signaller game where one signaller wanted a containment policy of only about $g_k - \alpha_i = 0.025$ or more and the other wanted about $g_k - \alpha_i = -0.025$ or less all signals would be uninformative as the signallers would send different values. The Prime Minister would then choose a policy of $g_k = 0.9537$ regardless of the true recovery value of the assets (see the right-most column in Figure 1 for a similar situation). Because the true recovery value in the Irish case happened to be at the minimum possible value, the Prime Minister would end up choosing a containment level much higher than what he wanted.

How well does the model's prediction fit the sequence of events in the 2008 Irish banking crisis containment case?

The Events Multiple national and international shocks from 2007 through 2008 considerably undermined policymakers' understanding of the Irish banking system's health. Starting in March 2007 the Irish house price index began to decline for the first time in five years. The emergence of the subprime mortgage crises in the United States in mid-2007 resulted in a tightening of the market for short-term

[12]The overall discount that the Irish National Asset Management Agency (NAMA) applied when it acquired assets from five banks, including the most troubled ones, was 58 percent from when it became operational, more than one year after the containment policy choice, into January 2010 (Economic, Staff of the Directorate-General for Economic and Financial Affairs, 2011, 14). We assume that the assets NAMA acquired were not the most troubled, so we further discount the recovery percentage to 50 percent.

wholesale funding in August 2007. Hedge funds in the the United States began to short Irish banks in Summer 2007, and the collapse of Bear Stearns investment bank in March 2008 and then Lehman Brothers in September 2008, created a global credit crunch with major ripple effects for the Irish banking system. Irish banks found it increasingly difficult to rollover the debt they used to make property-based loans.

On September 20th the Irish Government began its response to the crisis by increasing the deposit guarantee scheme limit. It was initially raised from €20,000 to €100,000.[13] However these moves had little effect on slowing corporate deposit withdrawals.[14] By the end of September, a number of key Irish banks, such as Anglo Irish Bank, were finding it very difficult to roll over the wholesale funds they had borrowed and did not have adequate collateral to refinance with the European Central Bank.

On 30th September 2008, the Government announced a guarantee of all deposits (retail, commercial, institutional, and interbank), covered bonds, senior debt and dated subordinated debt (lower tier II) at the six main Irish banks (Irish Department of Finance, 2008).[15] This amounted to €365 billion or 2.5 times Gross National Product (Honohan, 2010, 19). The figure is fairly close to the total value of banking system assets as, for example when measured against just domestic credit to the private sector which was almost 2.4 times Irish GDP in 2009 (World Bank, 2013).[16] This does not include, for instance, the banks' significant operations in the United Kingdom and United States. In hindsight we have seen that "although international pressures contributed to the timing, intensity and depth of the Irish banking crisis, the essential characteristics of the problem were domestic and classic" (Honohan, 2010, 22). However, in Fall 2008 the real nature of the problem was less clear to policymakers and they had to rely on other actors for information.

A full account of the events surrounding the decision to issue such a 2008 guarantee has not yet emerged. We can however piece together the preferences and signals of the main actors from the independent reports, transcripts of the committee hearings, released documents on the crisis, and telephone recordings. The Irish PM from May 2008 was Brian Cowen. He became prime minister after serving as the MoF from 2004 until 2008. In political debates many accusations of cronyism were levelled at their political party, Fianna Fail, and the PM. Though it is impossible to fully rule out the possibility that decision-makers were not crony capitalist, we found no substantive evidence that the PM or MoF had a preference for insolvent institutions to continue operating. Rather it appears the government were relying heavily on signals from DoF civil servants, the FR, and the banks themselves, to make a policy

[13]The previous guarantee only covered 90 percent of an account under €20,000. The later guarantee covered 100 percent of the first €100,000.

[14]See data from the Central Bank of Ireland (2011).

[15]The guarantee covered Allied Irish Banks, Bank of Ireland, Irish Life and Permanent, Educational Building Society, Anglo Irish Bank, and Irish Nationwide Building Society.

[16]Indicator number: FS.AST.PRVT.GD.ZS.

decision that would contain the crisis at a low cost to taxpaying voters, thus warranting the our approach here.

The Department of Finance civil service staff in general appear to have had a preference for a lower containment level and sent a signal that the recovery value of assets may be relatively low. In 2008 they gave a policy presentation stating that "open-ended/legally binding State guarantees which would expose the Exchequer to the risk of very significant costs are not regarded as part of the toolkit for successful crisis management and resolution" (House of the Oireachtas, 2008*a*, empahsis in the origninal). This position was qualified in the full scoping paper that the presentation was based on. It defined what were likely to be situations with a high "risk of very significant costs". It noted that solvent, but illiquid institutions should be treated differently from illiquid and insolvent institutions. The former would likely be given guarantees early to avoid failure and avoid contagion (House of the Oireachtas, 2008*c*).[17] Insolvent institutions, assuming they were not systemically important, were not seen as eligible for guarantees. Overall, this suggests that the DoF had a somewhat low containment level preference. At a meeting with all of the major policymakers and information providers on the 25 September 2008, just days before the decision to issue the guarantee, civil service officials for the Department of Finance expressed great concern with the potential cost of the guarantee. They noted that "Government would need a good idea of the potential loss exposures within Anglo [Irish Bank] and INBS [Irish Nationwide Building Society]–on some assumptions INBS could be €2 billion after capital and Anglo could be €8.5 billion" (House of the Oireachtas, 2008*e*). Capital in Anglo Irish Bank at the time was claimed to be €7.1 billion (see House of the Oireachtas, 2008*d*) and they were therefore warning of potentially large exposures to the State and large losses in the banks. Nyberg (2011, 81) indicates the DoF civil servants may have had a preference for the nationalisation of Anglo Irish Bank with costs imposed on creditors. While McWilliams notes that officials in the Department of Finance "were dead set against a full guarantee" (2009, 25).

Conversely the Financial Regulator appears to have had a preference for a higher containment level and sent signals–conflicting with the DoF civil service staff's–that the assets' recovery value was in fact high. Their information came primarily from unobtrusive evaluations of bank's own positions. Private bank officials had a clear preference for a higher containment level. Honohan (2010, 124) notes that Bank of Ireland and Allied Irish Bank pushed for an immediate general guarantee (including subordinated debt) and the nationalisation of Anglo Irish Bank (and possibly INBS) at a meeting with the PM and MoF on September 29. Anglo Irish Bank made a presentation to the Department of Finance on the 18 September 2008 forecasting pre-tax profits of €1.4 billion for 2008 and €1.1 billion for 2009.

[17] The document cites the Northern Rock experience, where a bank run was precipitated by the Bank of England giving the bank liquidity assistance. This quickly undermined confidence in the bank. The run ended when the UK Government guaranteed 100 percent of its deposits.

It has been shown the Financial Regulator had very little independent knowledge of the underlying exposures of the banks in Ireland. This is because the Financial Regulator had a deferential approach to financial institutions, whereby there was an acceptance that the system was working (Honohan, 2010, 9). This led them to have an unintrusive supervisory model which placed a large amount of trust in the banks themselves and focused on processes and verification rather than attempting independent assessments (Honohan, 2010, 8). Leaked internal recordings of telephone conversations between Anglo Irish Bank employees made in September 2008 are particularly informative in this regard.[18] In one conversation between the head of retail banking Peter Fitzgerald and the head of the capital markets division John Bowe discuss a meeting Bowe had with the Financial Regulator.[19] In this conversation Bowe claims that, when asked how much Anglo Irish Bank needed and if it would be enough, he told the officials that Anglo Irish Bank required €7 billion in funding. He tells Fitzgerald that this is in fact significantly lower than the actual amount of financing that the bank needs and that he had pulled the €7 billion estimate "out of [his] arse".

At that same meeting on the 25 September 2008 where the DoF staff warned of potential losses, the Financial Regulator stressed that "there is no evidence to suggest that Anglo is insolvent . . . it is simply unable to continue on the current basis from a liquidity point of view" (House of the Oireachtas, 2008*e*).[20] A post-crisis commission investigating the banking crisis in Ireland states that discussions surrounding the long-term risks of the guarantee were discarded and the FR "supported the assessments of the major banks, the attention of the Ministers became concentrated on how to avoid the short term risk of insufficient funding in the morning" (Nyberg, 2011, 79). This suggests the FR[21] was a key actor pushing for a broad guarantee partially by providing information that the banks' assets' recovery value was high. Although some have noted that a consensus had emerged amongst all officials that no Irish bank should be allowed to fail (Honohan, 2010, 119), we have evidence of clear divergent preferences in terms of the signals provided and the preferred level of containment support needed among the financial bureaucrats and banks.

DoF civil service staff, the Financial Regulator, and bank officials had divergent preferences and sent conflicting signals to the Prime Minister. With conflicting information, the PM choose a higher containment policy level than he wanted. Our model also aligns with the findings of the Report of the Commission of Investigation into the banking sector in Ireland which concludes "the discussions

[18] The recordings are available from the Irish Independent (http://www.independent.ie/business/irish/inside-anglo-the-secret-recordings-29366837.html), accessed Summer 2013.

[19] The head of the central bank was also present.

[20] This position was reaffirmed by Merrill Lynch, who were hired to provide options to decision-makers at the time. On 29 September–the day before the full guarantees were made, a report issued by them stressed that

> "at present, liquidity concerns aside; all of the Irish banks are profitable and well capitalised. However, liquidity for some could run out in days rather than weeks." (House of the Oireachtas, 2008*b*, 2)

[21] The officials at the Central Bank of Ireland largely concurred with the FR's view (Nyberg, 2011, 79).

for alternative measures before and on September 29, 2008, were conducted on the basis of very deficient information ... If more relevant information on and analysis of the underlying position of some of the banks had been available, discussions and policy recommendations may have been very different" (Nyberg, 2011, 93).

The Government went on to suffer considerable losses in the next election, very much due to strong public opposition to the bank bailouts. PM Cowen resigned as leader of his Fianna Fáil party before the 2011 election. The party's vote share fell by about 24 percentage points and the party was not returned to government.[22] Information asymmetries led the PM to choose a policy that he and the voters did not want, for which the PM and his party paid considerably at the ballot box.

The Alternatives How well does the Irish narrative fit the signalling argument relative to alternative explanations? Were Irish decision-makers simply crony capitalists? The documents we have found do not indicate that the PM had high guarantee preferences or that he wanted insolvent institutions to continue operating as would be the case if he was a crony capitalists. A key feature in the Irish financial system was a lack of bureaucratic capacity. The Financial Regulator, the actor primarily tasked with gathering financial sector information, appears to have had very little capacity to actually gather its own information, relying instead on the banks' assessments. It also had very similar preferences to the banks regarding the guarantee and did not appear gather information that would contradict the the bank's policy conclusions. As such bureaucratic incapacity could be endogenous to the signalling game.

It does not appear that the number of veto players influenced policy choices. The governing parliamentary coalition supported the decision to issue the guarantee. Even among the opposition there seems to have been a general consensus that, as a senior opposition politician commented: "when the government comes to you with emergency legislation, you have a duty to support them".[23] In a sense this situation is similar to Rodrik's (1999) view that if veto players are arranged to manage conflict then responses will be quick. Though, it is may be better to describe it as a situation where coalition veto players gave up their power in order to hasten decision-making which was the outcome of a signalling game. Ireland had competitive elections but the outcomes were nonetheless very costly to the public. This is the opposite of Keefer's (2007) prediction.

We did not find evidence that international actors like the International Monetary Fund or another external actor with low guarantee preferences was a relevant information provider or directly involved in the decision-making process. The European Central Bank had provided substantial liquidity to the Irish banking system leading up to the guarantee decision (Honohan, 2010, 117), but do not appear to

[22]See the European Election Database: http://www.nsd.uib.no/european_election_database/. Accessed January 2015.

[23]From interview with senior government politician.

have supported the decision to issue the guarantee (see for example European Central Bank, 2008*a*,*b*).

Was the government unable to bargain with the banking sector to secure private sector contributions to crisis containment because of the sector's collective action problems in line with Woll's (2014) argument?Rather than being unable to secure private sector contributions, the government was in fact able to get commitments from Allied Irish and Bank of Ireland to provide a €5 billion short-term liquidity facility to aid Anglo Irish around the time of the guarantee.

7 Conclusion

The model and findings in this article have important implications for crisis containment policymaking, as well as financial supervision even in countries with sophisticated financial markets. Our model and evidence indicate that when responding to banking crises policymakers greatly benefit from having as close to full information as possible about their countries' banking system. Good information may be purposefully hard to come by during crises, even in advanced democratic economies. When strategically minded signallers preferences diverge from decision-makers' they can have incentives to give inaccurate information.

Much of the recent research on the optimal design of financial supervisors and economic policymaking generally has been aimed at tying the hands of strategic elected policymakers. The typical solution, as with central banking, has been to grant regulators' *de facto* operational independence from elected policymakers (Gandrud, 2013; Walter, 2008, Ch. 1). Independence may help shield regulators from the most blatant crony capitalistic pressure that banks can exert on politicians or electoral time-inconsistency problems that elected officials may have. However, our findings suggests another problem should also be considered. Even if elected policymakers have preferences for minimising public crisis management costs, they can be led astray by their bureaucrats, independent or not. Independence does not ensure that they will provide unbiased information to policymakers, because it does not ensure that these strategic actors will have preferences that lead them to do so. Hayo and Hefeker argue that nothing about actors being independent rules out them "pursuing a political agenda" of any sort (2002, 123). As strategic actors they use the tools available to them to pursue these preferences.

Future work should address how institutional design improvements could be made to change financial bureaucrats' preferences so that they are more inclined to provide accurate information. Some research has been done on this topic, including Persson and Taballini's (1993) work on targets and Dewatripont and Tirole's (1999) work on incentivising signallers. Satyanath (2006) argues that politicians should have more discretion to appoint information providing bureaucrats or that increasing bureaucratic independence will lead to more accurate information. Another related possibility would be to delegate more responsibility for supervision and crisis containment to independent central banks who can appoint their own staff. Hopefully studies in this area will treat decision-makers, financial bureaucrats, and other information providers as strategic actors, potentially with divergent preferences.

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Online Annex 1: The Single Signaller Game

Utilities Because the DM requires information from the FR to make her preferred containment policy choice the DM's payoff depends on the message m_i sent by the FR and an unknown state of the world. The DM's payoff can be thus characterised by:

$$U^{DM}(g, \alpha) = -(g - \alpha)^2 . \tag{5}$$

The payoff of the FR is

$$U^{FR}(g,\ \alpha,\ b) = -(g - (\alpha - b))^2 \tag{6}$$

where $b \geq 0$. The b parameter captures the distance between the DM's and the FR's ideal containment policy points, denoted x_{DM} and x_{FR}. As we will see this distance influences the *bias* in the information the FR gives to the DM. If $b = 0$ then their preferences are perfectly aligned and, as has been well established in the signalling literature (Crawford and Sobel, 1982), the FR's message will be completely accurate.

Equilibrium Suppose the FR can choose to send two messages $m_{L\alpha}$ and $m_{H\alpha}$ where $m_{L\alpha} < m_{H\alpha}$. The signal is costless. Let $g(m)$ denote the action taken by the DM in response to the message sent by the FR. If α is uniformly distributed over [0, 1] with mean $\bar{\alpha}$, in equilibrium the FR will use a threshold strategy, whereby the FR will choose $m_{L\alpha}$ when $\alpha \in [0,\ \alpha^*)$ and $m_{H\alpha}$ when $\alpha \in (\alpha^*,\ 1)$. α^* represents the threshold value of α at which the FR is indifferent between $m_{L\alpha}$ and $m_{H\alpha}$. So, the payoffs for the FR are characterised as:

$$\begin{array}{c} m_{L\alpha} : (g(m_{L\alpha}) - (\alpha - b))^2 \\ m_{H\alpha} : (g(m_{H\alpha}) - (\alpha - b))^2 \end{array} . \tag{7}$$

The benefit for the FR of sending message $m_{H\alpha}$ over $m_{L\alpha}$ is increasing in α and can be characterised as:

$$\Delta g = -(g(m_{L\alpha}) - (\alpha - b))^2 + (g(m_{H\alpha}) - (\alpha - b))^2. \tag{8}$$

After receiving the message from the types in $[0, \alpha^*)$ the DM will believe that the FR's type, message, is uniformly distributed on $\alpha \in [0,\ \alpha^*)$, and type $(\alpha, 1)$ is uniformly distributed on $\alpha \in (\alpha^*, 1)$. Therefore the DM's equilibrium strategy will be:

$$g(m_{L\alpha}) = \frac{\alpha*}{2} \text{ and } g(m_{H\alpha}) = \frac{\alpha^* + 1}{2}. \tag{9}$$

For all types in $[0,\ \alpha^*)$ for the FR to prefer sending $m_{L\alpha}$ to $m_{H\alpha}$, it must be that all types in $[0,\ \alpha^*)$ prefer $g(m_{L\alpha}) = \frac{\alpha^*}{2}$ over $g(m_{H\alpha}) = \frac{\alpha^*+1}{2}$, also all types in $(\alpha^*, 1)$ must prefer $g(m_{H\alpha}) = \frac{\alpha^*+1}{2}$ over $g(m_{L\alpha}) = \frac{\alpha^*}{2}$. Given that α^* characterises the type that is indifferent we solve for the partially pooling equilibrium by using the fact that when the utilities of the FR and DM are equal as:

$$\alpha^* + b - \frac{\alpha^*}{2} = \frac{\alpha^* + 1}{2} - (\alpha^* + b). \tag{10}$$

simplifying to the formula $\alpha^* = \frac{1}{2} - 2b$. Given $\alpha = [0, 1]$, α^* must be positive. A two-step equilibrium only exists if $|b| < \frac{1}{4}$. Thus when the value of $|b| \geq \frac{1}{4}$, the FR does not distinguish between high and low recovery values and the signal becomes completely uninformative and a completely pooling equilibrium called a "babbling equilibrium" exists where the FR does not even make a crude distinction between types, whereby he chooses randomly over one interval $[0, 1]$ and uses each message $m \in M$ regardless of α_i and no information is transmitted. Therefore if the FR always reports the same message the DM's optimal strategy is to simply ignore the message and assign a uniform belief to all values $\alpha \in [0, 1]$. Her optimal strategy when she is unable to update her prior is to set $g = \bar{\alpha}$, i.e. 0.5. Therefore, central to the argument presented here is the distance between the preferences of the financial regulator and the decision-maker.

It may be more realistic to consider the equilibrium in the one signaller game when the FR makes very fine distinctions between different levels of α. Crawford and Sobel (1982) show that in the n-step equilibrium, the number of intervals is a function of the preference parameter and largest integer given by the quadratic formula:

$$\frac{1}{2}\left[1 + \sqrt{1 + \left(\frac{2}{|b|}\right)}\right]. \tag{11}$$

Therefore as b approaches zero, more communication occurs and only if preferences are perfectly aligned and an infinite number of intervals exist, does full communication occur (Gibbons, 1992). However, when $|b| > 0$, signals become vague and uninformative. When $|b| > \frac{1}{4}$, the FR randomises over the interval and the DM simply ignores the messages. Therefore, as Crawford and Sobel (1982) show, all equilibria are partition equilibria where the FR can introduce noise in his signal by not distinguishing as finely between information states. The FR does this to a larger degree the further their preferences are from the DM.

Online Annex 2: Equilibrium with Two Signallers

Building on Satyanath (2006, 139-140) a Perfect Bayesian Equilibrium for two signallers is a set of strategies $g_k^*(m_{1\alpha},\, m_{2\alpha})$, $m_{1\alpha}^*(\alpha_i,\, m_{2\alpha},\, g_k)$, $m_{2\alpha}^*(\alpha_i,\, m_{1\alpha},\, g_k)$, and posterior beliefs, $h^*(\alpha_i;\, m_{1\alpha},\, m_{2\alpha})$ such that;

1. $m_{1\alpha}(\alpha_i, m_{2\alpha}, g_k) \in arg\, max\, EU_{s1}$, given $g_k^*(m_{1\alpha}, m_{2\alpha})$ and $m_{2\alpha}^*(\alpha_i, m_{1\alpha}, g_g)$
2. $m_2(\alpha_i, m_{1\alpha}, g_k) \in arg\, max\, EU_{s2}$, given $g_k^*(m_{1\alpha}, m_{2\alpha})$ and $m_{1\alpha}^*(\alpha_i, m_{2\alpha}, g_g)$
3. $g_k^*(m_{1\alpha}, m_{2\alpha}) \in arg\, max\, EU \int_{0.65}^{0.95} u_c\,(g_k, \alpha_i)\, h*(\alpha_i, m_{1\alpha}, m_{2\alpha}) d\alpha_i$
4. $h^*(\alpha_i; m_{1\alpha}, m_{2\alpha}) = \Pr(\alpha = \alpha_i \mid m_{1\alpha}^*, m_{2\alpha}^*)$, as per Bayes' rule.

Assuming that α is uniformly distributed in [0.65, 0.95], though another range could be used.

Proposition: There exists a Perfect Bayesian Equilibrium in which;

1. $m_{1\alpha}^*(\alpha_i,\, m_{2\alpha},\, g_k) = \alpha_i$ if $\alpha_i = \bar{\alpha} + 2x_{s1}$ or $\alpha_i = \bar{\alpha} + 2x_{s2}$, and s_1 randomises with equal probability over $[\bar{\alpha} + 2x_{s1},\, \bar{\alpha} + 2x_{s2}]$ otherwise.
2. $m_{2\alpha}^*(\alpha_i,\, m_{1\alpha},\, g_k) = \alpha_i$ if $\alpha_i = \bar{\alpha} - 2x_{s1}$ or $\alpha_i = \bar{\alpha} + 2x_{s2}$, and s_2 randomises with equal probability over $[\bar{\alpha} + 2x_{s1},\, \bar{\alpha} + 2x_{s2}]$ otherwise.
3. $g_k^*(m_{1\alpha},\, m_{2\alpha}) = \alpha_i$ if $m_{1\alpha} = m_{2\alpha}$, and $\bar{\alpha}$ otherwise.
4. If $m_{1\alpha} = m_{2\alpha}$, $h^*(\alpha_i;\, m_{1\alpha},\, m_{2\alpha}) = 1$. If $m_{1\alpha} \neq m_{2\alpha}$, $h^*(\alpha; m_{1\alpha}, m_{2\alpha}) = 0$ for all $\alpha_i \notin [\bar{\alpha} + 2x_{s1},\, \bar{\alpha} + 2x_{s2}]$

Note that we used a more general notation (s_1 and s_2) than above to denote the two signallers, where s_1 prefers an outcome $x_{s1} < 0$ and s_2 prefers an outcomes $x_{s2} < 0$.

Proof: There are four parts to the proof.

1. To show that s_1 maximises her expected utility given the DM's policy choice and s_2's optimal signalling strategy, as in part 1 above, we discuss each component of $m_{1\alpha}^*(\alpha_i,\, m_{2\alpha},\, g_k)$:
   (a) $m_{1\alpha}^*(\alpha_i,\, m_{2\alpha},\, g_k) = \alpha_i$ if $\alpha_i < \bar{\alpha} + 2x_{s1}$:
      i. When $\alpha_i < \alpha + 2x_{s_1}$ the DM will choose $\bar{\alpha}$ and $x_k > 2x_{s1}$ if $m_{1\alpha} \neq m_{2\alpha}$, as in the proposed equilibrium $g_k^*(m_{1\alpha},\, m_{2\alpha}) = \bar{\alpha}$
      ii. When $m_{1\alpha} = m_{2\alpha} = \alpha_i$, $g_k^*(m_{1\alpha},\, m_{2\alpha}) = \alpha_i$, and $x_k = 0$ which results in s_1 having a greater utility than $x > 2x_{s1}$.
   (b) $m_{1\alpha}^*(\alpha_i,\, m_{2\alpha},\, g_k) = \alpha_i$ if $\alpha_i > \bar{\alpha} + 2x_{s1}$: If $m_{1\alpha} \neq m_{2\alpha}$ the the DM chooses $\bar{\alpha}$. This is less utility for s_1 than $x = 0$ because $x < 2x_{s2}$.

(c) s_1 randomises with equal probability over $[\bar{\alpha} + 2x_{s1},\ \bar{\alpha} + 2x_{s2}]$ when $\alpha_i \in [\bar{\alpha} + 2x_{s1},\ \bar{\alpha} + 2x_{s2}]$: If $\alpha_i \in [\bar{\alpha} + 2x_{s1},\ \bar{\alpha} + 2x_{s2}]$ signaller s_2 will randomise between these two values and so s_1 will not be able to match his signal. Her signal will thus have no effect on the DM's decision as she will think that $\alpha_i \in [\bar{\alpha} + 2x_{s1},\ \bar{\alpha} + 2x_{s2}]$ regardless.

2. To show that s_2 maximises his utility given the DM's policy choice and s_1's optimal signalling strategy, as in part 1 above, simply use the same logic as in the previous section, reversing the signaller notation.

3. To show that the DM maximises her utility given her posterior belief about the value of α:

   (a) If $h^*(\alpha_i; m_{1\alpha}, m_{2\alpha}) = 1$, which happens when $m_{1\alpha} = m_{2\alpha}$, she can simply choose her optimal strategy $g_k = \alpha_i$ if her ideal point is $x = 0$.

   (b) If, however, $h^*(\alpha_i;\ m_{1\alpha},\ m_{2\alpha}) = 0$ for all $\alpha_i \notin [\bar{\alpha} + 2x_{s1},\ \bar{\alpha} + 2x_{s2}]$, which happens when $m_{1\alpha} \neq m_{2\alpha}$, she chooses g_k to maximise:

$$\int_{\bar{\alpha}+2x_{s1}}^{\bar{\alpha}+2x_{s2}} -(g_k - \alpha_i)^2 h^*(\alpha_i,\ m_{1\alpha},\ m_{2\alpha}) d\alpha_i$$

   which produces $g_k(m_{1\alpha},\ m_{2\alpha}) = \bar{\alpha}$.

4. The consistency of $h^*(\alpha_i;\ m_{1\alpha},\ m_{2\alpha})$ was established in 1(c) of the proof.