THÈSE

En vue de l'obtention du

DOCTORAT DE L'UNIVERSITE DE TOULOUSE

Délivré par l'Université Toulouse Capitole

École doctorale : **Sciences Economiques-Toulouse School of Economics**

Présentée et soutenue par

MAHIEUX Lucas

le 6 juillet 2018

"Essays in Financial Accounting and Auditing"

Discipline : **Sciences Economiques**

Unité de recherche : **TSE-R (UMR CNRS 5314 – INRA 1415)**

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Essays in Financial Accounting and Auditing
Ph.D. Thesis

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June 20, 2018

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Acknowledgment

My years of study at Toulouse School of Economics have been both enjoyable and hugely formative. I am grateful to everyone who has influenced me during my work on my PhD. I have had countless discussions with students, colleagues, teachers and professors, both within the Toulouse School of Economics and beyond, and everyone of these has helped me to produce this thesis. While I cannot name everyone individually, I thank you all.

My greatest debt goes to Guillaume Plantin, my advisor, for his invaluable guidance and help during my PhD as well as for his support in my orientation decisions. His passion and enthusiasm for research is very infectious and he will always be my academic role model. I am also very grateful to Jacques Crémer, for keeping his door open during those six years. He was here to share the good news and give his support in the more difficult times.

I greatly benefited from my visits at the University of Chicago Booth School of Business and at the UCLA Anderson School of Management. At Chicago, the support and advice I received within Haresh Sapra was a decisive step in the progress of my research. The year I have spent at UCLA has been an extraordinary and important time during my PhD and I would like to thank in particular Judson Caskey for inviting me, and David Aboody and Henry Friedman for their detailed comments on my work. Moreover, I would like to thank my other coauthor, Jeremy Bertomeu, for his efforts in our project and his patience with me.

I am also thankful to all those whose support and kindness have made my PhD an unforgivable experience: my fellow PhD students from both Toulouse School of Economics and the UCLA Anderson School of Management.

Special thanks also go to Jonathan Glover and Thomas Hemmer for accepting to be the external members of my PhD Thesis Committee.

Last but not least, I am more than grateful to my family, and to my parents in particular, for their continuing support. Their enthusiasm and interest helped me get through those six years and never forget the purpose of my choice in entering a PhD. Finally, I want to thank my wife Mélanie Magnier. She was always confident and optimistic when I had doubts, and this thesis would not be in your hands without her marvellous and loving support.

Abstract - English

This thesis focuses on financial reporting with a particular emphasis on financial reporting for banks in the first two chapters and on auditors' incentives in the third chapter. The first part of my thesis (chapter 1 and chapter 2) concerns the link between accounting rules and the financial system. Financial statements are key inputs to compute the regulatory capital of financial institutions and, therefore, play a major role in the efficiency and the stability of the financial system. However, the role of accounting standards on banks' behaviors has been the subject of academic research mostly since the 2007-08 financial crisis. In particular, fair value accounting has been blamed for increasing systemic risk during the crisis. Loan loss provisioning, securitization and derivatives are the three other important aspects of financial reporting for banks that have been heavily debated since the crisis. The other part of my thesis (chapter 3) concerns the analysis of auditors' incentives and the regulation of the audit industry. Financial reporting is not the only way accounting has been implicated in the past crisis and in recent corporate scandals. Indeed, the major accounting firms have also been directly targeted in part because of the provision of non-audit services to their audit clients.

The main objective of the first chapter is to understand the role of fair value accounting, taking into account the possibility for banks to use their private information (Level 3 reporting) to compute fair values. Namely, I analyze a model of prudential regulation to shed some light on banks' incentives to use Level 3 reporting and on the economic consequences they entail. I bring in accounting measures as the primary inputs into capital requirements set by a regulator to efficiently allocate control rights within a bank and to provide managerial discipline. My analysis of the Level 3 reporting externalities highlights an interesting tradeoff between transparency and financial stability. On the one hand, Level 3 reporting reduces the ability for a bank's stakeholders to extract information from financial statements of similar banks. On the other hand, Level 3 reporting decreases systemic risk caused by mark-to-market accounting. Further, manipulation makes Level 3 reporting less desirable, which may in turn increase systemic risk. I believe that the framework of this chapter offers other opportunities to study the real-effects of fair value accounting that have not yet been explored.

The second chapter of this thesis is co-authored with Jeremy Bertomeu of the University of California San Diego and Haresh Sapra of the University of Chicago. In this chapter, we tackle the question of the optimal loan loss provisioning system for banks. In particular, we develop first a framework to study how accounting measurement and prudential regulation interact to affect a bank's incentives to originate credit. Our

main result is that the accounting measurement system and bank leverage are policy tools that should be used in tandem, generating more value than systems that rely either on accounting regulation or on prudential regulation. Then, we use our results to shed some light on the current debate on the appropriate loan loss provisioning model for banks. We show that while banks engage in excessive risk-taking under an incurred loss model, an expected loss model can lead to excessive liquidations. More interestingly, we show that as credit conditions in the economy improve, the optimal measurement system moves towards an expected loss model. Conversely, as credit conditions deteriorate, the optimal measurement regime tilts more towards an incurred loss model.

The third chapter of this thesis moves away from financial reporting for banks to focus on the analysis of auditors' incentives to deliver high audit quality. In particular, I try to understand the impact of the provision of non-audit services (NAS) on audit firms' incentives, in order to conclude on the best way to regulate this industry. I believe that a better understanding of auditors' incentives is necessary to design better regulations. To that end, I develop a framework that provides new insights into the incentive effects of NAS on auditors. I show that it can be optimal for the investors of a client firm to let the external auditor provide NAS because of an incentive externality. Indeed, the possibility of providing NAS contingent on detecting financial misstatements increases the auditor's incentives to exert audit effort. However, despite this positive externality, the provision of NAS may decrease perceived audit quality, which may in turn render the provision of NAS by auditors undesirable. Thus, my analysis uncovers an interesting tradeoff for regulators between the positive incentive effect and the decrease in audit quality. Removing the current restriction on contingent audit fees may offset this ex post decrease in audit quality while preserving the ex ante incentives.

Abstract - French

Cette thèse de doctorat porte sur le reporting financier avec un accent particulier sur l'information financière des banques dans les deux premiers chapitres et sur les incitations des auditeurs dans le troisième chapitre. La première partie de ma thèse (chapitre 1 et chapitre 2) concerne le lien entre les règles comptables et le système financier. Les états financiers sont des intrants clés pour calculer le capital réglementaire des institutions financières et, par conséquent, jouent un rôle majeur dans l'efficacité et la stabilité du système financier. Cependant, le rôle des normes comptables sur les comportements des banques a fait l'objet de recherches universitaires principalement depuis la crise financière de 2007-2008. En particulier, la comptabilité à la juste valeur a été accusée d'accroître le risque systémique pendant la crise. Les provisions pour créances douteuses, la titrisation et les produits dérivés sont les trois autres aspects importants de l'information financière pour les banques qui ont été largement débattus depuis la crise. L'autre partie de ma thèse (chapitre 3) concerne l'analyse des incitations des auditeurs et la régulation de l'industrie de l'audit. L'information financière n'est pas la seule façon dont la comptabilité a été impliquée dans la crise passée et dans les récents scandales financiers. En effet, les grands cabinets comptables ont également été ciblés directement en partie en raison de la prestation de services non liés à l'audit à leurs clients d'audit.

L'objectif principal du premier chapitre est de comprendre le rôle de la comptabilité à la juste valeur, en tenant compte de la possibilité pour les banques d'utiliser leur information privée (reporting de niveau 3) pour calculer les justes valeurs. À savoir, j'analyse un modèle de réglementation prudentielle pour faire la lumière sur les incitations des banques à utiliser les rapports de niveau 3 et sur les conséquences économiques qu'elles entraînent. J'introduis des mesures comptables en tant qu'intrants primaires dans les exigences de fonds propres établies par un organisme de réglementation afin de répartir efficacement les droits de contrôle au sein d'une banque et de fournir une discipline de gestion. Mon analyse des externalités de reporting de niveau 3 met en évidence un arbitrage intéressant entre la transparence et la stabilité financière. D'une part, les rapports de niveau 3 réduisent la capacité des parties prenantes d'une banque à extraire des informations des états financiers de banques similaires. D'un autre côté, les rapports de niveau 3 réduisent le risque systémique causé par la comptabilisation à la valeur de marché. En outre, la manipulation rend le signalement de niveau 3 moins souhaitable, ce qui peut à son tour augmenter le risque systémique. Je crois que le cadre de ce chapitre offre d'autres occasions d'étudier les effets réels de la comptabilisation à la juste valeur qui n'ont pas encore été explorés.

Le deuxième chapitre de cette thèse est co-écrit avec Jeremy Bertomeu de l'Université

de Californie à San Diego et Haresh Sapra de l'Université de Chicago. Dans ce chapitre, nous abordons la question du système optimal de provisionnement des pertes sur prêts pour les banques. En particulier, nous développons d'abord un cadre pour étudier comment la mesure comptable et la réglementation prudentielle interagissent pour affecter les incitations d'une banque à obtenir un crédit. Notre résultat principal est que le système de mesure comptable et l'effet de levier bancaire sont des outils politiques qui devraient être utilisés en parallèle, générant plus de valeur que les systèmes reposant soit sur la réglementation comptable, soit sur la réglementation prudentielle. Ensuite, nous utilisons nos résultats pour faire la lumière sur le débat actuel sur le modèle approprié de provisionnement des pertes sur prêts pour les banques. Nous montrons que si les banques prennent des risques excessifs dans le cadre d'un modèle de pertes encourues, un modèle de pertes attendues peut entraîner des liquidations excessives. Plus intéressant, nous montrons qu'à mesure que les conditions de crédit s'améliorent dans l'économie, le système de mesure optimal évolue vers un modèle de pertes attendues. À l'inverse, à mesure que les conditions de crédit se détériorent, le régime de mesure optimal s'oriente davantage vers un modèle de pertes encourues.

Le troisième chapitre de cette thèse s'éloigne des rapports financiers pour les banques afin de se concentrer sur l'analyse des incitations des auditeurs à fournir une qualité d'audit élevée. En particulier, j'essaie de comprendre l'impact de la fourniture de services autres que d'audit (NAS) sur les incitations des sociétés d'audit, afin de conclure sur la meilleure façon de réguler cette industrie. Je crois qu'une meilleure compréhension des incitations des auditeurs est nécessaire pour concevoir de meilleures réglementations. À cette fin, je développe un cadre qui fournit de nouvelles perspectives sur les effets incitatifs des NAS sur les auditeurs. Je montre qu'il peut être optimal pour les investisseurs d'une entreprise cliente de laisser l'auditeur externe fournir des NAS en raison d'une externalité d'incitation. En effet, la possibilité de fournir des NAS en cas de détection d'anomalies financières augmente les incitations de l'auditeur à exercer un effort d'audit. Cependant, en dépit de cette externalité positive, la fourniture de NAS peut diminuer la qualité perçue de l'audit, ce qui peut à son tour rendre la fourniture de NAS par les auditeurs indésirable. Ainsi, mon analyse révèle un arbitrage intéressant pour les régulateurs entre l'effet d'incitation positif et la diminution de la qualité de l'audit. L'élimination de la restriction actuelle sur les honoraires d'audit conditionnels peut compenser cette baisse ex post de la qualité de l'audit tout en préservant les incitations ex ante.

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Chapter 1

Fair Value Accounting, Transparency and Financial Stability

1.1 Introduction

While accounting standards have gradually evolved towards the use of fair value measurements, very little is known on the desirability of using banks' private information (Level 3 reporting) to compute fair values. In this paper, my objective is to shed some light on banks' incentives to use Level 3 reporting and on the economic consequences they entail.[1] To that end, I develop a framework which brings in accounting measures as the primary inputs into capital requirements set by a prudential regulator to efficiently allocate control rights within a bank and to provide managerial discipline.[2] Then, I analyze the externalities of the optimal measurement rules for one bank in a multi-bank economy and uncover an interesting tradeoff. On the one hand, Level 3 reporting decreases the consistency and the comparability of financial statements,

[1] The Financial Accounting Standard Board (*FASB*, 2011) and the International Accounting Standard Board (*IASB*, 2011) define fair value as "the price that would be received to sell an asset (...) in an orderly transaction." They have developed a methodology that categorizes into three levels the inputs to valuation techniques used to measure the fair value. For assets listed on liquid markets, the fair value is the market price (Level 1 input), which is both the most relevant and reliable information. I discuss in more details the fair value reporting guidance in the appendix 2.

[2] The allocation of control rights within a bank is a major reason for the regulation of bank capital structure (e.g. Acharya et al., 2016; Dewatripont and Tirole, 1994*c*).

Moreover, capital requirements are largely based on accounting inputs: see, e.g., the Comptroller of the Currency (OCC) (http://www.occ.treas.gov/publications/publications-by-type/other-publications-reports/Keydifferences-document-public.pdf), the Federal Deposit Insurance Corporation (FDIC) (http://www.federalreserve.gov/bankinforeg/stress-tests/CCAR/201503-comprehensivecapital-analysis-review-preface.htm) and the Bank for International Settlements (http://www.bis.org/bcbs/basel3/b3summarytable.pdf).

which in turn reduces the ability for a bank's stakeholders to extract information from financial statements of similar banks. On the other hand, Level 3 reporting decreases systemic risk caused by mark-to-market accounting (i.e. fair value with observable inputs). Indeed, under mark-to-market accounting, liquidation decisions are based on public information, which may trigger simultaneous inefficient liquidations. Further, manipulation makes Level 3 reporting less desirable, which may in turn increase systemic risk. Standard setters and prudential regulators, who may have conflicting interests, should carefully investigate the tradeoff between transparency and financial stability.

Understanding the economic consequences of using banks' private information to compute fair values is an important policy concern given that most of the assets accounted for with fair value are not traded on liquid markets. Therefore, both noisy public information (Level 2 input) and banks' private information (Level 3 input) are available to compute their fair values. Although several empirical studies (e.g. Hanley et al., 2018) provide evidence that firms strategically choose the fair value classification levels of their assets, standard setters lack a framework to assess the costs and benefits of Level 3 reporting. Understanding the tradeoffs at stake is even more important for prudential regulators given the debate that has been raging for years about the role of fair value accounting for financial stability. Namely, many academic researchers, policymakers and other practitioners have blamed mark-to-market for increasing systemic risk.[3] Banks have been at the forefront of this debate because they are key players in the economy and carry significant amounts of fair valued assets and liabilities. My formal analysis of Level 3 reporting highlights that systemic risk may be reduced by allowing banks to report more assets into the Level 3 category.

I draw my conclusions from a standard model of prudential regulation à la Dewatripont and Tirole (1994*c*). There is a moral hazard problem within a bank and formal incentive schemes (bonuses, stock options) are limited by imperfect verifiability of bank performance. As a result, additional incentives are provided to the banker by the threat of external involvement by the prudential regulator. The banker derives private benefits from running the bank and prefers a low level of intervention. The prudential regulator should promise a low level of intervention in case of good performance and a high level of intervention in case of bad performance to provide managerial discipline. Reliable accounting information increases the ability of the prudential regulator to monitor the banker's behavior, increasing the probability that

[3] Laux and Leuz (2010) provide an overview of this debate. For critics of fair value accounting, see, for example, "Are the Bean Counters Ensuring a Crash?" *The Economist*, March 6, 2008; "The Crisis and Fair Value Accounting," *The Economist*, September 18, 2008 and "Mark-to-Market Accounting Exacerbates the Crisis," *The Wall Street Journal*, October 15, 2008. See also Cifuentes et al. (2005*a*), Heaton et al. (2010*a*) and Securities and Exchange Commission (2008).

the bank's asset is of high quality.

I add a fair value measurement friction to this standard model of prudential regulation and make explicit the type of accounting information available to the prudential regulator. There are two sources of information available to decide of the intervention policy: a public Level 2 input and a Level 3 input, which is private information to the banker. If the asset is reported at Level 3, the external auditor audits the banker's assumptions and the Level 3 input becomes public. Hence, Level 3 reporting reveals the banker's private information but there is an audit cost borne by the bank's investors.

The optimal intervention policy that maximizes the bank's value has intuitive features. When the Level 2 input is informative enough, the banker uses Level 2 reporting and the intervention decision is based on the Level 2 input. Otherwise, when the Level 2 input is noisy, the prudential regulator relies on the Level 3 input. Interestingly, the asset is reported at Level 3 and there is no intervention if and only if the Level 3 input is good information on the asset quality and the Level 3 reporting cost is low. This optimal intervention policy admits a realistic implementation using an appropriate capital structure, whereby the banker is allowed to use Level 3 if the reporting cost is low and shareholders keep the control if and only if the reported book value is above a capital requirement set by the prudential regulator. Control should shift from shareholders to the prudential regulator if the banker does not meet the capital requirement.

After analyzing the optimal fair value reporting decision for a single bank, I investigate the optimal fair value standards in the full-fledged multi-bank model. I extend the model to a continuum of ex ante identical banks and the Level 2 inputs are endogenized as prices quoted by a broker. In equilibrium, some banks have high quality assets and others low quality assets. The uninformed broker quotes a price for a high (resp. low) quality asset based on the information he obtains by observing a sample of financial statements of banks that have assets similar to this high (resp. low) quality asset. However, there is a misclassification risk in case of Level 3 reporting. Specifically, Level 3 valuations are based on bankers' assumptions and hence, reduce the consistency and the comparability of financial statements. It is harder for the broker to compare the different assets and the quoted prices are noisier. Thus, Level 3 reporting leads to a negative informational externality. On the other hand, upon sufficiently bad public information, Level 2 reporting triggers simultaneous liquidations by distressed banks, which may depress the liquidation values of the assets as in Plantin et al. (2008*a*). Level 3 reporting, by relying on bankers' private information, then acts as a circuit-breaker and leads to a positive payoff externality. Hence, there is a tradeoff between increasing the use of Level 3 reporting to reduce systemic risk by relying more on the bankers' private information, and restricting Level 3 reporting to increase the comparability and the informativeness of financial statements. The optimal Level 3 reporting cost is endogenously determined taking into account this tradeoff. This paper is the first study, to the best of my knowledge, to offer an analytical framework to analyze this key tradeoff for standard setters and prudential regulators in the context of fair value accounting.

Finally, Level 3 reporting has been heavily criticized by some practitioners and accounting researchers (e.g. Acharya and Ryan, 2016*a*; Buffett, 2002; Weil, 2007) because of potential manipulation of Level 3 inputs. I show that, when the banker is able to manipulate the distribution of the Level 3 input, there is indeed a unique degree of manipulation in equilibrium. My analysis underscores that prudential regulators internalize the resulting decrease in the informativeness of those inputs when setting capital requirements and that Level 3 reporting still provides some valuable information to prudential regulators. However, the manipulation of the Level 3 input, which reduces the use of Level 3 reporting, may in turn increase systemic risk.

To illustrate the main results of the paper, take the example of mortgage backed securities (MBS), which were at the heart of the 2007-08 financial crisis. An example of a Level 2 input is the credit spread over the risk-free rate based on the most comparable index (e.g. CMBX index). A banker might use a Level 3 input in its valuation model, such as adjustments for differences between the index used and the actual asset. My model predicts that banks adjust the public index data to compute the fair values of their MBS holdings only when this public index is noisy, the bankers' private information is good news on the quality of the MBS holdings and the Level 3 reporting cost is low. Moreover, my multi-bank analysis suggests that reclassifications by banks of MBS into the Level 3 category may have reduced systemic risk during the crisis (Laux and Leuz, 2010).

The one-bank model has important predictions for auditors and auditing standard setters. The audit of fair value classifications is an important subtask in auditing the overall fair value reporting process because of the ambiguity in fair value estimation guidance.[4] For instance, Glover et al. (2016) and Earley et al. (2015) underline that some audit partners consider the classification of Level 2 versus Level 3 to be the most important aspect of the overall fair value process. Hanley et al. (2018) provide evidence that insurance companies strategically use Level 3 reporting to meet capital requirements while Altamuro and Zhang (2013) show that managers use their discre-

[4]It is well documented that firms have some discretion when deciding to report an illiquid asset at Level 2 or Level 3 (e.g. Altamuro and Zhang, 2013; Earley et al., 2015; Hanley et al., 2018; Hendricks and Shakespeare, 2013). The Public Company Accounting Oversight Board (2017) has just proposed new auditing standards related to fair value.

tion to generate more accurate fair value estimates. Thus, my results contribute to the understanding of banks' incentives to use Level 3 reporting and why estimates of a similar asset may differ across banks.

The findings of the multi-bank model are relevant to accounting standard setters and prudential regulators. As stressed earlier, there is a global debate since the 2007-08 financial crisis on the role of fair value accounting. Opponents of fair value accounting argue that it can lead to a feedback loop between falling market prices and sell-offs if banks are not able to deviate from market prices.[5] Proponents of fair value claim that it provides more relevant accounting numbers but standard setters constrain deviations from market information mainly because Level 3 reporting decreases the consistency and the comparability of financial statements, which are important characteristics (*FASB*, 2011). As noted by Laux and Leuz (2009), the fair value debate is "far from over" and, in particular, the relevance-reliability tradeoff is "at the heart of the debate when to deviate from market prices in determining fair value." I provide a new mechanism which links mark-to-market to systemic risk: sufficiently bad public signals trigger simultaneous liquidations, which are inefficient when the market's demand for the assets is less than perfectly elastic. Furthermore, I highlight an important tradeoff: allowing banks to deviate from observable inputs reduces systemic risk but decreases the consistency and the comparability of financial statements. This result echoes the classic tradeoff between transparency and financial stability.

1.1.1 Literature review

First of all, this paper is related to the agency theory and performance evaluation literature.[6] In a seminal contribution, Hölmstrom (1979) derives a necessary and sufficient condition for imperfect information of the unobservable effort to be of value. As in Dewatripont and Tirole (1994*c*), I use a model of prudential regulation based on an agency friction within a bank that I augment with a fair value measurement friction. Optimal capital requirements are derived from fair value measurements, which use both Level 2 and Level 3 inputs.

An interesting parallel can be drawn with Verrecchia (1986), in which a principal may find it optimal to let an agent take a costly action which leads to more precise

[5] For instance, the International Monetary Fund (2008) states that: "fair value accounting gives the most comprehensive picture of a firm's financial health...investment decision rules based on fair value accounting outcomes could lead to self-fulfilling forced sales and falling prices when valuations fell below important thresholds." (https://www.imf.org/external/pubs/ft/gfsr/2008/01/)

[6] Lambert (2001) reviews agency theory and its application to accounting issues. Beatty and Liao (2014) emphasize that agency problems are core issues in the theory of banking but there are surprisingly few papers analyzing agency issues at the intersection of the banking literature and the accounting literature.

reports, and with Gigler and Hemmer (2001), in which an agent may become informed and voluntarily disclose some private information at a cost before the financial report is produced. Similarly, the variance investigation literature (e.g Baiman and Demski, 1980; Dye, 1986) uses agency models in which the principal has the choice to produce costly information. In my setup, the banker has the discretion to report the asset at Level 2 or Level 3. Level 3 reporting is similar to a costly investigation of the banker's private information and leads to more precise reports. I find that the extent to which the prudential regulator allows the banker to use Level 3 reporting depends upon the improvement in fair values as an indicator of the banker's ex ante effort when Level 3 reporting takes place versus the cost of Level 3 reporting.

This paper belongs to a burgeoning strand of the banking literature studying the role of fair value accounting. On the one hand, a part of this literature emphasizes the potential contagion effect caused by mark-to-market accounting. Allen and Carletti (2008*a*), Cifuentes et al. (2005*a*) and Heaton et al. (2010*a*) highlight this effect using exogenous capital requirements whereas in Plantin et al. (2008*a*), a manager is focused on short-term earnings. Bhat et al. (2011) and Khan (2014) provide empirical evidence of this contagion effect during the Great Recession. On the other hand, Laux and Leuz (2010) and Barth and Landsman (2010*a*) argue that this effect is negligible. I provide a novel channel that links mark-to-market accounting and systemic risk: relying only on observable information may lead to simultaneous liquidations. Yet, I add a dimension to the debate on the role of fair value accounting and argue that the systemic risk caused by mark-to-market may be reduced by allowing banks to use Level 3 reporting.

This paper intends to contribute to our understanding of the role of transparency in the banking system. Goldstein and Sapra (2014) review the tradeoffs related to transparency in financial systems. Dang et al. (2017) argue that banks are optimally opaque in order to avoid runs. In the same vein, Gao and Jiang (2016) show that reporting discretion reduces panic-based runs. Burkhardt and Strausz (2009) find that transparent accounting can worsen the asset substitution effect of debt. I emphasize that standard setters and prudential regulators should tradeoff between comparability of financial statements and systemic risk.

Some recent theoretical papers study the real effects of accounting standards (e.g. Bleck and Liu, 2007; Caskey and Hughes, 2011; Marinovic, 2016; Otto and Volpin, 2017).[7] Kanodia and Sapra (2016*a*) underscore that identifying the real economic consequences of accounting standards is of first-order importance to the accounting discipline. I extend this literature by focusing my analysis on the design of optimal fair

[7] There is also a large literature studying the real effects of voluntary disclosures by firms. For instance, Bertomeu et al. (2011) predict a negative association between firms' cost of capital and the extent of information firms disclose.

value accounting standards and by stressing some real effects of fair value accounting on financial institutions' behaviors and on financial stability.

Lastly, my model is closely related to Plantin and Tirole (2017), who analyze the optimal accounting information in an agency setup with two signals. My baseline model differs in two ways from theirs: the costly signal is certified with an audit instead of a resale decision and this signal imperfectly reveals the asset quality. Besides those two differences, my multi-bank model has a completely different focus and uncovers a different tradeoff for regulators. Specifically, they show that relying on public information ("marking-to-market") dries up market liquidity and reduces the informativeness of public signals. On the contrary, in my model, it is the use of private information ("Level 3 reporting") which reduces the comparability of financial statements and may, in turn, leads to a negative informational externality.

The rest of the paper proceeds as follows. In section 3.3, I develop the baseline model, discuss the main assumptions and characterize the optimal intervention policy. In section 1.3, I study the externalities of Level 3 reporting in a multi-bank equilibrium. I analyze the impact of manipulation of the banker's private information in section 3.3.4. In section 1.5, I discuss some implications of the results and section 1.6 provides concluding remarks.

1.2 The baseline one-bank model

1.2.1 The setup

My baseline one-bank model builds on a standard model of prudential regulation à la Dewatripont and Tirole (1994*c*), to which I add a fair value measurement friction. There are four stages, $t = 0, 1, 2$ and 3. The timing of the model is summarized in Figure 1. There are two risk-neutral players involved in an asset - a "bank": the banker, who manages the bank, and the prudential regulator, who maximizes the investors' utility. The "bank" could be any regulated financial institution: commercial bank, insurance company, pension fund, securities market institution...

The banker must select an asset (e.g. a loan portfolio) at $t = 0$. There are two types of assets: high quality assets (H) and low quality assets (L). Both types entail the same initial investment outlay at $t = 0$. The probability $q \in \{q_L, q_H\}$ of having a high quality asset depends on the banker's initial non-observable effort at $t = 0$. If the banker exerts high effort, which is socially efficient, then this probability is high ($q = q_H \in [0, 1]$). Otherwise, if the banker shirks and exerts low effort, this probability is low ($q = q_H - \Delta q = q_L \in [0, 1]$). The banker incurs a private cost $K > 0$

when exerting high effort. For example, a banker can improve the expected return on loans that the bank originates by screening loan applicants to identify better quality borrowers.

The main friction, above and beyond this moral hazard problem, is a fair value measurement issue. The prudential regulator has potentially access to two types of information to decide of the intervention policy: a public information (Level 2 input) and a private information to the banker (Level 3 input). The Level 2 input and the Level 3 input are signals on the asset quality, realized at $t = 1$, which may be used in the fair value reporting process.[8]

At $t = 2$, the prudential regulator has to take an action $A \in \{C, S\}$. The payoff of the asset depends on both the asset quality and the action A. Action C (continuation) yields the banker a private benefit $B > 0$ (perks, social status, ego) and an expected cash flow η to the investors at $t = 3$. In contrast, action S (liquidation) yields no private benefit to the banker and a cash flow $\mathcal{L}$ to the investors. I assume that the banker does not value monetary transfers.[9] His salary is equal to the salary in an alternative job and is normalized to zero. For an asset of quality $Q \in \{L, H\}$, the expected continuation payoff η takes the value $\eta_Q > 0$, with $\eta_L < \eta_H$. Similarly, the liquidation payoff $\mathcal{L}$ takes the value $\mathcal{L}_Q > 0$, with $\mathcal{L}_L = \eta_L + l < \mathcal{L}_H = \eta_H$, where $l > 0$ is fixed.[10] High quality assets are not bank-specific can be sold to any bank as risk-free assets: their liquidation value $\mathcal{L}_H$ is equal to their final payoff η_H. Low quality assets can be seen as risky loans with an expected payoff η_L. They can be restructured, say, by liquidating a safe asset held as collateral, for an immediate cash payment $\mathcal{L}_L = \eta_L + l$.

The distribution of the two inputs is the following. First, the public Level 2 input is a continuous signal $p \in \mathbb{R}$ distributed according to the density f_H for high quality assets and f_L for low quality assets. The two distributions satisfy the classic monotone likelihood ratio property (MLRP), i.e.

$$\frac{f_H(p)}{f_L(p)} \text{ is strictly increasing in } p.$$

[8]Throughout the paper, unless otherwise mentioned, I study the accounting treatment of an asset that is reported at fair value (see the appendix 2 for a discussion on the relevant assets).

[9]It is a well-known idea that formal incentive schemes (bonuses, stock options), while useful, do not fully resolve the agency problem (Kaplan and Strömberg, 2003). A number of models prevent the use of managerial monetary incentives schemes or equity (see, among others, Grossman and Hart, 1986). The results can be generalized under some assumptions to the opposite case with no private benefit but monetary transfers (Dewatripont and Tirole, 1994*a*).

[10]The optimal intervention policy is similar if $l < 0$ (see proof of Proposition 1). In the appendix 3, I also show that the results hold if the liquidation value of the high quality asset is strictly smaller than its final payoff ($\mathcal{L}_H < \eta_H$).

Thus, the larger (resp. lower) is the observable input, the more likely the asset is a high (resp. low) quality one. I assume that the image of f_H/f_L is $(0, +\infty)$ to avoid corner solutions. The Level 2 input can be observable quoted prices for identical or similar assets in markets that are active or not. I endogenize the Level 2 input in section 1.3 in the full-fledged model with multiple banks.

Second, there is a binary Level 3 input $s \in \{g, b\}$, which is private information to the banker, and can be either good ($s = g$) or bad ($s = b$). The banker learns the value of the Level 3 input s at $t = 1$. To capture the idea that the unobservable input is noisy even in absence of the banker's influence, s is assumed to be imperfectly correlated with the asset quality. The distribution of the Level 3 input is defined by the following conditional probabilities:[11]

$$P(s = g \mid H) = 1 \quad \text{and} \quad P(s = g \mid L) = \beta_L = 1 - P(s = b \mid L).$$

I endogenize the precision of the Level 3 input and let the banker manipulate its distribution in section 3.3.4.

The banker is in charge of preparing the financial statements and chooses the classification level of the asset. The only constraint will be an endogenous cap on the Level 3 reporting cost set by the prudential regulator. Depending on the level of the inputs used in the valuation, the asset is reported at Level 2 or Level 3. Hence, if the banker uses only the Level 2 input, the reported fair value, $FV(p)$, is a Level 2 valuation. Otherwise, if the banker uses both the Level 2 input and the Level 3 input, then the reported fair value, $FV(p, s)$, is a Level 3 valuation. In both cases, the valuation method is public. If the asset is reported at Level 3 in the financial statements, the Level 3 estimate $FV(p, s)$ is then audited by the external auditor and the Level 3 input s becomes public.

In case of Level 3 reporting, the investors bear an audit and a reporting cost c, which is distributed on $[0, +\infty)$ according to the density g.[12] The distribution of c is common knowledge and the cost is publicly realized at $t = 2$. The banker reports the asset at Level 2 when indifferent between the two levels because this is the preferred choice of the investors. The optimal distribution of the cost c is endogenously determined in section 1.3.4, given the externalities of Level 3 reporting in the multi-bank economy.

Coming back to the introductory example of MBS, originators have access to de-

[11] The results would still hold with an other distribution of s as long as s is informative enough. In particular, assuming that $P(s = g \mid H) = \beta_H < 1$ yields similar results as long as β_H is close to one (see the appendix 3 for robustness checks).

[12] The cost of observing the Level 2 input is zero for simplicity. As in Plantin and Tirole (2017), the qualitative results would not be affected by the introduction of a positive cost, lower than the Level 3 reporting cost.

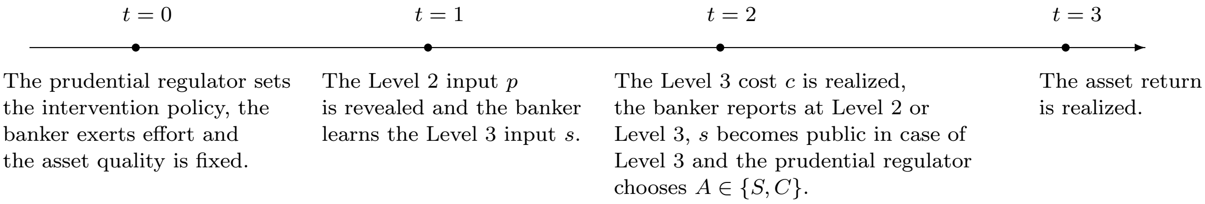

Figure 1: Timeline of the one-bank model

tailed information about the borrower that is usually not disclosed to the outside investors, such as the payment-to-income ratio of the borrower or the number of points paid at origination. This private information could help originators to make adjustments[13] to the public credit spread and to better predict future cashflows of those securities. If this private detailed information is used to compute the fair value of the securities, the auditor has to discuss and certify the banker's assumptions. As a result, the private information becomes known to the outside investors.

I assume that the parameters are such that the investment in an asset is socially desirable only if the banker exerts high effort.[14] Further, the private cost of effort K is assumed to be sufficiently small such that effort incentives can be provided only using the Level 2 input.[15] The prudential regulator maximizes the expected utility of the investors subject to the constraint that induces the banker to exert high effort. I assume away any renegotiation and the prudential regulator has full commitment power. However, as in Dewatripont and Tirole (1994*c*), the results are robust to renegotiation as long as the banker may lose his private benefit after continuation is chosen if he has to make concessions to prevent liquidation (see the appendix 3 for robustness checks).

1.2.2 Discussion of the main assumptions

I discuss in this subsection the main assumptions of the model.

Action A For simplicity, I consider only two regulatory actions. Action C can be interpreted as a continuation, no intervention, or as an expansion in the scope of the bank's activities. Similarly, action S admits several interpretations: a liquidation, a reorganization, a partial asset sale or a downsizing of the bank. More broadly, the model focuses on external interference as a managerial discipline device and action S

[13] The valuation of MBS requires detailed assumptions on the prepayment risk, the default risk and the interest rate risk.

[14] This is equivalent to assume that $q_H\eta_H + (1-q_H)\eta_L + B - K > I > q_L\eta_H + (1-q_L)(\eta_L + l) + B$, where I is the initial investment in the asset.

[15] I state formally this assumption in the proof of Lemma 2.

represents any regulatory intervention. For example, the Office of the Comptroller of the Currency, a US banking regulator, can force a bank to stop some activities with "Cease & Desist Orders". Action S can also be interpreted as a "Prompt Corrective Action" that the Federal Deposit Insurance Corporation Improvement Act of 1991 requires U.S. bank regulators to take to resolve the problems of financial institutions (Bushman and Landsman, 2010*b*).

Contingent Level 3 and reclassification Level 3 reporting is contingent on the realization of the observable Level 2 input p, which is consistent with empirical evidence. Altamuro and Zhang (2013) examine the determinants for banks of Level 2 versus Level 3 classification for mortgage servicing rights. They find that the Level 3 choice is contingent and negatively associated with changes in housing prices. Moreover, Hanley et al. (2018) find that insurers that report at Level 3 have significantly larger fair value inflation than insurers who report at Level 2 for the same asset at the same point in time.

Standard setters allow firms to move assets into the Level 3 category when the public information becomes too noisy (e.g. Altamuro and Zhang, 2013; Kohlbeck et al., 2017; Laux and Leuz, 2010). Hanley et al. (2018) point out that changes in level over time are strategic and linked to firms' characteristics. For instance, for a given security, they observe transfers from Level 2 to Level 3 whenever insurers experience a decline in regulatory capital.

Level 3 reporting cost Another key assumption of the model is the cost of reporting assets at Level 3. First, auditors should work harder to audit less reliable Level 3 valuations. Indeed, they have more information to process and should discuss insiders' assumptions.[16] Further, the risk of misstatements is higher for Level 3 valuations. There is empirical evidence that Level 3 reporting is associated with higher audit fees.[17] Then, in practice, a reporting company should provide detailed explanations of the valuation techniques and the inputs used to value a Level 3 asset in the footnotes of the financial statements. Consistent with reporting costs associated to Level 3 reporting, Altamuro and Zhang (2013) and Botosan et al. (2011) find that Level 3 classification is more likely to be chosen by larger banks with Big Four auditors.

[16] Auditing standards explicitly entail the auditor to test "management's significant assumptions" (PCAOB AU 328).

[17] Ettredge et al. (2014) find a positive link between audit fees and the use of Level 3 inputs in the banking industry. Likewise, Kohlbeck et al. (2017) provide evidence that transfers into the Level 3 category are positively associated with audit fees.

1.2.3 Benchmark models

I start by solving two benchmark cases, which correspond to the second-best solution and to a clear cut Level 2 asset. First, the second-best solution to this agency problem is attained when the Level 2 input p is perfectly informative, i.e. it reveals the quality of the asset: $p = g$ for a high quality asset and $p = b$ for a low quality asset.

Lemma 1. *Suppose that the public signal is perfectly informative. The optimal intervention policy is characterized by any $\pi \in [K/(B\Delta q), 1]$ such that if the public information is good ($p = g$), the prudential regulator chooses continuation with probability π and liquidation with probability $1 - \pi$. Otherwise, if the public information is bad ($p = b$), the prudential regulator chooses liquidation.*

The incentive-compatibility constraint that ensures that the banker exerts effort is $B\pi q_H - K \geq B\pi q_L$. The probability π is optimally set by the prudential regulator such that this constraint is satisfied. In this second-best environment, the utility of the banker when this constraint binds, i.e. $\pi = K/(B\Delta q)$, is $U_{banker} = q_L K/\Delta q$. This is a classic result of the agency literature. Next, I solve another benchmark with no possibility of using the banker's private information and the asset is always reported at Level 2 in the financial statements.

Lemma 2. *Suppose that there is no Level 3 input. The optimal intervention policy is characterized by a cutoff σ such that $F_L(\sigma) - F_H(\sigma) = K/(B\Delta q)$. If $p > \sigma$, the prudential regulator chooses continuation, and if $p < \sigma$, the prudential regulator chooses liquidation.*

Proof. See the appendix. □

In this second benchmark, the observable input is the only way for the prudential regulator to measure the asset quality. Hence, for high values of p, the banker is rewarded whereas the asset is liquidated for low values of p. The cutoff σ is set such that the incentive-compatibility constraint is binding. Under the optimal intervention policy, the expected utility of the banker is $U_{banker} = q_L K/\Delta q + B(1 - F_L(\sigma))$. The banker is strictly better-off than in the second-best world with $\pi = K/(B\Delta q)$ because a low quality asset may sometimes generate a sufficiently good Level 2 input, i.e. $p \geq \sigma$.

1.2.4 The optimal intervention policy

The first proposition of the paper gives the optimal intervention policy in the general model for an asset with both a Level 2 input and a Level 3 input.

Proposition 1. *The optimal intervention policy* $(\underline{p}, \bar{p}, \bar{c})$ *is as follows:*

- *if* $p < \underline{p}$*, the banker reports the asset at Level 2 and the prudential regulator chooses liquidation;*
- *if* $\underline{p} < p < \bar{p}$ *and the cost of Level 3 reporting is low* $(c < \bar{c})$*, the banker reports the asset at Level 3 when the banker's private information is good* $(s = g)$ *and the prudential regulator chooses continuation. Otherwise, the banker reports the asset at Level 2 and the prudential regulator chooses liquidation;*
- *if* $\bar{p} < p$*, the banker reports the asset at Level 2 and the prudential regulator chooses continuation.*

Proof. See the appendix. □

This optimal intervention policy has intuitive features. Indeed, for extreme values of p, the Level 2 input is relevant enough and the banker reports at Level 2 whereas, for intermediate values of p, the Level 2 input is too noisy and the prudential regulator needs to rely on the Level 3 input. This is in line with FASB/IASB fair value guidance which does allow managers to make the argument that Level 3 fair values are preferable when Level 2 inputs are low quality (Altamuro and Zhang, 2013).

For intermediate realizations of the Level 2 input $(\underline{p} < p < \bar{p})$ and a low realization of the Level 3 reporting cost $(c < \bar{c})$, Level 3 reporting is only used if the banker's private information is good $(s = g)$. However, the investors then infer that a banker using Level 2 reporting has a bad private signal $(s = b)$. Level 3 reporting, which makes the private signal public, is a way for the prudential regulator to verify that the banker's private information is good. The cap $\bar{c}$ on the Level 3 reporting cost is set such that the incentive-compatibility constraint that ensures that the banker exerts high effort binds.

Note that the Level 3 reporting cost c plays a key role in my model. This cost is similar to the proprietary cost upon disclosure in Verrecchia (1983) in the sense that it prevents the banker to always report the asset at Level 3. Nevertheless, even if this cost is arbitrarily close to zero, the main interesting features of the optimal intervention policy still hold. Indeed, it is still optimal to use Level 3 reporting only when the Level 3 input is good information on the asset quality to provide incentives to the banker. Furthermore, for low realizations of p, it is still optimal to use Level 2 reporting because even a good Level 3 input would not sufficiently improve the prudential regulator's posterior belief.

Corollary 1. *If the Level 2 input is sufficiently informative and/or the informativeness of the Level 3 input is too low relative to the Level 3 reporting cost, the asset is never* *reported at Level 3, i.e.* $G(\bar{c}) = 0$. *In particular, there exists* $\bar{\beta}_L$ *such that, if* $\beta_L \geq \bar{\beta}_L$, *then* $G(\bar{c}) = 0$.

Proof. See the appendix. □

This corner solution $G(\bar{c}) = 0$ corresponds to the second benchmark model with no use of Level 3 input. This is akin to a clear cut Level 2 asset as in Lemma 2. On the other hand, if the likelihood ratio f_H/f_L were bounded, it could be a case with continuation of the bank only in case of Level 3 reporting. In the appendix 4, I solve for the optimal intervention policy in that latter case.

1.2.5 Implementation with capital requirements

The optimal intervention policy derived in Proposition 1 is uniquely and fully characterized by two thresholds, $\underline{p}$ and $\bar{p}$, on the Level 2 input and a cap $\bar{c}$ on the Level 3 reporting cost. I now discuss a simple and intuitive implementation of this optimal intervention policy using an appropriate capital structure when action A is non-contractible. In this subsection, I assume that a high quality asset is riskless with a constant payoff η_H whereas a low quality asset is risky with an expected payoff η_L.

In practice, banks' depositors are dispersed and lack the competence or incentives (e.g. free-riding problem) to monitor bankers' behaviors. This free-riding problem creates a need for a representative of the depositors. As a result, the prudential regulator is more biased towards the depositors, which raises the issue of commitment to the optimal intervention policy when action A is non-contractible. Indeed, depositors, with their concave return structure, favor liquidation. Conversely, shareholders, with a convex return structure, favor continuation. Hence, outsiders upon whom control is conferred must be given incentives to intervene in the proper way. I denote D the value of deposits to be reimbursed at $t = 3$.

In effect, bankers report one book value per asset or per class of assets in the financial statements. In my setup, this reported book value is the fair value of the asset. For a financial asset, the fair value is the expected liquidation value if I interpret the latter as the resale price. Thus, in case of Level 2 reporting, the book value is $FV(p) = \mathbb{E}(\mathcal{L} \mid p)$.[18] Similarly, in case of Level 3 reporting, the book value is $FV(p, s) = \mathbb{E}(\mathcal{L} \mid$

[18] I consider the simplest pricing model, which is the expectation of the future payoff conditional on the inputs used. Pricing models can be quite complex and in particular, the determination of the discount rate is important for the valuation of MBS. I remain agnostic about the specific valuation model used.

In line with practice, I do not condition with respect to the realization of the cost of Level 3 reporting. This would lead exactly to the same implementation.

$p, s)$. The following lemma compares the book values at the thresholds of the optimal intervention policy.

Lemma 3. *At the thresholds of the optimal intervention policy, the book values under Level 2 and Level 3 reporting are equal:* $FV(\bar{p}) = FV(\underline{p}, s = g) \stackrel{\text{def}}{=} \overline{BV}$.

Proof. See the appendix. □

The prudential regulator requires the expected value of the bank's assets to be larger than $\overline{BV}$ in order to choose continuation. Next, I shall restate the optimal intervention policy set by the prudential regulator when the intervention policy is solely based on the financial statements of the bank, i.e. on the book value $FV(p)$ (resp. $FV(p, s)$) in case of Level 2 (resp. Level 3) reporting, and on the Level 3 reporting cost.

Proposition 2. *If* $D > \mathcal{L}_L = \eta_L + l$*, the optimal intervention policy can be implemented as follows. The prudential regulator sets a threshold* $\overline{BV}$ *and leaves to the banker the discretion to use Level 2 reporting or Level 3 reporting when the cost* c *is lower than* $\bar{c}$*.*

- *If the banker reports at Level 2 (resp. Level 3) and the book value* $FV(p)$ *(resp.* $FV(p, s)$*) is larger than* $\overline{BV}$*, then the shareholders keep the control rights and chooses continuation;*
- *otherwise the control rights shift to the prudential regulator who chooses liquidation.*

Proof. Direct consequence of Proposition 1. □

Given this capital structure, depositors are strictly better-off in case of liquidation: for a low quality asset, their payoff is $\mathcal{L}_L = \eta_L + l$ in case of liquidation, which is greater than their expected payoff in case of continuation. Conversely, shareholders get zero in case of liquidation of a low quality asset and strictly prefer continuation to "gamble for resurrection". Indeed, the payoff of the low quality asset may be greater than D at the final stage $t = 3$.[19] Shareholders are biased towards continuation whereas depositors are biased towards liquidation. Thus, this optimal capital structure implements the optimal choice of action by investors, namely action C when the reported book value is larger than $\overline{BV}$ and action S when the reported book value is lower than $\overline{BV}$.

[19] The expected payoff of depositors in case of continuation of the low quality asset is $\mathbb{E}(\min(D, \tilde{R})) < \eta_L + l$, where $\tilde{R}$ is the final payoff of a low quality asset with $\mathbb{E}(\tilde{R}) = \eta_L$.

The expected payoff of shareholders in case of continuation of a low quality asset is $\mathbb{E}(\max(0, \tilde{R} - D)) \geq 0$.

The optimal intervention policy is similar to capital requirements for banks or insurance companies.[20] In line with practice, Lemma 3 states that capital requirements are not contingent on the reporting level of the assets. As in Dewatripont and Tirole (1994*c*), capital rules are a means to efficiently allocate control rigths between shareholders and depositors, thereby indirectly influencing the incentives of banks' insiders. The model predicts that banks' insiders use their discretion to classify assets at Level 3 and meet capital requirements set by prudential regulators when the public information is not good enough. This is consistent with several empirical studies (e.g. Hanley et al., 2018) which find that financial institutions actively manage the accounting treatment of their assets to increase regulatory capital.

One interesting feature of the optimal intervention policy is that the banker has the discretion to choose between Level 2 and Level 3 reporting and, in equilibrium, he only classifies an asset at Level 3 when the Level 3 input is good news on the quality of the asset ($s = g$). Hence, this result could explain the empirical results of Hanley et al. (2018), who find that, for insurance companies, the same asset can be reported at the same point in time at Level 2 or Level 3 depending on the company. When the asset is reported at Level 3, the reported price is higher than the Level 2 reported price. This prediction of the optimal intervention policy is also consistent with Laux and Leuz (2010) who argue that banks exercise substantial discretion in fair valuing their assets and provide evidence that points more toward overvaluation.

Corollary 2. *For a deterministic cost c,* $\underline{p}$ *and* $\bar{p}$ *decrease in the Level 3 reporting cost c. When c is sufficiently large, the optimal intervention policy is as in the second benchmark with a Level 2 input but no Level 3 input, i.e.* $\underline{p} = \bar{p} = \sigma$*.*

Proof. See the appendix. □

In case of a deterministic Level 3 reporting cost c, the banker uses less Level 3 reporting as the cost increases and the thresholds converge toward the cutoff σ of the Level 2 benchmark. When the cost of Level 3 reporting is too high relative to the informativeness of the Level 3 input, the prudential regulator does not find it optimal to let the banker classify the asset at Level 3. In that latter case, the prudential regulator relies only on the Level 2 input, as in Lemma 2.

Corollary 3. *As the precision of the private signal s increases, the upper threshold* $\bar{p}$ *increases whereas the lower threshold* $\underline{p}$ *decreases for sufficiently low* β_L*.*

In the limiting case of a perfectly informative private signal ($\beta_L = 0$)*, there is no lower bound on the public signal* ($\underline{p} = -\infty$)*.*

[20] For a fixed amount of deposits D in the bank, setting a constraint on the value of the asset or on the equity E is similar: $BV > \overline{BV}$ is equivalent to $E > \overline{E} = \overline{BV} - D$.

Proof. See the appendix. □

The higher the precision of the private signal (the lower β_L), the larger the range of the Level 2 input in which the prudential regulator relies on Level 3 reporting. In the extreme case of a perfectly informative private signal ($\beta_L = 0$), the prudential regulator chooses continuation if the Level 3 input is good even for very low realizations of the Level 2 input p. In that latter case, the optimal intervention policy is similar to the optimal contract derived in Plantin and Tirole (2017).

Under the optimal intervention policy, the banker's expected utility is

$$U_{banker} = q_L \frac{K}{\Delta q} + B\Bigg(1 - F_L(\bar{p}) + \beta_L G(\bar{c})(F_L(\bar{p}) - F_L(\underline{p}))\Bigg). \tag{1.1}$$

The banker's expected utility is composed of two terms. The first term, $q_L K/\Delta q$, is the second-best utility that would prevail absent measurement frictions, as in Lemma 1 with $\pi = K/(B\Delta q)$. The second term is the rent that the banker gets in case of continuation of a low quality asset for a high Level 2 input, $1 - F_L(\bar{p})$, or for a noisy Level 2 input but a good private signal and a low Level 3 reporting cost, $\beta_L G(\bar{c})(F_L(\bar{p}) - F_L(\underline{p}))$. Corollary 3 implies that the banker's expected utility increases with the probability β_L to get a good Level 3 input given a low quality asset. As a result, the banker is willing to increase ex ante this probability β_L. I analyze the impact of the Level 3 input manipulation in section 1.4.

1.3 The full-fledged multi-bank model

This section is the core of the paper. I endogenize the observable input p in a multi-bank economy and I investigate the externalities of the optimal measurement rules for capital requirements set by the prudential regulator derived in section 3.3.[21]

1.3.1 The model

There is a continuum of banks with unit mass. Each bank faces the same situation as that described in the previous section. In equilibrium, the prudential regulator provides incentives to all the bankers to exert high effort, which in turn implies that a fraction q_H of banks have a high quality asset and a fraction $1 - q_H$ have a low quality asset.

[21]Externalities from prudential regulatory rules may exist because of a lack of coordination among the prudential regulators of different countries or among the prudential regulators within the same country (e.g. OCC, FDIC and Fed in the US). Equivalently, a single prudential regulator may use only microprudential regulations.

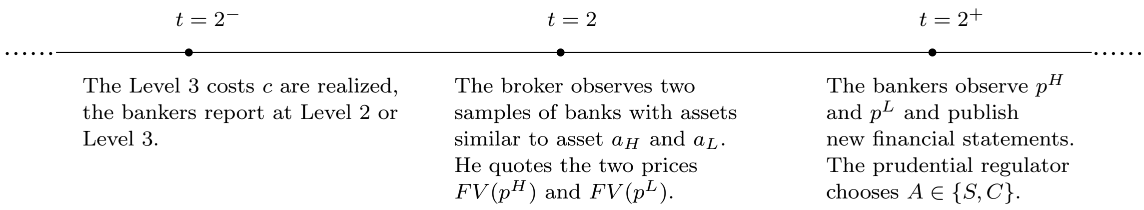

Figure 2: Timeline of the multi-bank model

The timing is similar to the baseline model except for the reporting stage, $t = 2$, which is now decomposed into three dates: $t = 2^-$, $t = 2$ and $t = 2^+$. The timeline of this multi-bank model is summarized in Figure 2.

At $t = 1$, the private Level 3 inputs are realized and are independent across bankers. Further, each banker also observes an arbitrarily weakly informative exogenous Level 2 input on the quality of his asset. Those Level 2 inputs are i.i.d. across banks with assets of the same quality. For instance, the bankers with assets of the same quality observe a very noisy index at different points in time (e.g. S&P's Case–Shiller Home Price Indices).

At $t = 2^-$, the publicly observable costs c of Level 3 reporting are realized and are independent across banks.[22] The bankers report simultaneously their financial statements for the first time. At this date, each banker only observes a weakly informative Level 2 input and his private signal. Hence, if a banker decides to report at Level 2, only the weakly informative Level 2 input becomes public. Otherwise, if a banker reports at Level 3, both the weakly informative Level 2 input and his private signal become public.

At $t = 2$, a third-party (e.g. a broker) quotes a price for a high quality asset a_H and a price for a low quality asset a_L. However, the broker does not know the quality of the assets a_H and a_L. The broker is perfectly competitive and quotes the price $FV(p^H)$ (resp. $FV(p^L)$) at which he is willing to buy/sell asset a_H (resp. a_L) by observing a sample of financial statements of banks that have assets similar to asset a_H (resp. a_L). For asset a_H (resp. a_L), the information p^H (resp. p^L) available to the broker is the fraction of banks in his sample that meet the capital requirement.

Next, I describe how the broker's samples of banks that have assets similar to asset a_H and asset a_L are formed. To that end, I define an asset of quality $Q \in \{L, H\}$ as a *Level 3 asset* if a non-zero fraction of bankers with assets of the same quality Q use Level 3 reporting. In contrast, an asset of quality Q is a *Level 2 asset* if all the bankers

[22]As mentioned previously, the cost of Level 3 reporting depends on some firms' specific factors (size of the auditor, asset...). Assuming independence is a simplification without loss of generality: the results hold as long as correlation is not perfect.

(except a measure zero) with assets of quality Q report at Level 2. As a result, in this multi-bank setting, an asset has two characteristics: it is either a low quality or a high quality asset and either a *Level 2* or a *Level 3 asset*.

Definition An asset of quality $Q \in \{L, H\}$ is a *Level 3 asset* if a non-zero fraction of banks with assets of quality Q use Level 3 reporting. Otherwise, it is a *Level 2 asset*.

Consistency and comparability are the key determinants of the fair value hierarchy. According to the *IASB* (2011), in order "to increase consistency and comparability in fair value measurements", the fair value hierarchy gives "the lowest priority to unobservable inputs (Level 3 inputs)." Accounting standard setters consider that Level 2 reporting is better than Level 3 reporting in terms of comparability and the possibility for outsiders to identify the different banks' assets.[23] Therefore, I assume that, if asset a_H (resp. a_L) is a Level 2 asset, the broker can perfectly identify the banks with similar assets to asset a_H (resp. a_L), i.e. there is no misclassification risk.

Assumption 1. *If asset a_H (resp. a_L) is a Level 2 asset, the broker's observed sample of banks with similar assets to a_H (resp. a_L) is only composed of banks with high (resp. low) quality assets.*

On the contrary and in line with the fair value classification, I introduce a positive misclassification risk for Level 3 assets.[24] Specifically, if asset a_H (resp. a_L) is a Level 3 asset, the broker cannot ascertain perfectly how similar the reporting assets are to asset a_H (resp. a_L). The accuracy of his classification is denoted by α. Thus, if asset a_H (resp. a_L) is a Level 3 asset, only a fraction α of the broker's sample of banks is formed with banks that have high (resp. low) quality assets. The broker does not observe the realization of α, which is distributed on $[0, 1]$ according to the density h, which increases on $[0, 1]$ with $h(0) > 0$. This assumption is broadly consistent with Magnan et al. (2015) who find that analysts' forecasts are more accurate for banks that have a larger proportion of assets reported at Level 2 rather than Level 3.

Assumption 2. *If asset a_H (resp. a_L) is a Level 3 asset, the broker's sample of banks with similar assets to a_H (resp. a_L) is composed of α banks with high (resp. low) quality assets and, misleadingly, $1 - \alpha$ of banks with low (resp. high) quality assets.*

At the last date of the reporting stage, $t = 2^+$, a bank's stakeholders (including the banker and the prudential regulator) with a high (resp. low) quality asset observe

[23] There are more disclosure requirements in the financial statements for Level 3 assets precisely to reduce this misclassification risk.

[24] More generally, assuming that the misclassification risk for Level 2 assets is positive but lower than the one for Level 3 assets would not change qualitatively the results.

the quoted price $FV(p^H)$ (resp. $FV(p^L)$) of asset a_H (resp. a_L) and get the signal p^H (resp. p^L). The bankers report simultaneously their financial statements for the second time using the signals p^H and p^L as Level 2 inputs. As in the baseline model, the prudential regulator then takes an action $A \in \{C, S\}$.

Note that the dates $t = 2^-$ and $t = 2^+$ can be interpreted as two consecutive reporting quarters. The investors of a bank incur the Level 3 reporting cost whether the banker uses Level 3 at $t = 2^-$ or $t = 2^+$. In equilibrium, the bankers report at the same level at $t = 2^-$ and $t = 2^+$.[25]

Definition An *equilibrium* of this multi-bank economy is characterized by an optimal intervention policy $(\underline{p}, \bar{p}, \bar{c})$ and two broker's prices ($FV(p^H)$ and $FV(p^L)$) such that

- given the broker's prices ($FV(p^H)$ and $FV(p^L)$), the optimal intervention policy set by the regulator is $(\underline{p}, \bar{p}, \bar{c})$;
- given the intervention policy $(\underline{p}, \bar{p}, \bar{c})$, the banks report at Level 2 or Level 3 and the broker sets the two prices $FV(p^H)$ and $FV(p^L)$.

1.3.2 Informational externality

I shall now solve for the two equilibria of this economy. First, there is an equilibrium (A) with an optimal intervention policy $(\underline{p}_A, \bar{p}_A, \bar{c}_A)$ similar to Proposition 1. In this equilibrium, the Level 2 inputs p^H and p^L are noisy and banks with both high and low quality assets meet the capital requirement only when using Level 3 reporting, i.e. $\forall Q \in \{L, H\}$, $\bar{p}_A > p^Q > \underline{p}_A$. At $t = 2$, for asset a_H, the fraction of banks that used Level 3 reporting in the broker's observed sample is distributed according to

$$\overbrace{\alpha G(\bar{c}_A)}^{\substack{\text{banks with high quality assets} \\ \text{that are continued}}} + \overbrace{(1-\alpha) G(\bar{c}_A)\beta_L}^{\substack{\text{banks with low quality assets} \\ \text{that are continued}}},$$

which implies that $p^H = \alpha$.[26] Similarly, for asset a_L, the fraction of banks that used Level 3 reporting in his observed sample is distributed according to $(1-\alpha)G(\bar{c}_A) + \alpha G(\bar{c}_A)\beta_L$, which implies that $p^L = 1 - \alpha$. As a result, the likelihood ratio

$$\frac{f_H(p)}{f_L(p)} = \frac{h(p)}{h(1-p)} \text{ increases in } p \text{ because } h_{L3} \text{ also increases in } p.$$

[25] In the appendix 3, I show as a robustness check that the results of this section are the same in case of a sequential game in which a large number N of banks publish sequentially their financial statements and the broker updates the quoted prices by looking at those sequential reports.

[26] The fraction of banks using Level 3 reporting in the sample is $p^H_{L3} = \alpha G(\bar{c}_A) + (1-\alpha)G(\bar{c}_A)\beta_L$. Hence, this signal is equivalent to $p^H = (p^H_{L3}/G(\bar{c}_A) - \beta_L)/(1-\beta_L) = \alpha$.

Thus, the MLRP property is satisfied and I can apply the results of section 3.3. The prudential regulator sets the capital requirement $\overline{BV}_A$ based on the thresholds $\bar{p}_A$ and $\underline{p}_A$ of the optimal intervention policy as in the baseline model in section 1.2.5. This equilibrium only exists if the Level 2 inputs p^H and p^L are sufficiently noisy. I assume that it is indeed verified, i.e. α and $1-\alpha \in]\underline{p}_A, \bar{p}_A[$.[27]

In the other equilibrium (B), which corresponds to the second-best benchmark, all the banks use Level 2 reporting. At $t=2$, the aggregation by the broker of the arbitrarily weakly informative Level 2 inputs reported at $t=2^-$ is perfectly informative because there is no misclassification risk for Level 2 assets. In this equilibrium, the Level 2 inputs available at $t=2^+$ are perfectly informative: $p^H=1$ for banks with high quality assets and $p^L=0$ for banks with low quality assets. As in Lemma 1, a fraction $\pi \in [K/(B\Delta q), 1]$ of banks with high quality assets are continued whereas the other fraction $1-\pi$ of the banks with high quality assets and all the banks with low quality assets are liquidated. The following lemma sums up this discussion.

Lemma 4. *There are two equilibria:*

- (A) *the banks with a good private signal* ($s=g$) *and a low cost of Level 3* ($c<\bar{c}_A$) *report at Level 3 and are continued. All the other banks report at Level 2 and are liquidated;*
- (B) *all the banks use Level 2 reporting and the Level 2 inputs are perfectly informative. A fraction* π *of banks with high quality assets are continued and the other banks are liquidated.*

Proof. See the appendix. □

A direct implication of Lemma 4 is that Level 3 reporting leads to a negative informational externality.

Proposition 3. *In equilibrium* (A)*, banks do not use the socially optimal amount of Level 3 reporting, which in turn implies that investors are better-off in equilibrium* (B).

Proof. See the discussion above. □

Investors are better-off in the second-best equilibrium (B) compared to equilibrium (A). Indeed there is a misclassification risk for Level 3 assets and hence, in equilibrium (A), the Level 2 inputs are less informative for banks carrying Level 3 assets. In equilibrium (A), banks do not internalize the decrease in the informativeness of the public signals when using Level 3 reporting. Thus, due to this informational externality, a social planner maximizing the investors' surplus would be willing to increase the

[27]See the proof of Lemma 4 for a formal statement of this assumption.

use of Level 2 reporting. This objective is in line with accounting standard setters' goal of increasing transparency of financial statements. My findings may also reconcile the conflicting results of the empirical literature on the value relevance of Level 3 information. Using market prices, Kolev (2009), Goh et al. (2015) and Song et al. (2010) find that Level 3 estimates are less value relevant than Level 2 and Level 1 estimates. Other studies using realized future cash flows (e.g. Altamuro and Zhang, 2013; Lawrence et al., 2015) conclude that Level 3 measurements are more efficient in reflecting underlying intrinsic values. My one-bank model predicts that Level 3 fair values are optimally greater and more value relevant than Level 2 fair values for the same asset at the same point in time. Interestingly, I show in section 3.3.4 that this is true even if Level 3 inputs are subject to manipulation. However, my multi-bank analysis shows that fair values of Level 2 assets are more relevant than fair values of Level 3 assets because of this negative informational externality of Level 3 reporting.

My analysis of this informational externality uncovers a drawback of Level 3 reporting. One important takeaway is that the fair value hierarchy may be endogenous because the quality of the public information for one asset depends on the classification levels of similar assets. I show that this endogeneity may lead to an inefficient equilibrium. Using a different argument, Bleck and Gao (2017*b*) and Plantin and Tirole (2017) also point out the endogeneity of the fair value classification by showing that the attempt to extract information from market prices (Level 1 or Level 2 reporting) may destroy the price informativeness. Next, I analyze a benefit of Level 3 reporting.

1.3.3 Payoff externality

There is a potential payoff externality in this multi-bank economy. Indeed, the Level 2 input is identical for the banks with similar assets, which in turn implies that the banks with similar assets using Level 2 reporting have the same book value. Hence, Level 2 reporting may cause a negative payoff externality if banks simultaneously liquidate their assets and the market demand for those illiquid assets is less than perfectly elastic. This congestion effect for financial assets has been at the heart of the debate on fair value accounting during the 2007-08 financial crisis. The main fear was that fire sales may lead to a decrease in assets' prices and this would negatively impact banks' balance sheets, as empirically shown by Bhat et al. (2011) in the case of MBS. Therefore, if I interpret the liquidation decision as a resale decision and the liquidation value as the resale price, simultaneous resale decisions may lead to a decrease of the price because of the illiquidity of the market.

I model the congestion effect as follows. The liquidation price of an asset of quality Q at an intermediate date, $\mathcal{L}_Q(\mu_Q) > 0$, is a function of μ_Q, the fraction of the banks with an asset of quality Q which choose liquidation. There is a cutoff on the number of liquidations $\overline{\mu_Q}$ and a discount on the resale price $\delta \in [0,1)$ such that if $\mu_Q \geq \overline{\mu_Q}$, $\mathcal{L}_Q(\mu_Q) = \delta\mathcal{L}_Q$. Otherwise, if $\mu_Q < \overline{\mu_Q}$, $\mathcal{L}_Q(\mu_Q) = \mathcal{L}_Q$. For simplicity, I assume that $\overline{\mu_Q} = 1$.[28] In other words, there is a drop in the liquidation prices when almost all the banks with similar assets liquidate simultaneously. This way of modeling the congesting effect is consistent with Brunnermeier and Pedersen (2009), who predict sudden drops in market liquidity and hence, in market prices, for sufficiently large shocks on traders' capital.[29] Those drops in prices are larger for risky and illiquid securities. The reason is the existence of liquidity spirals caused by destabilizing margins for traders. As a result, the parameter δ is a function of the illiquidity of the resale market and of the riskiness of the asset. Specifically, the lower is the market liquidity and the riskier is the asset, the stronger is the congestion effect (the lower is δ).

Proposition 4. *There exists a cutoff $\bar{\delta} \in (0,1)$ such that, if there is a sufficiently strong congestion in the liquidation price (i.e. $\delta < \bar{\delta}$), the investors are better-off in equilibrium (A).*

Proof. See the appendix. □

As underlined in the introduction, mark-to-market accounting has been criticized by some practitioners and academics for leading to contagion effects due to a feedback loop between illiquid markets, banks' resale decisions and exogenous capital requirements (Allen and Carletti, 2008*a*) or managerial short-termism (Plantin et al., 2008*a*). In my setup, mark-to-market, or Level 2 reporting, increases systemic risk because liquidation decisions for banks using Level 2 reporting are based on the same public information. Therefore, upon sufficiently bad public information, Level 2 reporting triggers simultaneous liquidations by distressed banks. Those liquidations are inefficient because of the congestion in the liquidation prices of the assets. Namely, equilibrium (B) with only Level 2 reporting is worse than equilibrium (A) when δ is sufficiently small, i.e. for risky and illiquid securities. Securities classified at Level 2 or Level 3 have precisely those properties. This result emphasizes the real effects of fair value accounting on financial institutions' behaviors and on financial stability.

[28] The results are robust for any $\overline{\mu_Q}$ close to one. I provide in the proof of Proposition 4 the exact lower bounds needed for $\overline{\mu_H}$ and $\overline{\mu_L}$.

[29] Their model predicts that the effect of speculator capital on market liquidity is highly nonlinear. Although a marginal change in capital has a small effect when speculators are far from their constraints, this marginal change has a large effect when speculators are close to their constraints, leading to a jump in illiquidity and prices. Duffie et al. (2007) also predict jump in prices as a result of liquidity shocks.

My analysis of this second payoff externality underscores a relative benefit of Level 3 reporting compared to mark-to-market accounting.

In the introductory case of MBS, if all banks use the same credit spread over the risk-free rate (e.g. ABX index during the 2007-08 crisis) to compute fair values, then all banks with similar MBS report the same book value and distressed banks may be liquidated at the same time. On the other hand, if some bankers use their private information on the borrowers to adjust for differences between the index used and the actual asset, then there is some heterogeneity in the adjustments and the assumptions made to compute fair values. Indeed, in equilibrium, some banks use their private information to adjust public data but some banks do not because this private information is bad news or because their cost of Level 3 reporting is too high. Thus, under Level 3 reporting, banks with similar MBS report different book values, which in turn leads to different liquidation decisions.

1.3.4 Optimal fair value accounting standards

After studying the two opposite externalities of Level 3 reporting, I shall now conclude on the fair value accounting standards that a social planner maximizing investors' surplus would set.[30] To that end, I first state the following corollary that highlights the optimal fair value standards.

Corollary 4. *There is a tradeoff between comparability of financial statements and systemic risk:*

- *if the congestion effect is not too severe ($\delta > \bar{\delta}$), equilibrium (B) is efficient and banning Level 3 reporting is optimal;*
- *otherwise, if the congestion effect is severe ($\delta < \bar{\delta}$), equilibrium (A) is efficient and the optimal accounting standards use both Level 2 and Level 3 reporting.*

Further, $\bar{\delta}$ decreases in the probability q_H to get a high quality asset.

Proof. Direct consequence of Propositions 3 and 4. □

Increasing the use of Level 2 reporting may be socially optimal because it would increase the quality of the public information. However, when banks use only Level 2 reporting, the banks with the same type of assets report the same book value, which may lead to simultaneous inefficient liquidations. In other words, systemic risk is the price to pay to increase the consistency and the comparability of financial statements. The objective of standard setters is to increase transparency, whereas the objective of

[30]The social planner could be the prudential regulator or another public entity.

prudential regulators is to increase financial stability (Barth and Landsman, 2010*a*). My model underscores that those two objectives are in conflict when the congestion effect is severe ($\delta < \bar{\delta}$). In that latter case, a certain degree of opacity is optimal to increase financial stability. An interesting analogy can be drawn with Dang et al. (2017), who argue that banks are optimally opaque institutions to avoid runs. Goldstein and Sapra (2014) also accent this tradeoff between transparency and financial stability in the context of banks' stress tests disclosure.

In normal times, there are more potential buyers for banks' assets, which implies that banks face less monopsony power (higher δ). On the contrary, during distressed times, potential buyers are financially constrained and banks face more monopsony power (lower δ). As a result, it could well be the case that the efficient equilibrium is (B) under normal economic conditions and it switches to equilibrium (A) when a financial crisis hits. Having flexible accounting standards and letting banks move assets into the Level 3 category during financial collapses may therefore be the optimal policy to increase financial stability. Level 3 reporting then acts as a circuit-breaker and reduces systemic risk caused by mark-to-market. Laux and Leuz (2010) underline that banks were able to use this accounting discretion during the 2007-08 financial crisis. This policy could be more efficient to reduce systemic risk rather than isolating the effect of fair value measures on regulatory capital, which would strengthen the moral hazard problem between banks' insiders and investors.[31] I discuss in further details the policy implications of the model in section 1.5.3.

One way for standard setters to influence the use of Level 3 reporting is to change the Level 3 reporting cost. For instance, accounting standard setters may impose standardized valuation models for Level 3 assets. This would increase the reliability of Level 3 valuations and reduce auditing costs associated to Level 3 reporting. On the other hand, increasing the reporting requirements would increase the cost.[32] Auditing standard setters can also influence the audit cost by requiring more due diligence and disclosure requirements from auditors for Level 3 assets, which would in turn increase audit fees. Increasing auditors' litigation risks for mispricing would also increase audit fees and reduce the use of Level 3 reporting. For example, Botosan et al. (2011) provide evidence that auditors' litigation risks limited the use of Level 3 reporting during the 2007-08 financial crisis. In the following corollary, I shall solve for the optimal distribution of the Level 3 reporting that maximizes the investors' surplus.

[31] For instance by applying a filter on unrealized fair value gains and losses or by allowing financial institutions to reclassify assets into the HTM category and use amortized cost (Huizinga and Laeven, 2012).

[32] For example, the FASB is currently proposing to eliminate the disclosure of transfers between Level 1 and Level 2 category but they have increased the disclosure requirements for Level 3 (*FASB*, 2016).

This distribution of the cost is fixed by a social planner at $t = 0^-$, anticipating that capital requirements are fixed at $t = 0$, based on the banks' financial statements.

Corollary 5. *In order to maximize the investors' surplus:*

- *if $\delta > \bar{\delta}$, the social planner sets the Level 3 reporting cost to infinity, i.e. bans Level 3 reporting;*
- *otherwise, if $\delta < \bar{\delta}$, the social planner sets the minimum Level 3 reporting cost.*

Proof. Direct consequence of Corollary 4. □

In the first case, when the market's demand for the assets is sufficiently elastic ($\delta > \bar{\delta}$), accounting standard setters and prudential regulators' objectives coincide and it is then optimal to ban Level 3 reporting. Otherwise, when the congestion effect is severe ($\delta < \bar{\delta}$), prudential regulators and standard setters should compromise on the objective. As discussed above, there is a tradeoff between transparency and financial stability. It is optimal to decrease the Level 3 reporting cost as much as possible. An interesting extension of this model, which lies beyond the scope of this paper, would be to consider explicitly two types of regulators, accounting standard setters and prudential regulators, to study their optimal behaviors and the implementation of the optimal fair value standards.[33]

1.4 Manipulation of the banker's private information

Up to this point, the precision of the Level 3 input, $1 - P(s = g \mid L) = 1 - \beta_L$, has been exogenous. I now endogenize this precision as a costly choice of the banker. In practice, manipulation of the banker's private information is a major concern for regulators and practitioners. Level 3 reporting is considered as the less reliable level. For example, it has been compared by practitioners to "mark-to-myth" (Buffett, 2002) or "mark-to-believe" (Weil, 2007). For the introductory case of MBS, Dechow et al. (2010) provide evidence that managers are able to manipulate discount rates, which are key inputs into the valuation process.[34] Therefore, I assume that the banker can increase by $\beta \in [0, 1 - \beta_L]$ the probability of receiving a good private signal ($s = g$)

[33]For a first step towards the understanding of the political economy of accounting choices, see Bertomeu and Magee (2011).

[34]They find that, on average, discount rates are lower when firms report securitization losses than when they report gains. Lower discount rates increase the fair value of retained interest, resulting in smaller losses.

when the asset is a low quality one. The distribution of the Level 3 input becomes

$$P(s = g \mid H) = 1 \text{ and } P(s = g \mid L) = \beta_L + \beta = 1 - P(s = b \mid L). \tag{1.2}$$

The parameter β can be interpreted as the extra probability that the banker succeeds in generating a good signal for low quality assets. For simplicity, the manipulation decision is taken by the banker at $t = 0$ after the intervention policy is set but before the effort decision. Hence, the manipulation level β does not depend on the effort decision and on the Level 2 input. Of course, manipulation in practice can occur in all stages of fair value reporting, both before and after the effort decision and the realization of the public information. As a robustness check, I discuss the other possible timings of manipulation in the appendix 3.

The private cost of manipulation for the banker is quadratic, $k\beta^2/2$, with $k > 0$. This cost covers all the costs to the banker of concocting and camouflaging the falsification as well as the cost of bribing the auditor.[35] The parameter k measures the magnitude of all these effects. As in Laux and Stocken (2012), I consider separately in the online appendix the impact of litigation risks for mispricing as well as reputation costs.

The banker affects the distribution of the Level 3 input before having any private information on the asset quality. This is similar to the "signal-jamming" literature (e.g. Stein, 1989), whereby an agent takes a costly action that is intended to mislead but actually misleads no one in equilibrium. Indeed, in equilibrium, the level of manipulation β^* is known by the prudential regulator.

Definition I define k as the *reliability* of the Level 3 input.

I assume that the reliability of the Level 3 input is large enough in order that the equilibrium level of manipulation is interior.

Lemma 5. *In the single-bank model, as long as $k > \bar{k}$, there is a unique equilibrium level of manipulation $\beta^* \in (0, 1)$. This equilibrium level of manipulation β^* decreases in the reliability of the Level 3 input and increases in the private benefit B.*

Proof. See the appendix. □

The first part of Lemma 5 confirms the existence of a unique level of manipulation in equilibrium as long as the prudential regulator finds it optimal to let the banker

[35]For instance, the banker might understate the discount rate for the future cash flows of a given security to boost the fair value. With probability β, the external auditor accepts the discount rate and with probability $1 - \beta$, the auditor requires a reevaluation of the fair value. Orchestrating this manipulation is costly to the banker.

use Level 3 reporting, i.e. the Level 3 input is sufficiently informative (see Corollary 1). The second part provides some comparative statics. In particular, the higher is the benefit of manipulation or the smaller is the banker's private cost of manipulation, the higher is the extent of manipulation. This prediction is in line with the empirical evidence that weaker corporate governance (lower cost k) implies less relevant Level 3 information (Song et al., 2010). However, it is worth underlining that, even if Level 3 reporting is subject to manipulation, it still provides some valuable information to the prudential regulator. More generally, it is not because an accounting system is subject to earnings management that this system is not desirable (Barth and Taylor, 2010).

Lemma 6. *The optimal intervention policy for a single bank is such that $\bar{p}(\beta^*)$ increases and $\underline{p}(\beta^*)$ decreases in the reliability of the Level 3 input.*

If the reliability of the Level 3 input is too low ($k < \bar{k}$), then the optimal intervention policy relies only on the Level 2 input.

Proof. Direct consequence of Corollary 3 and Lemma 5. □

As in Gao (2015), the optimal accounting thresholds of the intervention policy depend on the equilibrium level of manipulation. The higher is the manipulation, the less informative the banker's private signal is. Hence, the prudential regulator relies more on the public signal as manipulation increases. The prudential regulator internalizes the decrease in the precision of the Level 3 input caused by manipulation when setting the optimal intervention policy. Next, I analyze the impact of manipulation in the multi-bank economy.

Proposition 5. *If the reliability of the Level 3 input is too low, then the only equilibrium in the multi-bank economy is the equilibrium (B) with no Level 3 reporting.*

Proof. Direct consequence of Lemma 6. □

In the multi-bank economy, when manipulation is too high, banks do not use Level 3 reporting and the only equilibrium is (B). An important takeaway from this analysis is that manipulation of Level 3 inputs may increase systemic risk in the economy. Indeed, manipulation decreases the informativeness of Level 3 inputs, which may increase systemic risk according to the results of section 1.3. Manipulation of Level 3 inputs entails a social cost. As a result, the social planner should increase the reliability of Level 3 inputs. Another counterintuitive solution would be to expand the use of Level 3 reporting when Level 3 inputs are subject to manipulation to decrease systemic risk.

Another implementation problem of Level 3 reporting that may arise is the litigation and reputation risks that preparers face when deviating from observable information to compute fair values (Laux and Leuz, 2009; Securities and Exchange Commission, 2008). Preparers of financial statements may be reluctant to deviate from low market prices and to report higher Level 3 fair values when being exposed to litigation and reputation risks resulting from mispricing errors. In the online appendix, I study a simple extension of the model with litigation/reputation risks and I point out that those risks reduce the use of Level 3 reporting in equilibrium and may also increase systemic risk.

1.5 Discussion

1.5.1 Fair value versus historical cost

The alternative accounting method to measure illiquid assets is the use of historical cost accounting. For instance, financial assets classified as "held-to-maturity" (HTM) under US GAAP are reported at amortized cost less impairment. In particular, the lower-of-cost-and-net-realizable-value rule (LCNRV) requires a downward revaluation of the book value of an asset from its current book value but does not allow an upward revaluation. Using the baseline model, I shall compare the fair value accounting regime and the historical cost regime with the LCNRV rule.[36]

Corollary 6. *The cutoff on the reported book value of the optimal intervention policy is greater than the historical cost (HC):* $\overline{BV} > q_H\eta_H + (1-q_H)(\eta_L + l) \geq HC$.

As a result, there are too many continuations under historical cost accounting.

Proof. See the appendix. □

Under the LCNRV rule, the prudential regulator only has access to two truncated signals. The optimal intervention policy would be for the prudential regulator to choose continuation if the book value is HC and to choose liquidation whenever the reported book value is lower than HC. The optimal intervention policy under historical cost leads to too many continuations compared to the one under fair value and the prudential regulator (i.e. the investors) is worse-off. Historical cost accounting increases the agency rents bankers are able to extract. This extension bears interesting relationship to the regulatory forbearance observed during the savings and loan (S&L) crisis of the

[36] The historical cost HC is unknown in this paper because I do not model the primary markets for the assets. Nonetheless, HC is at most equal to the expected payoff of this asset at $t = 0$. This implies that $HC \leq q_H\eta_H + (1-q_H)(\eta_L + l)$.

1980s and 1990s (Dewatripont and Tirole, 1994*c*). At that time, historical cost was the main accounting rule for financial instruments. Many insolvent S&L associations were allowed to remain open, and their financial problems only worsened over time. As a result, in 1991, the Government Accounting Office (GAO) pushed for immediate adoption of mark-to-market accounting for all debt securities. Thus, my paper provides a rationale for the gradual move of accounting standards from historical cost accounting towards the use of fair value measurements.

1.5.2 Empirical predictions

My findings generate a number of interesting empirical predictions. The main prediction of the one-bank model is that Level 3 reporting is only used when the banker's private information is good information on the asset quality, above and beyond the public information (Level 2 input). This prediction is easy to test and previous empirical studies have already provided evidence of this effect. Contrary to some of those previous studies, I claim that this effect is not necessarily due to manipulation detrimental to investors but may be part of an optimal mechanism for the prudential regulator to provide managerial discipline. My analysis highlights that discretion in fair value estimates may be welfare improving (Barth and Taylor, 2010).

In the same vein, my model predicts that bankers use their discretion to classify assets at Level 3, increase the fair value and meet capital requirements. This is consistent with prior empirical studies that show that insurers (Ellul et al., 2015*a*; Hanley et al., 2018) and banks (Huizinga and Laeven, 2012) use their discretion to manage the accounting treatment of their financial assets to increase their regulatory capital.

Another intuitive empirical prediction of the one-bank model is that in equilibrium, only banks with a low cost of Level 3 reporting classify assets at Level 3. This is in line with Altamuro and Zhang (2013) and Botosan et al. (2011) who provide evidence that large firms with a Big Four auditor are more likely to report an asset at Level 3. Iselin and Nicoletti (2017) show that banks avoid costly disclosure of Level 3 assets through changes in both asset composition and classification.

My analysis may also reconcile the conflicting empirical evidence from previous research on the value relevance of Level 3 reporting. Level 3 reporting is valuable because it adds some information in addition to the public information. As discussed in section 1.3.2, value relevance studies using market prices to evaluate fair values conclude that Level 1 and Level 2 fair values are more value relevant, while studies using realized future cash flows to evaluate fair values conclude that Level 3 fair values are more value relevant. My analysis suggests that bankers provide some valuable information on the asset quality when using Level 3 reporting, above and beyond the public information. Importantly, this result holds even in the presence of manipulation. However, fair values of Level 3 assets are less relevant than fair values of Level 2 assets because of the negative informational externality of Level 3 reporting.

My multi-bank analysis might also explain the inconclusive nature of the preceding empirical evidence on the role of fair value accounting during the financial crisis. While fair value accounting is found to be associated with systemic risk in the financial system (e.g. Bhat et al., 2011; Khan, 2014), multiple papers conclude that fair value accounting played little or no role in the crisis (e.g. Barth and Landsman, 2010*a*; Laux and Leuz, 2010). Several studies also underscore that fair value does not contribute to procyclical leverage (e.g. Amel-Zadeh et al., 2017). My results predict that the systemic risk linked to fair value accounting depends on the possibility for banks to move assets into the Level 3 category.

1.5.3 Policy implications

The predictions of the one-bank model may be of interest to auditors and auditing standard setters, such as the PCAOB. Specifically, my results contribute to the understanding of banks' incentives to use Level 3 reporting and why estimates of a similar asset may differ across banks.

The full-fledged multi-bank model underscores a tradeoff for standard setters and prudential regulators between having uniform and restrictive standards (Level 2 reporting), which can lead to systemic risk, and flexible standards (Level 3 reporting), which provide potentially more relevant information but reduce the consistency and the comparability of financial statements. This tradeoff, which relates to the relevance-reliability tradeoff, is central to determine whether or not banks should be allowed to use Level 3 reporting. Indeed, during the financial panic of 2007-08, regulators, banks and investors pressured standard setters to ease the possibility for banks to move assets into the Level 3 category because of sharp declines in quoted prices. The IASB and the FASB issued several guidelines in that direction which have highlighted hesitations of standard setters on this issue.[37] This could be explained by the conflicting interests between standard setters, who favor transparency, and prudential regulators, who care about financial stability. But the relaxation of the fair value reporting rules by standard setters during the crisis could be interpreted as an implicit acknowledgement that in periods of bust, less information may be better (Bank for International Settlements, 2015).

[37] For an overview of the FASB successive guidelines during the 2007-08 crisis, see Bhat et al. (2011).

The results are important amid the debate on the impact of accounting rules on financial stability. As commonly argued by the opponents of mark-to-market, carrying assets valued with public market prices may lead to inefficient contagion effects in bad times. I provide a novel channel that links Level 2 reporting and systemic risk: relying only on public market data may lead to simultaneous liquidations. As a result, allowing banks to deviate from public information and use the bankers' private information to compute fair values may mitigate this systemic risk. On the contrary, allowing banks to reclassify assets into the HTM category in bad times and use historical cost seems suboptimal. As shown in section 1.5.1, historical cost accounting may increase agency costs associated to moral hazard problems. Fair value accounting yields better ex ante decisions making by banks, especially in the presence of severe agency conflicts (Lu et al., 2016). Moreover, historical cost accounting with impairment may not protect against systemic risk because downward adjustments should be taken into account. Another policy, which has been adopted by some countries, is a filter to shield regulatory capital from fair value losses. My analysis suggests that this policy also strengthens the initial moral hazard problem. This is consistent with Chircop and Novotny-Farkas (2016*b*), who find that the removal of the fair value filter on regulatory capital would reduce ex ante risk taking by banks. In the same vein, Ellul et al. (2015*a*) find that the use of fair values in statutory accounting reduces ex ante risk-taking incentives in insurance firms.

My multi-bank analysis also underlines that the endogeneity of the fair value classification is not neutral. Indeed, the quality of the public information available for an asset depends on the classification level of this asset. This in turn implies that fair value classification decisions by banks may lead to informational externalities in equilibrium.

Lastly, the concern for manipulation is a substantial argument against Level 3 reporting but Level 3 inputs can be informative even if they are subject to manipulation (Laux, 2012). Regulators internalize the potential manipulation of Level 3 inputs when setting capital requirements. However, manipulation reduces the desirability of Level 3 reporting and may increase systemic risk.

1.6 Conclusion

While accounting standards have gradually evolved towards the use of fair value measurements, very little is known on the desirability of using banks' private information (Level 3 reporting) to compute fair values. In this paper, my objective is to shed some light on banks' incentives to use Level 3 reporting and on the economic consequences they entail. To that end, I develop a model of prudential regulation à la Dewatripont and Tirole (1994*c*), which brings in accounting measures as the primary inputs into capital requirements set by a prudential regulator to efficiently allocate control rights within a bank and to provide managerial discipline. I show that, for a single bank, it is optimal to leave the choice between Level 2 and Level 3 reporting to the discretion of the banker. In equilibrium, Level 3 reporting is only used by the banker to reveal good information, above and beyond observable inputs, and to meet capital requirements. The predictions of the baseline model are consistent with empirical studies on fair value accounting.

Then, I analyze the externalities of the optimal measurement rules for one bank in a multi-bank economy and uncover an interesting tradeoff. On the one hand, Level 3 reporting decreases the consistency and the comparability of financial statements, which in turn reduces the ability for a bank's stakeholders to extract information from financial statements of similar banks. On the other hand, Level 3 reporting decreases systemic risk caused by mark-to-market (i.e. fair value with observable inputs). Indeed, under mark-to-market accounting, liquidation decisions are based on public information, which may trigger simultaneous inefficient liquidations. The full-fledged multi-bank model sheds some light on the potential role of fair value accounting during the 2007-08 financial crisis. Standard setters and prudential regulators, who may have conflicting interests, should tradeoff transparency and financial stability.

Finally, Level 3 reporting has been heavily criticized because of potential manipulation of Level 3 inputs. My analysis underscores that prudential regulators internalize the resulting decrease in the informativeness of those inputs when setting capital requirements and that Level 3 reporting still provides some valuable information to prudential regulators. However, manipulation of Level 3 inputs, which reduces the use of Level 3 reporting, may in turn increase systemic risk.

This paper is a first step towards a more comprehensive understanding of the economic consequences of Level 3 reporting. I believe that this framework could be used to address other questions related to Level 3 reporting. One important caveat to my analysis is that I do not model the market liquidity for the assets held by the banks. Therefore, an interesting extension of the model would be to consider another equilibrium effect that Level 3 reporting may have on assets' market liquidity. If the bankers have different types of information on the value of their assets, Level 3 reporting may reveal their private information and increase the public information available for those assets. This may, in turn, increase the market liquidity of those assets. Another important route for future research would be to analyze the optimal level of aggregation of fair values on banks' balance sheets given the heterogeneity of their assets.

More broadly, the tradeoff between transparency and financial stability is key to standard setters and prudential regulators. My analysis challenges the conventional wisdom that higher accounting quality and improved transparency is always desirable for the banking system in the context of fair value accounting. This tradeoff would require further investigations to identify other desirable accounting properties for the banking industry (securitization, loan loss provisioning...).

Appendix 1: Proofs

Proof of Lemma 2

The optimal intervention policy rewards the banker if the public signal p is sufficiently large. The incentive-compatibility constraint that ensures that the banker exerts effort is

$$B\int_{-\infty}^{+\infty}(q_H f_H(p)+(1-q_H)f_L(p))dp-K\geq B\int_{-\infty}^{+\infty}(q_L f_H(p)+(1-q_L)f_L(p))dp,$$

which is equivalent to

$$B\int_{-\infty}^{+\infty}(f_H(p)-f_L(p))dp\geq\frac{K}{\Delta q}.$$

Define the threshold σ such that the incentive-compatibility constraint binds:

$$B\int_{\sigma}^{+\infty}(f_H(p)-f_L(p))dp=\frac{K}{\Delta q}.$$

The optimal intervention policy is such that the prudential regulator rewards the banker if and only if p is larger than σ.

Finally, I have assumed that K is small enough such that effort incentives can be provided by using the Level 2 input only, i.e. $K<\bar{K}=B\Delta q\max_\lambda(\int_\lambda^{+\infty}(f_H(p)-f_L(p))dp)$. This assumption guarantees the existence of σ.

Proof of Proposition 1

At $t=2$, as part of the optimal mechanism, the banker makes a cheap talk report $r\in\{g,b\}$ on the signal s to the prudential regulator. To simplify the analysis, I apply the Revelation Principle (Myerson, 1981) and, hence, I can restrict the analysis to direct mechanisms in which the banker truthfully reports the private signal, i.e. $r=s$. I state the optimization problem for a fixed public cost c of Level 3 reporting and then solve the case of a random cost.

The intervention policy set by the prudential regulator contains three elements. First, $\pi_r(p)$ is the probability of reporting the asset at Level 3, contingent on a Level 2 input p and a report r. Then, $v_r(p)$ is the probability of continuation contingent on a Level 2 input p and a report r. Finally, $w_r(p,s)$ is the probability of continuation contingent on a Level 2 input p, Level 3 input s and a report r.

Lemma 7. *In equilibrium, the prudential regulator always liquidates the asset when the banker is caught lying ($w_g^*(p,b)=w_b^*(p,g)=0$).*

In equilibrium, the banker has incentives to report s truthfully. As a result, it is optimal for the prudential regulator not to reward the banker after being caught lying. Taking into account this lemma, the truthtelling constraints that ensure that the banker reveals the private information are

$$(1-\pi_g(p))v_g(p)+\pi_g(p)w_g(p,g) \geq (1-\pi_b(p))v_b(p), \tag{1.3}$$

and

$$(1-\pi_b(p))v_b(p)+\pi_b(p)w_b(p,b) \geq (1-\pi_g(p))v_g(p). \tag{1.4}$$

The expected utility of the banker is

$$\begin{aligned} U_{banker}(q) = B\int \Bigg[& qf_H(p)\Big((1-\pi_g(p))v_g(p)+\pi_g(p)w_g(p,g)\Big) \\ & + (1-q)(1-\beta_L)f_L(p)\Big((1-\pi_b(p))v_b(p)+\pi_b(p)w_b(p,b)\Big) \\ & + (1-q)\beta_L f_L(p)\Big((1-\pi_g(p))v_g(p)+\pi_g(p)w_g(p,g)\Big)\Bigg]dp - K\mathbb{1}_{\{q=q_H\}}. \end{aligned}$$

The ex ante incentive-compatibility constraint of the banker is

$$U_{banker}(q_H) \geq U_{banker}(q_L).$$

This is equivalent to

$$\begin{aligned} B\int \Bigg[& (f_H(p)-\beta_L f_L(p))\Big((1-\pi_g(p))v_g(p)+\pi_g(p)w_g(p,g)\Big) \\ & - f_L(p)(1-\beta_L)\Big((1-\pi_b(p))v_b(p)+\pi_b(p)w_b(p,b)\Big)\Bigg]dp \geq \frac{K}{\Delta q}. \end{aligned} \tag{1.5}$$

This constraint ensures that the banker exerts high effort in equilibrium. If the private cost of exerting high effort is too large, it is too costly and this is not possible to induce the banker to exert high effort. Thus, I assume that the cost of effort K is not too large, so that, high effort by the banker is optimal for the prudential regulator.

The expected utility of the prudential regulator is

$$\begin{aligned} U_{investors}(q) = \int \Bigg[& qf_H(p)\Big(\eta_H - \pi_g(p)c\Big) \\ & + (1-q)(1-\beta_L)f_L(p)\Big(\eta_L + l - (1-\pi_b(p))lv_b(p) - \pi_b(p)(lw_b(p,b)+c)\Big) \\ & + (1-q)\beta_L f_L(p)\Big(\eta_L + l - (1-\pi_g(p))lv_g(p) - \pi_g(p)(lw_g(p,g)+c)\Big)\Bigg]dp. \end{aligned}$$

The prudential regulator's optimization problem is

$$\max_{\pi_g(.),v_g(.),w_g(.,.)} U_{investors}$$

subject to the constraints (1.3), (1.4) and (1.5).

The solution of this optimization problem yields the optimal intervention policy of this model. To solve this problem, I first state a lemma which is intuitive and simplifies the analysis to get the optimal intervention policy.

Lemma 8. *In equilibrium, it is never optimal to classify the asset at Level 3 after a bad report ($\pi_b^*(p) = 0$). Furthermore, $v_b^*(p) = (1 - \pi_g^*(p))v_g^*(p)$.*

This relaxes the incentive constraint and increases the utility of the investors. Indeed, Level 3 reporting makes the banker's private information public. The banker wants to make a good report to induce continuation and, therefore, it is optimal for the prudential regulator to verify only a good report ($r = g$).

First, suppose that the cost of Level 3 reporting c is a constant. The lagrangian of the prudential regulator's maximization problem is

$$\begin{aligned} L(v_g(.), \pi_g(.), w_g(.,.), \lambda) = \int \Bigg[& q_H f_H(p)\Big(- \pi_g(p)c\Big) \\ & + (1 - q_H)\beta_L f_L(p)\Big(- (1 - \pi_g(p))lv_g(p) - \pi_g(p)(lw_g(p, g) + c)\Big) \\ & + (1 - q_H)(1 - \beta_L)f_L(p)\Big(- (1 - \pi_g(p))lv_g(p)\Big) + \lambda\Big(B(f_H(p) - \beta_L f_L(p))(1 - \pi_g(p))v_g(p) \\ & + \pi_g(p)w_g(p, g)) - B(1 - \beta_L)f_L(p)(1 - \pi_g(p))v_g(p)\Big)\Bigg] dp, \end{aligned}$$

where λ is the lagrange multiplier.

Taking the FOCs, the solution of this maximization problem is $\pi_g(p) = \pi \mathbb{1}_{\{\underline{p}<p<\bar{p}\}}$, $v_g(p) = \mathbb{1}_{\{p>\bar{p}\}}$, $w_g(p, g) = \mathbb{1}_{\{p>\underline{p}\}}$ with $\dfrac{f_H(\underline{p})}{f_L(\underline{p})} = \beta_L \dfrac{f_H(\bar{p})}{f_L(\bar{p})}$ and

$$\frac{f_H(\bar{p}) - f_L(\bar{p})}{f_L(\bar{p})} \frac{q_H f_H(\bar{p}) + (1 - q_H)\beta_L f_L(\bar{p})}{(1 - \beta_L)f_H(\bar{p})} = (1 - q_H)\frac{l}{c}.$$

The probability π is set optimally such that (1.5) binds.

Next, I suppose that the Level 3 cost is random. The prudential regulator can achieve this optimal probability π of using Level 3 at the lowest cost by letting the banker reports the asset at Level 3 if the cost is lower than some cap $\bar{c}$. Therefore, the prudential regulator optimally set $\bar{c}$ such that $\pi = G(\bar{c})$.

Under the optimal intervention policy,

$$\begin{aligned} U_{investors} = {} & q_H\eta_H + (1 - q_H)(\eta_L + l) - l(1 - q_H)(1 - F_L(\bar{p})) \\ & - G(\bar{c})\mathbb{E}(c \mid c < \bar{c})\Big(q_H(F_H(\bar{p}) - F_H(\underline{p})) + (1 - q_H)\beta_L(F_L(\bar{p}) - F_L(\underline{p}))\Big) \\ & - G(\bar{c})l(1 - q_H)\beta_L(F_L(\bar{p}) - F_L(\underline{p})). \end{aligned}$$

Thus, the optimal intervention policy solves

$$\min_{\underline{p},\bar{p},\bar{c}} l(1-q_H)(1-F_L(\bar{p})) - G(\bar{c})l(1-q_H)\beta_L(F_L(\bar{p})-F_L(\underline{p}))$$
$$+ G(\bar{c})\mathbb{E}(c \mid c < \bar{c})\Big(q_H(F_H(\bar{p})-F_H(\underline{p})) + (1-q_H)\beta_L(F_L(\bar{p})-F_L(\underline{p}))\Big)$$

subject to the incentive-compatibility constraint

$$F_L(\bar{p}) - F_H(\bar{p}) + G(\bar{c})\Big(F_H(\bar{p}) - F_H(\underline{p}) - \beta_L(F_L(\bar{p})-F_L(\underline{p}))\Big) = \frac{1}{B}\frac{K}{\Delta q}. \tag{1.6}$$

The FOCs yield

$$\frac{f_H(\bar{p}) - f_L(\bar{p})}{f_L(\bar{p})}\frac{q_H f_H(\bar{p}) + (1-q_H)f_L(\bar{p})}{(1-\beta_L)f_H(\bar{p})} = \frac{G(\bar{c})((1-q_H)lG(\bar{c}) + \int_0^{\bar{c}} cg(c)dc)}{\int_0^{\bar{c}} cg(c)dc} \tag{1.7}$$

and

$$\frac{f_H(\underline{p}) - \beta_L f_L(\underline{p})}{f_L(\underline{p})}\frac{q_H f_H(\underline{p}) + (1-q_H)\beta_L f_L(\underline{p})}{(1-\beta_L)f_H(\underline{p})} = \beta_L\frac{G(\bar{c})((1-q_H)lG(\bar{c}) + \int_0^{\bar{c}} cg(c)dc)}{\int_0^{\bar{c}} cg(c)dc}. \tag{1.8}$$

The system $\{(1.6),(1.7),(1.8)\}$ has one solution $(\underline{p},\bar{p},\bar{c})$ which is the interior solution of the optimization problem. I rule out corner solutions for this problem.

Finally, I have assumed in the main text that $l > 0$. Assuming $l < 0$ yields exactly the same optimal intervention policy (identical proof).

Proof of Corollary 1

It is optimal for the regulator to let the banker use Level 3 reporting if and only if the utility of the investors under the optimal intervention policy derived in Proposition 1 is strictly higher than the utility of the investors in Lemma 2, i.e.

$$q_H\eta_H + (1-q_H)(\eta_L + l) - l(1-q_H)(1-F_L(\bar{p}))$$
$$- G(\bar{c})\mathbb{E}(c \mid c < \bar{c})\Big(q_H(F_H(\bar{p})-F_H(\underline{p})) + (1-q_H)\beta_L(F_L(\bar{p})-F_L(\underline{p}))\Big)$$
$$- G(\bar{c})l(1-q_H)\beta_L(F_L(\bar{p})-F_L(\underline{p})) > q_H\eta_H + (1-q_H)(\eta_L+l) - l(1-q_H)(1-F_L(\sigma)),$$

which is equivalent to

$$l(1-q_H)(F_L(\bar{p})-F_L(\sigma)) - G(\bar{c})\mathbb{E}(c \mid c < \bar{c})\Big(q_H(F_H(\bar{p})-F_H(\underline{p})) + (1-q_H)\beta_L(F_L(\bar{p})-F_L(\underline{p}))\Big)$$
$$- G(\bar{c})l(1-q_H)\beta_L(F_L(\bar{p})-F_L(\underline{p})) > 0.$$

The threshold $\bar{\beta}_L \in [0,1]$ is defined such that the above expression is equal to zero.

Proof of Corollary 2

From the proof of Proposition 1, for a deterministic Level 3 reporting cost c, the upper threshold $\bar{p}$ is defined such that

$$\frac{f_H(\bar{p}) - f_L(\bar{p})}{f_L(\bar{p})} \frac{q_H f_H(\bar{p}) + (1-q_H)\beta_L f_L(\bar{p})}{(1-\beta_L) f_H(\bar{p})} = (1-q_H)\frac{l}{c}$$

The left-hand side increases in $\bar{p}$, which implies that $\bar{p}$ increases in the liquidation value l. Furthermore, $\bar{p}$ decreases in the Level 3 reporting cost c.

Finally, recall that $\frac{f_H(\underline{p})}{f_L(\underline{p})} = \beta_L \frac{f_H(\bar{p})}{f_L(\bar{p})}$, which implies that $\underline{p}$ and $\bar{p}$ have the same monotonicity with respect to l and c.

Proof of Corollary 3

The function

$$\frac{f_H(p) - f_L(p)}{f_L(p)} \frac{q_H f_H(p) + (1-q_H)\beta_L f_L(p)}{(1-\beta_L) f_H(p)}$$

increases in β_L for p such that $f_H(p) > f_L(p)$.

$\bar{p}$ is such that $f_H(\bar{p}) > f_L(\bar{p})$, which implies that $\bar{p}$ is decreasing in β_L.

Moreover, we have

$$\frac{f_H(\underline{p})}{f_L(\underline{p})} = \beta_L \frac{f_H(\bar{p})}{f_L(\bar{p})},$$

which implies that

$$\frac{f_H(\underline{p}) - \beta_L f_L(\underline{p})}{f_L(\underline{p})} \frac{q_H f_H(\underline{p}) + (1-q_H)\beta_L^2 f_L(\underline{p})}{\beta_L(1-\beta_L) f_H(\underline{p})} = (1-q_H)\frac{l}{c}.$$

As a result, $\underline{p}$ increases in β_L for small values of β_L.

In the case of a perfectly informative private signal s ($\beta_L = 0$),

$$\frac{f_H(\underline{p})}{f_L(\underline{p})} = 0, \text{ which implies that } \underline{p} = -\infty.$$

Further, in that latter case, for a deterministic Level 3 reporting cost c, $\bar{p}$ is defined such that

$$\frac{f_H(\bar{p}) - f_L(\bar{p})}{f_L(\bar{p})} = (1-q_H)\frac{l}{q_H c}.$$

Proof of Lemma 3

The fair value in case of Level 3 reporting is

$$
\begin{aligned}
FV(\underline{p}, s=g) &= \mathbb{E}(\mathcal{L} \mid \underline{p}, s=g) \\
&= \frac{q_H f_H(\underline{p})\eta_H + (1-q_H) f_L(\underline{p})\beta_L(\eta_L + l)}{q_H f_H(\underline{p}) + (1-q_H) f_L(\underline{p})\beta_L} \\
&= (1 + \beta_L \frac{1-q_H}{q_H}\frac{f_L(\underline{p})}{f_H(\underline{p})})^{-1}\eta_H + (1 + \frac{1}{\beta_L}\frac{q_H}{1-q_H}\frac{f_H(\underline{p})}{f_L(\underline{p})})^{-1}(\eta_L + l).
\end{aligned}
$$

Furthermore, the fair value in case of Level 2 reporting is

$$
\begin{aligned}
FV(\bar{p}) &= \mathbb{E}(\mathcal{L} \mid \bar{p}) \\
&= \frac{q_H f_H(\bar{p})\eta_H + (1-q_H) f_L(\bar{p})(\eta_L + l)}{q_H f_H(\bar{p}) + (1-q_H) f_L(\bar{p})} \\
&= (1 + \frac{1-q_H}{q_H}\frac{f_L(\bar{p})}{f_H(\bar{p})})^{-1}\eta_H + (1 + \frac{q_H}{1-q_H}\frac{f_H(\bar{p})}{f_L(\bar{p})})^{-1}(\eta_L + l).
\end{aligned}
$$

Therefore, $\frac{f_H(\underline{p})}{f_L(\underline{p})} = \beta_L \frac{f_H(\bar{p})}{f_L(\bar{p})}$ implies that $FV(\underline{p}, s=g) = FV(\bar{p})$.

Proof of Lemma 4

In this proof, I provide the necessary and sufficient conditions for the existence of equilibrium (A). As shown in the main text, in equilibrium (A), the distribution of the public signal in case of a high quality asset is $f_H(p) = h(p)$ and $F_H(p) = H(p)$. For a low quality asset, it is such that $f_L(p) = h(1-p)$ and $F_L(p) = 1 - H(1-p)$.

The maximization problem of the prudential regulator for an individual bank is the following:

$$
\begin{aligned}
\max_{\bar{p}_A, \underline{p}_A, \bar{c}_A} U^A_{investors} &= q_H\eta_H + (1-q_H)(\eta_L + l) - l(1-q_H)H(1-\bar{p}_A) \\
&- G(\bar{c}_A)\mathbb{E}(c \mid c < \bar{c}_A)\Big(q_H(H(\bar{p}_A) - H(\underline{p}_A)) + (1-q_H)\beta_L(H(1-\underline{p}_A) - H(1-\bar{p}_A))\Big) \\
&- lG(\bar{c}_A)(1-q_H)\beta_L(H(1-\underline{p}_A) - H(1-\bar{p}_A))
\end{aligned}
$$

subject to the (IC) constraint

$$
1 - H(\bar{p}_A) - H(1-\bar{p}_A) + G(\bar{c}_A)\Big(H(\bar{p}_A) - H(\underline{p}_A) - \beta_L(H(1-\underline{p}_A) - H(1-\bar{p}_A))\Big) \geq \frac{1}{B}\frac{K}{\Delta q}.
$$

This optimization problem has a unique interior solution $(\underline{p}_A, \bar{p}_A, \bar{c}_A)$ with a similar structure to the optimal contract of the baseline model:

$$\frac{h(\bar{p}_A) - h(1-\bar{p}_A)}{h(1-\bar{p}_A)} \frac{q_H h(\bar{p}_A) + (1-q_H)h(1-\bar{p}_A)}{(1-\beta_L)h(\bar{p}_A)} = \frac{G(\bar{c}_A)((1-q_H)lG(\bar{c}_A) + \int_0^{\bar{c}_A} cg(c)dc)}{\int_0^{\bar{c}_A} cg(c)dc}$$

and

$$\begin{aligned}\frac{h(\underline{p}_A) - \beta_L h(1-\underline{p}_A)}{h(1-\underline{p}_A)} & \frac{q_H h(\underline{p}_A) + (1-q_H)\beta_L h(1-\underline{p}_A)}{(1-\beta_L)h(\underline{p}_A)} \\ &= \beta_L \frac{G(\bar{c}_A)((1-q_H)lG(\bar{c}_A) + \int_0^{\bar{c}_A} cg(c)dc)}{\int_0^{\bar{c}_A} cg(c)dc}.\end{aligned}$$

Therefore, this equilibrium always exists if the misclassification risk is sufficiently important such that $[0,1] \subset]\underline{p}_A, \bar{p}_A[$.

Proof of Proposition 4

When the congestion effect is sufficiently strong, the investors are strictly better-off in equilibrium (A) compared to equilibrium (B). Assume that $\delta = \eta_L/(\eta_L + l)$. This implies that $\mathcal{L}_L(\mu_L) = \eta_L$ if $\mu_L \geq \overline{\mu_L}$ and $\mathcal{L}_L(\mu_L) < \eta_L + l$ if $\mu_L < \overline{\mu_L}$. I denote by TW^E the sum of the utilities of all the investors in equilibrium $E \in \{(A), (B)\}$.

In equilibrium (B), the surplus of the investors is

$$TW^{(B)}(\delta) = q_H \eta_H + (1-q_H)\delta(\eta_L + l).$$

I have assumed that $[0,1] \in]\underline{p}_A, \bar{p}_A[$, then the investors' surplus in equilibrium (A) is given by

$$\begin{aligned}TW^{(A)} &= q_H\eta_H + (1-q_H)(\eta_L + l) - G(\bar{c}_A)\mathbb{E}(c \mid c < \bar{c}_A)(q_H + (1-q_H)\beta_L) \\ &\quad - G(\bar{c}_A)l(1-q_H)\beta_L \geq TW^{(B)}(\delta = \eta_L/(\eta_L + l)) = q_H\eta_H + (1-q_H)\eta_L.\end{aligned}$$

$TW^{(A)}$ is the surplus of the investors in the case with no public information. This is equivalent to the Level 3 asset benchmark, with $G(\bar{c}_A) = \frac{1}{(1-\beta_L)B}\frac{K}{\Delta q}$ (see appendix 4).

In a nutshell, for $\delta = 1$, $TW^{(B)}(\delta = 1) > TW^{(A)}$, and for $\delta = \eta_L/(\eta_L + l)$, $TW^{(B)}(\delta = \eta_L/(\eta_L + l)) < TW^{(A)}$. The function $(TW^{(B)} - TW^{(A)})(\delta)$ is continuous and increases in δ. As a result, the intermediate values theorem implies that there exists $\bar{\delta}$ such that if $\delta > \bar{\delta}$, $TW^{(B)}(\delta) > TW^{(A)}$, and if $\delta < \bar{\delta}$, $TW^{(A)} > TW^{(B)}(\delta)$. The results hold as long as $\overline{\mu_H} \geq 1 - G(\bar{c}_A)$ and $\overline{\mu_L} \geq 1 - \beta_L G(\bar{c}_A)$.

Finally, $TW^{(A)} - TW^{(B)}(\delta) = (1-q_H)(1-\delta)(\eta_L + l) - G(\bar{c}_A)\mathbb{E}(c \mid c < \bar{c}_A)(q_H + (1-q_H)\beta_L) - G(\bar{c}_A)l(1-q_H)\beta_L$. This last expression is increasing in η_L and decreasing in q_H.

Proof of Lemma 5

The utility of the investors is the same to the one on page 43 taking into account the new precision of the banker's private information given by equation (1.2). The expected utility of the banker when exerting high effort is given by

$$U_{banker}(\beta) = B\int \Big[q_H f_H(p)\Big((1-\pi_g(p))v_g(p) + \pi_g(p)w_g(p,g)\Big) + (1-q_H)(1-\beta_L-\beta)f_L(p)(1-\pi_g(p))v_g(p) + (1-q_H)(\beta_L+\beta)f_L(p)\Big((1-\pi_g(p))v_g(p)+\pi_g(p)w_g(p,g)\Big)\Big] dp - k\frac{\beta^2}{2} - K.$$

Hence, the new incentive-compatibility constraint of the banker is

$$B\int \Big[(f_H(p) - (\beta_L+\beta)f_L(p))\Big((1-\pi_g(p))v_g(p)+\pi_g(p)w_g(p,g)\Big) - (1-\beta_L-\beta)f_L(p)(1-\pi_g(p))v_g(p)\Big] dp \geq \frac{K}{\Delta q}.$$

After the intervention policy is set but before the effort is exerted, the banker chooses β to maximize his expected payoff:

$$\beta \in \arg\max_{\beta\in[0,1-\beta_L]} U_{banker}(\beta).$$

I define the optimal thresholds $\underline{p}(\beta)$ and $\bar{p}(\beta)$ as in section 1.2.4 and, in particular,

$$\frac{f_H(\underline{p}(\beta))}{f_L(\underline{p}(\beta))} = (\beta_L+\beta)\frac{f_H(\bar{p}(\beta))}{f_L(\bar{p}(\beta))}.$$

From (1.1), the expected utility of the banker is

$$U_{banker}(\beta) = q_L\frac{K}{\Delta q} + B\Big(1 - F_L(\bar{p}) + (\beta_L+\beta)G(\bar{c})(F_L(\bar{p}) - F_L(\underline{p}))\Big) - k\frac{\beta^2}{2}.$$

Taking the first-order condition with respect to β yields

$$k\beta^* = B\Big[\overbrace{G(\bar{c})(F_L(\bar{p})-F_L(\underline{p}))}^{\text{direct effect}} \underbrace{-\frac{\partial\bar{p}}{\partial\beta}f_L(\bar{p}) + (\beta_L+\beta^*)\frac{\partial}{\partial\beta}\Big(G(\bar{c})(F_L(\bar{p})-F_L(\underline{p}))\Big)}_{\text{indirect effect}}\Big]. \tag{1.9}$$

β^* is positive as long as $\beta_L+\beta^*$ is sufficiently small. On the left-hand side of this equality, it is the marginal cost of manipulation for the banker. The expression on the right-hand side is equal to the marginal benefit for the banker of increasing the value of β. This marginal benefit is made up of two terms. The first term is the direct benefit of getting a good Level 3 input ($s = g$) for a low quality asset, which implies that the prudential regulator chooses continuation for intermediate values of the Level 2 input and a low cost of Level 3 reporting. The second term reflects the dependency of the optimal intervention policy $(\underline{p}, \bar{p}, \bar{c})$ on the precision of the Level 3 input.

Next, I prove that β^* is decreasing in k. By taking the derivative of (1.9) with respect to k, we get

$$\beta^* = \frac{\partial \beta^*}{\partial k} B \Bigg[2\frac{\partial}{\partial \beta}(G(\bar{c})(F_L(\bar{p}) - F_L(\underline{p})) - (\frac{\partial^2 \bar{p}}{\partial \beta^2} f_L(\bar{p}) + (\frac{\partial \bar{p}}{\partial \beta})^2 f_L'(\bar{p})) \\ - (\beta_L + \beta^*) \frac{\partial^2}{\partial \beta^2}(G(\bar{c})(F_L(\bar{p}) - F_L(\underline{p}))) - k/B \Bigg].$$

Furthermore, the equilibrium level of manipulation β^* is positive and hence, the right-hand side of the inequality is also positive. For sufficiently large values of k, the last term in brackets is negative. Hence, this implies that $\frac{\partial \beta^*}{\partial k}$ is negative. As a result, β^* decreases in the cost k.

Finally, note that the prudential regulator finds it optimal to use Level 3 reporting as long as $\beta_L + \beta^* < \bar{\beta}_L$ (see Corollary 1), which is equivalent to $k > \bar{k}$.

Proof of Corollary 6

Let p^* such that $\frac{f_H(p^*)}{f_L(p^*)} = \beta_L$. Note that $f_H(\bar{p}) > f_L(\bar{p})$ implies that $\frac{f_H(\bar{p})}{f_L(\bar{p})} > 1 > \frac{f_H(p^*)}{f_L(p^*)}$. As a result of the MLRP property, $\underline{p} > p^*$.

Moreover $FV(\underline{p}, s = g) > FV(p^*, s = g) = q_H \eta_H + (1 - q_H)(\eta_L + l)$.

As a result, $FV(\underline{p}, s = g) = FV(\bar{p}) = \overline{BV} > q_H \eta_H + (1 - q_H)(\eta_L + l)$.

Appendix 2: Fair value reporting guidance

The IASB (IFRS 13) and the FASB (ASC 820) have very similar guidelines regarding fair value reporting, which is mostly used for financial assets. Debt securities that are classified as held-to-maturity under US GAAP or held-to-collect under IFRS are reported at amortized cost. All the other debt securities are reported at fair value, which include available-for-sale or held-for-trading securities under US GAAP. Minority equity passive investments are also reported at fair value. Lastly, there is a fair value option that can be applied to accounts and notes receivables, and to some tangible long-lived assets (e.g. investment properties under IFRS).

As mentioned in the introduction, there are three levels to the fair value hierarchy. Level 1 inputs are observable inputs that reflect quoted prices (unadjusted) for identical assets in active markets (Listed equity securities traded in active markets (NYSE, NASDAQ,...), on-the-run Treasury bonds, exchange-traded futures and options...). Level 2 inputs are inputs other than quoted prices included in Level 1 that are observable for the asset either directly or indirectly (dealer quote for a non-liquid security, provided the dealer is standing ready and able to transact, posted or published clearing prices, if corroborated with market transactions...). Thus, both Level 1 inputs and Level 2 inputs are observable by the firms' outsiders and therefore, both are public information. As noted by Ryan (2008), there are two types of Level 2 estimates: adjusted prices of similar assets and observable inputs aggregated through a model. Finally, Level 3 inputs are unobservable inputs by the firms' outsiders (inputs obtained from broker quote that are indicative or not corroborated with market transactions, management assumptions that cannot be corroborated with observable market data...). Those inputs are the insiders' private information.

Depending on the level of inputs used in the valuation process, an asset is reported at Level 1, Level 2 or Level 3. The level of classification of the asset is the lowest level of the significant inputs used to get the fair value. Hence, in my framework, if both the Level 2 input and the Level 3 input are used, the asset is reported at Level 3. Otherwise, if only the Level 2 input is used, the asset is reported at Level 2. Some examples of Level 2 assets are most U.S. public debt, short-term cash instruments and certain derivative products. Furthermore, complex instruments (longer-dated interest rate and currency swaps and structured derivatives), fixed-income asset-backed securities, impairment testing of goodwill are examples of Level 3 assets.

Several empirical studies provide evidence of the coarseness of this classification resulting in strategic reporting choices. For example, Hanley et al. (2018) show that some insurers in the US deviate from the consensus level to a level indicative of higher quality inputs to convey better asset liquidity. Moreover, Hanley et al. (2018) find that banks and insurers strategically change the classification of their assets over time. As a result, firms' insiders have some discretion in the classification and can transfer assets between the different levels.

When reporting Level 3 assets on its financial statements, a firm must comply with more disclosure requirements. For instance, the firm must provide quantitative information on the main unobservable inputs used in determining both recurring and nonrecurring Level 3 measurements. Furthermore, the firm must provide a description of the valuation processes and a description of the sensitivity of recurring Level 3 fair value measurements to changes in the unobservable inputs. The objective of the disclosure is not to enable outsiders to replicate the pricing models but to provide information for users to assess whether the firm's views about inputs differed from their own and, if so, how to incorporate those views in their decisions. It is also to facilitate comparisons across time and across different firms. Those required disclosures impose a cost to firms carrying assets at Level 3. Note that the FASB is currently proposing to eliminate the disclosure of transfers between Level 1 and Level 2 category but they have increased the disclosure requirements for Level 3.

Appendix 3: Robustness checks

Distribution of the Level 3 input s

I check that the optimal intervention policy of the baseline model holds for a more general distribution of the Level 3 input. Assume that

$$P(s = g \mid H) = \beta_H = 1 - P(s = b \mid H)$$

and

$$P(s = g \mid L) = \beta_L = 1 - P(s = b \mid L).$$

The expected utility of the banker is

$$U_{banker}(q) = B \int \Big[(q\beta_H f_H(p) + (1-q)\beta_L f_L(p)) \Big((1-\pi_g(p))v_g(p) + \pi_g(p)w_g(p,g) \Big)$$
$$+ (q(1-\beta_H)f_H(p) + (1-q)(1-\beta_L)f_L(p)) \Big((1-\pi_b(p))v_b(p) + \pi_b(p)w_b(p,b) \Big) \Big] dp - K\mathbb{1}_{\{q=q_H\}}.$$

The ex ante incentive-compatibility constraint of the banker is

$$B \int \Big[(\beta_H f_H(p) - \beta_L f_L(p)) \Big((1-\pi_g(p))v_g(p) + \pi_g(p)w_g(p,g) \Big)$$
$$- (f_L(p)(1-\beta_L) - f_H(p)(1-\beta_H)) \Big((1-\pi_b(p))v_b(p) + \pi_b(p)w_b(p,b) \Big) \Big] dp \geq \frac{K}{\Delta q}.$$

I conjecture that for β_H close to one, the optimal intervention policy has the same structure as in the main text. Moreover, for all p between $\underline{p}$ and $\bar{p}$,

$$f_L(p)(1-\beta_L) - f_H(p)(1-\beta_H) \geq 0$$

I leave it to the reader to check that this last inequality holds after determining $\underline{p}$ and $\bar{p}$. As a result, $\pi_b^*(p) = 0$ and $v_b(p) = (1-\pi_g(p))v_g(p)$.

For a constant cost of Level 3 reporting c, the Lagrangian of the prudential regulator's maximization problem is

$$L(v_g(.), \pi_g(.), w_g(.,.), \lambda) =$$
$$\int \Big[q_H\beta_H f_H(p)\Big(-\pi_g(p)c \Big) - (1-q_H)(1-\beta_L)f_L(p)(1-\pi_g(p))lv_g(p)$$
$$+ (1-q_H)\beta_L f_L(p)\Big(-(1-\pi_g(p))lv_g(p) - \pi_g(p)(lw_g(p,g)+c) \Big)$$
$$+ \lambda B\Big((\beta_H f_H(p) - \beta_L f_L(p))(1-\pi_g(p))v_g(p) + \pi_g(p)w_g(p,g))$$
$$- ((1-\beta_L)f_L(p) - (1-\beta_H)f_H(p))(1-\pi_g(p))v_g(p) \Big) \Big] dp,$$

where λ is the lagrange multiplier associated to the (IC) constraint.

The solution of this maximization problem is $\pi_g(p) = \pi \mathbb{1}_{\{\underline{p}<p<\bar{p}\}}$, $v_g(p) = \mathbb{1}_{\{p>\bar{p}\}}$, $w_g(p,g) = \mathbb{1}_{\{p>\underline{p}\}}$ with $\frac{f_H(\underline{p})}{f_L(\underline{p})} = \frac{\beta_L}{\beta_H}\frac{f_H(\bar{p})}{f_L(\bar{p})}$ and $\frac{f_H(\bar{p}) - f_L(\bar{p})}{f_L(\bar{p})}\frac{q_H f_H(\bar{p})\beta_H + (1-q_H)\beta_L f_L(\bar{p})}{(\beta_H - \beta_L) f_H(\bar{p})} = (1-q_H)\frac{l}{c}$. The probability π is set optimally such that the (IC) constraint binds.

Hence, my results do not depend on the assumption $P(s = g \mid H) = 1$.

Payoff of the investors

I have assumed that the investors are strictly better-off with action S in case of a low quality asset and are indifferent between action C and action S in case of a high quality asset. The results of the paper are similar if the investors are strictly better-off in case of continuation of high quality assets.

Assume that the investors get η_H for a high quality asset and $\eta_L < \eta_H$ for a low quality asset in case action C is chosen. If action S is chosen, the investors get the liquidation value $\mathcal{L}_H = \mathcal{L}_L = \mathcal{L}$ such that $\eta_L < \mathcal{L} < \eta_H$.

The ex ante incentive-compatibility constraint of the banker is

$$B\int \Bigg[(f_H(p) - \beta_L f_L(p))\Big((1-\pi_g(p))v_g(p) + \pi_g(p) w_g(p,g)\Big) - f_L(p)(1-\beta_L)(1-\pi_g(p))v_g(p)\Bigg]dp \geq \frac{K}{\Delta q}.$$

For a fixed cost c, the expected utility of the investors is

$$\begin{aligned} U_{investors}(q) = \int \Bigg[& q f_H(p)\Big(\eta_H + (1-\pi_g(p))(1-v_g(p))(\mathcal{L}-\eta_H) - \pi_g(p)((1-w_g(p,g))(\eta_H - \mathcal{L}) + c)\Big) \\ & + (1-q)(1-\beta_L) f_L(p)\Big(\mathcal{L} - (1-\pi_g(p))v_g(p)(\eta_L - \mathcal{L})\Big) \\ & + (1-q)\beta_L f_L(p)\Big(\mathcal{L} + (1-\pi_g(p))v_g(p)(\eta_L - \mathcal{L}) - \pi_g(p)(w_g(p,g)(\mathcal{L}-\eta_L) + c)\Big)\Bigg]dp. \end{aligned}$$

The Lagrangian of the prudential regulator's maximization problem is

$$
\begin{aligned}
&L(v_g(.), \pi_g(.), w_g(.,.), \lambda) = \\
&\int \Bigg[q_H f_H(p) \Big(\eta_H + (1-\pi_g(p))(1-v_g(p))(\mathcal{L}-\eta_H) - \pi_g(p)((1-w_g(p,g))(\eta_H-\mathcal{L})+c) \Big) \\
&\qquad + (1-q_H)(1-\beta_L) f_L(p) \Big(\mathcal{L} + (1-\pi_g(p)) v_g(p)(\eta_L-\mathcal{L}) \Big) \\
&\quad + (1-q_H)\beta_L f_L(p) \Big(\mathcal{L} + (1-\pi_g(p)) v_g(p)(\eta_L-\mathcal{L}) - \pi_g(p)(w_g(p,g)(\mathcal{L}-\eta_L)+c) \Big) \\
&\qquad + \lambda B \Big[(f_H(p) - \beta_L f_L(p)) \Big((1-\pi_g(p)) v_g(p) + \pi_g(p) w_g(p,g) \Big) \\
&\qquad\qquad - f_L(p)(1-\beta_L)(1-\pi_g(p)) v_g(p) \Big] \Bigg] dp,
\end{aligned}
$$

where λ is the lagrange multiplier associated to the (IC) constraint.

The solution of this maximization problem is $\pi_g(p) = \pi \mathbb{1}_{\{\underline{p}<p<\bar{p}\}}$, $v_g(p) = \mathbb{1}_{\{p>\bar{p}\}}$, $w_g(p,g) = \mathbb{1}_{\{p>\underline{p}\}}$ with $\frac{f_H(\underline{p})}{f_L(\underline{p})} = \beta_L \frac{f_H(\bar{p})}{f_L(\bar{p})}$ and $\frac{f_H(\bar{p}) - f_L(\bar{p})}{f_L(\bar{p})} \frac{q_H f_H(\bar{p}) + (1-q_H)\beta_L f_L(\bar{p})}{(1-\beta_L) f_H(\bar{p})} = \frac{\mathcal{L} - (q_H \eta_H + (1-q_H)\eta_L)}{c}$. The probability π is set optimally such that the (IC) constraint binds.

Hence, the results of the paper hold with this different specification of the asset's payoff.

Sequential game

In the main text, I solve the multi-bank model using a simultaneous game. In this appendix, I show that the two simultaneous equilibria (A) and (B) are also the equilibria of a sequential game with a large number of banks.

I suppose that there are N banks that publish their financial statements sequentially. Each bank faces the same situation as in the baseline model. I denote by s_n the private information of the n-th bank. The first bank's stakeholders have only access to an arbitrarily weakly informative public signal. Therefore, as shown in the appendix 4, the prudential regulator chooses continuation if the cost of Level 3 reporting is lower than $\bar{c}_{L3}$ and the private information is good $s_1 = g$. Otherwise, the banker does not report at Level 3 and the prudential regulator chooses liquidation. The second bank's stakeholders observe one public signal $p_2 \in \{g, 0\}$, which is the book value of the first bank and an arbitrarily weakly informative public signal. Given the misclassification parameter α, we have

$$
\frac{P(p_2 = g \mid H)}{P(p_2 = g \mid L)} = \frac{G(\bar{c}_{L3})(\alpha + (1-\alpha)\beta_L)}{G(\bar{c}_{L3})(1-\alpha+\alpha\beta_L)} = \frac{\alpha + (1-\alpha)\beta_L}{1-\alpha+\alpha\beta_L}. \tag{1.10}
$$

The optimal intervention policy set by the prudential regulator for the second bank

$(\bar{p}_2, \underline{p}_2, \bar{c}_2)$ has a similar structure that the one in the baseline for a single bank. Assume that it is such that $\underline{p}_2 < p_2 = 0 < p_2 = g < \bar{p}_2$. Therefore, the second banker reports at Level 3 if $s_2 = g$ and $c_2 < \bar{c}_2$ and there is continuation. Otherwise, the banker reports at Level 2 and there is liquidation.

The third bank's stakeholders observe the reported book values of the first two banks and an arbitrarily weakly informative public signal. Therefore, the public signal p_3 can take three values: $p_3 \in \{gg, g0, 00\}$, which corresponds to the two banks have reported at Level 3, one bank has reported at Level 3 and none of the bank has reported at Level 3. Assuming that those signals are not informative enough, i.e. $\underline{p}_3 < p_3 < \bar{p}_3$, the third banker also reports at Level 3 if $s_3 = g$ and the Level 3 reporting is low. Otherwise, the banker reports at Level 2 and there is liquidation. Taking the limit of this game when the number of banks N goes to infinity, there are two possible cases:

- the public signal becomes a continuous signal such that: $p_{L3} = G(\bar{c})(\alpha + (1 - \alpha))$ for banks with high quality assets and $p_{L3} = G(\bar{c})(1 - \alpha + \alpha)$ for banks with low quality assets. Bankers report at Level 3 if they have good private information and their Level 3 reporting cost is low. Otherwise, they report at Level 2 and there is liquidation. It is equilibrium (A);
- there is a cascade because, at some point, the public signal becomes too informative. In that case, all the subsequent banks report at Level 2 and their weakly informative public signals become perfectly informative. We are then back in equilibrium (B).

Therefore, both equilibrium (A) and equilibrium (B) are the equilibria of a sequential game with a large number of banks.

Renegotiation[38]

I discuss the robustness of the results of the baseline model to renegotiation. To check robustness of the results, I analyze the polar case of perfect renegotiation. In that case, the efficient ex post action is taken but the governance structure is meant to force the banker to make concessions in case of bad interim information. The key assumption that is crucial for the robustness of the results is that the banker's utility after renegotiation be increasing in the utility the banker would obtain in the absence of renegotiation. As in Dewatripont and Tirole (1994*c*), I illustrate this assumption with the following example but the idea applies to more general model.

The banker loses the private benefit B if action S is chosen or if, under the credible threat of action S, the banker reduces the perks as part of reorganization package imposed by the controlling party. The banker is assumed to be indispensable to implement action C but is fired when S is chosen.

In order to determine the ex post efficient action, one has to compare the surplus of liquidation, $\mathcal{L}_Q$, with the surplus of continuation, $B + \eta_Q$. I assume that $B < l$. Hence, continuation is ex post efficient for a high quality asset and liquidation is ex

[38]This section summarizes and therefore, borrows without restraints from, detailed accounts by Dewatripont and Tirole (1994*c*).

Table 1.1: Pre- and post renegotiation actions and payoffs

	Ex post efficient action	Choice of A in the absence of renegotiation	Ex post choice (after renegotiation)	Who gets B?
Case 1	Action C	Action C	Action C	Initial banker
Case 2	Action C	Action S	Action C	Investors
Case 3	Action S	Action C	Action S	Initial banker
Case 4	Action S	Action S	Action S	Investors

post efficient for a low quality asset. The ex post efficient action maximizes $B+\mathbb{E}(\eta \mid \mathcal{I})$ or $\mathbb{E}(\mathcal{L} \mid \mathcal{I})$. $\mathcal{I}$ is the information available to the prudential regulator and depends on the reporting level.

Renegotiations occur when the depositors have control and prefer ex post inefficient action S and when the shareholders have control and prefer ex post inefficient action C. The results hold if the threat of action S induces the banker to concede more of B than when the banker has control and prefers action C. Assume for example that the private benefit B is fully transferable; that is, the investors' gain is equal to the banker's loss in private benefit. For instance, the banker could be forced to propose a plan reducing the cost by B in order to keep the job, and fully internalizes the cost reduction. This assumption simplifies notation but is not crucial.

Under the assumptions of Table 1, the results are robust to renegotiation. Indeed, the optimal intervention policy between the prudential regulator and the banker is similar. Moreover, there are continuations for sufficiently good information and liquidations for sufficiently bad information.

Other possible timings of manipulation of s

In the main text, I have assumed for tractability that the manipulation is done before the effort is exerted. Two other possible timings of manipulation are possible: after the effort is exerted but before the realization of p or after the realization of p.

- First, the banker may be able to manipulate the distribution of s after the effort decision but before the realization of p. The equilibrium amount of manipulation is then the same as in the main text, to the extent that the optimal intervention policy keeps the same structure (which is the case if the equilibrium level of manipulation is sufficiently low).

- Otherwise, the banker may manipulate the distribution of s after the realization of p.

Lemma 9. *For a public signal p such that there is continuation with Level 3 reporting, the equilibrium amount of manipulation is uniquely defined by*

$$k\beta^*(p) = G(\bar{c})\frac{(1-q_H)f_L(p)}{q_H f_H(p) + (1-q_H)f_L(p)}B.$$

On the left-hand side of this equality, it is the marginal cost of manipulation for the banker. The expression on the right-hand side is equal to the marginal benefit for the banker of increasing the value of β. It is equal to the conditional probability of having a low quality asset given p times the probability of continuation $G(\bar{c})$ when the private signal is $s = g$ times the private benefit B of continuation.

The equilibrium level of manipulation $\beta^*(p)$ is decreasing in p, for p such that there is continuation with Level 3 reporting. The higher the observable input p is, the lower is the probability to have a low quality asset. Note that the banker manipulates the unobservable input only if there is continuation with Level 3 reporting. Otherwise, the prudential regulator does not care about the banker's private information and there is no point for the banker of incurring a manipulation cost.

In the two cases, there is a unique amount of manipulation in equilibrium and it reduces the informativeness of the Level 3 input. Thus, my results do not depend on the timing of the manipulation decision.

Appendix 4: Benchmark Level 3 asset

I consider a Level 3 asset with no available Level 2 input, or, equivalently with a sufficiently noisy Level 2 input. Therefore, the prudential regulator relies only on the banker's private information to solve the moral hazard problem.

The optimal intervention policy rewards the banker for a good signal and when the cost c is not too high (lower than $\bar{c}_A$). The incentive-compatibility constraint that ensures that the banker exerts effort is

$$BG(\bar{c}_A)(q_H + (1 - q_H)\beta_L) - K \geq BG(\bar{c}_A)(q_L + (1 - q_L)\beta_L),$$

which is equivalent to

$$G(\bar{c}_A) \geq \frac{1}{B(1 - \beta_L)} \frac{K}{\Delta q}.$$

Therefore, the prudential regulator rewards the banker for a good signal when c is lower than $\bar{c}_A$ with $G(\bar{c}_A) = \frac{1}{B(1 - \beta_L)} \frac{K}{\Delta q}$, such that the incentive-compatibility constraint binds.

Lemma 10 (Level 3 asset). *The optimal intervention policy is characterized by a cutoff $\bar{c}_A$ such that:*

- *if $c > \bar{c}_A$, the banker does not report at Level 3 and the prudential regulator chooses liquidation;*
- *if $c < \bar{c}_A$ and $s = g$, the banker reports at Level 3 and the prudential regulator chooses continuation. Otherwise, the banker does not report at Level 3 and the prudential regulator chooses liquidation.*

Online Appendix: Liability and reputation risks

As discussed by Laux and Leuz (2009), another major issue for the practical implementation of Level 3 reporting is the possible litigation costs incurred by the bankers for mispricing. Both managers and board members bear substantial litigation costs in case of misreporting in the financial statements. Those litigation costs can include prison terms and they have been increased by the Sarbanes-Oxley Act of 2002. The misreporting costs also capture expected reputation costs for the bankers (Karpoff et al., 2008). Thus, I assume that the banker incurs a cost ρ when there is Level 3 reporting, the private information is good ($s = g$) and the final payoff is low ($\eta = \eta_L = 0$). I analyze the reporting choice of the banker depending on the litigation and reputation costs ρ. For simplicity, I assume that the cost of Level 3 reporting is deterministic and that probability to get a high quality asset when the banker shirks is zero, i.e. $q_L = 0$.

A banker who observes a noisy Level 2 input and a good Level 3 input faces the following tradeoff. On the one side, this banker wants to use the Level 3 input to increase the reported fair value of the asset and meet the capital requirement set by the prudential regulator. Nevertheless, if the litigation and reputation costs are too high, the banker is not willing to disclose additional information to the prudential regulator by using unobservable inputs. The regulator takes the expected litigation and reputation costs into account when designing the intervention policy because the incentive-compatibility constraint of the banker depends on ρ.

Lemma 11. *For a single bank, there exists a cutoff $\bar{\rho}$ such that*

- *if $\rho < \bar{\rho}$, the optimal intervention policy is as in the baseline model;*
- *if $\bar{\rho} \leq \rho$, there is no Level 3 reporting and the optimal intervention policy is as in the benchmark model with a Level 2 asset.*

Proof. I first state and prove the following result.

Lemma 12. *For a given realization of the Level 2 input p, the banker does not report the asset at Level 3 when*

$$\rho > B\left(1 + \frac{q_H f_H(p)}{(1 - q_H)\beta_L f_L(p)}\right).$$

Proof. Suppose that the banker, after having exerted high effort, observes a noisy realization of p ($\underline{p} < p < \bar{p}$) and receives a good private signal $s = g$. Then, the banker should decide whether or not to classify the asset at Level 3.

We have the following conditional probabilities

$$P(\text{asset H} \mid p \text{ and } s = g) = \frac{q_H f_H(p)}{q_H f_H(p) + (1 - q_H) f_L(p)\beta_L}$$

and

$$P(\text{asset L} \mid p \text{ and } s = g) = \frac{(1 - q_H)\beta_L f_L(p)}{q_H f_H(p) + (1 - q_H) f_L(p)\beta_L}.$$

The expected utility of the banker of using Level 3 reporting is

$$\frac{q_H f_H(p)}{q_H f_H(p) + (1-q_H) f_L(p)\beta_L} B + \frac{(1-q_H)\beta_L f_L(p)}{q_H f_H(p) + (1-q_H) f_L(p)\beta_L}(B-\rho).$$

The banker only uses Level 3 reporting if this last expression is positive, which is equivalent to

$$B > \rho \frac{(1-q_H)\beta_L f_L(p)}{q_H f_H(p) + (1-q_H) f_L(p)\beta_L}$$

or

$$\rho < B\left(1 + \frac{q_H f_H(p)}{(1-q_H)\beta_L f_L(p)}\right).$$

□

Then, I prove the general result. First, when $\rho \in [0, B)$, the optimization problem of the prudential regulator is to maximize the utility of the investors under the new incentive-compatibility constraint of the banker:

$$\begin{aligned}\int \Bigg[& f_H(p) B\Big((1-\pi_g(p))v_g(p) + \pi_g(p) w_g(p,g)\Big) \\ & - \beta_L f_L(p)\Big(B(1-\pi_g(p))v_g(p) + (B-\rho)\pi_g(p) w_g(p,g)\Big) \\ & - (1-\beta_L) f_L(p) B (1-\pi_g(p)) v_g(p)\Bigg] dp \geq \frac{K}{\Delta q}. \end{aligned} \tag{1.11}$$

The FOCs yield

$$c\frac{f_H(\bar{p}_\rho) - f_L(\bar{p}_\rho)}{f_L(\bar{p}_\rho)} \frac{q_H f_H(\bar{p}_\rho) + (1-q_H)\beta_L f_L(\bar{p}_\rho)}{(1-\beta_L) f_H(\bar{p}_\rho)} - \frac{\beta_L}{1-\beta_L}\frac{\rho}{B} l \frac{(1-q_H) f_L(\bar{p}_\rho)}{f_H(\bar{p}_\rho)} = l(1-q_H)$$

and

$$\frac{f_H(\underline{p}_\rho)}{f_L(\underline{p}_\rho)} = \beta_L \frac{f_H(\bar{p}_\rho)}{f_L(\bar{p}_\rho)} - \frac{\nu \beta_L \rho}{\nu B - l(1-q_H) q_H},$$

where ν is the lagrange multiplier associated to the constraint (1.11). The thresholds $\bar{p}_\rho$ and $\underline{p}_\rho$ are well defined because $-f_l/f_H$ increases in p. We can rewrite (1.11) under the optimal contract $(\bar{p}_\rho, \underline{p}_\rho, \pi_\rho)$:

$$B(F_L(\bar{p}_\rho) - F_H(\bar{p}_\rho)) + \pi_\rho(B(F_H(\bar{p}_\rho) - F_H(\underline{p}_\rho)) - (B-\rho)(F_L(\bar{p}_\rho) - F_L(\underline{p}_\rho))) \geq \frac{K}{\Delta q}.$$

Next, for $\rho \in [B, \bar{\rho})$, there is a new (IC) constraint because the banker does not use Level 3 reporting when shirking. The new incentive-compatibility constraint of the banker is

$$\int \Big[\Delta q B(1-\pi_g(p))v_g(p)(f_H(p)-f_L(p)) + q_H f_H(p) B \pi_g(p) w_g(p,g) + (1-q_H)\beta_L f_L(p)(B-\rho)\pi_g(p)w_g(p,g) \Big] dp \geq K. \quad (1.12)$$

Under the optimal contract $(\bar{p}'_\rho, \underline{p}'_\rho, \pi'_\rho)$, (1.12) is equivalent to

$$q_H B(F_L(\bar{p}'_\rho) - F_H(\bar{p}'_\rho)) + \pi'_\rho (q_H B(F_H(\bar{p}'_\rho) - F_H(\underline{p}'_\rho) + (1-q_H)(B-\rho)(F_L(\bar{p}'_\rho) - F_L(\underline{p}'_\rho))) \geq K.$$

Finally, for $\rho \in [\bar{\rho}, +\infty)$, the banker does not use Level 3 reporting even when exerting effort. The cutoff $\bar{\rho}$ is defined such that $U_{investors}(\bar{p}'_{\bar{\rho}}, \underline{p}'_{\bar{\rho}}, \pi'_{\bar{\rho}}) = U_{investors}(\text{Lemma 2})$. As a result, in that latter case, the prudential regulator only has access to the Level 2 input and the optimal intervention policy is similar to the one of the benchmark model for a Level 2 asset. □

Intuitively, for large expected litigation and reputation costs ($\rho > \bar{\rho}$), the banker is willing to use Level 3 reporting only for high realizations of the Level 2 input. However, in that latter case, the prudential regulator does not find it optimal to let the banker using Level 3 reporting because the Level 2 input is sufficiently informative. This is consistent with the concerns raised by some market participants and relayed by the Securities and Exchange Commission (2008): "Potential legal exposure in many cases deter the use of judgment" when computing fair values. Specifically, when the expected cost of mispricing is high, bankers prefer to use only observable inputs even if those inputs are very noisy.

Proposition 6. *In the multi-bank model, if the litigation/reputation cost ρ is sufficiently high, the only equilibrium is equilibrium (B).*

Proof. Direct consequence of Lemma 11. □

Similarly to the manipulation of the Level 3 input, litigation and reputation risks for mispricing may increase systemic risk because banks' insiders (e.g. managers and board members) may be reluctant to deviate from public information. An important takeaway for standard setters is that the implementation of accounting standards should take into account the regulatory environment in which they operate (Laux and Leuz, 2009).

Chapter 2

Accounting versus Prudential Regulation (joint with Jeremy Bertomeu and Haresh Sapra)

2.1 Introduction

Prudential regulation typically relies on inputs from accounting numbers but, so far, banking regulators and accounting standard setters seem to have worked independently and therefore failed to operationalize their joint objectives. Perhaps, this is due to the differing objective functions of both parties. On the prudential side, the mission of the Board of Governors of the Federal Reserve is to "foster the stability, integrity, and efficiency of the nation's monetary, financial, and payment systems so as to promote optimal macroeconomic performance" (Government Performance and Results Act Annual Performance Report, 2011) while, on the accounting side, standard setters such as the Financial Accounting Standard Board aim at "providing financial information about the reporting entity that is useful to existing and potential investors" (FASB Concepts Statement No.8). Interestingly, the FASB explicitly mentions that concerns for bank stability may be in conflict with its objective of providing useful information to outsiders (FASB Concepts Statement No.8, 2011, OB 2 and BC 1.19-1.23).

We believe that the core of this problem is the lack of a framework that explains the role that accounting measurement plays for banks that are subject to prudential regulation. In this paper, we offer a parsimonious theory that investigates the economic tradeoffs that tie decision-useful information in the accounting systems (accounting regulation) to a concern for prudential regulation. Formally, we model two forms of regulation in order to understand how they interact with each other and how they should jointly respond to agency problems in the banking sector. We admit that we model a small subset of the vast set of questions faced by accounting and prudential regulators. However, our model generates some simple and useful insights to a yet-obscure problem and highlights the important role that accounting standards may play in influencing a bank's capital requirements.

We develop a simple model of a bank in which there are shareholder-debtholder conflicts such that shareholders have incentives to engage in excessive risk-taking that reduces the bank's surplus. The banking regulator can mitigate such inefficiencies in two ways: (a) by imposing capital requirements that constrain the ability of the bank's shareholders to originate risky loans and (b) by committing to a measurement system that control the bank's ex-post loan liquidation policy. We show that, in order to provide ex-ante incentives to choose safe loans, the regulator will choose a liquidation policy that is excessive from an ex-post perspective. However, absent a suitable reporting system, such ex-post excessive liquidation policy is not credible. Under a pure prudential regulation setting that does not control the bank's liquidation policy, i.e., when the measurement system is such that a state of the world that would cause a loss is perfectly revealed, the regulator would optimally continue banks too often from an ex-ante perspective. As a result, under a pure prudential regulation regime, a prudential regulator imposes overly strict capital requirements (to solve the risk-shifting problem), thereby constraining the bank's ability to lend. Accounting regulation can be designed ex ante to increase ex-post liquidations - similar to a conservative measurement system which makes bad news more likely - which, in turn, reduces risk-taking incentives and allows for lower capital requirements. Our main result is that the bank's optimal accounting measurement system and level of capital requirements depend on each other and are therefore policy tools that should be used in tandem, generating more surplus for banks than systems that rely either on accounting regulation or on prudential regulation, even though each type of regulation might individually provide incentives on its own.

Our model informs the recent debate surrounding the change in the way banks would recognize losses on their loan portfolios. Under the new standards, banks would no longer use an incurred loss model which has been criticized as delaying recognition of losses as it only considers current and historical information to determine if a credit loss exists. The new standards will require an expected loss model that measures credit losses based on estimates of cash flows that the lender does not expect to collect, which incorporates historical information, current conditions, and reasonable forecasts of collectability. Stated differently, by recognizing losses earlier, the threshold for recognizing losses are lower under the expected loss model relative to the incurred loss model. Our model shows that such excessive liquidation under the "expected loss" model could indeed be efficient because it not only reduces the bank's risk taking behavior but it also increases the bank's capacity to originate loans. More interestingly, we show that as credit market conditions improve, an expected loss regime that induces excessive liquidation becomes more desirable.

Literature review. From a theoretical standpoint, there is an extensive literature that shows how agency frictions place bounds on the size of firms, see e.g., Holmstrom and Tirole (1997). We borrow heavily from these ideas in that in our model, a capital requirement on the bank bounds the size of its loan portfolio. To our knowledge, this literature does not focus on the size of firms and the design of the information system which we view as the novel elements of our model. Nevertheless, the general question of the optimal design of an information system in response to agency problems has a long history in accounting, with contributions along two paths: first, in Arya et al. (1997), and an ongoing follow-up literature, the design of the information system can address commitment problems in dynamic contracting settings; second, the real effects literature finds many environments in which price pressure will distort investment decisions Kanodia and Sapra (2016*b*). Our model borrows from both types of approaches, in that we examine an optimal contract with only partial commitment but nest within this problem an investment decision. In summary, the theoretical side of our contribution is to bring together the theory of the size of banks with that of information system design in order to study their interactions.

There is a burgeoning strand of banking and debt-related literature in accounting, which takes specific institutional elements of these problems into a measurement question Corona et al. (2013, 2014). However, the focus is different in that the variable of interest is the degree of bank competition which we do not explicitly model. The first study shows that fair-value may be strategically adopted in order to commit some banks to exit ex-post and reducing competition. The second study examines the channel through which more bank transparency can induce more risk-taking. A primary difference with our question is that these studies take the capital requirement as exogenous. Within this area, many other studies investigate the role of accounting information given pre-existing capital requirements, see, e.g., Cifuentes et al. (2005*b*), Allen and Carletti (2008*b*), Heaton et al. (2010*b*) and Bleck and Gao (2017*a*). In these models, capital requirements are socially undesirable so they are not well-suited to examine some of the questions we examine here.

Within this literature, the paper by Li (2017) is the closest to ours and deserves additional comments. She analyzes risk-taking incentives in banks in presence of capital regulation under different accounting regimes. She shows that the accounting regime

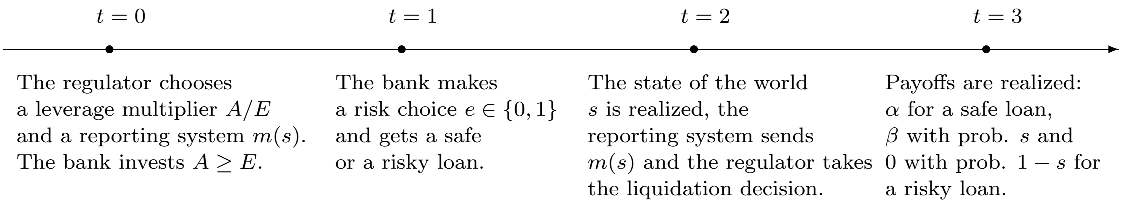

Figure 1: Model Timeline

that maximizes the social welfare is determined by a tradeoff between the social cost of capital regulation and the efficiency of the bank's project discovery efforts. In our paper, there is no exogenous cost of capital regulation and the bank is not focused on short-term earnings. We solve for the optimal accounting system given a tradeoff between banks' ex-ante risk-taking incentives and ex-post inefficient liquidations.

The impact of accounting standards on financial institutions' behaviors has received a great attention among academia since the 2007-08 financial crisis Acharya and Ryan (2016*b*); Barth and Landsman (2010*b*); Bushman and Landsman (2010*a*). Dewatripont and Tirole (1994*b*) show that historical cost accounting may reduce the ability of prudential regulators to discipline banks. Some empirical studies provide evidence that financial reporting indeed affects banks' risk-taking incentives. For instance, Chircop and Novotny-Farkas (2016*a*) suggest that extending the use of fair values for regulatory purposes reduces ex-ante risk-taking. This is consistent with Ellul et al. (2015*b*), who find that the use of fair values in statutory accounting reduces ex-ante risk-taking incentives in insurance firms. In the same vein, Bushman and Williams (2012) find that forward-looking provisions reflecting timely recognition of expected future loan losses is associated with enhanced risk-taking discipline. Consistent with those studies, we show how a well-designed accounting system may interact with a bank's capital requirements to control the bank's risk-taking incentives.

2.2 The model

The timeline has four event dates, indexed by $t = 0, 1, 2, 3$ and features a regulator, a bank, and passive insured depositors. We present the timeline of the model in Figure 1.

At date $t = 0$, the bank invests an exogenous amount of equity E. The regulator chooses a leverage multiplier for the bank, which we model as a maximum size of the loan portfolio $A \in [E, A_{\max}]$, where $A_{\max}$ is chosen to be sufficiently large. Given size A, the bank will borrow $A - E$ from depositors, so that we shall think of A/E as permissible leverage. Deposits are perfectly insured for reasons outside of the model (e.g., bank runs, risk-aversion by depositors).[1] Thus, the pricing of deposits does not incorporate the default risk of the bank. We normalize the interest rate of deposit, i.e. the risk-free rate, to zero. The regulator commits to a reporting system that maps a variable s, to an interim signal which will determine whether the bank is liquidated at date $t = 2$. The state s has a distribution $F(.)$ and a density $f(.)$, with full support on $[0, 1]$.

At date $t = 1$, the bank makes a binary risk choice $e \in \{0, 1\}$.[2] Conditional on low risk, $e = 1$, the loan portfolio has a probability $q \in (0, 1)$ to be safe and a probability $1-q$ to be risky. Conditional on high risk, $e = 0$, the probability that the loan portfolio is safe is equal to zero.[3] Safe loans return a payoff α regardless of the state s of the world. Risky loans return $\beta > \alpha$ with probability s and 0 with probability $1 - s$ if they are continued.

At date $t = 2$, the regulator optimally liquidates banks if the expected total payoff from liquidation is greater than the expected total payoff from continuation. If the safe loan is liquidated, we assume that the payoff from liquidation is α. However, if the risky loan is liquidated, for simplicity, we assume that the equity holders in liquidated banks with risky loans do not recover terminal dividends. This assumption is consistent with most bank liquidations observed in practice Granja et al. (2017). It can be micro-founded if banks cannot efficiently liquidate loans and, instead, requires action by a regulator or a better-capitalized intermediary. Formally, we assume that only the regulator can restructure a risky loan and recover, possibly over time, a payoff $\mathcal{L} \in (0, 1)$, so that the residual surplus of the banker conditional on liquidation is zero - we discuss in an extension a version of the model in which banks have some residual equity left even after they liquidate.[4]

The decision to liquidate is made based on the information produced by the re-

[1] The deposit insurance is an inherent feature of the banking sector. Diamond and Dybvig (1983) model the bank's role as a liquidity provider and rationalize the deposit insurance as a tool to prevent bank runs. In the US, deposits are insured by the Federal Deposit Insurance Corporation (FDIC).

[2] In this paper, we focus our analysis on the conflict of interests between stockholders and depositors of the bank. Therefore, we assume that the bank's manager acts in the best interest of the shareholders.

[3] From linearity, the incentive-compatibility condition is unchanged if we assume, more generally, that the probability of safe loans is reduced by $\Delta q \in (0, q)$.

[4] Note that, in our model, the risky loan changes payoffs in each state but not their probability. Specifically, we interpret states as an aggregate state of the economy which makes risky loans more likely to default, as in Furlong and Keeley (1989) or Hellmann et al. (2000), and, for our model of conflict of interest between bank and regulator, emphasizes the fact that banks do not internalize payoffs in the low state when they do not repay depositors. This also differs from other models, such as Holmstrom and Tirole (1997), Goex and Wagenhofer (2009) or Bertomeu and Cheynel (2015), where the state is idiosyncratic to the firm and, therefore, productive effort (by an entrepreneur) affects the probability of each outcome.

porting system. Without loss of generality, we set the number of signals equal to the number of induced actions and use a binary signal structure $m \in \{0,1\}$, where $m = 1$ induces liquidation and $m = 0$ induces continuation. With a slight abuse of language, we define a reporting system as a probability $m(s) \equiv \mathbb{E}(m|s) \in [0,1]$ that state s triggers a liquidation signal.[5] Because liquidating must be optimal when conditional on receiving $m = 1$, we assume that

$$\mathbb{E}(s \mid m = 1) \leq \frac{\mathcal{L}}{\beta} \leq \mathbb{E}(s \mid m = 0). \tag{2.1}$$

At date $t = 3$, the loan payoffs are realized. The payoff π of the bank's loan is $\pi = \alpha$ if the loan is safe, $\pi = \mathcal{L}$ if the loan is risky and liquidated, or $\pi = \beta$ with probability s or $\pi = 0$ with probability $1 - s$ if the loan is risky and continued. The regulator compensates depositors if the bank fails, $\pi < A - E$, which we assume is financed via a frictionless ex-ante tax. The social surplus from the loans is measured as $\Sigma = \mathbb{E}(\pi - 1)A$ where $\mathbb{E}(.)$ denotes the expectations operator.

Conditional on low risk, a liquidating bank receives an expected payoff

$$U_l = q(\alpha A - A + E)$$

and a continuing bank receives an expected payoff

$$U_c(s) = q(\alpha A - A + E) + (1 - q)s(\beta A - A + E).$$

The regulator chooses two policies, a leverage multiplier A and an optimal reporting mechanism, to maximize the total surplus from the loans. The optimal reporting mechanism is a control problem over the probability distribution of the liquidation signal m. The regulator therefore maximizes

$$\Sigma = (q\alpha + (1 - q)\mathbb{E}(m\mathcal{L} + (1 - m)s\beta) - 1)A \tag{2.2}$$

subject to the following incentive-compatibility condition that induces the low risk loan:[6]

[5] In practice, prudential regulators cannot liquidate a bank arbitrarily upon receiving some negative news. Regulators may liquidate a bank that is violating the regulatory leverage constraint. Hence, one way of interpreting our accounting system is that upon receiving bad news, the regulator forces a bank to write-down the book value of the loan (via provisioning for loan losses) which, in turn, implies that the bank will violate the regulatory leverage constraint. We discuss the provisioning interpretation of our results in section 2.4.

[6] One potential solution to this risk-shifting problem would be to prohibit loans whose interest rate is too high, which we do not allow in our model since we assume that loan characteristics are not contractible. This is a strong assumption and, empirically, several institutional structures verify

$$\mathbb{E}\Bigg[\alpha A - A + E - s(1-m)(\beta A - A + E)\Bigg] \geq 0. \tag{2.3}$$

Definition An efficient policy $(A^*, m^*(.))$ maximizes Σ subject to (2.1) and (2.3).

For the entire analysis of the model, we impose the following assumptions.

A0. The parameters of the model $(\mathcal{L}, A_{\max}, E, \alpha, \beta)$ satisfy

$$\max\left(\frac{\alpha A_{\max} - A_{\max} + E}{\beta A_{\max} - A_{\max} + E}, \frac{1-q\alpha}{(1-q)\beta} - F(\mathcal{L}/\beta)\mathcal{L}/\beta\right) < \int_{\mathcal{L}/\beta}^{1} s f(s) ds < \min\left(\frac{\alpha}{\beta}, 1/\beta - F(\mathcal{L}/\beta)\mathcal{L}/\beta\right). \tag{2.4}$$

A0 rules out degenerate cases for which the analysis of our model becomes straightforward. The first part of the left-hand side of the inequality implies that the bank cannot achieve its first-best surplus by lending to the maximal extent $A_{\max}$ and implementing the ex-post surplus-maximizing liquidation policy. The second part requires the low risk portfolio to have positive value because, otherwise, the regulator would always induce a bank of size zero.

Similarly, the first part of the right-hand side of the inequality rules out parameter values in which the agency problem is so severe that the bank would lend only its own equity. The second part of the right-hand side of the inequality guarantees that the risky loan is value-destroying and therefore rules out a solution in which the regulator prescribes risky loans with maximal size.

A bank balance sheet interpretation

While it is theoretically practical to define the information as a signal that triggers liquidation, we can think as a real world implementation in terms of a constraint on the bank balance sheet at an interim stage $t = 2$. To elaborate on this further, note that when the bank starts, its balance sheet is given by

$$A = E + D,$$

where the deposit D is simply $A - E$, the amount the bank lends (at face value) minus its starting equity.

characteristics of loans (e.g., qualified loans must satisfy certain borrower requirements). However, not all loan characteristics are easily observable by regulators and issuing a set of acceptable interest rates conditional on each type of loan would require a degree of regulatory control that is far beyond current institutions.

After receiving a negative news on the value of its loan at $t = 2$, i.e. $m(s) = 1$, the bank should write down the value of its loan portfolio by taking a provision for loan losses. The new balance sheet of the bank is

$$A_2 = E_2 + D,$$

where $A_2{=}A(q\alpha + (1-q)\mathcal{L}) < A$ is the new value of the bank's loan portfolio after the bad signal is received. Note that this is the expected loan payoff conditional and, later on, we shall interpret these measurements as a form of expected loss. Assuming that the bank does not value its federally-insured deposits at fair value (which is typically not the case for commercial banks), the resulting equity is $E_2 = A(q\alpha + (1-q)\mathcal{L}) - (A - E)$. Hence, the new leverage of the bank is given by

$$\frac{A(q\alpha + (1-q)\mathcal{L})}{A(q\alpha + (1-q)\mathcal{L} - 1) + E} > \frac{A}{E}.$$

So that an interim capital ratio can be set to liquidate banks whose leverage becomes higher than this new threshold.

2.3 Analysis

2.3.1 Prudential regulation benchmark

Before solving the general model in which the regulator chooses both the optimal reporting system and prudential regulation, we first examine a benchmark setting in which the regulator controls the leverage of the bank but takes as given a reporting system that perfectly reveals the state. Formally, we assume that the regulator perfectly observes the state s and liquidates the bank whenever $\beta s < \mathcal{L}$. We refer to this setting as a (pure) prudential regulation benchmark because it ignores the optimal design of the reporting system.

From A0, it follows that the regulator cannot induce a low risk portfolio if the bank has zero equity and therefore we assume for this benchmark that the bank has non-zero equity E to commit per unit of loan. Consistent with the existing literature on financial intermediation Holmstrom and Tirole (1997); Biais et al. (2007), we show that the regulator must impose a leverage A^*/E that is bounded by the incentive problem.

Proposition 7. *Under prudential regulation, the optimal leverage is given by*

$$\frac{A^*}{E} = \frac{1 - \int_{\frac{\mathcal{L}}{\beta}}^{1} sf(s)ds}{1 - \int_{\frac{\mathcal{L}}{\beta}}^{1} sf(s)ds - (\alpha - \beta \int_{\frac{\mathcal{L}}{\beta}}^{1} sf(s)ds)} > 1. \tag{2.5}$$

Equation (2.5) illustrates the tradeoff between continuing valuable risky loans and increasing bank leverage. Specifically, if we denote the surplus from continuing risky loans as $S_c = \int_{\frac{\mathcal{L}}{\beta}}^{1} sf(s)ds$ then,

$$\frac{\partial A^*/E}{\partial S_c} = -\frac{\beta - \alpha}{(1 - S_c - (\alpha - \beta S_c))^2} < 0,$$

implying that each unit of additional surplus from continuing a risky loan decreases the size of the loan portfolio that the bank can manage. Further, the right-hand side of (2.5) is greater than one (from A0), implying that there is always a low enough loan portfolio size such that low risk can be induced.

Corollary 7. *The optimal leverage A^*/E increases in the payoff α of the safe loan, in the liquidation value $\mathcal{L}$ of the risky loan, and decreases in the payoff β of the risky loan.*

The only tool available to the regulator under prudential regulation is the capital requirement. Hence, as the payoff of the risky loan in the good state increases, the risk-shifting problem becomes more severe and the regulator reduces bank leverage. Conversely, as the payoff of the safe loan or the liquidation payoff increase, the risk-taking problem becomes less severe and the regulator increases bank leverage.

Substituting the optimal leverage from equation (2.5) in equation (2.2) yields the following expression for the surplus of the bank as a function of the characteristics of its loan portfolio:

$$\Sigma = \frac{(1 - \int_{\frac{\mathcal{L}}{\beta}}^{1} sf(s)ds)(q\alpha + (1-q)(\mathcal{L}F(\frac{\mathcal{L}}{\beta}) + \beta \int_{\frac{\mathcal{L}}{\beta}}^{1} sf(s)ds) - 1)}{1 - \int_{\frac{\mathcal{L}}{\beta}}^{1} sf(s)ds - (\alpha - \beta \int_{\frac{\mathcal{L}}{\beta}}^{1} sf(s)ds)} E. \tag{2.6}$$

As intuitive, the surplus is increasing in the liquidation payoff $\mathcal{L}$. The surplus also increases both as the likelihood q of the safe loan increases and as the profitability α of the safe loan increases.

Closer inspection of equation (2.6), however, reveals that the impact of β on the bank's surplus is ambiguous due to two opposing effects of β on the bank's surplus. First, an increase in β makes the risky loan - which reduces expected surplus - more attractive to banks and, as shown in Corollary 7, causes a reduction in the equilibrium leverage. A low risk portfolio increases surplus so the reduction in size is socially costly. Second, an increase in β makes the risky loan more attractive because it implies a first-order stochastic dominance shift in their payoff structure. Therefore, even though the risky loan reduces social surplus under our maintained assumption A0, the adverse impact of the risky loan on the bank's surplus becomes more muted as β increases. The latter effect increases the total surplus generated by banks.

2.3.2 Accounting regulation benchmark

We now contrast the (pure) prudential setting discussed above to a polar opposite in which the regulator relies only on the design of a reporting system to discipline banks but does not control the bank's leverage. In essence, we are interested in a version of the model in which the regulator does not impose any upper bound on the size of the bank's assets so that the bank's leverage will be infinite. Accordingly, we set $E = 0$ since the bank equity per unit of loan is nearly zero and refer to this as (pure) accounting regulation because we entirely forfeit prudential tools to control banks.

Because the incentive-compatibility constraint is proportional to A, it can be rewritten as either $A = 0$ or

$$\mathbb{E}\Big[\alpha - 1 - s(1-m)(\beta - 1)\Big] \geq 0, \tag{2.7}$$

and so that regulator maximizes Σ as defined in (2.2) subject to liquidations being efficient in constraint (2.1) and incentive-compatibility in constraint (2.7).

Proposition 8. *Let κ be given by $\int_\kappa^1 sf(s)ds = (\alpha-1)/(\beta-1)$. Under accounting regulation,*

(i) if $\mathcal{L} \geq \beta \int_0^\kappa sf(s)ds/F(\kappa)$, the optimal policy is such that $A^* = A_{\max}$ and the reporting system issues a liquidation signal $m(s) = 1$ if and only if $s < \kappa$, where $\kappa > \mathcal{L}/\beta$;

(ii) otherwise, inducing low risk is infeasible.

Proposition 8 implies that if the liquidation value of the risky loan is high enough (case (i)), the optimal accounting regulation can discipline the bank to choose the low risk portfolio without any additional equity. However, the liquidation policy is inefficient as the bank is liquidated over some states of the world with $s \in [\mathcal{L}/\beta, \kappa]$. Therefore, in the absence of any prudential regulation, the need to provide ex-ante disciplining incentives is in conflict with the ex-post efficient liquidation constraint. Indeed, when the agency problem becomes sufficiently severe (case (ii)), the regulator is unable to commit to liquidate the loan portfolio sufficiently often to solve the risk-taking problem and the bank cannot induce the low risk portfolio.

Corollary 8. *Whenever $A^* > 0$, the optimal threshold κ decreases in the payoff α of the safe loan and increases in the payoff β of the risky loan.*

Another key implication of the accounting benchmark (which we shall generally demonstrate throughout our analysis) is given in Corollary 8. Absent any agency problem, the total surplus is increasing in β because this raises the payoff from the risky loan for any liquidation policy. However, when β is too large, it becomes infeasible to induce the low risk portfolio and, therefore, more profitable risky loans reduce the loan portfolio to zero.

This argument applies when switching from case (i) to case (ii) of Proposition 8 but we can also apply a similar logic within case (i) of the Proposition to show how an increase in β may reduce total surplus via its effect on the liquidation choice. Rewriting the total surplus after substituting (2.7),

$$\Sigma \quad = \quad A_{\max}(q\alpha + (1-q)(\mathcal{L}F(\kappa) + \beta\frac{\alpha-1}{\beta-1}) - 1).$$

Taking a total derivative with respect to β, the total surplus Σ is increasing in β if and only if

$$\frac{\alpha-1}{(\beta-1)^2}(\frac{\mathcal{L}}{\kappa} - 1) > 0. \tag{2.8}$$

The sign of the left-hand side of (2.8) has the sign of $\mathcal{L}/\kappa - 1$ and depends only on β and α via their effects on the liquidation threshold κ. We have shown that κ is increasing in β in Corollary 8 and, further, this term is positive when κ is close to $\mathcal{L}/\beta$. Hence, the total surplus is either increasing or inverse U-shaped in β, with its global maximum at the value of β that induces $\kappa = \mathcal{L}$. Reinjecting this in the definition of κ, the socially preferred payoff for risky loans is given by

$$\beta - 1 = \frac{\alpha - 1}{\int_{\mathcal{L}}^{1} sf(s)ds}. \tag{2.9}$$

In other words, our framework implies that the regulator may have an interior optimum about which type of risky loans the banks should be allowed to engage in. In particular, settings with higher safe loan payoffs and liquidation values are conducive to lending to more risky loan. Vice-versa, environments in which risky loans become more profitable, without any concurrent change in safe loans, will typically be detrimental.

As in Plantin, Sapra and Shin (2008*b*), we next conduct a comparison of the two modes of regulation taken in isolation and demonstrate that prudential regulation can do worse than accounting regulation. From a practical perspective, this result contrasts with the predominant model of bank regulation which primarily relies on controlling prudential tools. This is also, of course, an important step to motivating a theory where both pieces are jointly optimized. In our model, comparing prudential versus accounting regulation amounts to comparing total surplus when controlling only the reporting system (pure accounting regulation) versus requiring bank equity and controlling the amount of leverage (pure prudential regulation).

Corollary 9. *Accounting regulation with zero equity is preferred to prudential regulation if and only if* $\mathcal{L} \geq \beta \int_0^{\kappa} sf(s)ds/F(\kappa) + o(1/A_{max})$.

The main insight from Corollary 9 is that accounting regulation may be too rigid to tackle sufficiently important agency frictions but, if the risk-taking problem is not too severe, accounting regulation is preferred to prudential regulation. Because the regulator cannot commit to shut down banks if they have positive surplus, there are limits on liquidations under pure accounting regulation can induce and these can become insufficient to solve the agency problem. In this case, banks must be required to hold additional skin in the game in the form of an equity contribution and an upper bound on the size of their loan portfolio. Equivalently, the regulator imposes capital requirements. To summarize, accounting regulation become more efficient as the liquidation values of risky loans improve relative to the maximal payoffs of such loans.

2.3.3 Joint prudential and accounting regulation

We next derive the optimal accounting standard when the regulator jointly optimizes the reporting system and the capital requirement. Without loss of generality, we decompose this joint choice as a choice of A and, for a given A, a choice of the measurement $m(.)$, hereafter, the subproblem. As we will demonstrate, the bank will always choose to lend to the maximal extent allowed by the regulator, so we shall equivalently refer to A as allowed bank leverage or the size of the bank.

We can simplify the analysis by noting that the subproblem is equivalent to maximizing a Lagrangian objective function that is pointwise linear in $m(.)$, that is,

$$(P) \qquad \max_{m(.)\in[0,1]} \int ((q\alpha + (1-q)(m(s)\mathcal{L} + (1-m(s))s\beta) - 1)A)f(s)ds$$

s.t.

$$\frac{\mathcal{L}}{\beta}\int m(s)f(s)ds - \int sm(s)f(s)ds \geq 0 \tag{2.10}$$

$$\int s(1-m(s))f(s)ds - \frac{\mathcal{L}}{\beta}\int (1-m(s))f(s)ds \geq 0 \tag{2.11}$$

$$\alpha A - A + E - (\beta A - A + E)\int s(1-m(s))f(s)ds \geq 0. \tag{2.12}$$

where (2.10) and (2.11) are the left-hand and right-hand side of (2.1), respectively, and (2.12) is the incentive-compatibility condition.[7] We show next that the liquidation policy must take the form of a threshold above which the bank is continued.

Lemma 13. *A solution to (P) must be such that* $m(s) = 1$ *if and only if* $s < \tau$*, where* $\tau \geq \mathcal{L}/\beta$*.*

Lemma 13 contains two key parts, which we discuss separately. The fact that only low states must be liquidated may seem surprising given that, in the incentive-compatibility constraint, liquidating the loan conditional on higher states increases the left-hand side of (2.12) the most. However, in the objective function, higher states also improve the payoffs of the bank if the loan is continued and this latter effect dominates the former effect.

To see why, we offer below a heuristic proof which carries the intuition better than the formal proof. Assume that the incentive-compatibility condition binds (as will turn out to be the case) so that

$$\int s(1-m(s))f(s)ds = \frac{\alpha A - A + E}{\beta A - A + E}. \tag{2.13}$$

This condition means that a sufficiently large fraction of the surplus from continuation must be forfeited in order to solve the risk-taking problem. Intuitively, continuation gives the agent the ability to achieve the βs payoff and thus makes it more difficult to induce the low risk choice. Note that this condition does not say whether high or low states should be liquidated and, indeed, high states contribute more to this constraint because they are multiplied by s (and affect a manager choosing high risk the most). But, reinjecting in the objective function and regrouping terms, implies

$$\Sigma = \underbrace{A(q\alpha + (1-q)\frac{\alpha A - A + E}{\beta A - A + E}\beta - 1)}_{=cst(A)} + A(1-q)\mathbb{E}(m)\mathcal{L} \tag{2.14}$$

[7] Note that this is a relaxed version of the subproblem as we allow for a choice of $m(s)$ on the unit interval. However, the relaxed subproblem coincides with the original subproblem to the extent that, as a result of linearity, the solution must be an extreme value of the set of feasible policies.

where $cst(A)$ is a function of A that does not contain $m(.)$. Hence, once the incentive-compatibility binds, the objective function is *increasing* in the probability of liquidation. The policy that maximizes this probability while meeting incentive-compatibility is therefore to shut down firms conditional on low states. To further explain this feature of our model, note that the second term in (2.14) is the expected payoff from the risky loan, with the benefit being determined entirely from the incentive-compatibility. In other words, the entire continuation surplus cannot be increased beyond what is permissible by the risk-taking agency problem.

The second part of Lemma 13 demonstrates that the liquidation threshold is always weakly greater than the first-best threshold $\tau_{fb} = \mathcal{L}/\beta$. Put differently, the equilibrium may feature excess liquidations for incentive purposes. Liquidations, in this model, serve a dual objective, namely, to shut down ex-post inefficient risky projects and discipline ex-ante risk-taking.

The first objective is best solved by setting a threshold at $\tau_{fb} = \mathcal{L}/\beta$, such that states below τ_{fb} induce a liquidation. This constraint is very similar to the ex-post efficiency constraint in (2.1) except that, in the constraint, it is evaluated against the perceived state revealed by the reporting system. If one were to focus only on the first objective, the reporting system $m(s) = 1$ if and only if $s < \tau_{fb}$ were chosen.

The second objective requires to use liquidations to elicit a low risk portfolio. In turn, inspecting (2.3), the incentive-compatibility condition becomes easier to meet when $\mathbb{E}(sm)$ increases, that is, liquidating higher states of the world helps discipline risk-taking. Whenever risk-taking incentives bind, the implied distortion must take the form of more liquidations than would be demanded by the first objective.

Lemma 14. *The efficient continuation threshold τ satisfies*

$$\int_{\tau}^{1} sf(s)ds = \frac{\alpha A - A + E}{\beta A - A + E}. \tag{2.15}$$

Lemma 14 demonstrates that the incentive-compatibility condition must bind. The intuition for this observation in our model is straightforward. The first-best policy - lending the maximal amount of loans with no distortion to liquidation - is infeasible (from A0). Of interest, we can rewrite (2.15) as a statement about the leverage of a bank, by dividing both sides of the right-hand side of (2.15) by E and solving for bank leverage:

$$\frac{A}{E} = \frac{1 - \int_{\tau}^{1} sf(s)ds}{1 - \int_{\tau}^{1} sf(s)ds - (\alpha - \beta \int_{\tau}^{1} sf(s)ds)}. \tag{2.16}$$

This characterization illustrates how, holding a liquidation threshold fixed, more leverage is possible if the payoff from safe assets increases or the payoff from risky assets

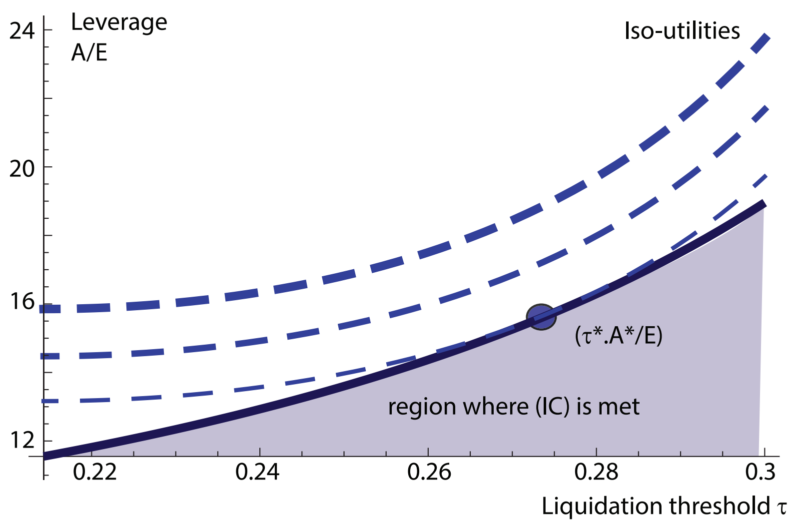

Figure 2.1: A/E as a function of τ (IC constraint and isosurplus curves)

decreases.

To further characterize the optimal policies chosen by the regulator, we write the optimal continuation threshold $\tau(A)$ in terms of A from (2.15). Applying the implicit function theorem, this threshold is increasing, i.e.,

$$\tau'(A) = \frac{(\beta - \alpha)E}{\tau(A)f(\tau(A))(\beta A - A + E)^2} > 0, \tag{2.17}$$

which is intuitive because the risk-taking problem is more severe when the ratio of loans to equity increases and thus requires a greater fraction of liquidation.

We have for now left aside the ex-post constraint $\mathbb{E}(s|m(s) = 1) \leq \mathcal{L}/\beta$, which is required for the bank to be credibly liquidated by the regulator. Yet, bringing back this constraint yields another crucial implication of our analysis. The more A is increased, the more difficult it becomes to meet the incentive-compatibility condition: to meet this condition, $\tau(A)$ must increase to raise $\mathbb{E}(s \mid m(s) = 1)$. But, if A is set too high, $\overline{\tau}(A)$ will no longer satisfy $\mathbb{E}(s \mid s \leq \tau(A)) \leq \mathcal{L}/\beta$. This implies an upper bound $\overline{\tau}$ on the liquidation threshold, defined by $\mathbb{E}(s \mid s \leq \overline{\tau}) = \mathcal{L}/\beta$, and an implied upper bound on the size of the bank $\overline{A}$, where $\overline{\tau} = \tau(\overline{A})$.

Reinjecting the optimal leverage (2.16) into the social surplus (2.2), this problem can be rephrased as choosing the optimal liquidation threshold to maximize

$$\Sigma(\tau) \equiv \frac{(q\alpha + (1-q)(\mathcal{L}F(\tau) + \beta\int_\tau^1 sf(s)ds) - 1)(1 - \int_\tau^1 sf(s)ds)}{1 - \int_\tau^1 sf(s)ds - (\alpha - \beta\int_\tau^1 sf(s)ds)} E \tag{2.18}$$

with a necessary condition for an interior solution given by $\Sigma'(\tau) = 0$.

We show next that the regulator would always choose to distort the ex-post liquidation threshold, i.e., choose $\tau > \tau_{fb} = \mathcal{L}/\beta$. As a corollary, the optimal reporting system induces a greater bank size and higher efficiency than a reporting system in which s is perfectly revealed. We prove this statement in the next proposition.

Proposition 9. *The efficient continuation threshold $\tau(A^*)$ is set at a level strictly higher than the first-best continuation threshold $\tau_{fb} = \mathcal{L}/\beta$.*

Recall that the liquidation is also governed by an ex-post constraint which bars policies in which the regulator would liquidate a bank with greater value if it were continued. The higher the liquidation threshold, the more this constraint becomes difficult to satisfy. Specifically, the ex-post constraint is satisfied if and only if $\tau \leq \overline{\tau} \equiv \tau(\overline{A})$, where

$$\int_0^{\overline{\tau}} sf(s)ds = \frac{\mathcal{L}}{\beta}F(\overline{\tau}). \tag{2.19}$$

For convenience, we assume here that $\mathbb{E}(s)\beta > \mathcal{L}$, which implies that $\overline{\tau} < 1$. This has little bearing on our main insights as long as, if this condition is not satisfied, the regulator can set the liquidation threshold at the maximal level, i.e. $\overline{\tau} = 1$.

To characterize the optimal threshold, note that $\Sigma'(\overline{\tau}) < 0$ is a sufficient condition for the existence of an interior solution $\tau(A^*) < \overline{\tau}$ since, then, the regulator would increase welfare by reducing the liquidation threshold. In the next proposition, we show that this condition is necessary and sufficient, and can be expressed in terms of a statement about the fraction of safe loans.

Proposition 10. $\tau(A^*) = \overline{\tau}$ *if and only if*

$$q > \bar{q} = \frac{\nu}{(\alpha-1)(\beta-\alpha)\overline{\tau}+\nu} \in (0,1), \tag{2.20}$$

where

$$\nu = (1-\beta\mathbb{E}(s))(\beta-\alpha)\overline{\tau} - (\mathcal{L}-\overline{\tau}\beta)(1+\frac{\mathcal{L}F(\overline{\tau})}{\beta} - \mathbb{E}(s))(1-\alpha+(\beta-1)(\mathbb{E}(s)-\frac{\mathcal{L}}{\beta}F(\overline{\tau}))).$$

The intuition for Proposition 10 is given in two steps, starting with a comparative static in q in this paragraph and followed by the rationale for $\tau(A^*) = \overline{\tau}$. Although the probability of a safe loan q did not play an important role in any of the benchmark settings, we show here that it is a key determinant of how the regulator chooses the optimal reporting system. Specifically, when q is large, there is a greater net benefit from increasing leverage. In the prudential benchmark, this leverage was fully determined by the incentive condition, so that there was little the regulator could do to increase it further. Here, on the other hand, the regulator can increase the inefficient liquidation of risky loans. Whether this is desirable depends on the trade-off with the cost of excessive liquidation. But, to pin down this trade-off, recall that the fraction of risky loans is lower so the cost of relying on inefficient liquidations is reduced. Putting both regulatory channels together, we conclude that the regulator will (weakly) increase the threshold $\tau(A^*)$ in response to an increase in the fraction of safe loans q.

Continuing on this logic, this implies that expectations about failing banks increase as a function of q, and it becomes increasingly difficult for the regulator to credibly shut down banks. When q becomes greater than $\bar{q}$, the required liquidation threshold to implement the ideal leverage would be above $\overline{\tau}$. At this point, the ex-post liquidation constraint $\mathbb{E}(s \mid s \leq \tau(A^*)) \leq \mathcal{L}/\beta$ becomes binding and the regulator implements the maximal credible threshold $\overline{\tau}$. Put differently, when the loans become sufficiently safe, the regulator implements the maximal credible level of liquidation (and would have been better-off with a policy of commitment to liquidation and even higher leverage). Naturally, when this point $q \geq \overline{q}$ is reached, the credible level of liquidation no longer depends on q since safe loans neither gain nor lose from liquidating the bank. We summarize these comparative statics in the next corollary.

Corollary 10. *A^*/E and $\tau(A^*)$ are increasing in q, strictly if and only if $q \leq \bar{q}$.*

A different logic is at play for an increase in the liquidation value $\mathcal{L}$ but the intuition remains entirely transparent. As for q, a greater liquidation payoff increases the total value earned by increasing leverage, leading to a greater desirability of higher leverage (provided it remains incentive-compatible). It also reduces the cost of liquidating risky loans for a given state. Therefore, the comparative static is similar to that of q and an increase in $\mathcal{L}$ leads to higher leverage and more liquidation for any given state. In addition, because higher $\mathcal{L}$ increases the credibility of a regulatory intervention (via its effect on $\mathcal{L}/\beta$ in the ex-post liquidation constraint), this comparative static holds even when the maximal threshold $\overline{\tau}$ is attained. We state it below.

Corollary 11. *A^*/E and $\tau(A^*)$ are increasing in $\mathcal{L}$.*

An increase in α increases the attractiveness of safe loans to banks and reduces the severity of agency problems while increasing the surplus generated by banks. Hence, we argue and find that the leverage increases as a function of α. If q is high, however, because the maximal liquidation threshold is attained and the credibility of liquidations does not depend on α, it will no longer affect the liquidation threshold.

Corollary 12. *A^*/E and $\tau(A^*)$ are increasing in α, strictly for A^*/E or if $q < \overline{q}$.*

Finally, the effect of the risky payoff β on leverage is ambiguous because it has two opposite effects on the liquidation threshold. On the one hand, a higher β makes it more costly to liquidate a firm for any level of s and this tends to reduce the liquidation threshold. On the other hand, a higher β also makes the risky loan portfolio more attractive which requires more liquidation to meet the incentive constraint.

As it turns out, the effect of β depends on whether the ex-post liquidation constraint $\overline{\tau}$ is reached (equivalently, whether the fraction of safe loans is high enough). If $\tau(A^*) = \overline{\tau}$, the constraining factor is to make the liquidation of failing banks credible, so that higher β, because it makes it more tempting for the regulator to continue, leads to a reduction in the threshold and a lower leverage. If $q < \overline{q}$, we have the only case where the optimal leverage and the liquidation may enter in different directions, as a result of the two trade-offs discussed earlier. We elaborate more on this in the next corollary.

Corollary 13. *If $q \geq \bar{q}$, A^*/E and τ^* are decreasing in β. Otherwise, for any parameter values such that $\partial\tau^*/\partial\beta < 0$ or $\partial(A^*/E)/\partial\beta > 0$, τ^* and A^*/E vary in the same direction as a function of β.*

The main new claim is contained in the second part of Corollary 13 which reveals that, for certain settings, the regulatory tools vary in the same direction as for the other comparative statics.[8] In particular, if the regulator raises leverage in response to higher β, a more severe agency problem is faced for the ex-post liquidation and liquidations must increase. Vice-versa, if the regulator reduces liquidations, then the more severe agency problem must be solved with lower leverage.

Table 2.1 wraps up with the comparative statics of the general model, with the main observation being that, for all variables but the payoff of the risky loan, accounting and prudential regulations move in tandem. When using only accounting regulation (third row) or only prudential regulation (fourth row), the regulations do not depend on the fraction of good projects q and, in the case of accounting regulation, the continuation threshold does not depend on the liquidation value. The regulations respond to more profitable risky loans by either reducing leverage or by increasing liquidations, and more profitable safe loans reduce the equilibrium level of inefficiency by either increasing bank leverage or reducing inefficient liquidations.

[8]This claim is, unfortunately, based on endogenous objects but, conceptually, it aims at establishing when we should observe the two regulatory variables co-moving and helps clarify some intuitions.

		q	$\mathcal{L}$	α	β
Joint regulation with $q > \bar{q}$	$\tau(A^*)$	0	+	0	−
	A^*/E	0	+	+	−
Joint regulation with $q \leq \bar{q}$	$\tau(A^*)$	+	+	+	?
	A^*/E	+	+	+	?
Accounting only benchmark	$\tau(A^*)$	0	0	−	+
Prudential only benchmark	A^*/E	0	+	+	−

Table 2.1: Comparative statics

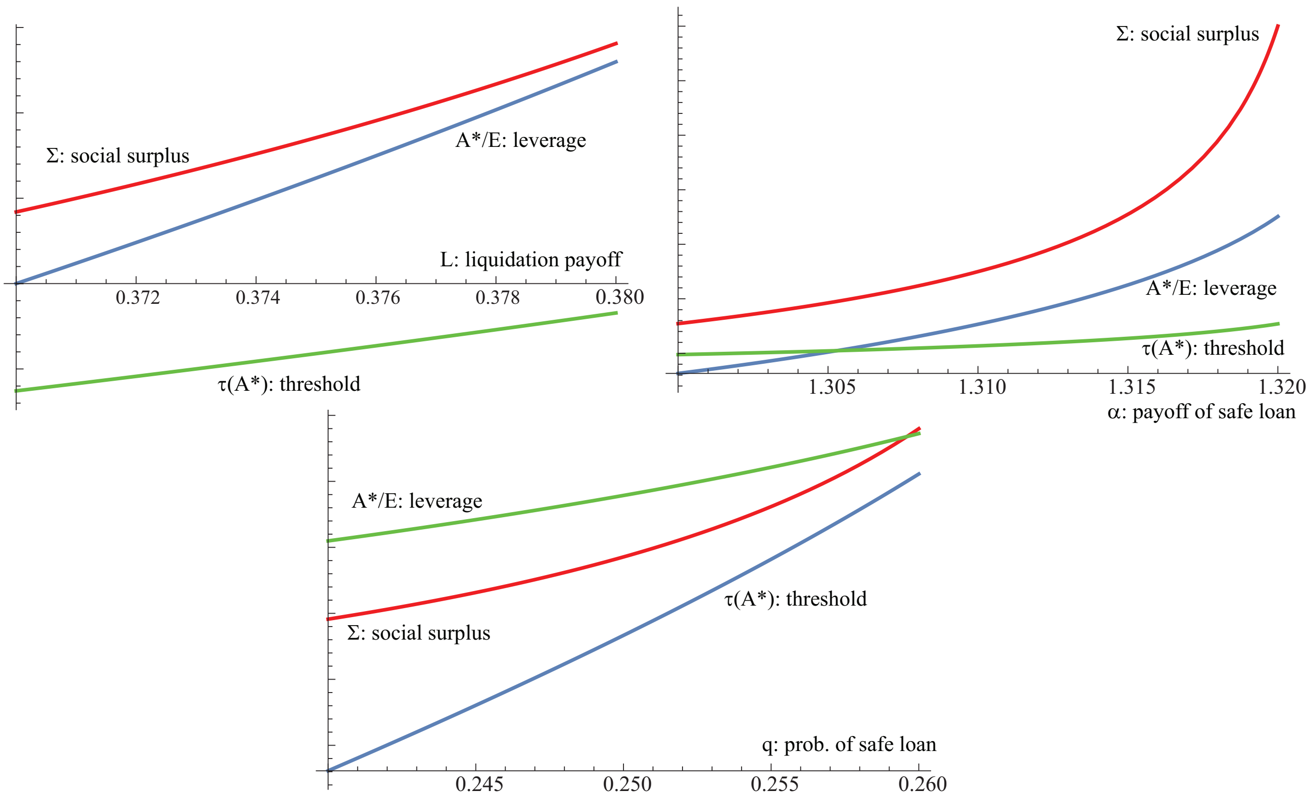

Figure 2.2: Σ, A^*/E and $\tau(A^*)$

2.4 An Application to expected loan loss provisioning

2.4.1 Institutional background

A practical application of our model is to inform the debate on the optimal provisioning model for loan losses that has received attention since the 2007-08 financial crisis. Under the previous IASB (IAS 39) and FASB (FAS 114) standards, the accounting model for recognizing loan losses was referred to as an incurred loss model. It requires the recording of loan losses that have been incurred as of the balance sheet date, rather than of probable future losses. Loss identification is based on the occurrence of triggering events supported by observable evidence (e.g. borrower loss of employment, decrease in collateral values...) combined with expert judgment. This model, it has been argued, may increase pro-cyclicality by delaying recognition of bad debt until there is evidence of increases in default rates - which, highly correlated to unemployment, is a lagging indicator of the cycle.

Individual countries have taken steps to overcome the limitations of the incurred loss model of loan loss provisioning. For example, Spain adopted dynamic loan loss provisioning in 2000 in order to reduce pro-cyclical effects. Dynamic loan loss provisioning requires banks to gradually accumulate loan loss reserves prior to loss events, with the intention of enabling banks to better weather stress events. However, dynamic loan loss provisioning need not fully account for future expected loan losses.

The new expected loan loss standards (IFRS 9 and ASU 2016-13) have a more forward-looking approach that emphasizes shifts to the probability of future loan losses, even if no triggering events have yet occurred. We think about our mechanism design as an efficient expected loss, in that banks report information about a state s before the realization of loan payoffs. There is always a benefit to having such information but, as our main contribution, we show that this expected measurement should not provide all information and may, in fact, cause more liquidations of banks, some of which are inefficient, at an interim stage of the life of a loan.

The Basel Committee on Banking Supervision (BCBS) has three principles calling for supervisors to adequately evaluate credit risk management, expected credit losses measurement and capital adequacy. The committee supports the use of expected credit losses approaches and encourages their application in a manner that will provide incentives for banks to follow sound credit risk management and robust provisioning practices.

The BCBS notes that banks may have well established regulatory capital models for the measurement of expected losses. However, while these models may be used as important starting points for estimating expected credit losses for accounting purposes, regulatory capital models may not be directly usable without adjustment in the measurement of accounting expected loan losses, given their different objectives and inputs. In particular, the regulatory expected losses are calculated under an internal ratings-based approach in Basel III.

2.4.2 Implications of the model

We can draw the following implications from our general model. First, an expected loss model should not incorporate all the information about the state of the world because it implies excessively low bank leverage (that is, prudential regulations that are too strict). But expected loss may be problematic as well, as a reporting system that causes too much liquidation in the interim stage if not carefully calibrated, in particular when the proportion of risky loans is high enough and such liquidations could be socially costly. So, expected loss may make the banking sector more fragile, and cause episodes similar to the recent financial crisis where otherwise good loans would be sold by banks.

Second, the comparative statics on the liquidation threshold tell us to what extent the reporting system moves toward inducing more aggressive liquidations. As we show under joint regulation, higher capital requirements typically come together with reporting systems that are more tilted towards expected loss; in particular, if the safe loans or the liquidation payoffs are higher, or the likelihood of safe loans is higher, the regulator will tend to readjust toward an expected loss model, increasing bank leverage in the process. We view these settings as situations when the economy as a whole features more favorable conditions so, according to our model, an expected loss model is more suitable to expansionary credit periods. This result also provides a rationale for the dynamic loan loss provisioning that has been implemented in Spain in 2000.

Third, while we solve for a full mechanism, we can examine a version of the model where the mechanism can be interpreted as a timing choice - thus, moving the question to the choice of when to measure the state of the loan. So far, we have assumed that there are no frictions in how information can be controlled ex-ante. However, some practical cases may feature constrained choices of mechanisms where certain information may arrive over time. To set ideas, consider first a setting in which information about the state over an horizon $t \in [0,1]$ where state $1 - s \geq t$ becomes public information after state t. Naturally, in this context, we could not implement certain reporting systems that were allowed in our baseline model. However, we can think about the reporting system choice as an intervention point in the timeline, with a date t_0 (committed ex-ante) where the regulator would decide to liquidate. In other words, the regulator commits to intervention once the information has a certain precision.

Inspecting this problem further, we know that by setting $t_0 = 1 - \tau^*$, the regulator would observe all states with $1 - s \geq t_0$ (and would not liquidate as we have shown that $\mathbb{E}(s \mid s \geq \tau^*) \geq \mathcal{L}/\beta$) and, for the remaining banks, observe the state $1 - s < t_0$ which would yield the liquidation policy of the baseline model. So, we can think about the optimal mechanism as commitment to intervene at a particular level of knowledge about the state. We can then think about "late" intervention, similar to incurred loss, as $1 - t^* = \tau^* = \mathcal{L}/\beta$ will correspond to intervention when it is certain that the loan is losing value while an expected loss model will correspond to intervention when the loan starts losing value in expectation.

It is of course also possible that the arrival of information may not allow for a solution that implements the "full-control" mechanism considered earlier and, unfortunately, there are too many processes of arrival of information to consider all cases. Instead, we analyze the opposite version of the previous example to make this point clear and assume that it is now the low states $s < t$ that are revealed as time progresses.[9] Intervention occurs at pre-committed time t_0. Setting $t_0 = \tau^*$ will not work here because it would imply that, at t_0, the regulator would know the state for all projects below t_0 and thus would liquidate if and only $s \leq \mathcal{L}/\beta$ and not liquidate in the region $(\mathcal{L}/\beta, \tau^*]$ or the region above τ^* since we know that $\mathbb{E}(s \mid s \geq \tau^*) \geq \mathcal{L}/\beta$. In this case, accounting measurements can do nothing better than revealing the state. The intuition for this is only useful to set up the additional considerations that come from an exogenous arrival of information and which reduce the scope for a mechanism. When low states are revealed purely sequentially over time, then an expected loss model is not possible since all states will be fully revealed before we get to the point where we can induce additional liquidations.

2.5 Extensions

2.5.1 Costly liquidation of safe loans

Suppose that the payoff of safe loans is equal to $\mathcal{L}$ when liquidated. In other words, safe loans suffer from liquidations in all states of the world. The first-best ex-post liquidation threshold τ_{fb} is now such that $q\alpha + (1-q)\tau_{fb}\beta = \mathcal{L}$, i.e. $\tau_{fb} = (\mathcal{L} -$

[9] Keep in mind that these refers to states of the world, not characteristics of individual loans so it would not be evident that this process would be more plausible than the earlier one as this is different from one individual loan failing a payment (further, payments occur at the end in our model).

$q\alpha)/(1-q)\beta$. Let us assume that $q\alpha < \mathcal{L}$ in order to have an interior first-best ex-post liquidation threshold. We can rewrite the ex post efficient continuation/liquidation constraints as

$$\mathbb{E}(s \mid m = 1) \leq \tau_{fb} = \frac{\mathcal{L} - q\alpha}{(1-q)\beta} \leq \mathbb{E}(s \mid m = 0). \tag{2.21}$$

The total surplus is now given by

$$\Sigma = \Big(\mathbb{E}(m\mathcal{L} + (1-m)(q\alpha + (1-q)s\beta)) - 1\Big)A \tag{2.22}$$

and the incentive-compatibility condition that makes low risk the preferred choice is

$$\mathbb{E}\Big[(1-m)(\alpha A - A + E - s(\beta A - A + E))\Big] \geq 0. \tag{2.23}$$

As in the baseline model, the regulator can increase the liquidation (m) or decrease the bank leverage (A), in order to elicit a low risk portfolio choice. In this setting, as in our baseline model, the optimal reporting system is a threshold τ^* above which loan portfolios are continued. To illustrate this intuition formally, let us write the Lagrangian of the baseline model, indicating by multiplier μ_0 the incentive constraint (2.23) (we omit the ex-post constraints for expositional purpose but they can be easily reincorporated). Differentiating with respect to the probability $m(s)$ of liquidating conditional on state s,

$$\frac{\partial L}{\partial m(s)} = s(\mu_0(A\beta - A + E) - (1-q)\beta) + \mathcal{L} - q\alpha - \mu_0(\alpha A - A + E).$$

Noting that this function is linear in s, we know that $m(s) = 1$ if and only if $s \leq \tau$, where τ is a threshold in $[0, 1]$. Hence, the incentive-compatibility constraint can be rewritten as

$$\int_\tau^1 (\alpha A - A + E - s(\beta A - A + E))f(s)ds \geq 0.$$

The left-hand side is negative if $\tau \geq (\alpha A - A + E)/(\beta A - A + E)$, which implies that $\tau^* < (\alpha A^* - A^* + E)/(\beta A^* - A^* + E)$. Moreover, the left-hand side is decreasing in τ for $\tau < (\alpha A - A + E)/(\beta A - A + E)$. Further, the objective function is increasing in τ when $\tau \in (0, \tau_{fb})$, hence, it must be that, $\tau^* \leq \tau_{fb}$. In contrast with our baseline model, the optimal liquidation policy is to induce excessive continuations. Indeed, for low realizations of s, the bank is strictly better-off with a safe rather than a risky loan in case of continuation, whereas the bank is indifferent between a safe and a risky loan in case of liquidation. As a result, excessive continuations are a way for the regulator to provide incentives to the bank to choose a low risk portfolio.

The incentive-compatibility constraint binds in equilibrium because, otherwise, the regulator set $\tau^* = \tau_{fb}$ and $A = A_{\max}$, a case that we rule out as in the baseline model.[10] Thus, the optimal leverage is such that

$$\frac{A}{E} = \frac{1 - F(\tau) - \int_\tau^1 sf(s)ds}{\int_\tau^1 sf(s)ds(\beta - 1) - (\alpha - 1)(1 - F(\tau))}. \tag{2.24}$$

Reinjecting, the total surplus is given by

$$\begin{aligned}\Sigma &= A(F(\tau)\mathcal{L} + q(1 - F(\tau))\alpha + (1 - q)\beta \int_\tau^1 sf(s)ds - 1) \\ &= E\frac{(1 - F(\tau) - \int_\tau^1 sf(s)ds)(F(\tau)\mathcal{L} + q(1 - F(\tau))\alpha + (1 - q)\beta \int_\tau^1 sf(s)ds - 1)}{\int_\tau^1 sf(s)ds(\beta - 1) - (\alpha - 1)(1 - F(\tau))}.\end{aligned}$$

Taking the first-order condition with respect to τ yields

$$\begin{aligned}H(\tau) = (F(\tau)\mathcal{L}+q(1-F(\tau))\alpha+(1-q)\beta \int_\tau^1 sf(s)ds-1)(\beta-\alpha)(\tau(1-F(\tau))-\int_\tau^1 sf(s)ds) \\ +(1-F(\tau)-\int_\tau^1 sf(s)ds)(\mathcal{L}-q\alpha-(1-q)\tau\beta)((\beta-1)\int_\tau^1 sf(s)ds-(\alpha-1)(1-F(\tau))) = 0.\end{aligned} \tag{2.25}$$

Evaluating the function H at the first-best threshold yields

$$H(\tau_{fb}) = \overbrace{(F(\tau_{fb})\mathcal{L} + q(1 - F(\tau_{fb}))\alpha + (1 - q)\beta \int_{\tau_{fb}}^1 sf(s)ds - 1)}^{>0} \underbrace{(\beta - \alpha) \int_{\tau_{fb}}^1 (\tau_{fb} - s)f(s)ds}_{<0}.$$

The first term of this product is the social surplus of a low-risk loan portfolio using the first-best liquidation policy and this surplus is assumed to be positive.[11] The second term is obviously negative. Hence, we can conclude that $H(\tau_{fb}) < 0$. Thus, the ex-post first-best threshold is always a local maximum of the total surplus Σ. This contrasts with our main model in which the ex post first-best threshold is never a local maximum.

[10] Specifically, we assume that $\alpha A_{\max} - A_{\max} + E - (\beta A_{\max} - A_{\max} + E) \int_{\tau_{fb}}^1 sf(s)ds < 0$.

[11] This is equivalent to assume that $F(\tau_{fb})\mathcal{L} + q(1 - F(\tau_{fb}))\alpha + (1 - q)\beta \int_{\tau_{fb}}^1 sf(s)ds > 1$.

2.5.2 Residual bank equity

Suppose that the bank can liquidate the risky loan without transferring it to the regulator. In this environment, when forced to liquidate, the bank obtains $\mathcal{L}$ per loan instead of having to transfer all of its equity to the regulator. One interpretation is that the bank can resell both risky and safe loans at the same market price $\mathcal{L}$. For high enough leverage A (to be derived later on), $A(q\alpha + (1-q)\mathcal{L}) - (A-E) < 0$, the bank will still have zero equity left in case of liquidation, so this case is only relevant for environments where banks start with high levels of equity or the agency friction is very high. Perhaps, for example, this model fits more closely the problem of certain financial intermediaries (e.g., guaranteed funds, specialized banks) which rely more on their own equity capital than on outside depositors. For simplicity, we assume that the bank learns perfectly the realization of the state of the world s, but the bank cannot credibly reveal s to the regulator.

The first-best ex-post liquidation threshold, $\tau_{fb} = \mathcal{L}/\beta$, is the same as in our baseline model. Given that a bank never defaults, a liquidating bank receives an expected payoff

$$U_l = q(\alpha A - A + E) + (1-q)(\mathcal{L}A - A + E). \tag{2.26}$$

The total surplus is the same than in our baseline model. The regulator cannot force the bank to keep a loan if the expected payoff for the bank in case of liquidation is higher than the expected payoff in case of continuation, i.e., for all s such that $m(s) = 0$, we have

$$q(\alpha A - A + E) + (1-q)(\mathcal{L}A - A + E) \leq q(\alpha A - A + E) + (1-q)s(\beta A - A + E), \tag{2.27}$$

which is equivalent to $\mathcal{L}A - A + E \leq s(\beta A - A + E)$. Further, the incentive-compatibility condition that makes low risk the preferred choice is

$$\mathbb{E}\Big[\alpha A - A + E - m(\mathcal{L}A - A + E) - s(1-m)(\beta A - A + E)\Big] \geq 0. \tag{2.28}$$

As in our baseline model, the regulator can decrease the bank leverage (A), in order to elicit a low risk portfolio choice. The effect of liquidations on the incentives of the bank to choose the low risk portfolio becomes ambiguous in this setting. On the one hand, for high values of s (such that $s(\beta A - A + E) > \mathcal{L}A - A + E$), liquidating the loan decreases the payoff to the bank and increases the incentives. On the other hand, for low values of s (such that $s(\beta A - A + E) < \mathcal{L}A - A + E$), the expected payoff of the bank increases in case of liquidation and the regulator would be willing to continue. However, in those states, the bank voluntarily liquidates the loan portfolio.

As a result, the optimal liquation policy cannot induce excessive continuations and, as in our baseline model, induces excessive liquidations.

Formally, we can write the Lagrangian of the baseline model, indicating by multiplier μ_0 the incentive constraint (2.28) and omitting the ex-post constraints. Differentiating this Lagrangian with respect to the probability $m(s)$ of liquidating conditional on state s,

$$\frac{\partial L}{\partial m(s)} = s(\mu_0(A\beta - A + E) - (1-q)\beta) + (1-q)\mathcal{L} - \mu_0(\mathcal{L}A - A + E).$$

Noting that this function is linear in s, we know there exists τ in $[0,1]$ such that $m(s) = 1$ for $s < \tau$, and $m(s) = 0$ for $s > \tau$. Then, we can rewrite the incentive-compatibility constraint as

$$\alpha A - A + E - (\mathcal{L}A - A + E)F(\tau) - (\beta A - A + E)\int_{\tau}^{1} sf(s)ds) \geq 0. \tag{2.29}$$

The left-hand side increases in τ for $\tau > (\mathcal{L}A - A + E)/(\beta A - A + E)$. Moreover, we know that condition (2.27) requires that $\tau^* \geq (\mathcal{L}A - A + E)/(\beta A - A + E)$ and $\tau_{fb} = \mathcal{L}/\beta \geq (\mathcal{L}A - A + E)/(\beta A - A + E)$. Hence, the optimal liquidation policy induces excessive liquidations, i.e. $\tau^* \geq \tau_{fb}$. As previously, we rule out the solution with τ_{fb} and $A_{\max}$, which implies that the incentive compatibility constraint is binding in equilibrium.[12] The optimal leverage is such that

$$\frac{A}{E} = \frac{1 - F(\tau) - \int_{\tau}^{1} sf(s)ds}{\int_{\tau}^{1} sf(s)ds(\beta - 1) - F(\tau)(1 - \mathcal{L}) - (\alpha - 1)}. \tag{2.30}$$

After deriving the optimal leverage, the condition that makes sure that the bank with a risky loan does not default in case of liquidation is given by $A^*/E \leq \mathcal{L} + 1$. This condition is satisfied if we assume that the parameters $(\alpha, \beta, \mathcal{L}, q)$ are such that

$$\frac{1 - F(\bar{\tau}) - \int_{\bar{\tau}}^{1} sf(s)ds}{\int_{\bar{\tau}}^{1} sf(s)ds(\beta - 1) - F(\bar{\tau})(1 - \mathcal{L}) - (\alpha - 1)} \leq \mathcal{L} + 1. \tag{2.31}$$

To summarize, when the bank does not default in case of liquidation and the bank can take the liquidation decision, the optimal accounting policy also induces excessive continuations.

[12]We assume that $\alpha A_{\max} - A_{\max} + E - (\mathcal{L}A_{\max} - A_{\max} + E)F(\tau_{fb}) - (\beta A_{\max} - A_{\max} + E)\int_{\tau_{fb}}^{1} sf(s)ds) < 0$.

2.6 Conclusion and perspectives on integrated accounting policy

Economists worry about the efficient allocation of resources. Unfortunately, transparency need not always serve this objective and the FASB's position on increasing access will lead to recurrent conflicts between accounting and economic policy. This paper, as part of many others in this stream of literature, offers an alternative perspective on accounting as integrated to economic policy sharing common objectives, and where dissemination information is a means-to-an-end. To do this, accounting standard setters need to be equipped to think about economic consequences and place these consequences in their primary goal.

We have approached this research problem in the context of a setting that is currently affected by both accounting and prudential regulators. The current institutional arrangement is odd, as prudential regulators use accounting information as input, but then transform some elements of these accounting numbers or entirely ignore information that the FASB views as important. Occasionally, various bodies have noted that the actions of accounting standard setters have gone against efforts to stabilize credit markets by other bodies. The position, stated repeatedly, that accountants should give public access to as much information as possible while letting other regulatory bodies deal with consequences using other levers is difficult to justify. In fact, we show here that accounting choices can only be partially addressed using a capital requirement, often leading to prudential choices that are too strict. Put differently, if accounting choices yield outcomes that are detrimental to investors, other policy tools are only partial substitutes.

More work is needed to address various difficult problems that may rise when using economic objectives. First, we do not know yet how accounting regulators would effectively implement provisioning rules that are time-varying, thus creating informational levers that activate or deactivate as conditions in the capital market change. A threshold in a simple model offers a high-level perspective but does not speak much of its implementation at a micro-level in terms of the measurements of particular transactions. Should regulators control impairment ceilings, in terms of varying percentages of loss of value causing an impairment? Should accounting numbers be indexed on distance from a capital ratio if banks access different profiles of risky loans?

Second, we have still almost no research about other regulatory levers that interact with accounting policy. From a macroeconomic perspective, regulators control access to credit via interest rate policy, budgetary choices or tax policy, all of which are based on accounting information but do not seem coordinated with accounting. It seems an underlying belief in the accounting profession that such choices are purely politically-minded and would damage accounting regulation. There is confusion here as to economic definition of political as “what affects welfare in society" to the accountants’ definition as “what affects special interests at the expense of others" and we hope that, taking the first, the profession can see the benefit of justifying the political economy of such choices.

Appendix

Appendix A.1: Proofs

Proof of Proposition 7: We can rewrite the (IC) constraint as

$$\int_0^{\mathcal{L}/\beta}(A\alpha - A + E)f(s)ds + \int_{\mathcal{L}/\beta}^1 (A\alpha - A + E - s(A\beta - A + E))f(s)ds \geq 0. \quad (2.32)$$

By contradiction, if the (IC) is not binding, the regulator will choose $A = A_{\max}$ large, which contradicts A0. Hence, binding the (IC), the optimal size A^* is given by equation (2.5) in text. Further A^*/E is greater than 1, implying that there is always a loan portfolio size such that the (IC) constraint is satisfied, i.e. low risk can be induced.□

Proof of Proposition 8: It is convenient to state the optimal reporting problem for each unit of loan as a program linear in the reporting policy where, with a slight abuse in notation, we write the control as a function $m(s) \in [0,1]$ indicating the probability that a firm is liquidated.

$$(P) \qquad \max_{m(s),A} A \int (q\alpha + (1-q)(m(s)\mathcal{L} + (1-m(s))s\beta - 1)f(s)ds$$

s.t.

$$\alpha - 1 - (\beta - 1)\int s(1-m(s))f(s)ds \geq 0 \qquad (\mu_0)$$

$$\int (1-m(s))sf(s)ds \geq \frac{\mathcal{L}}{\beta}\int (1-m(s))f(s)ds \qquad (\mu_a)$$

$$\frac{\mathcal{L}}{\beta}\int m(s)f(s)ds \geq \int sm(s)f(s)ds \qquad (\mu_b)$$

Differentiating the lagrangian L in $m(s)$, we obtain

$$\begin{aligned}\frac{\partial L}{\partial m(s)} &= (1-q)(\mathcal{L} - s\beta) + \mu_0 s(\beta - 1) + (\mu_a + \mu_b)(\frac{\mathcal{L}}{\beta} - s) \\ &= s(\mu_0(\beta - 1) - (1-q)\beta - \mu_a - \mu_b) + (1 - q + \frac{\mu_a + \mu_b}{\beta})\mathcal{L}.\end{aligned}$$

In turn, noting that this function is linear in s and positive at $s = 0$, we know that $m(s) = 1$ if and only if $s \leq \tau$, where τ is a threshold in $[0,1]$.

Case 1. Suppose that $\mu_0 = 0$. Then, the solution $\mu_a = \mu_b = 0$ and $\tau_{ne} = \mathcal{L}/\beta$ maximizes the Lagrangian and satisfies the constraints associated to multipliers μ_a and μ_b. Reinjecting in the incentive-compatibility condition,

$$\alpha - 1 - (\beta - 1)\int_{\frac{\mathcal{L}}{\beta}}^1 sf(s)ds \geq 0, \qquad (2.33)$$

which contradicts A0.

Case 2. Suppose that $\mu_0 > 0$, in which case the complementary slackness condition implies $\alpha - 1 - (\beta - 1)\int_\tau^1 sf(s)ds = 0$, which is equivalent to

$$\int_\tau^1 sf(s)ds = \frac{\alpha - 1}{\beta - 1}. \tag{2.34}$$

Therefore, $\tau \in (\frac{\mathcal{L}}{\beta}, 1)$, where the lower bound is from A1.

Next, note that $\tau > \mathcal{L}/\beta$ implies that the constraint associated to μ_a is not binding. The constraint associated to μ_b requires the following inequality:

$$\mathcal{L}F(\tau) \geq \beta \int_0^\tau sf(s)ds, \tag{2.35}$$

which is equivalent to

$$\mathcal{L} \geq \frac{\beta \int_0^\tau sf(s)ds}{F(\tau)}, \tag{2.36}$$

To conclude the proof, note that if (2.36) is not satisfied, then inducing low risk is not feasible and, therefore, the optimal choice is $A^* = 0$. Otherwise, the optimal choice is $A^* = A_{\max}$.□

Proof of Corollary 8: Suppose that we are in the case with $A^* = A_{\max}$. The optimal threshold κ is defined such that $\int_\kappa^1 sf(s)ds = (\alpha - 1)/(\beta - 1)$. Therefore, as α increases, $\int_\kappa^1 sf(s)ds$ increases, which implies that κ decreases. Similarly, as β increases, $\int_\kappa^1 sf(s)ds$ decreases, which implies that κ increases.□

Proof of Lemma 13: We define the Lagrangian similarly with the lagrange multipliers μ_0, μ_a and μ_b, associated to constraints (2.12), (2.10) and (2.11) respectively. Differentiating with respect to $m(s)$,

$$\frac{\partial L}{\partial m(s)} = s(\mu_0(A\beta - A + E) - (1-q)\beta - \mu_a - \mu_b) + (1 - q + \frac{\mu_a + \mu_b}{\beta})\mathcal{L}.$$

Noting that this function is linear in s and positive at $s = 0$, we know that $m(s) = 1$ if and only if $s \leq \tau$, where τ is a threshold in $[0, 1]$.

Case 1. Suppose that $\mu_0 = 0$. Then, the solution $\mu_a = \mu_b = 0$ and $\tau = \mathcal{L}/\beta$ maximizes the Lagrangian and satisfies the constraints associated to multipliers μ_a and μ_b. But, then, it is desirable to set $A = A_{\max}$, which contradicts A0.

Case 2. Suppose that $\mu_0 > 0$. Writing the incentive-compatibility explicitly after reinjecting $m(s) = 1$ if and only if $s < \tau$,

$$\Delta_{IC} = \alpha A - A + E - (\beta A - A + E)\int_\tau^1 sf(s)ds \geq 0 \tag{2.37}$$

The left-hand side is increasing in τ and the objective function is increasing in τ when $\tau \in (0, \mathcal{L}/\beta)$, hence, it must be that, if the (IC) is binding, $\tau \geq \mathcal{L}/\beta$.□

Proof of Lemma 14: Suppose that the efficient continuation threshold is such that the incentive-compatibility constraint does not bind . Then, it is optimal for the regulator to set the threshold $\tau = \mathcal{L}/\beta$. This first-best ex post threshold satisfies the constraints (2.10) and (2.11).

The expected utility of the regulator is

$$(q\alpha + (1-q)F(\frac{\mathcal{L}}{\beta})\mathcal{L} + (1-q)\int_{\frac{\mathcal{L}}{\beta}}^{1} s\beta f(s)ds - 1)A.$$

This last expression is positive from A0. But then, it is desirable to set $A = A_{max}$. This is a contradiction with A0. Hence, the incentive-compatibility condition binds in equilibrium. □

Proof of Proposition 9: Let us denote

$$H(\tau) = \Sigma'(\tau)(1 - \int_{\tau}^{1} sf(s)ds - (\alpha - \beta\int_{\tau}^{1} sf(s)ds))^2/E \tag{2.38}$$

Taking the first order condition of the optimization problem,

$$\begin{aligned} H(\tau) &= (q\alpha + (1-q)(\mathcal{L}F(\tau) + \beta\int_{\tau}^{1} sf(s)ds) - 1)(\beta - \alpha)\tau \\ &+ (1-q)(\mathcal{L} - \tau\beta)(1 - \int_{\tau}^{1} sf(s)ds)(1 - \int_{\tau}^{1} sf(s)ds - (\alpha - \beta\int_{\tau}^{1} sf(s)ds)) = 0. \end{aligned} \tag{2.39}$$

Evaluating this expression at $\tau = \mathcal{L}/\beta$,

$$H(\frac{\mathcal{L}}{\beta}) = (q\alpha + (1-q)(\mathcal{L}F(\frac{\mathcal{L}}{\beta}) + \beta\int_{\frac{\mathcal{L}}{\beta}}^{1} sf(s)ds) - 1)(\beta - \alpha)\frac{\mathcal{L}}{\beta} > 0,$$

so that the first-best ex post threshold $\mathcal{L}/\beta$ is never the ex ante optimal choice for the regulator. Further, we know from Lemma 13 that $\tau(A^*) \geq \mathcal{L}/\beta$ which implies that the liquidation threshold must be in the set $(\mathcal{L}/\beta, \tau(\overline{A})]$.□

Proof of Proposition 10: Since the 'if' part is immediate, we prove here the 'only if' part. Differentiating H in τ,

$$\begin{aligned} H'(\tau) &= (q\alpha + (1-q)(\mathcal{L}F(\tau) + \beta\int_{\tau}^{1} sf(s)ds) - 1)(\beta - \alpha) \\ &+\tau(\beta-\alpha)(1-q)f(\tau)(\mathcal{L}-\tau\beta) - (1-q)\beta(1-\int_{\tau}^{1} sf(s)ds)(1-\int_{\tau}^{1} sf(s)ds - (\alpha-\beta\int_{\tau}^{1} sf(s)ds)) \\ &+(1-q)(\mathcal{L}-\tau\beta)\Big(\tau f(\tau)(1-\int_{\tau}^{1} sf(s)ds - (\alpha-\beta\int_{\tau}^{1} sf(s)ds)) + \tau f(\tau)(1-\beta)(1-\int_{\tau}^{1} sf(s)ds)\Big). \end{aligned} \tag{2.40}$$

To simplify the above equation, let us rewrite equation (2.39) at the optimal threshold

$\tau^* \equiv \tau(A^*)$ as

$$(q\alpha + (1-q)(\mathcal{L}F(\tau^*) + \beta \int_{\tau^*}^1 sf(s)ds) - 1)(\beta - \alpha)\tau^*$$
$$= -(1-q)(\mathcal{L} - \tau^*\beta)(1 - \int_{\tau^*}^1 sf(s)ds)(1 - \int_{\tau^*}^1 sf(s)ds - (\alpha - \beta \int_{\tau^*}^1 sf(s)ds)) \quad (2.41)$$

Reinjecting this last equality into (2.40) evaluated at τ^* yields

$$H'(\tau^*) = \tau^*(\beta - \alpha)(1-q)f(\tau^*)(\mathcal{L} - \tau^*\beta)$$
$$- (1-q)\frac{\mathcal{L}}{\tau^*}(1 - \int_{\tau^*}^1 sf(s)ds)(1 - \int_{\tau^*}^1 sf(s)ds - (\alpha - \beta \int_{\tau^*}^1 sf(s)ds))$$
$$+(1-q)(\mathcal{L}-\tau^*\beta)\left(\tau^* f(\tau^*)(1-\int_{\tau^*}^1 sf(s)ds-(\alpha-\beta \int_{\tau^*}^1 sf(s)ds))+\tau^* f(\tau^*)(1-\beta)(1-\int_{\tau^*}^1 sf(s)ds)\right).$$

$$= \underbrace{-(2\tau^*(1-q)f(\tau^*)(\tau^*\beta - \mathcal{L}) + (1-q)\frac{\mathcal{L}}{\tau^*}(1 - \int_{\tau^*}^1 sf(s)ds))}_{H_1}$$
$$\times \underbrace{(\beta \int_{\tau^*}^1 sf(s)ds + 1 - \int_{\tau^*}^1 sf(s)ds - \alpha)}_{H_2}. \quad (2.42)$$

It is immediate to verify that $H_1 < 0$. Next, $H_2 > 0$ can be written as

$$\frac{\beta - 1}{\alpha - 1} > \frac{1}{\int_{\tau^*}^1 sf(s)ds}. \quad (2.43)$$

This last inequality is an implication from the incentive-compatibility condition, since we know from the incentive-compatibility condition that

$$\frac{1}{\int_{\tau^*}^1 sf(s)ds} = \frac{\beta A - A + E}{\alpha A - A + E} < \frac{\beta - 1}{\alpha - 1}. \quad (2.44)$$

Therefore, we have shown that $\Sigma'(\tau^*) < 0$. Note that this holds at τ^* as well as at any root of $\Sigma'(.)$, implying that $\Sigma'(.)$ can cross zero at most once and from below so that Σ has a single peak. Evaluating $\Sigma'(.)$ at $\overline{\tau}$, we know that the the peak is located below $\overline{\tau}$ if $\Sigma'(\overline{\tau}) \leq 0$ and above $\overline{\tau}$ if $\Sigma'(\overline{\tau}) > 0$.

We can further rewrite

$$
\begin{aligned}
H(\bar{\tau}) &= (q\alpha + (1-q)(\mathcal{L}F(\bar{\tau}) + \beta\int_{\bar{\tau}}^{1} sf(s)ds - 1)(\beta-\alpha)\bar{\tau} && (2.45)\\
&\quad +(1-q)(\mathcal{L} - \bar{\tau}\beta)(1 - \int_{\bar{\tau}}^{1} sf(s)ds)(1 - \int_{\bar{\tau}}^{1} sf(s)ds - (\alpha - \beta\int_{\bar{\tau}}^{1} sf(s)ds)) \\
&= (q\alpha + (1-q)\beta\mathbb{E}(s) - 1)(\beta-\alpha)\bar{\tau} && (2.46)\\
&\quad +(1-q)(\mathcal{L} - \bar{\tau}\beta)(1 + \frac{\mathcal{L}F(\bar{\tau})}{\beta} - \mathbb{E}(s))(1 - \alpha + (\beta-1)(\mathbb{E}(s) - \frac{\mathcal{L}}{\beta}F(\bar{\tau}))), && (2.47)
\end{aligned}
$$

where the last equality is obtained from the definition of $\bar{\tau}$. Thus, $\Sigma'(\bar{\tau}) > 0$ is equivalent to

$$
q > \frac{(1-\beta\mathbb{E}(s))(\beta-\alpha)\bar{\tau} - (\mathcal{L} - \bar{\tau}\beta)(1 + \frac{\mathcal{L}F(\bar{\tau})}{\beta} - \mathbb{E}(s))(1 - \alpha + (\beta-1)(\mathbb{E}(s) - \frac{\mathcal{L}}{\beta}F(\bar{\tau})))}{(\alpha-\beta\mathbb{E}(s))(\beta-\alpha)\bar{\tau} - (\mathcal{L} - \bar{\tau}\beta)(1 + \frac{\mathcal{L}F(\bar{\tau})}{\beta} - \mathbb{E}(s))(1 - \alpha + (\beta-1)(\mathbb{E}(s) - \frac{\mathcal{L}}{\beta}F(\bar{\tau})))}. \quad (2.48)
$$

Therefore, we get condition (2.20) in text.□

Proof of Corollaries 10, 11 and 12 : Let us start by deriving the comparative statics in the case $q > \bar{q}$. The threshold $\bar{\tau}$ is defined by (2.19), which is equivalent to $\mathbb{E}(s \mid s \leq \bar{\tau}) = \mathcal{L}/\beta$. Obviously, $\bar{\tau}$ does not depend on α. Further, as $\mathcal{L}$ increases, $\mathbb{E}(s \mid s \leq \bar{\tau})$ increases, which implies that $\bar{\tau}$ increases. Similarly, as β increases, $\mathbb{E}(s \mid s \leq \bar{\tau})$ decreases, which implies that $\bar{\tau}$ decreases.

The optimal leverage is given by

$$
\frac{A^*}{E} = \frac{1 - \int_{\bar{\tau}}^{1} sf(s)ds}{1 - \int_{\bar{\tau}}^{1} sf(s)ds - (\alpha - \beta\int_{\bar{\tau}}^{1} sf(s)ds)}. \quad (2.49)
$$

Therefore,

$$
\frac{\partial(\frac{A^*}{E})}{\partial\bar{\tau}} = \frac{\bar{\tau}f(\bar{\tau})(1 - \int_{\bar{\tau}}^{1} sf(s)ds - (\alpha - \beta\int_{\bar{\tau}}^{1} sf(s)ds)) + (1 - \int_{\bar{\tau}}^{1} sf(s)ds)(\beta-1)\bar{\tau}f(\bar{\tau})}{(1 - \int_{\bar{\tau}}^{1} sf(s)ds - (\alpha - \beta\int_{\bar{\tau}}^{1} sf(s)ds))^2} > 0. \quad (2.50)
$$

As a result,

$$
\frac{\partial(\frac{A^*}{E})}{\partial\mathcal{L}} = \frac{\partial\bar{\tau}}{\partial\mathcal{L}}\frac{\bar{\tau}f(\bar{\tau})(1 - \int_{\bar{\tau}}^{1} sf(s)ds - (\alpha - \beta\int_{\bar{\tau}}^{1} sf(s)ds)) + (1 - \int_{\bar{\tau}}^{1} sf(s)ds)(\beta-1)\bar{\tau}f(\bar{\tau})}{(1 - \int_{\bar{\tau}}^{1} sf(s)ds - (\alpha - \beta\int_{\bar{\tau}}^{1} sf(s)ds))^2} > 0 \quad (2.51)
$$

and

$$
\frac{\partial(\frac{A^*}{E})}{\partial\alpha} = \frac{1 - \int_{\bar{\tau}}^{1} sf(s)ds}{(1 - \int_{\bar{\tau}}^{1} sf(s)ds - (\alpha - \beta\int_{\bar{\tau}}^{1} sf(s)ds))^2} > 0. \quad (2.52)
$$

Finally, $\bar{\tau}$ decreases in β. Hence,

$$\frac{\partial(\frac{A^*}{E})}{\partial\beta} = \frac{\frac{\partial\bar{\tau}}{\partial\beta}\bar{\tau}f(\bar{\tau})(1-\int_{\bar{\tau}}^1 sf(s)ds - (\alpha - \beta\int_{\bar{\tau}}^1 sf(s)ds))}{(1-\int_{\bar{\tau}}^1 sf(s)ds - (\alpha-\beta\int_{\bar{\tau}}^1 sf(s)ds))^2} + \frac{(1-\int_{\bar{\tau}}^1 sf(s)ds)((\beta-1)\bar{\tau}f(\bar{\tau})\frac{\partial\bar{\tau}}{\partial\beta} - \int_{\bar{\tau}}^1 sf(s)ds))}{(1-\int_{\bar{\tau}}^1 sf(s)ds - (\alpha-\beta\int_{\bar{\tau}}^1 sf(s)ds))^2} < 0. \quad (2.53)$$

which implies that $\frac{A^*}{E}$ decreases in β.

Then, we can derive the comparative statics in the case $q \leq \bar{q}$. Let $H(\tau) = \Sigma'(\tau)$ be defined as the derivative of the social surplus in τ. We know from Proposition 10 that $\tau^* < \bar{\tau}$ and, given that it is a local maximum of Σ, $H'(\tau^*) \leq 0$. We will assume here that it is regular maximum, $H'(\tau^*) < 0$ so that the comparative statics are always well-defined. It then follows that the comparative static of τ^* in a variable X has the sign of $\partial H/\partial X$, which we conduct next:

$$\begin{aligned}
\frac{\partial H}{\partial\alpha} &= q(\beta-\alpha)\tau - \tau(q\alpha + (1-q)(\mathcal{L}F(\tau) + \beta\int_\tau^1 sf(s)ds) - 1) \\
&\quad -(1-q)(\mathcal{L}-\tau\beta)(1-\int_\tau^1 sf(s)ds); \\
\frac{\partial H}{\partial\beta} &= (1-q)\int_\tau^1 sf(s)ds(\beta-\alpha)\tau + \tau(q\alpha + (1-q)(\mathcal{L}F(\tau) + \beta\int_\tau^1 sf(s)ds) - 1) \\
&\quad +(1-q)(\mathcal{L}-\tau\beta)(1-\int_\tau^1 sf(s)ds)\int_\tau^1 sf(s)ds \\
&\quad -(1-q)\tau(1-\int_\tau^1 sf(s)ds)(1-\alpha+(\beta-1)\int_\tau^1 sf(s)ds; \\
\frac{\partial H}{\partial\mathcal{L}} &= (1-q)F(\tau)(\beta-\alpha)\tau \\
&\quad +(1-q)(1-\int_\tau^1 sf(s)ds)(1-\alpha+(\beta-1)\int_\tau^1 sf(s)ds) > 0; \\
\frac{\partial H}{\partial q} &= (\alpha - \mathcal{L}F(\tau) - \beta\int_\tau^1 sf(s)ds)(\beta-\alpha)\tau \\
&\quad -(\mathcal{L}-\tau\beta)(1-\int_\tau^1 sf(s)ds)(1-\alpha+(\beta-1)\int_\tau^1 sf(s)ds).
\end{aligned}$$

We know that $H(\tau(A^*)) = 0$. Therefore

$$-\tau^*(q\alpha + (1-q)(\mathcal{L}F(\tau^*) + \beta\int_{\tau^*}^1 sf(s)ds) - 1) = \frac{1-q}{\beta-\alpha}(\mathcal{L}-\tau^*\beta)(1-\int_{\tau^*}^1 sf(s)ds)(1-\alpha+(\beta-1)\int_{\tau^*}^1 sf(s)ds), \quad (2.54)$$

which implies that $\frac{\partial H}{\partial q}_{\tau=\tau(A^*)} = (\alpha + \frac{1}{1-q}(q\alpha-1))(\beta-\alpha)\tau(A^*) > 0$. Similarly,

$H(\tau(A^*)) = 0$, is equivalent to

$$- \tau^*(q\alpha + (1-q)(\mathcal{L}F(\tau^*) + \beta \int_{\tau^*}^1 sf(s)ds) - 1)$$
$$= \frac{1-q}{\beta-\alpha}(\mathcal{L} - \tau^*\beta)(1 - \int_{\tau^*}^1 sf(s)ds)(1 - \alpha + (\beta - 1)\int_{\tau^*}^1 sf(s)ds), \quad (2.55)$$

which implies that

$$\frac{\partial H}{\partial \alpha}(\tau(A^*)) = q(\beta-\alpha)\tau^* + (1-q)(\tau^*\beta - \mathcal{L})(1 - \int_{\tau^*}^1 sf(s)ds)(1 - \frac{1 - \alpha + (\beta-1)\int_{\tau^*}^1 sf(s)ds}{\beta - \alpha})$$
$$= q(\beta-\alpha)\tau^* + \frac{1-q}{\beta-\alpha}(\tau^*\beta - \mathcal{L})(1 - \int_{\tau^*}^1 sf(s)ds)(\beta - 1 - (\beta-1)\int_{\tau^*}^1 sf(s)ds)) > 0. \quad (2.56)$$

We can conclude that the optimal threshold τ^* increases in α, in q and in $\mathcal{L}$.

From (2.16), we can also conclude that the optimal leverage moves in the same direction than the optimal threshold with respect to q, α and $\mathcal{L}$. More precisely, we know that

$$\frac{\partial(\frac{A^*}{E})}{\partial \mathcal{L}} = \frac{\partial \tau^*}{\partial \mathcal{L}} \frac{\tau^* f(\tau^*)(1 - \int_{\tau^*}^1 sf(s)ds - (\alpha - \beta\int_{\tau^*}^1 sf(s)ds)) + (1 - \int_{\tau^*}^1 sf(s)ds)(\beta-1)\tau^* f(\tau^*)}{(1 - \int_{\tau^*}^1 sf(s)ds - (\alpha - \beta\int_{\tau^*}^1 sf(s)ds))^2} > 0, \quad (2.57)$$

$$\frac{\partial(\frac{A^*}{E})}{\partial q} = \frac{\partial \tau^*}{\partial q} \frac{\tau^* f(\tau^*)(1 - \int_{\tau^*}^1 sf(s)ds - (\alpha - \beta\int_{\tau^*}^1 sf(s)ds)) + (1 - \int_{\tau^*}^1 sf(s)ds)(\beta-1)\tau^* f(\tau^*)}{(1 - \int_{\tau^*}^1 sf(s)ds - (\alpha - \beta\int_{\tau^*}^1 sf(s)ds))^2} > 0, \quad (2.58)$$

and

$$\frac{\partial(\frac{A^*}{E})}{\partial \alpha} = \frac{\frac{\partial \tau^*}{\partial \alpha}\tau^* f(\tau^*)(1 - \int_{\tau^*}^1 sf(s)ds - (\alpha - \beta\int_{\tau^*}^1 sf(s)ds)) + (1 - \int_{\tau^*}^1 sf(s)ds)((\beta-1)\tau^* f(\tau^*)\frac{\partial \tau^*}{\partial \alpha} + 1)}{(1 - \int_{\tau^*}^1 sf(s)ds - (\alpha - \beta\int_{\tau^*}^1 sf(s)ds))^2} > 0. \quad (2.59)$$

Therefore, the optimal leverage $\frac{A^*}{E}$ also increases in α, q and $\mathcal{L}$.

The comparative statics with respect to β is slightly more complicated. Indeed, we know that

$$\frac{dH}{d\beta} = (1-q)\int_{\tau}^{1} sf(s)ds(\beta-\alpha)\tau + \tau(q\alpha + (1-q)(\mathcal{L}F(\tau) + \beta\int_{\tau}^{1} sf(s)ds) - 1)$$
$$- (1-q)(\tau\beta - \mathcal{L})(1 - \int_{\tau}^{1} sf(s)ds)\int_{\tau}^{1} sf(s)ds$$
$$- (1-q)\tau(1 - \int_{\tau}^{1} sf(s)ds)(1 - \alpha + (\beta-1)\int_{\tau}^{1} sf(s)ds). \quad (2.60)$$

The first two terms are positive whereas the last two terms are negative. There is an ambiguity for the following reason. As β increases, the risk-shifting problem becomes more severe (first two terms) and the regulator should provide more incentives to the banker to choose the low risk portfolio by increasing the liquidation threshold. On the other hand, as β increases, the payoff in case of continuation is increasing (last two terms) and hence, the regulator is willing to reduce the liquidation threshold.□

Proof of Corollary 13: Taking the derivative of (2.16) with respect to β yields

$$\frac{\partial A^*/E}{\partial \beta} = \frac{\frac{\partial \tau^*}{\partial \beta}\tau^* f(\tau^*)(1 - \int_{\tau^*}^{1} sf(s)ds - (\alpha - \beta\int_{\tau^*}^{1} sf(s)ds))}{(1 - \int_{\tau^*}^{1} sf(s)ds - (\alpha - \beta\int_{\tau^*}^{1} sf(s)ds))^2}$$
$$- \frac{(1 - \int_{\tau^*}^{1} sf(s)ds)(-(\beta-1)\frac{\partial \tau^*}{\partial \beta}\tau^* f(\tau^*) + \int_{\tau^*}^{1} sf(s)ds)}{(1 - \int_{\tau^*}^{1} sf(s)ds - (\alpha - \beta\int_{\tau^*}^{1} sf(s)ds))^2}.$$

Hence, $\frac{\partial \tau^*}{\partial \beta} < 0$ implies that $\frac{\partial A^*/E}{\partial \beta} < 0$.

Further, we know that the leverage is given by

$$\int_{\tau^*}^{1} sf(s)ds = \frac{\alpha A^* - A^* + E}{\beta A^* - A^* + E}. \quad (2.61)$$

Taking the derivative of the right hand side with respect to beta yields

$$\frac{(\alpha-1)\frac{\partial A^*}{\partial \beta}(\beta A^* - A^* + E) - (\alpha A^* - A^* + E)((\beta-1)\frac{\partial A^*}{\partial \beta} + A^*)}{(\beta A^* - A^* + E)^2}$$
$$= \frac{E(\alpha-\beta)\frac{\partial A^*}{\partial \beta} - (\alpha A^* - A^* + E)A^*}{(\beta A^* - A^* + E)^2} \quad (2.62)$$

Hence, $\frac{\partial A^*}{\partial \beta} > 0$ implies that the right-hand side of (2.61) decreases in β, which in turn implies that $\int_{\tau^*}^{1} sf(s)ds$ decreases in β, i.e. τ^* increases in β. □

Appendix A.2: uniform states

In this appendix, we develop the main results in the context of the uniform distribution where the main tradeoffs can sometimes be expressed in closed-form. Specifically, we assume that s is uniformly distributed with support on $[0, 1]$. A point of interest of this uniform choice is that it can be viewed as a principle of maximal ignorance (absent any well-formed prior) or as a linear approximation for low levels of uncertainty as, for example, in Plantin, Sapra and Shin (2008*b*). Our assumption that $\mathbb{E}(s)\beta > \mathcal{L}$ is equivalent to $2\mathcal{L}/\beta < 1$ and implies that the liquidation threshold $\bar{\tau}$ is interior.

Solving explicitly for κ in Proposition 8,

$$\kappa = \sqrt{\frac{1+\beta-2\alpha}{\beta-1}}. \tag{2.63}$$

With uniform states, the continuation threshold κ is also the probability of liquidation. This probability is decreasing and concave in α, which is intuitive because the value of liquidating loans becomes increasingly attractive when most loans are safe and there is very little opportunity cost from excess liquidation of risky loans. Further, it is increasing and convex in β if and only if $3\alpha-1-2\beta>0$, which reflects a situation in which safe loans are sufficiently common that increasing the probability of liquidation (as β increases) benefits incentives more than they reduce total surplus.

Specifically, total surplus is given by

$$\Sigma = A_{\max}(q\alpha + (1-q)(\mathcal{L}\sqrt{\frac{1+\beta-2\alpha}{\beta-1}} + \beta\frac{\alpha-1}{\beta-1}) - 1). \tag{2.64}$$

The surplus is increasing in β if and only if $\mathcal{L} \geq \sqrt{\frac{1+\beta-2\alpha}{\beta-1}}$. In particular, the payoff of the risky loan that maximizes total surplus can be derived explicitly as

$$\beta - 1 = \frac{2(\alpha-1)}{1-\mathcal{L}^2}, \tag{2.65}$$

which represents the ideal loan risk profile for a bank with no equity.

Similarly, we derive total surplus under the maximum liquidation threshold $\bar{\tau} = 2\mathcal{L}/\beta$. This implies a surplus equal to

$$\begin{aligned}\Sigma &= A_{\max}(q\alpha + (1-q)(\mathcal{L}F(2\frac{\mathcal{L}}{\beta}) + \beta\int_{2\frac{\mathcal{L}}{\beta}}^{1} sds) - 1)\\ &= A_{\max}(q\alpha + (1-q)\frac{\beta}{2} - 1)\end{aligned}$$

and this measurement system yields positive surplus if and only if $q > \dfrac{1-\beta/2}{\alpha-\beta/2}$.

Under the pure prudential regulation benchmark, equation (2.5) implies a bank leverage

$$\frac{A^*}{E} = \frac{\beta^2+\mathcal{L}^2}{\beta^2(1+\beta-2\alpha)-\mathcal{L}^2(\beta-1)}, \tag{2.66}$$

which reveals how the bank becomes smaller in response to a more severe agency problem. Plugging this expression into the total surplus,

$$\Sigma = E\frac{\beta^2+\mathcal{L}^2}{\beta^2(1+\beta-2\alpha)-\mathcal{L}^2(\beta-1)}(q\alpha + (1-q)(\mathcal{L}^2/\beta + \frac{\beta}{2}(1-\frac{\mathcal{L}^2}{\beta^2})) - 1), \tag{2.67}$$

which is, as expected, increasing in the liquidation payoff since this helps sustain a greater bank size and higher payoffs conditional on liquidation. It is also increasing in fraction of sale loans q because $\alpha > \mathcal{L}^2/\beta + \frac{\beta}{2}(1 - \frac{\mathcal{L}^2}{\beta^2}))$ and ambiguous in β.

We solve next for the general case with an endogenous continuation threshold and an optimally set capital requirement.

Proposition 11. *Let*

$$\bar{q} = \frac{1+Q}{\alpha + Q}. \tag{2.68}$$

where $Q > 0$ (see proof below). If $q > \bar{q}$, the reporting system issues a liquidation signal $m(s)$ if and only if $s < \tau(A^*) = 2\mathcal{L}/\beta$.

Proof of Proposition 11: With a uniform distribution, the incentive-compatibility condition is now given by

$$\Delta_{IC} = \int \Big(A\alpha - A + E - s(1 - m(s))(A\beta - A + E) \Big) ds \geq 0. \tag{2.69}$$

We define the Lagrangian similarly with associated multipliers μ_0, μ_a and μ_b. Differentiating with respect to $m(s)$,

$$\frac{\partial L}{\partial m(s)} \quad = \quad s(\mu_0(A\beta - A + E) - (1-q)\beta - \mu_a - \mu_b) + (1 - q + \frac{\mu_a + \mu_b}{\beta})\mathcal{L}.$$

Noting that this function is linear in s and positive at $s = 0$, we know that $m(s) = 1$ if and only if $s \leq \tau$, where τ is a threshold in $[0, 1]$.

Case 1. Suppose that $\mu_0 = 0$. Then, the solution $\mu_a = \mu_b = 0$ and $\tau = \mathcal{L}/\beta$ maximizes the Lagrangian and satisfies the constraints associated to multipliers μ_a and μ_b. But, then, it is desirable to set $A = A_{\max}$, which contradicts A0.

Case 2. Suppose that $\mu_0 > 0$. Writing the incentive-compatibility explicitly after reinjecting $m(s) = 1$ if and only if $s < \tau$,

$$\Delta_{IC} = \tau^2(A(\beta - 1) + E) + E - A(\beta + 1 - 2\alpha) \geq 0 \tag{2.70}$$

The left-hand side is increasing in τ and the objective function is increasing in τ when $\tau \in (0, \mathcal{L}/\beta)$, hence, it must be that, if the (IC) is binding, $\tau \geq \mathcal{L}/\beta$. In addition, the optimality of ex-post liquidations requires $\mathcal{L} \geq \beta\tau/2$, that is, $\tau \leq 2\mathcal{L}/\beta$.

Solving for the optimal leverage,

$$\frac{A}{E} = \frac{1 + \tau^2}{1 + \beta - 2\alpha - (\beta - 1)\tau^2} \tag{2.71}$$

and reinjecting into the social surplus

$$\begin{aligned} \Sigma \quad &= \quad A \int (q\alpha + (1-q)(m(s)\mathcal{L} + (1 - m(s))s\beta - 1)ds \\ &= \quad E(1 + \tau^2)\frac{(q\alpha + (1-q)(\mathcal{L}\tau + \frac{1}{2}\beta(1 - \tau^2)) - 1)}{1 + \beta - 2\alpha - (\beta - 1)\tau^2}. \end{aligned} \tag{2.72}$$

Differentiating this expression with respect to τ,

$$H(\tau) = k_0 \sum_{i=0}^{5} \nu_i \tau^i,$$

where $k_0 > 0$ and

$$\begin{aligned}
\nu_0 &= (\beta + 1 - 2\alpha)(1-q)\mathcal{L} > 0 \\
\nu_1 &= \beta(\beta + q - \beta q - 5) + 4\alpha(1 + \beta q) - 4\alpha^2 q \\
\nu_2 &= 2\mathcal{L}(1-q)(1 + 2\beta - 3\alpha) > 0 \\
\nu_3 &= -2\beta(1-q)(1 + \beta - 2\alpha) < 0 \\
\nu_4 &= -(\beta - 1)(1-q)\mathcal{L} < 0 \\
\nu_5 &= \beta(1-q)(\beta - 1) > 0.
\end{aligned}$$

It is readily verified that this polynomial is positive at $\tau = \mathcal{L}/\beta$:

$$H(\frac{\mathcal{L}}{\beta}) = 2(1-q)(\beta-\alpha)\frac{\mathcal{L}^3}{\beta^2} + 4(\beta-\alpha)(q\alpha - 1)\frac{\mathcal{L}}{\beta} + 2(1-q)(\beta-\alpha)\mathcal{L} \quad (2.73)$$

$$= 4(\beta-\alpha)\frac{\mathcal{L}}{\beta}(q\alpha + (1-q)(\mathcal{L}\frac{\mathcal{L}}{\beta} + \beta\int_{\frac{\mathcal{L}}{\beta}}^{1} s ds) - 1) > 0. \quad (2.74)$$

Therefore, the solution implies excess liquidations, i.e., $\tau > \mathcal{L}/\beta$, and full-information is not optimal.

Further, we have

$$H(2\mathcal{L}/\beta) = 16(1-q)(\beta-1)\frac{\mathcal{L}^5}{\beta^4} + 8(1-q)(\alpha-1)\frac{\mathcal{L}^3}{\beta^2} + 8\alpha\frac{\mathcal{L}}{\beta}(1 + \beta q - \alpha q) + \mathcal{L}(2(q-5) + (1-q)(3\beta + 1 - 2\alpha)). \quad (2.75)$$

The condition $q \geq \bar{q}$ is equivalent to $H(2\mathcal{L}/\beta) > 0$. From our analysis of the model with a general distribution, the optimal solution is the corner solution $\tau(A^*) = \bar{\tau} = 2\mathcal{L}/\beta$.

Otherwise, if $q < \bar{q}$, the solution is interior. □

Chapter 3

Non-Audit Services, Incentives and Audit Quality

3.1 Introduction

What are the incentive effects of the provision of non-audit services (NAS) on auditors? This is an important policy question of concern to regulators given the debate that has been raging for years on whether an audit company should provide NAS to its audit clients. This debate is often reduced to a simple cost and benefit tradeoff. On the one side, joint NAS and audit services provision is likely to be more efficient in terms of production costs because of knowledge spillovers (Simunic, 1984). On the other side, NAS may threaten the auditor's independence because it creates an economic bond between the auditor and the client (DeAngelo, 1981*a*). In the absence of a clear sense of the incentive effects, the conventional wisdom that "providing both NAS and audit services to the same client threatens auditor independence and may affect audit quality" seems to prevail (Causholli et al., 2014). For instance, this conventional wisdom led US policymakers to prohibit auditors from providing many non-audit services with the Sarbanes Oxley Act (SOX) in 2002. Nevertheless, as underscored by Ewert (2004), "the incentive problems of combining NAS and auditing are still an open issue." I believe that a proper understanding of the incentive effects of NAS would guide regulators in designing new regulatory actions.

In this paper, I depart from the conventional wisdom and emphasize a novel reason in favor of the provision of NAS by auditors. Specifically, I build a framework to study a positive incentive externality of NAS: the possibility of providing NAS contingent on detecting financial misstatements may increase the auditor's effort to detect those misstatements. This represents a benefit of the provision of NAS by auditors. Nonetheless, my analysis also underlines that the provision of NAS may create conflicts of interest and decrease perceived audit quality. I highlight a negative impact of this decrease in audit quality when two firms in the same industry rely on peers' financial statements. Restricting auditors from providing NAS may in turn be desirable. Thus, regulators face a tradeoff between the ex ante positive incentive effect and the ex post decrease in audit quality. Removing the current restrictions on contingent audit fees on unfavorable audit opinions may offset the ex post decrease in audit quality while preserving the ex ante incentives.

My theory starts with a classic conflict of interests between an empire building manager and the investors of a firm as in Baldenius (2003). The manager enjoys some private benefits from running the firm and wants to hide a poor financial situation from the investors, so that the latter do not intervene and liquidate the firm, which would be optimal for them. The auditor must exert a costly audit effort to detect financial misstatements by the manager. After the publication of the financial statements, if the firm is not liquidated, the manager hires a consultant to increase the firm's value. The consultant, who can be either the auditor or an outsider, earns an economic rent from the NAS contract.[1]

The optimal mechanism for the investors is such that the auditor is rewarded in case of misstatements detection. This reward can either be contingent audit fees or the economic rent attached to the NAS contract. In that latter case, the auditor has then incentives ex ante to detect misstatements in order to obtain the lucrative NAS contract. If the value added of NAS is high, my analysis shows that the investors optimally commit with some probability not to liquidate the firm and to have the auditor provide NAS if the auditor detects misstatements. This optimal mechanism admits a simple implementation whereby the provision of NAS might create conflicts of interest and reduce auditor independence. Specifically, the manager is willing to give the NAS contract to the auditor so that the latter gives a favorable audit opinion and the firm is not liquidated, as in Lu and Sapra (2009) and Kornish and Levine (2004). This NAS contract yields a positive rent that provides incentives to the auditor to exert audit effort. Thus, based on my previous analysis, I underscore that it is optimal for the investors to commit ex ante to let the manager hire the auditor as consultant with some probability. In light of this incentive effect, banning auditors from providing NAS to audit clients in order to increase auditors' independence may harm investors.

However, in this setup, the impact of the provision of NAS on audit quality, which I define as the probability that the auditor gives an unfavorable audit opinion to manipulated financial statements, is unclear. On the one hand, allowing the auditor to provide both NAS and auditing services may increase ex ante audit effort. On the other hand, if the auditor is banned from providing NAS to audit clients, the auditor is fully independent because the manager is not able ex post to exert pressure on the former with a NAS contract. Therefore, I investigate the impact of the optimal mechanism and I show that audit quality is higher when the auditor can provide NAS if the economic rent from NAS is sufficiently high. Conversely, if the rent from NAS is low, audit quality is higher when the provision of NAS by the auditor is banned and audit fees contingent on a negative audit opinion are allowed. Audit fees contingent on unfavorable audit opinions preserve the ex ante incentive effect while preventing ex post conflict of interests.

The series of financial reporting scandals in the late 1990s and early 2000s at companies such as Enron or Worldcom are relevant examples in which the traditional market-based incentive forces for auditors, i.e. litigation and reputation costs, were not effective enough to prevent audit firms from giving clean audit opinions to fraudulent financial statements. Similar to the case of the credit rating agencies during the financial crisis of 2007-08, reputation risks do not seem to play an important enough

[1] The economic rent from the NAS contract admits several interpretations: private benefit, efficiency wage, rent from imperfect competition...

role to prevent certification intermediaries from providing false information to the investors. Moreover, despite the recent increase in litigation costs, it is not possible for regulators to impose very high litigation costs.[2] Hence, this paper highlights how an incentive effect of NAS, above and beyond litigation and reputation costs, can affect audit effort.

I highlight a potential role for the regulation of NAS using a sequential equilibrium model with two firms in the same industry. The investors of the first-moving firm face the same situation as in the baseline setup described above whereas the investors of the second-moving firm also observe the liquidation decision of the investors of the first firm. There is an informational externality resulting from the decrease in audit quality caused by the provision of NAS by the auditor of the first-moving firm. Indeed, the investors of the second firm may rely on the first firm decision to make their own liquidation decision. Hence, the decrease in audit quality resulting from the provision of NAS by the auditor of the first firm may induce an inefficient herding behavior in case of bad firms. I underline that investors can recover truth-telling if the provision of NAS by auditors is banned and contingent audit fees on unfavorable audit opinions are allowed as in Kornish and Levine (2004). This latter policy would increase audit quality and reduce the negative informational externality.

The results of the paper contribute to both the regulatory and academic communities. Regulators and practitioners fear that auditors would be unwilling to challenge a client if a negative audit opinion would mean losing future NAS contracts (e.g. Bell et al., 2015; *The Guardian*, 2010; SEC, 2001).[3] As underlined by DeFond et al. (2002), there is an important tradeoff for auditors. Auditors are willing to sacrifice their independence if reputation and litigation costs associated with audit failures are smaller than the economic rents from NAS contracts. The corporate accounting scandals are examples of ex post conflicts of interest. However, my findings shed some light on the desirability of the provision of NAS by auditors and suggest that regulators may need to investigate more carefully the tradeoff between ex ante incentives and ex post conflicts on interest.

Lastly, my model generates empirical predictions about the effects of the provision of NAS on audit effort and audit quality. The main empirical takeaway is that finding a negative relationship between the provision of NAS and financial misstatements does not imply that NAS negatively affect audit quality. On the contrary, a negative relationship may indicate that incentives are provided to auditors using NAS and this mechanism improves ex ante audit quality.

3.2 Background and literature review

3.2.1 Institutional setting

The corporate scandals of the early 2000s reignited the debate on auditors providing NAS. Indeed, those accounting scandals are relevant cases of conflicts of interest re-

[2] I discuss some reasons why it is indeed the case on page 116.

[3] Another concern is that auditors may audit their own work after providing NAS to an audit client. I discuss this point in section 3.6.1.

sulting from the provision of NAS by auditors. For instance, Arthur Andersen, the auditor of Enron and Worldcom, was criticized for approving the accounting treatment of many suspect transactions. Andersen, which was a member of the Big Five, went bankrupt just a few months after Enron. One potential explanation of the audit failures is the provision of lucrative NAS services by Andersen to the top managements of Enron and Worldcom. Nonetheless, the impact of those contracts on Andersen's incentives to provide high audit effort is still unclear.

The regulatory response to those corporate scandals has been to increase auditors' independence as much as possible. Regulators have put restrictions on the provision of NAS by auditors in order to increase audit quality. In the US, Section 201 of SOX restricts auditors from providing some NAS such as internal audit outsourcing to audit clients. In the European Union, legislation approved in 2014 puts a cap on the level of non-audit fees that auditors can earn from audit clients (70% of audit fees) and also prohibits a set of NAS.

After the passage of SOX, the Big Four audit firms (Deloitte, EY, KPMG and PwC) stopped most of their non-audit activities and signed non-compete agreements with their former consulting divisions. Those agreements expired in the mid-2000s and the Big Four firms again provide NAS to audit clients outside the US, where SOX does not apply, and also in the US for NAS unaffected by SOX.[4] From 2011 to 2016, they acquired over 160 consulting entities, according to the PCAOB. The Big Four's total global revenues from consulting services provided to both audit and non-audit clients exceeded their audit revenues in the last few years. Further, in recent studies, Carcello et al. (2017) and Whalen et al. (2015) find that NAS still make up a sizeable portion of the fees that auditors collect from their audit clients (around 20 percent). For example, in 2014, at least 300 companies in the U.S. and Europe paid their auditors as much for add-on services as they did for audit work (*Wall Street Journal*, 2014).

Gven those facts, the provision of NAS by auditors to audit clients is still a major issue for regulators (Causholli et al., 2014; Beardsley et al., 2017). I briefly highlight the main reasons of this concern, based on the more exhaustive discussion of Kowaleski et al. (2016). Although in many cases Big 4 personnel work only as auditor or as consultant, the Big 4 firms have some employees that make both audit and consulting decisions. First, Big 4 firms provide opportunities for their employees to rotate or to participate in transfers between different service lines. Second, recent graduates acknowledge the opportunities to rotate in auditing and in consulting within the same year. Third, some consultants also participate as specialists for certain audits. Finally, when the audit firm provides both auditing and consulting services to the same client, one partner is generally in charge of the entire client relationship.

As a result of those practices, regulators continue to see auditor independence violations (Harris, 2016). A recent example comes from an investigation of KPMG in 2016 for possible independence violations related to non-audit services provided to Ted Baker, an audit client (*Financial Times*, 2016). Regulators closely monitor the Big Four in order to avoid a new accounting scandal like Enron. Nonetheless, they are focused on the ex post problems linked to a lack of auditor's independence and they

[4]In the US, an extensive list of permissible non-audit services remains: benefit plan audits, assistance related to mergers and acquisitions, attestation services, accounting consultations, tax compliance, tax planning, tax advice and operational audits...

seem not to have considered the ex ante incentive externalities. This paper offers a framework to investigate both the ex post problems and the ex ante externalities of the provision of NAS by auditors and might help to design better regulations.

3.2.2 Related literature

First, there is a large strand of the auditing literature studying the behavior of audit companies providing NAS to audit clients. In a seminal paper, Simunic (1984) argues that auditors should provide NAS to audit clients because of potential knowledge spillovers between the two types of services. Since then, many empirical studies have been conducted to study the link between NAS and audit quality and the evidence is mixed.[5] Studies using output-based proxies find that NAS do not impair audit quality (e.g. DeFond et al., 2002; Krishnan et al., 2005; Schmidt, 2012), and some NAS may even improve it (e.g. Kinney et al., 2004); while studies using perception-based proxies find that investors penalize companies purchasing NAS (e.g. Frankel et al., 2002; Higgs and Skantz, 2006; Khurana and Raman, 2006). The main difficulty in this area is to find a good proxy to measure audit quality and to identify the counterfactual observations (Carcello et al., 2017). My model predicts a positive relationship between NAS and audit effort. More importantly, it also predicts that a ban of the provision of NAS by auditors would increase auditor independence but decrease audit quality.

The most related papers to mine are Kornish and Levine (2004) and Lu and Sapra (2009), who also investigate the impact of NAS on audit quality. Lu and Sapra (2009) find that a mandatory restriction on NAS decreases a conservative auditor's audit quality and increases an aggressive auditor's audit quality. Kornish and Levine (2004) also use a contractual setting to investigate the impact of NAS on auditors' behaviors. Their conclusions are similar to mine: managers can influence auditors with NAS to issue favorable audit opinions while contingent audit fees can induce an unbiased audited accounting report. Nevertheless, they do not analyze the potential impact of NAS and contingent audit fees on audit effort and focus instead on their ex post effects. I study the impact of NAS on both the ex ante audit effort and on the ex post audit quality.

This paper intends to contribute more broadly to the literature studying auditors' incentives to provide high audit quality. An important number of papers study the impact of legal liability on audit quality. Dye (1993) studies the impact of an increase in auditor's liability and in auditing and accounting standards. Laux and Newman (2010) and Schwartz (1997) also analyze the impact of legal liability on auditor's incentives. Magee and Tseng (1990) study the pricing of audit services and the potential threats for the auditor's independence. Analyzing the incentive effects of NAS, this paper provides a new argument in favor of the provision of NAS by auditors to audit clients.[6]

Lastly, following the seminal work of Tirole (1986), an extensive literature has been devoted to the analysis of collusion in a principal-supervisor-agent setting.[7] Baiman

[5] For a recent survey of the archival auditing literature, see DeFond and Zhang (2014).

[6] The conflict of interest stemming from the provision of NAS by auditors is similar to the one faced by credit ratings agencies that offer non-ratings services (Baghai and Becker, 2018). A similar conflict also arises in sell-side research.

[7] For a more exhaustive survey and discussion of this literature, see Laffont and Rochet (1997). For

et al. (1991) study the ex ante collusion between a manager and an auditor and characterize the resulting optimal owner-manager contract. In the same vein, Friedman (2014) studies a CEO pressuring a CFO to bias financial reports. In this paper, allowing ex post collusion between the manager and the auditor is a way to implement the optimal mechanism for the investors.

The rest of the paper proceeds as follows. Section 3 describes the setup of the model, discusses the assumptions, and solves the static model with binary audit effort. Section 4 examines the case of a continuum of possible audit effort levels and studies the impact of the optimal mechanism on audit quality. Section 5 investigates a negative informational externality of NAS in a sequential equilibrium with two firms. Finally, I discuss the regulatory and empirical implications in section 6 and section 7 concludes.

3.3 The model

3.3.1 The setup

There are three stages, $t = 0, 1$ and 2. The timing of the model is summarized in Figure 3.1. There are four types of risk-neutral players involved in a firm: investors, the auditor, consultants and the manager. The investors own the firm from $t = 0$ until $t = 2$. The manager runs it with private information about its efficiency and the auditor collects information for the investors at $t = 1$. One of the consultants might be hired to provide consulting services and increase the firm's value at $t = 1$.[8] The manager is an empire builder and gets a private benefit b (perks, human capital...) of running the firm until $t = 2$. The firm can be of two types: good (G) with probability p and bad (B) with probability $1 - p$. Consistent with Lu and Sapra (2009), I refer to the parameter $1 - p$ as "client business risk." At $t = 2$, a good firm yields a cash flow R with probability q and a zero cash flow with probability $1 - q$, whereas a bad firm always yields a zero cash flow. Any firm can be liquidated at the intermediate stage $t = 1$ to get the liquidation payoff L such that $qR > L > 0$. The liquidation decision is made by the investors and admits several interpretations: a reorganization of the firm, a partial asset sale, a reduction in the scope of the firm, layoffs and firings... Those decisions are typically made by the board of directors, who acts in the best interests of the investors.

The manager's liquidation aversion is strong enough such that the investors do not find optimal to induce the manager to liquidate the firm or reveal his private information about the firm's viability. This implies that there is a conflict of interests between the manager and the investors in case of a bad firm.[9] The manager always certifies to the investors that the firm is good so that continuation is chosen by the

example, Che (1995) studies the optimality of allowing collusion for incentives reasons in a different setup.

[8] I use the terms NAS and consulting services interchangeably in the rest of the paper. They refer to all the types of NAS provided by the Big Four firms (tax services, compensation services,...).

[9] Like Dye (1993) and Lu and Sapra (2009), my model does not include manager's legal liability in order to focus on the role of auditing. If such a liability were effective so that a manager with a bad firm would indeed report it, the auditor would be useless.

investors.[10] Namely, in case of a bad firm, the manager manipulates the financial statements. I assume that the investors lack either the time or the knowledge required to supervise the manager, and that the auditor lacks either the time or the resources required to run the firm.

The key friction is a moral hazard problem. The auditor must exert an unobservable audit effort $e \in \{e_L, e_H\}$ to verify the accuracy of the financial statements.[11] At $t = 1$, after exerting effort, the auditor receives a signal $s \in \{\emptyset, s_B\}$ according to the following probabilities:[12]

$$P(s = \emptyset \mid G) = 1 \text{ and } P(s = s_B \mid B) = 1 - P(s = \emptyset \mid B) = e.$$

The essence of this audit technology is that more audit effort increases the probability that the auditor detects financial misstatements.[13] If the firm is good, the auditor receives no evidence of misstatements ($s = \emptyset$) because the manager is right to report that the firm is good. If the firm is bad, the manager lies and manipulates the financial statements. The auditor collects evidence of financial misstatements ($s = s_B$) with probability e and receives no evidence of misstatements ($s = \emptyset$) with the complementary probability $1 - e$. The auditor incurs a private cost c from exerting high audit effort ($e = e_H$) whereas the cost of exerting low audit effort ($e = e_L$) is normalized to 0. After receiving the signal s, the auditor makes a report $r \in \{\emptyset, s_B\}$ to the investors. The auditor cannot claim to possess evidence of financial misstatements ($r = s_B$) when he has no evidence because s_B is hard information. The auditor can only lie by omission and hide evidence of misstatements.

After the audit report, the investors decide whether to continue or liquidate the firm. If the investors choose continuation, the manager hires a consultant, who increases the probability of success of the firm by $\tau \in [0, 1 - q]$. There is a pool of consultants including the auditor. If a consultant is hired, a bad firm yields a cash flow R with probability τ and a zero cash flow with probability $1 - \tau$. Similarly, a good firm with a consultant yields a cash flow R with probability $q + \tau \leq 1$ and a zero cash flow with probability $1 - q - \tau$. The consultant earns an economic rent β from providing consulting services. This economic rent admits several interpretations.

(i) First, it can be a private benefit that may accrue for a variety of reasons: human

[10] Over-reporting is the more fequent source of financial misrepresentation at the firm level. For empirical evidence using SEC enforcement actions aimed at violations of US Generally Accepted Accounting Principles (GAAP), see e.g. (e.g. Beneish, 1999; Feroz et al., 1991; Karpoff et al., 2008). This assumption is commonly made in the literature to simplify the firm's reporting system and focuses the model on the auditing issue (e.g. Dye, 1993; Laux and Newman, 2010; Lu and Sapra, 2009).

[11] In practice, the role of the auditor is also to monitor ex post the cash flows of the firm, like in the costly state verification model of Townsend (1979). I focus on the forward-looking role of the auditor.

[12] I assume that the auditor receives a signal imperfectly correlated with the true type of the firm. In practice, auditors do not have all the possibilities to examine all the firm's records; they make inferences with a sample of them. This inference is subject to errors.

[13] This audit technology assumes away false positives, i.e. when the auditor discovers misstatements in case of a good firm. This is innocuous and reflects that Type I errors are rare and unimportant in audit practice. See, among others, Ewert (1999), Newman et al. (2005) and Simunic et al. (2017) for a similar assumption.

capital accumulation, perks, ego, social status...[14]

(ii) The economic rent β can be an efficiency wage that the investors need to pay to the consultant in order to get the expected monetary gain τR.[15]

(iii) Lastly, β can be a rent from imperfect competition on the consulting market: collusion between consultants, competition on quantities instead of prices, product differentiation...

In the first two interpretations (*i*) and (*ii*), the rent β survives even in case of perfect competition on the consulting market as long as the consultants are financially constrained.[16] Indeed, it is not possible for the investors to auction the consulting contract and get the monetary gain β because the consultants are financially constrained.

I stick to the first interpretation in the rest of the paper but the results are exactly the same under the two other interpretations. Perfect competition on the consultant market implies that the reservation utility of a consultant is zero. Hence, a consultant earns a private benefit $\beta > 0$ from the consulting contract but there is no NAS fees.[17] It is ex post optimal for the investors to liquidate a bad firm even if the consultant creates some value, i.e. $L > \tau R > 0$. The total expected value added of consulting services is $\tau R + \beta$, the sum of the monetary gain and of the private benefit. The consultant learns the type of the firm after the liquidation decision has been made by the investors.

The auditor is protected by limited liability. In the baseline model, in case of continuation, the manager is indifferent between signing the consulting contract with the auditor or with an outside consultant; I assume that the manager makes the preferred choice of the investors. Finally, the investors have deep pockets and, without loss of generality, the reservation utility of the manager and the auditor are equal to zero.[18]

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[14]This private benefit could also capture indirect benefits including the possibility of signalling ability, developing a personal relationship with the firm's senior management, a greater likelihood of retaining the client, enhancing the chances of gaining other rewarding assignments, receiving positive spillovers on other non-audit activities and increasing the likelihood of obtaining a top management position in the firm.

[15]In the Appendix 3, I provide one way of endogenizing β.

[16]One explanation of the financial constraint could be the intangibility of consulting firms assets, which implies that those firms have no debt capacity.

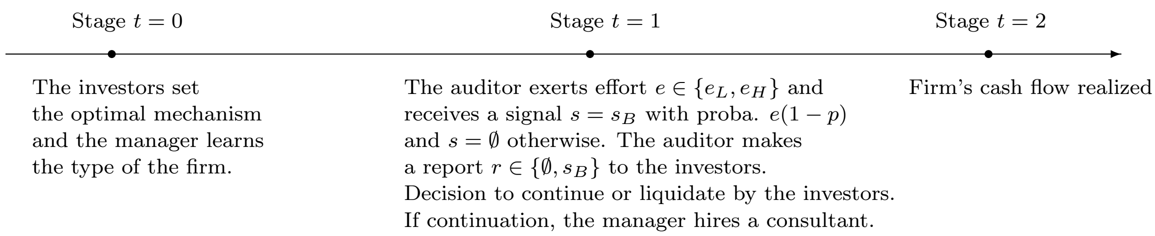
[17]I could add non-audit fees in that case by supposing that a consultant should be paid a minimum wage w_0. For example I could assume that the utility function of a consultant with respect to money is

$$U_{consultant}(w) = \begin{cases} w & \text{for } w \geq w_0 \\ -\infty & \text{for } w < w_0. \end{cases}$$

This would not change the results.

[18]I assume that there is perfect competition on the audit market to focus on the incentive effects of NAS.

Figure 3.1: Timing of the model



3.3.2 Discussion of the main assumptions

Contingent audit fees As emphasized by Wagenhofer (2004), the current restriction on contingent audit fees (i.e. fees based on the outcome of the audit) is "clearly a questionable exogenous restriction on feasible contracts with the auditor." I start from a general mechanism without restrictions on the contingency of audit fees. In equilibrium, I will show that only audit fees contingent on a report of evidence of financial misstatements by the auditor might be optimal. In practice, regulators fear a compensation contingent on favorable audit opinions. For instance, the *SEC* (2000) states that "contingent fees result in the auditor having a mutual interest with the audit client in the outcome of the work performed." Hence, the regulators' concern does not relate to audit fees contingent on misstatements detection. In section 3.4.2, I add a restriction on the contingency of audit fees to be consistent with practice and provide some empirical implications.

Empire builder The manager's private benefit of continuation is sufficiently high so that the agency conflict cannot be eliminated through compensation contracts.[19] As in Acemoglu and Gietzmann (1998), this assumption is not crucial and other conflicts of interest between the manager and the investors would work as well. Given this conflict of interests, hiring an external auditor is optimal for the investors rather transferring b to the manager so that the latter reveals the firm type.[20] The manager plays no other role in the baseline model and the problem would be similar with an owner-manager hiring an auditor to discover the type of the firm. Nonetheless, I discuss later in section 3.3.4 an implementation of the optimal mechanism in a more realistic setup in which the manager may exert pressure on the auditor with the consulting contract.

Liquidation when report of misstatements only Continuation is the optimal decision for the investors when receiving no evidence of financial misstatements from the auditor at $t = 1$. The auditor reports no misstatements either because the firm is good or because the firm is bad and the auditor has not detected financial misstate-

[19]In the model, there is no contract between the manager and the investors. Assuming that the conflict of interests manager/investors may be partially resolved with compensation contract would not change the results as long as the incentives of the manager and the investors cannot be fully aligned.

As discussed by Baldenius (2003), *The Economist* lists empire benefits as the main example for agency problems in its online "Economics A-Z." Further, Hennessy and Levy (2002) find strong empirical evidence for empire benefits to affect investment decisions.

[20]See Appendix 2 for a formal statement of this assumption.

ments. Hence, I assume that the probability of having a good firm conditional on no report of misstatements from the auditor is large enough.

Consulting services The value-added of consulting services is the same both for a good and a bad firm. This is not crucial to my results as long as there is some value-added for a bad firm. Many consulting firms provide, in effect, special services for distressed firms. Furthermore, the consultant is usually chosen after the manager learns the type of the firm. Indeed, in effect, the provision of consulting services is often contingent on the type of the firm. Note that in the model, the auditor can provide consulting services both for good and bad firms.

The consultant earns an economic rent β from providing consulting services that admits three interpretations. The interpretations (*ii*) and (*iii*) are consistent with Lu and Sapra (2009) and Simunic et al. (2017), who assume that the present value of the expected monetary rents from future engagements from NAS is non-zero and exogenously given. In those two interpretations, β is a monetary transfer and the expected investors' surplus from consulting is $\tau R - \beta$ instead of τR under the interpretation (*i*). As discussed in the introduction, a major fear of regulators and practitioners is that the auditors' independence is at risk due to "lucrative consulting contracts" (e.g. *Financial Times*, 2015; *The Guardian*, 2010). In the context of my model, the economic rents from those "lucrative contracts" can be both monetary and non-monetary benefits.

3.3.3 The optimal mechanism

I focus my analysis on the mechanism that maximizes the investors' surplus, which is in line with regulators' objectives. For instance, SOX states that "the PCAOB is a nonprofit corporation established by Congress to oversee the audits of public companies in order to protect investors (...)." The investors may decide to continue a bad firm and to have the manager hire the auditor as consultant. Indeed, this provides ex ante incentives to the auditor to exert audit effort and to detect financial misstatements. Let l be the probability for the investors to choose continuation and to get the manager to hire the auditor as consultant when the auditor reports evidence of financial misstatements. I denote by w_L the audit fees contingent on a report of financial misstatements and a liquidation decision by the investors.

If the auditor provides evidence of misstatements, the utility of the investors (resp. the auditor) is $L - w_L$ (resp. w_L) in case of liquidation and $\tau R < L$ (resp. β) in case of continuation. I denote by W_A the sum of the utilities of the auditor and the investors when the latter take action $A \in \{\text{liquidation}, \text{continuation}\}$. This surplus is $W_{\text{continuation}} = \tau R + \beta$ in case of continuation and $W_{\text{liquidation}} = L + w_L - w_L = L$ in case of liquidation.[21] The following proposition is the core result of the paper.

Proposition 12. *The optimal mechanism for the investors is as follows.*

- *If the auditor does not report financial misstatements, continuation is chosen by the investors, the manager hires an outside consultant and there is no audit fee;*

[21]If the economic rent β represent consulting fees as in interpretations (*ii*) and (*iii*), the surpluses are given by $W_{\text{continuation}} = (\tau R - \beta) + \beta = \tau R$ and $W_{\text{liquidation}} = L$.

- *otherwise, if the auditor reports financial misstatements:*
  - *if the surplus from continuation is larger than the surplus from liquidation ($W_{continuation} > W_{liquidation}$), continuations that are costly to investors occur with a positive probability ($l^* = (c/\Delta e)/((1-p)\beta)$) in which case the manager hires the auditor as consultant and there is no audit fee ($w_L^* = 0$);*
  - *if the surplus from continuation is smaller than the surplus from liquidation ($W_{continuation} < W_{liquidation}$), the firm is liquidated, the auditor provides no consulting services ($l^* = 0$) and there are positive contingent audit fees ($w_L^* = (c/\Delta e)/(1-p)$).*

Proof. See the appendix. □

In words, the optimal mechanism rewards the auditor for detecting financial misstatements. If the total value added of consulting services is larger than the liquidation surplus ($W_{\text{continuation}} > W_{\text{liquidation}}$), the investors optimally commit to costly continuations with some positive probability ($l^* > 0$) and to get the manager to hire the auditor as consultant. The investors use the economic rent attached to the consulting contract to reward the auditor. Otherwise, if the total value added of consulting services is smaller than the liquidation surplus ($W_{\text{continuation}} < W_{\text{liquidation}}$), there is no costly continuation ($l^* = 0$) and the investors provide incentives to the auditor with contingent audit fees.

This latter case of the optimal mechanism is counterfactual because contingent audit fees are not allowed in practice. However, as discussed on page 110, regulators are more afraid of fees contingent on favorable audit opinions because such fees put the audit firm in the position of wanting the same outcome as the manager, creating a self-interest threat. In my setting, only fees contingent on unfavorable (e.g., qualified or adverse) audit opinions might be optimal.

Otherwise, the first case ($W_{\text{continuation}} > W_{\text{liquidation}}$) is in line with reality. Indeed there is no contingent audit fee and the investors provide incentives to the auditor via the consulting contract.

Under the optimal mechanism (l^*, w_L^*), the expected utility of the investors is

$$U_{investors} = p(q+\tau)R + (1-p)\left[(1-e_H)\tau R + e_H\left((1-l^*)(L-w_L^*) + l^*\tau R\right)\right]. \quad (3.1)$$

If the firm is good, with probability p, the auditor never reports evidence of financial misstatements. Therefore, the investors continue the firm, the manager hires an outside consultant and the expected final cash flow is $(q+\tau)R$. Similarly, if the firm is bad and the auditor gets no evidence of financial misstatements, which happens with probability $(1-p)(1-e_H)$, the expected final cash flow is τR. Finally, if the firm is bad and the auditor gets evidence of financial misstatements, which happens with probability $(1-p)e_H$, the investors choose continuation and the auditor is hired as consultant with probability l^*. With the complementary probability $1-l^*$, the investors liquidate the firm and pay contingent audit fees w_L^* to the auditor.

Given the optimal mechanism (l^*, w_L^*), the expected utility of the auditor is

$$U_{auditor} = (1-p)e_H(l^*\beta + (1-l^*)w_L^*) - c = e_L \frac{c}{\Delta e}.$$

The investors reward the auditor when the latter provides evidence of financial misstatements. If the firm is bad, the auditor receives evidence of financial misstatements and reports it to the investors with probability e_H. The latter choose continuation with probability l^* and the manager hires the auditor as consultant, who gets the economic rent β. Otherwise, with probability $1-l^*$, the investors choose to liquidate the firm and pay the audit fees w_L^* to the auditor. Finally, the auditor incurs the private cost c when exerting high audit effort. The auditor earns a positive rent $e_L c/(\Delta e)$ because of the moral hazard problem.[22]

The main insight of this simple model is that eliciting high audit effort using a lucrative consulting contract with a positive probability is cheaper than using contingent audit fees if the value added of NAS is large enough.[23] This is true even if the investors would be better-off liquidating a bad firm ex post. A direct implication is that, in equilibrium, the auditor provides consulting services only to firms with bad projects. From conversations with former auditors, this prediction seems in line with the real world in which auditors are often hired to help solve a problem after detecting a breach in the accounts. For example, corporate finance services are a type of NAS often provided to distressed firms.

3.3.4 Implementation

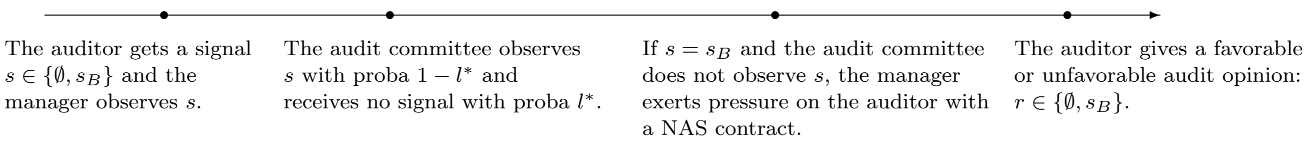
After describing the optimal mechanism for the investors, I analyze an implementation of this mechanism in a more realistic setting with potential conflicts of interest resulting from the provision of both auditing and consulting services by the auditor. I assume that the choice of the consultant is non-contractible and is made by the manager because investors often lack either the time or the knowledge to choose the consultant.

In practice, the audit committee is supposed to play a key role in generating the financial statements. According to Section 301 of SOX, it is in charge of hiring an external auditor, other advisors as needed, and collecting information through different sources. As noted by Caskey et al. (2010), the audit committee plays an important role in monitoring potential conflicts of interest between the auditor and the manager. The manager should also get the approval of the audit committee if the former chooses to hire the external auditor as consultant. Nevertheless, it is still challenging for audit committees to provide effective oversight, especially in large, complex organizations. For instance, Cohen et al. (2010) show that, even after SOX, some audit committees still play a passive role in helping resolve disagreements between the external auditor and the management. In the same vein, Beasley et al. (2009) quote a statement from a NYSE audit committee chair: "No one really understands how limited an audit

[22] Assuming imperfect competition on the audit market would not change the result. If the reservation utility of the auditor were $\bar{U} > e_L c/(\Delta e)$, the investors would pay noncontingent audit fees $F^* = \bar{U} - e_L c/(\Delta e)$.

[23] If $W_{continuation} = W_{liquidation}$, there is an infinity of optimal mechanisms. The investors are indifferent between providing incentives to the auditor via contingent audit fees or via a consulting contract.

Figure 3.2: Reporting process



committee is in its work. In big companies, it is virtually impossible to know what is going on without relying on management (...) and the external auditor."

The reporting process in the presence of the audit committee is summarized in Figure 3.2 and is as follows.[24] After exerting audit effort, the auditor gets a signal $s \in \{\emptyset, s_B\}$ and the manager also observes the auditor's signal.[25] The audit committee observes the auditor's signal s only with probability $1 - l$. If the audit committee does not observe s, there is a bargaining process between the manager and the auditor to decide on the report $r \in \{\emptyset, s_B\}$ to make to the investors. Finally, the auditor gives a public favorable audit opinion ($r = \emptyset$) or an unfavorable audit opinion ($r = s_B$). The investors always liquidate the firm after an unfavorable audit opinion[26] Hence, the manager should induce a positive audit report to continue running the firm. If the audit committee observes s, the auditor is forced to report $r = s$. Otherwise, the auditor may lie and agree on a positive report to a bad firm even if he has hard evidence of financial misstatements. Indeed, the manager is an empire builder and always wants to continue running the firm. Therefore, during the bargaining process, the manager lures the auditor with future consulting services to get a favorable opinion.

The investors set the probability l at $t = 0$. There are several ways for the investors to influence l. It could be by increasing or decreasing the number of internal controls. The probability l also captures the skills of the audit committee and decreases with the experience of the audit committee's members. More generally, the value $1 - l$ is a measure of corporate governance of the firm.[27]

According to Proposition 1, the investors optimally have the manager hire an outside consultant if the auditor does not collect evidence of financial misstatements. In that case, the auditor does not have hard evidence of financial misstatements and poses no threat to the manager. As a result, the auditor never provides consulting

[24]See Beasley et al. (2009) for a detailed discussion on the role of the audit committee and on the oversight process.

[25]The manager usually knows what records were examined by the auditor and can deduce the inferences they support.

[26]An unfavorable opinion, particularly a modified unqualified opinion (i.e. a going concern disclosure), is sometimes considered as a "self-fulfilling prophecy"(Dopuch et al., 1986) because it could, for instance, increase regulatory scrutiny. Therefore, the audit committee and the board would not allow continuation if the auditor were to release an unfavorable opinion.

[27]I have assumed that there is no cost of decreasing l for the investors. In practice, there could be substantial costs to improve the corporate governance. Adding such costs would reinforce my result on the optimality to have $l^* > 0$.

services when he does not have evidence of financial misstatements. In case the auditor detects financial misstatements and the audit committee does not observe s, the manager can effectively exert pressure on the auditor for a favorable audit opinion with the consulting contract. The investors let the manager hire the auditor as a consultant with probability l. As in Lu and Sapra (2009) and Kornish and Levine (2004), the consulting contract can effectively be contingent on the audit opinion, representing client pressure on auditors.

I rule out direct monetary bribes by the manager to the auditor even when disguised as audit fees in excess of the competitive level, on the ground that such openly illegal bribes would be easily detectable via "whistle-blowing", and therefore punishable by law enforcers.[28] I also do not allow the manager to exert pressure on the auditor by committing to keep him as auditor in the future. Indeed, it is much more complicated and costly to fire an auditor than to fire a consultant (e.g. Coffee, 2002).[29] Hence, the threat of firing the auditor in the future may not be credible. The following corollary restates the main result of the paper when the choice of the consultant is non-contractible for the investors.

Corollary 14. *If $W_{continuation} > W_{liquidation}$ and the auditor detects financial misstatements:*

- *with probability l^*, the auditor gives a favorable audit opinion, the investors choose continuation and the auditor is hired as consultant;*
- *with probability $1 - l^*$, the auditor gives an unfavorable audit opinion and the investors choose liquidation.*

Proof. Direct consequence of Proposition 1. □

The ex post collusion between the manager and the auditor is a way to implement the optimal mechanism for the investors. This implicit contract using conflicts of interest is a commitment device for the investors to commit not to liquidate a bad firm at $t = 1$ after the auditor has detected financial misstatements. Indeed, the investors do not learn that the auditor has detected misstatements when the manager and the auditor collude and agree on a good report.

Previous empirical studies provide evidence that investors perceive negatively the provision of NAS by auditors (DeFond and Zhang, 2014). The main prediction of my baseline model is in line with this empirical evidence because the model predicts that, in equilibrium, auditors provide NAS only after detecting financial misstatements. The outside investors can deduce that the auditor hid misstatements when the latter provides NAS.

[28]If monetary bribes were allowed, conflicts of interest would arise even if the auditor were banned from providing NAS. However, practitioners consider the joint provision of auditing services and NAS as the main source of the auditors' involvement in corporate scandals (Crockett et al., 2003)

[29]Regulation S-K imposes some specific disclosures in that case. Namely, a reporting company needs to file a Form 8-K after the resignation or dismissal of the independent auditor. Further, the choice to change auditors is often perceived as a way to shop for more favorable audit opinions. This a major concern for regulators and the empirical evidence underscores that investors perceive an auditor change negatively (e.g. Chhaochharia and Grinstein, 2007; Fried and Schiff, 1981; Shu, 2000).

3.4 Equilibrium level of effort and audit quality

3.4.1 Continuous audit effort

Up to this point, the audit effort has been a binary variable, either high or low. I have explained my main result by the fact that inducing audit effort without consulting services is sometimes more expensive. If this is the case, in a model with many levels of effort, the equilibrium level of audit effort should be sometimes smaller without consulting services. This section tests this hypothesis. The auditor generates a probability $e \in [0, 1]$ of detection by expanding an effort at a cost $C(e) = ke^2/2$, with $k > 0$ sufficiently large so that the equilibrium level of audit effort is interior. The utility of the investors is similar to that of the binary effort case and is given by (3.1).

Further, I introduce a litigation/reputation cost $\rho > 0$ for the auditor for giving a favorable opinion and the final cash flow is zero. Litigation and reputation costs are considered as the main market-based incentive forces that drive audit quality (e.g. Skinner and Srinivasan, 2012; Venkataraman et al., 2008). Hence, I analyze the impact of those costs on the auditor's incentives in my model. An "error" of the auditor is either due to a lack of effort or to a voluntary lie. In practice it is difficult to determine whether an auditor misled investors ex post. Thus, I assume that the auditor bears litigation and reputation costs for both a lack of audit effort or a voluntary lie.

The expected cost for the auditor of giving an unmodified opinion when receiving evidence of financial misstatements is the product of the litigation and reputation costs ρ and of the probability of failure of a bad firm $(1 - \tau)$. Therefore, the auditor is willing to lie to get the consulting contract only if the expected benefit of receiving this contract is larger than the expected litigation and reputation costs.

Lemma 15. *The auditor's reporting strategy after receiving evidence of financial misstatements is the following.*

- *If $(1-\tau)\rho > \beta$, then the auditor never lies and gives an unfavorable audit opinion;*
- *otherwise, if $(1 - \tau)\rho < \beta$, then the auditor gives a favorable audit opinion and is hired as consultant with probability l.*

When detecting financial misstatements and facing potential litigation and reputation risks, the auditor balances the benefit of giving a clean audit opinion to get the consulting contract and the threat of being fined and/or the reputation loss if the firm ultimately fails. As discussed in the introduction, the main fear of regulators is precisely that auditors would be willing to sacrify their independence if litigation and reputation costs are smaller than the economic rents from NAS contracts. Lu and Sapra (2009) notice that what is crucial for the auditor is this tension rent-liability captured by the ratio $\beta/((1-\tau)\rho)$. If this ratio is larger than one, the auditor is willing to sacrifice his independence.

The numerous corporate and audit scandals that arose during the last twenty years raise the question why regulators do not increase legal liabilities for auditors such that there is always truthtelling in equilibrium. There are several theoretical explanations: increasing the penalty on one crime might induce criminals to shift towards other crimes (Stigler, 1970) or increasing the penalty might result in a lower conviction rate because jurors will be less willing to convict (Andreoni, 1991). In the specific context of auditing, Laux and Newman (2010) underline that excessive litigation costs could imply that auditors would be unwilling to provide audit services to risky clients, limiting the access to external capital for those potential clients. Further, as discussed in the introduction, the repeated corporate and audit scandals suggest that the expected reputation costs are not large enough to prevent certification intermediaries from providing false information to the investors.

As a result, I assume that litigation and reputation costs are not too high compared to the economic rent of the consulting contract, i.e. β is larger than $(1-\tau)\rho$, such that the audit effort problem becomes

$$e \in \arg\max_{\hat{e}} \hat{e}\Big((1-p)(1-l)w_L + l(1-p)(\beta-(1-\tau)\rho)\Big) - (1-\hat{e})(1-p)(1-\tau)\rho - C(\hat{e}). \tag{3.2}$$

From (3.2), one can conclude that the litigation and reputation costs ρ provide incentives to the auditor to exert audit effort. As a result, the investors need to provide less incentives using contingent audit fees or consulting services. If the firm is good, the litigation and reputation costs do not influence the auditor's choice of effort. Indeed, in that case, the auditor never detects financial misstatements and the auditor has no influence on the final cash flow of the firm.

If the auditor detects financial misstatements, the utility of the investors (resp. auditor) is $L - w_L$ (resp. w_L) in case of liquidation and $\tau R < L$ (resp. $\beta - (1-\tau)\rho$) in case of continuation. The surplus of the investors and the auditor is $W_{continuation} = \tau R + \beta - (1-\tau)\rho$ in case of continuation and $W_{liquidation} = L + w_L - w_L = L$ in case of liquidation. The following proposition gives the optimal mechanism in the presence of litigation and reputation costs.

Proposition 13. *The optimal mechanism for the investors is as follows.*

(i) If the continuation surplus is larger than the liquidation surplus ($W_{continuation} > W_{liquidation}$), then, in equilibrium, the auditor provides consulting services to the manager with some strictly positive probability,

$$l^* = \frac{C'(e^*) - (1-p)(1-\tau)\rho}{(1-p)(\beta-(1-\tau)\rho)},$$

and there is no contingent audit fee ($w_L^* = 0$). The equilibrium level of audit effort is given by $e^* = (1-p)\beta/2k$;

(ii) otherwise, if the liquidation surplus is larger than the continuation surplus ($W_{liquidation} > W_{continuation}$), then, in equilibrium, the auditor provides no consulting services to the manager ($l^* = 0$) and there are positive contingent audit fees ($w_L^* = C'(e^*)/(1-p) - (1-\tau)\rho$). The equilibrium level of audit effort is given by $e^* = (1-p)(L - \tau R + (1-\tau)\rho)/2k$.

Proof. See the appendix. □

As long as the liability and reputation costs are not too high, the positive incentive effect described in the baseline model still holds and the optimal mechanism has similar features to the one in the binary audit effort case. The investors are better off in the presence of liability and reputation costs because it is then cheaper to give incentives to elicit high audit effort.

The continuous effort model is useful to compare the equilibrium levels of audit effort. I focus on the most interesting case (i), $W_{continuation} > W_{liquidation}$, in which the provision of consulting services is optimal for the rest of the paper and I analyze the impact of a regulatory intervention on audit effort. If the auditor cannot provide consulting services due to a regulatory ban, the equilibrium level of audit effort is given by $e^*_{NC} = (1-p)(L - \tau R + (1-\tau)\rho)/2k$. This is smaller than the equilibrium audit effort when the auditor can provide consulting services, $e^*_C = (1-p)\beta/2k > e^*_{NC}$. The following corollary sums up this result.

Corollary 15. *The audit effort is smaller if the regulator bans the provision of consulting services by the auditor ($e^*_C > e^*_{NC}$).*

Therefore, if the regulator bans the provision of consulting services by the auditor, this decreases the auditor's incentives to exert audit effort. This is true even if contingent audit fees are allowed. If contingent audit fees are banned, the audit effort is even smaller after a regulatory ban on consulting services. In that latter case, the litigation and reputation risks are the only incentives for the auditor to exert audit effort.

3.4.2 Audit quality

In this section, I define audit quality within my setup and analyze the impact of the optimal mechanism on audit quality. First, I derive some comparative statics on the equilibrium level of audit effort e^* and on the equilibrium probability l^* that the auditor provides consulting services contingent on detecting financial misstatements.

Corollary 16. *The equilibrium level of audit effort e^**

- *increases with the client business risk $1-p$;*
- *decreases with the cost of audit effort k;*
- *increases with the rent β of the consulting contract.*

First, the level of audit effort increases in the client business risk, $1-p$, because the auditor is rewarded only if he detects financial misstatements and the manager manipulates the financial statements only in case of a bad firm. Obviously, the equilibrium level of audit effort decreases with the cost of effort. Finally, the level of audit effort increases in the economic rent from the consulting contract because the investors use NAS to provide incentives to the auditor.

Corollary 17. *The equilibrium probability l^* that the auditor provides consulting services contingent on detecting financial misstatements*

- *increases with the rent β of the consulting contract;*
- *decreases with the expected litigation and reputation costs ρ.*

The marginal benefit of audit effort, which is equal to the marginal cost in equilibrium, increases with the rent β. As a result, the probability l^* increases to compensate the increase in the cost of audit effort. Further, the larger the litigation and reputation costs, the less incentives the investors need to provide to the auditor to exert audit effort. Hence, the auditor provides less often NAS in equilibrium.

Next, I analyze the impact of the provision of consulting services by the auditor on audit quality. First, I define the concept of audit quality within the context of this paper. Most studies define audit quality as some variation of "the market-assessed joint probability that a given auditor will both detect a breach in the client's accounting system and report the breach" (e.g. DeAngelo, 1981*b*). I apply this definition to my specific setup.

Definition The *audit quality* (AQ) is the probability that the auditor gives an unfavorable audit opinion to a bad firm.

Notice that this definition is a measure of ex ante audit quality. Interestingly, audit quality in this setup may be different from audit effort. This contrasts with a large strand of the literature that does not study ex post conflicts and therefore, assume that the ex ante choice of audit effort is the audit quality. In my setup, when conflicts of interest happen, the auditor gives a clean audit opinion to manipulated financial statements while audit effort provided ex ante is independent of the final audit opinion. Therefore, ex ante audit quality is the product of the audit effort and of the probability of having no conflict of interest ex post, i.e. $AQ^* = e^*(1 - l^*)$.

Corollary 18. *In equilibrium, audit quality* AQ^*

- *increases with the expected litigation and reputation costs* ρ*;*
- *increases with the client business risk* $1 - p$*;*
- *increases with the rent* β *of the consulting contract.*

This result is a direct consequence of Corollaries 16 and 17. First, if the expected litigation and reputation costs increase, the probability l^* decreases and therefore, audit quality increases. Second audit effort increases with the client business risk and l^* does not depend on the client business risk. I investigate now the impact of a ban of the provision of consulting services by the auditor in two regimes: contingent audit fees allowed and contingent audit fees banned.

Contingent audit fees allowed

The impact of a ban on the provision of NAS by the auditor to its audit clients on audit quality is unclear. On the one hand, audit quality is negatively affected by the provision of consulting services because of the conflicts of interest which happen with probability l when the auditor can provide consulting services. When conflicts of interest happen, the auditor gives a favorable audit opinion to a bad firm. Therefore, a ban of NAS would increase auditor independence. On the other hand, such a ban may decrease audit effort because the incentive effect of the consulting contract would disappear. The following corollary studies this tradeoff as a function of the economic rent β of the consulting contract.

Corollary 19. *Suppose contingent audit fees are allowed. There exists a cutoff value $\bar{\beta}$ such that, if $\beta < \bar{\beta}$, audit quality is higher when the auditor cannot provide consulting services. Otherwise, if $\beta > \bar{\beta}$, audit quality is higher when the auditor can provide consulting services.*

Proof. See the appendix. □

If the economic rent from the consulting contract is low, $\beta < \bar{\beta}$, audit quality is lower when the auditor optimally provides consulting services despite the fact that audit effort is larger. A ban of consulting services would force the investors to use contingent audit fees to provide incentives to the auditor and this would increase audit quality. Empirically, we may not see this effect because contingent audit fees are banned.

From a regulatory point of view, it might be optimal to allow contingent fees for unfavorable audit opinions and to ban the provision of consulting services by the auditor. Removing the current restriction on contingent audit fees for unfavorable opinions would increase auditor independence while preserving the ex ante incentives to exert audit effort. The regulator may want to increase the overall quality of audit reports because there are possible negative externalities when audit quality is low.[30] I study one of these negative externalities in section 3.5 in the context of audit reports in the same industry.

If the economic rent from the consulting contract is high, $\beta > \bar{\beta}$, then both audit effort and audit quality are higher if the auditor can provide consulting services. In that latter case, there is no role for regulation of NAS because both audit quality and audit effort are higher when the auditor can provide consulting services.

Contingent audit fees disallowed

Finally, as discussed above, contingent audit fees are banned by the American Institute of Certified Public Accountants' Code of Professional Conduct (the last version became effective in 2014). Therefore, I assume that there is no contingent audit fee ($w_L = 0$) until the end of the section. The only forces that remain to provide incentives to the auditor are the market-based reputation/litigation costs ρ and the economic rent of NAS β. In this context, I investigate the impact of a ban for auditors to provide consulting services to audit clients. On the one hand, the audit effort is smaller because I have assumed that the rent-liability ratio is larger than one, i.e. $\beta/((1-\tau)\rho) > 1$. On the other hand, the auditor is fully independent and the manager cannot exert pressure on the auditor with a NAS contract to bias the audit report. Nevertheless, I show that this regulatory action unambiguously decreases audit quality because the investors cannot provide incentives with contingent audit fees. Corollary 20 follows from this discussion.

Corollary 20. *Suppose contingent audit fees are allowed. If the regulator bans the provision of consulting services by the auditor, there is an increase in the auditor's independence. Furthermore, there is also a decrease in the audit effort e^* and a decrease in audit quality AQ^*.*

[30] For example, the PCAOB 2014 annual report states: "Over the last 12 years, the PCAOB has built a robust and insightful auditor oversight program to promote high-quality, independent audits."

Proof. See the appendix. □

This result emphasizes that even during times of corporate failures, having an auditor who provided consulting services to its audit clients due to conflicts of interest does not mean that the auditor did not do his audit job properly. Indeed ex ante audit effort would have been smaller if the auditor could not have provided consulting services. Therefore, a ban on the provision of consulting services would unambiguously decrease audit effort and audit quality, even in the presence of litigation and reputation costs.

As discussed in the introduction, recent regulatory actions have been taken to ban a number of NAS that auditors can provide and cap the consulting fees auditors can receive from audit clients. My analysis underlines that those actions might be inefficient from the investors' point of view and increasing auditors' independence may even decrease ex ante audit quality. The main reason is that regulators are focusing on only one piece of the puzzle: the ex post conflicts of interest. However, I demonstrate that both the ex post problems and the ex ante incentive externalities should be considered.

3.5 Informational externalities and regulation

In the one-firm model there is little room for regulation on NAS because investors choose the optimal amount of NAS that the auditor provides in equilibrium. The goal of this section is to investigate a negative informational externality arising from the provision of consulting services by the auditor to its audit clients in a two-firm setting. It is important for regulators to take into account those types of externalities when deciding whether or not to ban the provision of NAS by auditors.

For simplicity, I consider the binary audit effort model with $e_L = 0$ and no litigation and reputation cost ($\rho = 0$). In the binary effort model, audit quality is lower when incentives are provided to the auditor with consulting services instead of contingent audit fees.[31] In the continuous effort model, as we have seen previously in Corollary 19, audit quality is lower when consulting services are allowed for low values of the economic rent β ($\beta < \bar{\beta}$). Hence, I conjecture that the results of this section are the same for the continuous effort model in the case $\beta < \bar{\beta}$. The results of this section are more general than this specific case because the investors may in practice tolerate a higher probability of collusion between the manager and the auditor if, for example, decreasing l is costly. This would further decrease audit quality when incentives are provided using NAS instead of contingent audit fees.

In the proof of Proposition 14, I consider first a case in which the investors have access to an exogenous informative public signal on the firm's type before deciding whether to provide incentives to the auditor. In this setup, I show that the investors make the liquidation decision solely based on the public signal without giving incentives to the auditor when the public signal is informative enough. Otherwise, when the

[31] In the binary effort model, the audit quality is $AQ^*_{NC} = e_H$ if there is no provision of NAS and incentives are provided using contingent fees. Otherwise, $AQ^*_C = e_H(1 - l^*) < AQ^*_{NC}$ if incentives are provided using NAS.

public signal is not informative enough, the investors provide incentives to the auditor and make the liquidation decision as a function of the audit report, as in the basic setup.

Then, I endogenize the public signal in an equilibrium model with two firms F_1 and F_2 in the same industry and with perfectly correlated projects.[32] Each firm has a different auditor. I consider a sequential equilibrium in which the investors of firm F_1 move first and then the investors of firm F_2 make their liquidation decision. The investors of firm F_1 send a negative public signal ($s = 0$) when choosing liquidation whereas they send a positive public signal ($s = 1$) when choosing continuation. In the second period, the investors of firm F_2 make the liquidation decision taking into account the signal s.[33]

The optimal mechanism for the investors of firm F_1 is such that there is no contingent audit fee and there is a positive probability $l^* > 0$ that the auditor gets the NAS contract in case of misstatements detection. The investors of firm F_2 receive the signal s according to the following distributions:

$$P(s = 0 \mid B) = e_H(1 - l^*) = 1 - P(s = 1 \mid B),$$

and

$$P(s = 0 \mid G) = 0 = 1 - P(s = 1 \mid G).$$

The investors of firm F_1 liquidate their firm if and only if the auditor gives an unfavorable audit opinion, which happens with probability $e_H(1 - l^*)$ in case of bad firms. Otherwise the auditor gives a favorable audit opinion and the investors choose continuation. Computing the ratios of probabilities for the two values of the signal yields

$$\frac{P(s = 1 \mid G)}{P(s = 1 \mid B)} = \frac{1}{1 - e_H(1 - l^*)} \quad \text{and} \quad \frac{P(s = 0 \mid G)}{P(s = 0 \mid B)} = 0.$$

This ratio of conditional probabilities increases in the value of the signal s and, thus, a signal $s = 1$ from firm F_1 is good news for firm F_2.

Proposition 14. *For some parameter values, the investors of firm F_2 make the same liquidation decision as the investors of firm F_1. In particular, in case of bad firms, if there are conflicts of interest and the auditor of firm F_1 gives a favorable audit opinion, both the investors of firm F_1 and of firm F_2 choose continuation.*

Proof. See the appendix. □

If the signal s sent by firm F_1 is sufficiently informative, there is herding because the investors of firm F_2 make the same liquidation decision as the investors of firm F_1. As a result, in case of bad firms, when the auditor can provide consulting services, the investors of firm F_1 let the auditor provide such services in some states of the world.

[32] Foster (1981) provides empirical evidence on the importance of peers' financial statements. Furthermore, De Franco et al. (2011) and Chen et al. (2016) provide evidence on the importance of financial statements' comparability.

[33] There is a one to one mapping between the liquidation decision and the audit opinion. Therefore, it is equivalent to say that the investors of firm F_2 observe the financial statements or the liquidation decision of the investors of firm F_1.

In those states of the world, there is continuation of the two firms. This is a negative externality due to the provision of consulting services by the auditor of firm F_1. If this negative informational externality dominates the incentive externality of consulting services, there is a role for regulating the provision by auditors of consulting services to audit clients. Indeed, it is optimal for the investors of firm F_1 to get the manager to hire an auditor who provides consulting services but they failed to internalize the negative informational externality that they impose on the investors of firm F_2.

The main takeaway of this extension is that, if the negative informational externality of consulting services dominates the positive incentive externality, then maximizing audit quality increases investors' surplus and audit fees contingent on an unfavorable audit opinion might be optimal. Indeed, the investors can recover truthtelling if the provision of consulting services by the auditor is banned and contingent audit fees on unfavorable audit opinions are allowed as in Kornish and Levine (2004). Removing the current restrictions on contingent audit fees for unfavorable audit opinions would increase audit quality and eliminate this negative informational externality.

3.6 Discussion

3.6.1 Regulating the audit industry

As underlined in the introduction, the numerous corporate scandals have brought to line the challenges that the audit industry is facing. I discuss in this section some of the most important regulatory issues in the context of my model. First, in the baseline one-firm model, it is always optimal to let audit firms provide NAS to audit clients. Indeed, the optimal probability that the auditor provides NAS is fixed by the investors. This result heavily depends on the possibility for the investors to choose the right amount of conflicts of interest. Thus, assuming that there is a cost of decreasing the probability of conflicts of interest between the auditor and the manager (e.g. improving the corporate governance), restricting the provision of NAS by the external auditor may be optimal. To the extent that the cost of improving the corporate governance is larger than the benefit of having an audit firm providing NAS, the investors would prevent the auditor from providing NAS to the manager. Empirically, there is evidence that firms with high agency costs do have auditors who provide less NAS.[34] If the investors are able to prevent the auditor from providing NAS when it is needed, there is little room for regulatory intervention. Furthermore, if auditors benefit from knowledge spillovers, regulations implemented in the US and the EU may be questionable. For instance, Romano (2005), in an influential critique of SOX, states that "the best inference to draw for policy-making from the extensive literature is that SOX's prohibition of NAS by auditors is a policy that makes little sense."

The regulatory debate is mostly focused on the impact of the provision of NAS by auditors to audit clients on audit quality and on the auditors' independence. My analysis suggests that it could be optimal for the investors of a client firm to let the manager exerts pressure on the auditor with a NAS contract even if this ultimately leads to a lower audit quality. Nevertheless, regulators may want to maximize audit

[34] See, e.g., Firth (1997) and Parkash and Venable (1993).

quality because of negative externalities resulting from this lower audit quality. I analyze a possible externality resulting from this decrease in audit quality in a model with multiple firms within the same industry in section 3.5 and I show indeed that the decrease in the reliability of the financial statements due to the provision of NAS by the auditor may lead to an inefficient herding behavior. Namely, the investors of a firm may make an erroneous liquidation decision by relying on low-quality financial statements of similar firms within the same industry. Therefore, allowing audit fees contingent on unfavorable audit opinions might be optimal because it would increase overall audit quality while preserving the ex ante incentives to exert audit effort. The optimality of contingent audit fees to increase auditor independence is also discussed by Kornish and Levine (2004).

Another important concern of regulators about the provision of NAS by auditors is that auditors may be auditing their own work in the future. In this paper, I do not consider this potential negative impact of NAS. This threat has been partially addressed by regulators by banning certain NAS which are closely related to external auditors' work.[35] For example, the external auditor cannot implement internal controls because this work overlaps with the external auditor's work. Nonetheless, an interesting extension, which lies beyond the scope of this paper, would be to study this effect and analyze the interaction with the incentive externality presented in this paper.

Finally, the provision of NAS by auditors to non-audit clients is also a major concern of regulators, who consider that the current growth in revenues from NAS provided to non-audit clients within public accounting firms could also impair auditors' independence (Harris, 2016). Regulators implicitly assume that auditors could be influenced in their decisions, even if the individuals within the organization perform only audit or consulting services. For instance, Kowaleski et al. (2016) provide experimental evidence that providing NAS increases cooperation with managers. Thus, having separate audit and consulting departments within the Big Four firms may not solve the auditor independence concerns.

3.6.2 Empirical implications

The model generates several empirical predictions that I discuss in this subsection. First, in equilibrium, the auditor provides consulting services to the audit client only when the auditor detects financial misstatements. This a direct consequence of the optimal mechanism for the investors to elicit high audit effort. The empirical implication is straighforward: the larger the level of non-audit fees, the lower the financial health of the company. This result could explain the negative reaction of investors when they learn that the auditor also provides NAS. Indeed, as discussed in the introduction, studies using perception-based proxies find that investors penalize companies purchasing NAS. For example, NAS is associated with more negative abnormal returns, larger cost of capital and lower likelihood of auditor ratification (DeFond and Zhang, 2014). Those results are in line with the main predictions of my model.

[35] Krishnan et al. (2011) suggest that only harmful NAS banned by SOX may lead to a lower audit quality. Causholli et al. (2014) provide evidence that selling future NAS could impair auditor independence, which supports the fact the effect analyzed in this paper may dominate.

Corollaries 16 and 18 provide the main comparative statics of the model. An important cross-sectional prediction of the baseline model is that audit quality increases with the client business risk. Indeed, the optimal mechanism implies that the auditor is rewarded for detecting financial misstatements. Furthermore, the manager manipulates the financial statements only in case of bad projects. Hence, in industries with a larger probability of projects' failures, audit quality should be higher.

Lastly, according to the extension with expected litigation and reputation costs and no contingent audit fee, the audit effort is larger when the auditor is allowed to provide consulting services. Obviously, this empirical prediction is very challenging to test because there exists no perfect proxy to measure audit effort. Otherwise, the model predicts that a ban of the provision of NAS by auditors would increase auditor independence but decrease audit quality. This result is important given that many empirical studies use proxies of audit quality to assess auditor independence. My analysis underscores that this relation may be more complex.

3.7 Conclusion

In this paper, I examine how the provision of consulting services by auditors to audit clients affects the auditors' incentives to exert ex ante audit effort and how it impacts audit quality. As commonly argued by opponents of the provision of both auditing and consulting services by audit companies, I underline that NAS may create conflicts of interest between the auditor and the audit client, which may in turn decrease audit quality. Indeed, the manager of the client firm is able to exert pressure on the auditor with the economic rent attached to the NAS contract to get a favorable audit opinion.

Nevertheless, my analysis also emphasizes that there is a positive incentive effect ex ante which can dominate the resulting expected loss ex post incurred by the investors. Namely, the possibility for an auditor of providing NAS contingent on detecting financial misstatements increases audit effort. Thus, allowing auditors to provide both types of services to client firms could be optimal for the investors of client firms even without considering any knowledge spillover between auditing services and NAS. My analysis sheds some light on the current growth rate of consulting practices within the Big Four despite regulatory hurdles.

On the other hand, my results show that the provision of NAS may harm audit quality when conflicts of interest happen and the auditor gives a favorable audit opinion after detecting financial misstatements because of client pressure. NAS may decrease the reliability of financial statements. When multiple firms in the same industry rely on peers' financial statements to make their own liquidation decision, there is a potentially negative ex post informational externality that could dominate the positive ex ante incentive effect. The regulator should consider this tradeoff when taking the decision whether to ban the provision of NAS by auditors. Further, if the investors cannot choose the optimal amount of NAS that the auditor provides in equilibrium, the positive incentive effect might vanish. In that case, the manager of the client firm may be able to exert pressure on the auditor too often and banning the provision of NAS by auditors is always optimal. The model proposed in this paper underscores some incentives effects of NAS on auditors and provides a framework for understanding the tradeoffs at stake for regulators.

My model admits broader interpretations and many other potential applications of this idea come to mind. This tradeoff between incentives and conflicts of interest could be applied to other situations such as the revolving doors in the accounting industry. It has often been argued that letting auditors work for their audit clients could create potential conflicts of interest. Indeed, auditors would be willing to let a client hide losses hoping that their favor would be rewarded later in their careers by being hired by the client. Section 206 of SOX was enacted to increase the independence of accounting firms whose ex-auditors obtained a senior financial reporting position with their current audit clients. According to the main intuition of this paper, it could be optimal for the investors of client firms to let auditors having the possibility to work for client firms later. Indeed, hiring a former auditor, like hiring a consultant, can increase a firm's value because of his valuable experience as an auditor. Therefore, if the benefit from hiring an auditor is large enough, the investors of a client firm may find it optimal to commit to let manager hire the auditor when the latter detects misstatements in the financial statements.

Finally, I believe that this framework could be extended in several directions and there are many interesting routes for future research. For instance, I have assumed perfect competition on the audit market to keep the model simple and to focus on the incentives effects of NAS. It would be interesting to consider the case of imperfect competition and investigate the interaction between audit competition, provision of non-audit services and incentives for auditors to exert audit effort.

Appendix

Appendix 1: proofs

Proof of Proposition 12

I describe the general mechanism $(l, l_R, w_{RS}, w_{RF}, w_L, w_B)$ set by the investors. l is the probability for the investors to choose continuation and to hire the auditor as consultant when the auditor reports evidence of financial misstatements. l_R is the probability set by the investors to choose the auditor as consultant after no report of misstatements from this auditor. The audit fees in case of no report of misstatements are w_{RS} if the final cash flow is R and w_{RF} if the final cash flow is 0. The audit fees in case the auditor reports evidence of financial misstatements are w_L in case of liquidation and w_B in case of continuation.

The auditor is protected by limited liability (LL), i.e.

$$w_{RS} \geq 0, w_{RF} \geq 0, w_B \geq 0 \text{ and } w_L \geq 0.$$

The expected utility of the auditor is

$$U_{auditor}(e) = p\Big[(q+\tau)w_{RS} + (1-q-\tau)w_{RF} + l_R\beta\Big]$$
$$+(1-p)\Big[(1-e)\Big(\tau w_{RS}+(1-\tau)w_{RF}+l_R\beta\Big)+e\Big(l(\beta+w_B)+(1-l)w_L\Big)\Big]-c\mathbb{1}_{\{e=e_H\}}. \quad (3.3)$$

The incentive compatibility constraint of the auditor is

$$U_{auditor}(e=e_H) \geq U_{auditor}(e=e_L). \quad (3.4)$$

Lemma 16. *If the auditor does not report misstatements ($r = \emptyset$), the auditor is not hired as consultant ($l_R^* = 0$) and there is no contingent audit fee ($w_{RS}^* = w_{RF}^* = 0$).*

Proof. I can rewrite the incentive compatibility constraint (3.4) using (3.3):

$$(1-l)(1-p)w_L + l(1-p)(\beta + w_B) \geq \frac{c}{\Delta e} + (1-p)(\tau w_{RS} + (1-\tau)w_{RF} + l_R\beta). \quad (3.5)$$

From (3.5), it is optimal for the investors not to reward the auditor in case of no report of misstatements. Therefore, in equilibrium, the investors set $w_{RS}^* = w_{RF}^* = l_R^* = 0$. □

The intuition of this result is straightforward. Indeed, the auditor is hired to find hard evidence of financial misstatements. If he makes no report of misstatements, saying that he does not have hard evidence, it is optimal for the investors not to reward him. This implies that the auditor is only rewarded when he reports evidence of financial misstatements. Therefore, in equilibrium, there is no reason for the auditor to lie and hide financial misstatements.

Taking this first result into account, the expected utility of the investors is

$$U_{investors} = p(q+\tau)R + (1-p)\left[(1-e_H)\tau R + e_H\left((1-l)(L-w_L) + l(\tau R - w_B)\right)\right].$$

Lemma 17. *If the auditor reports evidence of financial misstatements and the investors choose continuation, there is no contingent audit fee, i.e.* $w_B^* = 0$.

In case of continuation that is costly to the investors, the auditor receives the economic rent β via the consulting contract but no contingent audit fee. Taking those results into account, the new incentive compatibility constraint (IC) is

$$(1-l)(1-p)w_L + l(1-p)\beta \geq \frac{c}{\Delta e}. \tag{3.6}$$

There are two ways for the investors to provide incentives to the auditor to exert audit effort. If the auditor detects and reports financial misstatements, the investors can either reward him with contingent audit fees w_L or with the economic rent β of the consulting contract. The investors' optimization problem is

$$\max_{l,w_R,w_L} U_{investors}$$

subject to the constraints (IC) and (LL).

I do not impose any upper bound on the contingent audit fee w_L and the reservation utility of the auditor is assumed to be zero. Therefore, under the optimal mechanism, (IC) is binding and is equivalent to

$$w_L = \frac{\frac{c}{\Delta e} - l(1-p)\beta}{(1-p)(1-l)}. \tag{3.7}$$

Reinjecting (3.7) into the objective function, I rewrite the maximization problem of the investors as

$$\max_l p(q+\tau)R + (1-e_H)(1-p)\tau R + e_H(1-p)L$$
$$- e_H(1-p)l(L-\tau R) - e_H\frac{c}{\Delta e} + e_H l(1-p)\beta,$$

which is equivalent to

$$\max_l e_H l(1-p)(\tau R + \beta - L).$$

The problem is linear in l:

- if $W_{continuation} > W_{liquidation}$, then the optimal probability of continuation is the maximal value of l such that (IC) is binding, i.e. $l^* = \frac{\frac{c}{\Delta e}}{(1-p)\beta}$. Moreover, there is no contingent audit fee ($w_L^* = 0$);
- otherwise, if $W_{continuation} < W_{liquidation}$, the optimal probability of providing NAS is $l^* = 0$. The contingent audit fees are set such that (IC) is binding, i.e. $w_L^* = \frac{\frac{c}{\Delta e}}{(1-p)}$.

Proof of Proposition 13

The first order condition of the auditor's maximization effort problem is

$$C'(e) = (1-l)(1-p)w_L + l(1-p)(\beta - (1-\tau)\rho) + (1-p)(1-\tau)\rho. \tag{3.8}$$

The right hand side of (3.8) is the marginal benefit of effort for the auditor. By generating the probability e of detecting financial misstatements in case of a bad firm, the auditor may receive the audit fees w_L or the economic rent β attached to the consulting contract minus the expected litigation/reputation risk $(1-\tau)\rho$. The left hand side of (3.8) is the marginal cost of effort borne by the auditor.

I rewrite the maximization problem of the investors

$$\max_{l,e,w_L} e(1-l)(L - \tau R - w_L)$$

subject to

$$C'(e) = (1-l)(1-p)w_L + l(1-p)(\beta - (1-\tau)\rho) + (1-p)(1-\tau)\rho.$$

This is equivalent to

$$\max_{l,e} e(1-l)(L-\tau R)(1-p) + el(1-p)(\beta-(1-\tau)\rho) + e(1-p)(1-\tau)\rho - C'(e)$$

subject to

$$C'(e) = (1-l)(1-p)w_L + l(1-p)(\beta - (1-\tau)\rho) + (1-p)(1-\tau)\rho.$$

There are two cases:

- if $\beta - (1-\tau)\rho < L - \tau R$, then $w_L^* = \dfrac{C'(e^*)}{(1-p)} - (1-\tau)\rho$, $l^* = 0$ and $e^* = (1-p)(L - \tau R + (1-\tau)\rho)/2k$;
- otherwise, if $\beta - (1-\tau)\rho > L - \tau R$, then $w_L^* = 0$, $l^* = \dfrac{C'(e^*) - (1-p)(1-\tau)\rho}{(1-p)(\beta - (1-\tau)\rho)}$ and $e^* = (1-p)\beta/2k$.

Proof of Corollary 19

Recall that $W_{continuation} > W_{liquidation}$. Hence, allowing the auditor to provide consulting services is optimal. I denote by e^*_{NC} the audit effort when consulting is not allowed and e^*_C the audit effort when consulting is allowed. Corollary 15 implies that $e^*_C > e^*_{NC}$.

In the binary model, audit quality is always lower when it is optimal to incentivize the auditor with consulting services compared to when it is optimal to incentivize the auditor with contingent audit fees: $e_H(1-l^*) < e_H$. In the continuous effort model, I compare $e^*_C(1-l^*)$ with e^*_{NC}.

First,

$$AQ_C = e_C^*(1 - l^*) = \frac{(1-p)\beta}{2k}\left(1 - \frac{(1-p)\beta/2 - (1-p)(1-\tau)\rho}{(1-p)(\beta - (1-\tau)\rho)}\right),$$

which is equivalent to

$$AQ_C = \frac{(1-p)\beta}{2k}\frac{\beta}{2(\beta - (1-\tau)\rho)}.$$

Furthermore,

$$AQ_{NC} = e_{NC}^* = \frac{(1-p)(L - \tau R + (1-\tau)\rho)}{2k}.$$

As a result, $AQ_{NC} > AQ_C$ is equivalent to

$$2(\beta - (1-\tau)\rho)(L - \tau R + (1-\tau)\rho) > \beta^2,$$

which is equivalent to $\beta < \bar{\beta}$, where

$$\bar{\beta} = (L - \tau R + (1-\tau)\rho)\left(1 + \sqrt{\frac{L - \tau R - (1-\tau)\rho}{L - \tau R + (1-\tau)\rho}}\right).$$

Proof of Corollary 20

If there is a ban on the provision of consulting services by auditors to audit clients, the audit effort is $e_{NC}^* = \frac{1}{k}(1-p)(1-\tau)\rho$ and if there is no ban $e_C^* = \frac{(1-p)\beta}{2k}$. As a result, it always the case that $e_C^* > e_{NC}^*$ because $\beta > L - \tau R + (1-\tau)\rho > 2(1-\tau)\rho$.

Furthermore, one can check that $e_C^*(1 - l^*) > e_{NC}^*$ is always satisfied.

Proof of Proposition 14

In the first part of the proof, I solve for the optimal mechanism in the one-firm model when the investors of the firm have access to two types of information to make an informed decision. There is a public source of information besides the costly report of the auditor. The public signal $s \in \mathbb{R}$ is available before the investors set a mechanism to elicit high audit effort. The distribution of this signal conditional on the type of the firm $y \in \{G, B\}$ admits a continuous density $f_y(s)$ such that the likelihood ratio

$$L(s) = \frac{f_G(s)}{f_B(s)}$$

is strictly increasing. As a result, the larger the public signal s, the more likely it was drawn from distribution f_G rather than f_B, that is, the more likely the firm is good. I denote by F_y the conditional c.d.f of the signal. The investors have to elicit high audit effort in order to get an informative audit report. Otherwise, the auditor shirks and the audit is uninformative because $e_L = 0$.

First, I derive the new optimal mechanism for the investors to elicit high audit effort, taking into account the public signal s. Recall that $W_{continuation} > W_{liquidation}$, so that it is optimal for the investors to let the auditor provide consulting services to the manager.

Lemma 18. *The optimal mechanism for the investors is characterized by two thresholds σ_1 and σ_2 such that $\sigma_2 > \sigma_1$ and*

- *if the public signal is smaller than σ_1, the investors liquidate the firm;*
- *if the public signal is larger than σ_2, the investors continue the firm;*
- *otherwise, if $s \in [\sigma_1; \sigma_2]$, the investors give incentives to the auditor before making the liquidation decision. There is no audit fee but the auditor provides consulting services after detecting financial misstatements with probability*

$$l^* = \frac{(1-p)f_B(s) + pf_G(s)}{(1-p)f_B(s)} \frac{\frac{c}{\Delta e}}{\beta} > 0.$$

Proof. I denote by $x_2(s)$ the probability of liquidating the firm without providing incentives to the auditor conditional on signal s.
Similarly, I denote by $x_1(s)$ the probability of continuing the firm without providing incentives to the auditor conditional on signal s.

Given the signal s, the probability to have a good firm is

$$P(G \mid s) = \frac{pf_G(s)}{pf_G(s) + (1-p)f_B(s)}.$$

The investors' optimization problem is

$$\max_{x_1(s),x_2(s),l} \int [pf_G(s)\Big(x_1(s)(qR+\tau R)+x_2(s)L+(1-x_1(s)-x_2(s))(qR+\tau R)\Big)+ (1-p)f_B(s)\Big(x_1(s)\tau R+x_2(s)L+(1-x_1(s)-x_2(s))((1-e_H)\tau R+e_H l\tau R+e_H(1-l)L)\Big)]ds$$

such that

$$l\frac{(1-p)f_B(s)}{pf_G(s)+(1-p)f_B(s)}\beta \geq \frac{c}{\Delta e}.$$

Taking the first-order condition with respect to $x_1(s)$ yields

$$\frac{c}{\Delta e}(pf_G(s) + (1-p)f_B(s)) - (1-p)f_B(s)\beta = 0.$$

Similarly, the first-order condition with respect to $x_2(s)$ yields

$$(pf_G(s)+(1-p)f_B(s))(L-\tau R)(1+e_H\frac{\frac{c}{\Delta e}}{\beta})-pf_G(s)qR-(1-p)f_B(s)e_H(L-\tau R) = 0.$$

Hence, we can define σ_2 such that

$$L(\sigma_2) = \frac{(1-p)}{p} \frac{\beta - \frac{c}{\Delta e}}{\frac{c}{\Delta e}}$$

and define σ_1 such that

$$L(\sigma_1) = \frac{(1-p)}{p} \frac{1 - e_H(1 - \frac{\frac{c}{\Delta e}}{\beta})}{\frac{qR}{L-\tau R} - (1 + e_H \frac{\frac{c}{\Delta e}}{\beta})}.$$

From the first-order conditions, we have

- for $s \leq \sigma_1$, $x_2^*(s) = 1$ and $x_1^*(s) = 0$;
- for $s \geq \sigma_2$, $x_2^*(s) = 0$ and $x_1^*(s) = 1$;
- for $\sigma_1 \leq s \leq \sigma_2$, $x_2^*(s) = x_1^*(s) = 0$.

□

In words, whenever the public signal is informative enough, it is optimal for the investors to rely on it rather than acquiring costly information via the auditor.

Lemma 19. *If the auditor cannot provide consulting services, the optimal mechanism is characterized by two thresholds $\hat{\sigma_2}$ and $\hat{\sigma_1} < \hat{\sigma_2}$ such that:*

- *if the public signal is smaller than $\hat{\sigma_1}$, the investors liquidate the firm;*
- *if the public signal is larger than $\hat{\sigma_2}$, the investors continue the firm;*
- *otherwise, if $s \in [\hat{\sigma_1}; \hat{\sigma_2}]$, the investors give incentives to the auditor before making the liquidation decision. There are positive audit fees contingent on an unfavorable audit opinion*

$$w_L^* = \frac{pf_G(s) + (1-p)f_B(s)}{(1-p)f_B(s)} \frac{c}{\Delta e}.$$

Proof. Same calculations as in the proof of the previous proposition. The threshold values are now defined as

$$L(\hat{\sigma_1}) = \frac{(1-p)}{p} \frac{1 - e_H(1 - \frac{\frac{c}{\Delta e}}{L-\tau R})}{\frac{qR}{L-\tau R} - (1 + e_H \frac{\frac{c}{\Delta e}}{L-\tau R})}$$

and

$$L(\hat{\sigma_2}) = \frac{(1-p)}{p} \frac{L - \tau R - \frac{c}{\Delta e}}{\frac{c}{\Delta e}}.$$

□

When the auditor cannot provide consulting services to its audit clients, I obtain a similar result as the previous proposition except that it is costlier to give incentives to the auditor and he is paid via contingent audit fees. $W_{\text{continuation}} > W_{\text{liquidation}}$ implies that $L(\hat{\sigma_1}) > L(\sigma_1)$ and $L(\hat{\sigma_2}) < L(\sigma_2)$. It means that the investors rely more on the public signal when the auditor cannot provide NAS because it is costlier to provide incentives to the auditor using contingent audit fees.

In the second step of the proof, I endogenize the public signal s in the two-firm model as a signal sent by the investors of firm F_1. In particular, the public signal $s \in \{0, 1\}$ observed by the investors of firm F_2 is such that

$$\frac{P(s=1 \mid G)}{P(s=1 \mid B)} = \frac{1}{1 - e_H(1 - l^*)} \text{ and } \frac{P(s=0 \mid G)}{P(s=0 \mid B)} = 0.$$

The investors of firm F_2 make the same liquidation decision as the investors of firm F_1 if and only if $0 < \hat{\sigma_1} < \hat{\sigma_2} < 1$ and $0 < \sigma_1 < \sigma_2 < 1$, i.e. s is sufficiently informative. Hence, I restrict my analysis to the values of the exogenous parameters such that $\sigma_2 < 1$ and $\hat{\sigma_2} < 1$. The inequality

$$\sigma_2 < 1$$

is equivalent to

$$\frac{(1-p)}{p} \frac{\beta - \frac{c}{\Delta e}}{\frac{c}{\Delta e}} < \frac{1}{1 - e_H}. \tag{3.9}$$

Moreover, the inequality

$$\hat{\sigma_2} < 1$$

is equivalent to

$$\frac{(1-p)}{p} \frac{L - \tau R - \frac{c}{\Delta e}}{\frac{c}{\Delta e}} < \frac{1}{1 - e_H}. \tag{3.10}$$

Assume that (3.9) and (3.10) are satisfied. Then the investors of firm F_2 choose continuation whenever the investors of firm F_1 choose continuation.

Moreover, I also restrict my analysis to the values of the exogenous parameters such that $\sigma_1 > 0$ and $\hat{\sigma_1} > 0$. This is equivalent respectively to

$$\frac{(1-p)}{p} \frac{1 - e_H(1 - \frac{\frac{c}{\Delta e}}{\beta})}{\frac{qR}{L - \tau R} - (1 + e_H \frac{\frac{c}{\Delta e}}{\beta})} > 0 \tag{3.11}$$

and

$$\frac{(1-p)}{p} \frac{1 - e_H(1 - \frac{\frac{c}{\Delta e}}{L - \tau R})}{\frac{qR}{L - \tau R} - (1 + e_H \frac{\frac{c}{\Delta e}}{L - \tau R})} > 0. \tag{3.12}$$

Assume that (3.11) and (3.12) are satisfied. Then, the investors of firm F_2 choose liquidation whenever the investors of firm F_1 choose liquidation.

Appendix 2: three technical assumptions

In the paper, I have made three assumptions on the parameter values that I explicit formally below.

- *Hiring an auditor is desirable, i.e.*

$$b \geq e_H \frac{c}{\Delta e} + (1 - e_H)(1 - p)(L - \tau R). \tag{3.13}$$

  The investors are better-off hiring an auditor rather than transferring b to the manager if and only if

$$p(q + \tau)R + (1 - p)L - b \leq U_{investors}(e = e_H, l = 0).$$

  This is equivalent to

$$p(q+\tau)R + (1-p)L - b \leq p(q+\tau)R + (1-e_H)(1-p)\tau R + e_H(1-p)L - e_H \frac{c}{\Delta e},$$

  which leads to (3.13).

- *High audit effort by the auditor is desirable, i.e.*

$$L - \tau R \geq e_H \frac{c}{\Delta e} \frac{1}{\Delta e(1 - p)}. \tag{3.14}$$

  The investors are better-off when the auditor exerts high audit effort if and only if

$$U_{investors}(e = e_H, l = 0) \geq U_{investors}(e = e_L, l = 0).$$

  This is equivalent to

$$\begin{aligned} p(q + \tau)R + (1 - e_H)(1 - p)\tau R + e_H(1 - p)L - e_H \frac{c}{\Delta e} \\ \geq p(q + \tau)R + (1 - e_L)(1 - p)\tau R + e_L(1 - p)L, \end{aligned}$$

  which leads to (3.14).

- *Continuation is optimal for the investors when receiving no report of misstatements from the auditor at $t = 1$, i.e.*

$$\tau R + \frac{p}{p + (1 - e_H)(1 - p)} qR > L. \tag{3.15}$$

  The probability of having a good firm, conditional on no report of misstatements from the auditor, is

$$P(G|r = \emptyset) = \frac{p}{p + (1 - e_H)(1 - p)}.$$

  Hence, I assume that the expected continuation cash flow is larger than the liquidation payoff.

It is easy to see that the set of parameters under those three assumptions $\{(3.13), (3.14), (3.15)\}$ is non-empty. It is sufficient to have a large private benefit b, a low cost from exerting high audit effort c and an intermediate value for the net gain of liquidation $L - \tau R$.

Appendix 3: endogenous rent beta β

I provide in this appendix a way of endogenizing the economic rent β from NAS as an efficiency wage that the investors need to pay to the consultant.

The consultants face a moral hazard problem. Indeed, they privately choose $\tau \in \{\tau_L = 0, \tau_H\}$. They incur a cost K_C if they choose $\tau = \tau_H$.

In order to provide incentives to the consultant choose $\tau = \tau_H$, the investors offers a contract w_C such that

Online appendix: endogenous reputation cost

The goal of this online appendix is to study the dynamics of audit quality and the propensity of auditors to provide consulting services along the business cycle. I consider a dynamic extension of the model with endogenous reputation costs. The players are now involved in a firm with two consecutive projects. There are two periods with the same three stages in each period, as in the baseline model. In order to get empirical predictions, I do not allow for contingent audit fees.

I introduce an endogenous reputation cost by supposing that auditors can be of two types: poor or good. Before the first period begins, neither the investors nor the auditor can know whether the auditor is productive in his job. A poor auditor never detects financial misstatements, while the productivity of a good auditor depends on his effort e, as in the previous sections. Let u be the probability of having a good auditor at $t = 0$.

Suppose that $\rho = \kappa U_{auditor,2}$ where κ is the cash flow weight attached to the second period (as, for example in Laffont and Tirole, 1993), where κ may be larger than 1. The size of the parameter κ represents the importance of future relative to current profits for auditors. For example, at the onset of a boom, future capitalized profits are likely to be larger, so that κ is large. In contrast, at the end of a boom and at the onset of a recession, κ is small because future capitalized profits are likely to be smaller. I denote by $U_{auditor,2}$ the utility of a good auditor in the second period.

The investors live only for one period and there are two generations of investors who own the firm during the first and the second period respectively. There are no overlapping projects and investors. I solve the problem by backward induction, starting from the second-period investors problem. At the end of the first period, the second-period investors update their beliefs about the auditor's type after observing the audit opinion and the outcome of the first project.

Lemma 20. *The second-period investors hire a new auditor at the end of the first period if the auditor gives a favorable audit opinion and the final cash flow of the first project is* 0*.*

Proof. The conditional probability of having a good auditor after a positive opinion and a zero cash flow at the end of the first project is

$$P(\text{good auditor} \mid \text{positive audit opinion and zero cash flow})$$
$$= \frac{u\left[p(1-q-\tau) + (1-p)(1-e_1^* + e_1^* l_1^*)(1-\tau)\right]}{(1-u)\left[p(1-q-\tau) + (1-p)(1-\tau)\right] + u\left[p(1-q-\tau) + (1-p)(1-e_1^* + e_1^* l_1^*)(1-\tau)\right]} < u.$$

Hence, it is optimal for the second-period investors to hire a new auditor rather than keeping the first-period auditor. □

Therefore, at the end of the first period, an auditor who gave a favorable audit opinion to a project with a 0 cash flow does not get any profit in the second period[36]. Indeed, it is optimal for the second-period investors to hire for the second period a new auditor with a probability u of being good, which is larger than the probability that the first-period auditor is good.

Thus, at the beginning of the second period, the second-period investors believe the auditor is good with probability $u' \in \{u, 1\}$: either this is the first-period auditor ($u' = 1$) or this is a new auditor ($u' = u$). As the second period is the last period, there is no more reputation cost for the auditor in this period. The effort choice problem of the auditor is

$$e \in \arg\max_{\hat{e}} \hat{e}u'l(1-p)\beta - C(\hat{e}).$$

Then the optimal mechanism for the second-period investors is such that

$$l_2^* = \frac{C'(e_2^*)}{u'(1-p)\beta} \text{ and } e_2^* = u'(1-p)\beta/2k.$$

Therefore, the second-period utility of a good auditor is $U_{auditor,2} = e_2^* C'(e_2^*) - C(e_2^*) > 0$. This is the rent from providing auditing services to the firm in the second period.

I now consider the problem of the first period. Given that the auditor is fired whenever he gives a favorable audit opinion and the cash flow of the first project is 0 at the end of the first period, the effort problem of the auditor during the first period is

$$e \in \arg\max_{\hat{e}} u\Bigg(\hat{e}l(1-p)\max(\beta - (1-\tau)\kappa U_{auditor,2}, 0) - (1-\hat{e})(1-p)(1-\tau)\kappa U_{auditor,2}\Bigg) - C(\hat{e}).$$

Providing incentives to the auditor is less costly for the first-period investors because of the reputation costs that the auditor may incur at the end of the first period after a favorable audit opinion if the cash flow of the project is zero. I define the cutoff value $\bar{\kappa} = \dfrac{\beta}{(1-\tau)U_{auditor,2}}$. At this cutoff value, the economic rent β from the consulting contract is equal to the expected reputation cost $(1-\tau)U_{auditor,2}$ from hiding financial misstatements, i.e. the rent-liability ratio is equal to one.

Lemma 21. *Giving this new incentive constraint, the investors set the following mechanism to elicit high effort from the first-period auditor:*

- *if* $\kappa > \bar{\kappa}$, *then* $l_1^* = 0$ *and* $C'(e_1^*) = u(1-p)\kappa(1-\tau)U_{auditor,2}$;
- *if* $\kappa < \bar{\kappa}$, *then* $l_1^* = \dfrac{C'(e_1^*) - u(1-p)(1-\tau)\kappa U_{auditor,2}}{u(1-p)(\beta - (1-\tau)\kappa U_{auditor,2})}$ *and* $e_1^* = u(1-p)\beta/2k$.

[36]Note that I assume here that the cost of firing the auditor is negligible. This assumption is reasonable because it is the decision of new investors. Dao et al. (2011) discuss the voting power of shareholders to change auditors.

In the first case, when the project is bad, the auditor is not willing to accept a consulting contract and to give a favorable audit opinion. Indeed, the expected reputation cost is larger than the economic rent of providing consulting services to the firm. In the second case, it is the reverse, the expected reputation cost is smaller than the economic rent and the auditor is willing to accept a consulting contract and give a favorable audit opinion to the financial statements even if there are some misstatements.

Proposition 15. *The behavior of the auditor is as follows:*

- *when future profits are likely to be larger ($\kappa > \bar{\kappa}$), during the first period, the auditor does not provide consulting services;*
- *when future profits are likely to be smaller ($\kappa < \bar{\kappa}$), during the first period, the auditor provides consulting services.*

Proof. See the discussion above. □

This result predicts that, to the extent that reputation risks for auditors are smaller towards the end of a boom, auditors provide more NAS towards the end of booms.[37]

As discussed in section 3.4.2, the provision of consulting services affects audit quality. Hence, it is interesting to investigate the evolution of audit quality along the business cycle. To the extent that the reputation risk for auditors of getting caught giving favorable audit opinions to bad projects is smaller in booms, my model predicts that audit quality is likely to be smaller in booms than in recessions. This result is similar to Bolton et al. (2012) and Bar-Isaac and Shapiro (2013). Both show that credit rating agencies are more likely to inflate their ratings in booms than in recessions. Although the audit industry has some key differences with the credit ratings industry, there are some common features.[38] For instance, both auditors and credit ratings agencies are paid by their clients, which might create conflicts of interest. Further, those industries are both oligopolies. Thus, to the extent that auditors and credit ratings agencies face the same types of reputation costs, their behaviors along the business cycle may be similar.

[37]Towards the end of a boom, the client business risk, $1 - p$, could also be larger due to moral hazard problem. This would increase audit effort and reinforce this prediction.

[38]For example, a client firm can "shop" for ratings and the ratings are not public as long as they are not approved by the client firm. Moreover, a firm can disclose several ratings from different CRAs.

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