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How to reach all Basel requirements at the same time?[1]

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How to reach all Basel requirements at the same time?

We use confidential bank-level data from the BCBS's quantitative impact studies between 2011 and 2014 to document how banks have been adjusting to Basel III solvency and liquidity requirements. We first develop a non-linear optimization model to assess how banks' balance sheets should have adjusted between 2011 and 2014, absent any external factor other than the new regulations. We find that the increase in capital observed during this period was far larger than that predicted by our model, thus suggesting that banks may have faced pressures from financial markets. In contrast, the observed increase in HQLA was lower than that predicted by the model. We then use the model to assess the adjustments that were still needed, at the end of 2014, for banks to fully comply with Basel III. Based on data at the end of 2014 (and assuming, beyond 2014, a change in deposits similar to the one observed in 2011-2014), we find that the required adjustment in HQLA still necessary to meet all Basel requirements, was half of the one achieved in 2011-2014, and that the required adjustment in capital would come exclusively from TLAC. Finally, any required increase in capital helps to fulfil liquidity regulation but the reverse is not true.

Key words: banking regulation, Basel III, financing of the real economy, credit supply, solvency ratios, leverage ratio, liquidity ratios

JEL classification: G21, G28

Comment atteindre tous les ratios bâlois en même temps ?

Nous utilisons des données individuelles confidentielles remises par les banques au Comité de Bâle dans le cadre des études d'impact quantitative en 2011 et 2014, pour décrire comment les banques se sont adaptées à la réglementation sur la solvabilité et la liquidité de Bâle III. Nous développons tout d'abord un modèle d'optimisation non linéaire pour établir comment les bilans bancaires auraient dû s'ajuster entre 2011 et 2014, en l'absence de tout facteur externe autre que la contrainte réglementaire. Il en ressort que l'ajustement de capital effectivement observé pendant cette période était beaucoup plus fort que celui qui était prédit par le modèle, mettant en évidence la pression des marchés financiers à laquelle les banques ont fait face. Inversement, l'accroissement des actifs liquides de grande qualité nécessaire au respect du LCR s'est révélé inférieur à celui que prévoit le modèle. Le modèle est ensuite utilisé pour prévoir les ajustements qui restent à effectuer à fin 2014 pour que les banques respectent pleinement les ratios Bâle III. Sur la base des données à fin 2014 (et d'une croissance des dépôts après cette date, similaire à celle observée entre 2011 et 2014), nous prévoyons pour atteindre tous les ratios bâlois, un accroissement des actifs liquides de haute qualité moitié moindre que celui observé entre 2011 et 2014. L'accroissement nécessaire en fonds propres provient exclusivement de l'obligation de TLAC. Enfin, l'accroissement du capital aide à satisfaire les contraintes de liquidité, mais l'inverse n'est pas vrai.

Mots-clés: réglementation bancaire, Bâle III, financement de l'économie réelle, offre de crédit, ratios de solvabilité, ratio de levier, ratios de liquidité

JEL classification: G21, G28

Non-technical summary

Research question

This paper assesses whether the Basel III requirements induced banks to reduce their financing to the economy. Indeed, practitioners put a higher cost on capital finance than on debt finance. In addition, net stable funding ratio implies financing with a higher maturity that is more costly in the context of an upward-sloping yield curve. Finally, the liquidity coverage ratio implies higher investment in very liquid low risk low return assets. This increase in cost induced by prudential regulation may reduce the net return on lending activity. However, this argument falls short in the light of the Modigliani Miller principle, which states that the structure of financing of the firm does not influence its overall cost. Confronted to the difficult assessment of the return and costs incurrent by banks, we look at quantities. We thus try to assess if the implementation of Basel III had an impact on balance sheets and induced a reduction in the financing of the economy by banks. However, this question cannot be solved only through the observed change in credit, as the latter may result from external factors such as a change in demand for loans due to the macroeconomic environment. We build a non-linear optimization model in order to isolate the pure impact of the regulatory constraints. The latter is based on a simplified balance sheet. Constraints come from the 4 Basel ratios.

Contribution

In order to describe the effective and modeled change in balance sheet, we use confidential bank-level data from the BCBS's quantitative impact studies as at end 2011 and end 2014. The regulatory constraints are not set as uniform, based on the solvency and liquidity weights defined by the regulation. In our model, these weights are entity-specific and depend on each bank's product mix, on the characteristics of its customers and on its risk strategy. These weights are deduced from the balance sheet and ratios reported by banks to the BCBS. They evolve through time, showing how banks adapt to the new regulatory constraints and optimize their balance sheet and activity.

Results

We find that the increase in capital required by the model is half of the one observed during this period, thus suggesting that banks faced pressures from financial markets. In contrast, the increase in HQLA predicted by the model was higher than the one observed. We show that any increase in capital helps to fulfil liquidity regulation. Thus capital regulation is a potential substitute to liquidity regulation. The reverse is not true. In addition, LCR and NSFR are not direct substitutes. We then use the model to assess the adjustments that were still needed, at the end of 2014, for banks to fully comply with Basel III. Assuming a change in deposits after 2014 similar to the one observed in 2011-2014, we find that the required adjustment in HQLA still necessary to meet all regulatory requirements would be half of the one achieved in 2011-2014, and that the required adjustment in capital would come exclusively from TLAC.

Résumé non-technique

Problématique

Le renforcement des exigences réglementaires en capital et en liquidité sous Bâle III conduit-il les banques à réduire leur contribution au financement de l'économie ? D'un côté, les professionnels jugent que le coût des fonds propres est plus élevé que celui de la dette. De l'autre, l'allongement de la maturité des ressources bancaires imposé par le ratio de financement stable accroît le coût de financement des banques dans un contexte de courbe ascendante des taux d'intérêt. De plus, le ratio de liquidité de couverture exige des investissements élevés en actifs liquides à faible rendement. Cet accroissement des coûts bancaires induit par la réglementation est de nature à réduire le rendement net des activités de prêt. Néanmoins, cet argument est contredit par le théorème de Modigliani Miller qui stipule que la structure du financement n'influence pas son coût. Confrontés à la difficulté pratique d'évaluer les coûts et rendements bancaires, nous centrons cette étude sur l'analyse des changements des volumes induits par les nouveaux dispositifs réglementaires. Nous cherchons ainsi à déterminer quel a été l'impact de la mise en application de Bâle III sur les bilans bancaires et s'il s'est traduit par une réduction du financement de l'économie par les banques. Toutefois, cette question ne peut être résolue par la seule observation du changement du volume du crédit dans la mesure où celui-ci est aussi déterminé par des facteurs externes et en particulier par les changements des perspectives macroéconomiques qui affectent la demande de crédit. C'est pourquoi, pour isoler l'impact pur des contraintes réglementaires nous construisons un modèle d'optimisation non-linéaire fondé sur un bilan bancaire simplifié. Dans ce modèle, les contraintes sont associées aux quatre ratios bâlois.

Contribution

Pour documenter les changements effectifs des bilans bancaires autant que les changements prévus par le modèle, nous utilisons les données individuelles de banques figurant dans la base de données confidentielle des études quantitatives d'impact (Quantitative Impact Studies - QIS) du Comité de Bâle sur la période fin 2011 à fin 2014. Les contraintes réglementaires ne sont pas fixées comme uniforme, suivant les pondérations de solvabilité et de liquidité prévues par la réglementation. Dans notre modèle, ces pondérations sont mesurées banque par banque et elles dépendent des combinaisons d'activités et de produits, des structures de clientèle et des stratégies en matière de risque spécifiques à chaque banque. Ces pondérations sont déduites de leur bilan et des ratios déclarés par les banques au Comité de Bâle dans les études d'impact. Elles changent dans le temps, montrant comment les banques réagissent aux nouvelles exigences réglementaires et optimisent leurs bilans et leur activités.

Résultats

Nos résultats montrent que l'accroissement des fonds propres prévus par notre modèle représente la moitié de celui observé durant la période, ce qui suggère que les banques ont été confrontées à la pression des marchés financiers. En revanche, l'accroissement des actifs hautement liquides HQLA prévu par le modèle est plus élevé que l'accroissement observé. Les résultats montrent que tout accroissement du capital contribue aussi à satisfaire les exigences en liquidité. Ainsi, la réglementation du capital est un substitut potentiel de la réglementation de la liquidité. Mais la réciproque n'est pas vraie. De plus, les ratios LCR et

NSFR ne sont pas des substituts l'un pour l'autre. Le modèle est aussi utilisé pour évaluer les ajustements qui restent à accomplir, en fin 2014, pour que les banques soient en parfaite conformité avec Bâle III. En supposant que le changement du volume des dépôts bancaires se poursuit au-delà de 2014 au rythme observé sur la période 2011-2014, on trouve que les ajustements encore requis à fin 2014 pour atteindre tous les ratios bâlois, étaient deux fois moindre que ceux réalisés de 2011 à 2014 pour les actifs très liquides, et que le ajustements en capital requis devaient résulter exclusivement des TLAC.

How to reach all Basel requirements at the same time?[2]

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1. Introduction

The financial crisis highlighted the negative consequences of excessive leverage, too high dependence on unstable short-term funding, and too large maturity mismatches in the banks' balance sheets. As a result, to strengthen the resiliency of the banks to shocks, regulators have reinforced Basel II micro-prudential capital standards which prevailed before the crisis, introduced new liquidity requirements, supplemented by new macro-prudential standards (BCBS, 2009). Under the new Basel III regime, at the 2019 horizon after phasing -in, banks will have to comply with mandatory levels of four different regulatory ratios: the solvency capital ratio[3], the leverage ratio, the liquidity coverage ratio (LCR), and the net stable funding ratio (NSFR). For global systemically important banks (GSIBs), the solvency requirement also includes a systemic buffer. More recently, the need to enlarge the capital base in case of resolution also imposed new requirement to GSIBs in terms of total loss absorbing capacity, (TLAC) defined as a percentage of risk weighted assets on the one hand and total leverage ratio exposures on the other hand, and which can be fulfilled with debt-like forms of capital.

Even if the 2008-2009 crisis was immediately followed by a massive restructuring of banking sector balance sheets, only few banks fulfilled the new regulatory ratios at the beginning of the 2010s. However, these banks since have produced considerable effort to fill in the gaps : in the mid-term of the 2010s, a majority of banks around the world was compliant with all the new ratios at the planned horizon, even if additional adjustments were still to be done by a non-negligible number of them. To comply with the new rules, banks could have developed a great variety of strategies of portfolio rebalancing and growth which could not have the same consequences on the real economy. Looking at the balance sheet adjustments may help to shed light on how the banks' strategies took place. Therefore, the main goal of this study is to explain the most important balance sheet adjustments which have been implemented by the banks in order to become compliant with the new Basel III rules and to identify the associated consequences for the financing of the economy.

This paper proposes a comprehensive balance sheet adjustments framework which documents the main balance sheet and prudential adjustments that banks have implemented at the same time in order to become compliant at the due date with the mandatory values of the four ratios. In a sense, our approach is close to the Balance Sheet Approach used by the IMF (see Allen and al., 2002) and academics to explain how financial crises could find their roots in balance sheets weaknesses of non-financial and financial sectors (Krugman, 1999, Dornbush, 2001, Gray, Merton and Bodie, 2002). But, as the size of the adjustment depends on the size of the shortfall at the date of the measurement, our framework combines a distance to

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We greatly benefited from the suggestions made by Frederic Boissay (discussant).
[3] In fact, the capital solvency ratio covers 3 ratios that defer by the quality of capital required: a common equity tier 1 ratio (CET1), a tier 1 ratio and a total capital ratio. Note that the leverage requirement is also defined for tier 1 capital. TLAC is included as an additional requirement in solvency ratio and leverage.

compliance approach with the balance sheet adjustment approach. This comprehensive framework shows how banks' assets have shifted and what role new regulatory constraints have played in the restructuring of banks' balance sheets since the announcement of the Basel III. It allows also considering the four ratios simultaneously taking into account the complex interactions among the constraints that the new liquidity and capital ratios are creating altogether.

Therefore, our approach departs from the most common one which measures the banks' distance to compliance on a ratio-by-ratio basis. This is the approach adopted by the Basel Committee in its monitoring reports, published on a semi-annual basis, and based on the Quantitative Impact Study (QIS) data of around 235 banks around the world. In this report, the Basel Committee provides the values of the current shortfalls, that is the distance to compliance, for every ratio on an aggregated basis (see, for instance, BCBS 2014). Most of the academic papers also consider the impact of "substantially" higher capital or/and liquidity regulatory requirements separately (Elliot, 2009, 2010, King, 2010, Angelini et al., 2011, Hanson et al., 2011, Cornett et al., 2011). But, in fact, new regulatory rules may have changed the way by which banks fund the assets holdings. They also could have modified the ability of banks to provide the credit intermediation and payment services provision needed by the real economy. As emphasized by Haldane (2015), by proceeding on a regulatory rule-by-rule basis - following the Tinbergen rule - the new regulatory regime has resulted in a multi-polar complex regulatory framework that does not consider explicitly the complex interactions between the regulatory rules and therefore might not provide the optimal response to the fragilities revealed during the crisis. While new capital and liquidity rules might have incentivized banks to modify their business models, there is no unified framework that organizes thinking about the complex interactions among them (Kashyap and al., 2014).

This paper is among the very few empirical papers which analyze the impact of all regulations at the same time and provides empirical results with a minimum of behavioral assumptions. Based on a unique simplified balance sheet framework it documents the banks' balance sheet changes and the effective links between prudential metrics and balance sheets from 2011 to 2014. It also models the banks' balance sheets adjustments that would have been required from banks in 2011 and in 2014 to eliminate the shortfalls, other things being equal, and to become compliant with the four regulatory ratios.

The second section of this paper relates to the current literature devoted to the impact of the new regulatory Basel III framework. The third section presents the balance sheet framework and the model. The fourth section describes the evolution of banks' balance sheets and prudential parameters between 2011 and 2014. The fifth section uses the model to estimate the changes over the same period and compares estimated changes with the observed ones. The sixth section concludes.

2. Contribution to the literature

This paper can be linked to the empirical literature on the impact of capital and liquidity buffers on banks' portfolio allocation, which emerged after the 2008 crisis. First papers have generally considered the impact of the two types of requirements separately. However, recent papers have tried to treat them jointly, considering the complex interactions between capital

and liquidity requirements. In addition, few papers consider today the Basel III compliance issue itself.

First, this paper deals with empirical work on the importance of bank capital and funding conditions for lending. In that field of research, the effects of capital and liquidity requirements are frequently estimated separately. The great majority of papers have focused on capital regulation or the so-called pro-cyclicality of capital buffers and they have estimated the size of the effect of bank capital on the bank credit supply and its cost. For example, the Macroeconomic Assessment Group (2010) estimated that every percentage point of increased bank capital ratios would lead to a 15–17 basis points widening of lending spreads. Institute of International Finance (2011) forecasts a 30–80 basis points widening of spreads per additional percentage point of capital – while also stating that banks would need to raise capital ratios by up to 5 percentage points. Using a Modigliani-Miller framework, Hanson et al. (2011) have found that a ten percentage-point increase in the capital requirements only increases the weighted average cost of equity capital and the loan rates by 25 basis points. Elliott et al (2012), looking at the combined impact of higher capital and other regulatory reforms along with likely bank adjustment strategies, estimated that spreads would widen by 18 basis points in Europe, 8 basis points in Japan and 28 basis points in the United States. Miles et al. (2013) find that every percentage point increase in the capital ratio from its 2009 level leads to an approximate 10 basis point increase in the lending rate. Kapan and Minoiu (2013) find that banks with higher, better-quality capital did not reduce lending during the financial crisis as much as did other banks. Altogether, the previous papers show a mild expected impact of capital requirements on bank assets holding.

Only few papers have considered the impact of new liquidity regulatory constraints or the joint effect of capital and liquidity buffers. Cornett et al. (2011) look at how cash, other liquid assets, and provision of credit vary across banks. These variations help explaining differences in bank behavior during the crisis. According to the authors, banks that relied more heavily on core deposit and equity capital financing, which are stable sources of financing, continued to lend more than other banks. Banks that held more illiquid assets on their balance sheets, in contrast, increased asset liquidity and reduced lending. Off-balance sheet liquidity risk materialized on the balance sheet and constrained new credit origination. Authors conclude that efforts by banks to manage the liquidity crisis led to a decline in credit supply. King (2010) estimates the loan rates increase compensating a 2 percentage-point increase in the capital ratio and the compliance to the net stable funding ratio (NSFR). He finds a 50 basis points increase in the loan rates. Banerjee and Mio, 2014, also estimate the effect of liquidity regulation on bank balance sheets. Using the implementation of new liquidity requirements in U.K. as an experiment, they find that banks increased the funding from more stable deposits while reducing the short-term wholesale funding. In parallel to this change in the composition of their funding structure, banks also increased the share of HQLA, without a detrimental impact on lending supply. Most of the other studies leave out the leverage ratio, the liquidity coverage ratio (LCR) and the NSFR (Slovik and Cournede, (2011), Cosimano and Hakura, (2011), Kopp et al., (2010)). They also ignore the mutual interaction of the included capital ratio and the net stable funding ratio. As recognized by the ECB (2014), "a framework that identifies systemic liquidity risks and guides the implementation of macro-prudential liquidity tools is still missing".

A reason is that the new regulatory regime defined by Basel III was built on a rule-by-rule basis, assuming that each type of rules is able to pursue a distinct objective. However, because liquidity and solvency are closely interrelated, liquidity regulation and capital regulation are themselves closely intertwined and it is important to understand the interactions between capital and liquidity requirements. The system-wide impact of the multiple regulatory constraints needs thereby to be assessed, in order to assess if the Basel III architecture provides a consistent response to all uncertainties revealed by the crisis (Haldane, 2015). A common view is that capital regulation and liquidity regulation are substitutes. Capital is a source of funding while liquid assets are a use of funding. At first glance, higher capital holdings reduce the need of liquidity buffers, because they give confidence to banks' depositors and investors to provide funding to banks at lower cost. Higher holdings of liquid assets reduce capital needs because hey decrease risk-weighted assets. But, in fact, capital requirements and liquidity requirements could act as complement or substitute to help banks from reaching the four ratios in parallel. They act as complements if they help banks to pursue separate objectives: the control of credit risk for the risk-based capital and the leverage ratios, the control of liquidity risk for the LCR and the NSFR ratios. In that case, both regulations are needed. However, when they are complements, the difficulty to reach the regulatory constraints simultaneously at due date is reinforced. In particular, liquidity requirements could reduce lending because they hamper bank maturity transformation, as demonstrated in De Nicolo et al. (2014). Possibly, in that case, liquidity constraints and capital constraints may reinforce each other to reduce the size of the bank assets portfolio and increase the costs of the regulation for banks. But capital and liquidity requirements could also act as substitutes if they both help banks to reach at the same time the solvency and liquidity objectives. If they are perfect substitutes, only one regulation is needed. Admati et al. (2011) argue that high levels of capital allow banks to attract funding at lower cost and therefore liquidity regulation is not necessary if banks are highly capitalized (in the order of magnitude of 20% to 25% for the authors). A simpler regulatory framework might then provide more robust response to capital markets frictions. But, in practice, capital and liquidity requirements are usually imperfect substitutes. An increase of the capital ratio can help banks reducing their reliance on debt and fostering market confidence, thereby contributing to reduce the liquidity risk and not only to maintain the banks' solvency. Indeed, even highly capitalized banks could encounter difficulties to raise funds, what was the case during the 2009 crisis. The crisis showed that capital regulation does not fully mitigate liquidity risks. More mechanically, any increase in capital qualifies fully as an increase in available stable funding, thus releasing the constraint on NSFR. Any increase in the HQLA holdings, by decreasing the risk weighted assets, contributes also to maintain the solvency objective. On the contrary, an increase in stable funding other than capital, while reducing the maturity mismatch and contributing to maintain the banks' liquidity has no clear effect on the banks' solvency. Knowing the source of substitutability between liquidity requirements and capital requirements is crucial if we want to understand whether banks can become compliant with the new Basel III standards without incurring severe costs. In fact, the interactions between ratios fundamentally rely on complex and the not so well known relationships between liquidity risk and solvency risk. As shown by the available theoretical literature, modelling the substitutability between capital and liquid assets in deterring a run and in preserving against insolvency is not easy. Kashyap and al. (2014) illustrate this complexity by showing that there is a fundamental asymmetry in the way that liquidity and capital regulations can just reach one single objective that is to deter runs. Capital requirements essentially work on the liability-side of the bank's balance sheet. Higher equity requirements suggest that banks will be able to lend more and that the bank's assets

will become less liquid. On the other side, liquidity requirements, either under the form of LCR or NSFR, imply that the bank substitute liquid assets to illiquid assets, what deters runs automatically, but at a price of a lending reduction.

Thus, the issue of the interactions between capital and liquidity requirements became a central topic in recent theoretical or empirical papers (De Nicolo et al., 2012, Farag et al., 2013, Covas and Driscoll, 2014, Kashyap and al., 2014, De Nicolo and al., 2014, Diamond and Kashyap, 2016, Puhr and Schmitz, 2014, de Bandt and Chahad 2016, Boissay and Collard, 2016, Hugonnier and Morellec, 2016)[4]. De Bandt and Chahad (2016) use a multi-period DSGE model and take also into account interactions between the financial and the real sector. They show that liquidity and capital regulation have compounded effects while LCR and NSFR have similar qualitative effects and can substitute somehow. Building a macroeconomic framework and using U.S. data, Boissay and Collard, 2016, find that capital and liquidity requirements mutually reinforce each other, except when liquid assets are scarce. At the empirical level, an ECB (2014) study models the relationship between counter-cyclical capital buffer and the NSFR and finds a positive relationship between the two. Using Dutch data, Bonner and Hilbers (2015) suggest that synergies created by capital and liquidity requirements allow avoiding bank maturity transformation and lending disruptions.

This paper is also closely linked to the few studies that deal with the issue of "how to fill the capital and liquidity shortfalls". These papers consider explicitly the distance to compliance issue. First, a series of Quantitative Impact Studies (QIS) conducted by the Basel Committee on Banking Supervision since 2009 offer evidence of a significant aggregate rise in banks' capital ratios in recent years. The studies estimate average capital adequacy ratios for a global sample of banks according to the definitions that are scheduled to come into force in the Basel III framework. Cohen (2013) uses QIS data and looks at the stronger regulatory requirements. Using a sample of 82 large global banks from advanced and emerging economies, he shows that retained earnings accounted for the bulk of the increase in risk-weighted capital ratios over the period 2009/2012, while reductions in risk weights have played a lesser role. On average, banks continued to expand their lending, though lending growth was slower among advanced economies in Europe. Lower dividend payouts and wider lending spreads contributed to banks' ability to use retained earnings to build capital. Banks that came out of the crisis with higher capital ratios and stronger profitability were able to expand lending more. However, the issue of the impact of liquidity constraints on lending is not so well documented. Moreover, few papers have considered the interactions between leverage ratio, risk-weighted capital ratio and the liquidity ratios. The Basel reports, at least in their more recent versions, calculate joint leverage and risk-based capital shortfall, but do not articulate the reduction in capital shortfall with the fulfilment of liquidity ratios. Indeed, banks have many different ways to fulfill the ratios. Thus the assumptions that should be made would overpass the descriptive exercise assigned to the Committee.

[4] Moreover, bank capital and banks' liquidity positions are concepts that are central to understand how bank risks should be mitigated jointly by the financial markets and by the prudential regulators (Acharya, 2002). Market discipline that determines banks' risk taking decisions, and supervisory discipline could be strategic complements or strategic substitutes. Strategic complementarity arises when the disciplining power of market can enhance the disciplinary power of supervisors. Outside any regulatory framework, banks could themselves, face financial distress by reducing exposures, issuing senior debt, increasing retained earnings, or issuing equity. Together, market and supervisors discipline power may imply greater discipline and more prudent risk taking. Thus, strategic complementarity could help banks to reach easily regulatory objectives with less impact on bank portfolios.

The main issue at the empirical level is to define a framework to deal with the complexity of the relationships between the banks' capital and liquidity variables. Schmaltz et al. (2014) deal with this issue and provide a tractable methodological framework for such impact studies. Their paper considers a bank that maximizes profit over capital cost subject to all the Basel III constraints. The model requires only two main inputs to adjust banks' activities: accounting profit composed of positive margin income and negative adjustment cost, which captures contractual cost. The model requires a minimum of structural information like regulatory weights and segment profitability. Recognizing that banks' return and the four constraints of Basel III are of linear type, the issue is formulated as a linear program. The model is a Chance constraint model such that compliance can be achieved and maintained at a high confidence level. By setting the adjustment cost to the most expensive Basel II constraints, the bank does not have any incentive to change its business model. The authors apply the model to a set of typical German universal banks. The results demonstrate how banks could achieve compliance by restructuring funding. A limit of this approach is that it is largely dependent on the assumptions about the costs of the different changes of the funding instruments. In the approach, these costs are exogenous. Another limit of the approach is that the adjustment process assumes that any increase of the balance sheet items result entirely from given returns on assets or costs of liabilities. Consequently, depending on the level of these costs, and in particular if the funding costs are very high, banks could have to change their business model. Only a range of adjustment costs is consistent with the bank's prevailing business model.

This paper belongs to the very limited number of empirical studies dealing explicitly with the compliance with Basel III. But it departs from the current literature in two ways. Firstly, while most papers in that field propose impact studies focusing on some ratios taken separately, this paper considers the interactions between the new capital and liquidity requirements. Accordingly, this paper is close to the very limited number of papers, like the Schmaltz et al. (2014) paper, which adopt a comprehensive view including all new Basel III ratios in the modelling. Secondly, by combining a balance sheet adjustments approach with a compliance approach, this paper provides an empirical approach grounding on an accounting model of the banking firm and very unique information about the state of the shortfall by bank and by type of Basel III new regulatory constraints which takes explicitly into account the restrictions the new regulations impose on the banks' balance sheets as well as the mutual interactions between new regulatory capital and liquidity constraints. Therefore, this paper brings a new contribution to this rare empirical literature relying on a modeling of the quantitative adjustments to the new rules.

3. The framework

To study the compliance issue and consider its consequences on banks' balance sheets, we use data reported by banks to the Basel committee within the quantitative impact study exercise (QIS) as at end 2011 and end 2014. The data reported are the one that enter in the calculation of the Basel III ratios. They are analyzed bank by bank. First, we build a simplified stylized balance sheet and link it with the prudential metrics. Second, we build an adjustment model.

Within the model, regulatory requirements are represented through a system of five equations that interlink accounting items and prudential metrics and permit to determine the marginal required changes in balance sheet in order to fulfill all ratios. Four equations represent prudential constraints which are associated with the four Basel III ratios and the fifth equation represents the balance sheet constraint. We add a profit-cost equation and some upper and lower limits to the changes in balance sheet items and then resolve the set of equations by using non-linear optimization. In that case, the model develops an optimal adjustment with final ratios possibly higher than the minimum requirements.

When analyzing the data that enter in the model and their evolution between 2011 and 2014, our approach is backward looking. When using the model, our approach is forward looking: the objective is not to describe which balance sheet adjustments have happened but to figure which balance sheet adjustments are needed in the future to meet full Basel III and become compliant in the end with the mandatory values of the four ratios.

3.1. The accounting framework

Our framework considers a simplified stylized balance sheet with capital as defined in the capital ratios or leverage ratio (K), high quality liquid assets (Z) as defined in the LCR, total deposits (D), total market borrowing (M), and assets other than HQLA[5] (C), that includes loans and other earning assets. The balance sheet is as follows:

Table 1: A simplified balance sheet

Assets		Liabilities	
High quality liquid assets	Z	Capital	K
Other assets	C	Deposits	D
		Borrowed resources	M
Total	A	Total	L

In this framework, TLAC can be modeled as total capital, the latter then including different quality of capital and subordinated debt.

These balance sheet items are connected to the prudential metrics associated to Basel III rules, by "prudential parameters". The prudential metrics are needed to calculate the Basel ratios and are also reported by banks in the QIS. They are risk weighted assets (RWA for *Z* and *C*) as defined in the solvency ratio, total exposures (*exp*) as defined in the leverage ratio, inflows and outflows as defined in the LCR (for all items except *K*), available stable funding (*ASF*) and required stable funding (*RSF*), as defined in the NSFR. Those later are respectively, linear combination of capital, deposits and market borrowing (*ASF*) and linear combination of liquid assets and other assets (*RSF*).

We define prudential parameters as ratios of prudential metrics over balance sheet items, as follows:

[5] Further details, and especially the split between loans to non financial counterparties and other loans was not available in QIS 2011 data.

Table 2: Prudential parameters

source	numerator		denominator		Para-meter
Leverage ratio	Exposures on other assets	*Exp*	Other assets	*C*	γ
Solvency ratio	Solvency ratio × RWA on other assets	*Solv ×RWA (C)*	Other assets	*C*	*rc*
	Solvency ratio × RWA on liquid assets	*Solv×RWA (C)*	Liquid assets	*Z*	*rz*
NSFR	Required stable funding for other assets	*RSF (C)*	Other assets	*C*	*nc*
	Required stable funding for liquid assets	*RSF (Z)*	Liquid assets	*Z*	*nz*
	Available stable funding from deposits	*ASF (D)*	Deposits	*D*	*nd*
	Available stable funding from market borrowing	*ASF (M)*	Market borrowing	*M*	*nm*
LCR	Weighted high quality liquid assets	*p×Z*	High quality liquid assets	*Z*	*p*
	Inflows on other assets	*Inflows (C)*	Other assets	*C*	*lc*
	Outflows on deposits	*Outflows (D)*	Deposits	*D*	*ld*
	Outflows on market borrowing	*Outflows (M)*	Market borrowing	*M*	*lm*

These prudential parameters are calculated for each individual bank as at end 2011 and 2014.

3.2. The model

We suppose that an instantaneous transition process transforms the banks' balance sheets from the current situation to the end point, where all ratios are met. Thus, all the changes are in nominal terms and we don't have to care for inflation or any other changes in economic situation. We also focus on the full implementation of new Basel III ratios[6], setting aside the transition issues associated with phasing-in of the new regulation

We suppose that institutions won't decrease the level of prudential safety they have already attained.
Thus, when a bank already complies with one ratio, the latter is not required to diminish, as we expect financial markets to favor a higher level than the regulatory minimum. Technically, that is obtained by setting any excess buffer to zero (see below). However, the ratio can diminish, if it is required by adjustments due to shortfalls on other ratios.

The change in deposits is set to the effective increase observed on the 3 year period 2011-2014, either when the model is run on 2011 or 2014 balance sheets[7]. This suits well with the usual approach of banks that consider that the change in deposits is not manageable in the short run because it is strongly constrained by the domestic characteristics of the financial system architecture or the monetary policy.

The prudential parameters evolve through the period. In order for our model to fit better the 2011-2014 period, we will use average prudential parameters when modelling the adjustment required in 2011 to reach compliance. In order to predict the adjustments after 2014, we will use prudential parameters as they stand as at end 2014 (see 4.4. below).

Bk, Ba, Bz, are defined as the initial shortfall respectively in total capital (resulting from the maximum of leverage ratio and solvency ratio requirements), in available stable funding, and in HQLA. When minimum ratios are fulfilled or out-passed, spontaneous shortfalls are negative. In that case, the corresponding shortfalls are set to zero and thus the algorithm requires no adjustment to their respect. Further changes in balance sheet amounts are designated with a Δ.

$$Bk = \max(0; sol \times RWA - K; lev \times exp - K)$$
$$Ba = \max(0; RSF - ASF)$$
$$Bz = \max(0; pZ - outflows + inflows)$$

All changes are supposed to be marginal and to add to the existing balanced balance sheet. The initial balanced sheet is supposed to be already balanced[8]. The changes in assets and in liabilities are also perfectly balanced. This applies in the model through the balance sheet constraint, set as follows:

$$(1)\quad \Delta Z + \Delta C = \Delta K + \alpha D + \Delta M$$

α is the observed growth rate of deposits between ends of years 2011 and 2014.

The LCR constraint implies that initial shortfall in HQLA plus/minus any other change in net outflows entailed by the change in balance sheet are at least covered by new weighted HQLA:

$$(2)\quad p\Delta Z \geq Bz + ld.\alpha D + lm.\Delta M - lc.\Delta C$$

In equation (2), the variable *p* represents the regulatory weights for recognition in HQLA and is the opposite of haircut. To simplify, any change in HQLA is made on "level 1" securities.

The NSFR constraint implies that initial shortfall in available stable funding plus/minus any other change in shortfall entailed by the change in balance sheet is at least covered by new available stable funding.

[7] Making change in deposits a variable and not an input in the model was also tested with extreme variations of all items as a result. While theoretically possible in non-linear optimization, having fewer constraints than variables, leads in the model to corner solutions.

[8] In fact, this is not always the case due to the incomplete data in QIS. At least, the possible disequilibrium in balance sheet is remains constant after the adjustment has occurred.

(3) $nd.\alpha D + nm.\Delta M + \Delta K \geq Ba + nz.\Delta Z + nc.\Delta C$

The total capital constraint implies that initial capital shortfall plus or minus any change in required capital entailed by the change in assets is covered by new capital. Consequently, required new capital is the maximum of leverage ratio requirements and risk based total capital ratio requirements, when not fulfilled at the outset. While leverage ratio is defined as a constraint in tier 1, it is nevertheless the total capital that is relevant for liquidity ratios. Thus the leverage ratio binds only if the level of tier 1 capital it requires exceeds the total capital required by the risk based total capital ratio.

TLAC is modeled as a supplementary constraint on total capital, the latter then including different quality of capital and subordinated debt or TLAC. The word "total capital" is used for this composite aggregate. However, the balance sheet as at end 2011 and 2014 do not include any TLAC as discussion on resolution was just at its outset.

The constraint for leverage requirements is designed as follows. In equation (4), *lev* is the leverage ratio and *exp* is total exposures. Exposures comprise on and off balance sheet items on banking and trading book:

$$(4)\quad \Delta K \geq Bk + lev(\gamma\Delta C + \Delta Z) - (K - lev.exp)$$

The constraint for solvency requirement is designed as follows:

$$(5)\quad \Delta K \geq Bk + rc.\Delta C + rz.\Delta Z - (K - solv.RWA)$$

In equation (5), *solv* is the solvency ratio. The required total solvency capital ratio includes the conservation buffer of 2% and tier 2 of 2%. It is set to 10.5% for most banks. For GSIBs, the systemic risk buffer adds up. When estimates for GSIBs include TLAC in capital requirements, the ratio is set between 21.5% and 23.5%, depending on the GSIB surcharge. The leverage ratio equals 3% for most banks. When estimates include TLAC, it is set to 6.75% for GSIBs.

We cap the reduction of any item to 100% of its initial amount and the increase in any item to the total amount of liability.

$$(6) - C \leq \Delta C \leq L$$
$$(7) - Z \leq \Delta Z \leq L$$
$$(8) - K \leq \Delta K \leq L$$
$$(9) - M \leq \Delta K \leq L$$
$$(10) - D \leq \Delta D \leq L$$

A cost equation for profit maximization is added. Costs and yields are modeled as a hierarchy more than a precise setting. The yields on assets and costs on deposits are supposed to be net of management costs:

$$(11) Max\ 0{,}015\Delta Z + 0.035\Delta C - 0{,}125\Delta K - 0{,}026\Delta D - 0{,}024\Delta M$$

The assumed costs and returns included in equation (11) are the same for all banks. The reason is that QIS data being anonymized and excluding detailed profit and loss information,

it is not possible to use bank's specific cost of funding and asset return. To measure the cost of equity capital, we assume that the total compensation of shareholders is the sum of the dividend paid and the margin, which is accumulated as reserves by the bank and contributes to the increase in the equity's value that the shareholders may definitively extracted when they sell their equity holdings.

The eleven equations framework is solved by using non-linear optimization, using the method of Generalized Reduced Gradients[9], and allowing for negative solutions.

4. Descriptive statistics

4.1. Description of the sample

The consistent sample we have built using QIS data contains 156 banks with all relevant information over the 4 years (86 banks belonging to Group 1, 70 to Group 2)[10].

Table 3 gathers banks clustered according to the value of the highest shortfall. That provides four categories of banks: banks without any shortfall, banks with a "dominant" NSFR shortfall, banks with a "dominant" LCR shortfall, and banks with a "dominant" capital shortfall. The "dominant" shortfall is the largest in size.

Table 3 shows that compliant banks (without any shortfall) are the majority as at end 2014.The changes toward compliance came fast: while only a few banks were already compliant with the four ratios as at end 2011 (37 banks), their number increased to 109 in 2014.

In accordance with these changes, we observe a significant decrease in the size of the shortfalls (median of shortfalls divided by total liabilities). By design, the NSFR shortfalls are the largest individual shortfalls compared to total balance sheet (from 8.3% of liabilities in 2011 to 5.3% in 2014. LCR shortfall comes after (4.9% in 2011 to 3% in 2014). Capital shortfalls are far smaller, from 1.3% in 2011 to 0.6% in 2014. By design, capital shortfall including TLAC are larger, but still the smaller of the shortfalls.

[9] As under excel solver

[10] Through all the analysis, the changes in deposits and assets of French banks have been corrected from the change in treatment of passbooks transferred to the Caisse des dépôts et Consignations implemented in 2014, in order to calculate a rate of change with a constant methodology.

Table 3: Characteristics of banks by shortfall type

	existing shortfall	median shortfall /liabilities	maximum shortfall	median shortfall /liabilities	deposit /liabilities
2011					
zero shortfall	37	-	37	-	64,6%
NSFR	77	8,3%	59	10,0%	39,7%
LCR	80	4,9%	37	5,2%	47,7%
capital	78	1,3%	23	1,5%	66,0%
capital incl.TLAC	92	1,6%	38	3,2%	51,0%
2014					
zero shortfall	109	-	109	-	51,9%
NSFR	26	5,3%	24	5,5%	32,7%
LCR	27	3,0%	17	3,0%	56,1%
capital	8	0,6%	6	1,0%	45,9%
capital incl.TLAC	35	1,5%	25	2,0%	44,1%

Source: QIS data and authors' computations

Banks feature some very different characteristics depending on their main type of shortfall (including no shortfall). Banks with no shortfall have generally a high share of deposits in total balance sheet (measured by total liabilities): around 65% in 2011 and 52% in 2014. However, banks with LCR shortfall overpass this rate. On the contrary, banks with a NSFR shortfall are the banks with the lowest share of deposits in total balance sheet. This share is even lower in 2014: the banks that still have a NSFR shortfall in 2014 after 3 years of adjustment are really the ones with the lowest share of deposits on liabilities. Thus, the NSFR seems easier to fulfill for banks with a large deposit base. On the contrary, market financed banks have difficulties to fulfill NSFR requirements.

4.2. Changes in balance sheets items between 2011 and 2014

In this three year period, the median bank increased capital and liquidity buffers significantly. It disengaged from market assets while increasing credit to non-financial sectors, resulting in an increase in assets much smaller than the increase in deposits[11].

Indeed, as shown in Table 4, the median increase in capital is more than twice the increase in high quality liquid assets (+54.5% and +23.7%, respectively). The median increase in deposits is quite significant (+11.8%). Comparatively, the median increase in market borrowing and assets other than HQLA is modest (respectively +5.0% and +1.4%). As indicated from the evolution in exposures that also include off balance sheet activity, the quasi-stability of assets other than HQLA results from opposite changes in market activity, that decrease (-5.1%), and credit to non-financial sectors, that modestly increases (+2.4%).

The proportion of institutions that experienced a decrease in the said item goes accordingly: only 8% for capital; up to 41% for market borrowing and 47% for assets other than HQLA. This proportion is around a third for deposits and HQLA. Changes in deposits, credit

[11] Due to insufficient granularity in the 2011 NSFR template, the split between market activity and credit to non-financial sectors on balance sheet is not available through the period. However, the denominator of the leverage ratio provides such split through the period for the sum of on balance sheet and off balance sheet exposures.

exposures to non-financial sectors and assets other than HQLA are more concentrated than changes in HQLA and changes in market exposures and liabilities: the interquartile range of the former is around 30 pp while the one of the latter is around 50-70 pp. This also appears on distributions figured in appendix 2.

Table 4: Rate of change in balance sheet items and exposures between end 2011 and end 2014 – in %

	capital	deposits	HQLA	borrowing	assets	credit exposures	market exposures
Mean	**62,4**	**16,5**	**46,6**	**34,2**	**5,3**	**5,9**	**8,8**
Min	-401,9	-66,7	-100,0	-78,3	-88,7	-97,4	-95,9
Q1	22,1	-1,2	-10,3	-16,5	-14,2	-11,3	-25,8
Q2	**54,5**	**11,8**	**23,7**	**5,0**	**1,4**	**2,4**	**-5,1**
Q3	90,4	32,7	62,4	39,2	19,9	15,4	20,3
Max	430,2	129,1	1446,4	1957,1	267,1	168,9	641,0
% of inst. with negative growth	8	28	31	41	47	44	54
Relative IQ range in % of Q2	68,4	33,9	72,7	55,7	34,1	26,7	46,2

The change in balance sheet items is calculated as a period to period increase. The change in exposures is calculated as a chained annual rate across the 3 years.

Source: QIS data and authors' computations

4.3. Change in business models

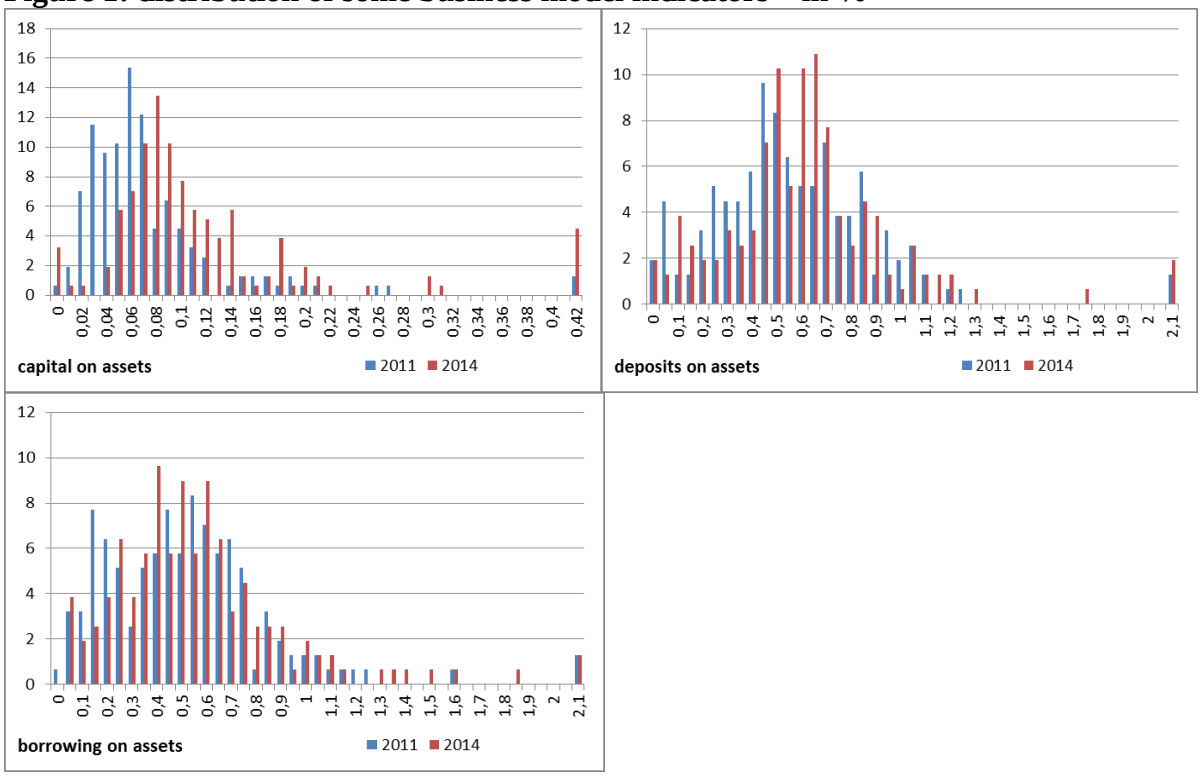
The adaptation to the new regulation implies a strong increase in median deposits on assets rates and a strong increase in capital on asset (see table 5 and figure 1). For all this items, the adaptation strategies of banks converge. This is not without an increase in dispersion though. For capital, interquartile range as well as standard deviation increase. For deposits on assets, the interquartile range for this ratio has decreased, but the standard deviation has increased. This means a small number of banks with very extreme rates have appeared. The central decrease in risk weight is very small with a significant increase in dispersion, implying more diverse bank strategies to adapt focused Basel III reforms on the calculation of risk weighted assets. On the contrary, the median rate of market borrowing on assets is almost stable as well as its dispersion, implying that, for a majority of banks of our sample, it was not a key strategic item in order to adapt to the new regulation. However, this ratio has increased in the banks where it was lower at the beginning of the period, showing a tendency to convergence between the banks' funding structure.

Table 5: Central value and dispersion for some business models' indicators between 2011 and 2014 – in %

	capital/assets		deposits/assets		borrowing/assets		risk weight	
	2011	2014	2011	2014	2011	2014	2011	2014
Q1	4,6%	7,6%	39,3%	46,6%	28,3%	37,7%	43,8%	39,2%
Q2	**6,7%**	**9,6%**	**54,5%**	**62,7%**	**52,5%**	**53,5%**	**55,2%**	**53,6%**
Q3	9,1%	13,8%	77,1%	75,6%	70,1%	71,4%	70,9%	75,2%
interquartile range	4,5%	6,2%	37,8%	29,0%	41,7%	33,7%	27,1%	36,0%
simple average	**16,5%**	**34,7%**	**65,6%**	**75,0%**	**60,9%**	**65,7%**	**56,0%**	**56,4%**
standard dev.	111,6%	156,9%	111,0%	127,0%	111,6%	112,0%	22,1%	25,8%

Source: QIS data and authors' computations

Figure 1: distribution of some business model indicators – in %



Source: QIS data and authors' computations

4.4. Distribution of prudential parameters and changes in prudential parameters

Table 5 shows the median value of the prudential parameters described in table 2. In the table, rw is a risk weight (RWA/other assets) and it replaces the capital charge for any unit of asset (rc). Indeed, capital charges differ from one institution to another due to buffers. Risk weights are more directly comparable.

Table 5: Median value of prudential parameters and median change in prudential parameters

		ld	nd	gc	rw	lc	nc	lm	nm
2011	gsibs	0,18	0,75	1,51	0,49	0,04	**0,59**	**0,13**	**0,22**
	non gsibs	0,15	0,79	1,33	0,57	0,04	**0,72**	**0,08**	**0,32**
2014	gsibs	**0,15**	**0,79**	**1,65**	0,55	0,06	**0,63**	**0,26**	**0,28**
	non gsibs	**0,10**	**0,85**	**1,32**	0,53	0,03	**0,72**	**0,18**	**0,43**
variation	all	**-0,04**	**0,05**	0,03	0,00	-0,01	0,00	**0,08**	**0,08**
	gsibs	-0,05	0,04	**0,17**	0,00	0,02	**0,07**	0,09	0,07
	non gsibs	**-0,04**	**0,05**	0,00	0,00	0,00	-0,01	**0,08**	**0,08**

For 2011 and 2014 median value of parameters, numbers are in bold when the difference between GSIBs and non-GSIBs prudential parameters is significant. For variation, numbers are in bold when the difference between 2011 and 2014 is significant.

Source: QIS data and authors' computations

The change in liquidity regulation between 2011 and 2014 explains the larger changes in parameters. Some changes lower the constraint. Thus, the decrease in outflows on deposits (ld) is partly due to the reduction in the outflows rate of retail and corporate deposits of the LCR regulation in 2012. Other changes increase the constraint. Thus, the increase in the outflows rate on market borrowing (lm) is due to the introduction of outflows on derivatives in the LCR (the so called "historical look back approach"). Due probably to the small size of the GSIB population, the similar change in the median for GSIB is overpassed by individual differences and is not statistically significant.

Regarding the NSFR, both ASF on deposits (nd) and ASF on market borrowing (nm) increase, reducing the regulatory constraint and suggesting an adaptation of the banks' funding for that purpose. This is significant for non GSIBs only, while GSIBs seem to have suffered from the change in NSFR regulation, with an increase in required stable funding on assets (nc). That may come from the change in the treatment of short term loans to financial counterparts, now depending on collateral. Treatment of derivatives was also made more stringent, due to the non-deductibility of margins in securities received and the add-on on derivatives received. As a consequence of their high involvement in derivatives, it makes sense that large international banks are penalized by the reform while other banks are untouched.

It is noteworthy that, for LCR and NSFR as well, GSIBs begin with less favorable outflows, ASF and NSFR rates and that they did not correct this disadvantage throughout the period, due to more intensive liquidity transformation. Such a difference does not emerge in risk weights but is relevant for the share of off-balance sheet operation in total exposures. GSIBs have a higher rate at the beginning of the period and increase this rate actively during the period, while other banks have not.

To summarize, banks have not only changed their balance sheets in order to comply with Basel III, they also adapted their product mix in order to minimize liquidity buffers charges. More precisely, banks have actively increased ASF per deposits and market borrowing in order to ease the adaptation to NSFR. On their side, GSIBs have actively increase the off-balance sheet operations that impacts leverage ratio. This optimization effort does not happen when considering solvency regulation. Furthermore, banks benefited from the change in LCR outflows rate on deposits and suffered from the change in outflows rate on market borrowing.

5. Modeled and effective variations

While simplistic, the model can figure the pure constraint of the change in regulation on balance sheets and extract it from reality. In reality, many other factors than regulatory changes triggered evolutions in balance sheets, such as the change in the demand for loans, the change in regulation other than Basel III, which may differ according to the jurisdiction, the change in market liquidity involved by the change in monetary policy. As a consequence, the fact that the model predicts the effective variations is not a proof of its ability to predict the changes implied by the new regulation and conversely. We will thus analyze the differences between the modeled and effective variations as a sign of pressures on balance sheets that come out of Basel III.

In order to focus on adjustment to compliance and to compare adequately modeled and effective adaptations when we run the model in 2011, we restrict the sample to banks that did not comply in 2011 but comply in 2014. To model adaptation to compliance from 2011,we use average 2011-2014 prudential parameters when running the model on 2011 data. That allows taking account for regulatory and behavioral changes in prudential parameters between 2011 and 2014. When we run the model as of 2014, the 2014 prudential parameters are used. Indeed, the same regulatory changes won't happen after 2014 and behavioral changes may not be of the same magnitude in the future.

5.1. Correlations between the variations of balance sheet items

In order to identify the interactions between changes in balance sheet items, we run regressions of items two by two, for banks that reach compliance, either effectively from 2011 to 2014, or according to the model (see appendix 3). We also compute correlations between effective variations for all banks from 2011 to 2014, either compliant or not in 2014. Results show that, when significant, coefficients are always positive, what means that balance sheet items usually move together, in an increasing or decreasing balance sheet. A strong correlation between all balance sheet items is especially observed in 2011 for effective variations and for all banks (compliant or not in 2014); the correlation is also strong when considering modeled variations, with or without TLAC, for banks that reach compliance in 2014: all coefficients are positive and significant, except the one that relates deposits to market borrowing, plus the one that relates deposits and HQLA for modeled data. Moreover, substitutions between items on the same side of the balance sheet scarcely happen: negative coefficients are never significant. When the model is run on 2014 data, change in liquid assets disconnects from the change in other items.

When banks are clustered by type of main shortfall, the correlation between the main items which has to be adjusted in order to comply with regulation and other items becomes looser, probably because of the reduction in the sample size.

5.2. Comparison of modeled and effective variations

When they can be compared, as of 2011, modelled and effective contributions to the total balance sheet's variation show significant differences. Assets and liquid assets median contribution is systematically lower in reality than in the model, either with or without the TLAC constraint. On the contrary, the contribution of market borrowing and capital is higher in reality than modeled, either with or without TLAC. For GSIBs, the difference is significant only for market borrowing.

As viewed from 2011 on the whole population, the median modeled[12] contribution of capital to the change in balance sheet is similar, with and without TLAC requirement. This is because TLAC was not anticipated before 2014 and because it applies to GSIBs only. Indeed, the

[12] In table 6, effective variation for TLAC is presented only to provide the effective variation of the same sample as the model.

contribution of capital with TLAC to the growth in balance sheet is much higher (double), when modeled for GSIBs.

GSIBs show other specificities: in 2011, while the median bank went on increasing assets moderately, GSIBs engaged in a decrease in assets, which is even stronger in reality than predicted by the model. This goes along with an increase in liquid asset which proved to be much higher (double) than for other banks, while it was not imposed by the model. These conclusions are similar to the one reached by Violon and alii. (2017), that are based on public data and difference in difference analysis.

As viewed from 2014, the increase in capital that remains to be done comes exclusively from TLAC and is of the same magnitude as in 2011, when TLAC requirement is imposed. Without TLAC requirement, the median required increase in capital is close to nil. The increase in asset is positively linked to the increase in capital. Finally, the required increase in liquid assets is half the one that had to be done in 2011. Thus, the progress made by banks between 2011 and 2014 reflects not only in the number of banks that have to adjust but also on the magnitude of the remaining adjustments.

Table 6: Median contribution of different items to the change in total balance, effective between 2011 and 2014 and according to different modeled assumptions

		#	assets	liquid assets	market borrowg	capital	deposits	ASF
all banks	effective change 2011-2014	156	0,009	0,026	0,014	0,027	0,056	0,071
banks that do not comply in 2011 and comply in 2014 without TLAC	effective change 2011-2014	75	**0,006**	**0,026**	**0,010**	**0,029**	0,067	0,071
	modeled change to compliance from 2011		**0,026**	**0,048**	**-0,008**	**0,015**	0,067	0,073
banks that do not comply in 2011 and comply in 2014 with TLAC	effective change 2011-2014	60	**0,029**	**0,023**	**0,016**	**0,031**	0,079	0,096
	modeled change to compliance from 2011		**0,056**	**0,052**	**0,000**	**0,016**	0,079	0,021
banks that do not comply in 2014 - modeled change to compliance	from 2014 without TLAC	47	-0,005	0,023	-0,035	0,001	0,027	0,036
	from 2014 with TLAC	65	0,011	0,024	-0,025	0,012	0,036	0,045
GSIBs (either complying or not in 2014)	effective change 2011-2014	27	**-0,047**	**0,053**	-0,028	0,026	0,036	0,064
	modeled change from 2011 with TLAC		**-0,005**	**0,050**	**-0,059**	**0,054**	0,036	**0,065**
	from 2014 with TLAC	23	0,036	**0,034**	**-0,024**	0,024	0,042	0,045

Numbers are in bold when the difference between effective and modeled contribution is significant. For GSIB, number in bold indicate that average for GSIBs are significantly different from the average for non GSIBs.

Source: QIS data and authors' computations

The aggregate changes go accordingly. They depend strongly on the number and specificities of banks involved in the change, depending on their initial shortfall at the beginning of period. With an individual change in deposits exactly similar for each individual bank, the aggregated change in deposits may represent less than half of the effectively observed change between 2011 and 2014. This results in a small but negative aggregated variation in market borrowing and assets, while a majority of banks grow. The reason is that the biggest banks, and namely the GSIBs, deleverage more than other banks.

Regarding capital and very liquid assets buffers, the previous conclusions hold. The magnitude of the observed change between 2011 and 2014 is close to the one modeled with TLAC and far larger than the one modeled without TLAC. The remaining change modeled from 2014 is smaller. The effective change in liquid assets observed from 2011 to 2014 was smaller than the modeled one and the remaining change is smaller. Note that if changes in capital and liquid assets are quite large in percentage of initial items (respectively 50% and 32% for effective changes between 2011 and 2014), the changes in percentage of total balance sheet are small (respectively 3.2% and 5.3%) due to the small initial size of the items.

Table 7: aggregated changes in balance sheet items, effective and modeled, as a % of the initial total liability

	# banks	assets	liquid assets	market borrowing	capital	deposits	ASF
effective 2011-2014	156	-4,0	5,3	-2,2	3,2	7,0	7,8
model 2011	119	-0,4	6,6	1,7	1,3	3,2	5,6
model 2011 TLAC	128	-2,9	6,9	-5,2	3,4	5,7	3,6
model 2014	46	-0,2	1,2	0,1	0,1	0,9	1,1
model 2014 TLAC	69	0,8	2,8	-1,8	1,3	4,1	5,0

Source: QIS data and authors' computations

The model predicts well the direction of effective changes for banks with LCR or capital shortfall as highest shortfall: in that case, there is a strong positive correlation for capital, assets or liquid assets depending if TLAC is modeled or not. On the contrary, the model usually predicts the wrong direction for banks with NSFR shortfall as highest shortfall, with non-significant coefficients, which proves that situations are very diverse.

Table 8: coefficient of regression of modeled contribution rate on effective contribution rate for different balance sheet items according to the highest shortfall – banks that comply in 2014

	effective on model				effective on model with TLAC			
highest shortfall	all	NSFR	LCR	CAP	all	NSFR	LCR	CAP
number of banks	75	32	25	18	60	25	18	17
assets	0,098	-0,069	0,214	**0,383**	0,110	-0,119	**0,269**	0,384
liquid assets	0,091	-0,024	**0,267**	0,020	0,025	-0,025	0,239	0,004
market borrowing	0,000	-0,073	0,165	0,081	-0,034	-0,099	0,084	0,082
capital	**0,410**	**-0,369**	0,509	**0,835**	**0,456**	**-0,529**	**0,962**	**0,822**

Source: QIS data and authors' computations

5.3. Capital and liquidity requirements are there substitutes or complements?

We now try to assess if the capital and liquidity regulations are complements or substitutes. First, if regulations are substitute, banks subject to multiple regulatory constraints, may be able to comply with one of the regulation at least with a smaller increase in buffer than the initial shortfall. To prove substitutability, this should be done without decreasing the whole balance sheet. In other words, "frugal" adjustment strategies in one ratio, distinct from deleveraging, are possible. This demonstrates that adjustments to comply with other ratios may help to comply with this ratio.

First, as shown by Table 9, more than a quarter of the banks with ASF shortfall as largest shortfall managed in reality to fulfill regulation with an increase in ASF smaller than the initial shortfall while keeping balance sheet growing. By the same token, more than a quarter of the banks, whatever their largest shortfall is, managed to fulfill LCR regulation with an increase in HQLA smaller than the initial shortfall while keeping balance sheet growing. Thus adaptation to regulation was obtained by a more complex strategy than the simple deleveraging or the simple increase of RSF or HQLA, implying an adaptation in the balance

sheet structure or in the prudential parameters. Also, for banks with ASF or HQLA shortfall as largest shortfall, the observed increase in shortfalls is smaller than the modeled one. Thus in these cases, banks were more frugal than the model would have expected.

This is not the case for capital shortfall: more than 50% of the banks with such a shortfall have increased capital more than the initial shortfall, in a context of a decreasing balance sheet. Also, the median excess of effective increase in shortfall over initial shortfall is always larger than the modeled one. This proves again that the market pressure imposed a larger increase in capital than the regulation itself. Previous development shows that it is not the case for liquidity buffers.

From these observations, we can conclude that capital regulation was used as a substitute to both liquidity regulations, either short term LCR or long term NSFR. On the contrary, liquidity regulations have not substituted to capital regulation. To increase solvency ratio, the only way implemented by banks is to increase capital.

Table 9: Median excess of modeled or effective change in shortfall over initial shortfall, as a percentage of total liability – banks that don't comply in 2011 and comply in 2014

		increasing balance sheet							decreasing balance sheet						
		#	model			effective			#	model			effective		
		banks	ba	bz	bk	ba	bz	bk	banks	ba	bz	bk	ba	bz	bk
all	Q1	50	1,4	0,6	0,1	2,6	-2,5	1,7	25	-3,6	-0,8	0,0	-10,6	-5,1	-0,6
	Q2		**7,2**	**2,8**	**0,5**	**7,7**	**1,9**	**2,8**		**2,9**	**0,6**	**0,2**	**-4,0**	**-1,5**	**0,4**
	Q3		22,7	7,2	1,7	18,0	4,6	4,7		7,0	3,1	0,4	-1,5	1,5	1,6
NSFR	Q1	25	-9,5	0,0	-0,3	-2,5	-3,3	1,7	7	-6,6	-2,2	-0,4	-17,4	-5,3	-0,6
	Q2		**3,0**	**3,5**	**0,4**	**3,4**	**1,5**	**2,7**		**-0,1**	**1,7**	**0,1**	**-16,6**	**-1,5**	**0,2**
	Q3		15,6	13,6	1,8	9,7	4,7	3,7		23,9	24,3	2,7	-6,0	1,9	0,7
LCR	Q1	13	3,4	2,0	0,2	5,0	-3,0	1,6	12	2,5	0,2	0,1	-5,4	-4,8	-0,6
	Q2		**14,7**	**3,1**	**1,2**	**13,4**	**2,4**	**2,4**		**4,1**	**0,6**	**0,2**	**-3,1**	**-3,4**	**0,4**
	Q3		21,8	5,8	1,6	19,6	4,1	5,8		7,1	2,1	0,4	-1,4	-0,7	1,7
CAP	Q1	12	6,0	0,7	0,2	8,6	-0,6	2,5	6	-12,7	-1,0	-0,7	-10,3	-3,0	0,2
	Q2		**12,6**	**2,3**	**0,6**	**15,2**	**2,4**	**2,9**		**-0,4**	**0,3**	**-0,1**	**-5,4**	**-1,1**	**0,9**
	Q3		38,3	2,9	3,3	27,2	4,9	5,0		4,7	1,4	0,1	1,6	0,9	2,3

Source: QIS data and authors' computations

Another way to investigate if regulatory requirements are substitutes is to verify if the efforts to comply with one regulation help to comply with the other. This is mechanically the case for an increase in capital initially done to comply with solvency regulation that also increases available stable funding. We will see then a strong correlation between the excess in capital buffer and available stable funding. By the same token, an increase in capital invested in low risk liquid assets to the detriment of high risk loans may at the same time enhance LCR and solvency ratio, and thus excess capital and liquidity buffer. The same result is obtained without initial increase in capital if liquid assets are substituted to risky loans.

The two relations described above are proven by the close correlation between excess in capital adjustment over initial shortfall on the one hand, excess in ASF or HQLA over initial shortfall on the other hand, that is observed on real data (see table 10). Additional capital is on average 7% of other buffers. It goes to more than 9% of the excess of ASF for banks with a large capital shortfall. By contrast, there is no correlation between the excess in HQLA over

initial shortfall and the excess in ASF over initial shortfall: coefficients are never significant on real data.

From these results about correlations, we conclude again that capital requirements may be substitute for liquidity buffers. On the contrary, LCR and NSFR work as complement and the excess in buffers are disconnected.

Table 10: Regression of the previous difference from one shortfall to another

			model			effective		
		# banks	bz/ba	bk/ba	bk/bz	bz/ba	bk/ba	bk/bz
all	coef.	75	**0,398**	**0,067**	**0,075**	0,131	**0,070**	**0,066**
	SD		0,048	0,003	0,008	0,069	0,014	0,025
	Ftest		0,000	0,000	0,000	0,062	0,000	0,010
NSFR	coef.	32	**0,476**	**0,062**	**0,077**	0,225	0,038	**0,067**
	SD		0,070	0,003	0,007	0,141	0,022	0,026
	Ftest		0,000	0,000	0,000	0,122	0,089	0,014
LCR	coef.	25	**0,494**	**0,064**	**0,070**	0,111	**0,133**	0,033
	SD		0,094	0,004	0,010	0,081	0,027	0,096
	Ftest		0,000	0,000	0,000	0,180	0,000	0,731
CAP	coef.	18	**0,183**	**0,086**	**0,191**	0,080	**0,095**	0,074
	SD		0,040	0,008	0,066	0,108	0,022	0,071
	Ftest		0,000	0,000	0,008	0,472	0,001	0,315

Source: QIS data and authors' computations

6. Conclusion

This paper considers the issue of the compliance of international banks to the new Basel III framework and it tries to assess the consequences of the new capital and liquidity requirements on the banks' balance sheet structure and growth. To this aim, it proposes a microeconomic framework that allows incorporating all the main prudential accounting constraints associated with the Basel III standards, taking account for the interactions between the capital and liquidity regulatory constraints. This framework helps to understand the strategies the banks have developed to comply with the new rules and to forecast the contents of the adjustments needed to the banks' activities. The paper uses Basel III quantitative impact studies data in 2011 and 2014 on a consistent sample of 156 banks.

Observation of changes in the banks' balance sheets based on QIS data shows that the median bank in the sample has experienced a sharp increase in capital (+55%) and a large increase in HQLA (+24%) on this 3 years period. Assets other than HQLA have increased much less than deposits (1.5% compared to 12%). The holdings of market exposures and exposures on interbank counterparties have decreased, while credit to non-financial sectors keeps on growing. The adaptation to regulation implies for a majority of banks a strong increase in deposits and capital compared to total balance sheets, while the dispersion increases somehow. Furthermore, banks have actively increased ASF per deposits and ASF per market borrowing in order to ease the adaptation to NSFR. This translates in an increase in buffers that is slightly smaller than the initial shortfall. This was also the case for HQLA shortfall, but the reason is the easing of regulatory constraints in 2012.

We also use non-linear optimization in order to assess the "pure" adaptation to regulatory constraints. The model is run on 2011 data and the modeled changes to compliance are compared to the effective changes in banks' balance sheets between 2011 and 2014, for banks that comply in 2014. The modeled as well as effective variations between 2011 and 2014 show a very strong positive correlation between almost all balance sheet items two by two: this means that balance sheet items move together and that there is no drastic restructuring of the balance sheet. This also explains why the model predicts a larger increase in assets when the TLAC constraint is modeled. The model predicts well the direction of effective changes for banks with LCR or capital shortfall as highest shortfall, but not for banks with NSFR shortfall as highest shortfall. Effective changes show a far higher (double) increase in capital than the model and a far lower (half) increase in liquid assets and assets. Between 2011 and 2014, GSIBs effectively increased liquid assets more than other banks and contrary to them, they decreased other assets.

Finally, analyzing the effective excess of buffer adjustments over initial shortfall between 2011 and 2014, we see that real adjustments in capital where always higher while adjustments in ASF and HQLA were lower, especially when ASF and HQLA was the main shortfall respectively. Furthermore, there is a strong correlation between the excess in capital buffer and the excess in HQLA on the one hand, ASF on the over hand after adjustment. We conclude that capital regulation is a substitute for each liquidity regulation - NSFR and LCR - separately, but that both liquidity regulations are complements.

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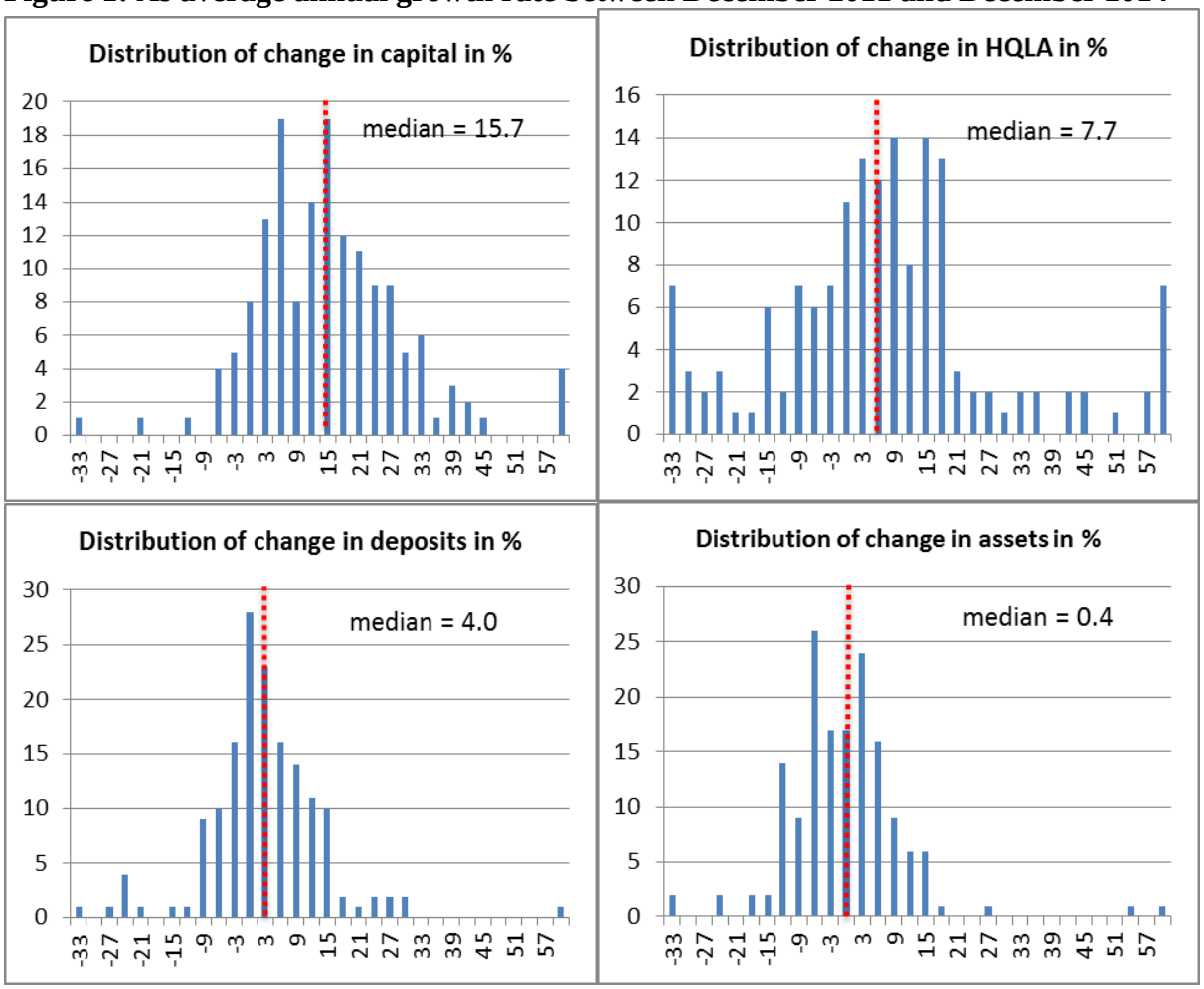
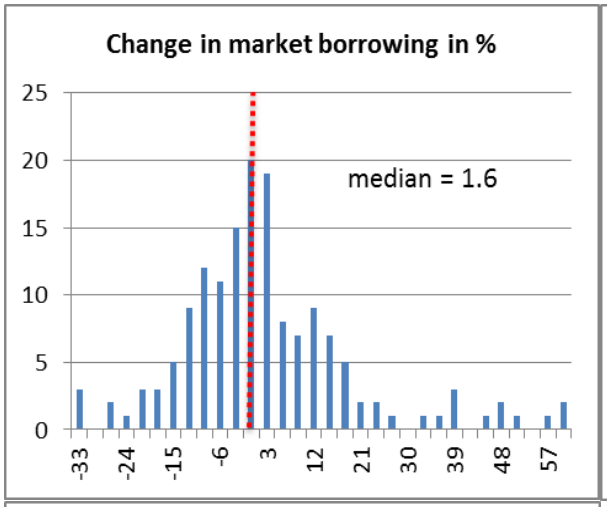
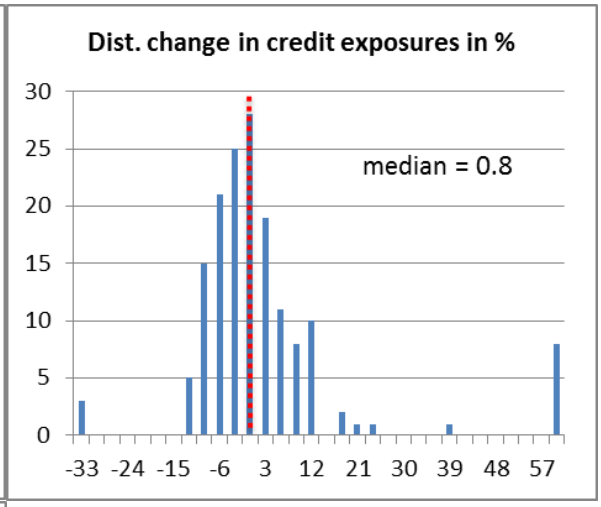
Appendix 1: distribution of observed changes in balance sheet items and exposures – all institutions

Figure 1: As average annual growth rate between December 2011 and December 2014




Change in market borrowing in %
median = 1.6
25
20
15
10
5
0
-33
-24
-15
-6
3
12
21
30
39
48
57


Dist. change in credit exposures in %
median = 0.8
30
25
20
15
10
5
0
-33 -24 -15 -6 3 12 21 30 39 48 57

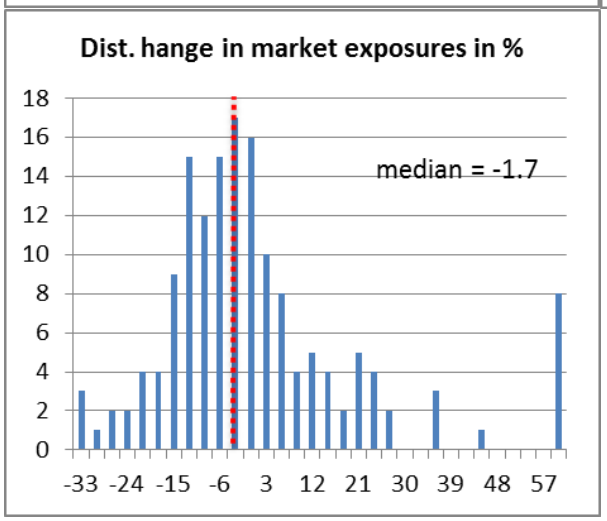
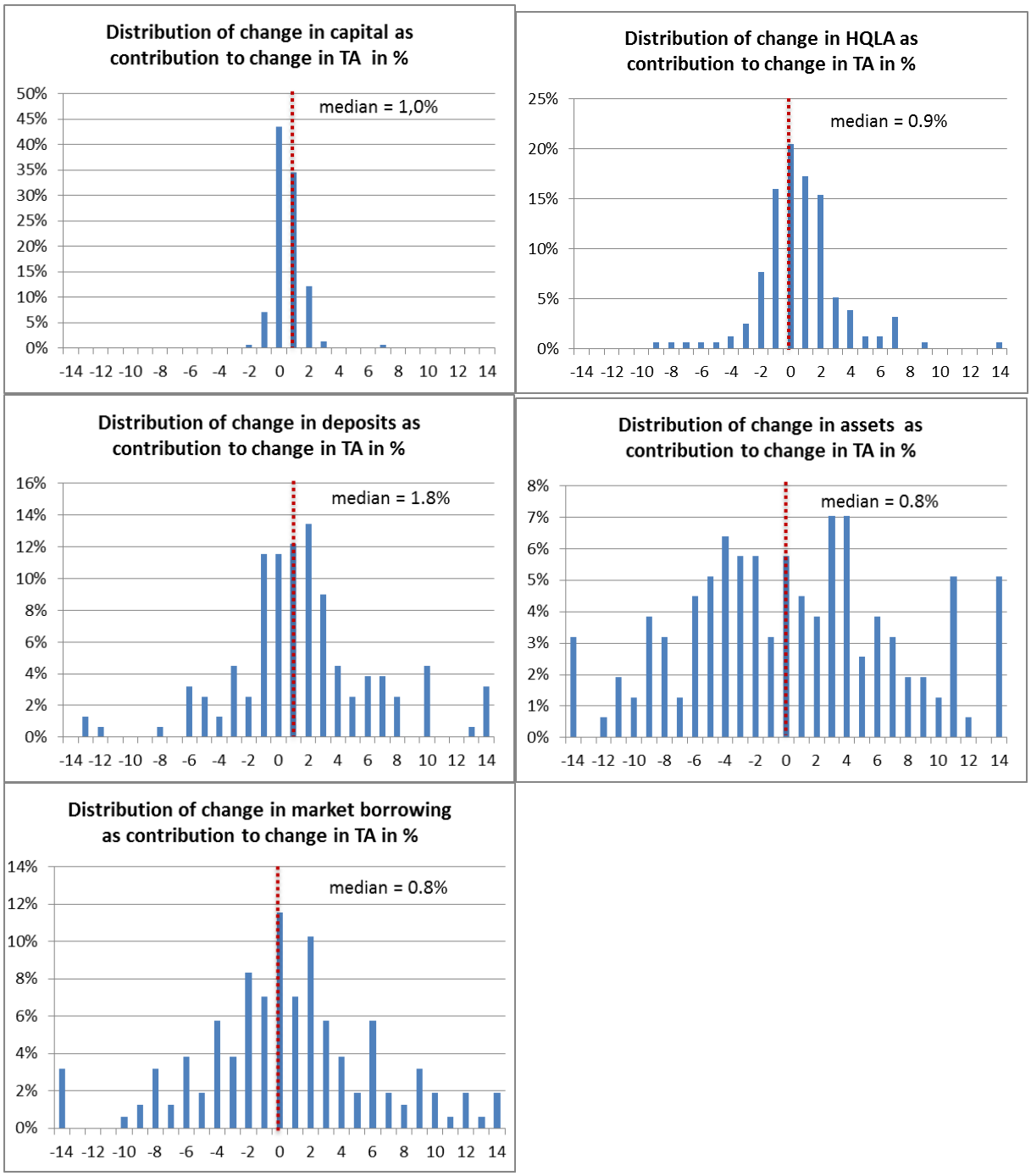
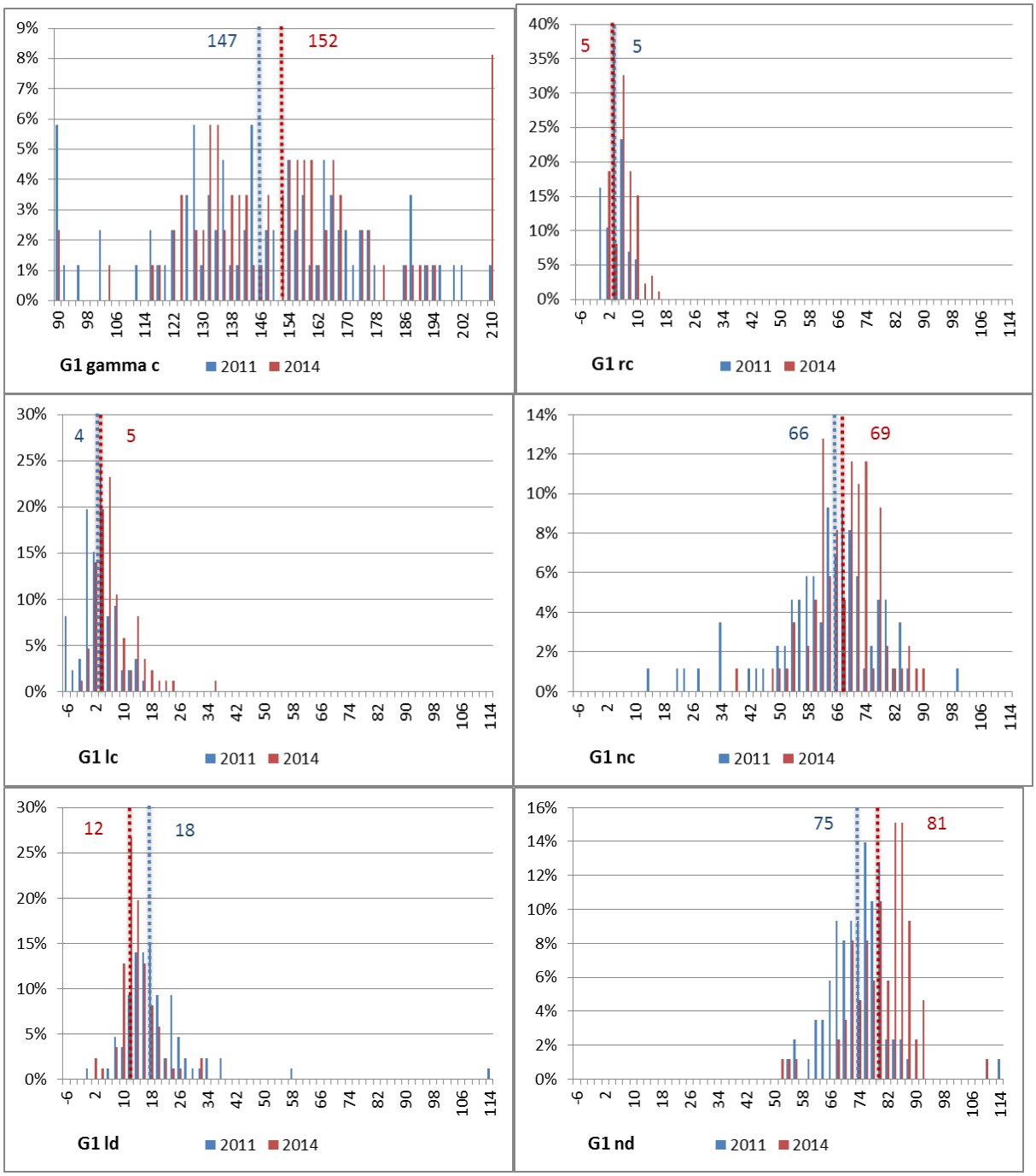

Dist. hange in market exposures in %
median = -1.7
18
16
14
12
10
8
6
4
2
0
-33 -24 -15 -6 3 12 21 30 39 48 57

Figure 2: As contribution to annual total asset growth rate between December 2011 and December 2014



Appendix 2: distribution of prudential parameters

Figure 1: Distribution of prudential parameters for group 1 December 2011 and December 2014



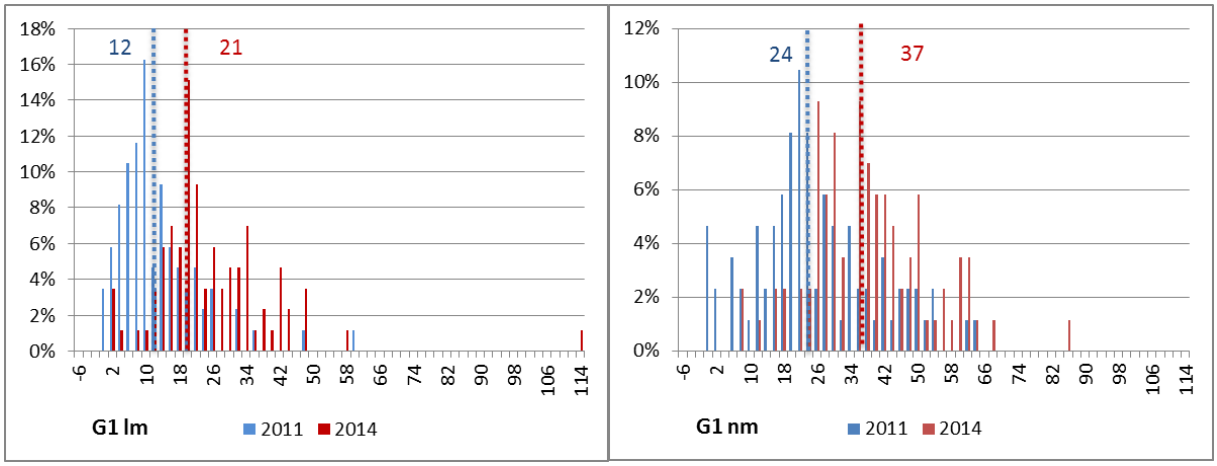
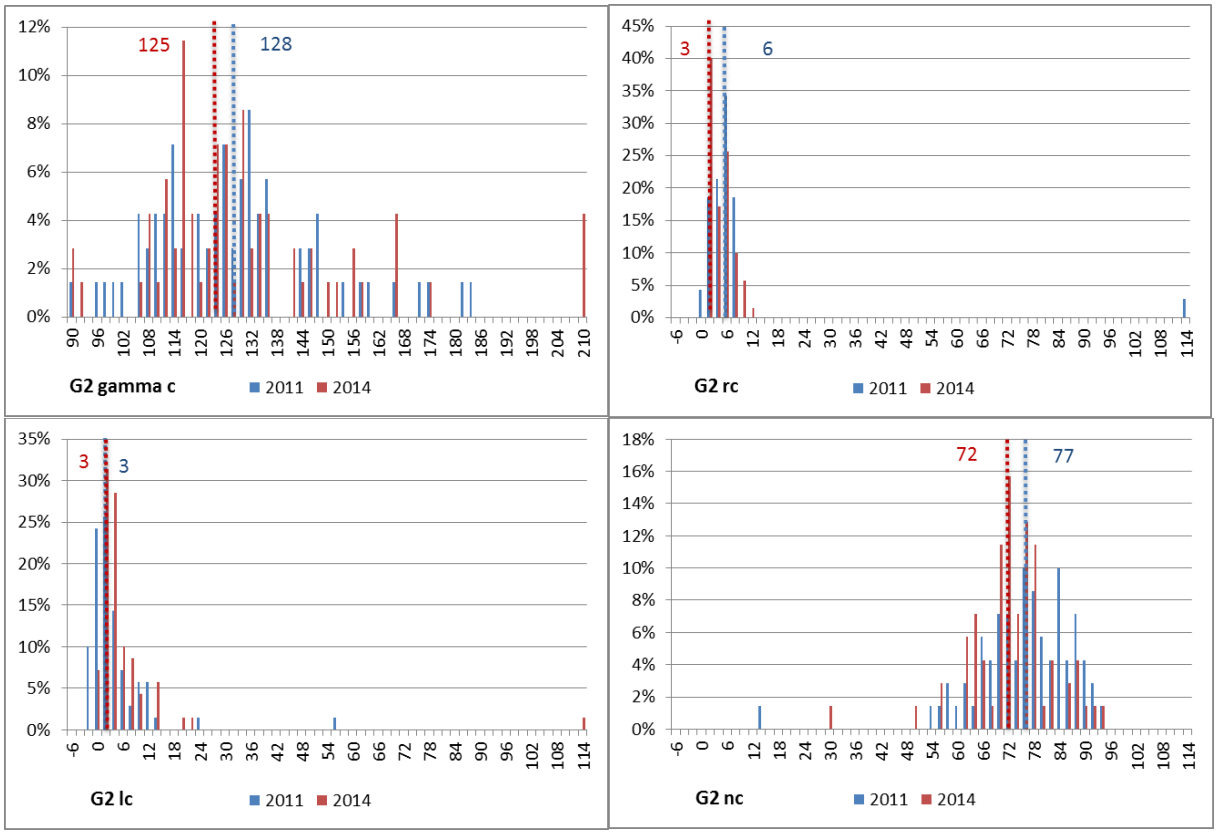
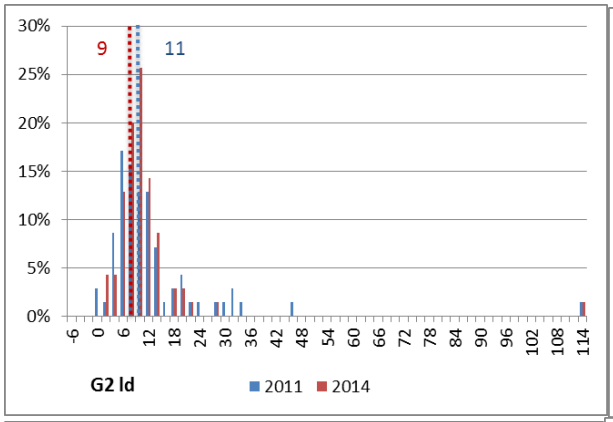
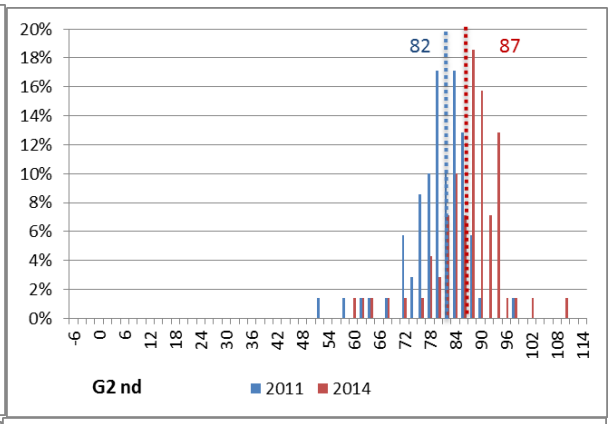
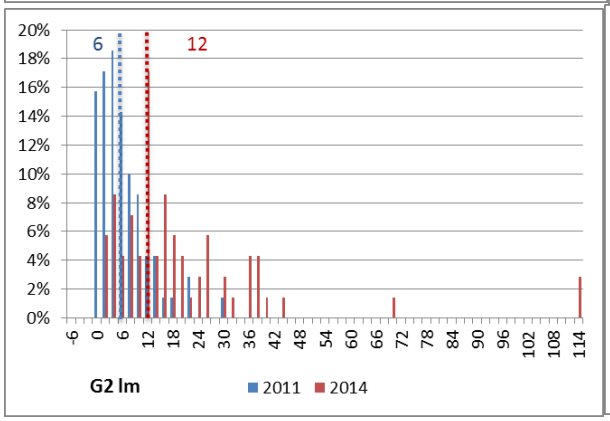


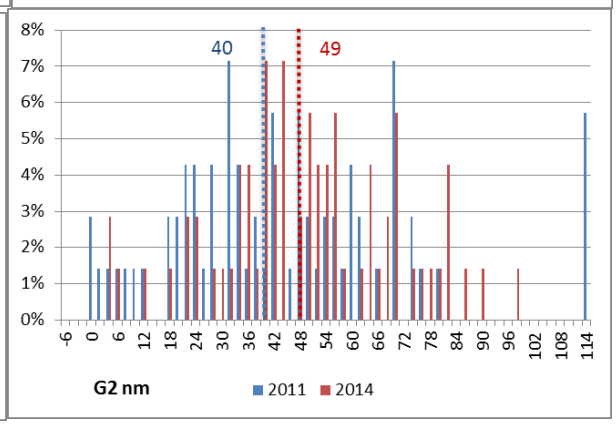
Figure 2: Distribution of prudential parameters for group 2 December 2011 and December 2014




9
11
G2 ld
2011
2014


82
87
G2 nd
2011
2014


6
12
G2 lm
2011
2014


40
49
G2 nm
2011
2014

Appendix 3: results of the regression on balance sheet items two by two

Results of the regression of the contribution rate for the item in line (Y), on the item in column (X) following the formula: $Y = aX + b$

For each regression are presented:

- the coefficient a, in bold if significant at a 5% level, according to the F test
- the standard deviation
- the F test

The sample differs depending on the tables.

Table 1: model to compliance – 2011 – 75 banks without TLAC – 60 banks with TLAC – that do not comply in 2011 and comply in 2014

	without TLAC					with TLAC				
	assets	liquid assets	market borrowing	capital	deposits	assets	liquid assets	market borrowing	capital	deposits
assets		**0,273**	**1,047**	**0,052**	**0,174**		**0,241**	**0,982**	**0,049**	**0,209**
		0,055	0,073	0,006	0,046		0,051	0,078	0,006	0,048
		0,000	0,000	0,000	0,000		0,000	0,000	0,000	0,000
liquid assets	**0,915**		**1,710**	**0,042**	0,163	**1,166**		**2,033**	**0,044**	0,089
	0,186		0,167	0,015	0,091	0,245		0,198	0,019	0,122
	0,000		0,000	0,006	0,077	0,000		0,000	0,025	0,467
market borrowing	**0,707**	**0,345**		**0,034**	0,018	**0,744**	**0,318**		**0,033**	0,029
	0,049	0,034		0,006	0,042	0,059	0,031		0,007	0,048
	0,000	0,000		0,000	0,674	0,000	0,000		0,000	0,548
capital	**9,924**	**2,377**	**9,504**		**1,798**	**10,288**	**1,904**	**9,043**		**2,149**
	1,128	0,839	1,626		0,669	1,341	0,828	1,837		0,755
	0,000	0,006	0,000		0,009	0,000	0,025	0,000		0,006
deposits	**0,930**	0,259	0,139	**0,050**		**1,169**	0,103	0,215	**0,057**	
	0,247	0,144	0,328	0,019		0,270	0,140	0,355	0,020	
	0,000	0,077	0,674	0,009		0,000	0,467	0,548	0,006	

Table 2: Model to compliance 2014– 47 banks without TLAC – 65 banks with TLAC – that do not comply in 2014

	without TLAC					with TLAC				
	assets	liquid assets	market borrowing	capital	deposits	assets	liquid assets	market borrowing	capital	deposits
assets		**- 0,089**	**0,221**	**0,037**	**0,650**		**0,154**	**2,045**	- 0,036	**0,320**
		0,036	0,054	0,003	0,064		0,075	0,259	0,441	0,092
		0,018	0,000	0,000	0,000		0,045	0,000	0,935	0,001
liquid assets	**- 1,328**		- 0,282	- 0,005	- 0,040	- 0,740		0,112	0,020	0,129
	0,542		0,242	0,025	0,450	0,515		0,270	0,024	0,385
	0,018		0,250	0,857	0,929	0,156		0,679	0,400	0,738
market borrowing	**1,223**	- 0,104		**0,045**	0,065	**1,187**	0,024		**0,052**	0,155
	0,300	0,089		0,014	0,273	0,193	0,059		0,009	0,179
	0,000	0,250		0,002	0,814	0,000	0,679		0,000	0,387
capital	**19,832**	- 0,162	**4,332**		**14,402**	**19,082**	0,565	**6,792**		**11,905**
	1,774	0,890	1,315		1,617	1,403	0,666	1,153		1,393
	0,000	0,857	0,002		0,000	0,000	0,400	0,000		0,000
deposits	**1,070**	- 0,004	0,019	**0,044**		**1,110**	0,014	0,076	**0,045**	
	0,105	0,049	0,081	0,005		0,099	0,041	0,088	0,005	
	0,000	0,929	0,814	0,000		0,000	0,738	0,387	0,000	

Table 3: Real 2011 – 156 banks (including banks that comply with all regulations in 2011)

	all				
	assets	liquid assets	market borrowing	capital	deposits
assets		**0,085**	**0,417**	**0,049**	**0,268**
		0,025	0,046	0,007	0,041
		0,001	0,000	0,000	0,000
liquid assets	**0,827**		**0,386**	**0,070**	**0,656**
	0,242		0,174	0,026	0,135
	0,001		0,028	0,007	0,000
market borrowing	**0,844**	**0,080**		**0,038**	0,009
	0,092	0,036		0,012	0,066
	0,000	0,028		0,001	0,897
capital	**4,497**	**0,664**	**1,716**		**2,227**
	0,682	0,242	0,525		0,409
	0,000	0,007	0,001		0,000
deposits	**0,802**	**0,202**	0,013	**0,073**	
	0,124	0,042	0,098	0,013	
	0,000	0,000	0,897	0,000	

Table 4: banks with NSFR shortfall as highest shortfall in 2011 that comply in 2014 – 32 banks

	model without TLAC					effective				
	assets	liquid assets	market borrowing	capital	deposits	assets	liquid assets	market borrowing	capital	deposits
assets		**0,386**	**1,198**	**0,050**	**0,138**		**0,300**	**0,798**	**0,056**	**0,372**
		0,074	0,107	0,005	0,061		0,110	0,100	0,015	0,107
		0,000	0,000	0,000	0,030		0,011	0,000	0,001	0,002
liquid assets	**1,234**		**2,110**	**0,066**	0,059	**0,659**		0,437	**0,055**	0,303
	0,236		0,202	0,015	0,117	0,242		0,249	0,025	0,179
	0,000		0,000	0,000	0,621	0,011		0,090	0,035	0,101
market borrowing	**0,675**	**0,372**		**0,035**	0,012	**0,853**	0,213		**0,065**	0,120
	0,060	0,036		0,005	0,049	0,107	0,121		0,015	0,129
	0,000	0,000		0,000	0,813	0,000	0,090		0,000	0,358
capital	**14,875**	**6,094**	**18,334**		1,635	**5,587**	**2,530**	**6,160**		0,173
	1,589	1,363	2,524		1,095	1,521	1,146	1,369		1,267
	0,000	0,000	0,000		0,146	0,001	0,035	0,000		0,893
deposits	**1,062**	0,141	0,161	0,042		**0,776**	0,288	0,235	0,004	
	0,467	0,282	0,674	0,028		0,223	0,170	0,252	0,026	
	0,030	0,621	0,813	0,146		0,002	0,101	0,358	0,893	

Table 5: banks with LCR shortfall as highest shortfall in 2011, that comply in 2014 – 25 banks

	model without TLAC					effective				
	assets	liquid assets	market borrowing	capital	deposits	assets	liquid assets	market borrowing	capital	deposits
assets		**0,278**	**1,210**	**0,040**	0,028		0,117	**0,696**	**0,044**	**0,337**
		0,133	0,116	0,007	0,110		0,066	0,107	0,017	0,098
		0,048	0,000	0,000	0,805		0,089	0,000	0,019	0,002
liquid assets	**0,572**		**1,135**	**0,042**	**0,396**	1,036		0,196	0,061	**1,001**
	0,274		0,320	0,014	0,135	0,583		0,536	0,057	0,293
	0,048		0,002	0,005	0,008	0,089		0,718	0,300	0,002
market borrowing	**0,683**	**0,311**		**0,031**	- 0,036	**0,931**	0,030		0,017	0,032
	0,065	0,088		0,006	0,083	0,143	0,081		0,023	0,139
	0,000	0,002		0,000	0,664	0,000	0,718		0,448	0,820
capital	**13,912**	**7,012**	**18,738**		1,185	**4,915**	0,766	1,453		**3,941**
	2,567	2,269	3,363		2,037	1,952	0,722	1,881		0,977
	0,000	0,005	0,000		0,566	0,019	0,300	0,448		0,001
deposits	0,098	**0,684**	- 0,230	0,012		**1,006**	**0,336**	0,071	**0,105**	
	0,393	0,234	0,522	0,021		0,293	0,098	0,311	0,026	
	0,805	0,008	0,664	0,566		0,002	0,002	0,820	0,001	

Table 6: banks with capital shortfall as highest shortfall in 2011 that comply in 2014 – 23 banks

	model without TLAC					effective				
	assets	liquid assets	market borrowing	capital	deposits	assets	liquid assets	market borrowing	capital	deposits
assets		**0,123**	**0,690**	**0,058**	**0,376**		- 0,087	**0,316**	0,038	0,281
		0,034	0,113	0,019	0,082		0,068	0,100	0,028	0,137
		0,002	0,000	0,009	0,000		0,220	0,006	0,185	0,058
liquid assets	**3,673**		**4,149**	0,114	0,410	- 1,058		0,120	- 0,024	0,476
	1,011		0,437	0,129	0,674	0,829		0,442	0,102	0,524
	0,002		0,000	0,389	0,551	0,220		0,790	0,818	0,377
market borrowing	**1,015**	**0,205**		0,045	0,175	**1,221**	0,038		0,081	0,417
	0,166	0,022		0,027	0,145	0,385	0,141		0,054	0,285
	0,000	0,000		0,116	0,246	0,006	0,790		0,151	0,163
capital	**6,162**	0,409	3,268		2,302	2,787	- 0,143	1,528		1,952
	2,071	0,461	1,964		1,153	2,013	0,611	1,014		1,221
	0,009	0,389	0,116		0,063	0,185	0,818	0,151		0,129
deposits	**1,508**	0,055	0,476	0,087		0,736	0,103	0,283	0,071	
	0,330	0,091	0,395	0,043		0,361	0,113	0,193	0,044	
	0,000	0,551	0,246	0,063		0,058	0,377	0,163	0,129	

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