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MACROECONOMIC CONDITIONS AND LEVERAGE IN MONETARY FINANCIAL INSTITUTIONS: COMPARING EUROPEAN COUNTRIES AND LUXEMBOURG

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Macroeconomic Conditions and Leverage in Monetary Financial Institutions: Comparing European countries and Luxembourg*

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Abstract

In this article we study the interaction between leading macroeconomic indicators (industrial production, stock prices, consumer sentiment and real interest rates) and financial sector leverage in major European countries. We base our analysis on monthly, country-aggregated panel VAR models for the pre-crisis period January 2003 to August 2008, and the crisis period September 2008 to June 2011. We find little evidence for a relationship between macroeconomic variables and leverage in the pre-crisis period, with only real interest rates having a negative short-term impact on leverage growth. We find positive feedback loops between sentiment and stock prices as well as MFI assets in the pre-crisis period, and a positive impact of real interest rate changes on equity and asset growth. Thus, balance sheet expansions were driven by sentiment and stock prices, while real interest changes allowed MFIs to profit from higher spreads. During the crisis period (starting in September 2008), we observe a counter-cyclical impact from leverage on sentiment and stock prices, while sentiment and stock prices bear a pro-cyclical impact on leverage. In contrast to this, MFI leverage in Luxembourg is negatively impacted by stock prices, suggesting significant impacts from marking-to-market. We conclude that leverage drives expectations of financial instability (via e.g. default expectations), while sentiment and stock prices drive financial institutions' investment decisions (via e.g. collateral value effects).

Keywords: leverage; macroeconomic conditions; Panel VAR; GMM estimation.
JEL classification: G21; G32; E32.

Résumé non-technique

Dans cette contribution, nous discutons de la relation entre les conditions macroéconomiques et le ratio de levier financier des institutions financières et monétaires (MFI). L'accent sera mis sur l'évaluation des résultats pour un échantillon des principaux pays européens ainsi que sur la comparaison avec les résultats obtenus pour le Luxembourg.

L'état actuel des connaissances suggère que des conditions économiques favorables incitent les MFIs à déployer davantage leurs bilans et leur ratio de levier financier, tandis que des perspectives négatives conduisent à des contractions des bilans et au désendettement. Cela peut déclencher des ventes de détresse ("fire-sales") suivies par des effets de rétroaction ("feedbacks") sous la forme de réductions du prix des actifs et de la valeur du collatéral, aboutissant à des problèmes de liquidité et/ou de solvabilité.

De nombreuses études théoriques examinent les liens entre les variables macroéconomiques dans un cadre d'équilibre général. L'endogénéité des variables dans un tel cadre soulève certaines difficultés pour l'analyse empirique des interactions dynamiques entre les variables réelles, financières et les anticipations économiques. Ainsi, afin d'être en mesure d'étudier de manière empirique ces interactions, nous nous appuyons sur une approche spécifiquement conçue à cet effet : la modélisation à vecteurs autorégressifs (VAR).

Nous avons recueilli des données mensuelles pour les pays européens, allant de janvier 2003 à juin 2011. Les variables considérées sont spécifiques à chaque pays et comportent des indices de production industrielle, de confiance des consommateurs et de marché d'actions, ainsi que les taux d'intérêt réels et le ratio de levier financier agrégé pour le secteur des MFIs. Ainsi, ces agrégats couvrent à la fois des variables réelles et financières. La production industrielle reflète l'activité économique du secteur réel, tandis que nos indicateurs de confiance sont censés intercepter les anticipations des agents économiques de la sphère réelle. Les indices boursiers indiquent la valeur de marché des sociétés actives dans un pays, et comprennent des informations à la fois sur leur valeur réelle ainsi que sur les anticipations des investisseurs vis-à-vis des fondamentaux économiques. Enfin, le taux d'intérêt réel à court-terme résume les actions des autorités monétaires face à l'inflation. Il apporte également des informations sur le coût du financement à court terme pour le secteur financier.

Nous allons comparer les résultats d'un modèle VAR en panel, estimé pour l'ensemble des pays européens considérés dans l'échantillon, avec les résultats obtenus pour le Luxembourg. Nous

étudions quatre modèles qui se différencient par les sous-périodes et les variables utilisées. Les sous-périodes comprennent, d'une part, une période de pré-crise, de janvier 2003 à août 2008, et d'autre part, une période de crise, de septembre 2008 à juin 2011. Pour chacune de ces sous-périodes, nous estimons un modèle, qualifié de "modèle à levier", lequel inclut, parmi les variables considérées le levier financier. Nous estimons également un modèle, qualifi de "modèle à composantes", qui contient, à la place du levier financier, les deux composantes du levier (le total d'actifs et les fonds propres).

Une première analyse descriptive montre que l'évolution du ratio de levier financier du secteur des MFIs au Luxembourg est approximativement la même que celle observée, en moyenne, pour l'échantillon des pays européens. On observe un ratio de levier croissant à partir de 2003 jusqu'à un pic vers la fin de l'année 2008, et une diminution par la suite pour converger vers les niveaux observés en 2003. Il y a lieu de noter que le ratio de levier financier du secteur des MFIs au Luxembourg est, en moyenne, de six à dix points plus élevé qu'en Europe.

L'analyse descriptive révèle également que le levier financier au Luxembourg et en Europe a été pro-cyclique pendant la dernière décennie. La pro-cyclicité est définie comme une corrélation positive et significative entre la croissance des actifs et la croissance du ratio de levier financier. Ainsi, une expansion du bilan est financée par l'augmentation de la dette plutôt que par des fonds propres. Un résultat similaire a été obtenu par Adrian et Shin (2010) pour le cas des Etats-Unis, mais seulement pour les banques d'investissement.

L'analyse économétrique sur l'échantillon des pays européens montre des liens plutôt faibles entre les variables macroéconomiques et le ratio de levier financier dans la période de pré-crise, à l'exception du taux d'intérêt réel qui affichait une relation négative à court terme avec la croissance du ratio de levier. Par ailleurs, nous avons identifié des mécanismes de rétroaction positifs entre le sentiment des consommateurs et les indices boursiers ainsi qu'avec les actifs des MFIs dans la période de pré-crise. Cela est cohérent avec la théorie économique selon laquelle une amélioration des attentes, dues à une baisse du taux espéré de faillite des contreparties ou à une augmentation de la valeur du collatéral, entraineraient des expansions du bilan (voir Bernanke and Gertler 1989, Kiyotaki and Moore 1997, Krishnamurthy 2010).

En outre, nous trouvons que l'impact des changements du taux d'intérêt réel sur la croissance des fonds propres et des actifs des MFIs est positif. Ainsi, dans un environnement caracterisé par des coûts de financement faibles, en raison des innovations financières (Brunnermeier 2009), les augmentations du taux d'intérêt réel ont permis aux MFIs de dégager des profits grâce à des marges

plus élevées. Ceci contraste avec les résultats classiques concernant les canaux de transmission de la politique monétaire, selon lesquel la progression des taux d'intérêt atténue le recours des MFIs au financement externe (Bernanke and Gertler 1995, Cecchetti 1995). Cependant, des études sur la transmission de la politique monétaire en Europe sont plus en ligne avec nos résultats. Celees-ci démontrent que les innovations financières semblent avoir réduit la sensibilité des prêts bancaires aux chocs de taux d'intérêt (Altunbas, Gambacorta and Marques-Ibanez 2009). Les différences dans les résultats sont dues à plusieurs raisons : (i) nous nous concentrons sur l'actif total au lieu de nous limiter à des sous-composantes des portefeuilles de prêts ; (ii) nous étudions le secteur des MFIs, qui comprend à la fois les banques et les organismes de placement collectif monétaires, alors que les travaux jusqu'à présent se sont principalement axés sur les banques uniquement ; (iii) enfin, nous utilisons des données à fréquence plus élevée.

Pendant la crise financière, nous observons un impact contra-cyclique du levier financier sur l'indice boursier et sur la confiance des consommateurs, tandis que l'indice boursier et la confiance ont un impact pro-cyclique sur le levier financier. Nous concluons que le ratio de levier financier guide les anticipations d'instabilité financière, tandis que l'indice boursier et la confiance gouvernent les décisions d'investissement des institutions financières. Cette hypothèse est étayée par nos résultats qui montrent, qu'au cours de la période de pré-crise, la croissance des actifs affecte à la fois la confiance et les cours des actions tandis que, pendant la crise, la croissance des fonds propres affecte la confiance de manière positive.

Les résultats économétriques pour le Luxembourg indiquent une faible corrélation entre les variables macroéconomiques et le levier financier des MFIs au cours de la période de pré-crise, tandis que nous observons une interaction plus forte durant la période de crise. Le même phénomène avait été observé dans l'échantillon des pays européens. Les résultats pour le Luxembourg mettent en évidence uniquement les relations unidirectionnelles des variables macroéconomiques sur le levier financier et la croissance des actifs au cours de la période de crise. Ceci est en contraste avec les relations bidirectionnelles observées pour l'échantillon européen mais reste cohérent avec l'orientation internationale des MFIs luxembourgeoises. De plus, le résultat des estimations indiquent une sensitivité accrue, par rapport à l'échantillon européen, du ratio de levier des institutions financières au Luxembourg vis-à-vis des changements des cours boursiers. Nous suggérons que ce résultat est dû à la part relativement élevée des titres et actions dans les portefeuilles des MFIs luxembourgeoises. Il y a lieu de noter que les organismes de placement collectif monétaires, dont le portefeuille est composé en grande partie d'actifs très liquides, représentent une part relativement

importante des actifs totaux du secteur des MFIs au Luxembourg.

Les résultats obtenus sont plutôt indicatifs des relations bidirectionnelles entre le levier financier et les anticipations pendant les périodes de ralentissement économique, tandis que les prêteurs et les emprunteurs ne semblent pas se préoccuper du niveau d'endettement durant les périodes plus prospères. Par conséquent, nos résultats sont en ligne avec des modèles centrés sur la relation entre le levier financier et les anticipations économiques (tels que Kiyotaki and Moore 1997, Brunnermeier and Sannikov 2011) plutôt que sur d'autres canaux de transmission.

Contents

1 Introduction

A financial intermediary's investment decisions are guided by its belief about the evolution of its portfolio's return. This belief should depend on the portfolio's underlying fundamentals which, among others, derive from the confidence in markets and the economic outlook. For example, increases in industrial production may be viewed as improved fundamentals in the real sector which could spill over to the financial sector. Increases in stock prices should improve collateral values while at the same time leading to marking-to-market profits on financial institutions' balance sheets. Likewise, improvements in consumer sentiment should induce market participants to increase their market activities, driving both the supply of, and the demand for, funds from financial intermediaries. Sentiment may then induce financial intermediaries to increase their leverage because of higher expected future income, lower risk aversion or improved rates of default. These lines of argument are common to the literature that investigates the links and feedbacks between various macroeconomic variables and leverage decisions of monetary financial institutions (MFIs) (e.g. Pozsar, Adrian, Ashcraft and Boesky, 2010; Gorton and Metrick, 2011; Coval, Jurek and Stafford, 2009). In general, this literature suggests that favorable economic conditions induce MFIs to expand their balance sheets and leverage, while negative outlooks lead to contractions of balance sheets and deleveraging. This may trigger distressed selling followed by feedbacks in the form of asset price and collateral value reductions, subsequently leading to liquidity and solvency problems. These, then, in turn feed back into the cycle and worsen the previous outlook.

This article adds to the literature by studying the importance of these links for the leverage decision of European MFIs. The contribution of this article is to empirically investigate the combined interaction between real, financial and expectational variables within a dynamic framework. In addition, we compare results for the European MFIs with those from Luxembourg. We collected country-aggregated, monthly data for European countries on real, financial and expectation variables, ranging from January 2003 to June 2011. Our variables are country-specific indexes of industrial production, consumer sentiment and stock prices, as well as real interest rates and MFI sector's leverage. With these variables we cover the real and financial sector, both in terms of their actual situation and expectations. Industrial production reflects the economic activity of the real sector, while our confidence indicators reflect the expectation of the real sector. The stock market indexes give information on the valuation of the companies active in a country as a whole, and include both information on their real value as well as investors' expectations on their potential value. Thus, while industrial production provides details on the economic activity of a country, the

stock indexes give information on the financial valuation of the economy in that country. Finally, the real interest rate summarizes the response of monetary policy to developments in both the financial and real sector. It also provides information on the ability of the financial sector to raise short-term funding in the interbank market.

Though there exist many theoretical studies that investigate the links between the variables that we use (see e.g. Bernanke and Blinder, 1992; Brunnermeier and Pedersen, 2009; Krishnamurthy, 2010; Shleifer and Vishny, 2010; Stein, 2011), in a general equilibrium framework it is difficult to precisely know which variables are endogenous and which ones are exogenous.[1] For this reason we resort to the Panel VAR methodology, which has been introduced in Holtz et al. (1988). We allow the variables to be endogenous to each other and, by exploiting the panel structure, we are able to reduce the inefficiencies of the estimates as we have more data points, less collinearity and control for unobserved individual fixed effects.

Our results are as follows. We, firstly, show that leverage in Europe's monetary financial sector was procyclical during the last decade. Procyclicality is defined as a positive and significant correlation between the growth of assets and the growth of leverage. Thus, a balance sheet expansion is financed through increasing debt rather than equity. A similar result has been shown by Adrian and Shin (2010), but only for US investment banks, while they found that US commercial banks target a constant leverage.

We then study the interaction between leading macroeconomic indicators (industrial production, stock prices, consumer confidence and real interest rates) and financial sector leverage in major European countries. We study four models which distinguish themselves by sub-period and variables use. The sub-periods are the pre-crisis period, January 2003 to August 2008, and the crisis period, September 2008 to June 2011. For both sub-periods we investigate a model with leverage, dubbed the 'leverage model', and one that contains both components of leverage, the 'component model'. Additionally, we compare the results for Luxembourg with our European sub-sample. We find weak evidence for a relationship between macroeconomic variables and leverage in the pre-crisis period, with only real interest rates having a negative short-term impact on leverage growth. In contrast to this, we identify positive feedback loops between sentiment and

[1]The reason underlying this argument is that the macroeconomic variables that we use here are endogenous to each others. For example, Friedman and Schwartz (1963), Sims (1990), Christiano and Ljungqvist (1988) as well as Bernanke and Blinder (1992) show how monetary policy affects industrial production and GDP, with Bernanke and Gertler (1995) as well as Cecchetti (1995) showing that the banking sector functions, at least partly, as a vehicle for the transmission of monetary policy. Moving along the cycle of transmission, Jokipii and Milne (2008) show how GDP growth affects banks' leverage, thus providing evidence for potential further rounds of feedback effects. Expectations have been tied to stock returns (Jansen and Nahuis (Jansen and Nahuis, 2003)), while it has been vice versa shown that confidence is pro-cyclical itself (Taylor and McNabb, 2007).

stock prices as well as MFI assets in the pre-crisis period. This supports the theoretical models where heightened expectations due to lower expected counter-party default rates or higher collateral values drive balance sheet expansions (e.g. Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997; Krishnamurthy, 2010).

In addition, we find a positive impact of real interest rate changes on equity and asset growth. Thus, in an environment of low funding costs due to financial innovations (e.g. Brunnermeier, 2009), increasing real interest changes allowed MFIs to profit from higher spreads. This stands in contrast to the standard results of transmission channels of monetary policy, where increasing interest rates reduce MFIs' funding (see Bernanke and Gertler, 1995; Cecchetti, 1995). However, studies on monetary policy transmission in Europe are more in line with our results. They show that financial innovations seemed to have reduced the sensitivity of bank lending to interest rate shocks (e.g. Altunbas et al., 2009). The differences in results comes about since we focus on the total asset side instead of only on subcomponents of the loan portfolios; we investigate MFIs, which includes both banks and funds, while the literature up to now focused mainly on banks; and we use higher frequency data (monthly compared to annually).

During the financial crisis, we observe a counter-cyclical impact from leverage on sentiment and stock prices, while sentiment and stock prices bear a pro-cyclical impact on leverage. We conclude that leverage drives expectations of financial instability (via e.g. default expectations), while sentiment and stock prices drive financial institutions' investment decisions (via e.g. collateral value effects). This is supported by our results that, during the pre-crisis period, asset growth both drove sentiment and stock prices, while during the crisis, equity growth affected sentiment positively.

Focusing now Luxembourg, we also find that MFI leverage in Luxembourg is procyclical. Our econometric results indicate a weak relationship between the macroeconomic variables and leverage during the pre-crisis period, while we find a stronger interaction in the crisis period. This basically conforms to our results on the European sub-sample. However, while we observe a statistically significant, two-way relationship between stock prices and assets for the European sample, we do not find the same results for Luxembourg. Instead, we can only find a one-way relationship from macroeconomic variables on leverage and asset growth during the crisis period in Luxembourg. This is consistent with the international orientation of Luxembourgish MFIs. Additionally, in comparison to the European sample, we find a stronger reaction of Luxembourgish MFI leverage when stock prices change. We suggest that his is due to the relatively higher share of securities

on Luxembourgish MFI portfolios.

The article is structured as follows. In Section 2 we present a literature overview that presents the channels that we subsequently try to identify. Section 3 describes the data that we use. In Section 4 we describe the econometric approach, and our results for the European sub-sample. These include results on poolability, unit roots, our main results and further robustness exercises. Then, Section 5 presents the data for Luxembourg, the main results and a comparison with the European sub-sample. Section 6 concludes.

2 Literature overview

Between the years 2003 and 2008, European countries (as well as the US) saw an apparent, steady improvement in the underlying fundamentals for investment. There was a substantial increase in industrial production, consumer confidence and stock prices. This environment was, until 2007, supported by a low real interest rate. We also saw important trends in the financial sector. Financial innovations (like securitization and increased use of repos) allowed MFIs to extend their balance sheets at little extra cost. Banks increasingly adopted the new 'originate-and-distribute' model, with a significant off-loading of risk and shortening of funding maturities (see e.g. Brunnermeier, 2009; Pozsar et al., 2010). This period, dubbed the Great Moderation, allowed MFIs to level up their balance sheets with little concern from investors.[2] In 2007 we witnessed the first turbulences in the financial sector, and the failure of AIG and Lehman Brothers in September 2008 are generally perceived to be the tipping point of the financial crisis. The leverage ratio started to be at the center of investors' attention after this point. Investors worried about the elevated leverage ratios[3] and started to withdraw their funds. This reduction in funding liquidity required MFIs to adjust their balance sheets, with subsequent impacts on prices and re-sell values. This led to fire sales and thus diminished market liquidity. MFIs saw, on the one hand, difficulties in raising funds[4] to sustain their assets, but at the same time faced large haircuts when trying to shed assets. The losses sustained led to additional feedback rounds.[5]

The theoretical literature tried to pinpoint the underlying mechanisms of the recent crisis. One

[2]The search 'bank leverage ratio' (or similar variations) via Google Insights shows little interest in bank leverage until roughly March 2008. Since then it has significantly increased, with most searches in October 2008, just after the failure of Lehman Brothers.

[3]Lehman Brothers, for example, had a leverage ratio of 30.

[4]For example, the interbank market broke down in 2008 when banks that tended to lend on the interbank market became uncertain about their own liquidity needs. In addition, banks demanded much larger premia for interbank lending because of the elevated counter-party risk (Caballero and Krishnamurthy, 2008).

[5]For example, Brunnermeier and Pedersen (2009) argue that some traders engaged in predatory trading by forcing investors to sell assets at large haircuts.

can broadly distinguish between the following approaches.

In one approach, macroeconomic variables like expectations, industrial production, monetary policy or stock prices work as a positive amplification mechanism and drive MFIs' leverage decisions. This line of causality has been studied extensively. Indeed, theoretical works tend to point towards a positive co-movement between leverage and macroeconomic variables. For example, increasing industrial production induces rises in firms' valuations. This, in turn, leads to heightened expectations in MFIs due to lower expected counter-party default rates or higher collateral values (e.g. Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997; Krishnamurthy, 2010), inclining them to expand their balance sheets. Thus, theory tends to predict a positive feedback loop between asset prices, sentiment and leverage. Most empirical research in this respect has been undertaken to study the impact of monetary policy. For example, Friedman and Schwartz (1963), Christiano and Ljungqvist (1988) as well as Bernanke and Blinder (Bernanke and Blinder, 1992) show how monetary policy affects industrial production and GDP, with Bernanke and Gertler (1995) as well as Cecchetti (1995) illustrating how the banking sector functions as a vehicle for the transmission of monetary policy. Empirical evidence by Jokipii and Milne (2008) suggests that capital buffers of EU15 banks have a negative co-movement with real GDP growth. Similarly, Jimenez et al. (2010) observe that worse economic conditions reduce loan supply from banks with lower capital or liquidity ratios. Additionally, expectations have been tied to stock returns (Jansen and Nahuis, 2003), while it has been vice versa shown that confidence positively co-moves with the real economic cycle (Taylor and McNabb, 2007).

Another approach looks more closely at the feedback loops in order to explain the recent crisis period. For example, theoretical models of fire-sales in financial assets provide the missing ingredients in order to account for the loss-spirals (Brunnermeier and Pedersen, 2009) and the uncertainty that can bring a market to collapse (Shleifer and Vishny, 1992; Shleifer and Vishny, 1997; Gromb and Vayanos, 2010). More precisely, Stein (2011) describes the role of the bank lending channel in the reduction of real investment which followed the 2007-2008 liquidity crisis. The determinants and consequences of banks' liquidity hoarding behavior are studied, among others, by Caballero and Smisek (2011), Shleifer and Vishny (2010), and Brunnermeir and Sannikov (2011). Caballero and Smisek (2011) characterize a 'complexity externality', pointing out the role of the interbank market as fueling the complexity in a highly interconnected financial market. The enhanced payoff uncertainty in such an environment makes financial institutions prone to hold cash as a flight-to-quality effect. Brunnermeier and Sannikov (2011) considered the interaction of exogenous risk

(which is driven by the fundamental determinants of assets' payoffs) and the endogenous risk which is linked to the endogenously determined level of leverage. They describe the 'volatility paradox' as a situation where low levels of exogenous risk (or fundamental volatility) results in a higher payoff of levering-up which exposes banks to higher endogenous risk. While cash hoarding is still a flight-to-quality effect, it results from a speculative behavior as, in periods of dampening expected assets prices, it is more profitable to hold on and buy at depressed prices. Likewise, in Shleifer and Vishny (2010) the cash hoarding effect also comes as a consequence of the higher expected payoff of low asset prices. In order to explain the build-up of leverage and the subsequent credit crunch, they focus on investors' sentiments, which are channeled to banks through securitisation practices.

3 Description of the data

We now turn to a description of the data for the European sub-sample. The data comes from the following sources (see also Table 1). We obtain the country-aggregated balance sheet data from the ECB statistical data warehouse (ECB SDW). The real interest rate (**RI**) is also taken from the ECB SDW and calculated as the Euribor 3 month rate minus the (annualized) change in HICP (Harmonized Index of Consumer Prices). Eurostat provided the data for the industrial production indexes (**IPI**). The data on the country-specific stock indexes (**SP**) comes from Bloomberg. The consumer confidence indicators (**CCI**) are taken from the Business and Consumer Surveys of the European Commission. We de-seasonalize all variables in order to minimize the effect seasonal components based on the least-squares seasonal adjustment method (see Lovell (1963)). Further, we minimize the role of fixed effects by subtracting the country-specific mean for each series.

All the series span the period January 2003 to June 2011 with observations on eight European countries. These countries are France, Germany, Italy, Netherlands, Portugal, Spain, Sweden and the United Kingdom.[6]

Leverage

We rely on the standard definition of Leverage (**L**) and calculate it as total assets divided by equity.

[6]Balance sheet data in the ECB SDW is available since September 1997. However, the series during that time show fundamental balance sheet restructuring in most countries, which would be likely to drive our subsequent results. Therefore, we only focus on the period starting from January 2003. We focus on this sub-group of major European countries since these are the ones that we found to be poolable according to the Roy-Zellner test for poolability.

Table 1: Variable description of monthly, country-aggregated data

Variable	Source	Description
A	ECB SDW	Total assets
E	ECB SDW	Equity (Tier 1 and 2)
L	ECB SDW	Leverage, defined as $L = (A/E)$
RI	ECB SDW	real interest rate, calculated as Euribor one month minus annual change in HICP
CCI	EC	Consumer confidence indicator by country, based on monthly questionnaire of a representative sample of EU citizens
IPI	Eurostat	Industrial Production Index by country
SP	Bloomberg	Stock indexes by country; PSI (Portugal); AEX (Netherlands); IBEX 35 (Spain); DAX (Germany); FTSEMIB (Italy); CAC-40 (France); FTSE 100 (United Kingdom); LUXXX (Luxembourg); OMX (Sweden)

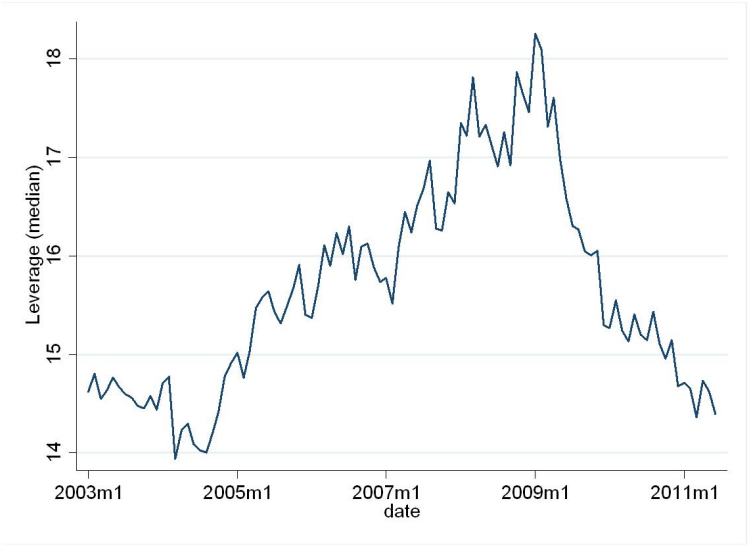
Explanations: European Central Bank Statistical Data Warehouse (ECB SDW), Business and Consumer Surveys of the European Commission (EC)

Equity itself is comprised of capital and reserves. Both series are stocks, i.e. the outstanding amounts at the end of the period, denominated in Euro and based on consolidated balance sheet data. Included are all monetary financial institutions (MFIs) except the European System of Central Banks. The ECB defines MFIs as "resident credit institutions (as defined in EU law) and all other resident financial institutions whose business is to receive deposits and/or close substitutes for deposits from entities other than MFIs and, for their own account (at least in economic terms), to grant credit and/or invest in securities. The latter group consists predominantly of money market funds." For most countries in our sample the number of credit institutions significantly exceeds that of money market funds with money market funds holding a marginal share of MFIs' assets. The only exception is France, where around 40% of MFIs are money market funds. Nevertheless, the total assets held by these funds account only for around 15% of MFIs' assets in France.

Figure 1 provides the median of MFI leverage across the countries in our sample. We observe a substantial increase in MFIs' leverage, starting at the beginning of 2004, until basically the failure of Lehmann brothers in September 2008. During that period, median leverage increased from a factor of roughly 14 to around 18. This implied an increase in leverage of 30% during the course of five years. After September 2009 we find a strong and fast decline in leverage. Within two years, leverage dropped, reaching nearly its initial level of 14.

In Figure 2 we present a scatter plot between the growth in leverage and the growth in assets. As suggested in Adrian and Shin (2010), a high positive correlation between the growth in asset and that of leverage indicates that balanced sheet expansions are mainly financed through increasing debt liabilities other than equity. This would imply that, within our sample, MFIs expanded their balance sheets while holding equity almost constant. Hence, this is an indication

Figure 1: Evolution of leverage (median, deseasonalized)



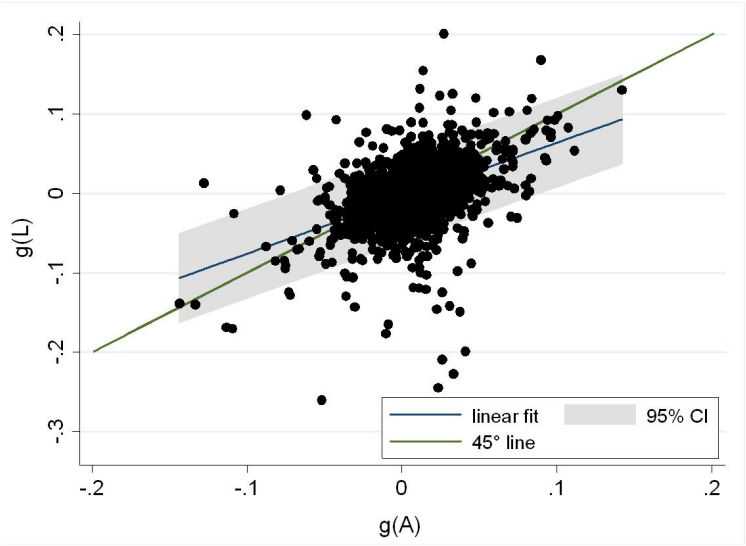
for a procyclical leverage ratio. This result has been found to hold for investment banks in the US, while commercial banks were found to target a constant leverage ratio (Adrian and Shin, 2010). In Giordana and Schumacher (2011) we show similar results for the same sample of European countries, with small Commercial and Cooperative banks, Investment banks and Securities Firms having a strongly procyclical leverage, while large Commercial and Cooperative banks as well as Savings banks have a very low correlation between asset growth and leverage growth. Thus, the strong procyclicality that we observe here comes from MFIs other than the large traditional banks.

Industrial production index

In our study we use industrial production as a proxy for GDP since only industrial production is available as a monthly series. Figure 3 shows that (median) industrial production in our sample of European countries moves quite closely with MFI sector leverage. Industrial production started to take off in 2003, peeked approximately at the same time as leverage, then dropped down to levels that have been seen for the last time around 15 years ago. It picked up slightly again in the beginning of 2010, though it still is far below the levels of 2003.

The level of production in the real economy may be linked to leverage in two ways. Firstly, it may explain future MFI sector leverage as times of increasing growth prospectives may induce MFIs to lend more (Jokipii and Milne (2008)). Since higher GDP growth leads to a larger availability of outside funding, MFIs can obtain deposits and market funding more cheaply and thereby

Figure 2: Scatter plot of asset versus leverage growth



Explanation: The confidence interval is for an individual forecast, which includes both the uncertainty of the mean prediction and the residual.

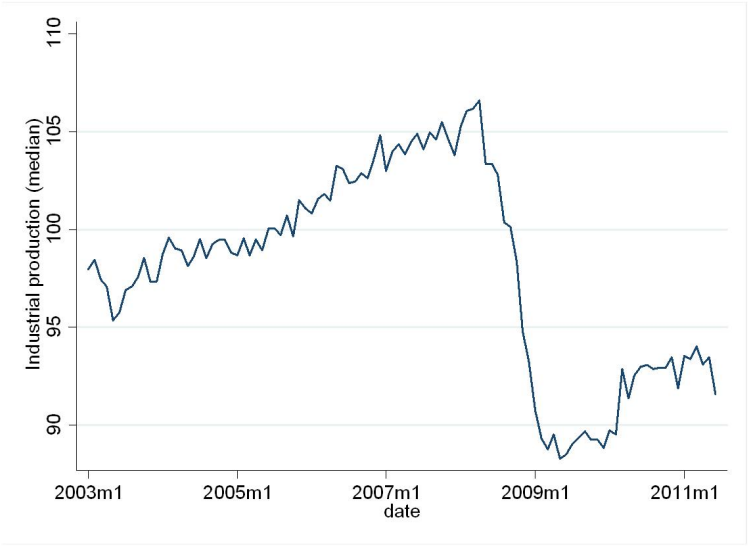
may be induced to increase their leverage. Secondly, leverage may explain industrial production since firms in Europe are to a larger extent debt funded.[7] Thus, they require larger loans if they want to increase their production and, as a consequence, an increase in industrial production tends to reflect a larger MFI lending which, at least in Europe, is often financed through higher deposits.

Stock indexes and expectations

The effect of stock prices and expectations on leverage has primarily been studied in theoretical contributions, notably Bernanke and Gertler (1989), Kiyotaki and Moore (1997), Miller and Stiglitz (2010), Shleifer and Vishny (Shleifer and Vishny, 2010) and, Brunnermeier and Sannikov (2011). These authors show that changes in asset prices and expectations affect collateral values and drive leverage decisions. To the authors' knowledge, little research has been undertaken that tries to empirically investigate the effect of stock prices or expectations on leverage. The econometric literature focused more on how expectations drive business cycles. For example, Taylor and McNabb (2007) show, for the case of four EU countries, that confidence is procyclical and can explain turning points in business cycles. Similarly, Matsusaka and Sbordone (1995) use a VAR

[7] Rivaud-Danset et al. (2001) show that own funds in European firms covers somewhere between 12% to 51% of balance sheet totals. European firms tend to be short-term funded, where firms raise between 25% to 71% of their debt in form of short-term debt (mainly from banks).

Figure 3: Evolution of Industrial Production (median, deseasonalized)

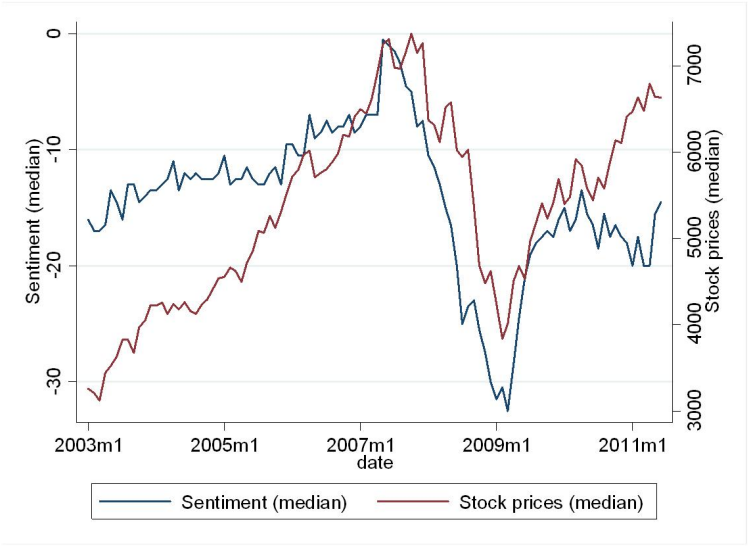


model and find that consumer confidence causes GDP. Ludvigson (2004) and Howrey (2001) find that confidence explains quarterly consumption growth, while Carroll and Dunn (1997) conclude that higher expectations of unemployment are able to predict lower levels of consumer spending. Other relationships have been found from consumer confidence to stock returns (Jansen and Nahuis, 2003), to short run consumption growth (e.g. Carroll, Fuhrer and Wilcox, 1994; Bram and Ludvigson, 1998; Nahuis and Jansen, 2004) and finally to the Great Depression (Romer, 1990). Studying the investment decisions of individual firms, (Baker, Stein and Wurgler, 2003) find that stock prices affect equity-dependent firms more strongly than bank-dependent ones. If one were to extend this result to our sample, then this would imply a limited impact from stock prices to loan demand, and thus potentially leverage Figure 4 depicts the evolution of both the stock prices and consumer sentiment over our horizon of study. Clearly, both co-move to a significant degree together. From 2003 until 2008 we notice an increase in both that is in line with that of leverage and industrial production, with both indexes also decreasing during the financial crisis.

Real interest rate

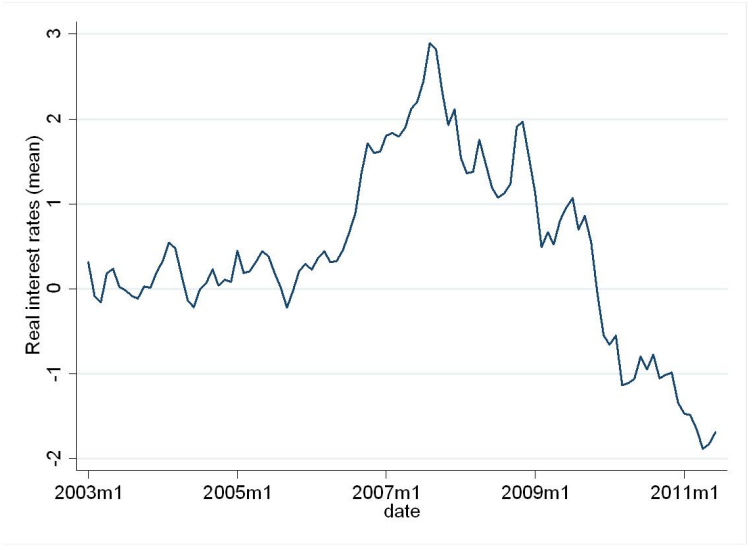
The level of the real interest rate in the economy can, at least partly, be viewed as the outcome of monetary policy. Clearly, leaving the role of monetary policy out of a study on MFI sector leverage would exclude one of the important variables that the literature so far placed substantial emphasis on. The transmission of monetary policy on credit supply and, therefore, the leverage decisions

Figure 4: Evolution of Stock Prices and Consumer Confidence (median, deseasonalized)



of firms, has been reviewed, among others, in Bernanke and Gertler (1995), Cecchetti (1995), and further empirically studied in Bernanke and Blinder (1992), Peek and Rosengren (1995), Kashyap and Stein (1995) or Angeloni et al. (2003). The important point to take away is that changes in monetary policy may raise the cost of funding and thereby induce banks to constrain their credit supply. Indeed, the fundamental contribution of these articles is that different banks may react differently to monetary policy shocks, with small and under-capitalized or illiquid banks tending to be most strongly affected. Though our data consists of MFIs, we would expect them to be subject to the same basic mechanism as banks. Additionally, our country-aggregated data does not allow us derive the heterogeneous reactions of individual banks. This is, also, not our focus. By looking at country-aggregated data we can derive the asset and equity movements of the country as a whole, and thereby identify the lending behavior as it affects the economy as a whole. Figure 5 presents the mean real interest rate (calculated as the Euribor one month minus annual change in HICP) across our sample of European countries. We can see a subsequent increase when the ECB tried to curb the financial expansion before 2008. At the outset of the crisis the real rate dropped, and it still is at its current all-time low.

Figure 5: Real interest rate (mean, deseasonalized)



4 Estimation strategy and results

In order to investigate how the macroeconomic variables interact together with MFI leverage, we study the following model:

$$\mathbf{X}_{it} = \Gamma_0 + \mathbf{\Gamma}_1 \mathbf{X}_{it-1} + \epsilon_{it}, \tag{1}$$

where X_{it} is a vector that consists of the country-aggregated growth rates of MFI sector leverage (g(L)), industrial production indexes (g(IPI)), real interest rates (d(RI)), stock market indexes (g(SP)) and finally the level of the confidence indicators (CCI). The parameter Γ_0 is a constant, $\mathbf{\Gamma}_1$ a vector of coefficients, and ϵ_{it} is the error term. Table 2 provides the descriptive statistics.

Our estimation strategy is to use a Panel Autoregressive Regression (PVAR) model. This we do for several reasons. Firstly, as all variables are endogenous (or at least weakly exogenous), we prefer to rely on the VAR modeling approach, since in this case we do not need to provide a structural model underlying the linkages between our variables. Thus, we can study the dynamic interactions without superimposing a structure a priori.

Most research investigated interactions between macroeconomic variables either by resorting to aggregated data (e.g. for the EU as a whole), or for individual series separately. The drawbacks of these exercises are that aggregated data hides heterogeneity in individual countries' actions and statistically insignificant results could simply be caused by countries having different reactions to given shocks. Studying individual series themselves has problems of its own. Firstly, they do not allow to control for the heterogeneity between panels and may lead to biased results. Secondly,

Table 2: Summary statistics, monthly data

Variable	Mean	Std. Dev.	Min.	Max.
g(L)	0	0.026	-0.206	0.157
g(IPI)	0	0.017	-0.076	0.062
CCI	-1.547	8.938	-32.477	20.215
g(SP)	0.006	0.051	-0.232	0.154
d(RI)	0.01	0.354	-2.165	1.258

No. of observations = 1008

panel data provides more information, may take care of biases from aggregation, has a lower collinearity among the variables and more degrees of freedom and efficiency (Baltagi, 2008, 4th ed.). Additionally, several articles resort to disaggregated bank-level data by analyzing how banks transmit monetary policy (Bernanke and Gertler, 1995; Cecchetti, 1995) or are affected by real shocks (Jokipii and Milne, 2008; Jiménez, Ongena, Peydró and Saurina, 2010). The disadvantage of these approaches is that neither the contagion mechanism identified in Fostel and Geanakoplos (2008), nor the negative feedback loops between funding liquidity, market liquidity and asset prices (Brunnermeier and Pedersen, 2009; Geanakoplos, 2009) can be studied. However, both issues rank highly in the discussions on the leverage cycle.

Furthermore, the VAR modeling allows us to isolate the individual effects of each variable via orthogonalized impulse responses. We decompose the residuals based on the Cholesky decomposition (see p.91-92, Hamilton, 1994). This requires us to impose an order on the variables that allocates any correlation between variables to those that come earlier in the ordering. In this way, variables that are ordered later are those that are assumed to be more endogenous. The order that we follow throughout the article is d(RI), g(IPI), $g(L)$, CCI and g(SP), though the results are robust to re-orderings. The actual model is estimated via OLS based on a modified version of the STATA routine kindly provided by Inessa Love (see Love and Zicchino (2006)). The long horizon of the monthly series makes the Nickell bias (Nickell (1981)) negligible (Judson and Owen, 1999), supporting the use of the OLS estimator.[8] For reasons of space we only show our results for the impulse responses and variance decomposition. Any further regression output is freely available from the authors.

Previous works (e.g. Pozsar et al., 2010; Gorton and Metrick, 2011; Coval et al., 2009) and our descriptive analysis in section 3 suggest that our period of study includes two distinctive phases. The period January 2003 to August 2008 can be viewed as a build-up phase and has been dubbed

[8]We obtained the same results with a GMM estimator that takes care of a potential bias induced by the correlation between the lagged dependent variable and potential fixed effects.

the Great Moderation, while the period September 2008 till June 2011 is a crisis period and has been called the Great Recession. Our strategy is, therefore, to split the analysis into a pre-crisis and a crisis period. We then study each of these sub-periods separately and compare their results.

4.1 Results

We now present the results for the pre-crisis and crisis periods and compare both.[9] In Figures 11 and 12 we display our PVAR results. The dashed lines provide the 5% and 95% confidence interval for the response of a variable to a one standard deviation shock in another variable. The confidence interval is obtained through a Monte-Carlo simulation based on 100 draws. The results are fully robust to draws with any larger number. Tables 3 and 4 provide the variance decompositions for the pre-crisis and the crisis period. For completeness we show all the impulse responses but concern ourselves mainly with those that relate to leverage.

Overall, we find that the links between leverage and the macroeconomic variables are stronger during the crisis period. Leverage growth during the pre-crisis period is virtually unaffected by any of the macroeconomic variables that we consider here. Equally, no change in leverage is found to bear an impact on a macroeconomic variable. As Table 3 shows, barely any variance of leverage growth can be explained by the macroeconomic variables considered here (less than 1%), and similarly leverage growth does not figure as an important determinant of the variance in the macroeconomic variables. Looking at the crisis period, the picture is different. The results here show a stronger interaction between leverage and the macroeconomic variables. Table 4 illustrates that a slightly larger amount of the variance in leverage growth can now be attributed to consumer sentiment (1.5%) and industrial production (1.4%), though leverage continues to explain most of its own variance (95.9%). These results are also robust to a variety of different modeling assumptions (see the robustness section).

Table 3: Variance decomposition of leverage model in the pre-crisis period (1/2003 - 08/2008)

	d(RI)	**g(IPI)**	**g(L)**	**CCI**	**g(SP)**
d(RI)	95.3	2.0	0.0	1.9	0.8
g(IPI)	2.3	95.4	0.4	0.4	1.5
g(L)	1.4	0.1	98.4	0.0	0.1
CCI	4.8	3.0	0.1	89.0	3.1
g(SP)	8.1	1.6	0.2	1.6	88.5

Figures 11 and 12 (third row, first column) show that changes in the real interest rate only

[9] We used several different starting periods for the crisis but the results stay robust.

bear a marginal effect on leverage growth. Thus, monetary policy, during the period 2003 to 2011, seemed essentially unable to curb the expansion of MFIs' balance sheets. We also find no statistically significant difference of the response of leverage to an interest rate shock between the two sub-periods.[10] However, the underlying reasons may differ. In the pre-crisis period, one may argue that MFIs were able to easily shield their portfolios from monetary policy shocks due to financial innovations. These innovations, like securitization, have helped MFIs in obtaining funding in a way that is to a lesser extent linked to the ECB policy rate (see e.g. Altunbas et al., 2009; Loutskina and Strahan, 2009) than traditional sources of funding. In comparison, during the liquidity crisis, the collapse of the interbank market effectively prevented the ECB from controlling the market rates through the traditional monetary policy instruments. Additionally, MFIs were uncertain about the potential returns of future investments and were consequently holding on to their liquidity. A further point is that most MFIs had to deleverage, either due to market pressures, funding pressures or investors' sentiments. Thus, they had little opportunities for responding to monetary policy.

Table 4: Variance decomposition of leverage model in the crisis period (09/2008 until 06/2011)

	d(RI)	**g(IPI)**	**g(L)**	**CCI**	**g(SP)**
d(RI)	96.9	1.5	0.6	0.4	0.6
g(IPI)	2	88.2	1.3	2.3	6.1
g(L)	0.6	1.4	95.9	1.5	0.6
CCI	2.7	6.2	12	72	6.6
g(SP)	2.2	5.3	3.4	6.3	82.8

Our findings suggest that the growth in leverage reacts positively to consumers' sentiment during the crisis period, though this takes a delay of two months (Figure 12, fourth row, third column). Likewise, shocks to stock prices, which may be associated with a rise in collateral values, have a delayed positive effect after 5 months (Figure 12, third row, fifth column). Hence, this supports the so-called balance-sheet channel that has been theoretically studied in many contributions (e.g. Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997). Basically, this literature argues that an increased net worth or heightened expectations induce investors and depositors to increase their willingness to lend funds.[11] We confirm this theoretical result here. Banks, faced with increasing consumer sentiment or stock prices, are enjoying a higher availability of funds and also tend to increase their loan supply. However, looking at the variance decompositions in

[10] This result is not shown but available from the authors.

[11] Empirical contributions studying this are Altman and Saunders (2001), Drucker and Puri (2009), Jimenez et al. (2010), Lowe (2002) and Stein (1998).

Table 4, the explained portions remain small; consumer confidence explains 1.5% and stock prices 0.6% of the variance of leverage growth. Overall, we can conclude that, at the aggregate, our macroeconomic variables seem to have a negligible effect on the variance of leverage growth, and the only variable that has a statistically significant effect is consumer sentiment.

We find no statistically significant impact from industrial production on leverage growth in the pre-crisis period (Figure 11, third row, second column). During the crisis period, we find a short-run impact from industrial production on leverage after two months (Figure 12, third row, second column). Also, the variance of leverage growth explained by industrial production is different between the sub-periods (0.1% in the pre-crisis and 1.4% in the crisis period). Hence, we can exclude the growth in industrial production as a driver of MFI leverage in our sample of European countries during the pre-crisis period, while there is a minor impact from industrial production on leverage during the crisis.[12]

There is some evidence that leverage growth impacts the other macroeconomic variables during the crisis period. Indeed, leverage growth can explain as much as 12% of the variance in consumer sentiment and 3.4% of the variance in the growth rate of stock prices. In constrast to the results on the pre-crisis period, in the crisis period we observe a statistically significant and negative impact of leverage growth on consumer sentiment (Figure 12, fourth row, third column). During a bear market, highly leveraged financial institutions are expected to be financially fragile and even small shocks to the asset or liability side can lead to large losses. Furthermore, we find a statistically significant negative response of stock prices during the first two months after a shock to leverage growth (Figure 12, fifth row, third column). This could be view as evidence for the amplifying effect of leverage within a loss-spiral during a period of liquidity stress, as has been observed during the last financial crisis. A higher leverage (and a possibly higher maturity mismatch), when funding for MFIs is scarce, is likely to induce fire-sales of assets and lower lending to households. Thus, during bull times, leverage is not viewed as a constraint for MFIs, while during bear times, it is expected to significantly harm MFIs. There have been several theoretical models that studied this mechanism. In particular, our findings fit well into the predictions by (Brunnermeier and Sannikov, 2011). In their model, banks endogenously choose their level of leverage in response to the riskiness of their asset portfolio. Low exogenous risk then leads to balance sheet expansions through building up leverage, while it also increases the exposure of the whole system to volatility spikes in asset prices. At some point, if leverage is too high, it may trigger liquidity hoarding that

[12] As a robustness check we excluded industrial production from the system of equations. The results remain qualitatively unchanged.

depreciates asset prices followed by loss spirals.

> Figures 11 and 12 around here <

4.2 A closer look at the components of leverage

We now take a look at the two components of leverage growth, namely the growth in asset and the growth in equity. This will give us additional information on the interaction between the macroeconomic variables and balance sheet expansions, as well as how changes in equity co-move with the macroeconomic environment. As a consequence, we will be able to see whether the link between macroeconomic conditions and leverage is simply due to changes in e.g. the total supply of MFI investments, or whether they are driven by a concern for leverage itself. In effect, we shall argue that leverage growth itself provides different information (especially during the crisis period) from those provided by assets or equity. As before, we distinguish between the pre-crisis and the crisis period. To facilitate the comparison, we dub the model with leverage the 'leverage model', while we call the one with assets and equity the 'component model'. Figures 13 and 14 present the impulse responses for the pre-crisis and the crisis period, and Figure 15 the difference in the impulse responses between the two sub-periods. The variance decomposition is shown in Tables 5 and 6.

Overall, the results suggest that the component model can explain somewhat more variance of each variable than the leverage model. The largest differences to the pre-crisis period in the leverage model arise through the dynamic interaction between assets, sentiments and stock prices. The crisis period of the leverage model and the component one predicts similar results, but the later one allows to see how the two elements of leverage drive leverage growth itself.

One important result relates to the interaction between the components of leverage themselves. Comparing Figure 11 and 13, the own dynamics of both asset and equity growth correspond to those that we have seen for leverage growth. Furthermore, a one standard deviation increase in equity growth has a positive impact on asset growth in both the pre-crisis and crisis period, while asset growth has no impact on equity growth. The response of asset growth to an increase in equity growth is, however, stronger in the crisis period. This may be explained as follows. On the one hand, equity growth might be less related to asset growth in the pre-crisis period since MFIs expanded their balance sheets mostly through short-term debt. On the other hand, large losses during the crisis period forced MFIs to run down their reserves and to sell assets. We do not find a statistically significant impact of asset growth on equity growth. Thus, we cannot yet confirm

that there were positive feedback loops from e.g. increases in assets due to marking-to-market on equity. We will come back to this point soon.

During the pre-crisis period, we find some evidence for a positive effect of sentiment and stock prices on assets (Figure 13, fourth row, fifth and sixth column). However, both do not account for a large proportion of the variance in assets. These affect asset growth with a short lag of 2 months and are able to respectively explain 0.7 and 1.5% of the variance in total assets (Table 5). Importantly, we find no effect from stock prices on equity growth, suggesting that profits from marking-to-market were too small to show up as statistically significant (this result also holds for the crisis period). This seems reasonable since the proportion of stocks held by European MFIs is small in comparison to their total asset holdings.[13]

We also find a significant feedback from asset growth to sentiments and stock prices during the pre-crisis period (Figure 13, fifth and sixth row, fourth column). Both are positively affected and asset growth explains 2.8% and 2.5% of the variance in sentiments and the growth in stock prices (Table 5). Thus, we find evidence for a positive feedback loop in the pre-crisis period between sentiment, stock prices and assets.

During the crisis period, these feedbacks change in important ways. We do not find an impact from stock prices on asset growth any longer (Figure 14, fourth row, sixth column). In contrast, we find a significant impact from sentiment to asset growth (Figure 14, fourth row, fifth column). Its impact is statistically bigger in the crisis period compared to the pre-crisis one and it explains more of the variance of asset growth (3.1% compared to 0.7%). The feedbacks from asset growth onto stock prices and sentiment changed, too. The impact of asset growth on sentiment is no longer statistically different from zero (Figure 14, fifth row, fourth column). In contrast, equity growth now positively affects sentiment (Figure 14, fifth row, third column). Hence, these two feedbacks combined help explain the negative relationship between leverage growth and sentiment that we observed in the previous section (Figure 14, fourth row, third column). This suggests that expectations during the crisis were not anymore shaped by the ease of access to credit, but by concerns for financial stability and default possibilities. This effect is, furthermore, slightly statistically significantly different between the pre-crisis and crisis period (Figure 15, third row, fifth column). Equity growth can explain now up to 16.1% of the variance in sentiment (Table 6). Thus, it is the variable, apart from sentiment itself, that explains most of the variance in sentiment.

[13] Our sample of European MFIs held, during our period of study, on average 56.3% of assets in loans and 15.7% in securities.

Changes in real interest rates have both a positive short-term impact on asset growth and equity growth in the pre-crisis period (Figure 13, first row, resp. third and fifth column), suggesting that MFIs' returns increase with increasing real interest rates. The variance of asset growth and equity growth explained by real interest rate changes are 2.4% and 1.4% (Table 5). MFIs, in the pre-crisis period, seem to have been able to expand their balance sheets and increase returns despite increases in the real interest rate. This is evidence not supportive of a balance sheet channel but of the 'originate-and-distribute' model where large financial innovations have allowed low-cost expansions of the liability side to sustain the net returns of assets in an environment of increasing interest rates (see e.g. Brunnermeier, 2009; Pozsar et al., 2010). In contrast, we find no effect from changes in the real interest rate on either asset or equity growth in the crisis period. This confirms that the market for cheap funds from financial innovations had virtually broken down in the crisis period, which implied that MFIs were unable to profit from interest rate differentials. It also supports the view that European MFIs were more strongly concerned with leverage and default problems in an environment of heightened uncertainty.

The final relationship that we study is between the components of leverage and industrial production. We do not find feedbacks between industrial production and equity or assets growth in the pre-crisis period (Figure 13, second row, resp. third and fourth column). This supports the view that the balance sheet expansion during the Great Moderation was at least partially detached from the real economy. On the converse, we find a positive effect from industrial production to both equity and asset growth during the crisis period (Figure 14, resp. third and fourth row, second column). This suggests that the large number of defaults and write-offs during the crisis period had a significantly negative impact on both asset and equity growth. Industrial production can explain 2.7% of both the variance in equity and asset growth in this case (Table 6).

Table 5: Variance decomposition of component model in the pre-crisis period (1/2003 until 08/2008)

	d(RI)	g(IPI)	g(E)	g(A)	CCI	g(SP)
d(RI)	95.1	1.9	0.1	0.4	1.8	0.7
g(IPI)	2.2	94.7	0.9	0.7	0.3	1.1
g(E)	2.4	0.4	96.4	0.4	0.2	0.1
g(A)	1.4	0.5	7.1	88.8	0.7	1.5
CCI	5.0	2.8	0.5	2.8	85.6	3.2
g(SP)	7.7	1.5	0.3	2.5	1.4	86.7

> Figures 13 and 14 around here <

Table 6: Variance decomposition of component model in the crisis period (09/2008 until 06/2011)

	d(RI)	g(IPI)	g(E)	g(A)	CCI	g(SP)
d(RI)	92.0	2.0	3.0	1.7	0.4	0.8
g(IPI)	1.8	87.2	2.7	0.4	1.9	6.0
g(E)	0.6	2.7	95.8	0.6	0.1	0.3
g(A)	0.2	2.7	11.0	82.5	3.1	0.5
CCI	1.4	7.5	16.1	0.3	66.9	7.8
g(SP)	2.0	5.6	1.9	3.4	6.1	81.0

4.3 Specification tests and Robustness

Stationarity and Poolability

In Table 7 we present panel data unit root tests based on the Breitung test (see Baltagi (2008, 4th ed.). Our results in Table 7 show that all variables except consumer confidence and the real interest rate have a unit root, while the differenced variables are stationary.

Table 7: Breitung unit root tests

Variable	**p-value** (No. of lags)	
	lags = 1	**lags = 3**
L	0.07	0.11
A	1	1
E	1	1
IPI	0.87	0.50
RI	0.02	0.03
CCI	0.00	0.00
SP	0.43	0.18
g(L)	0.00	0.00
g(A)	0.00	0.00
g(E)	0.00	0.00
g(IPI)	0.00	0.00
d(RI)	0.00	0.00
g(SP)	0.00	0.00

H0: All panels contain unit roots.

In addition, in Table 8 we present the results from the Westerlund error-correction-based panel cointegration tests. We can see that there is no evidence of cointegration in any of the equations for both sub-periods. This supports our emphasis on the differenced data (Ashley and Verbrugge, 2009).

One important criterion for any panel study is that the individual units, or panels, are actually poolable. This requires them to be sufficiently similar. In order to see whether countries are poolable we resorted to the Roy-Zellner poolability test (see Baltagi (2008, 4th ed.)). This test

Table 8: Westerlund error-correction-based panel cointegration tests

	P-values of test statistic							
Dependent variable	Gt	Ga	Pt	Pa	Gt	Ga	Pt	Pa
Pre-crisis								
RI	0.162	0.451	0.184	0.264	0.45	0.73	0.535	0.695
log(IPI)	0.963	0.959	0.932	0.907	0.42	0.62	0.605	0.395
Log(L)	0.49	0.542	0.171	0.078	0.65	0.85	0.45	0.58
CCI	0.414	0.242	0.1	0.019	0.395	0.465	0.285	0.195
log(SP)	0.917	0.968	0.812	0.819	0.795	0.62	0.83	0.59
Crisis								
RI	0.921	0.997	0.835	0.938	0.35	0.535	0.46	0.505
log(IPI)	0.815	0.982	0.88	0.932	0.1	0.58	0.705	0.445
Log(L)	0.971	0.995	0.71	0.848	0.86	0.82	0.57	0.445
CCI	0.894	0.989	0.721	0.85	0.175	0.955	0.51	0.815
log(SP)	0.208	0.928	0.222	0.452	0.76	0.53	0.81	0.58
Options								
Bootstrap	no	no	no	no	200	200	200	200
lags	2	2	2	2	2	2	2	2
trend	no	no	no	no	yes	yes	yes	yes
constant	no	no	no	no	yes	yes	yes	yes

Rejection of H0 for the Ga and Gt test statistics is evidence of cointegration of at least one of the cross-sectional units. The Pa and Pt test statistics pool information over all the cross-sectional units. Rejection of H0 is evidence of cointegration for the whole panel (Persyn and Westerlund, 2008).

has been initially designed for the comparison of restricted and unrestricted models.[14]

The restricted model is the pooled one which has the same parameters across time and across countries. Conversely, the unrestricted model allows for different parameters across both dimensions. This test does not constrain the residual variances to be equal. We have run the test for each equation of the system. The results of the test are shown in Table 9.

We find that European countries as a whole fail to be poolable. This is to be expected as especially the new accession countries are likely to still have different dynamics in the real and financial sector compared to the incumbent countries. However, the set of countries that turns out to be poolable is the one made up of France, Germany, Italy, Netherlands, Portugal, Spain, Sweden, United Kingdom. Of these, Sweden and the United Kingdom have their own monetary policy, and thereby the results with respect to the interest rate may be biased. However, excluding both countries from the analysis does not change the results.

[14] Applications of this test to the poolability of panel data are, for example, Baltagi (1981) and Schiavo and Vaona (2008).

Table 9: Roy-Zellner poolability test

		Equations						
Sample	**Stats**	**d(RI)**	**g(IPI)**	**g(LEV)**	**g(E)**	**g(A)**	**CCI**	**g(SP)**
pre-crisis	chi2(70)	33.04	33.18	53.342			11.54	35.7
	Prob > chi2	0.99	0.99	0.93			1	0.99
crisis	chi2(70)	31.86	53.62	50.91			10.67	31.45
	Prob > chi2	0.99	0.92	0.95			1	0.99
pre-crisis	chi2(84)	41.05	41.52		72.25	63.23	16.23	40.19
	Prob > chi2	0.99	0.99		0.82	0.96	1	0.99
crisis	chi2(84)	40.66	61.59		65.55	58.72	13.84	41.52
	Prob > chi2	0.99	0.96		0.93	0.98	1	0.99

H0: countries are poolable. Sample: France, Germany, Italy, Netherlands, Portugal, Spain, Sweden, United Kingdom.

Further robustness analyses

We conducted several robustness exercises to guarantee the robustness of the results above. The impulse response results are available from the authors upon request.

Sometimes, results based on VAR models are driven by the choice of the lag length. We compared the results from our PVAR with two lags with those having lag length of one, and three to six lags. All models gave rise to the same qualitative results.

In addition, the order of the variables is important for the impulse responses due to the Cholesky decomposition. The results are fully robust to changing the order of the variables.

We also transformed the variables in various ways. We used an HP-Filter with the standard monthly smoothing parameter 129,600 instead of the least-squares de-seasonalization.[15] Because the HP-Filter also de-means, we only took the differences and not the growth rates. The impulse response results for the interaction between leverage and the macroeconomic variables for the pre-crisis and crisis period are qualitative robust to this alternative transformation. One difference, however, occurs in the quantity of the variance decomposition. Since the HP-Filter takes the trend away but keeps seasonal components, we find a slightly stronger interaction between the macroeconomic variables and leverage during the crisis period. Additionally, instead of a month-on-month transformation we used the year-on-year one.[16] The month-on-month transformation may filter out part of the lower frequency components of our series while, if this were really the case, the year-on-year transformation may preserve it. Re-running all the regressions based on

[15] In case of permanent shocks or split growth rates the HP filter may provide misleading results, which is observable in the monthly data during the crisis period of 2007-2009. This is the reason why the least-squared de-seasonalization is our preferred method.

[16] We thank Paolo Guarda for suggesting us to take a look at the subsequent transformations.

the year-on-year transformation gives us, essentially the same results. One difference arises in the speed of convergence. Instead of a convergence within several months we now need to run the impulse-response functions over two years. This, thus, confirms that there are lower frequency components that are ignored in our month-on-month transformation. Another difference in the results based on the year-on-year transformation is that, during the pre-crisis period, the effect of leverage growth on stock prices is now statistically significant. In addition, the effect of consumer sentiment on leverage growth during the crisis loses some significance, while the overall sign is preserved. In terms of the variance decomposition we find little differences between the year-on-year and the month-on-month transformations. Finally, our first difference model with two lags is, essentially, a restricted one in log-levels with three lags. Thus, following Sims, Stock and Watson (1990) and Bernanke and Blinder (1992), we estimate the same model in log-levels with three lags. As an important remark, however, we must say that both models cannot be fully compared, since in the first differenced model we use consumer sentiment in levels, and not differences (as it is stationary). As it turns out, the impulse response results remain generally robust to the specification in log-levels. Also, the results of the variance decomposition with a VAR(3) in log-levels are very much similar to those of the VAR(2) in first differences. The only difference is that consumer sentiment, in the pre-crisis period, reacts marginally negatively to leverage. We can conclude that the month-on-month transformations may have somewhat washed out the long-run effect of leverage on consumer confidence. However, this holds for the pre-crisis period only, with the effects qualitatively similar during the crisis period.

Also, though the regression of the whole period has sufficiently many time periods, our regression of the sub-samples could potentially be subject to the Nickell bias. The literature calls the potential bias created by the correlation between the fixed effects and the lagged dependent variable the Nickell bias (Nickell (1981)). A Monte Carlo study by Judson and Owen (1999) finds that one need more than 30 periods in order to be certain that the Nickell bias is minimized. We have 96 time periods for the pre-crisis period and 33 for the crisis period. Thus, the Nickell bias could potentially play a role for the crisis period. In order to make sure that our results are robust, we ran the estimation using the helmert transformation on the variables (Arellano and Bover (1995)), which removes fixed effects through forward de-meaning, and the GMM estimator. This is important in case one believes that fixed effects might nevertheless play an important role for the leverage dynamics. The results stay robust in this case, which makes us sufficiently confident that a correlation between the lagged dependent variable and the fixed effects is not driving our

results.

5 Comparison to Luxembourg

In this section we compare the main macroeconomic variables of our European sample with those from Luxembourg. In addition, we run the same regressions for Luxembourg as we did for our sample of European countries and compare the two.

The evolution of leverage and the macroeconomic variables for Luxembourgish MFIs is depicted in Figures 6 to 10. As Figure 7 shows, leverage in Luxembourg is, overall, much higher than in the rest of Europe. While the European countries in our sample had, on average, a leverage ratio ranging between 14 to 18, Luxembourgish MFIs have one ranging between 20 and 27. Two factors contribute to this. Firstly, the banking sector in Luxembourg includes more branches than the other banking sectors in our sample. Branches are not required to hold capital and also do not need to be concerned with their leverage since their mother companies will be able to support them (Giordana and Schumacher, 2011). Secondly, other monetary financial institutions, like funds, contribute a much larger share to the total MFI balance sheet in Luxembourg. Funds in general are outside the regulatory frameworks and have expanded their balance sheets quite substantially in the pre-crisis period.

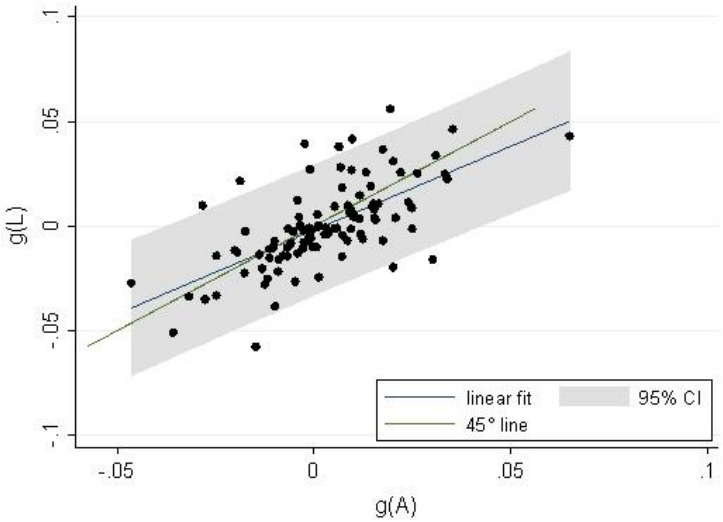
Figure 6 shows the correlation between leverage growth and asset growth in Luxembourg. We find, as is the case for our European sample, a strong procyclicality between both. This result confirms our previous work, where we had focused only on the Luxembourgish banking sector (Giordana and Schumacher, 2011).

Industrial production in Luxembourg had a similar evolution as industrial production in our European sample. We observe an increase in Luxembourgish industrial production between 2003 and 2008, a sharp decline at the start of the financial crisis, and then a slow increase during the past years (Figure 8).

Consumer sentiment in Luxembourg follows the same qualitative pattern as in the rest of our European sample (Figure 9). However, sentiment in Luxembourg increased to its pre-crisis peak, while this did not happen for the rest of Europe (c.f. Figure 4). It is likely that households in Europe suffer more from the crisis than those in Luxembourg.

Visual inspection shows that the Luxembourgish stock market co-varies with the European ones until the beginning of 2010 (Figures 9 and 4). From 2010 onwards, while the European stock prices increased again to nearly their 2008 peak, the Luxembourgish stock index stagnated. The

Figure 6: Scatter plot of asset versus leverage growth



Explanation: The confidence interval is for an individual forecast, which includes both the uncertainty of the mean prediction and the residual.

main reason for this is that financials figure more strongly in the Luxxx index than in the European indexes. Since the financial industry is still suffering from the crisis, this is a likely reason for the divergence between the two.

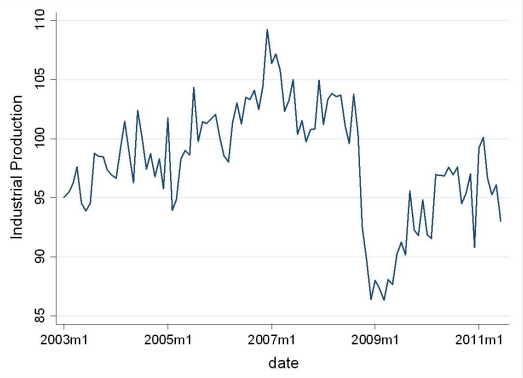
The real interest rates in Luxembourg have been mostly negative during the past decade (Figure 10). We find a similar evolution as for the European sample. However, there is a stronger peak in Luxembourg during 2009, while the European sample saw a decline in real interest rates during that year.

In order to be able to compare the results from the European panel VAR model to that in Luxembourg, we run the same VAR models for Luxembourg. The impulse-response results for the leverage and the component model during the pre-crisis period are depicted in Figures 16 and 17, with the corresponding variance decompositions shown in Tables 10 and 11. The impulse-response results for the leverage and the component model during the crisis period are given in Figures 18 and 19, and their variance decompositions in Tables 12 and 13.

Just like it is the case for our sample of European countries, we find a weak relationship between macroeconomic variables and leverage in the pre-crisis period, while we find stronger feedbacks between macroeconomic variables and leverage during the crisis period. Thus, our main observation here is that the Luxembourgish MFI sector sees stronger feedback loops between macroeconomic conditions and leverage than the sample of European countries that we investigated

Figure 7: Evolution of leverage

Figure 8: Industrial production



above.

We now discuss the results for Luxembourg in detail. Though we do find little evidence for interactions between the macroeconomic variables and leverage during the pre-crisis period, we nevertheless observe that the variance decomposition shows stronger interactions in the Luxembourgish MFI sector compared to our European sample (see Table 10). Leverage growth for Luxembourgish MFIs explains 84.82% of its own variance, while both real interest rates and consumer sentiment explain 4.92% and 5.95% respectively. This is much higher than for the European sample in the pre-crisis period and is suggestive for a stronger interaction between the macroeconomic condition and the leverage of Luxembourgish MFIs. Since the share of employees in the financial sector in Luxembourg is high in comparison to our European sample, it is likely that sentiment in Luxembourg drives the financial sector's investment decisions more strongly.

The components of leverage provide a more detailed picture. Table 11 shows that the macroeconomic variables in the pre-crisis period can explain roughly 14% more of variance of the components of MFI leverage in Luxembourg compared to the European sample. Overall, our impulse

Figure 9: Evolution of sentiment/stock prices

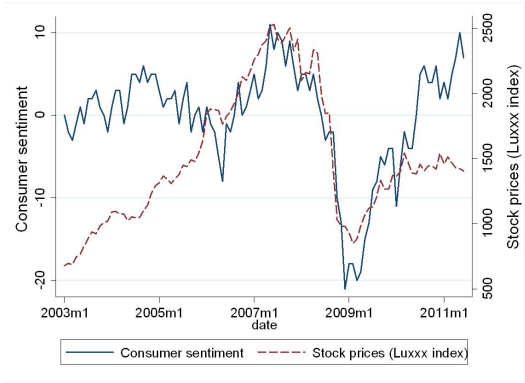
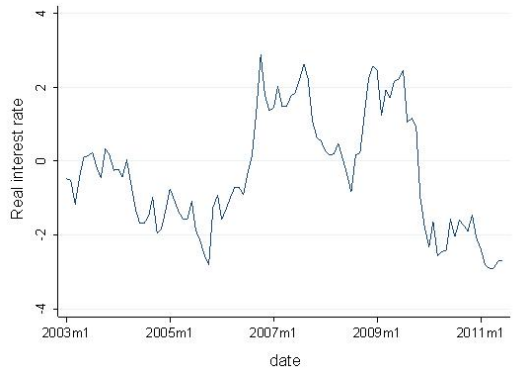


Figure 10: Evolution of real interest rate



responses in Figure 17 show qualitatively similar results compared to our sample of EU countries. One main difference is the feedback interaction between stock prices and the growth in assets. While we find a statistically significant, two-way relationship between stock prices and assets for the European sample, this is not the case for Luxembourg.

Table 10: Variance decomposition of leverage model, Luxembourg, pre-crisis period

	d(RI)	g(IPI)	g(L)	CCI	g(SP)
d(RI)	85.46	0.98	3.04	9.25	1.26
g(IPI)	1.92	86.37	3.12	1.95	6.64
g(L)	4.92	2.32	84.82	5.95	1.99
CCI	1.54	0.15	2.81	94.14	1.35
g(SP)	8.29	3.45	4.77	11.00	72.49

> Figures 16 and 17 around here <

Comparing the crisis with the pre-crisis results for Luxembourg, we continue to find that the growth in leverage or its components explain little of the macroeconomic variables in Luxembourg.

Table 11: Variance decomposition of component model, Luxembourg pre-crisis period

	d(RI)	g(IPI)	g(E)	g(A)	CCI	g(SP)
d(RI)	84.94	1.16	1.47	2.48	8.84	1.10
g(IPI)	2.06	84.99	2.97	1.29	1.80	6.90
g(E)	3.91	0.87	84.79	1.28	5.73	3.42
g(A)	4.27	3.43	4.17	72.98	14.38	0.77
CCI	1.51	0.24	2.37	1.56	92.59	1.74
g(SP)	9.06	4.04	8.62	2.05	9.08	67.15

This is consistent with the observation that the Luxembourgish MFI sector invests mostly outside of Luxembourg. Nevertheless, we find that a significant share of leverage and asset growth can be explained by the macroeconomic variables in Luxembourg.

When we compare the results for the crisis period between Luxembourg and our European sub-sample, then three large differences should be emphasized. Firstly, as Tables 12 and 13 show, while both leverage and equity growth are able to explain a large part of the variance in sentiment for the European sample (12% and 16.1%), this is not the case for Luxembourg (0.26% and 2.37%). The main reason is that leverage is not a concern for Luxembourgish sentiment since leverage itself tends to be a less powerful indicator of default or potential financial distress in Luxembourg compared to Europe. Banks in Luxembourg tend to be mostly branches or belong to a group, while funds tend to belong to investors outside of Luxembourg. As a consequence, Luxembourgish consumer sentiment can be better explained by industrial production and stock prices, that together account for 32% of the variance in sentiment.

Secondly, stock prices have a negative, short-run impact on leverage growth for the Luxembourgish MFIs during the crisis period (see Figure 17, third row, fifth column) and are able to explain 16.89% of the variance in leverage. As the impulse response functions in Figure 17 (third row, sixth column) show, this occurs through an impact of stock prices on equity. A potential reason for this result is the larger exposure of Luxembourg's MFIs to marking-to-market effects. While the European MFIs hold, on average, 15.7% of their assets in securities, Luxembourg's MFI hold on average 23.3%.

Thirdly, real interest changes have a positive, albeit short-lived, impact on leverage growth. This result is consistent with previous findings on the Luxembourgish banking sector (Giordana and Schumacher, 2011). Basically, we had found that credits from Luxembourgish banks are strongly correlated with the Euribor-EONIA spread. This indicates that in times of liquidity constraints, mother companies or groups demand more credit from their branches or subsidiaries

in Luxembourg.

We also compare the differences in the impulse responses from the European sample to those in Luxembourg during the crisis period in Figure 20. We find a statistically significant and positive differences in the feedbacks between leverage and sentiment. Furthermore, real interest rate changes had a stronger impact in Luxembourg during the crisis. Finally, stock prices reduced leverage in Luxembourg while we did not find any impact in our European sample.

Table 12: Variance decomposition of leverage model, Luxembourg crisis period

	d(RI)	g(IPI)	g(L)	CCI	g(SP)
d(RI)	85.78	1.57	5.38	0.67	6.60
g(IPI)	8.76	73.47	0.28	1.02	16.48
g(L)	19.45	2.96	47.35	13.34	16.89
CCI	0.21	11.10	0.26	67.20	21.23
g(SP)	4.84	7.62	3.02	4.18	80.34

Table 13: Variance decomposition of component model, Luxembourg crisis period

	d(RI)	g(IPI)	g(E)	g(A)	CCI	g(SP)
d(RI)	85.69	1.19	2.21	5.42	0.69	4.80
g(IPI)	9.88	70.23	4.35	3.82	1.10	10.62
g(E)	7.65	4.63	74.14	2.53	3.45	7.60
g(A)	8.12	13.79	15.15	48.95	8.65	5.34
CCI	0.21	12.41	0.80	0.26	66.77	19.56
g(SP)	4.85	9.95	2.97	3.51	5.54	73.20

> Figures 18, 19 and 20 around here <

6 Conclusion

In this article we investigated the dynamic interactions between several indicators of macroeconomic conditions and the leverage dynamics of monetary financial institutions (MFIs) in a sample of European countries and Luxembourg during the period January 2003 and June 2011.

We start by showing that leverage in Europe's monetary financial sector was procyclical during the last decade. Procyclicality is defined as a positive and significant correlation between the growth of assets and the growth of leverage. Thus, a balance sheet expansion is financed through increasing debt rather than equity. A similar result has been shown by Adrian and Shin (2010),

but only for US investment banks, while they found that US commercial banks target a constant leverage.

We then study the interaction between leading macroeconomic indicators (industrial production, stock prices, consumer confidence and real interest rates) and financial sector leverage in major European countries. We base our analysis on monthly, country-aggregated panel VAR models for the period January 2003 to June 2011. Our analysis focuses on two sub-perids, namely the pre-crisis period, or Great Moderation, from January 2003 to August 2008, as well as the crisis period, or Great Recession, ranging from September 2011 to Juny 2011. We study two specifications, one includes leverage itself, and the other one the two components of leverage, namely assets and equity.

We find little evidence for a relationship between macroeconomic variables and leverage in the pre-crisis period in our European sample, with only real interest rates having a negative short-term impact on leverage growth. We find positive feedback loops between sentiment and stock prices as well as MFI assets in the pre-crisis period. This supports the theoretical models where heightened expectations due to lower expected counter-party default rates or higher collateral values drive balance sheet expansions(e.g. Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997; Krishnamurthy, 2010). In addition, we find a positive impact of real interest rate changes on equity and asset growth. Thus, in an environment of low funding costs due to financial innovations (e.g. Brunnermeier, 2009), increasing real interest changes allowed MFIs to profit from higher spreads. This stands in contrast to the standard results of transmission channels of monetary policy, where increasing interest rates reduce banks' funding (see Bernanke and Gertler, 1995; Cecchetti, 1995).

During the financial crisis, we observe a counter-cyclical impact from leverage on sentiment and stock prices, while sentiment and stock prices bear a pro-cyclical impact on leverage. We conclude that leverage drives expectations of financial instability (via e.g. default expectations), while sentiment and stock prices drive financial institutions' investment decisions (via e.g. collateral value effects). This is supported by our results that, during the crisis, asset growth both drove sentiment and stock prices, while only sentiment was positively affected by equity growth.

When comparing these results to those for Luxembourg, then we also find that MFI leverage in Luxembourg is procyclical. Similar to the European case, we find a weak relationship between the macroeconomic variables and leverage during the pre-crisis period, while we find a stronger interaction in the crisis period. Nevertheless, while we observe a statistically significant, two-way relationship between stock prices and assets for the European sample, we do not find the same

results for Luxembourg. Instead, we can only find a one-way relationship from macroeconomic variables on leverage and asset growth during the crisis period in Luxembourg. This is consistent with the international orientation of the Luxembourgish MFI sector. Additionally, in comparison to the European sample, we find a more negative reaction of Luxembourgish MFI leverage when stock prices change. We suggest that this is due to the relatively higher share of securities on Luxembourgish MFI portfolios.

Thus, overall, we conclude that leverage growth was not a concern (for investors) in the pre-crisis period, while it significantly drove investors' decisions during the crisis. The large impact of equity growth on sentiments during the crisis period is especially noteworthy here, since we did not find a significant impact from equity on sentiment during the pre-crisis period.

What we thus find here is evidence that investors, in bull times, base their decisions to a lesser extent on fundamental indicators of financial health. In contrast, during the bear period, we find evidence for what one may dub pessimism, with investors being completely focused on default and financial stability, and where higher leverage reduces consumer sentiment and stock prices.

Our results are, therefore, more indicative of feedbacks between leverage and expectations during downturns, while we find that both lenders and borrowers are not concerned about leverage during upturning. We find, therefore, a stronger support for models that rely on an expectation-leverage feedback (like Kiyotaki and Moore, 1997; Brunnermeier and Sannikov, 2011) than on other channels.

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Figure 11: Impulse response of leverage model (pre-crisis period)

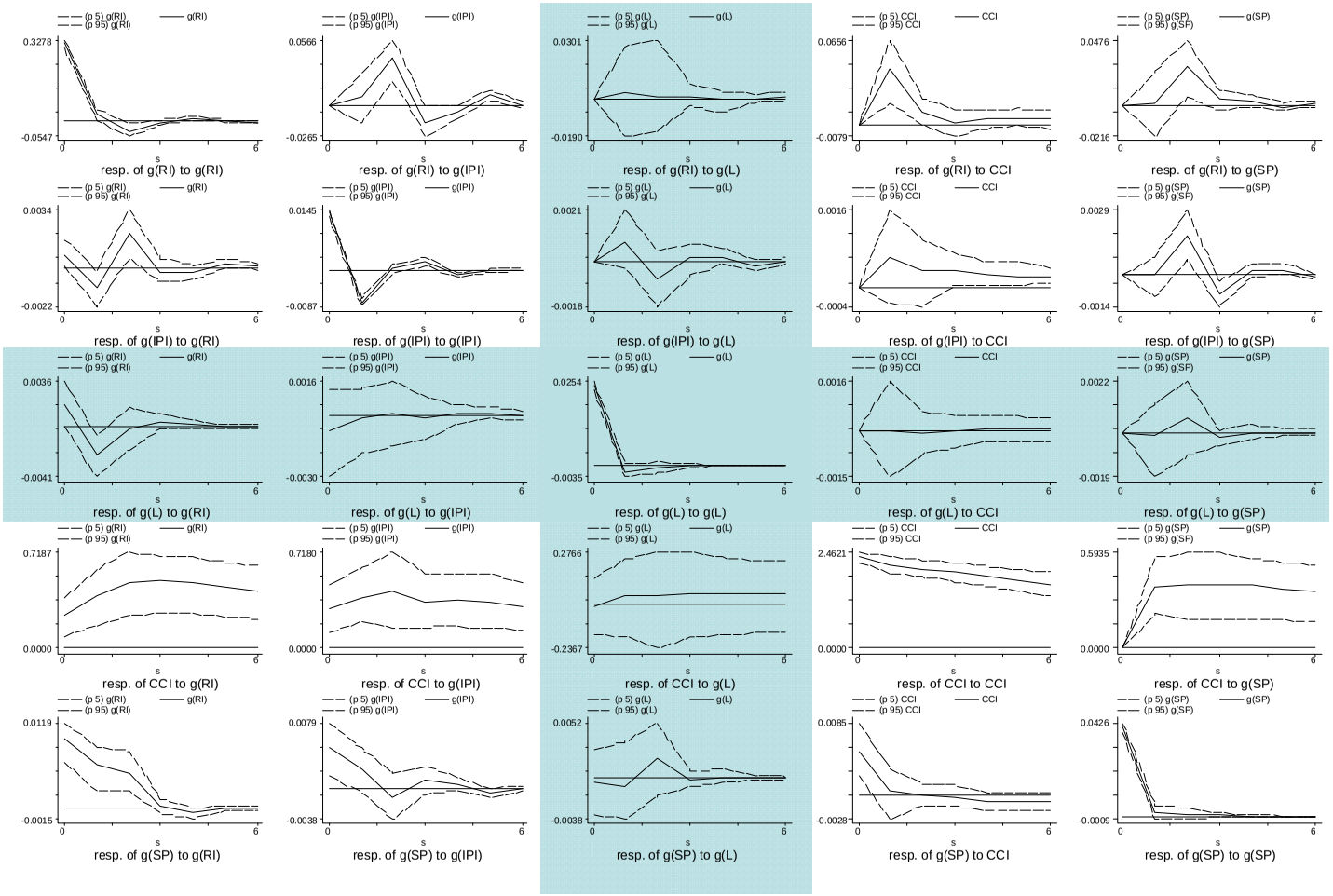


Figure 12: Impulse response of leverage model (crisis period)

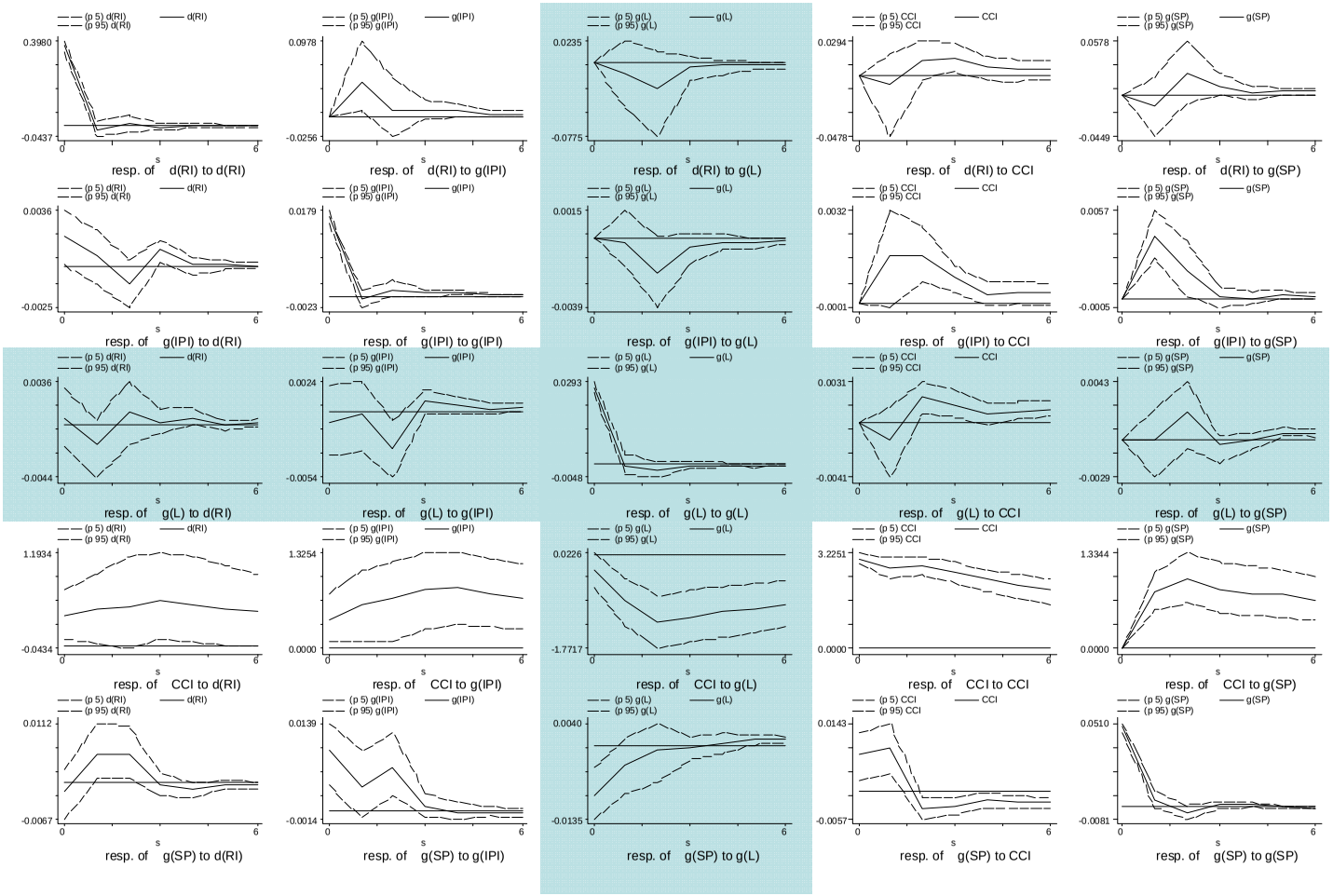


Figure 13: Impulse response of component model (pre-crisis period)

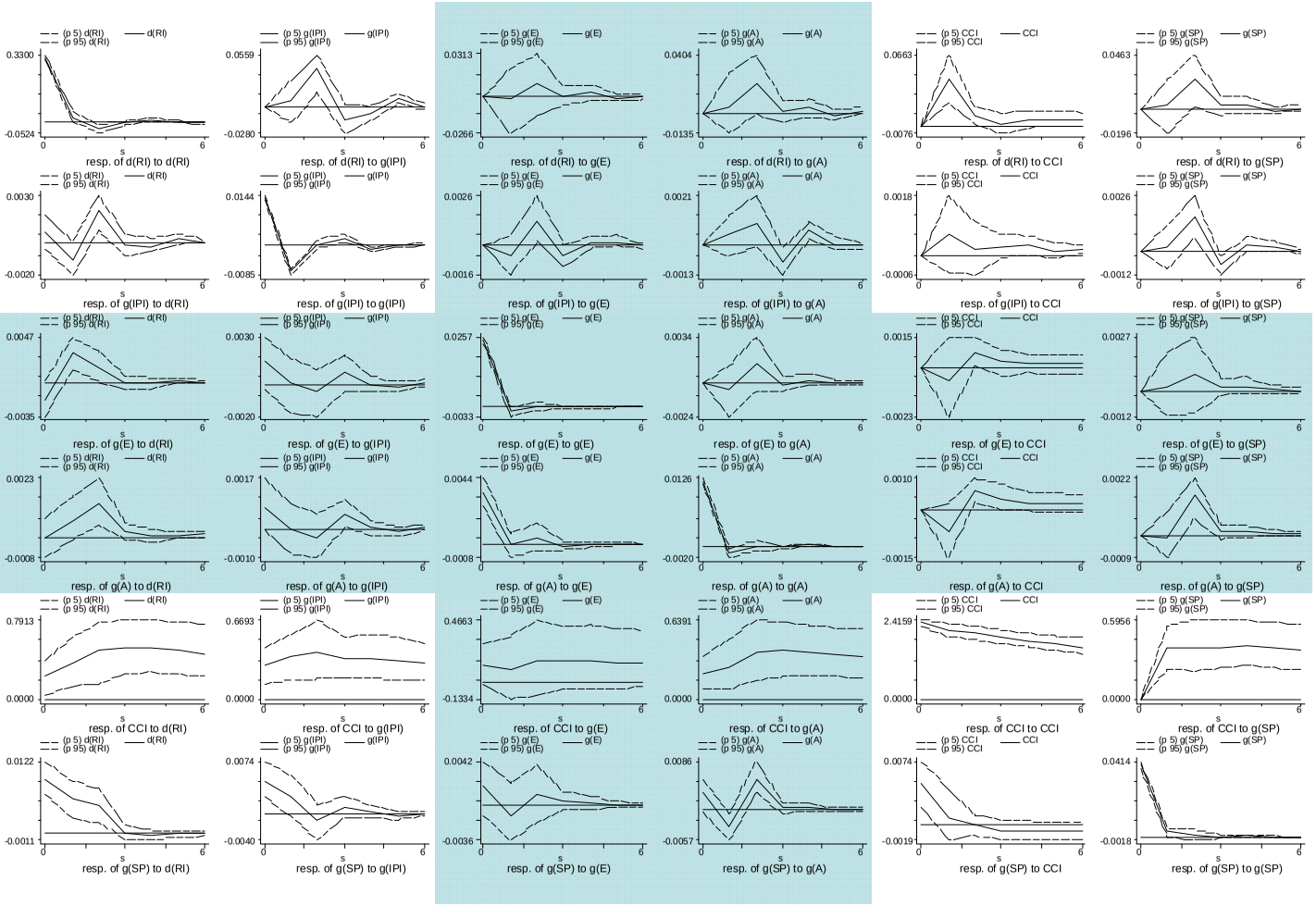


Figure 14: Impulse response component model (crisis period)

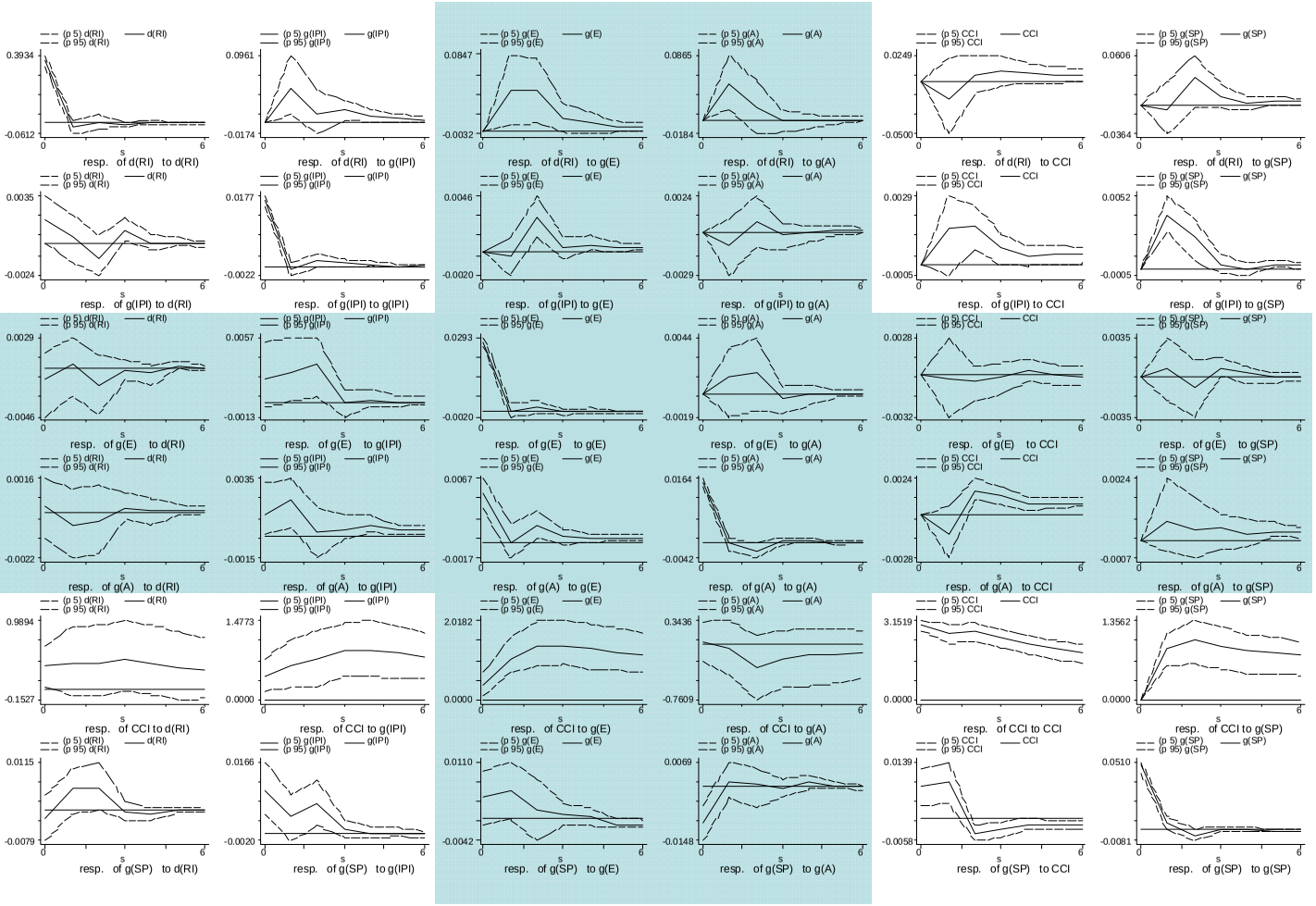


Figure 15: Difference in impulse responses component model between crisis and pre-crisis period

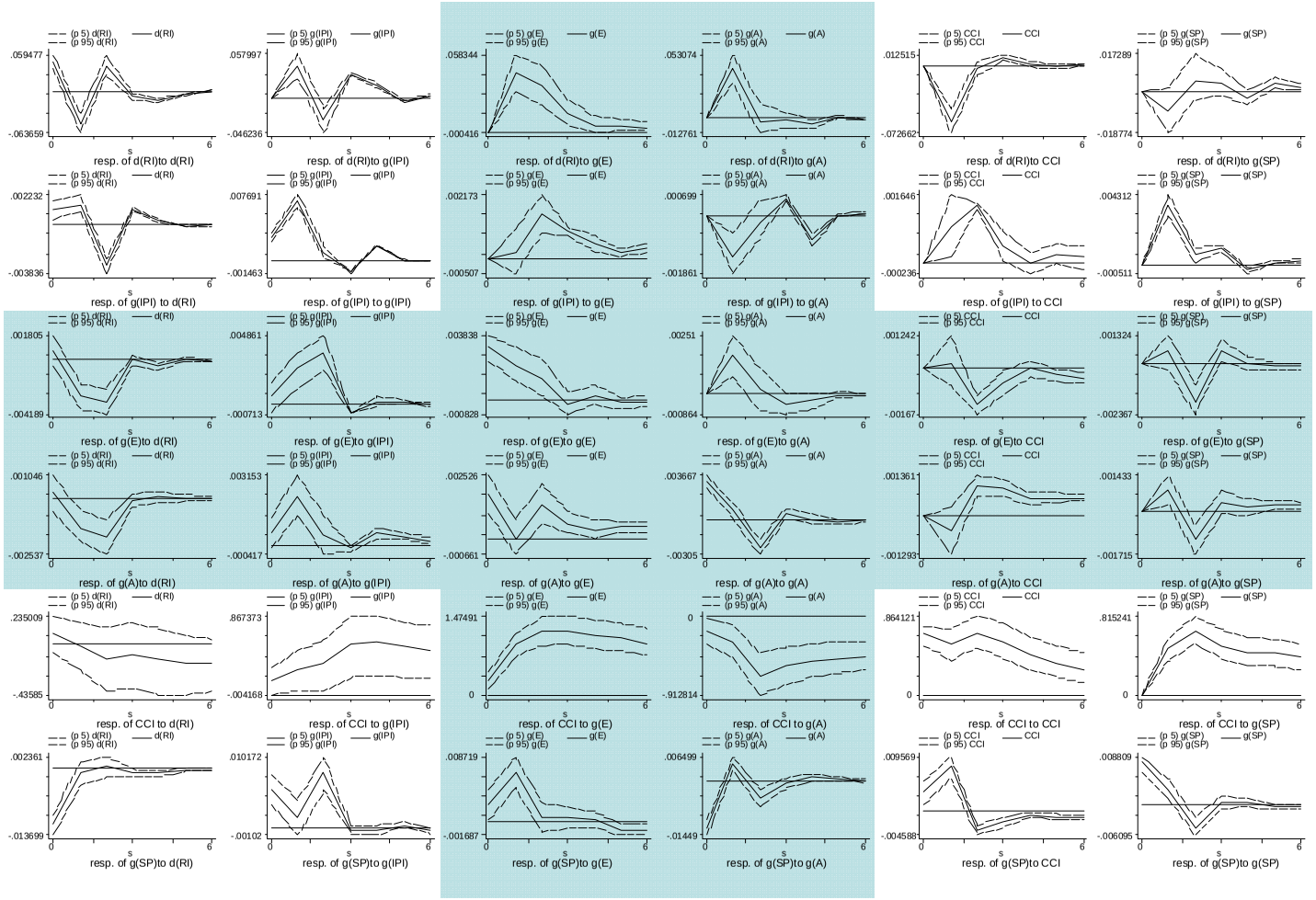


Figure 16: Impulse response, Luxembourg (pre-crisis period)

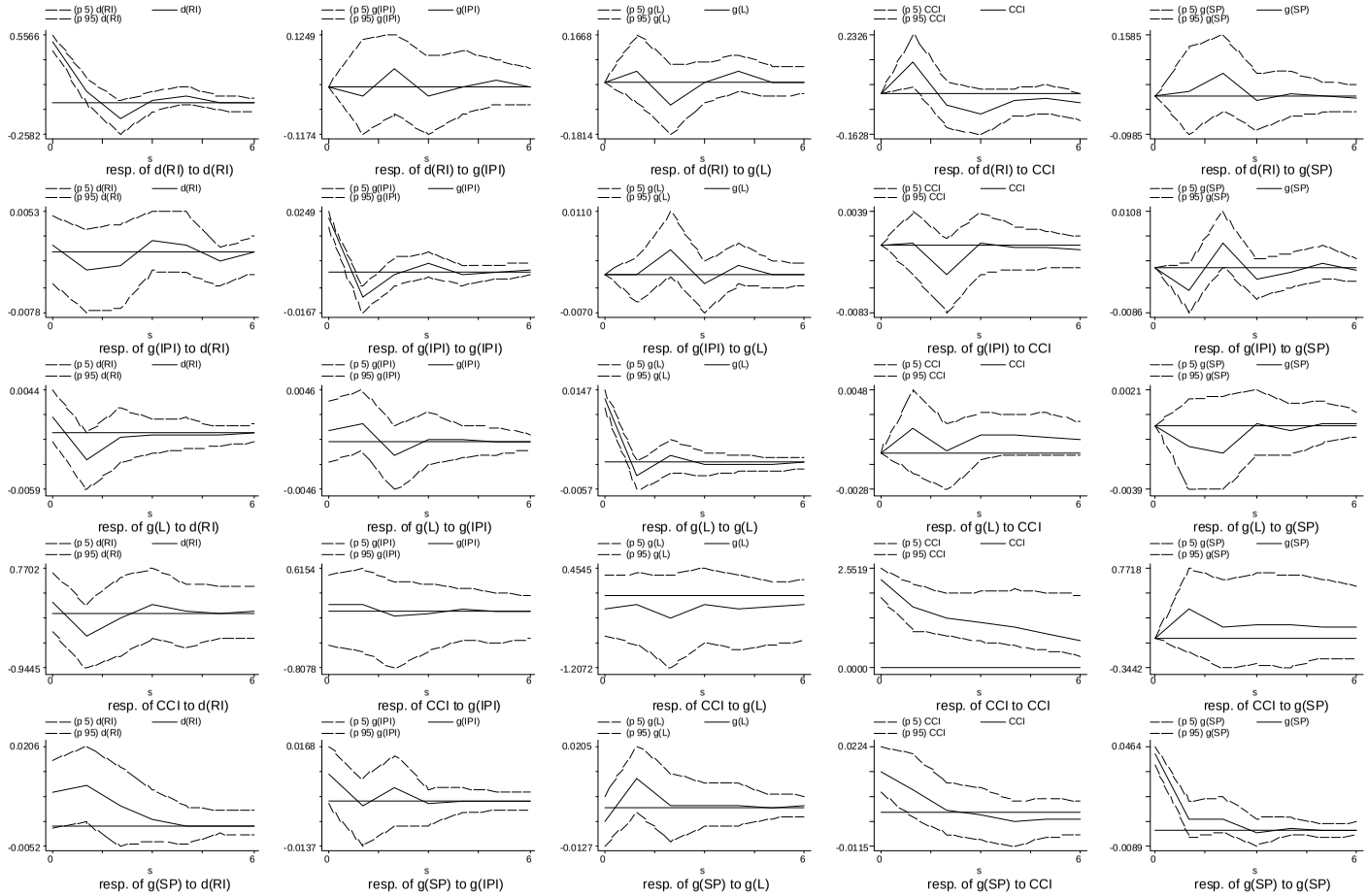


Figure 17: Impulse response, Luxembourg (pre-crisis period)

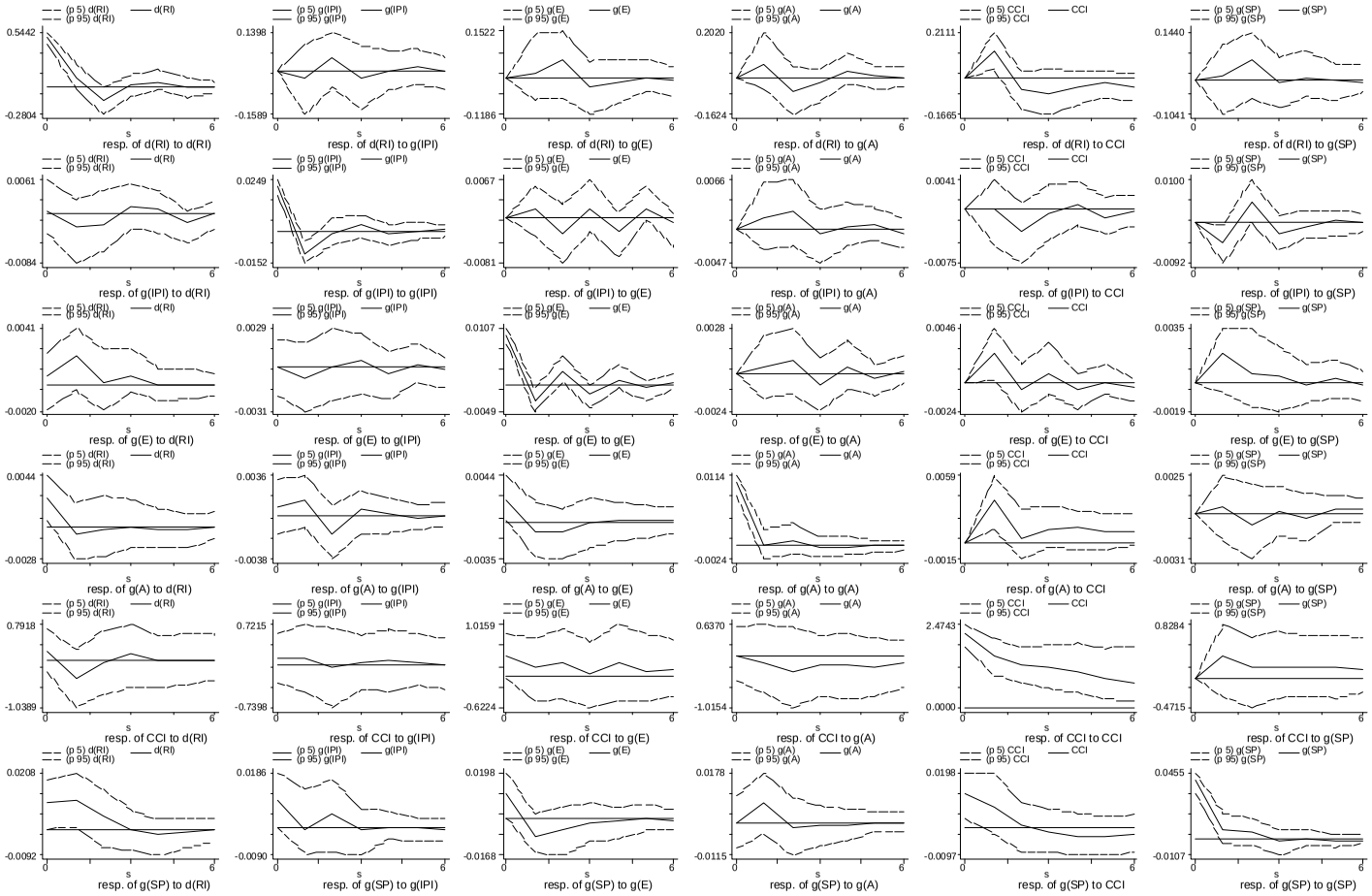


Figure 18: Impulse response of leverage model, Luxembourg (crisis period)

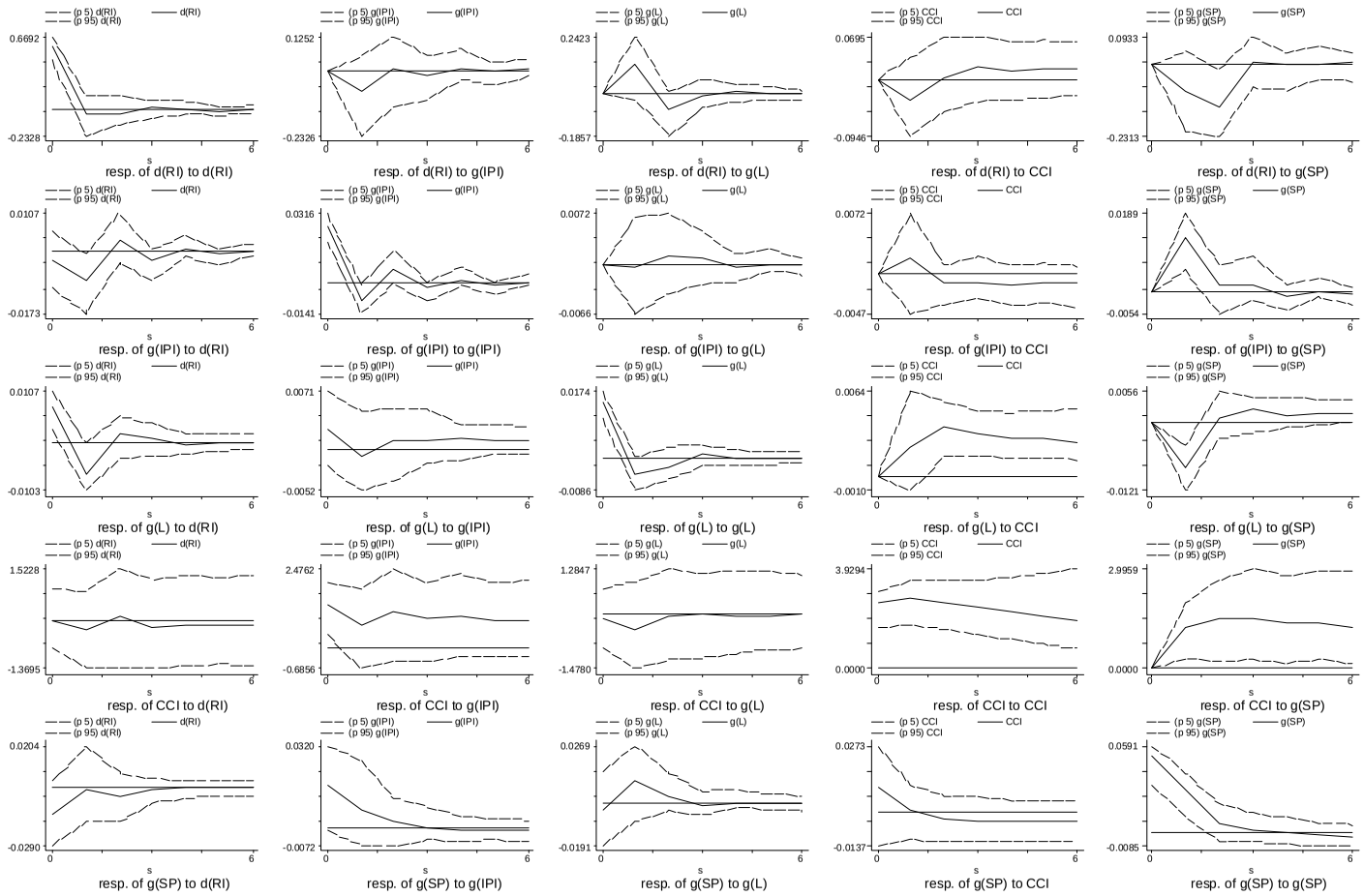


Figure 19: Impulse response of component model, Luxembourg (crisis period)

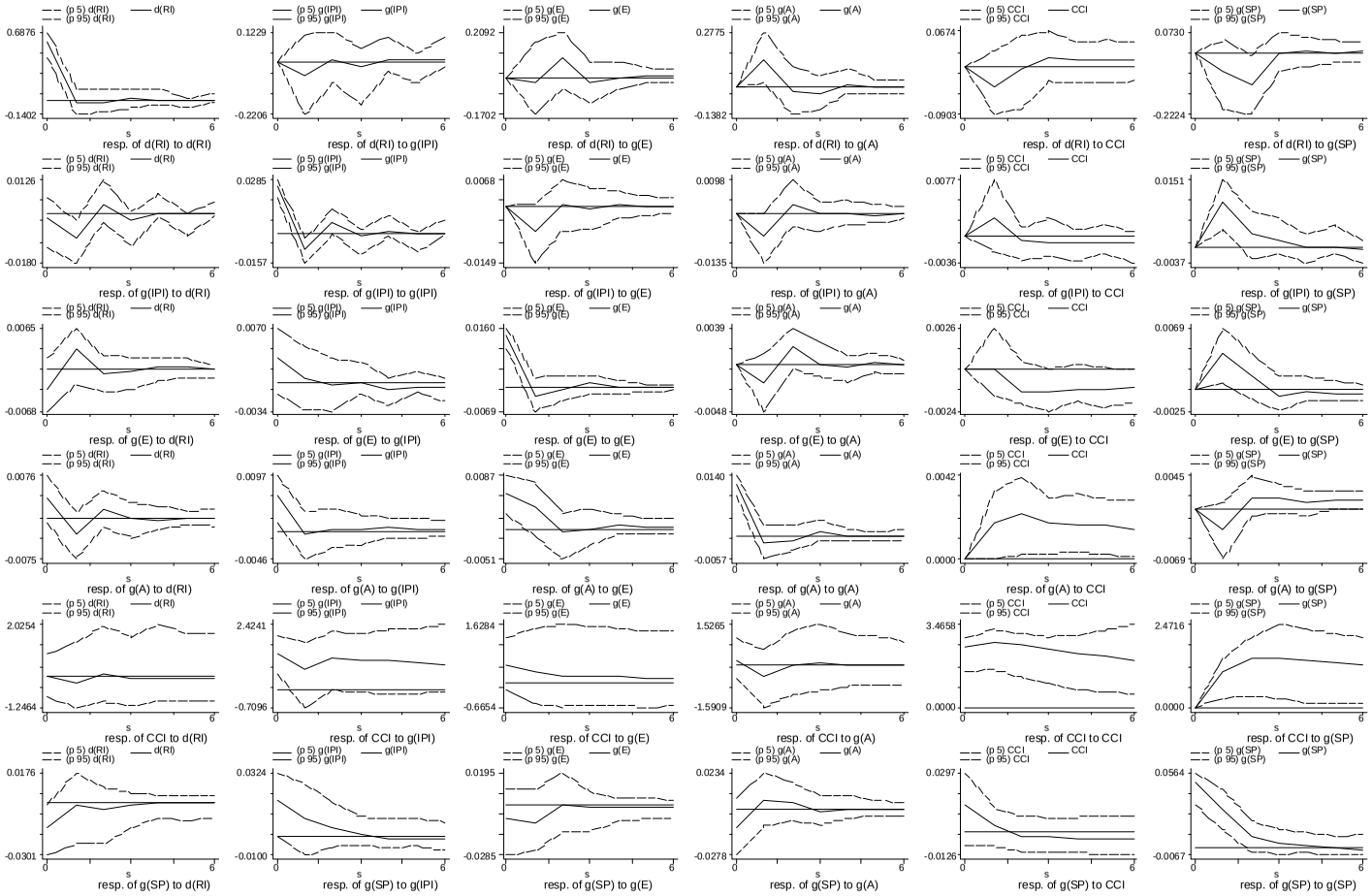
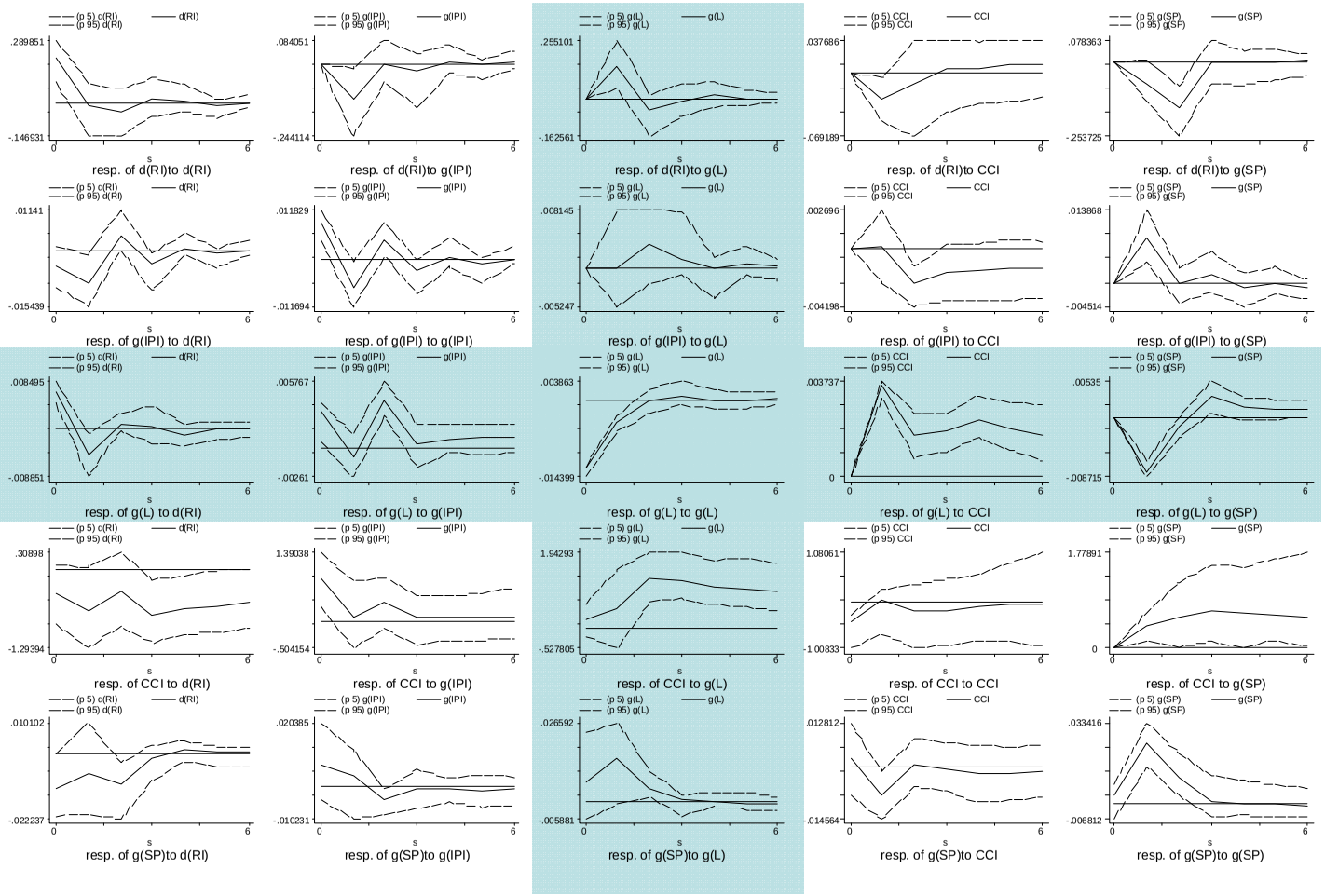


Figure 20: Difference in impulse responses of leverage model between Luxembourg and Europe, crisis period



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