# Macro-financial linkages: The role of the institutional framework

*Preliminary draft*

Aurélien Leroy[*]   Adrian Pop[†]

## Abstract

In this paper, we assess the quantitative impact of various financial shocks on real activity and explicitly address the issue of heterogeneity in the macro-financial linkages. For that purpose, we use VAR models as well as the local projection method for 18 OECD countries based on quarterly data between 1996 and 2015. We take into account three main dimensions of the institutional framework likely to explain the observed cross-country heterogeneity in the propagation of financial shocks: the product market regulation, the employment protection, and the financial structure. Overall, our main findings indicate that financial shocks have a stronger impact in countries characterized by a higher competition-friendly regulatory stance, a stronger employment protection, and a more market-oriented financial structure. We also show that the varieties of capitalism, described by the particular mix of these different institutional areas, do not play a significant role in shaping the macro-financial linkages. This result suggests that although considered individually goods, labor, and financial markets regulations are robustly linked to macroeconomic fluctuations, there is no support for superior performance of any institutional arrangement.

**Keywords:** macro-financial linkages; financial shocks; heterogeneity; institutional complementarities

**JEL Codes:** C32; E32; E44; E52

[*]LAREFI, University of Bordeaux, Campus de Pessac. Avenue Léon Duguit, 33608 Pessac Cedex, France. Corresponding author. E-mail: aurelien.leroy@u-bordeaux.fr

[†]LEMNA, University of Nantes, Chemin de la Censive du Tertre, BP 52231, 44322 Nantes, France. E-mail: adrian.pop@univ-nantes.fr

# 1   Introduction

The 2008 financial crisis and the Great Recession that followed has emphasized the importance of macro-financial linkages and fueled a vivid debate about the relevance of financial factors for business cycle fluctuations. Specifically, the crisis has underlined the fact that the real sector may interact with and be amplified by the financial sector, resulting in a high level of procyclicality and a build-up of systemic risk that becomes source of financial stress when the economy turns down. Because this sequence has had devastating and persisting effects on real economies, the so-called "macro-financial linkages", i.e. the two-way interplays between financial system and macro-economy, have become an increasingly hot topic on the agenda of economists and policy makers.

However, the interest for the macro-financial linkages and procyclicality did not start with the Great Recession. Bernanke and Gertler (1989), Greenwald and Stiglitz (1993), Kiyotaki and Moore (1997), Bernanke et al. (1999) and others have previously developed macro models that incorporate boom-bust cycles in the financial sector that affect the real sphere. Roughly speaking, these models show that information asymmetries (causing adverse selection and moral hazard in the financial markets) generate an external finance premium -a wedge between the cost of external finance and the opportunity cost of investment- that adds to the overall cost of credit and depends on the conditions of borrower balance sheets. In general equilibrium, this produces a "financial accelerator" effect: a positive (adverse) shock in the real sphere improves (deteriorates) the conditions of borrower balance sheets, reducing (increasing) the external finance premium and, in turn, enhances (weakens) borrower spending, which amplifies the initial real shock.

From a different perspective, outside the mainstream, Minsky (1982), Kindleberger (1978), Borio et al. (2001), and Lowe and Borio (2002) argue that the mismeasurements of risks over time in the financial sphere (under-/over-estimation during boom/bust phases) feed bubbles that are likely to trigger financial crises -meaning a disruption of financial intermediation and not just an increase of borrower credit constraints- and, subsequently, to lead to large swings in economic activity.

In spite of these prominent contributions, the macro models in use before the financial turmoil of 2007–2008 largely assumed perfect capital markets and saw finance as a veil and, hence, were inaccurate in predicting the severity of recessions. To address this shortfall and reproduce the stylised empirical features of the financial crisis, a large theoretical literature has embedded financial frictions and a financial sector into business cycle models (Curdia and Woodford (2010), Gerali et al. (2010), Iacoviello and Neri (2010), and Iacoviello (2015)) and analyzed the effects of financial shocks (Gilchrist

et al. (2009), Meh and Moran (2010), Jermann and Quadrini (2012)) amending the prevailing paradigm.

In the wake, a voluminous empirical literature has analyzed and sought to quantify the strength of the macro-financial linkages (see, among others, Gilchrist et al. (2009), Claessens et al. (2012), Hristov et al. (2012), Hubrich et al. (2013), Helbling et al. (2011), Prieto et al. (2016), and Aldasoro et al. (2017)). Three main questions have been explored so far in this literature: (i) which financial shocks really matter?, (ii) how important are financial shocks in shaping real economic fluctuations?, and (iii) are the macro-financial linkages heterogeneous across countries and over time? Overall, the main findings show that shocks to assets prices, banking sector net worth, term spread, and financial stress significantly affect the real activity. Importantly, the reported results also suggest that macro-financial linkages are characterized by a high degree of cross-country heterogeneity. Against this background, the aim of our study is to investigate the structural factors behind the observed cross-country heterogeneity, likely to produce large and significant differences in macroeconomic outcomes at the country level. More precisely, we seek to determine what are the most relevant institutions, at the root of the differential in economic structures across countries, which allow a better absorption of financial shocks and, therefore, to reduce macroeconomic volatility.

To address this question, we rely on the institutional and comparative political economy literatures. Up to now, the vast majority of papers in these literatures have questioned whether and how do the institutions, which define the rules and rights intended to protect and support private contracts, affect the long-term performance of various economies. The most common approach adopted in the literature has mainly consisted in focusing on institutions in one institutional domain at a time. According to Amable (2003), five institutional domains allow to apprehend the institutional diversity of various economies: the product market, the labor market, the financial market, the organization of social protection, and the education system. As a result, there are at least five different voluminous literatures on institutions that evolve separately from each other.

We depart from this body of research in two distinct ways: (i) we focus on the effects of institutions on business cycle fluctuations and (ii) we take explicitly into account the interactions among institutions belonging to different spheres of the political economy. Regarding the first point, the literature linking the macroeconomic volatility to institutions is relatively scarce. Rodrik (1999) and Acemoglu et al. (2003) document this topic by examining whether institutionally weak societies are characterized by a greater macroeconomic instability. Rodrik (1999) shows that non-democratic countries tend

to exhibit higher macroeconomic volatility than well-established democracies, while Acemoglu et al. (2003) argue that formerly colonized countries that benefited from institutions that reduce arbitrary exercise of power by politicians and social groups fighting for control of resources experience less volatility. Other contributions have focused on institutions in specific spheres of the economy. For instance, Blanchard and Wolfers (2000) examine the effects of labor institutions (unemployment insurance and employment protection) on the transmission of adverse shocks to unemployment for a sample of European countries. The authors argue that labor institutions are not able to directly explain the differential in unemployment across European countries as these institutions had already been in place when the unemployment rates reached broadly similar levels in the 70s. In contrast, the interaction between labor institutions and adverse shocks seems to explain much better the observed differential in unemployment: weak labor market institutions may affect the impact as well as the persistence of adverse shocks to unemployment. For instance, in labor markets characterized by low turnover rates (due, e.g., to high barriers to entry), adverse shocks are more likely to make unemployed workers leave the market because they either lose skills or lack motivation. This reduces the pressure of unemployment on wages and, therefore, the speed of adjustment to the long-run employment equilibrium.

In the same vein, Canova and Kontolemis (2012) investigate another important institutional sphere: the product market. Their analysis using industry-level data shows that product market reforms increase the resilience of economies to common shocks. The prevalence of common trends in structural reforms implemented in different areas, as well as complementarities between institutions, require to take into account the co-existence of different institutions (see, e.g., Amable (2000), Amable (2003), Boeri et al. (2000), Blanchard and Giavazzi (2003), Nicoletti and Scarpetta (2003)). By exploring this idea, Canova and Kontolemis (2012) show that besides product market regulations, cross-country differences in resilience can be explained by the degree of financial development, which governs the nature of the relationships in the financial markets. Duval and Vogel (2008) and Sondermann (2017) also carry out joint examinations of different structural policies and their impact on the ability of various economies to absorb shocks.

On the whole, the literature shows that product, labor, and financial market rigidities reduce the resilience to shocks and increase macroeconomic volatility. However, explaining these empirical results from a strict theoretical point of view remains a challenge. As stated by Duval and Vogel (2008), the inclusion of nominal rigidities in neo-keynesian macro models bends the Phillips curve. As a result, independent central banks mandated to stabilize inflation react optimally in a less aggressive way

to supply shocks (cost-push and technology shocks)[1]. This, in turn, would cushion the initial shock but, in the same time, slow down the adjustment to the stationary state. In contrast, real rigidities would induce a more aggressive response to supply shocks as they would lead to an increase in the persistence of inflation. In sum, the empirical effects of a supply shock seem quite difficult to anticipate. As far as the demand shocks are concerned, the absence of an inflation-output trade-off in this case obviates the effects of rigidities in standard neo-keynesian models. As a result, as it is unclear whether financial shocks are demand- or supply-driven with respect to their macroeconomic consequences (see, e.g., Fornari and Stracca (2012)), there is a theoretical uncertainty regarding the effects of rigidities on the transmission of financial shocks.

Against this background, the present paper represents a first attempt to empirically test, for a sample of 18 OECD countries, whether the institutional framework allows to cushion financial shocks and to reduce their persistence. In addition, we are interested in identifying among the various dimensions of the institutional framework, viz. (1) the product market regulation; (2) the employment protection; and (3) the architecture of the financial system, which are those that are the most relevant in shaping the macro-financial linkages.

From a methodological point of view, we proceed in two steps. First, we start with a basic correlation analysis and a set of standard reduced VAR models estimated at country level to draw a broad picture of the co-movements between the considered financial variables (asset prices, term spread, bank net worth, common financial stress) and macroeconomic outcome (output gap). The results of our preliminary analysis are consistent with the empirical regularities reported in the previous literature (see e.g. Hubrich et al., 2013, and the references therein): despite some observed commonalties, the real effects of financial shocks exhibit a high degree of heterogeneity across countries.

Second, we attempt to explain this cross-country heterogeneity by linking the real effects of financial shocks to the specific features of the institutional framework. For that purpose, we follow Towbin and Weber (2013) and apply the Interacted Panel VAR (IPVAR) methodology, which allows us to embed the structural variables directly into the VAR system and use them in a very flexible way to condition the relationships between the endogenous (macroeconomic) variables. We identify the structural financial shocks by imposing short-term restrictions assuming a recursive exogeneity structure for our model in line with Goodhart and Hofmann (2008), Musso et al. (2011), and Guarda and Jeanfils (2012). Alternatively, as a robustness check, we also apply the local projection method of Jordà (2005) -which has the advantage of not imposing a

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[1]The explanation is that the output cost to reduce inflation is higher.

particular data generating process- to estimate conditional relationships between financial and real variables.

Overall, our main findings indicate that shocks on asset (housing and stock) prices, term spread, banking sector net worth, VIX, and International Monetary Fund (IMF) composite indicator of financial stress have a stronger impact in countries characterized by a higher competition-friendly regulatory stance, a stronger employment protection, and a more market-oriented financial structure. Our results provide empirical support for the idea that specific features of the institutional framework do play an important role in shaping the macro-financial linkages. Furthermore, we also contribute to the literature on the varieties of capitalism by showing that the institutional differences between four archetypes of capitalism (viz., Liberal, Scandinavian, Continental, and Mediterranean) do not lead to systematic and significant differences in macro-financial linkages. We explain this result by the existence of institutional complementarities: each system can be viewed as a particular mix of institutions, in which stabilizing institutions in some areas act as a counterbalance to destabilizing institutions in some other areas.

In term of policy implications, one should keep in mind that our study solely focuses on the effects of the institutional framework on business cycle fluctuations, disregarding its effects on the long-term performance. As, in practice, some trade-offs are likely to exist between reducing business cycle fluctuation and increasing long-term performance, our study does not allow to unequivocally support structural policy reforms. Rather, it should be viewed as a path of worthwhile investigation that extends and complements the existing literature. In particular, we draw attention to the fact that an increase of competition in the product market, as well as the development of financial markets, may have serious downsides, largely neglected in the literature, in terms of business cycle fluctuations. As a result, the traditional cost-benefit analyses of the structural policy reforms have to carefully consider these effects. Regarding the labor market rigidities, our results do not seem to cast doubt on the direction of reforms recommended by the doxa. Indeed, less stickiness in the labor market seems to reduce business cycle fluctuations.

Finally, our study shows that there seems to be no canonical model of capitalism from the standpoint of business cycle fluctuations. The hegemony of the liberal model is questionable at best, as different types of institutional arrangements do not lead to significant differences in macro-financial linkages. This finding goes against the conventional wisdom suggesting the convergence of various capitalism models toward the liberal one. However, it is in line with a large body of the literature on the variety of capitalism showing that the co-existence between different types of institutional ar-

rangements is suitable (see e.g. Amable, 2000, 2003, Boyer, 2004, and the references therein).

The paper is organized as follows. Section 2 explains the construction of our main structural variables capturing specific features of the institutional framework, viz. (1) the product market regulation index; (2) the employment protection index; and (3) the financial structure index. Section 3 briefly describes data and the three blocks of variables: macroeconomic, financial, and structural. Section 4 provides preliminary evidence on the cross-country heterogeneity based on simple correlation analyses and standard reduced VAR models estimated at the country level. In Section 5, we focus on the role of the institutional framework and discuss the results obtained by estimating Interacted Panel VAR (IPVAR) models. *In fine*, Section 6 concludes and discusses some policy implications and directions for future research in this area.

## 2 The institutional framework

We choose three structural variables to capture the most relevant features of the institutional framework. The objective of this section is to briefly describe the construction of these variables and explain the expected link between each of the structural variables and the real effects of financial shocks. Figure 1 provides a broad picture of the link between each of our institutional variables and the macroeconomic volatility, computed as the standard deviation of the real GDP per capita growth rate over three distinct periods (1995-2001, 2002-2008, and 2009-2015). The stringency of the legislation on employment protection and the structure of the financial system do not seem to be related to macroeconomic volatility. However, countries characterized by a relatively more competition-friendly regulatory stance in the product market (low Product Market Regulation index) experience, on average, higher macroeconomic fluctuations.

### 2.1 Product Market Regulation

Our first dimension of the institutional framework is the Product Market Regulation (PMR). Product market institutions and policies are likely to affect the way financial shocks propagate to the real economy mainly through their effect on productivity performance, a crucial ingredient of GDP growth. Indeed, PMR affects in important ways firm governance structures, ownership, entrepreneurial incentives, and market access. In turn, best practices in corporate governance, incentive-compatible policies, and competitive pressures are likely to boost productivity and enhance framework conditions for macroeconomic performance and growth. Conversely, strict product market regulations (e.g. entry barriers, natural monopoly markets, state controls) and slow regulatory reforms may hinder the diffusion of innovation and inhibit technology

Figure 1: Economic Structures and Macroeconomic Volatility

(a) Product Market Regulation     (b) Employment Protection     (c) Financial Structure
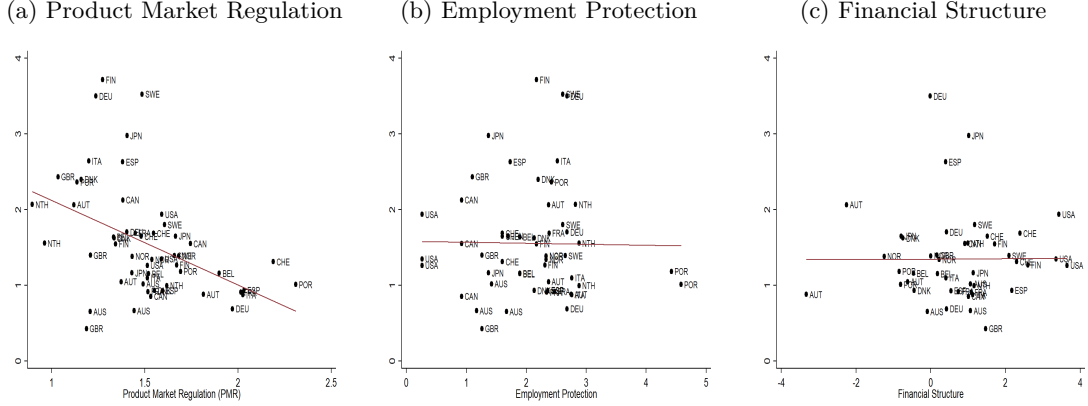


Note: Macroeconomic volatility, on the y-axis, corresponds to the standard deviation of the real GDP per capita growth rate and is computed over three sub-periods: 1995-2001, 2002-2008, and 2009-2015. The structure variables are averaged over the three sub-periods.

spillovers from innovative firms, leading to a poorer productivity.

By using data covering a large set of manufacturing and service industries in several OECD countries over the 1980—2000 period and original proxies for PMR and regulatory reforms, Nicoletti and Scarpetta (2003) show the existence of significant empirical links between product market policies and productivity performance. Bourlès et al. (2013) and Buccirossi et al. (2013) provide more recent evidence on the productivity and PMR / competition policies nexus.

Excessive product market regulation may also affect macroeconomic fluctuations through the shock absorption capacity of the economy. Indeed, the resilience of an economy to shocks is strongly dependent on the way prices adjust and production factors are reallocated across firms and sectors. According to Sondermann (2017), a quick price adjustment is crucial to ensure the competitiveness of an economy after a negative shock, when the labor cost declines. From this point of view, limited competition in product markets impedes entry of new firms and acts as one of the main obstacles to an effective shock absorption capacity at the country level. By using a large panel of OECD countries over nearly 35 years, Sondermann (2017) presents evidence that limited competition in product markets and institutional factors hindering the entrance of new firms weaken the resilience towards adverse common shocks and increase the incidence of crises, measured as pronounced falls in GDP.

Last, but not least, product market regulation is relevant for aggregate fluctuations through the effect of entry on the cyclical behavior of price-cost markups. As explained by Lewis and Stevens (2015), in standard New Keynesian models, an ex-

pansionary *demand* shock raises marginal costs and leads, if the prices are sticky, to a decline in markups. Conversely, an expansionary *supply* shock lowers marginal costs and induces, again, if prices are sticky, an increase in markups. However, product market competition conditions entry and exit of firms and, *in fine*, the dynamics of markups, the subsequent inflationary pressures, and the way the propagation of shocks is either amplified or dampened. To investigate this mechanism, Lewis and Stevens (2015) use Bayesian techniques to estimate the effect of entry on markups in a DSGE model. Their main conclusion is that the way product market competition shape macroeconomic fluctuations is highly dependent on the nature of the shock. Precisely, supply shocks (e.g., TFP shocks, entry cost shocks, and wage markup shocks), as well as monetary policy shocks, induce a procyclical movement of entry, which generates a countercyclical desired markup and dampens inflation. In contrast, demand shocks (e.g., government spending shocks, investment-specific technology shocks, and time preference shocks) lead to a countercyclical response of entry and procyclical desired markups.

Figure 2: Product Market Regulation
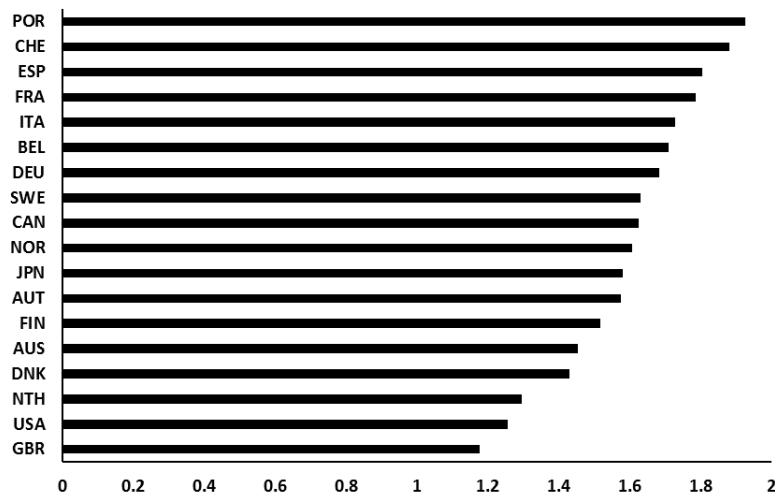


As a proxy for PMR, we use in our study the OECD composite indicator, which is internationally-comparable and available at the nation-wide levels. It measures the degree to which public policies promote or inhibit competition in several areas of the product market: state control of business enterprises; legal and administrative barriers to entrepreneurship; and barriers to international trade and investment. The construction of the PMR indicator involves the conversion of detailed qualitative information concerning individual regulatory provisions into cardinal values that allow ranking countries' regulations according to their potential impact on governance and competition. The aggregation of information takes place within a multi-step, bottom-up

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approach (see Koske et al. (2015) for a detailed description of the most updated ranking methodology). The PMR indicator is normalized over a zero-to-six scale, where a lower value indicates a relatively more competition-friendly regulatory stance. Figure 2 presents a ranking of our sample countries according to the value of the PMR indicator. As expected, countries like the US and the UK are characterized by relatively more competition-friendly environments compared with continental Europe countries like Portugal, Switzerland or Spain.

## 2.2 Employment Protection

While cross-countries differences in product market arrangements have often been emphasized to explain the observed heterogeneity in productivity and macroeconomic performance, labor market conditions are also likely to have a bearing on aggregate employment and economic growth and, *in fine*, on the real effects of financial shocks.[2] In particular, one of the most important institutional factors affecting the labor market conditions is the stringency of the legislation on employment protection. From a theoretical point of view, there are at least three broad channels through which the institutional framework prevailing in the labor market and the Employment Protection Legislation (EPL) could affect aggregate employment (see OECD, 2013). First, a stringent EPL may lead to higher unemployment and, in particular, to higher youth and long-term unemployment by hindering recruitment and reducing labor turnover. Second, employment protection may lead to lower productivity by reducing labor turnover and through rigidities in restructuring and organizing activity. Third, stringent EPL may increase the segmentation of the labor market by encouraging firms to favor the least protected employment forms. From an empirical point of view, the potential impact of EPL on aggregate employment or unemployment is ambiguous at best. Many studies found weak or no significant effects (see OECD, 2006; Howell et al., 2007; and Boeri, 2011), with some notable exceptions. In particular, Lazear (1990), Scarpetta (1996), Elmeskov et al. (1998), and Di Tella and McCulloch (2005) document that tougher EPLs have a negative effect on employment (i.e. increase unemployment), while Amable et al. (2011) find the opposite, viz. stringent EPLs decrease unemployment on average in a sample of OECD countries.

Besides the effect on aggregate employment, the EPL may also impact the productivity growth and macroeconomic performance. Theoretically, the EPL is likely to increase the cost of workforce adjustment by introducing more rigidity in the functioning of labor market or by distorting the mix between temporary and regular workers.

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[2]A distinct strand of literature focuses on the institutional complementarities between labor market arrangements (e.g. employment protection legislation or union density) and product market regulations. For further discussions, see e.g. Blanchard and Giavazzi, 2003, Amable and Gatti, 2004, Nicoletti and Scarpetta, 2003, and Griffith et al., 2006.

Thus, stringent EPLs may have a negative impact on the efficient allocation of resources in the labor market and, *in fine*, on productivity growth (see e.g. Hopenhayn and Rogerson, 1993, and Bertola, 1994, for theoretical models illustrating this effect). Recent empirical studies tend to lend support to these theoretical intuitions. Autor et al. (2007), Bassanini et al. (2009), and more recently Van Schaik and Van de Klundert (2013) show that stringent EPLs generally reduce multi-factor productivity growth, while structural reforms making the EPLs softer increase productivity.

Finally, other studies investigate the effect of EPL on the adjustment of the labor market to shocks or on the resilience of the economy to shocks. Blanchard and Wolfers (2000) and Nickell et al. (2005) find that EPL slows the adjustment, particularly when it comes to negative shocks. A related literature reveals that in countries characterized by more stringent EPLs, the productivity adjusts more slowly to long-run levels (see e.g. Burgess et al., 2000, and Caballero et al., 2004) and the employment rate is much slower to converge to its steady state value, especially after a monetary shock (see e.g. Lechthaler et al., 2010) or an output shock (see e.g. Bassanini, 2012, and Gal et al., 2012). Last, but not least, excessive EPLs may impede the adjustment of firms and affect the size of the labor force following an economic shock by discouraging firms to hire and favoring the unemployed over the employed. Sondermann (2015) presents evidence that more stringent EPL and rigid labor markets weaken the resilience towards adverse common shocks. Precisely, based on a sample of OECD countries observed over more than 35 years, he shows that an economy characterized by the highest labor market rigidities experiences a –1.61% reduction in contemporaneous output, while the country with the most flexible labor market only sees GDP deteriorate by -0.74%. More stringent EPLs have also a significant (negative) effect on the probability of experiencing a crisis, defined as a pronounced fall in GDP.

As a proxy for EPL, we use in the present study the OECD's overall summary indicator of EPL strictness, which is a discrete indicator ranging from 0 to 6. A higher value indicates a more stringent regulation of employment. The indicator covers more than 200 items, classified into two broad categories: 1/ the protection against individual dismissal of regular (permanent) workers and additional regulations on collective dismissals (EPRC) and 2/ the protection regarding temporary forms of employment (EPT). The computations of the EPRC and EPT indicators are based on a set of questionnaires sent by the OECD to government authorities. The main source of information is the labor laws, collective bargaining agreements, specific regulations, etc. In a first stage, each item is converted to a cardinal scale. Then, the synthetic indicator is compiled using *ad hoc* weighting schemes (see OECD, 2013, for additional methodological details, and Figure 3 for a ranking of countries with respect to the stringency of EPL).

Figure 3: Employment Protection Legislation
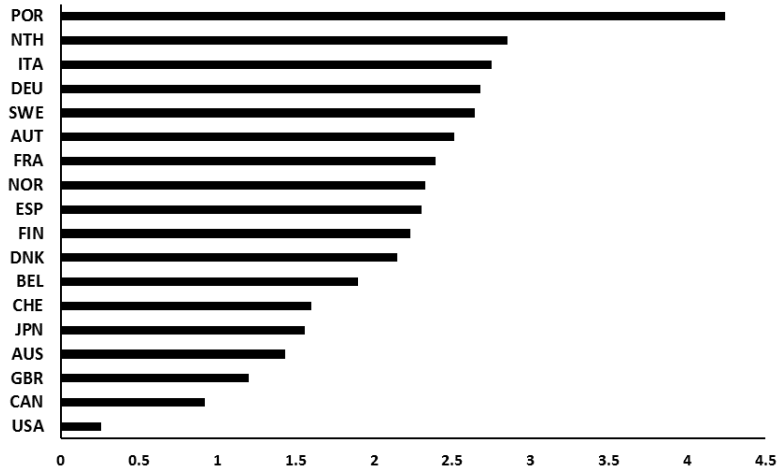


## 2.3 Financial Structure

The relationship between the structure of the financial system and various economic outcomes (growth, output volatility, income inequality, etc.) has been a privileged topic of a vast and now well-established literature. The central question of this literature has been whether bank- or market-oriented financial systems stimulate economic growth. On the one hand, it is stated that in a bank-oriented financial system, banks and other financial intermediaries are in a better position to process information and build long-term relationships with borrowers (see Allen and Gale, 2000). On the other hand, those who favor market-based systems put forward that the bank-oriented financial system may be more conservative in nature and so, less suitable to finance highly innovative projects (see Rajan, 1992).

The results reported in the literature are inconclusive and do not allow to provide a clear answer to the question. Demirgüç-Kunt and Maksimovic (2002), Levine (2002), and Beck and Levine (2004), among others, find that financial structure has no substantial effect on economic growth. Others, however, infer more nuanced conclusions. For instance, Demirgüç-Kunt et al. (2013) reveal that financial structure still matters after taking into account the level of economic development. As economies grow, the output becomes more (less) sensitive to changes in financial markets (banking system) development. In the same vein, Gambacorta et al. (2014) find that banks and markets differ considerably in their effects on business cycle fluctuations. Precisely, banks are more likely to continue to grant loans during a moderate downturn, thus smoothing the potential recessionary effect. However, when the downturn is much deeper (because, e.g., of a severe banking or financial crisis), recessions in countries with bank-based sys-

tems are three times worse than in countries with a market-based financial structure. In a recent work, Grjebine et al. (2018) focus on the relevance of the mix between market and bank debt financing in explaining macroeconomic fluctuations. Using a panel of 23 developed and developing countries over a long period of time covering several business cycles, they show that the substitution between the two sources of funding during the recovery phase is a prevalent feature of business cycles. Precisely, countries in which market debt financing counts for a significant share of aggregate funding and non-financial firms switch easily from bank to market financing, experience on average faster and more vigorous recoveries after recessions. This empirical regularity is robust to a series of other relevant determinants of recoveries, such as the size and quality of financial markets, the type of crisis (banking vs. financial), the dynamics of aggregate credit, and the characteristics of the empirical distribution of firm size in various countries. From a theoretical point of view, a natural explanation of this result is that bond financing allows firms to better face a contraction in bank lending, which stimulates in turn private investment and the return to economic growth.

In a recent study, more related to ours, Fornari and Stracca (2012) address the question of whether the strength and propagation of financial shocks depends on country-specific structural characteristics, such as the degree of financial development (the market capitalization to GDP ratio; private credit to GDP; liquid liabilities over GDP) and openness (ratio of foreign loans and international debt to GDP; trade openness). They reach the conclusion that financial development and financial structure of a given country "do not matter much" for the intensity of propagation of financial shocks.

Given the multiplicity of empirical results reported in the economic literature with respect to the link between the financial structure and various macroeconomic outcomes, we do not have any strong priors about the expected role the financial structure may play in explaining macro-financial linkages. Particularly, the results are highly sensitive to the definition of financial structure, the specific macroeconomic outcome, the composition of the sample of countries, the time-dimension of the panel, and the adopted empirical methodology.

Although there is no uniformly accepted definition of a bank-based or market-based financial system, we rely in this paper on a standard and commonly accepted measure of financial structure proposed by Levine (2002). By using a broad cross-country approach, Levine (2002) focuses on three aggregate indicators of financial structure based on measures of the relative size, activity, and efficiency of banks and financial markets:

Figure 4: Financial Structure
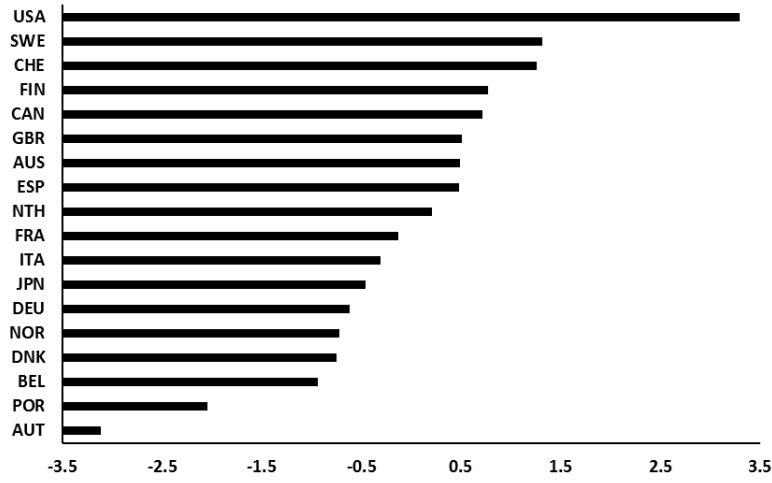


- Structure-Activity, a measure of the activity of stock markets (the share of the domestic equities in the country GDP or the total value traded ratio) relative to that of banks (the value of total bank credit to the private sector as a share of GDP or the bank credit ratio); this first indicator is computed as the logarithm of the total value traded ratio divided by the bank credit ratio, a higher value meaning a relatively more market-based financial system

- Structure-Size, a measure of the size of stock markets (the domestic market capitalization divided by GDP) relative to that of banks (the bank credit ratio); as in the previous case, the indicator is computed as the logarithm of the market capitalization ratio divided by the bank credit ratio, a higher value meaning a relatively more market-based financial system

- Structure-Efficiency, a measure of the efficiency of stock markets (the total value traded ratio) relative to that of banks (the ratio of overhead costs of the banking system to the aggregated banking assets); this third indicator is computed as the logarithm of total value traded ratio times the overhead costs ratio, a higher value meaning a relatively more market-based financial system

Besides the three indicators of financial structure, Levine (2002) proposes a conglomerate measure called Structure-Aggregate, based on the first three indicators and computed as the first principal component of Structure-Activity, Structure-Size, and Structure-Efficiency. Higher values of the financial structure composite indicator mean a higher degree of stock market development relative to the development of the banking system (see Figure 4 for a ranking of countries according to the value of the financial structure composite indicator proposed by Levine (2002)).

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Before moving to the next section, it is worth noting that some complementarities may exist between the three dimensions of the institutional framework considered in the present study. To give just a few examples, the complementarities between labor market institutions (EPL) and product market regulation (PMR) have been examined in a series of papers (see e.g. Blanchard and Giavazzi, 2003, Amable and Gatti, 2004, Nicoletti and Scarpetta, 2003, and Griffith et al., 2006). Acemoglu (2001), Pagano and Volpin (2005), and Gatti et al. (2012) investigated the interactions between the structure, regulation, and development of the financial system, on one hand, and the labor market conditions and institutional arrangements, on the other hand.

## 3 Data

We estimate our different econometric models based on quarterly data characterizing the following 18 OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Due to lack of availability of long time-series of data regarding product market regulation and financial structure, the dataset used in our analysis starts in 1996:Q1 and ends in 2015:Q4. Therefore, we use in our estimations a maximum of 80 quarterly observations per cross-section unit. However, for a few number of countries, in some specifications, the time dimension is smaller due to lack of availability of end-period data for some structural variables. For instance, we are unable to build Levine's (2002) financial structure index for Denmark and Sweden over the 2014–2015 period.[3]

The dataset used in our analysis covers three main categories of variables: macroeconomic, financial, and structural variables. First, the block of macroeconomic variables comprises indicators of output, prices, and monetary policy. As standard in monetary economics, we measure output by the seasonally adjusted real GDP, prices by the seasonally adjusted consumer price index (CPI), and monetary policy stance by the nominal short-term interest rates extracted from the OECD database. However, for computational reasons, we use the following transformed variables in our empirical models: the HP-filtered series of the log of real GDP, the year-on-year growth rate of the CPI, and the first-difference of the nominal short-term interest rate. In doing so, we ensure that the series are stationary. Furthremore, the use of the cyclical component of the real GDP allows us to disentangle the effect of economic structures on fluctuations from their effects on long term growth, which are well documented in the literature.

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[3]See Appendix for an overview of basic trends in the data by country.

Turning to the financial variables, we consider six different indicators: two measures of asset prices, a measure of bank net worth, the term spread, the VIX, and a financial composite indicator of stress. In what follows, we describe the data and explain the main channels through which the selected indicators may impact the real sphere.

As in Assenmacher-Wesche and Gerlach (2008), we consider both residential property and equity prices in our analysis. Empirically, the two assets do not co-vary much and exhibit, in particular, significant differences in their levels of volatility. Consequently, we consider each series individually rather than combining them in order to extract the common component. Despite their specific trends, both variables share common features when it comes to their effects on financial constraints and, *in fine*, on output. The financial accelerator theory (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997; Bernanke et al., 1999) is a natural way to explain the linkages between asset prices and output. In an asymmetric information context, borrowers face an external finance premium that fluctuates with their net worth and collateral values. As a result, by affecting collateral values, changes in asset prices impact the agency cost related to borrowing (i.e. the cost of capital), which in turn affects the capital spending and, therefore, the output.[4] In a similar vein, asset prices may also affect bank's balance sheets by shifting the regulatory capital constraint and decrease financial intermediaries' ability to raise new financial resources.[5] Hence, a drop in asset prices impairs the bank loan supply, potentially causing a credit crunch, which in turn affects the output. In the present study, we use the year-on-year growth of the real OECD residential property price index and the year-on-year growth of the real OECD share price index to measure asset price movements.

An alternative way to define a financial shock consists in focusing on financial intermediaries. Following the DSGE models developed, for instance, by Meh and Moran (2010), in which financial shocks are defined as exogenous changes in bank capital, an

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[4]There is no reason to limit the financial accelerator effect to firms. Households also face an external finance premium that affects their spending decisions. We emphasize that the distinction between equity and residential property prices is particularly relevant in our context as the two assets do not necessarily have the same effect on wealth and, therefore, on aggregate consumption. Unlike an increase in equity prices, which reflects a rise in the present value of future dividends, an increase in residential property prices does not lead to an expansion of aggregate wealth. Actually, an increase in residential property prices only leads to redistribution effects from first-time buyers to house sellers.

[5]Capital requirements, especially under the Basel II or Basel III capital accords, are a factor reinforcing the macro-financial linkages. This phenomenon has two well-known sources. First, when asset prices go down, banks experience financial losses on their assets, which tends to immediately weaken their equity capital (due to mark-to-market requirements) and their ability to take new risks and supply new loans. The second source of procyclicality is rooted in the risk-weighted capital requirements rules. Indeed, a risk-sensitive capital regulation leads to a co-movement between the bank capital requirement and the overall market situation, irrespective of the reported capital losses. Precisely, the risk valuation of a given asset, by either internal models or external rating agencies, fluctuates over time and, more important, increases in bad times.

empirical solution could be to use macroeconomic series on consolidated bank capital. This would be particularly relevant due to the leading role of bank capital in explaining bank loan supply and, therefore, fluctuations in the real economy. Unfortunately, series on bank capital are not available for the whole sample at quarterly frequency. As a result, we use in our analysis the stock prices of the banking sector as a measure of financial intermediaries' net worth.[6] Similar to a drop in bank capital ratios, a sharp decline in the banking sector capitalization is indicative of banking system vulnerabilities, which restrain firms' and households' access to credit and worse economic growth perspectives, as illustrated during the recent Great Recession episode.[7]

Besides reported losses, i.e. changes in financial intermediaries' net worth, we also identify bank vulnerabilities when the volatility of the banking sector capitalization increases. Consequently, we favor in our analysis a hybrid volatility-loss measure, namely the CMAX indicator (cumulative loss over a certain period of time), first proposed by Patel and Sarkar (1998) and frequently employed since then (see, e.g., Illing and Liu (2006) and Holló et al. (2012)).[8]As in Holló et al. (2012), we compute the CMAX indicator over a two-year period as follows:

$$CMAX = 1 - \frac{P_t}{max[P \in (P_{t-j}|j = 0, 1, ..., T)]} \qquad (1)$$

where $P_t$ is the daily value of the banking sector stock market index, sourced from Datastream Thomson Financial. Given the formula, an increase of the CMAX indicates more equity stress on financial market. To make easier the interpretation and comparison of the different financial shocks, all financial variables will be defined so that an increase of them can be interpreted as a positive financial shock. As a result, we consider the inverse of the CMAX indicator in our empirical framework.

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[6]A major drawback in doing so is that we focus exclusively on the soundness of public listed financial intermediaries, whereas cooperative or saving banks, whose financial conditions are not necessarily correlated with those of listed banks, represent in some countries a large share of the banking system. Furthermore, the share of privately held banks is not necessarily disconnected from the architecture of the financial system and, more broadly, from the type of capitalism prevailing in the economy. However, our measure based on the stock prices of publicly listed financial intermediaries remains, in our view, one of the best ways to capture the evolution of bank net worth.

[7]See, e.g., Laeven and Valencia (2013), Claessens et al. (2014), and Reinhart and Rogoff (2014) for assessments of the output costs of systemic banking crises.

[8]Alternatively, to identify financial intermediary shocks, we follow Fornari and Stracca (2012) and consider a relative measure of the health of the financial sector. The indicator corresponds to the ratio of the financial sector stock price index to the broad stock price index. Fornari and Stracca (2012) demonstrate that this indicator is particularly well-suited to capture financial distress. Furthermore, we also consider the probability of default of the financial sector published by the Risk Management Institute (RMI) of the University of Singapore and based on the forward intensity model developed by Duan et al. (2012). In our case, both measures of financial intermediaries shocks (viz., the ratio of the financial sector stock price index to the broad stock price index and the probability of default) generate similar results in line with those of the CMAX indicator.

The fourth financial variable used in our study is the term spread, that is the spread between the long-term benchmark interest rate and the short-term interest rate, both coming from the OECD database. Similar to changes in asset prices, a movement of term spread may deteriorate banks' balance sheets by affecting the bank profitability due to the maturity mismatch between their assets and liabilities. As a result, banks are more willing to supply loans when the term spread is high. Consequently, we expect a positive relationship between term spread and the performance of the real sphere. However, besides its effect on bank profitability and expectations of future inflation, the term spread may also reflect financial stress. In other words, an increase in term spread could also be interpreted as a sign of a rise in risk aversion due to higher uncertainties (e.g., investors require higher risk premia on long-term debt). In this case, an unexpected increase in term spread may have a negative effect on the real sphere.

Finally, we include two indicators of common financial stress: the VIX and a financial composite indicator of financial stress in the United States. The VIX measures the implied volatility on the S&P index options. It is commonly interpreted as an indicator of global risk aversion in financial markets and, therefore, as a proxy of financial turmoil (see Whaley (2009)). By using the VIX, we look at the effects of *common* financial shocks on the country-specific reaction to those shocks. The focus on *common* shocks is important given the fact that financial systems are globally integrated and each country's financial conditions are potentially more dependent on global factors. In the same vein, we also use a financial composite indicator (FCI) of financial stress in the U.S., computed and reported by the International Monetary Fund (see Swiston (2008)). The FCI, based on a large set of financial variables, aims to capture the cost of funding for the U.S. economy, which (presumably) impacts the other economies in our sample. To ensure consistency with other financial variables, we consider the inverse of the VIX and FCI in our study.

The remaining variables used in our analysis aim at measuring institutional features, which are in our view at the root of the observed differences in the reaction of the real sphere to shocks affecting the financial sphere. In particular, we look at three indicators that we described at length in the previous section: a product market regulation index, a labor protection index, and a financial structure index. The three indicators are intended to capture structural differences in the goods, labor, and financial markets, respectively. The Appendix at the end of the paper provides more details on the composition of the dataset and data sources and includes additional graphs depicting the time evolution of our main variables.

# 4 Macro-financial linkages: Preliminary evidence on the cross-country heterogeneity

To shed light on the heterogeneity across countries characterizing the relationship between the financial and real spheres, we use two approaches. First, we compute country-by-country correlation coefficients between the real activity and financial variables. In this way, we get a broad picture of the co-movements between the financial and real variables and of their degree of heterogeneity across countries. However, different degrees of association between the variables of interest do not necessarily mean that financial shocks have a different impact on output. Therefore, our second approach to explore the heterogeneity consists in estimating standard reduced VAR models.

Table 1 reports the correlation coefficients between output gap ($Y_t$) and the growth of residential property prices, the growth of equity prices, term spread, the CMAX (the inverse), VIX (the inverse), and the financial composite indicator of financial stress in the U.S. (the inverse).

Table 1: Correlation coefficients between output gap and financial variables

| $COR(Y_t, FIN_t)$ | Property Prices | Equity Prices | CMAX | Term Spread | VIX | FCI |
|---|---|---|---|---|---|---|
| Australia | 0.1265 | 0.1153 | 0.1312 | -0.2344* | 0.0131 | -0.0906 |
| Austria | -0.0067 | -0.1659 | 0.2754* | -0.5386* | 0.2581* | -0.0278 |
| Belgium | 0.018 | 0.2530* | 0.3989* | -0.3370* | 0.3289* | 0.0771 |
| Canada | 0.4076* | 0.4282* | 0.4815* | -0.5543* | 0.4037* | 0.1178 |
| Denmark | 0.4532* | 0.4466* | 0.5897* | -0.2387* | 0.3615* | 0.0638 |
| Finland | -0.0651 | 0.3813* | 0.4973* | -0.4993* | 0.2997* | 0.0137 |
| France | 0.2866* | 0.3358* | 0.4682* | -0.5332* | 0.3607* | 0.0463 |
| Germany | -0.0581 | 0.2683* | 0.3629* | -0.4219* | 0.3020* | 0.1105 |
| Italy | 0.2241* | 0.2668* | 0.4762* | -0.3140* | 0.3614* | 0.1057 |
| Japan | 0.1345 | 0.5048* | 0.6232* | 0.1048 | 0.6052* | 0.4209* |
| Netherlands | 0.3557* | 0.1863 | 0.3970* | -0.6246* | 0.0433 | -0.2515* |
| Norway | 0.3430* | 0.3330* | 0.4020* | 0.047 | 0.1975 | 0.007 |
| Portugal | 0.3137* | 0.1071 | 0.0973 | -0.2696* | -0.0216 | -0.139 |
| Spain | 0.2416* | 0.0227 | 0.1975 | -0.5409* | 0.0067 | -0.2884* |
| Sweden | 0.4734* | 0.3564* | 0.4253* | -0.2933* | 0.4362* | 0.1799 |
| Switzerland | -0.2196 | 0.1896 | 0.4030* | -0.6818* | 0.2143 | -0.1251 |
| United Kingdom | 0.3948* | 0.3375* | 0.5093* | -0.3741* | 0.4837* | 0.2225* |
| United States | 0.1107 | 0.4803* | 0.6901* | -0.5998* | 0.4747* | 0.1305 |

Note: An asterisk indicates a coefficient significantly different from zero using a 5% one-side test.

Several comments can be made based on the correlation table. First, even if the contemporaneous association between output gap and asset price growth are in most cases high and significant, there is a high degree of heterogeneity across countries. Cross-sectional standard deviations also reflect this cross-country heterogeneity: 0.30 and 0.19 for residential property and equity prices, respectively (unreported result). Second, regarding the hybrid volatility-loss measure (the CMAX indicator), we observe significant co-movements with the output gap variable in the vast majority of countries.

In order to explore the dynamic effect of a financial shock, i.e. an unexpected change in the financial variable orthogonal to other innovations, our second preliminary analysis is based on standard VAR methods. The VAR model we consider in this section for a country $i$, $i = 1, ..., 18$, has the following representation:

$$Y_{i,t} = c_i + A_i(L_i)Y_{i,t-1} + \varepsilon_{i,t} \qquad\qquad \varepsilon_{i,t} \hookrightarrow N(0, \Sigma) \qquad\qquad (2)$$

$Y_{i,t}$ is a $(4*1)$ vector of endogenous variables, $A_i(L)$ is a matrix polynomial in the lag operator, $c_i$ is an intercept, and $\varepsilon_{i,t}$ a vector of disturbances.[9]
For sake of clarity, the specification of model (2) contains the three following baseline variables: the HP-filtered version of the real GDP growth ($GDP$), the growth rate of the consumer price index growth ($CPI$), the nominal short-term interest rate ($r$), plus one financial variable ($FIN$) at a time (residential property prices, equity prices, CMAX indicator, term spread or the financial stress indicators).

The $6 \times 18$ (i.e., the number of different specifications $\times$ the number of countries) VAR systems are estimated by OLS. Shocks are identified based on a recursive identification scheme by applying a Cholesky decomposition of the residuals with the variables ordered as follows: $GDP$, $CPI$, $r$, and $FIN$. The ordering of inflation and GDP growth in a first block, followed by the financial variables in a second block, is fairly standard in the macroeconomic literature using the VAR methodology. This implies that financial variables may respond immediately to real shocks and the real activity does not change at time $t$ in response to a time $t$ financial shock.
In what follows, in order to investigate the degree of heterogeneity in the macro-financial linkages, we analyze the country-by-country responses of the output gap to a shock on one of the six financial variables. We report orthogonalized impulse response functions normalized to unity in order to ease the comparisons across the sample countries. It is worth noting that we do not make any strong inference from the impulse

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[9]Note that the order of matrix polynomial is common to all specifications and is fixed to 2. This choice allows a transparent cross-country comparability of the impulse response functions. In the vast majority of cases, considering 2 lags corresponds to the optimal choice according to the Akaike Information Criterion (AIC). For some specifications, imposing 2 lags leads to reject the null of no autocorrelation. In these cases, we check that increasing the number of lags until the residual auto-correlation is eliminated does not dramatically change the impulse response functions.

response functions at this stage. Moreover, we do not report confidence intervals in order the lighten the presentation of the results, which should be viewed as exploratory.

Figure 5 shows the orthogonalized impulse response functions to an unexpected increase of 1% in the residential property prices, equity prices, term spread, CMAX, and the two indicators of common financial stress, VIX and FCI.

Figure 5: Country-specific impulse response functions of output gap to various financial shocks

(a) House prices

(b) Stock prices



(c) Term spread

(d) CMAX



(e) VIX

(f) FCI
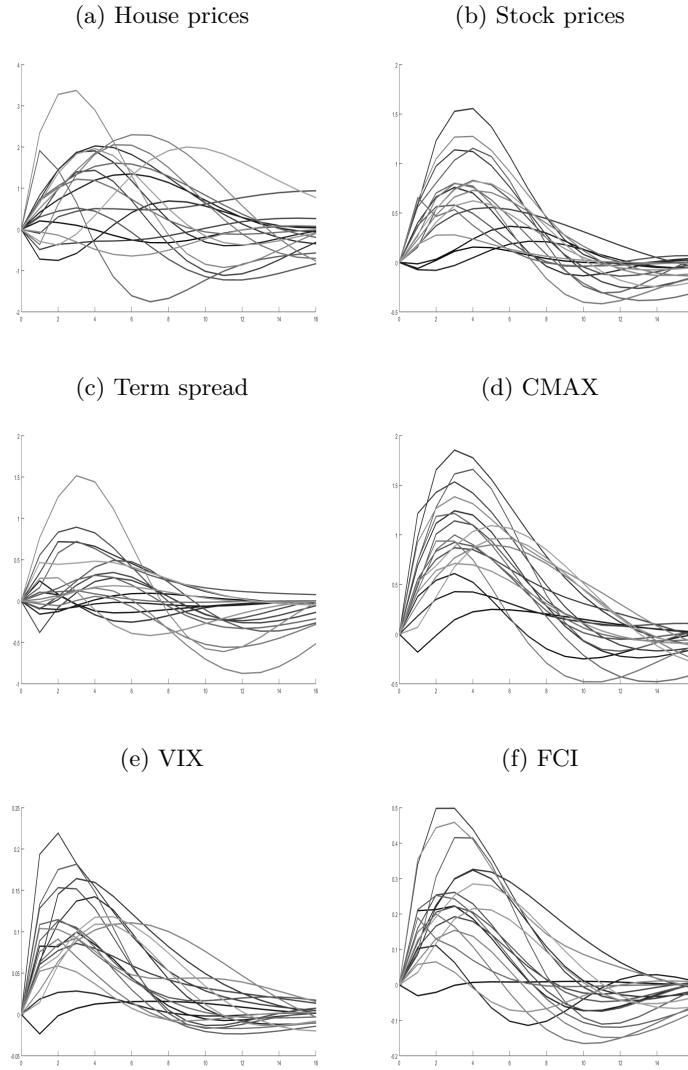


 Note: The figure displays country-specific impulse response functions of the output gap to a one unit shock to one of our six financial variables.

Given the high number of impulse responses, we limit our comments here to the general features of the results. First, it appears that the impulse responses differ significantly from one country to another in our sample of OECD countries. Further, the

degree of heterogeneity varies according to the type of financial shock considered in the analysis. For instance, the output gap responses are more heterogeneous following a house price, a banking sector or a FCI shock compared with an equity price or a term spread shock.

Second, it is worth noting that almost all financial shocks lead to a positive reaction of the output gap. In particular, as expected, and contrary to what a simplistic correlation analysis would have suggested, a term spread innovation leads to better GDP growth perspectives. Yet, behind this overall expected behavior, there are however some exceptions. At this point, it is critical to check whether these exceptions concern at each time the same countries. In what follows, we spot for each shock the countries that behave differently than the average. In the case of residential property prices, it appears that Austria, Germany, Japan, and Switzerland exhibit specific patterns, which could have also been observed in the correlation analysis. Japan and Switzerland also exhibit somewhat different GDP responses following a financial sector shock. Australia, Finland, and Sweden react differently to bank credit shocks, while Portugal and Spain respond differently to term spread innovations.[10] Finally, there seems to be no "country anomaly" regarding the output gap reaction to equity price shocks.

Table 2 reports the forecast error variance decompositions that allow assessing, in an alternative way, how shocks to financial factors reverberate through our sample of OECD countries and affects the adjustment path of the output gap variable.

## 5  Macro-financial linkages: The role of the institutional framework

Having established the existence of a high degree of heterogeneity across countries in the response of real activity to financial shocks, we now study whether some relevant institutional features are behind these differences. In particular, we analyze the effect of three main dimensions of the institutional framework: the goods market regulation, labor market regulation, and financial structure.

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[10]The extreme reaction of Portugal and Spain to term spread shocks can be explained by the sovereign crisis affecting these countries. This led to a sudden increase of yields on long term debt and simultaneously of the term spread because the short-term interest rate, which is not country-specific for the Eurozone, remained at a very low level. That being said, this means that our measure of term spread is potentially biased for Eurozone countries, which could explain the diverging reaction of Spain and Portugal. To address this issue, we could have used short-term Treasury bill rates instead of money market rates. Unfortunately, complete time series of T-bill rates are not available for all the countries included in our panel sample. Another solution consists in replacing the long-term interest rate by a benchmark long-term interest rate for the whole Euro area. An examination was carried out to ensure that our results are not sensitive to the definition of the Eurozone members' term spread.

Table 2: Forecast-Error Variance of output gap driven by financial factors

|   | AU | AT | BE | CA | DK | FI | FR | DE | IT |
|---|----|----|----|----|----|----|----|----|----|
| 1 | 8% | 29% | 11% | 23% | 22% | 25% | 19% | 11% | 11% |
| 2 | 11% | 48% | 19% | 39% | 45% | 34% | 26% | 15% | 23% |
| 3 | 15% | 49% | 22% | 39% | 43% | 34% | 26% | 14% | 20% |
| 4 | 16% | 50% | 23% | 39% | 41% | 34% | 26% | 15% | 21% |
|   | JP | NL | NO | PT | SP | SW | CH | UK | US |
| 1 | 22% | 7% | 14% | 19% | 14% | 44% | 3% | 17% | 4% |
| 2 | 36% | 33% | 30% | 33% | 32% | 49% | 10% | 49% | 14% |
| 3 | 39% | 37% | 33% | 32% | 38% | 45% | 18% | 50% | 19% |
| 4 | 40% | 39% | 33% | 34% | 39% | 48% | 18% | 53% | 23% |

## 5.1   Panel VAR framework

As in the previous section, we build our empirical analysis on VAR methods. Several empirical strategies could be pursued. First, one of the simplest ways to analyze the effect of the institutional environment on the sensitivity of real activity to financial shocks is to apply the following two-step procedure. The first step consists in computing country-by-country impulse responses. Then, in the second step, one could regress statistics of impulse responses (e.g., the average or initial effect, the number of quarters before the endogenous variable reaches the baseline) on relevant institutional indicators. However, the main drawback of this approach is that cross-country regressions are unlikely to provide accurate estimates in our case because of the small size of our sample of countries.

Second, an alternative empirical strategy is to estimate panel-VAR models on different sub-samples of countries, defined with respect to the level of the structural variables under investigation. In that way, one could obtain different impulse response functions for countries characterized by different levels (e.g., "high" vs. "low") of product market regulation. This approach allows to test whether the difference between the two IRFs is statistically significant, that is, to test whether a given financial shock has a differential impact according to the degree of product market regulation. However, this alternative empirical strategy also has some serious pitfalls. On one hand, it does not exploit the time variation, as well as the continuous nature, of the structural variables. As we have already mentioned in Section 2, macro-financial linkages vary over time (see also Hubrich et al. (2013), who note that time variation is an important feature of macro-financial linkages, especially for the link between GDP and the real house prices). On the other hand, it does not allow to control simultaneously for different structural variables, as well as for the unobserved heterogeneity between the sub-samples of countries.[11] This is a serious issue as complementarities between

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[11]Such an empirical strategy can only control for the unobserved intra-group heterogeneity.

goods, labor, and financial markets do exist. Precisely, one of the aims of our study is to assess the impact of structural changes in one market, given the institutional features prevailing in other markets.

Third, a suitable empirical methodology in our view should directly embed the structural variables into the VAR system and use them to condition the relationships between the endogenous variables. Recently, Loayza and Raddatz (2007), Towbin and Weber (2013), Sá et al. (2014), and Georgiadis (2014) have developed such methodological frameworks in which the model dynamics varies deterministically with structural, potentially time-varying, country characteristics. In the present study, we follow Towbin and Weber (2013) and estimate an Interacted Panel VAR (IPVAR). The structural form of the IPVAR that we consider can be written as follows:

$$
\begin{pmatrix} 1 & 0 & 0 & 0 \\ \alpha_{0,it}^{21} & 1 & 0 & 0 \\ \alpha_{0,it}^{31} & \alpha_{0,it}^{32} & 1 & 0 \\ \alpha_{0,it}^{41} & \alpha_{0,it}^{42} & \alpha_{0,it}^{43} & 1 \end{pmatrix} \begin{pmatrix} GDP_{i,t} \\ CPI_{i,t} \\ r_{i,t} \\ FIN_{i,t} \end{pmatrix} = \sum_{l=1}^{L} \begin{pmatrix} \alpha_{l,it}^{11} & \alpha_{l,it}^{12} & \alpha_{l,it}^{13} & \alpha_{l,it}^{14} \\ \alpha_{l,it}^{21} & \alpha_{l,it}^{22} & \alpha_{l,it}^{23} & \alpha_{l,it}^{24} \\ \alpha_{l,it}^{31} & \alpha_{l,it}^{32} & \alpha_{l,it}^{33} & \alpha_{l,it}^{34} \\ \alpha_{l,it}^{41} & \alpha_{l,it}^{42} & \alpha_{l,it}^{43} & \alpha_{l,it}^{44} \end{pmatrix} \begin{pmatrix} GDP_{i,t-1} \\ CPI_{i,t-1} \\ r_{i,t-1} \\ FIN_{i,t-1} \end{pmatrix}
$$
$$
+ \begin{pmatrix} \delta^1 \\ \delta^2 \\ \delta^3 \\ \delta^4 \end{pmatrix} \left( Z_{i,t-4} \right) + \varepsilon_{i,t} \quad (3)
$$

Indices $i$ and $t$ refer to countries and quarters, respectively; $Z_{i,t-4}$ is a cross-time-varying vector of structural variables and $\varepsilon_{i,t}$ a vector of uncorrelated iid innovations;[12] $L$ refers to the number of lags of the endogenous variables (based on usual lag selection criteria, we set the lag length to 2).

One crucial point of our framework is that the structural parameters $\alpha_{l,it}$ vary over time and across countries, which means that, unlike standard panel-VARs, the economic dynamics are potentially non-linear. The non-linearities come from the fact that $\alpha_{l,it}$ are treated as a function of cross-time-varying structural characteristics:

$$
\alpha_{l,it} = \beta_l + \eta_l Z_{i,t-4} \tag{4}
$$

where $\beta_l$ and $\eta_l$ are two vectors of coefficients.

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[12]We consider the 4-period lagged values of the structural variables to rule out the possibility that the evolution of the structural variables depends on the endogenous variables. Furthermore, we draw attention to the fact that our model assumes that there are no dynamic cross-unit interdependencies, i.e., residuals are uncorrelated across countries, which is certainly a restrictive assumption (Canova and Ciccarelli, 2013).

In order to identify the financial shocks, we still employ a recursive identification procedure by imposing the impact matrix to be lower triangular. As the financial variables are ordered last, we assume that real variables do not react contemporaneously to a financial shock. This means that we consider the financial variables as "less" exogenous than the macro variables.

The recursive structure of the model implies that the error terms are uncorrelated across equations and, hence, allows to estimate the model equation-by-equation without any loss of efficiency (see Towbin and Weber (2013) for more details). We estimate our model by standard OLS. For robustness, we also estimate the system after having previously demeaned the data in order to control for country fixed effects. Outcomes are in this case broadly similar. [13]

To assess whether the differences in the architecture of the institutional framework (product market regulation, employment protection legislation, and financial structure) are at the root of the cross-country heterogeneity observed in the linkages between the financial and real spheres, we estimate our initial model (3) by replacing the vector of structural variables by two different specific vectors. Precisely, we set the value of the structural variable under investigation at the 20th percentile of its empirical distribution in the first vector and at the 80th percentile in the second vector. The two other structural variables are set at their median values in both vectors in order to isolate the effects of the structural variable under investigation. Thus, we obtain two different coefficient matrices, i.e. two different sets of interactions and feedbacks between variables. In this way, we are able to compute different impulse response functions and perform variance decomposition analyses according to the levels ("high" vs. "low") of the structural characteristic (Product Market Regulation, Employment Protection Legislation or Financil Structure).

Finally, to obtain confidence bands for the impulse responses, we run a bootstrapping procedure based on 1,000 replications.[14] As we plot the 90% confidence bands,

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[13]As it is well known, the estimation results in this case are biased because demeaning the data in a dynamic model makes the error term correlated with the regressors. However, as shown by Nickell (1981), the size of the fixed effect bias decreases as the time dimension of the sample increases. In our case, we are confident that the fixed effect bias is fairly low given the relatively large time dimension of our panel (80 observations per country). Actually, whether we prefer a pooled OLS estimator is due to the weak time-variability of the three structural variables.

[14]The bootstrap procedure consists of the following steps: 1/ estimate the model by OLS using the original data; 2/ draw an artificial vector of innovation from a normal distribution centered on zero and with a variance equal to the OLS estimated variance; 3/ create artificial endogenous variables based on randomly resampled residuals, original data, and structural OLS coefficient estimates; 4/ interact the simulated endogenous variables with the interaction terms; 5/ use the artificial endogenous and interaction variables to re-estimate the model by OLS; 6/ compute the IRFs for "high" and "low" levels of the interaction variable; 7/ calculate the difference between the two IRF estimates; 8/ repeat the procedure 1,000 times; 9/ compute the mean, 20th, and 80th percentiles for the two types of IRFs,

the lower (higher) band is the 5th (95th) percentile of the 1,000 bootstrapped IRF.
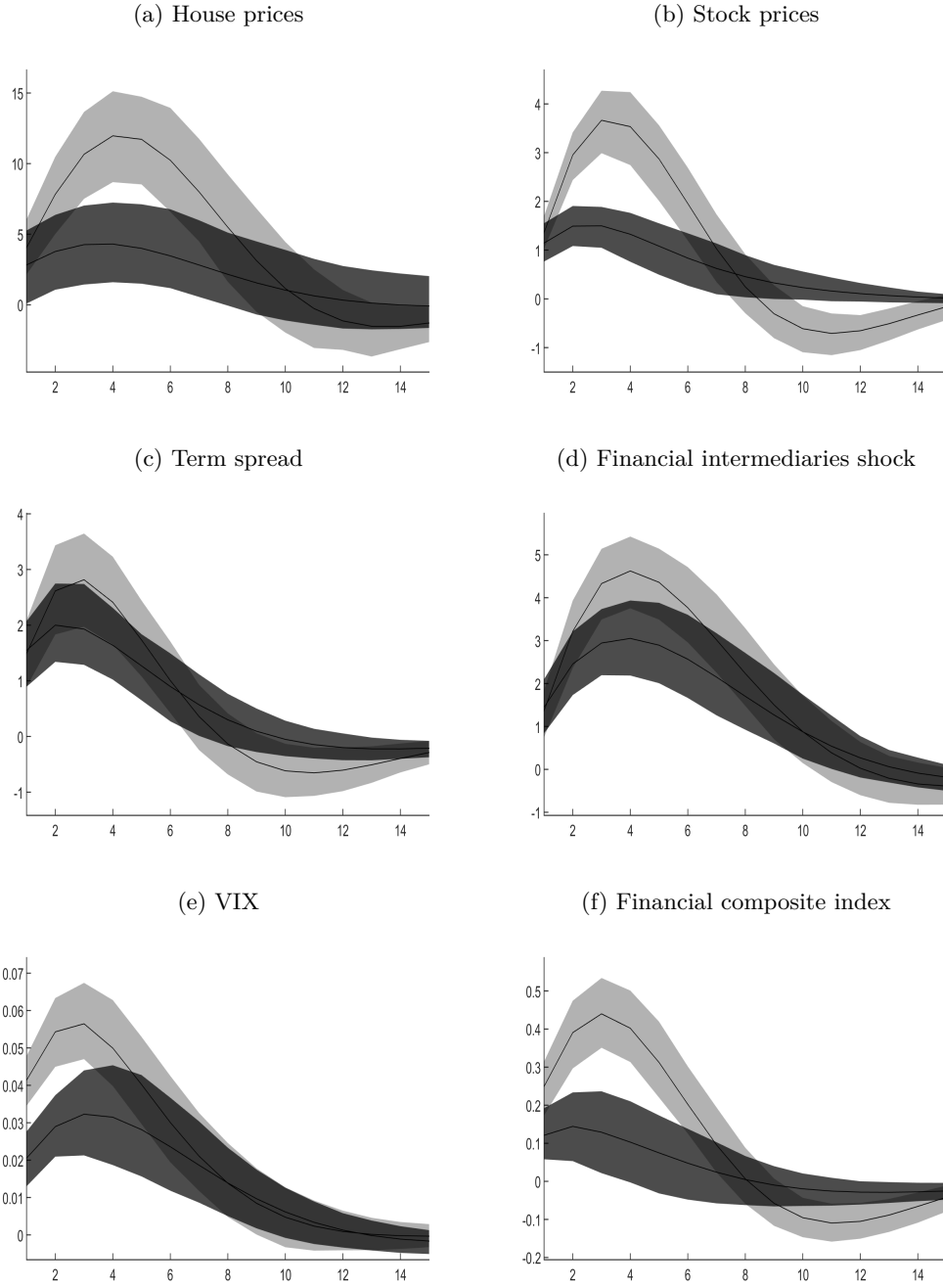
## Impulse Response Functions analysis

In the first set of impulse response functions depicted in Figure 6), we analyze the effect of the product market regulation on the reaction of economic activity to an unpredictable movement (from past data) in one of the financial variables. For each of the six financial variables, the figure depicts two different IRFs. The dark one is computed under the hypothesis that the PMR index is set at a "high" level ("high regulation" or less competition-friendly regulatory stance) and the two other structural indicators (Employment Protection Legislation and Financial Structure) are set at their median level. To plot the second IRF, surrounded by grey 90% confidence bands, we set a "low" level for the PMR index ("low regulation" or more competition-friendly regulatory stance) and keep all the other structural indicators at their median level.

As shown in Figure 6, the intensity of Product Market Regulation matters in understanding the cross-country heterogeneity observed in macro-financial linkages. Indeed, the
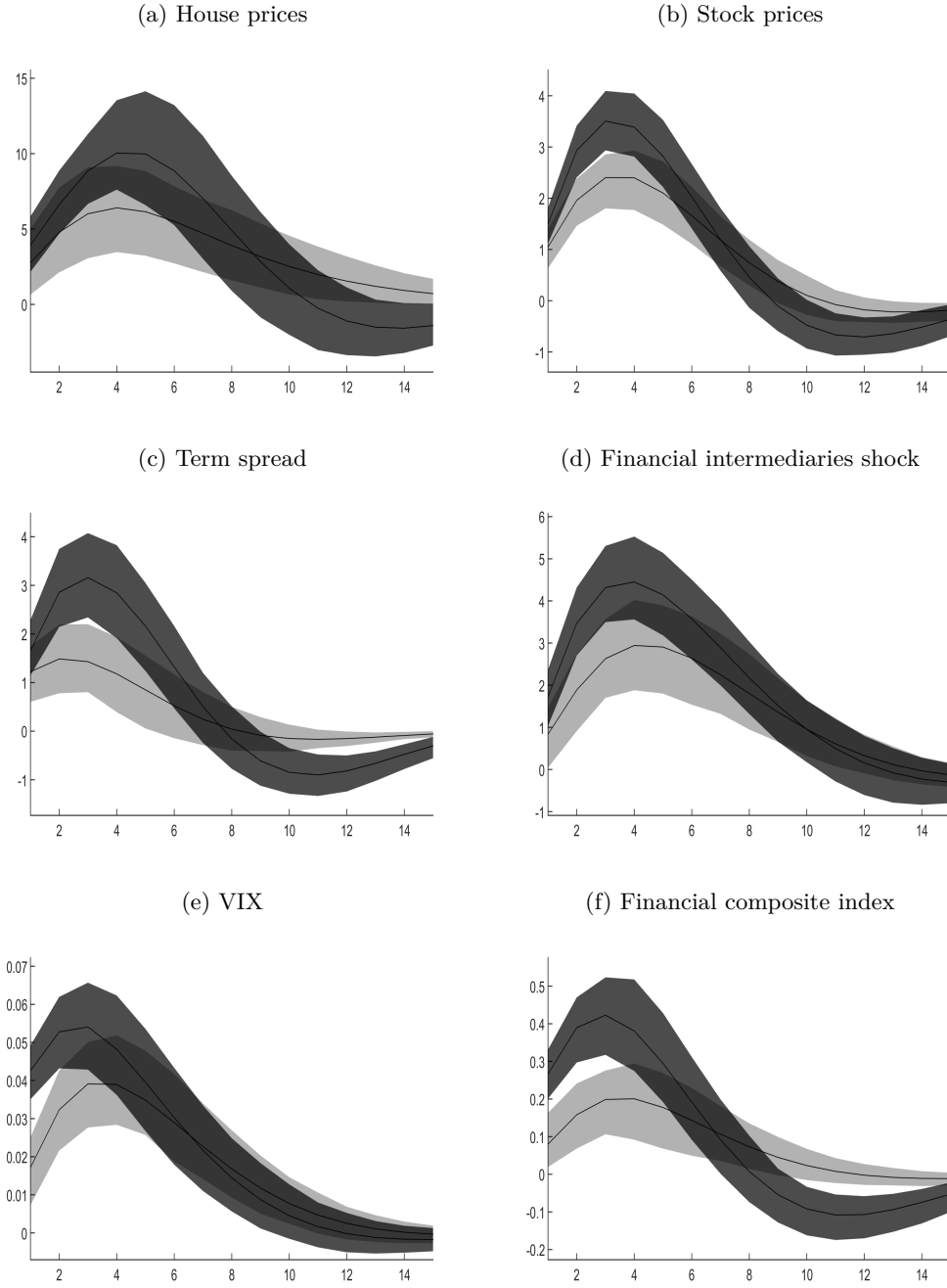
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as well as the difference between the two IRFs. See Towbin and Weber (2013) for more details about the implementation of the bootstrap procedure.

Figure 6: Macro-financial linkages and the Product Market Regulation

(a) House prices

(b) Stock prices

(c) Term spread

(d) Financial intermediaries shock

(e) VIX

(f) Financial composite index

Note: The figure shows impulse responses of output gap to unexpected changes (all the shocks are normalized to unity) in several financial variables for a "high" (the $80^{th}$ percentile, dark shadow) and a "low" (the $20^{th}$ percentile, grey shadow) intensity of Product Market Regulation (the empirical distribution of the PMR indicator).

## Figure 7: Macro-financial linkages and the Employment Protection

(a) House prices

(b) Stock prices



(c) Term spread

(d) Financial intermediaries shock



(e) VIX
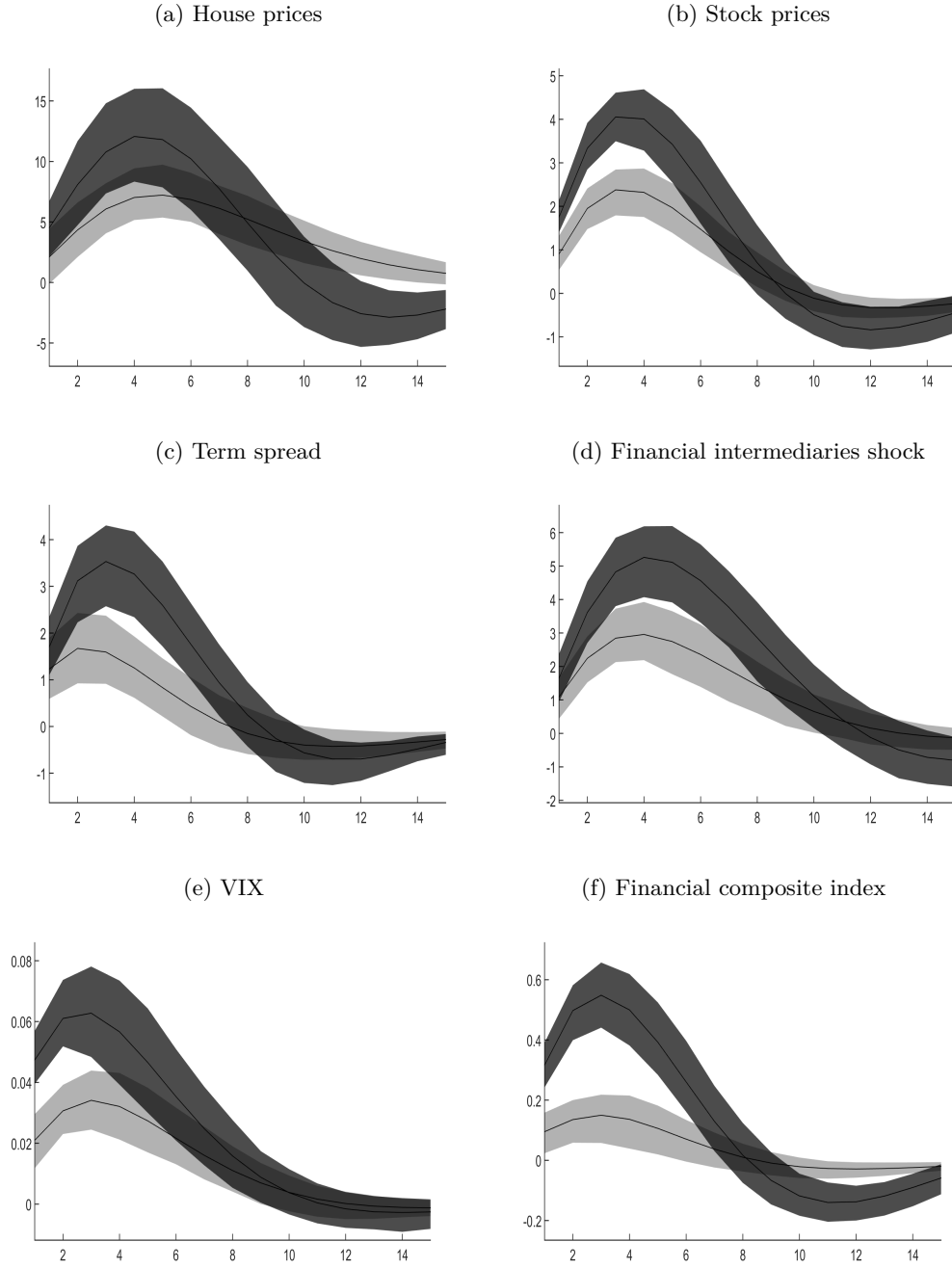
(f) Financial composite index



Note: The figure shows impulse responses of output gap to unexpected changes (all the shocks are normalized to unity) in several financial variables for a "high" (the $80^{th}$ percentile, dark shadow) and a "low" (the $20^{th}$ percentile, grey shadow) level of employment protection (the empirical distribution of the EPL index).

Figure 8: Macro-financial linkages and the Financial Structures

(a) House prices

(b) Stock prices

(c) Term spread

(d) Financial intermediaries shock

(e) VIX

(f) Financial composite index

Note: The figure shows impulse responses of output gap to unexpected changes (all the shocks are normalized to unity) in several financial variables for "market-based" (the $80^{th}$ percentile of the financial structure index, dark shadow) and "bank-based" financial systems (the $20^{th}$ percentile, grey shadow).

**Variance decomposition analysis**

In order to evaluate to what extent the GDP cycle is driven by financial shocks, in this sub-section we report and interpret the forecast error of the variance decomposition (FEVD). One important difference with the previous section is that the underlying estimated models, used to compute FEVD, include now all the six endogenous financial variables at the same time. In this way, we get a more comprehensive assessment of the role played by our three structural variables by focusing on the overall impact of financial shocks on fluctuations in the real activity.

Table 3 presents the forecast error variance of the GDP cycle that can be assigned to the set of financial innovations in our system at various simulation horizons going from 1Y to 4Y. As in the case of IRFs, Table 3 shows in an alternative manner the adjustment paths of the output gap variable following financial shocks, separately for "high" vs. "low" levels of the PMR index, the EPL index, and the financial structure indicator, respectively.

Table 3: Forecast Error Variance of the GDP driven by financial factors

|  | PMR | | EPL | | Fin. Struct. | |
| --- | --- | --- | --- | --- | --- | --- |
|  | High | Low | High | Low | High | Low |
| 1Y | 0.101 | 0.195 | 0.184 | 0.096 | 0.244 | 0.099 |
| 2Y | 0.198 | 0.289 | 0.284 | 0.205 | 0.359 | 0.182 |
| 3Y | 0.213 | 0.289 | 0.278 | 0.220 | 0.349 | 0.190 |
| 4Y | 0.213 | 0.289 | 0.280 | 0.222 | 0.349 | 0.192 |

## 5.2 Local projections

In this section, we investigate the dynamic effects of financial shocks conditional on the institutional framework using the local projection method proposed by Jordà (2005). As pointed out by Jordà (2005), the local projections are a natural alternative to estimating impulse response functions from VARs. They have the advantage of being robust to misspecification errors and of dealing in a flexible way with non-linear specifications. Both advantages are highly relevant in our case, as we are not sure that our VAR models plausibly describe the true data generating process and we aim at testing the existence of non-linearities. Compared to VARs, local projections do not assume a given specification for the underlying multivariate dynamic system. Indeed, the basic idea consists in estimating, for different prediction horizons, a sequence of univariate regressions of a variable of interest on a structural shock. The impulse response function is then simply given by the sequence of regression coefficients of the structural shock. To take into account the potential non-linearities, we interact the structural financial shock in our specifications with our main institutional indicators:
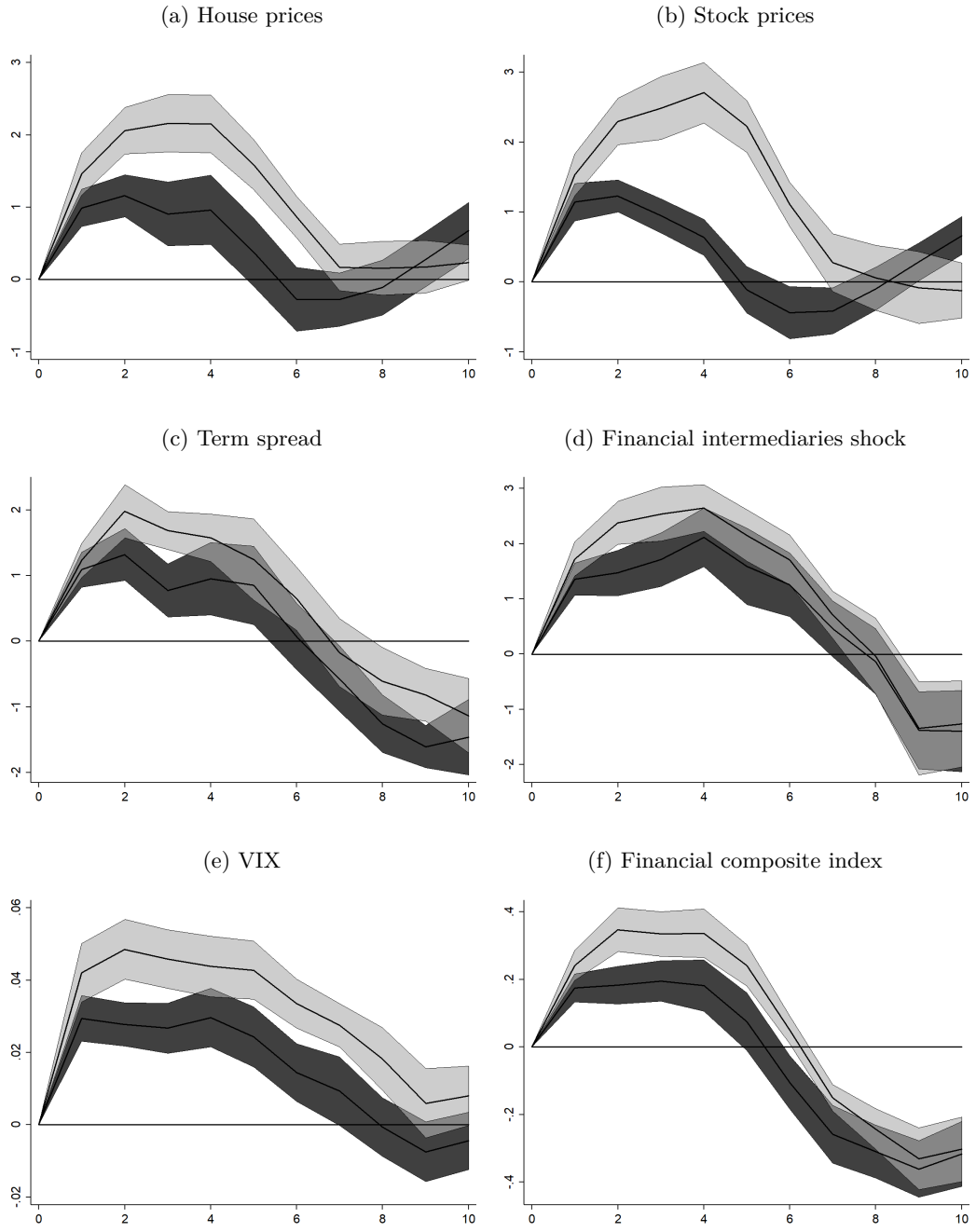
$$GDP_{i,t+k} = \alpha_i + \beta_1 Fin_{i,t-1} + \beta_2 Fin_{i,t-1} * Z_{i,t-4} + \beta_3 Z_{i,t-4} + \beta_4 CPI_{i,t-1} + \beta_5 r_{i,t-1} + \varepsilon_{i,t}$$

(5)

where $GDP_{i,t+k}$ is our dependent variable, the output gap, at the horizon $k$; $Fin_{i,t-1}$ is the financial structural shock, $Z_{i,t-4}$ one institutional indicator, and $Fin_{i,t-1} * Z_{i,t-4}$ the interaction term. Equation 5 is estimated for 16 different horizons by using the fixed effects estimator with standard errors clustered at the country level. Note that unlike our VAR framework, the regression model 5 does not include simultaneously our three institutional variables in interaction with the financial structural shock. Indeed, this would have considerably lowered the efficiency of parameter estimates. As a result, we favor in our analysis the following two-step approach. First, we regress the institutional variable under investigation on the other two plus a time trend and use the estimated residuals to generate an institutional indicator that is orthogonal to the two others. Second, we use this orthogonalized measure as $Z_{i,t-4}$ in equation 5.

As in the previous section, Figures 9-11 depict the responses from local projections of the output gap variable to unexpected, orthogonalized, changes in one of the six financial variables, separately for different levels ("high" vs. low") of the PMR index, EPL index, and financial structure indicator, respectively. Broadly speaking, there is clear correspondence among the responses computed by applying the two different methods (IPVAR, Figures 6-8, and local projections, Figures 9-11), with a few exceptions. The local projection responses show that impulse responses of output gap to shocks on asset (housing and equity) prices are highly sensitive to the degree of competition-friendly regulatory stance in the product market. This sensitivity is, however, lower in the case of a term spread or FIs shock and comparable to that reported from IPVAR in the case of financial stress shocks (see 9). Moreover, the associated output gap response to an unexpected housing price shock computed by applying the local projection method is relatively less aggressive four quarters after impact. The other sensitivities of the responses of output gap to the stringency of employment protection and financial structure are comparable across the two methods (see Figures 10 and 11).
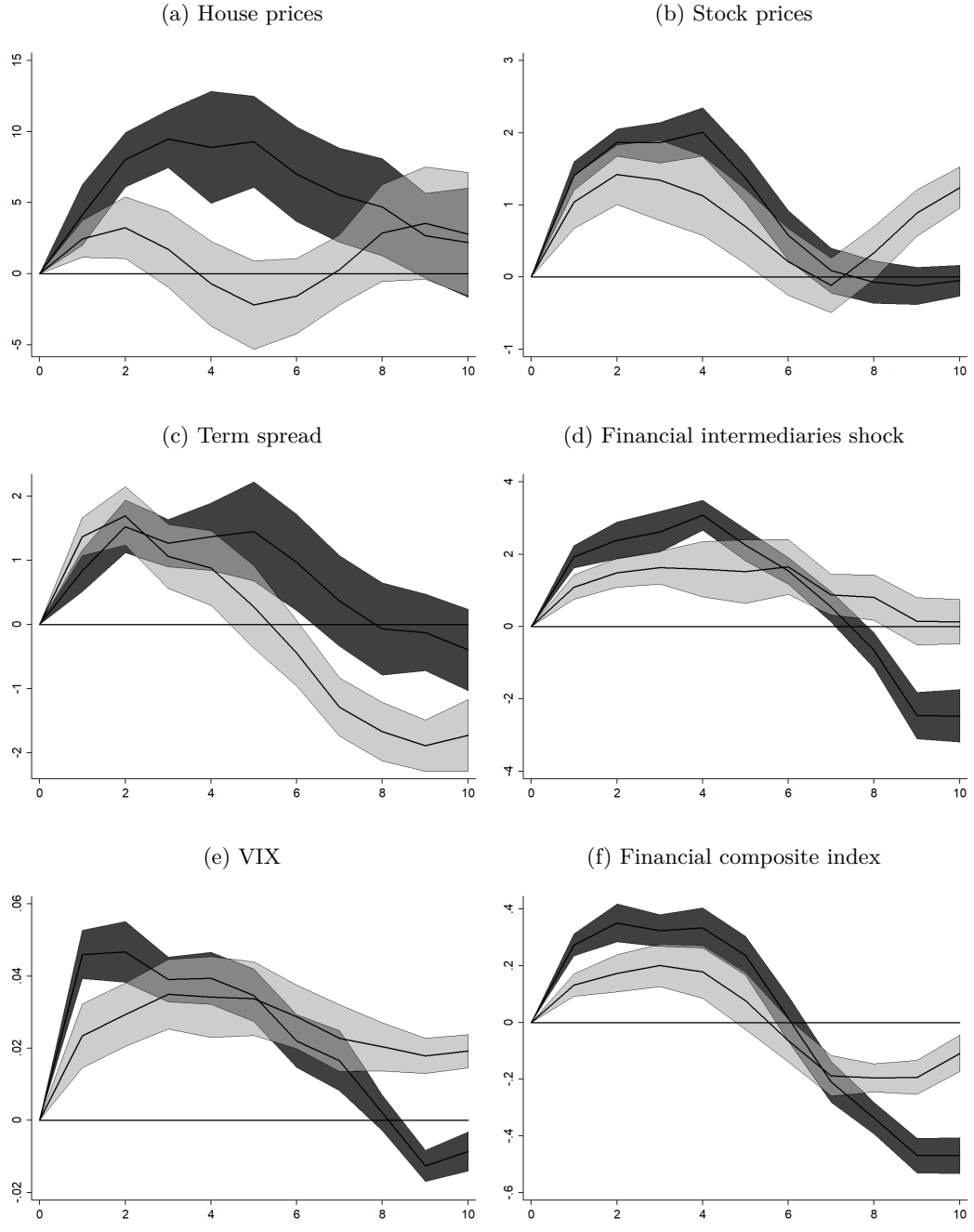
All in all, our results discussed in the previous section are robust to the choice of the estimation method. This is reassuring because, as convincingly showed by Jordà (2005), the local projection method is more flexible than standard VARs in dealing with non-linearities and other misspecification problems.

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Figure 9: Macro-financial linkages and the Product Market Regulation from local projections
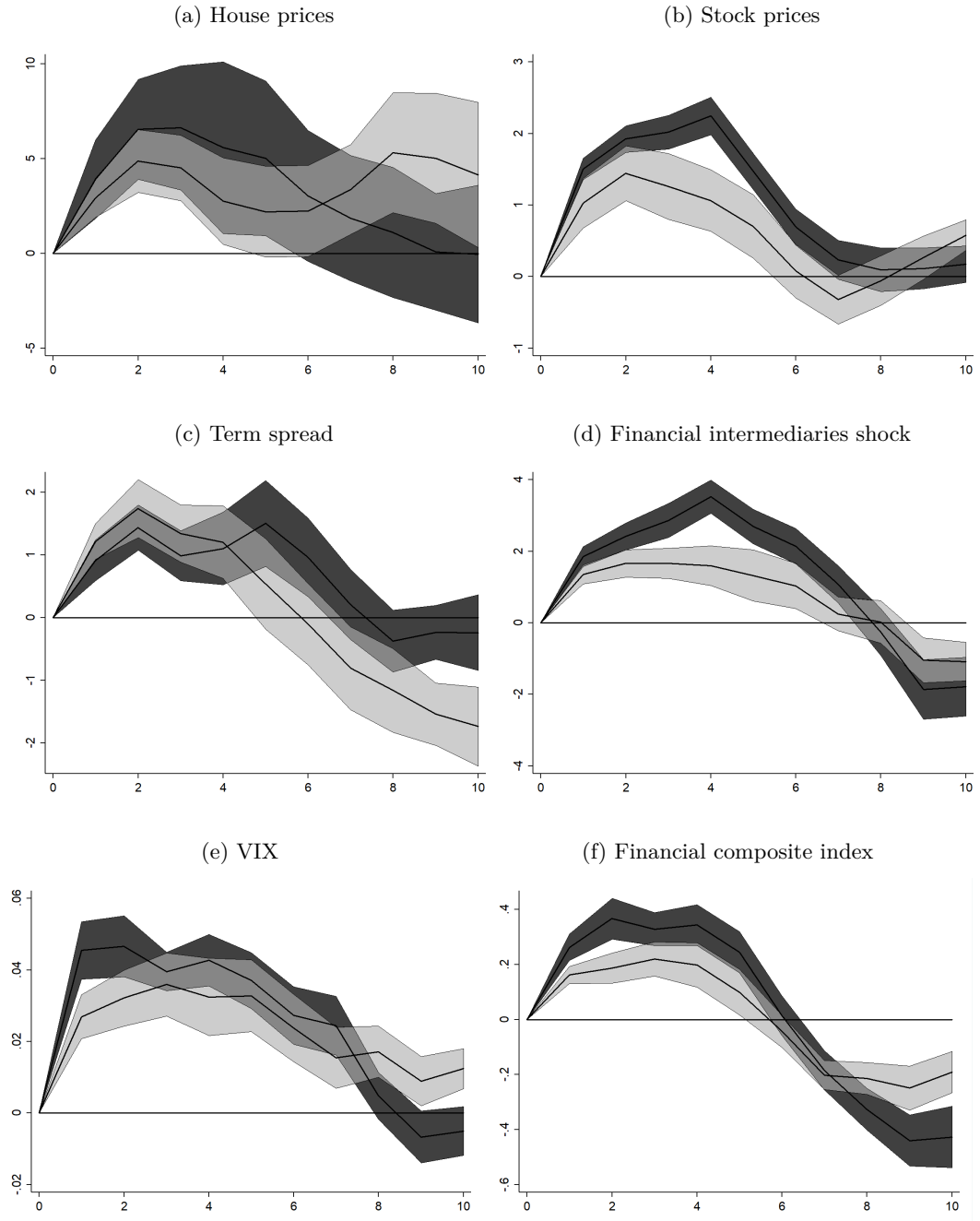


(a) House prices

(b) Stock prices

(c) Term spread

(d) Financial intermediaries shock

(e) VIX

(f) Financial composite index

Note: The figure shows impulse responses of output gap to a one unit change in several financial variables, separately for a "high" (the $80^{th}$ percentile) and a "low" (the $20^{th}$ percentile, dashed line) intensity of Product Market Regulation (the empirical distribution of the PMR indicator), obtained by applying the local projection method.

Figure 10: Macro-financial linkages and the Employment Protection from local projections



(a) House prices

(b) Stock prices

(c) Term spread

(d) Financial intermediaries shock

(e) VIX

(f) Financial composite index

Note: The figure shows impulse responses of output gap to one unit change in several financial variables, separately for a "high" (the $80^{th}$ percentile) and a "low" (the $20^{th}$ percentile, dashed line) level of employment protection (the empirical distribution of our employment protection index), obtained by applying the local projection method.

Figure 11: Macro-financial linkages and the Financial Structures from local projections

(a) House prices

(b) Stock prices



(c) Term spread

(d) Financial intermediaries shock



(e) VIX

(f) Financial composite index



Note: The figure shows impulse responses of output gap to a one unit changes in several financial variables, separately for "market-based" (the $80^{th}$ percentile of our index of financial structure) and "bank-based" financial systems (the $20^{th}$ percentile, dashed line), obtained by applying the local projection method.

# 6 Macro-financial linkages and the variety of capitalism

The results reported in the previous sections show that the institutional framework does matter in shaping macro-financial linkages. Precisely, lower product market regulation, tougher employment protection, and more market-based financial systems are indeed associated with stronger responses of the real sphere to an unexpected financial shock. To obtain these results, we have taken into consideration the fact that product, labor, and financial market characteristics are not independently distributed and, therefore, some degrees of interaction do exist between these different features of the institutional framework. However, the empirical methods used in the previous sections implicitly neglect the existence of interactions between institutions, i.e. of what Aoki (1994), Amable (2000), Boyer (2004), and Soskice and Hall (2001) conceptualize as "institutional complementaries". Basically, the notion of complementarity refers to the fact that the performances of one institution strongly depends on the characteristics of the other institutions. For instance, flexible labor markets are likely to be more efficient when they evolve together with market-based financial systems that allow for a quick mobilization and reallocation of resources toward new sectors, favor the creation of new firms and, *in fine*, support the labor demand. In the same vein, following a financial shock, the arm's length relationships prevaling in market-based financial systems may induce the risk that many firms suddenly experience funding dry-ups. To absorb the shock, firms need to adjust adaptively, in the short run, the structure of their costs and the production scale, which can be done more effectively when labor markets are flexible and employment protection is low.

Taken together, these two examples illustrate the idea that structural inefficiencies may arise from the combination of low employment protection and bank-based financial systems, although our results discussed in the previous sections would suggest otherwise. Our conjecture is that a structural change in one institutional area does not necessarily remain localized to that particular area: institutions do not affect economic decisions independently of each others. For instance, structural reforms aiming at liberalizing labor markets would inexorably lead the economy to favor the development of a more market-based financial system. As a result, even if labor market reforms may induce, at first sight, a decrease in macroeconomic fluctuations, over the long run, those fluctuations may exacerbate with the adjustment of the architecture of the financial system.

In what follows, to take explicitly into account the two-way interplays between various institutional areas, we draw a distinction between several major types of institutional arrangements that coexist in our sample of OECD countries. In our view, the major "models" we are able to identify are definitely not a random collection of institu-

tional characteristics. On the contrary, they correspond to institutional arrangements that arise endogenously in order to exploit complementarities between institutions. Following Amable (2003), we distinguish four major models of capitalism : the Continental European model (prevailing in countries like Austria, Belgium, Germany, and the Netherlands), the Liberal model (Australia, Canada, the United Kingdom, and the United States), the Mediteranean model (France, Italy, Portugal, and Spain), and the Scandinavian model (Denmark, Finland, Norway, and Sweden). Note that Amable (2003) identifies in his work a fifth model, *viz.* the Asian model of capitalism, which we assimilate here to the liberal one. Our choice is not fortuitous as Japan is the only country in our sample belonging to the Asian model, which is close, from a statical point of view, to the Liberal model.[15] In this section, our main empirical question is not whether a particular institution matters, but whether there exists a model of capitalism that induces softer macro-financial linkages.
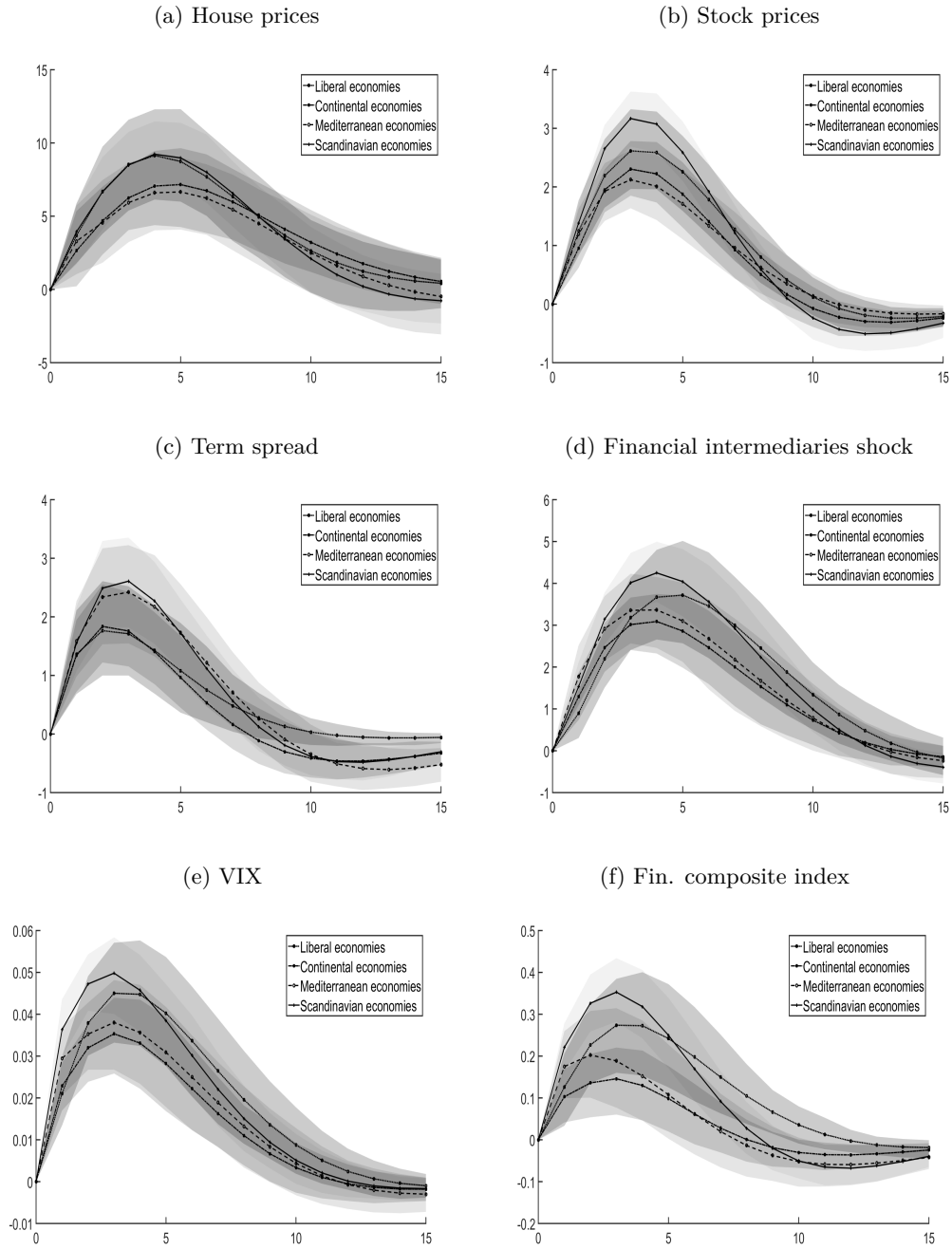
To address this question, our empirical approach consists, in a first step, in estimating IPVAR models containing our three main institutional variables, in interaction, with autoregressive terms. In a second step, we set these exogenous variables to various values to obtain different sets of parameters that allows to compute different impulse responses functions. Compared to the previous section, the only difference concerns the values we assign to the exogenous variables. Here, we set the values of the exogenous variables to the empirical average of the different models of capitalism. The values used to condition our parameters are reported in Table 4. This approach allows us to compute the average macro-financial linkages conditional to institutional characteristics that are specific to each of the four major models of capitalism. The impulse response functions are displayed on Figure 12. Comparing the IRFs, it can be seen that there are no statistically significant differences between the various models of capitalism. We interpret this finding as tentative evidence that the different economic models are characterized by strong institutional complementarities. That means that from the point of view of macroeconomic fluctuations induced by financial shocks, there seems to be a multiplicity of "optimal" institutional arrangements, rather than a unique, superior, model for organizing economies. Consequently, liberal(ized) markets – as supported by some economists and policy markers – should not be considered as the ideal and universal institutional arrangement for ensuring strong economic resilience and fast recovery

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[15]Our results are the same if we consider five, instead of four, major models capitalism.

Table 4: Average values of the institutional characteristics for different models of capitalism

|  | PMR | EPL | Fin. Struct. |
|---|---|---|---|
| Continental European model | 1.638 | 2.487 | -0.738 |
| Liberal model | 1.594 | 1.161 | 1.254 |
| Mediterranean model | 1.897 | 2.917 | -0.200 |
| Scandinavian model | 1.587 | 2.339 | 0.402 |

Figure 12: Macro-financial linkages and the variety of capitalism

(a) House prices

(b) Stock prices

(c) Term spread

(d) Financial intermediaries shock

(e) VIX

(f) Fin. composite index



Note: The figure shows impulse responses of output gap to unexpected changes (all shocks are normalized to unity) of several financial variables by taking into account four major models of capitalism, *viz.* the Liberal, Continental European, Mediterranean, and Scandinavian model, respectively. The lines correspond to the median ($50^{th}$) impulse responses. The confidence bands represent the 10% error bands generated by bootstrap.

# 7  Conclusion

In the present paper, we use macroeconomic data characterizing a sample of 18 OECD countries over the 1996—2015 period to better understand the asymmetries in the transmissions of shocks from the financial sector to the real activity. In particular, we focus on the role of the institutional framework to explain the cross-country heterogeneity in the macro-financial linkages. Our privileged dimensions of the institutional framework are: (1) the product market regulation; (2) the employment protection; and (3) the architecture of the financial system.

We start with a basic correlation analysis and a set of standard reduced VAR models estimated at country level to draw a broad picture of the co-movements between financial (asset prices, relative performance of the financial sector, term spread, and two measures of common financial stress) and real variables (CPI, GDP growth, and nominal short-term interest rate). The results of our preliminary analysis are consistent with the findings reported in the previous literature (see e.g. Hubrich et al., 2013, and the references therein): despite some observed commonalties, the real effects of financial shocks exhibit a high degree of heterogeneity across countries.

We then attempt to explain this cross-country heterogeneity by linking the real effects of financial shocks to the specific features of the institutional framework. For that purpose, we implement the Interacted Panel VAR (IPVAR) methodology, as described in Towbin and Weber (2013), which allows us to embed the structural variables directly into the VAR system and use them in a very flexible way to condition the relationships between the endogenous variables.

Overall, our main findings indicate that shocks on housing and stock prices and the relative performance of the financial sector have a stronger impact in countries characterized by a higher competition-friendly regulatory stance, a stronger employment protection, and a more market-oriented financial structure. However, the propagation of a term spread shock to the real activity does not seem to depend on the specific features of the institutional framework. Our results provide empirical support for the idea that specific features of the institutional framework do play an important role in shaping the micro-financial linkages.

# Appendix

## Table A1: Correlation between the financial variables

| $COR(FIN_{i,t}, FIN_{j,t})$ | Property Prices | Equity Prices | Term Spread | Fin. Shock | VIX | FCI |
|---|---|---|---|---|---|---|
| Property Prices | 1 | | | | | |
| Equity Prices | 0.2748 | 1 | | | | |
| Term Spread | -0.1403 | 0.0876 | 1 | | | |
| Fin. Shock | 0.3818 | 0.6757 | -0.1740 | 1 | | |
| VIX | 0.1880 | 0.5998 | 0.1305 | 0.6253 | 1 | |
| FCI | 0.2060 | 0.5007 | 0.3585 | 0.4903 | 0.7401 | 1 |

## Table A2: Data and Sources

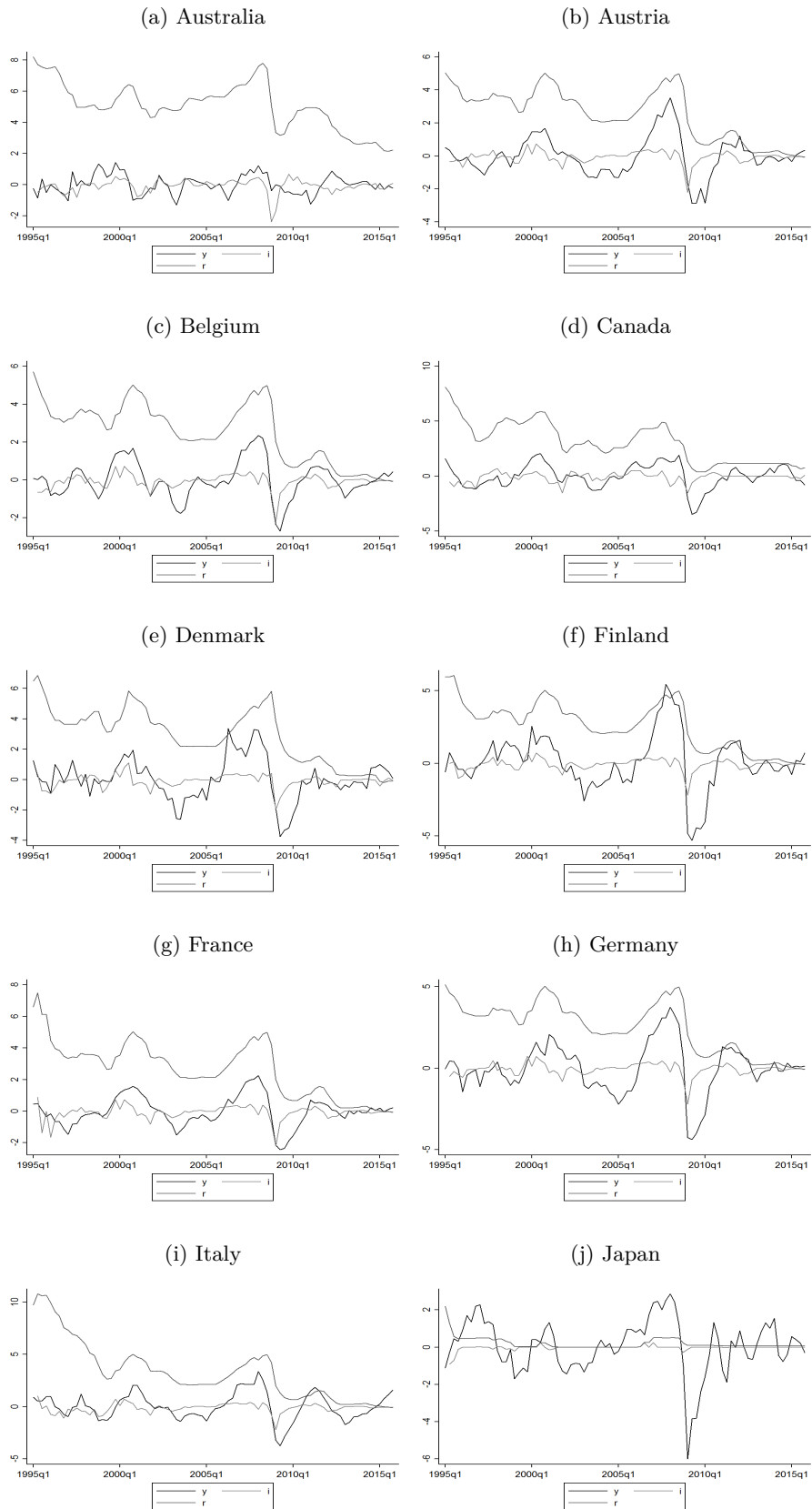| Variable | Description | Source |
|---|---|---|
| Output gap | We apply the HP filter with conventional $\lambda$ value for quarterly data ($\lambda = 1600$) on the real GDP | OECD |
| Inflation rate | We compute the year-on-year difference of the logarithm of the Consumer Price Index (CPI) | OECD |
| Short-term interest rate | It corresponds to the first-difference of the three month interbank offer rate | OECD |
| Real equity price growth | Determined by the year-on-year difference of the logarithm of the real equity index | OECD |
| Real residential price growth | Determined by the year-on-year difference of the logarithm of the real residential price index | BIS |
| Term spread | We take the logarithm of the difference between long term government bond (10 year) and the 3 months interbank rate. Since the difference is in some cases negative, we add the empirical minimum + 1 before the log transformation to the computed difference | OECD |
| CMAX | The CMAX is a hybrid volatility-loss measure. $$CMAX = 1 - \frac{P_t}{max[P \in (P_{t-j}|j=0,1,...,T)]}$$ where $P_t$ is the daily value of the banking sector stock market index. Note that we consider the inverse of the indicator | Datastream |
| VIX | It corresponds to the CBOE volatility index that measures the market's expectation of 30-day volatility. Note that we consider the inverse of the indicator | Datastream |
| FCI | It corresponds to the U.S. financial condition indicator Note that we consider the inverse of the indicator | IMF |
| PMR | Product Market Regulation index | OECD |
| EPL | Employment Protection Legislation index | OECD |
| Financial Structure | It corresponds to the indicator of financial structure defined by Levine (2002). | OECD |

Figure 13: Time series by country: Macroeconomic variables

(a) Australia

(b) Austria

(c) Belgium

(d) Canada

(e) Denmark

(f) Finland

(g) France

(h) Germany

(i) Italy

(j) Japan

Figure 14: Time series by country: Macroeconomic variables

(a) Netherlands

(b) Norway

(c) Portugal

(d) Spain

(e) Sweden

(f) Switzerland

(g) United Kingdom

(h) United States

41
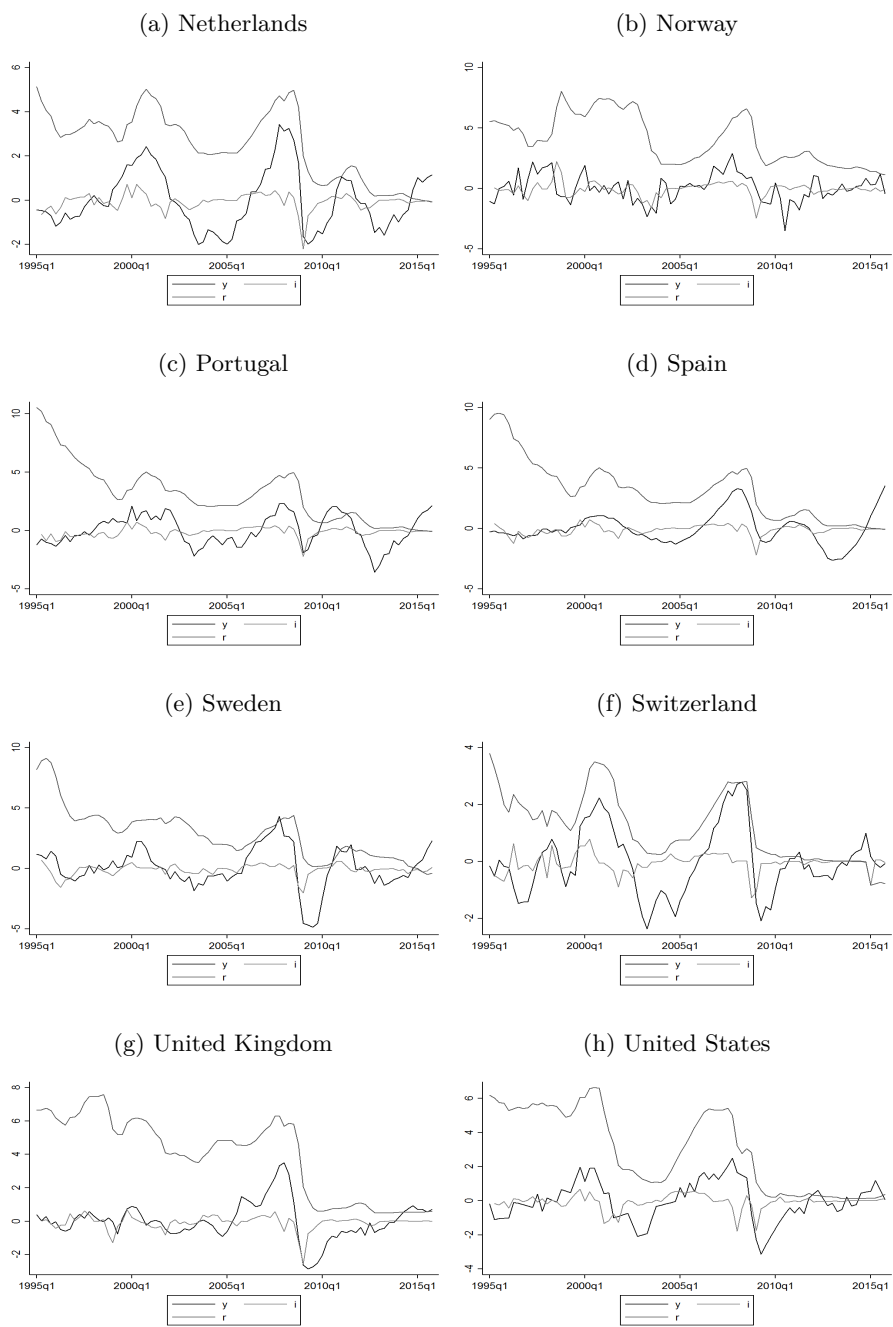
## Figure 15: Time series by country: Financial variables

### (a) Australia



### (b) Austria



### (c) Belgium



### (d) Canada



### (e) Denmark



### (f) Finland



### (g) France



### (h) Germany



### (i) Italy



### (j) Japan
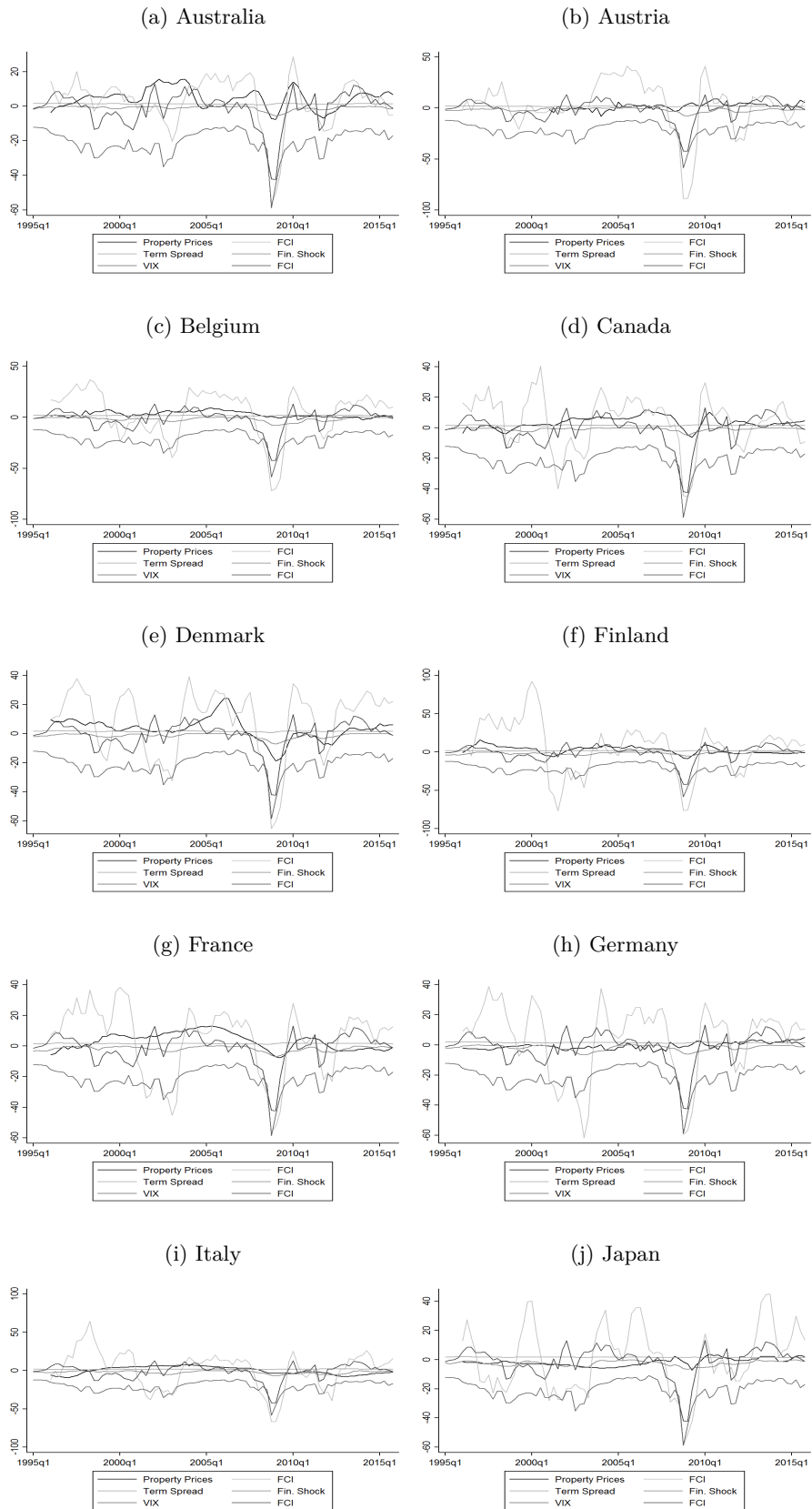
## Figure 16: Time series by country: Financial variables

(a) Netherlands



(b) Norway



(c) Portugal



(d) Spain



(e) Sweden



(f) Switzerland



(g) United Kingdom



(h) United States



43
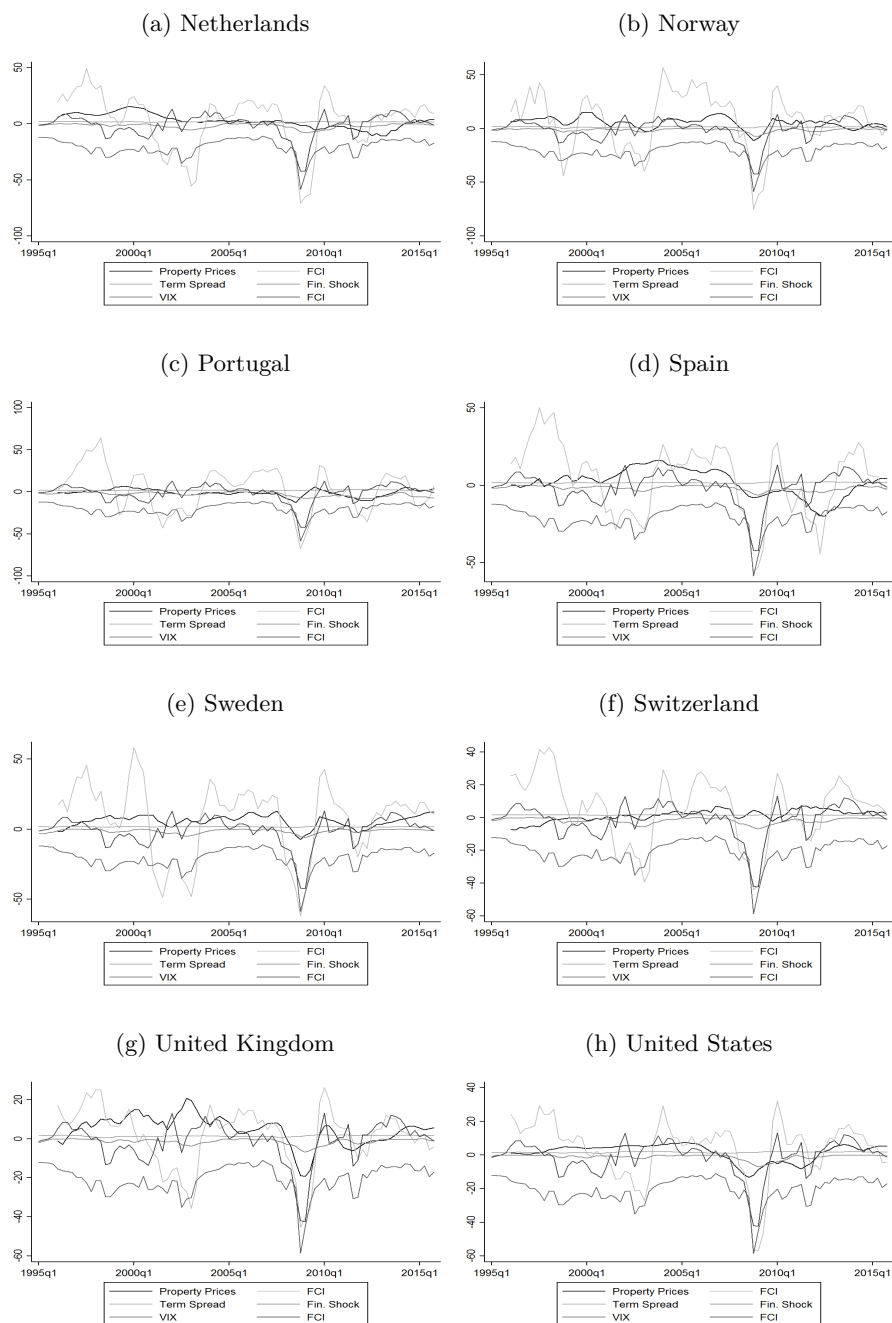
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