

RESEARCH ARTICLE

Transmission of the 2007–2008 financial crisis in advanced countries of the European Union

Kamila Tomczak 

Liverpool Hope Business School,
Liverpool Hope University, Hope Park,
Liverpool, UK

Correspondence

Kamila Tomczak, Liverpool Hope
Business School, Liverpool Hope
University, Hope Park, Liverpool, L16 9JD,
UK.
Email: tomczak@hope.ac.uk

Abstract

The aim of this paper is to identify the main factors responsible for the 2007–2008 crisis development and transmission across the 10 developed European Union (EU) countries. In order to achieve this objective, trade and financial linkages, crisis contagion from the United States and EU countries and countries' internal and external economic vulnerabilities are examined. The results of logistic regression model covering the period from 2002 to 2012 presented in this paper indicate that the transmission of the crisis occurred through contagion from the United States but also from other EU countries. Additionally, the empirical results confirm that high inflation, a decrease in the exchange rate, and a decrease in the US long-term interest rates increased the probability of the 2007–2008 financial crisis.

KEYWORDS

contagion of financial crisis, 2007–2008 financial crisis, transmission of financial crisis

JEL CLASSIFICATION

G01, G2, E44

This is an open access article under the terms of the [Creative Commons Attribution](https://creativecommons.org/licenses/by/4.0/) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2022 The Authors. *Bulletin of Economic Research* published by Trustees of the Bulletin of Economic Research and John Wiley & Sons Ltd

1 | INTRODUCTION

The 2007–2008 crisis that originated in the United States of America's (US) financial market is considered one of the most profound and severe in history. Speed of transmission of crisis and a stark recession of the global economy that this crisis caused and posed questions about its transmission and development.

The crisis affected not only international financial markets but also the real economy in many countries. Moreover, the crisis was transmitted to countries with relatively weak linkages to the US financial system and/or with very little exposure to so-called “toxic assets” issued by investment banks in the United States. The most affected countries were advanced economies of the European Union (EU), where the recession, the aftermath of the crisis, was more severe than in the United States.

Although the crisis of 2007–2008 and its propagation attracted many analyses and publications, there is still an ongoing debate about the main reasons for the crisis transmission and contagion and the literature provides conflicting answers.

This study will examine cross-country crisis transmission. The objective of this article is to identify main causes of development and transmission of the 2007–2008 financial crisis. In particular, this research aims to answer two questions: What were the real linkages between countries or contagion from other countries responsible for the crisis transmission and what factors contributed to the crisis development in the EU countries? To achieve the above objective, a panel logistic model is applied where evidence will be analyzed quantitatively. To identify the crisis, the index of banking stress (IBS) will be constructed.

This paper complements a growing literature on the financial crisis transmission to developed countries. First, this study presents a new crisis index that is designed to effectively capture banking crisis occurrence, previous studies either did not include specific banking crisis index or imposed one crisis data for all countries. Second, this paper focuses not only on US transmission but also includes transmission from other EU countries. To the best of my knowledge, the literature so far does not analyze the possible contagion from United States and other EU countries simultaneously. Third, it provides a comprehensive analysis of different sources of crisis transmission and contagion in advanced countries.

The remainder of the paper is organized as follows. A literature review discusses crisis-contagion and non-crisis-contagion theories. The methodology section provides information related to the empirical model and data used in this analysis. The results and discussion section presents the empirical results. A final section concludes the paper.

2 | LITERATURE REVIEW

In the literature, there are many definitions and conflicting views of financial contagion. The most elementary understanding of contagion is that a crisis in one financial organization increases the crisis occurrence probability in other institutions and countries (Sanchis et al., 2007). Masson (1998) distinguished between pure contagion and spillover, which is a result of interdependence between countries. Forbes and Rigobon (2001) defined shift contagion as an increase in linkages between markets after a financial shock. Fratzscher (2002) includes the transmission channels such as real and financial channels in his definition of contagion. On the contrary, Pericoli and Sbracia (2003) understand crisis transmission as a contagion that cannot be explained by funda-

mentals. In turn, Dungey et al. (2010) distinguished between contagion and hypersensitivity. They defined contagion as a transmission of shock from a crisis to a noncrisis country, while hypersensitivity is defined as an increase in country's sensitivity to a crisis as the effect of shock from other markets. Pesaran and Pick (2007) categorized crisis transmission due to "monsoonal effects" (i.e., the correlation of macroeconomic variables), "spillovers" (i.e., external links like trade), and "pure contagion" (defined as markets shift from good equilibrium to bad equilibrium). They argued that "monsoonal effects" transmission and "spillovers" transmission are illustrations of interdependence, and this kind of crises propagation can be predicted by using macroeconomic variables, as opposed to "pure contagion" (Pesaran & Pick, 2007).

However, some researchers noticed that crises may occur in clusters rather than from contagion. In cases of clusters, factors that trigger crises occur simultaneously in several countries. For example, global macroeconomic conditions can result in high unemployment which in turn weakens the economy and prompts the government to defend a currency peg. This may result in a cluster of speculative attacks (Eichengreen & Rose, 1999).

In this article, contagion is defined as financial crisis transmission due to financial crisis occurrence in another country which is not based on real linkages between countries. This definition helps to distinguish between real linkages between countries and other factors that may have contributed to the crisis transmission but cannot be explained by real links. Moreover, this definition allows for simultaneous testing for different transmission channels.

The crisis-contingent theories assume that crises can be transmitted by:

- *Multiple equilibrium.* Crisis transmission and a move from good to bad equilibrium happens because of change in investors' expectations and beliefs (Forbes & Rigobon, 2001).
- *Change of investor's behavior.* Change of investor's behavior and investors' risk appetite, also called "shifts in investor sentiment" can be especially dangerous for countries with weak financial fundamentals (González-Hermosillo, 2008).
- *Endogenous liquidity shocks.* According to this theory, a crisis in one country will reduce the liquidity of market participants and that may force investors to rebalance their portfolios and sell assets in other countries and thus transmit the crisis (Valdes, 1996). Moreover, investors may liquidate assets in other countries to raise cash to meet margin calls. A country highly indebted to such lenders or highly represented in the lender's portfolio is prone to capital outflows and crisis (Caramazza et al., 2004).
- *Political contagion.* Drazen (1998) explained that when a decision to devalue the currency is political and objectives of this decision are not always clear this may trigger a speculative attack.
- *Uncertainty channel of contagion.* An increase in uncertainty is connected to a higher probability of financial crises occurrence. Kannan and Köhler-Geib (2009) argued that the degree of anticipation of a crisis influences investor's uncertainty which determines contagion.

Non-crisis-contingent theories assume that a crisis is transmitted because of relations between countries that existed before the crisis and are based on economic fundamentals. The theory identifies five main channels of crisis transmission:

- *Trade linkage.* When a country suffers from a crisis, depreciation of its currency may improve price competitiveness of its exports (Caramazza et al., 2004). An increase in a country's competitiveness in trade of goods will negatively affect a trade partner's domestic sales and also other countries that are competing in third markets. This means a decrease in exports and out-

put in other countries and therefore an increase of pressure for those countries to devalue their currency or a possibility of a speculation attack (Forbes & Rigobon, 2001).

- *Policy coordination.* Countries may apply certain policies as a reaction to an economic policy in another country. An example is a trade agreement that obliges its participants to raise trade barriers as a reaction to a member country's lax monetary policy (Forbes & Rigobon, 2001).
- *Country revaluation or learning.* According to this theory, investors assess countries' performance based on their experience from previous crises (Forbes & Rigobon, 2001).
- *Random aggregate shocks (Common shock).* Transmission of a crisis is explained by random aggregates or global shocks that may have an impact on the economy (Forbes & Rigobon, 2001). A crisis is caused by an interaction between macroeconomic fundamentals and common shock. An example of a common shock is an increase in the US interest rates in the early 1980s, which played a significant role in the development of debt crisis in Latin America (Caramazza et al., 2004).
- *Financial linkages are financial links between countries existing before a financial crisis.* The tight financial linkages depend on the degree of integration between countries and their financial systems and are a result of financial globalization. Moreover, close financial linkages could increase the transmission of a crisis.

As there is no agreement on what contagion is, there is also a variety of different methodological approaches used to detect contagion. In this study, methodology that distinguishes between real channels of crisis transmission and pure contagion was selected in order to conduct a comprehensive analysis of the sources of crisis.

Additionally, the literature on the 2007–2008 financial crisis focuses on the contagion from the United States (Bekaert et al., 2011; Horta and Vieira, 2010; Huang et al., 2012; Kazia et al. 2013; Yamamoto 2014). In this study the contagion from the EU is also tested.

This paper also proposes a new IBS to capture banking crisis occurrence. The index will also be used in measuring the impact of crisis contagion. The literature on banking crises uses both qualitative and quantitative methodologies to measure banking crisis. An example of qualitative research in this area is the study of Kaminsky and Reinhart (1999) and Reinhart and Rogoff (2009). This approach is less well suited for the purposes of this paper as the precise measurement of banking crisis occurrence is not only important to identify crisis transmission but also to detect contagion of the crisis.

3 | METHODOLOGY

3.1 | Identification of the banking crisis

The main focus of this paper is to identify the most significant channels of crisis transmission in the EU countries. The identification of the right type of crisis will help in choosing relevant crisis transmission channels.

The literature identifies four main types of financial crises:

- currency crisis,
- banking crisis,
- debt crisis, and
- account balance crisis (sudden stops).

The above classification is based on a crisis' s origins and the sectors and markets which are affected the most. In the case of the 2007–2008 financial crisis, a banking crisis is the most relevant in explaining its dynamics and causes. A banking crisis usually occurs as a consequence of banks' inability to allocate resources. This may be caused by bank runs or bankruptcy, banks and financial institutions insolvency, or government intervention in the banking sector. Similarly, in the financial crisis of 2007–2008 many financial institutions and banks experienced losses and financial difficulties, mainly because of exposure to subprime mortgage securities. Examples include Merrill Lynch, US Citigroup, Swiss bank UBS, HSBC, Bear Stearns takeover by JP Morgan, Fortis, Daxia, and finally Lehman Brothers' bankruptcy. Furthermore, the crisis also affected the European financial market where financial turmoil was experienced by many European financial institutions such as Northern Rock, a UK Dresdner Kleinwort investment bank, HBOS, Dexia SA, Fortis, Landsbanki Hypo Real Estate Holding, Royal Bank of Scotland, and Lloyds TSB group Plc.

A banking crisis is usually connected to banking system failure, so researchers concentrated on variables linked to a bank' s vulnerability. Caprio and Klingebiel (1996) defined a crisis as a significant decrease in a bank' s capital. To establish changes in a bank' s capital loss, they used official data as well as banking systems' reports and experts' opinions and on that basis they identified when a systematic banking crisis occurred. In the study of Davis and Karim (2008), a banking crisis was identified if at least one of the following was true: 10% of nonperforming loans to total banking assets, 2% of GDP spent on public bailout, and large-scale nationalization of a bank or bank runs. Similarly, the research of Kauko (2012) identified the problems in banking systems by deterioration of credit quality measured by the relative share of nonperforming loans. In turn, in research conducted by Laeven and Valencia (2013), a banking crisis was defined as an event that meets two conditions. The first condition includes the symptoms of financial distress in the banking system such as bank losses, bank liquidation, and bank runs. The second condition includes measures to minimize losses in the banking system such as freezing deposits, significant nationalization of banks, bank restructuring greater than 3% of GDP, significant liquidity support, and 5% of GDP of assets purchases.

The high ratio of nonperforming loans to total loans is usually a sign of a banking crisis. A significant increase in the amount of nonperforming loans can seriously jeopardize banks' profitability and financial sector performance. The financial system in the United States and EU countries did not meet the 10% threshold of the nonperforming loans ratio used in methodology by Demirgüç-Kunt and Detragiache (2005) and Davis and Karim (2008) but, according to Laeven and Valencia (2008), a large number of defaults in the banking system was sufficient criterion to classify an event as a banking crisis.

As it was pointed out by von Hagen and Ho (2007), the potential weakness of studies based on the methodology of Demirgüç-Kunt and Detragiache (2005) and Laeven and Valencia (2018) is that a government intervention also occurs when there is no banking crisis and in some banking crises there is no government intervention. Additionally, decisions about the significance of government intervention are taken arbitrarily by researchers, and interventions do not usually occur at the beginning of the crisis, which can bias the timescale of the crisis.

There are several models used to measure a crisis based on the financial stress index, namely Illing and Liu (2006), Hanschel and Monnin (2005), and Cardarelli et al. (2009), and a money market pressure index proposed by von Hagen and Ho (2007). Chaudrona and de Haana (2014) constructed a time series based on bank failures measured by losses in the banking sector' s equity or proportion of failed bank assets together with support measures, financial account data, and an aggregate balance sheet. Another example is the Country-Level Index of Financial Stress (CLIFS) index used by the European Central Bank (ECB) based on methodology of Duprey et al. (2017).

CLIFS is used to identify systematic financial crisis, and one of its subindexes captures banking sector stress using bank stock prices indices.

In this study in order to create a more precise and objective measure of banking stress, a quantitative approach was used and the banking crisis index was constructed. The role of the index was to capture an ongoing stress level. This approach was useful to identify the key features of the 2007–2008 financial crisis and enable precise identification of the main transmission channels.

With the assumption that the financial crisis of 2007–2008 was a banking crisis, two variables in real time were used to identify a banking sector's vulnerability and thus capture the period of crisis: the return on the banking stock and the TED spread. The return on a banking stock was chosen due to the fact that during a banking crisis there is usually a decrease in return of the banking stock as it was shown in the research of Byström (2004), where the index based only on the banking return was used to assess the banking system's health and was successful in marking market distress. In turn, Moshirian and Wu (2009) found that volatility in the banking sector (measured by bank stock prices) can be a good indicator of a banking crisis in advanced countries.

The TED spread was selected because it is a proxy for counterparty risk and creditworthiness. The TED spread tends to widen at times of crisis, and it is linked to a high probability of bank failure. A high TED spread means that higher interest rates are charged for unsecured loans, which is indicated by a higher London Interbank Offered Rate (LIBOR). A high TED spread also means that the treasury bonds' rate decreases, because treasury bonds during times of uncertainty created by a financial crisis are perceived as less risky and thus become more attractive to investors.

The advantage of IBS is its transparency and reproducibility as IBS relies on prices of financial instruments rather than on subjective perception of researchers and experts. It is also constructed to capture the crisis in real time.

The index, which comprises of TED spread and banking prices returns, is constructed by using the variance-equal weights method, where each variable is first standardized and then aggregated into the index. Index results were also standardized. The crisis is marked when the index result is one standard deviation above its mean. The index was calculated quarterly (Equation 1).

Index of banking stress (IBS)

$$IBS_{it} = \sum_{i=1}^k \frac{x_{it} - \bar{x}_i}{\sigma_i}, \quad (1)$$

where IBS_{it} is the IBS, k is the number of variables in the index, x_{it} is variable i , \bar{x}_i is mean of variable x_{it} , and σ_i is the standard deviation of variable x_{it} .

The sample of countries under consideration includes 10 advanced European economies, namely Belgium, Denmark, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom in the period between the fourth quarter of 2002 until the second quarter of 2012, which comprises 39 observations. The quarterly frequency was the lowest frequency available for data used in this study. Additionally, the period in the research includes 5 years before, 2 years during, and 4 years after the financial crisis.

The reason behind this sample choice is to concentrate solely on advanced economies and to identify and analyze the main reasons behind the banking crisis transmission and contagion.

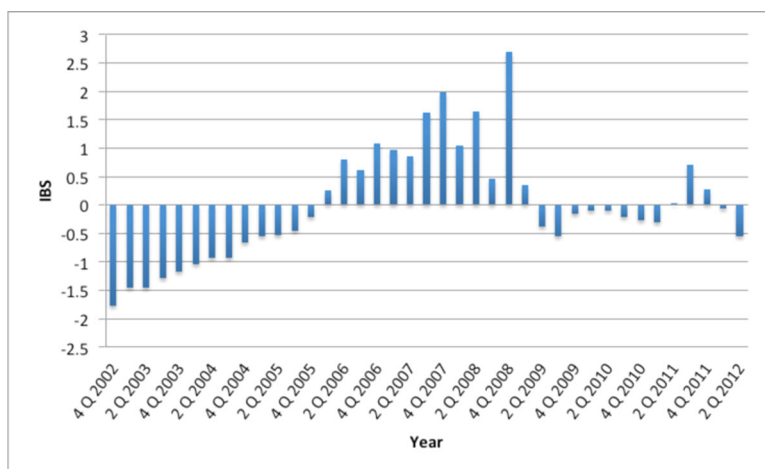


FIGURE 1 France IBS from 2002–2012

[Colour figure can be viewed at wileyonlinelibrary.com]

Source: Author's calculations, data from Datastream.

Abbreviations: IBS, index of banking stress; Q, quarter.

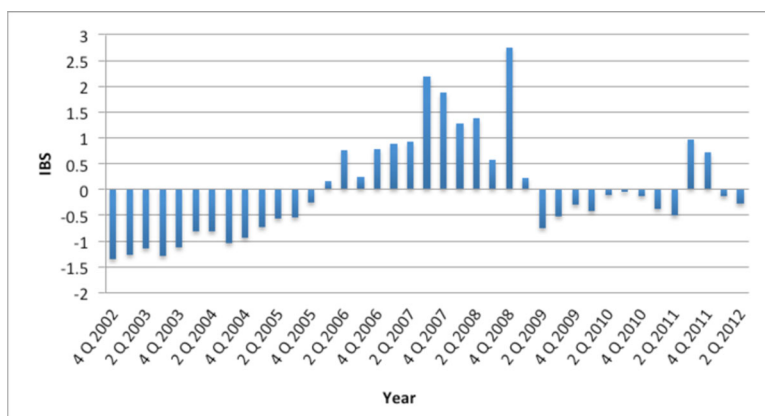


FIGURE 2 Germany IBS 2002–2012

[Colour figure can be viewed at wileyonlinelibrary.com]

Source: Author's calculations, data from Datastream.

Abbreviations: IBS, index of banking stress; Q, quarter.

In the chosen sample of 10 countries, banking stress began in the fourth quarter of 2006 in France (Figure 1) and in 2007 in the remaining countries (Figures 2–10). In all analyzed countries, banking stress is marked in 2007 and continued in 2008.

In all countries in the sample, banking stress is evident in the fourth quarter of 2008 (Figures 1–10), which coincided with the aftermath of Lehman Brothers' collapse. Bankruptcy of Lehman Brothers increased uncertainty in the markets, especially in interbank markets leading to liquidity problems which was indicated by an increase in TED spread (Figure 11).

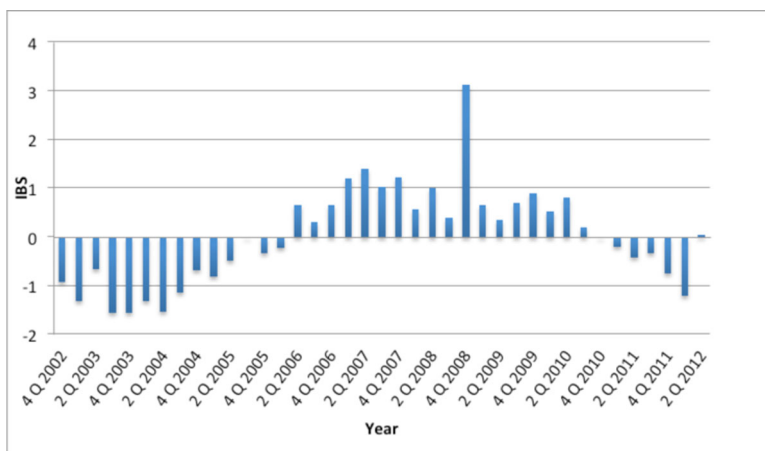


FIGURE 3 Denmark IBS 2002–2012
 [Colour figure can be viewed at wileyonlinelibrary.com]
 Source: Author’s calculations, data from Datastream.
 Abbreviations: IBS, index of banking stress; Q, quarter.

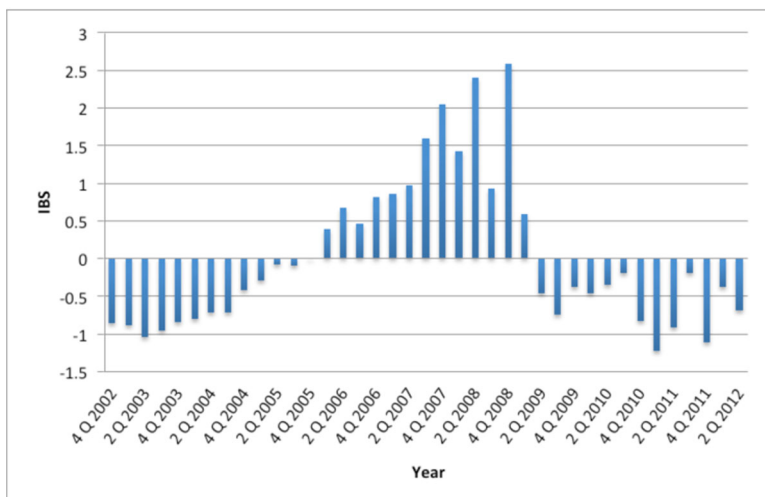


FIGURE 4 Belgium IBS from 2002–2012
 [Colour figure can be viewed at wileyonlinelibrary.com]
 Source: Author’s calculations, data from Datastream.
 Abbreviations: IBS, index of banking stress; Q, quarter.

3.2 | Crisis transmission channels

In the literature, two channels of crisis transmission, trade and financial linkages, are mainly considered. The number of studies confirmed the financial channel transmission of the 2007–2009 crisis including Park and Shin (2020), BenMim and BenSaida (2019), and Apergis et al. (2019). In Asian countries, according to Yamamoto (2014), the financial crisis of 2007–2008 was transmitted from the United States through financial channels because of high integration between the United

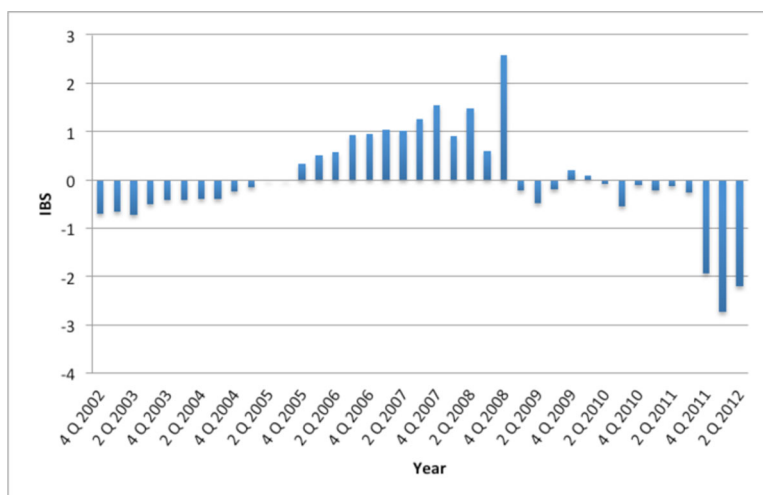


FIGURE 5 Italy IBS 2002–2012

[Colour figure can be viewed at wileyonlinelibrary.com]

Source: Author's calculations, data from Datastream.

Abbreviations: IBS, index of banking stress; Q, quarter.

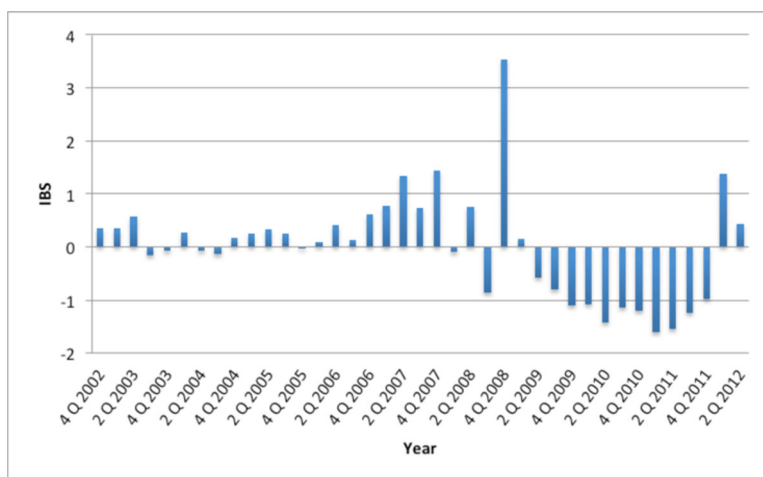


FIGURE 6 Netherlands IBS 2002–2012

[Colour figure can be viewed at wileyonlinelibrary.com]

Source: Author's calculations, data from Datastream.

Abbreviations: IBS, index of banking stress; Q, quarter.

States and Asian economies. Similarly, the transmission of the crisis through financial channel was also confirmed in the study of Asian firms by Shikimi (2019). In turn, Kazia et al. (2013) proved that the crisis from the United States to 14 OECD countries was transmitted through asset prices, interest rates, and trade channel.

The financial and trade channels were calculated following the methodology of Forbes and Chinn (2003). To test financial links between countries that existed before crisis, financial linkages

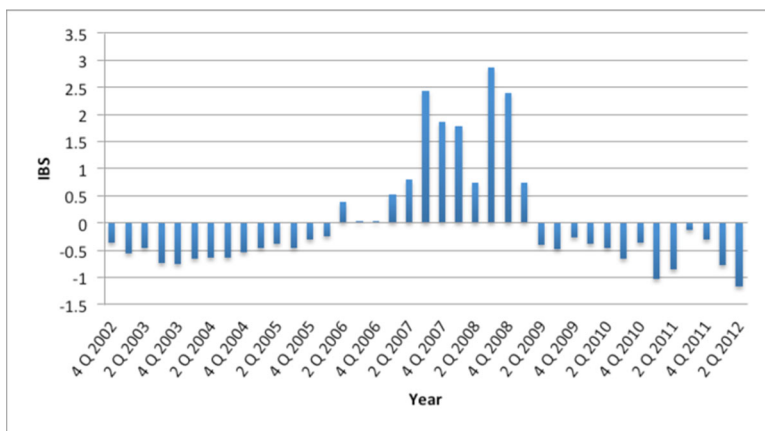


FIGURE 7 Portugal IBS 2002–2012
 [Colour figure can be viewed at wileyonlinelibrary.com]
 Source: Author’s calculations, data from Datastream.
 Abbreviations: IBS, index of banking stress; Q, quarter.

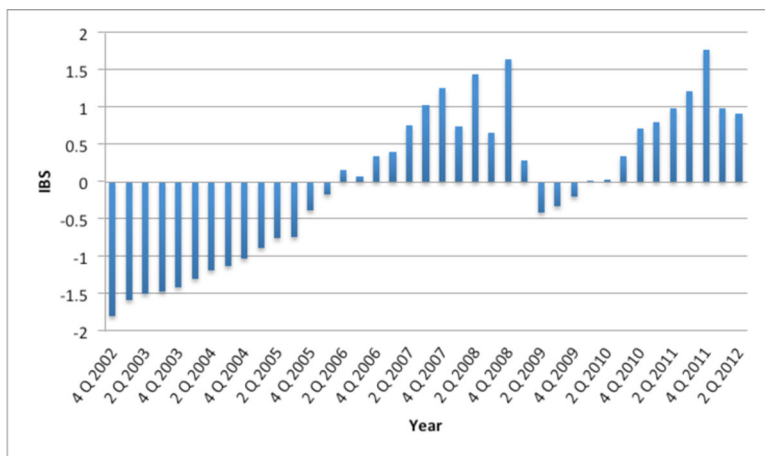


FIGURE 8 Sweden IBS 2002–2012
 [Colour figure can be viewed at wileyonlinelibrary.com]
 Source: Author’s calculations, data from Datastream.
 Abbreviations: IBS, index of banking stress; Q, quarter.

were included in the regression based on the consolidated international claims of the Bank for International Settlements (BIS).

Financial linkage with the United States and each European Union country was calculated as a total of bank lending reported to the BIS from the United States to each country *i* in the sample divided by the GDP of the European country (GDPEU) *i*.

$$\text{Linkage US} = \frac{\text{bankLENDING}_{it}^{US}}{\text{GDPEU}_{it}}. \tag{2}$$

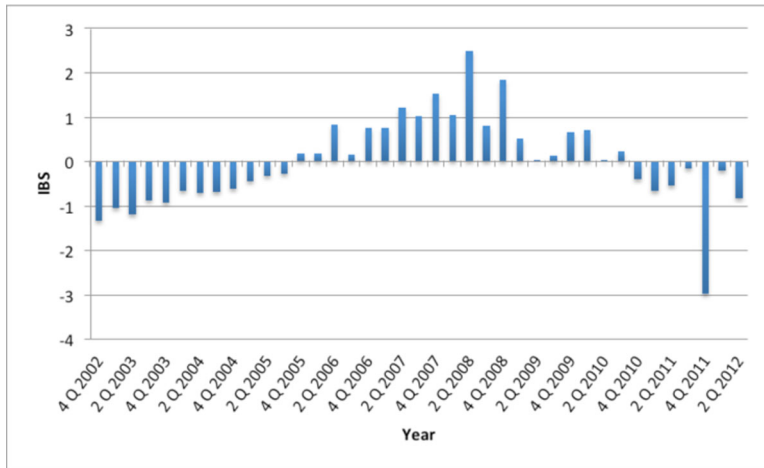


FIGURE 9 Spain IBS 2002–2012

[Colour figure can be viewed at wileyonlinelibrary.com]

Source: Author's calculations, data from Datastream.

Abbreviations: IBS, index of banking stress; Q, quarter.

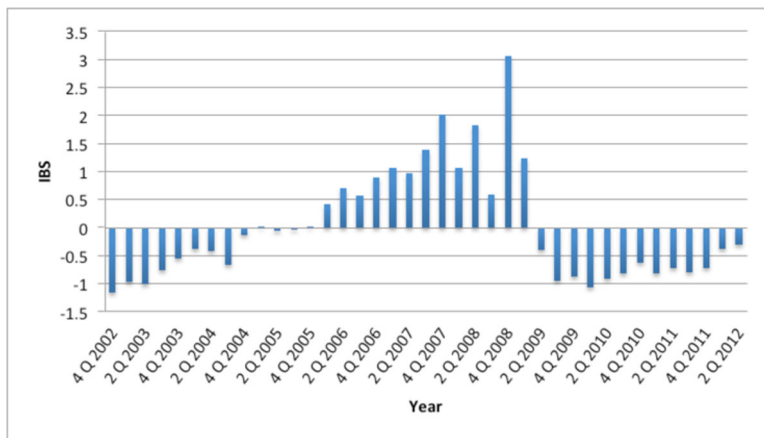


FIGURE 10 UK IBS 2002–2012

[Colour figure can be viewed at wileyonlinelibrary.com]

Source: Author's calculations, data from Datastream.

Abbreviations: IBS, index of banking stress; Q, quarter.

Financial linkages with other EU countries are presented as the aggregated total of bank lending data reported to the BIS from all countries in the sample to each country i divided by GDP of country i (data were calculated for all countries in the sample with the exception of the first quarter of 2010 and the first quarter of 2011 when total bank lending was calculated without France. This was due to the lack of data). The total bank lending is the consolidated international claims of BIS reporting banks, which include cross-boarder on-balance sheet claims by banks outside the counterparty country and local claims by banks inside the counterparty country in a foreign currency. Reporting institutions include commercial banks, saving banks, credit unions, cooperative

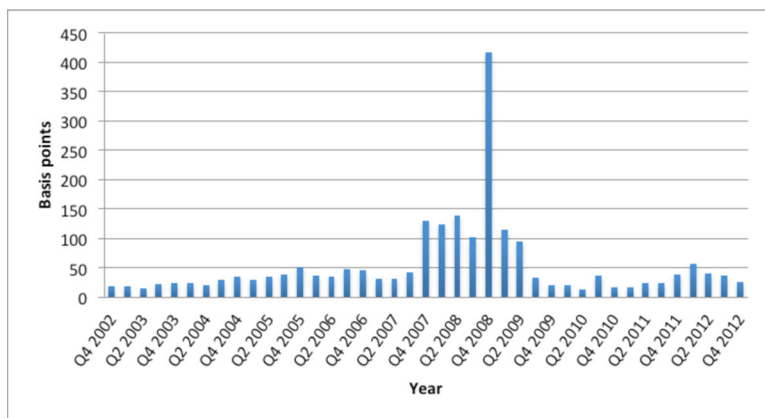


FIGURE 11 TED spread

[Colour figure can be viewed at wileyonlinelibrary.com]

Source: Author's calculations data from Datastream. The TED spread was calculated as a difference between LIBOR and 3 months US treasury bill rate

credit banks, and other financial credit institutions.

$$\text{Linkage EU} = \frac{\sum_{i=1}^k \text{bankLENDING}_{it}^{EU}}{GDP_{it}}. \quad (3)$$

Another possible channel of crisis transmission is the trade link. Trade links with other European countries were calculated as the aggregate total of export in millions in US\$ from all countries in the sample to each country i divided by GDP of country i .

$$\text{Trade links EU} = \frac{\sum_{i=1}^k \text{export}_{it}^{EU}}{GDP_{it}}. \quad (4)$$

Trade links with the United States were calculated as the total export in millions in US\$ from the United States to each country i divided by GDP of country i .

$$\text{Trade links US} = \frac{\text{export}_{it}^{US}}{GDP_{it}}. \quad (5)$$

3.3 | Crisis contagion

Contagion is measured in the literature as a significant increase in co-movement between countries, such as an increase in co-movement between financial markets during a crisis (Baig & Goldfajn, 1999). However, Forbes and Rigobon (1999) showed that the above methodology could be biased, as correlation coefficient of market co-movement during a crisis is biased upwards. Bae et al. (2003) also criticized the approach of testing for correlation between financial markets and proposed a new methodology that is based on the coincidence of extreme returns in financial markets rather than correlation between returns.

Eichengreen et al. (1996) used a panel probit model to test how a crisis occurrence in one country will affect the probability of a crisis in another country. The authors constructed financial, trade, and macroeconomic similarities contagion channels with an assigned weighted “crisis elsewhere” variable. In this model, the authors also controlled for macroeconomic fundamentals. Similar methodology was used by Glick and Rose (1999), Van Rijckeghem and Weder (2001), and Haile and Pozo (2007).

Moralesa and Andreosso-O’Calla (2014) criticized the approach to measure contagion because it concentrates solely on contagion between financial markets. The authors suggested that contagion can be also measured through other financial and economic fundamentals.

In studies of the crisis of 2007–2008, a number of authors used the Generalized AutoRegressive Conditional Heteroskedasticity (GARCH) model to test contagion (Bouaziz et al., 2012; Dungeya et al., 2015; Horta & Vieira, 2010; Naoui & Brahim, 2010). In turn, Bekaert et al. (2011) formulated a factor model with a US factor, domestic factor, and global financial factor and a crisis dummy. Three factors used in the model stand for three different types of contagion, and contagion was defined as an excessive co-movement above what is expected from the factor model. Huang et al. (2012) applied The exponential general autoregressive conditional heteroskedastic (EGARCH) methodology to assess contagion. The authors distinguished between three types of economic linkages between the United States and European countries. First is total assets in international investment portfolios, second is total liabilities in international investment portfolios, and, finally, trade linkages. Cross-market linkages were compared before, during, and after the crisis.

Guo et al. (2011) used Markov regime-switching VAR (vector autoregression) framework to measure the contagion effect. In turn, Wong et al. (2010) used a contagion variable in their empirical study. The contagion variable was constructed as the weighted sum of crisis occurrence in neighboring countries. Weights reflected macroeconomic similarities between countries based on the GDP growth rate. Similarly, Longstaff (2010) also tested contagion by using VAR to estimate cross market linkages between asset-backed collateralized debt obligation (CDO) markets, stock exchange markets, and bond markets.

In the study of contagion in the banking sector, Daly et al. (2019) examined the contagion nature of risk. The risk was measured by distance to default, distance to insolvency, and distance to capital. These measurements were calculated as the distance between the current condition in financial institutions to theoretical default, insolvency, and capital conditions. Authors then calculated the probability of extreme shocks within the distance measures and investigated how these shocks were transmitted between different banking sectors.

Danninger et al. (2009) investigated transmission channels of the financial crisis 2007–2008 from advanced countries to developing countries. Apart from taking into account global factors and countries’ specific vulnerabilities, the authors also used a co-movement parameter of financial stress, which measured if financial stress in an advanced country influenced financial stress in a developing country. In their methodology, Danninger et al. (2009) used a two-step approach based on Forbes and Chinn (2003) methodology. In the first step, the stress index for emerging countries is the dependent variable while the stress index in advanced countries, global factors, and countries’ vulnerabilities are independent variables. In the second step, the co-movement parameter of financial stress between advanced and emerging countries is then modeled as a function of financial and trade linkages between emerging and advanced countries.

The approach to contagion measurement in this study is similar to that of Danninger et al. (2009) and Forbes and Chinn (2003). However, it differs in respect to the use of statistical procedures as nonlinear logistic regression is used, and the estimation procedure is not split into two steps. Additionally, all contagion and real linkages are tested at the same time. This methodologi-

cal approach results from the definition of contagion adapted in this study, which is defined as an increase in the probability of a banking crisis due to the occurrence of a banking crisis in another country. The methodology used clearly distinguishes between transmission channels based on real fundamentals, namely financial linkage with the United States and the EU countries, trade links with the EU and the United States, and contagion channels namely index EU and index US. Index EU for each country i is calculated as an average of IBS of remaining European countries from the sample. Index US is calculated as the value of IBS of the United States. The high value of IBS captures the crisis occurrence, and so the statistical significance of index UE and index US variables will signal contagion of crisis due to crisis occurrence in the EU and the United States, respectively.

Although the statistical significance of the contagion channels will not offer an explicit explanation as to what were the sources of contagion, but it will be possible to identify reasons for crisis contagion.

3.4 | Macroeconomic vulnerabilities

The severity of recession that occurred in the 10 countries from the sample suggests that the development of a financial crisis in these countries depended on internal and external economic vulnerabilities. In the literature, indicators that increase the probability of a crisis occurrence include positive deviation of the real effective exchange rate from its trend (Edison, 2003; Bussiere & Fratzscher, 2006), high real exchange rate appreciation (Sachs et al., 1996), fast increase of the credit to the private sector (Bussiere & Fratzscher, 2006), high ratio of short-term debt to reserves (Edison, 2003; Bussiere & Fratzscher, 2006), real interest rate of 3 months US treasury bill, the current account-to-GDP ratio, foreign direct investment, changes in GDP growth, export growth (Kamin et al., 2001), low lending to deposit rate, high private sector liabilities to the banking sector, and public debt.

Many studies assessed different variables in relation to the instability of a financial system. Banking crises are caused by a combination of fragility of domestic financial structure and global economic conditions. For example a rise in interest rates in the United States, Europe, and Japan can cause a banking crisis in other countries. This was especially important in emerging markets where US interest rates had an effect on the cost, creditworthiness, and availability of funds (Bustillo & Velloso, 2002).

In addition, the global business cycle and OECD growth also had an impact on the development of a banking crisis, especially in periods of slow growth in advanced economies (Eichengreen & Rose, 1998). According to Demirgüç-Kant and Detragiache (1997), low economic growth, high inflation rate, and high and volatile interest rates increased the risk of a banking crisis. Stoker (1995) argues that external shocks such as a raise in foreign interest rates together with commitment to a fixed parity led to the loss of reserves and resulted in a credit crunch, increasing bankruptcies, and financial crises.

In a review of 69 banking crises, Caprio and Klingebiel (1996) revealed that countries with high export concentration suffered more severe banking crises. In countries with high export concentration, domestic banks were more vulnerable to market volatility. Additionally, there is evidence showing that the shift in terms of trade contributed to a bank crisis in Chile in the early 1980s and Malaysia in the mid-1980s (Lindgreen et al., 1996).

In developed countries, high inflows of capital were linked to more volatile macroeconomic outcomes for GDP growth, inflation, and the external accounts. At the end of a capital inflow

period in advanced economies, slower economic growth and fall in equity and housing prices were likely to occur (Reinhart & Reinhart, 2008).

Some studies did not confirm a relationship between economic variables and an increase in vulnerability of a financial system. An example is the work of Caramazza et al. (2004) where the authors did not find evidence supporting the assumption that banking crises or lending booms are associated with the transmission of crises. According to Caramazza et al. (2004), indicators such as inflation, growth in total or private domestic credit, the level and growth of the ratio of public debt to GDP, changes in the terms of trade, the trade balance, exports, as well as the growth of exports in relation to GDP, and the type of exchange rate regime did not play any role in the transmission of crises. However, as far as fundamentals are concerned, weak output growth increased the probability of a crisis more than external imbalance.

To investigate whether weak macroeconomic fundamentals could have made countries more susceptible to crisis transmission, this study will include macroeconomic vulnerability variables and external shock variables. The above variables will enable to test for other than transmission and contagion causes of financial crisis.

3.5 | Model specification

Pooled logistic regression analysis covering the period from the fourth quarter of 2002 until the second quarter of 2012 (39 quarters) was used to determine which crisis transmission channels and variables were responsible for the 2007–2008 crisis propagation. Regression tested the dichotomous-dependent variable: crisis versus noncrisis. The independent variable takes the value of 1 when there is a crisis and the value of 0 when there is no crisis. The value is based on the IBS result, and the crisis is marked when the index result is one standard deviation above its mean.

The variables included in the model are divided into four groups.

1. Crisis transmission channel variables include linkage US, linkage EU, trade links EU, and trade links US (Tables 1 and 2).
2. Macroeconomic vulnerability variables include unemployment, GDP growth, GDP to current account, inflation, exchange rate, direct investment, and short-term and long-term interest rates (Tables 1 and 2).
3. External shock variables include US long-term interest rates and US short-term interest rates (Tables 1 and 2).
4. Crisis contagion variables include index EU and index US (Tables 1 and 2).

3.5.1 | Logistic regression-random effect model

$$\ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1\Delta\text{linkage US} + \beta_2\Delta\text{linkage EU} + \beta_3\text{GDP growth} + \beta_4\Delta\text{unemployment} \\ + \beta_5\Delta\text{GDP to current account} + \beta_6\text{inflation} + \beta_7\Delta\text{long interest rates} \\ + \beta_8\Delta\text{short interest rates} + \beta_9\Delta\text{foreign reserves} + \beta_{10}\text{index US} + \beta_{11}\Delta\text{index EU}$$

$$+ \beta_{12} \Delta \text{short interest rates US} + \beta_{13} \Delta \text{long interest rates US} + \beta_{14} \Delta \text{exchange rate} \\ + \beta_{15} \Delta \text{direct investment} + \beta_{16} \Delta \text{trade links EU} + \beta_{17} \Delta \text{trade links US} + v_i + e_{it}$$

where

$$p = \frac{e^{\beta_0 + \beta_1 x + \dots + \beta_{17} x}}{1 + e^{\beta_0 + \beta_1 x + \dots + \beta_{17} x}}, \quad (7)$$

$$1 - p = \frac{1 + e^{\beta_0 + \beta_1 x + \dots + \beta_{17} x} - e^{\beta_0 + \beta_1 x + \dots + \beta_{17} x}}{1 + e^{\beta_0 + \beta_1 x + \dots + \beta_{17} x}}, \quad (8)$$

p_i is the probability that i country will be in crisis, $p_i = 1$ if there is a crisis, $p_i = 0$ if there is no crisis, v_i is a country-specific error, e_{it} is an idiosyncratic error, and Δ is the first difference operator.

The model is estimated by maximum likelihood, with the likelihood function defined as

$$L = \prod_{y_i=1} P_i \prod_{y_i=0} (1 - P_i), \quad (9)$$

where L is the likelihood function, P_i is a probability, and y_i is a dummy variable

$$y_i = 1 \quad (10)$$

$$y_i = 0. \quad (11)$$

P_i probability

$$P_i = F\left(\beta_0 + \sum_{j=1}^k \beta_j x_{ij}\right), \quad (12)$$

where F is the cumulative distribution function of error term u .

The Wald test is an F -test to examine the significance of all variables in the model:

$$W = \frac{\hat{\beta}^2}{\text{Estimate of var}(\hat{\beta})} \quad (13)$$

with x^2 distribution.

$$\text{Estimate of var}(\hat{\beta}) = \frac{\hat{\sigma}^2}{s_{xx}} \quad (14)$$

where

$$\hat{\sigma}^2 = \frac{S_{yy}(1-r^2)}{n} \quad (15)$$

$$\hat{\beta} = \frac{S_{xy}}{S_{xx}} \quad (16)$$

$$W = \frac{nr^2}{1-r^2} \quad (17)$$

where

$$S_{yy} = \sum (y_i - \bar{y})^2 = \sum y_i^2 - ny^{-2},$$

$$S_{xy} = \sum (x_i - \bar{x})(y_i - \bar{y}) = \sum x_i y_i - n\bar{x}\bar{y},$$

$$S_{xx} = \sum (x_i - \bar{x})^2 = \sum x_i^2 - nx^{-2}$$

(Maddala, 1992). The odds ratio is

$$\frac{(e^{-\beta_0 + \beta_1 x})}{(\beta_0 + e^{-\beta_0 + \beta_1 x})}$$

$$OR = \frac{1}{(1 + e^{\beta_0 + \beta_1})}$$

$$\frac{(e^{\beta_0})}{(1 + e^{\beta_0})}$$

$$OR = \frac{e^{\beta_0 + \beta_1}}{e^{\beta_0} + \beta_1}$$

$$OR = e^{(\beta_0 + \beta_1) - \beta_0}$$

$$OR = e^{\beta_0 + \beta_1},$$

where $e^{\beta_0 + \beta_1}$ is the effect of the independent variable on the odds ratio (Hosmer & Lemeshow, 2013).

4 | RESULTS AND DISCUSSION

Results of logistic regression presented in Table 1 show that five variables are statistically significant: inflation, US long-term interest rate, exchange rate, index US, and index EU. Estimation results suggest that among macroeconomic vulnerability variables, two variables are statistically significant in explaining the causes of the 2007–2008 crisis. One of these is inflation. Empirical results indicate that an increase in inflation increases the probability of a banking crisis, which is consistent with the literature findings (Demirgüç-Kant & Detragiache, 1997; Jacobs & Kuper, 2003; Kaminsky et al., 1998; Berg et al., 2005). The high inflation is a product of an economic boom, which very often precedes the banking crisis. During an economic boom, there is an increase in the demand for credit and financial investments leading to an increase in bank profits. The accumulation of nonperforming loans or risky credits and investments from the boom period may contribute to future bank problems and unfolding of a banking crisis. Additionally, the increase in the inflation rate can have a negative effect on the economy and banking sector. The inflation is associated with a rise in a bank's cost because of an increase in the number of transactions (Demirgüç-Kunt & Huizinga, 1999). In the case of the banking crisis of 2007–2008, a low

TABLE 1 Logistic regression-random effect model results

Variable	Coef.	Std. Err.	z	p > z	[95% Conf. Interval]	
GDP to current account	-0.2197183	0.1800439	-1.22	0.222	-0.5725978	0.1331613
Inflation	0.5469129	0.2762507	1.98	0.048	0.0054714	1.088354
Short interest rates	-1.733259	1.520418	-1.14	0.254	-4.713223	1.246705
US long interest rates	-3.086705	1.237638	-2.49	0.013	-5.51243	-0.6609802
US short interest rates	-0.7355842	0.744577	-0.99	0.323	-2.194928	0.7237598
Linkage US	-4.034167	26.42664	-0.15	0.879	-55.82942	47.76109
Unemployment	-0.1469761	0.8150067	-0.18	0.857	-1.74436	1.450408
GDP growth	-0.2426358	0.2089495	-1.16	0.246	-0.6521693	0.1668978
Long interest rates	0.6489243	0.9148924	0.71	0.478	-1.144232	2.44208
Trade links EU	-22.40228	63.42237	-0.35	0.724	-146.7078	101.9033
Foreign reserves	0.0002397	0.000199	1.2	0.228	-0.0001503	0.0006298
EU linkage	8.006692	6.767423	1.18	0.237	-5.257214	21.2706
Exchange rate	-0.5016357	0.2363229	-2.12	0.034	-0.96482	-0.0384514
Index US	2.86E+00	0.641334	4.46	0	1.60474	4.118723
Direct investment	2.62E-06	0.0000146	0.18	0.858	-0.0000261	0.0000313
Index EU	3.104889	1.031877	3.01	0.003	1.082448	5.12733
Trade links US	-546.1542	405.8763	-1.35	0.178	-1341.657	249.3487
Constant	-4.63515	0.962385	-4.82	0	-6.52139	-2.74891

Note: Data in bold are statistically significant.

Abbreviations: ; Coef, coefficients in log-odds units; Std Err, standard error; z, z value; p, two-tailed p-value; [95% Conf. Interval, 95% confidence interval for the coefficient Wald $\chi^2(17) = 53.58$; Log likelihood = -70.569113 Prob > $\chi^2 = 0.0000$.

inflation rate before the crisis could contribute to ease of loans requirements and when inflation rose this could increase interest rates on loans increasing the debt burden and leading to loan repayment problems.

Another statistically significant macroeconomic vulnerability variable identified in the model was the exchange rate. According to the results presented, a decrease in the rate of the exchange rate will increase the probability of a banking crisis. The results are in line with the literature; for example, Davis and Karim (2008) found that currency depreciation increases the probability of a banking crisis. Similarly, Duttagupta and Cashin (2011) revealed that currency depreciation together with high liability dollarization is one of the causes of a banking crisis. The implication of this result might be that either banking systems in European countries or bank borrowers were subject to exchange rate risk. On the other hand, there are also studies indicating that currency appreciation rather than depreciation precedes a banking crisis (Kaminsky & Reinhart, 1999).

The above results confirm the interest rate transmission linkage between the United States and Europe. The financial market liberalization in the 1980s increased global integration between countries. The evidence of economies' integration is co-movement of economic indicators such as GDP, inflation, or asset price. The study of Kazia et al. (2013) of the impact of the US monetary policy shock on 14 OECD countries (the United States, Canada, France, Germany, Italy, the UK, Japan, Australia, Spain, Norway, Sweden, Switzerland, Finland, and New Zealand) revealed that the monetary policy shock, measured as the unexpected change in effective federal funds rate (FFR), had a negative impact on GDP growth for most of the researched countries. Kazia et al. (2013) also noticed that during the 2007–2008 financial crisis the monetary policy shock also

TABLE 2 Odds ratio-panel logistic model

Variable	Odds ratio	Std. Err.	z	<i>p</i> > z
GDP to current account	0.8027449	0.1445293	-1.22	0.222
Inflation	1.727911	0.4773365	1.98	0.048
Short interest rates	0.1767077	0.2686694	-1.14	0.254
US long interest rates	0.0456521	0.0565008	-2.49	0.013
US short interest rates	0.4792254	0.3568202	-0.99	0.323
Linkage US	0.0177004	0.4677626	-0.15	0.879
Unemployment	0.8633146	0.7036072	-0.18	0.857
GDP growth	0.7845572	0.1639329	-1.16	0.246
Long interest rates	1.913481	1.75063	0.71	0.478
Trade links EU	1.87E-10	1.18E-08	-0.35	0.724
Foreign reserves	1.00024	0.0001991	1.2	0.228
EU linkage	3000.972	20308.85	1.18	0.237
Exchange rate	0.6055394	0.1431028	-2.12	0.034
Index US	17.49179	11.21808	4.46	0
Direct investment	1.000003	0.0000146	0.18	0.858
Index EU	22.30675	23.01781	3.01	0.003
Trade links US	6.40E-238	2.60E-235	-1.35	0.178

Note: Data in bold are statistically significant.

Abbreviations: Std Err, standard error, z, z value, *p*, two-tailed *p* value.

significantly decreased GDP growth and caused a reduction in share prices. Additionally, Byrne et al. (2012) found evidence of international correlation of long-term interest rates. According to Estrella and Mishkin (1997), long interest-term rates are influenced by two factors: low expectations of long-term inflation and real activity.

Eichengreen and Rose (1998) found a correlation between an increase in the interest rates in the United States, Europe, and Japan and a banking crisis in emerging countries. However, results of regression presented in Tables 1 and 2 show that a decrease in the US long-term interest rates increased the probability of a crisis in 2007–2008 in European Union countries. The results are consistent with the economic situation in the United States. In the 2000s, the US long-term interest rates were unusually low. The low long-term interest rates were due to increased foreign investment into the US government bonds. This in turn caused a more lax Federal policy, which particularly affected the US mortgage market. The US long-term interest rates can be seen in this context as a proxy of unfolding banking problems in the United States in the 2000s, which was an indirect cause of the banking crisis in the European countries.

Another group of variables, which were significant to the 1% threshold, were crisis contagion variables: index US and index EU. A high value of index indicates a potential banking problem and signals the banking crisis. The positive sign of both estimated coefficients suggests that high indexes of a banking crisis in the United States and the EU increased the probability of a banking crisis in countries in the sample. As it was expected and shown in the literature, the banking crisis in the United States and other European countries increased the probability of a banking crisis occurrence in countries in the sample. Based on odds ratios presented in Table 2, an increase in index US by one unit increases the odds of a banking crisis occurrence by 17.49179. Similarly, an increase in index EU by one unit increases the odds of a banking crisis occurrence by 22.30675.

The model used allowed not only testing for contagion from the United States but also from the EU and as results showed, both contagion from the United States and the EU were important. As a contagion variable used in this study is IBS, the potential contagion sources are connected to the banking sector in the United States and in the EU. One of the possible causes of contagion might be a decrease in trust and increase in uncertainty among banks and investors which was captured by the high result of IBS due to widening of the and increase in volatility of banking share prices. Another cause of crisis contagion might be problems with liquidity in the banking sector, which started to be visible in the second part of the year 2007 and worsened after the collapse of Lehman Brothers in September 2008. Additionally, as a rise in the TED spread is a proxy of an increase in counterparty risk, the uncertainty that contributed to contagion could have been triggered by change of risk perception among investors. When investors and banks realized the real value of mortgage-backed securities, their value decreased which contributed to an increase in uncertainty among banks. The uncertainty contributed to banks' reluctance to borrow from one another as they were unsure which banks had the most toxic assets.

Real links between countries such as trade links and financial linkages were statistically insignificant, and results suggest that contagion was one of the main reasons for crisis transmission between the United States and the European countries. Longstaff (2010) found similar evidence of crisis contagion of a subprime crisis through financial markets by liquidity and risk-premium channels. In addition, Michaelides and Papageorgi (2012) proved that from 1960 until 2011 economic fluctuations such as output fluctuations were transmitted from the United States to the 15 EU countries, and this was increased after the introduction of the euro.

None of the crisis transmission channels were statistically significant, implying that a real connection between countries in terms of trade and financial linkage did not contribute to crisis transmission and enhanced the notion that one of the main causes of the banking crisis of 2007–2008 transmission was a contagion from the United States and also between the EU countries.

5 | THE ROBUSTNESS ANALYSIS

In order to conduct the robustness analysis, additional tests are presented. The robustness of the results is tested using logit regression with monthly data, which are specified separately for each country from the sample. The regression analysis includes 117 observations from October 2002 to June 2012. For each country, a monthly IBS index is constructed and logistic regression analysis is conducted.

Overall, the monthly IBS (Figures 1–9 in Online Appendix 1) display similar patterns of the crisis occurrence to quarterly indices and similarly to quarterly indices were successful in marking the crisis.

The regression results presented in Tables 3–12 in Online Appendix 2 partially confirm the results from the logistic model with panel data. In five countries, namely Belgium, France, the Netherlands, Sweden, and the United Kingdom, the contagion from the EU was statistically significant and that means that the crisis in the EU increased the probability of crisis occurrence in those countries. Additionally, what was also confirmed by the robustness analysis was the significance of a decrease in the exchange rate in increasing the probability of the crisis in Portugal and the United Kingdom. Moreover, an increase in inflation was linked to the probability of the crisis in Denmark and a decrease in the US long-term interest rates was significant for crisis occurrence in the Netherlands. However, it needs to be noted that index US was not statistically significant in any of the countries.

The presented robustness test also indicates that other variables than those in the panel model were statistically significant in crisis occurrence; for example, a decrease in the US short interest rates was significant in Belgium, Germany, Italy, Spain, and Portugal. Furthermore, a separate logistic regression showed that among macroeconomic vulnerabilities, a decrease in unemployment in France, the Netherlands, Portugal, and Germany, increased in direct investment in Italy, France, Spain, and the United Kingdom and a decrease in GDP in Italy and Portugal contributed to the crisis development. In all countries, a rise in financial and trade linkages with the United States and EU did not increase the probability of the crisis; however, the decrease in financial linkages with the United States in Sweden and a decrease in trade links with EU countries in the Netherlands increased probability of financial crisis in those countries.

The overall results confirm that macroeconomic variables and crisis contagion variables were the most significant in crisis transmission and that trade and financial linkages did not increase crisis transmission between the United States and selected EU countries.

6 | CONCLUSIONS

The main aim of this research was to identify the mechanisms behind the crisis transmission to the European Union. First, to capture the 2007–2008 crisis, the IBS was built using the variance-equal weights method based on two variables: TED spread and return on banking stock. The index correctly captured the crisis period, and it was consistent with the turbulence in the EU financial markets and the collapse of Lehman Brothers. Moreover, the robustness analysis of the index based on monthly data also proved to correctly mark the crisis period in the chosen sample of 10 EU countries. Pooled logistic regression was then used to determine which crisis transmission channels and variables were responsible for the crisis propagation.

The results indicate that the transmission of the 2007–2008 financial crisis was not down to real linkages between countries but rather occurred through contagion. Both indices, index US and index EU, were statistically significant which confirmed that the crisis in the United States and the crisis in the EU were responsible for a contagion of the 2007–2008 crisis to the EU countries. Although the logistic model presented in the study does not explicitly state what the potential sources of contagion are, based on the IBS index, certain conclusions can be drawn. First, as the index US and the index EU are constructed to signal a banking crisis it could be assumed that a banking sector is the main source of contagion. Moreover, the TED spread widened during the crisis in the United States and also in the EU countries, which is a signal of an increase in a risk in the financial markets and a change in the risk perception among investors. A change in a risk perception influenced investors' behavior, and they became more reluctant to invest. Furthermore, banks refused to lend money to other financial institutions. This led to a decrease in interbank loans and an increase in uncertainty that contributed to further banks' problems and a spread of the crisis.

The results of logistic regression also identified other causes of crisis development such as high inflation, a decrease in the exchange rate, and a decrease in the US long-term interest rates. The results are consistent with the literature's empirical evidence regarding banking crises and also with the economic situation in the United States and the EU countries before the financial crisis of 2007–2008. A high inflation rate is usually followed by a banking crisis, and, additionally, it may negatively affect banks' costs. The significance of the exchange rate in the crisis occurrence in the EU countries may suggest that European borrowers or banks were exposed to exchange rate risk. Furthermore, the US long-term interest rates were low before the 2007–2008 financial

crisis because of high inflows of foreign investments to the United States, and this led to a lax FED policy which fueled an increase in subprime loans and later led to the financial crisis in the United States. Therefore, the US long-term interest rates can be a proxy of the banking problems in the United States that indirectly triggered the financial crisis in the EU countries.

Additionally, to check the robustness of the results of pooled logistic regression, the separate monthly logistic regression analysis for each country in the sample was conducted. The results confirmed the significance of contagion and macroeconomic vulnerabilities to the crisis development and transmission to 10 selected EU countries and supported the results of pooled logistic regression that tight financial and trade linkages did not increase the probability of the financial crisis.

The findings presented in this article contributed to the literature on the crisis transmission and especially a crisis spread to advanced economies. Evidence presented suggests that the real linkages between countries were not responsible for the crisis transmission and indicates that the crisis contagion from the United States and the EU was the main source of crisis transmission. The results are only partially in line with the literature, where the number of studies presented the evidence of crisis spread through financial and trade transmission channels.

The results of this research could be used by authorities to monitor the country's IBS together with crisis contagion channels variables identified in this study to better understand conditions in banking sectors and also to help detect a banking crisis. Additionally, this result could help to decide what regulations should be introduced to prevent a global banking crisis in the future.

However, there are some limitations of this study. There is a need to perform alternative tests to further verify robustness, for example, in addition to the IBS, different indices or variables could be used to detect the presence of financial crisis. Additionally, the model might be improved by using alternative methodologies such as Bayesian model averaging estimation. Further research would also benefit from including other than banking contagion variables concerning other financial markets, in particular the CDO market (although it has to be noted that data on this market started to be collected just recently and may not be available for all countries). In addition, larger sample sizes could be used; however, at the time of writing this article, data, in particular the financial linkages and short-term t-bills, were available for 10 EU countries only.

CONFLICT OF INTEREST

On behalf of all authors, the corresponding author states that there is no conflict of interest.

ORCID

Kamila Tomczak  <https://orcid.org/0000-0002-4366-7820>

REFERENCES

- Apergis, N., Christou, C., & Kynigakis, I. (2019). Contagion across US and European financial markets: Evidence from the CDS markets. *Journal of International Money and Finance*, 96, 1–12.
- Bae, K. H., Karolyi, G. A., & Stulz, R. M. (2003). A new approach to measuring financial contagion. *The Review of Financial Studies*, 16(3), 717–763.
- Baig, T., & Goldfajn, I. (1999). Financial market contagion in the Asian crisis. *IMF Staff Papers*, 46(2), 167–195.
- Bekaert, G., Ehrmann, M., Fratzscher, M., & Mehl, A. (2011). *Global crises and equity market contagion*. [Working Paper no 1381]. European Central Bank.
- BenMim, I., & BenSaida, A. (2019). Financial contagion across major stock markets: A study during crisis episodes. *The North America Journal of Economics and Finance*, 48, 187–201.
- Berg, A., Borensztein, E., & Pattillo, C. (2005). Assessing early warning systems: How have they worked in practice? *IMF Staff Papers*, 52(3), 462–502.

- Bouaziz, M. C., Selmi, N., & Boujelbene, Y. (2012). Contagion effect of the subprime financial crisis: Evidence of DCC multivariate GARCH models. *European Journal of Economics, Finance and Administrative Sciences*, 44, 66–76.
- Bussiere, M., & Fratzscher, M. (2006). Towards new early warning system of financial crises. *Journal of International Money and Finance*, 25(6), 953–973.
- Bustillo, I., & Velloso, H. (2002). United States interest rates, Latin American debt and financial contagion. *CEPAL Review* 78, 83–99.
- Byrne, J. P., Fazio, G., & Fiess, N. (2012). Interest rate co-movements, global factors and the long end of the term spread. *Journal of Banking and Finance*, 36(1), 183–192.
- Byström, H. N., E. (2004). The market's view on the probability of banking sector failure: Cross-country comparisons. *Journal of International Financial Markets, Institutions and Money*, 14(5), 419–439.
- Caprio, G., & Klingebiel, D. (1996). Bank insolvencies: cross-country experience. *Policy Research Working Paper No. 1620*.
- Caramazza, F., Ricci, L., & Salgado, R. (2004). International financial contagion in currency crises. *Journal of International Money and Finance*, 23(1), 51–70.
- Cardarelli, R., Elekdag, S., & Lall, S. (2009). *Financial stress, downturns, and recoveries* [IMF Working Paper 09/100]. IMF.
- Chaudrona, R., & de Haana, J. (2014). Dating banking crises using incidence and size of bank failures: Four crises reconsidered. *Journal of Financial Stability*, 15, 63–75.
- Daly, K., Batten, J. A., Mishra, A. V., & Choudhury, T. (2019). Contagion risk in global banking sector. *Journal of International Financial Markets, Institutions and Money*, 63, 101136.
- Danninger, S., Balakrishnan, R., Elekdag, S., & Tytell, I. (2009). How linkages fuel the fire: The transmission of financial stress from advanced to emerging economies. *World Economic Outlook*, April 2008 chapter 4: IMF. Available from <https://doi.org/10.5089/9781589068063.081.ch004> [Accessed 05 March 2022].
- Davis, E. P., & Karim, D. (2008). Comparing early warning systems for banking crises. *Journal of Financial Stability*, 4, 89–120.
- Demirgiuc-Kunt, A., & Huizinga, H. (1999). Determinants of commercial bank interest margins and profitability: some international evidence. *The World Bank Economic Review*, 13(2), 379–408.
- Demirgüç-Kant, A., & Detragiache, E. (1997). *The determinants of banking crisis: evidence from developing and developed countries* [IMF Working Paper 97/106]. IMF
- Demirgüç-Kunt, A., & Detragiache, E. (2005). *Cross-country empirical studies of systematic bank distress: A survey* [IMF Working Paper 05/96]. IMF.
- Drazen, A. (1998). Political contagion in currency crisis. In *NBER Conference on Currency Crises*. (pp. 47-67). NBER.
- Dungey, M., Milunovich, G., & Thorp, S. (2010). Unobservable shocks as carriers of contagion. *Journal of Banking and Finance*, 34(5), 1008–1021.
- Dungeya, M., Milunovich, G., Thorp, S., & Yang, M. (2015). Endogenous crisis dating and contagion using smooth transition structural GARCH. *Journal of Banking and Finance*, 58, 71–79.
- Duprey, T., Klaus, B., & Peltonen, T. (2017). Dating systemic financial stress episodes in the EU countries. *Journal of Financial Stability*, 32, 30–56.
- Duttagupta, R., & Cashin, P. (2011). Anatomy of banking crises in developing and emerging market countries. *Journal of International Money and Finance*, 30(2), 354–376.
- Edison, H. J. (2003). Do indicators of financial crises work? An evaluation of an early warning system. *International Journal of Finance and Economics*, 8(1), 11–53.
- Eichengreen, B., & Rose, A. K. (1998). The empirics of currency and banking crises. *NBER Reporter*, 1998(1), 9–13.
- Eichengreen, B., Rose, A. K., & Wyplosz, C. (1996). *Contagious currency crises* [NBER Working Paper no. 5681]. NBER.
- Eichengreen, B., & Rose, A., K. (1999). Changes in exchange rates in rapidly development countries: theory, practice, and policy issues. In T. Ito & A. O. Krueger (Eds.), *Contagious currency crises: Channels of conveyance* (pp. 29–56). The University of Chicago Press.
- Estrella, A., & Mishkin, F. S. (1997). The predictive power of the term structure of interest rates in Europe and the United States: Implications for the European Central Bank. *European Economic Review*, 41(7), 1375–1401.
- Forbes, K., & Rigobon, R. (2001). Contagion in Latin America: Definitions, measurement, and policy implications. *Economia* . 1(2), 1–46.

- Forbes, K. J., & Chinn, M. D. (2003). *A decomposition of global linkages in financial markets over time* [NBER Working Paper 9555]. NBER.
- Forbes, K. J., & Rigobon, R. (1999). Measuring contagion: Conceptual and empirical issues. Paper presented at the UNU-WIDER Conference on Financial Contagion.
- Fratzcher, M. (2002). *On currency crises and contagion* [ECB Working Paper no. 139]. ECB.
- Glick, R., & Rose, K., A. (1999). Contagion and trade: Why are currency crises regional? *Journal of International Money and Finance*, 18(4), 603–617.
- González-Hermosillo, B. (2008). *Investors' risk appetite and global financial market conditions* [IMF Working Paper 08/85]. IMF.
- Guo, F., Chen, C. R., & Huang, Y. S. (2011). Markets contagion during financial crisis: A regime-switching approach. *International Review of Economics and Finance*, 20(1), 95–109.
- Haile, F., & Pozo, S. (2007). Currency crisis contagion and the identification of transmission channels. *International Review of Economics and Finance*, 17(4), 572–588.
- Hanschel, E., & Monnin, P. (2005). *Measuring and forecasting stress in the banking sector: evidence from Switzerland* [BIS Working Paper No. 22]. BIS.
- Horta, P., Mendes, C., & Vieira, I. (2010). Contagion effects of the subprime crisis in the European NYSE Euronext markets. *Portuguese Economic Journal*, 9(2), 115–140.
- Hosmer, D. W., & Lemeshow, S., & Sturdivant, R. X. (2013). *Applied logistic regression*. John Wiley and Sons.
- Huang, C. L., Lin, H. P. & Chen, C. R. (2012). International contagion in the global financial crisis. *Asian Finance Association and Taiwan Finance Association (TFA) Joint International Conference*. Available at <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.687.9927&rep=rep1&type=pdf>
- Illing, M., & Liu, Y. (2006). Measuring financial stress in a developed country: an application to Canada. *Journal of Financial Stability*, 2(3), 243–265.
- Jacobs, L. J., & Kuper, G. H. (2003). Indicators of financial crises do work! An early-warning system for six Asian countries. *International Journal of Finance Economics*, 8(1), 11–53.
- Kamin, S. B., Schindler, J. W., & Samuel, S. L. (2001). *The contribution of domestic and external factors to emerging market devaluation crises: An early warning system approach* [International Finance Discussion Paper 711]. Board of Governors of the Federal Reserve System .
- Kaminsky, G., Lizondo, S., & Reinhart, C. M. (1998). Leading indicators of currency crises. *IMF Staff Papers*, 45(1), 1–48.
- Kaminsky, L. G., & Reinhart, C. M. (1999). The twin crises: the causes of banking and balance of payments problems. *The American Economic Review*, 89(3), 473–500.
- Kannan, P., & Köhler-Geib, F. (2009). *The uncertainty channel of contagion* [IMF Working Paper 09/219]. IMF.
- Kauko, K. (2012). External deficits and non-performing loans in the recent financial crisis. *Economics Letters*, 115(2), 196–199.
- Kazia, I. A., Wagan, H., & Akbar, F. (2013). The changing international transmission of U.S. monetary policy shocks: Is there evidence of contagion effect on oecd countries. *Economic Modelling*, 30, 90–116.
- Laeven, L., & Valencia, F. (2008). *Systematic banking crises: A new database* [IMF Working Paper, 08/224]. IMF.
- Laeven, L., & Valencia, F. (2013). Systemic banking crises database. *IMF Economic Review*, 61, 225–270.
- Laeven, L., & Valencia, F. (2018). *Systemic banking crises revisited* [IMF Working Paper 18/206]. IMF.
- Lindgreen, C. J., García, G., & Saal, M. I. (1996). *Bank soundness and macroeconomic policy*. International Monetary Fund.
- Longstaff, F. A. (2010). The subprime credit crisis and contagion in financial markets. *Journal of Financial Economics*, 97(3), 436–450.
- Maddala, G. S. (1992). *Introduction to econometrics*. Macmillan.
- Masson, P. R. (1998). *Contagion: Monsoonal effects, spillovers and jumps between multiple equilibria* [IMF Working Paper 98/ 142]. IMF.
- Michaelides, G. M., & Papageorgi, T. (2012). On the transmission of economic fluctuations from the USA to EU-15 (1960–2011). *Journal of Economics and Business*, 64(6), 427–438.
- Moralesa, L., & Andreosso-O'Calla, B. (2014). The global financial crisis: World market or regional contagion effects? *International Review of Economics and Finance*, 29, 108–131.
- Moshirian, F., & Wu, Q. (2009). Banking industry volatility and banking crises. *Journal of International Financial Markets, Institutions and Money*, 19(2), 351–370.

- Naoui, K., Liouane, N., & Brahim, S. (2010). A dynamic conditional correlation analysis of financial contagion: The case of the subprime credit crisis. *International Journal of Economics and Finance*, 2(3), 85–96.
- Park, C. Y., & Shin, K. (2020). Contagion through national and regional exposures to foreign banks during the global financial crisis. *Journal of Financial Stability*, 46, pp. 1–17.
- Pericoli, M., & Sbracia, M. (2003). A primer on financial contagion. *Journal of Economic Surveys*, 17(4), 571–608.
- Pesaran, M., & Pick, A. (2007). Econometric issues in the analysis of contagion. *Journal of Economic Dynamics and Control*, 31(4), 1245–1277.
- Reinhart, C. M., & Reinhart, V. R. (2008). *Capital flow bonanzas: an encompassing view of the past and present* [NBER Working Paper 14321]. NBER.
- Sachs, J., Tornell, A., & Velasco, A. (1996). Financial crises in emerging markets: the lessons from 1995. *Brookings Papers on Economic Activity*, 1996(1), 147–198.
- Sanchis, A., Segovia, M. J., Gil, J. A., Heras, A., & Vilar, J. L. (2007). Rough sets and the role of the monetary policy in financial stability (macroeconomic problem) and the prediction of insolvency in insurance sector (microeconomic problem). *European Journal of Operational Research*, 181(3), 1554–1573.
- Shikimi, M., & Yamada, K. (2019). Trade and financial channels as the transmission mechanism of the financial crisis. *International Review of Economics and Finance*, 63, 364–381.
- Stoker, J. H. (1995). *Intermediation and the Business Cycle Under a Specie Standard: The Role of the Gold Standard in English Financial Crises, 1790-1850*. The University of Chicago Press.
- Valdes, R. (1996). *Emerging market contagion. evidence and theory* [MIT mimeo]. MIT.
- Van Rijckeghem, C., & Weder, B. (2001). Sources of contagion: is it finance or trade? *Journal of International Economics*, 54(2), 293–308.
- von Hagen, J., & Ho, T. K. (2007). Money market pressure and the determinants of banking crises. *Journal of Money, Credit and Bank*, 39(5), 1037–1066.
- Wong, J., Wong, T. C., & Leung, P. (2010). Predicting banking distress in the EMEAP economies. *Journal of Financial Stability*, 6(3), 169–179.
- Yamamoto, S. (2014). Transmission of US financial and trade shocks to Asian economies: Implications for spillover of the 2007–2009 US financial crisis. *The North American Journal of Economics and Finance*, 27, 88–103.

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

How to cite this article: Tomczak, K. (2023). Transmission of the 2007–2008 financial crisis in advanced countries of the European Union. *Bull Econ Res*, 75, 40–64.

<https://doi.org/10.1111/boer.12338>