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Causality between credit depth and economic growth: Evidence from 24 OECD countries

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Abstract

Causality between the ratio of domestic private credit to GDP and growth in real GDP per capita is investigated in a country-by-country time-series framework for 24 OECD economies over the period 1980–2013. The proposed threefold methodology to test for causal linkages integrates (i) lag-augmented VAR Granger causality tests, (ii) Breitung-Candelon causality tests in the frequency domain, and (iii) testing for causal inference based on a fully modified OLS (FMOLS) approach. For 12 of 24 countries in the sample, the three tests yield uniform results in terms of causality presence (absence) and direction. Causality running from credit depth to economic growth is found for the UK, Australia, Switzerland, and Greece. The findings lend no support to the view that financial development shifts from a supply-leading to demand-following pattern as economic development proceeds. The aggregate results mesh well with the current discussion on "too much finance" and disintermediation effects. However, idiosyncratic country determinants also appear significant.

Keywords: causality, economic growth, financial development, FMOLS, frequency domain.
JEL-Classification: C22, E44, G21, O16.

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1 Introduction

Research on the finance-growth nexus has expanded rapidly over the past two decades, reflecting both advances in econometric methodology and increased data availability. While early studies tended to focus on growth regressions (King and Levine, 1993), the field now boasts a complete agenda that includes assessment of causal linkages between financial development and economic growth.

Causality may be assessed on a country-by-country basis or estimation with a panel time series. The first approach has been a staple of finance-growth research since the seminal study of Demetriades and Hussein (1996). While later panel cointegration and causality tests (e.g. Pedroni, 2004; Hurlin and Dumitrescu, 2012) have raised interest in the panel estimation approach, its peculiar flaw of masking country-specific effects remain a cause for concern. Indeed, masking effects may explain the conflicting results that arise when country-by-country and panel analyses are performed on the same samples (Bloch and Tang, 2003). As a result, researchers now tend to prefer extensive application of time-series to panel data methods in assessing finance-growth causal linkages (e.g. Luintel et al., 2008; Arestis et al., 2010).

This work considers causality between credit depth (measured as the ratio of domestic private credit to GDP) and economic growth for 24 OECD countries on country-by-country basis for the period 1980–2013. The sample economies have impressive financial depth. The average private-credit-to-GDP ratio for OECD countries was twice as high as for developing economies, even in the aftermath of the 2007–2009 global financial crisis (Cihák et al., 2012).

Yet, even if developed economies significantly contributed to a new wave of global financial deepening commencing around 1980 (Rajan and Zingales, 2003), a causal linkage with economic growth is not apparent. Indeed, given the mounting evidence that the finance-growth nexus has weakened worldwide since the 1980s (e.g. Rousseau and Wachtel, 2011; Valickova et al., 2014), this area appears to warrant better understanding.

This study contributes to the literature on causality between finance and growth in three ways. First, it applies unit root tests to account for possible nonlinearity and structural breaks in data. Unit root tests allow determination of the order of variable integration with reasonable precision, thereby ensuring an accurate realization of the Toda-Yamamoto (1995)

approach to VAR estimation. As a result, standard Granger causality tests can be expected to be more robust.

Second, based on the VAR models for individual OECD countries, a Breitung-Candelon test (Breitung and Candelon, 2006) is applied to test for causality between credit depth and economic growth in the frequency domain. This test disentangles short- and long-run causal linkages, as well as captures causal clustering not observable in the conventional time domain.

Third, a fully modified ordinary least squares (FMOLS) method is used to uncover possible cointegrating relationships. While this procedure is asymptotically equivalent to the Johansen (1988) cointegration test, it is better suited for short time series. These cointegrating relationships constitute a prerequisite for the causality that I subsequently test for in an error-correction model framework. The technique also distinguishes between short- and long-run causality.

Using this threefold methodological approach, I confirm that causal linkages between credit depth and economic growth are not widespread among OECD economies. For 12 of 24 countries in the sample the three tests yield uniform results in terms of causality presence (absence) and direction. Causality is found to run from credit depth to economic growth for the UK, Australia, Switzerland, and Greece. There is, however, little evidence of causality running the other way, i.e. from growth to credit depth. Thus, my findings lend no support to Patrick's (1966) assertion that financial development in advanced economies begins to adjust to changes in the aggregate demand, switching from a supply-leading pattern to a demand-following form. There is also no discernible evidence of causal links for major economies such as the US, Japan, Germany, or France.

Overall, these results comport with the current discussions on "too much finance" and disintermediation effects. The first effect is crucial for explaining the few causal linkages for OECD countries in Europe. Contrary to conventional wisdom, these economies appear to have become more bank-based in recent years. Some may have even crossed the "over-banked" threshold, beyond which credit is unlikely to have any causal link with growth. The disintermediation effect accounts for no (or inconsistent) causalities in the cases of the US, Mexico, and Chile. However, country-specific determinants, e.g. for Japan, appear significant. From a policymaking perspective, these findings strongly argue against reliance on bank-based financial development as a sole driver of economic growth.

The paper proceeds as follows. Section 2 reviews recent literature on finance-growth causality in developed countries. Section 3 describes the data and methodology. Section 4 presents and discusses the major findings. Section 5 concludes.

2 Literature review

A number of comprehensive surveys of research on the finance-growth nexus have recently appeared.[1] Stolbov (2013) discusses the origins of this branch of research. Panizza (2013) ferrets out the methodological challenges and puzzles of modern finance-growth studies, while Pasali (2013) presents the full spectrum of issues related to financial development. Notable among surveys with narrower agendas is the paper of Nyasha and Odhiambo (2014), which focuses on causal relationships between bank-based financial development and economic growth. These reviews generally pool cross-country, panel data, and time-series studies. Moreover, most lack distinct sections on causal linkages in developing and developed countries.

I confine my overview here to recent research on causality between financial development and economic growth in OECD countries.[2] I include both country-by-country and single-country studies in a time-series framework, but ignore panel and cross-country studies, because, as noted, their findings are not directly comparable with time-series studies.

An extensive search of bibliographic databases yields just twelve articles matching my search criteria, suggesting a significant gap still exists in country-level research on causality between financial development and growth in advanced economies. Five of these papers are cross-country studies, while the other seven are single-country analyses.

[1] Earlier influential surveys include Levine (2005) and Ang (2008). Summarizing the literature up to the early 2000s, they identify the channels through which financial development facilitates growth. Levine (2005) notably focuses on specific functions such as producing ex ante information on investments and capital allocation, exerting corporate governance after providing finance, facilitating risk management, mobilizing savings and easing the exchange of goods and services. When these functions are performed well, Levine argues, it increases the likelihood that financial development can be a robust predictor of future economic activity. Given that Granger causality hinges around the notion of predictability, it legitimizes the assessment of causal links between finance and growth.

[2] Only papers published in refereed journals since 2008 are considered here. My search was conducted in the *SCOPUS* and *ECONLIT* databases. Though the choice of year is arbitrary, my hope was to select research with significant chronological overlap to the current study. Papers published before 2008 likely miss a significant part of the 1980–2013 observation period.

Within the cross-country framework, Colombage (2009) investigates causality among the development of five financial markets (the US, Canada, the UK, Japan, and Switzerland) over the period 1995Q1–2007Q1 in terms of the ratios of stock and bond market capitalization to GDP, the ratio of private credit to GDP, and economic growth. She finds that causal relationships between the financial market variables and growth are more widespread than credit-growth linkages. Credit depth Granger-causes growth in Japan, Switzerland, and the US at the 10 % significance level. A reverse link is found solely for Canada. Strong causal effects of credit depth on stock and bond market deepening are found for all five countries.

Lee (2012) examines a trivariate link among the size of banking sector (bank assets), stock market capitalization, and economic growth for the US, UK, Japan, France, Germany, and South Korea from the early 1960s to 2002. He finds stock market development drives economic growth the US, UK, and Japan, while the banking system plays a pivotal role growth in France, Germany, and South Korea. Lee also explores the evolution of these causal relationships from the historical perspective, noting that banking sector development contributed to economic growth in all six countries up to 1985.

Peia and Rosbazch (2014) analyze causality between domestic private credit to GDP, stock market capitalization to GDP, and economic growth over the period 1973–2011 for 21 OECD economies and Singapore. Their findings emphasize the role of stock market development as a driver of economic growth in developed countries. Output growth Granger- causes credit for 16 countries in their sample, while there is scarce evidence for reverse or bidirectional causal links between output growth and credit.

Gozcor (2014) studies causal linkages between domestic credit and economic growth during the period 1970–2010 for 58 countries, including 24 OECD economies. Using the KOF index of economic liberalization as a control variable, he finds evidence of causality only running from growth to domestic credit for seven OECD countries (Austria, Finland, Japan, the Netherlands, New Zealand, Spain, and the UK).

Dal Colle (2011) investigates causality between financial development and growth in the context of financial liberalization for a mixed sample of developing and developed countries, including South Korea and Chile. She finds no signs of causality for South Korea and a bidirectional link in case of Chile.

Rahman et al. (2015) consider a trivariate link between domestic private credit to GDP, trade openness, and economic growth for Australia during 1965–2010. They confirm a causal link running from credit depth to growth.

Yang and Hoon Yi (2008) examine causal patterns for South Korea for the period of 1971–2002, adopting a composite measure of financial development (credit and trading volumes of stocks and bonds relative to GDP), as well as a number of controls from growth regressions. They apply superexogeneity tests and conclude that financial development spurred Korean economic growth over the three-decade time span. However, they do not specify which components of their composite financial development measure contributed most to increasing economic activity.

Marques et al. (2013) find no causal link between total domestic credit to GDP and economic growth in Portugal over the period 1993Q1–2011Q4, but do find it for stock market capitalization. Perhaps most surprising is their assertion that economic growth tends to feed stock market development in Portugal's bank-based economy.

In a policy paper on Irish financial development, Beck (2014) questions any causal linkage between finance and growth in the Irish economy at least since the early 2000s. He argues that a distinct decoupling of credit from the real sector in Ireland has occurred over the past two decades.

Soytaş and Küçükkaya (2011) construct a composite index of Turkish financial development based on the principal component analysis (PCA), but find no causal link with economic growth for the period 1991Q3–2005Q4. In a similar vein, Martínez et al. (2009) introduce a composite measure of financial development for Mexico and find its weak, yet significant, causal effect on economic growth for 1961–2007.

Abu-Bader and Abu-Qarn (2008) study causality between credit depth and growth in six MENA countries, including Israel, for the period of 1960–2004. They conclude that there is a weak causal link running from economic growth to credit depth in Israel, the most developed MENA economy, but not vice versa.

Overall, the empirical literature is quite heterogeneous and highly sensitive to the design of financial development indicators, observation periods, and econometric methods applied. Therefore, a more consistent (and presumably more nuanced) approach is needed to assess causal linkages between bank-based financial development and economic growth in OECD countries. I propose such an analytical framework below.

3 Data and methodology

3.1 Data

The paper builds on the conventional indicator of bank-based financial development: the ratio of domestic private credit to GDP (CRED). This is a comprehensive measure of financial intermediation that combines bank and non-bank credit. Real GDP per capita growth rate (GDP), in turn, is taken as a growth indicator. This metric is typical for finance-growth studies. Both series are annual estimates for the period 1980–2013 and come from the World Bank Global Financial Development Database (GFDD) and World Development Indicators (WDI), respectively. The causal analysis is conducted on country-by-country basis for 24 OECD economies.[3]

Testing for causality in bivariate framework may lead to spurious results due to the influence of latent variables to cause co-movement of credit depth and growth. In anticipation of this problem, two additional indicators are included: the ratio of gross domestic savings to GDP (SAV) and the ratio of trade to GDP (TRADE), i.e. the sum of merchandise exports and imports scaled by nominal GDP. Both indicators are compiled from WDI and belong to the set of standard growth regressors (Levine and Renelt, 1992; Barro, 1997). They are also intertwined with financial development.

As for gross domestic savings to GDP ratio, the literature remains largely inconclusive as to whether financial development fosters or undermines saving. On one hand, there is empirical evidence suggesting that increased access to finance has a negative impact on saving rates in the OECD countries (Hüfner and Koske, 2010). On the other, there are studies uncovering a hump-shaped link between financial development and saving. In line with this view, financial development initially spurs the latter by providing more saving instruments to households and firms, but eventually curbs incentives for precautionary savings. As a result, overall saving rates shrink (Wang et al., 2011).

Beck (2002) empirically confirms the hypothesis that financial development is conducive to the comparative advantage in manufacturing industries, thereby increasing exports and trade openness. In other words, financial development can also boost output growth in

[3] The sample includes Australia, Austria, Belgium, Chile, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Mexico, the Netherlands, Portugal, South Korea, Spain, Sweden, Switzerland, Turkey, the UK, and the US. Canada, Luxemburg, New Zealand, and Norway are excluded due to significant data gaps in the series for domestic private credit to GDP.

a roundabout way. Conversely, financial constraints may seriously hamper exports. This effect is particularly tangible during financial crises and reinforced by several recent studies (e.g. Chor and Manova, 2012; Manova, 2013). Do and Levchenko (2007) document a reverse link running from comparative advantage and trade openness to financial development, and show both theoretically and empirically that countries where exports are more reliant on external finance tend to have higher levels of financial development.

Against this backdrop, the gross domestic savings-to-GDP ratio and the trade/GDP ratio have been used as conditioning variables when testing for causal linkages between credit depth and growth on country-by-country basis. Iyare and Moore (2011) adopt the same variables to examine the robustness of such analysis for four high- and upper-middle-income small open economies (Singapore, Jamaica, Trinidad and Tobago, and Barbados). Unlike Iyare and Moore (2011), who use the variables as controls one by one, this paper simultaneously includes *SAV* and *TRADE* into the econometric analysis.

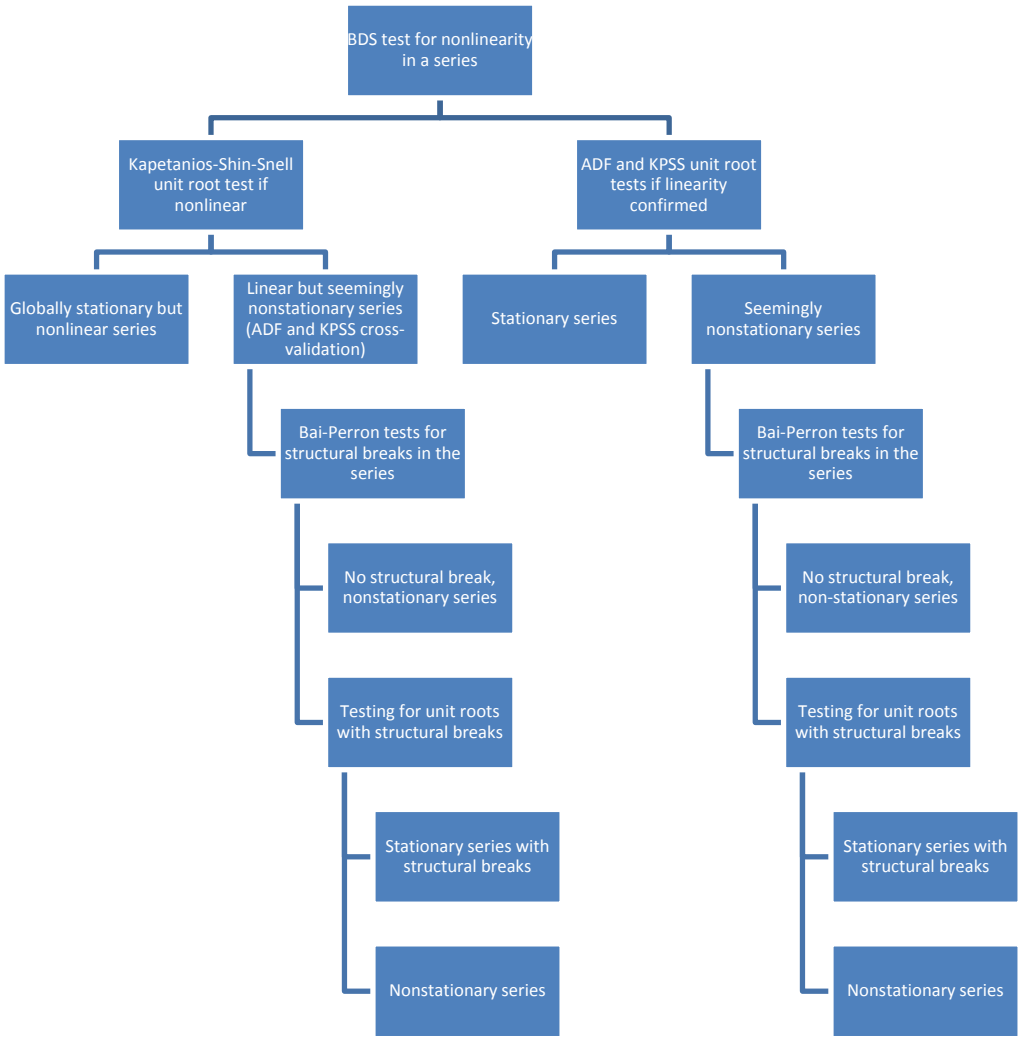
3.2 Methodology

3.2.1 Baseline causal analysis

My baseline approach is to implement Granger causality tests based on VAR models fitted for each country in the sample. To ensure the correct specification of the models, time series are examined for stationarity. Most studies on the finance-growth nexus still rely on first generation Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. The ADF and PP have low power against I(0) alternatives that are close to I(1), because globally stationary time series with a structural break(s) or other forms of nonlinearity may erroneously be found nonstationary with these tests. Hence, they may result in unreliable VAR specifications and computational exercises derived from them (Granger causality testing, impulse-response analysis, variance decompositions).

The paper introduces a recursive strategy of unit root testing that is summarized below in Figure 1.

Figure 1 Unit root testing scheme for VAR models.



First, a Brock-Dechert-Scheinkman, or BDS, test (Brock, Dechert, Scheinkman, and LeBaron, 1996) is applied to examine all the series for signs of nonlinearity. If this test indicates that a series is nonlinear, then it is subject to Kapetanios-Shin-Snell, or KSS, test (Kapetanios, Shin, and Snell, 2003), which has the null of a unit root process against an alternative of a nonlinear, but globally stationary, process. The KSS test reportedly has more power than first generation unit root tests and has been extensively used in empirical research.[4] If the null of the KSS test cannot be rejected, such series are additionally tested with ADF and KPSS tests as well as by means of the Bai-Perron (1998, 2003) test to control for potential structural breaks. Their presence in linear processes, as indicated above, may mask stationary series. To verify this, unit root tests allowing for one and two structural breaks are

[4] As of the 23 March 2015, there were 473 citations of the Kapetanios, Shin and Snell (2003) paper in the SCOPUS Database. To the best of my knowledge, their test has yet to be applied in a finance-growth context.

applied. The Zivot and Andrews (1992) and Perron (1997) tests account for a single break, whereas the Clemente-Montañez-Reyes (1998) procedure allows for two breaks.[5] Like most standard unit root tests, their null is that a series has a unit root in the presence of one or more structural breaks. The chain of tests depicted in the right part of Figure 1 is the same. The starting point, however, is the presence of a unit root in a linear process captured by the ADF and KPSS tests.

Learning integration order I(k) of each variable allows to set up VAR(p) models on country-by-country basis. All four variables (*CRED*, *GDP*, *SAV*, *TRADE*) enter the models endogenously. The general set up of a VAR(p) model can be written as:

$$y_t = \mu + \sum_{i=1}^{p} A_i y_{t-i} + \varepsilon_t, \quad (1)$$

where y_t is a vector of jointly determined variables, μ is a vector of constants, A_i is a matrix of coefficients to be estimated, and ε_t is a vector of error terms.

Assuming that there may be I(0), I(1), and I(2) series for the same country, a feasible approach to VAR estimation is the procedure proposed by Toda and Yamamoto (1995). It ensures the validity of Granger causality test when some of the data are nonstationary. The Toda-Yamamoto approach requires that the VAR(p) model be set up in levels, regardless of the orders of integration of the time series. An appropriate lag length for the variables in the VAR model is then determined based on information criteria. The Bayesian Schwartz Information Criteria (BSIC) is used as a benchmark here.

The model is also examined for overall stability and no serial correlation in the residuals. If the maximum order of integration of the variables is *m*, then the preferred VAR model should be extended to include these *m* additional lags. For example, if the maximum order of integration is I(k)=2 and the optimal model is VAR(2), the specification that ensures the validity of Granger causality test will be VAR(4). It is important to note that the test should be based on the initial number of lags, i.e. p=2, while the additional lagged variables are necessary to fix up the asymptotics. These lagged variables enter the augmented VAR model exogenously.

[5] EViews 8 is used to perform the Zivot-Andrews and Perron tests; the CMR procedure is carried out in STATA 13. Technical details of the tests are omitted for brevity. Test output is available from the author upon request.

3.2.2 Testing for causality in the frequency domain

Breitung and Candelon (2006) propose a test for Granger causality in the frequency domain that is based on the Fourier transform of initial time series and builds on the estimated VAR models. The rationale for this test is to examine causal linkages at different frequencies to detect "causal clusters" that cannot be captured in the time domain. Breitung and Candelon (2006) also emphasize that this test can be run in the presence of nonstationary variables, i.e. after implementation of the Toda-Yamamoto procedure. The test can be applied when the variables in the VAR model are cointegrated. Therefore, this test appears a natural extension to the VAR Granger causality/block exogeneity Wald tests.

The test statistic $R(w)$ computed is a function of the frequencies $w_j = \frac{2\pi j}{T}$, where $j = 1,..,\frac{T}{2}$. To convert them into time scale, the relation $P_j = \frac{2\pi}{w_j}$ applies. Smaller P_j values imply higher frequencies. These P_j values correspond to different time intervals over which causal relationships may hold.[6]

The Breitung-Candelon test only recently debuted in the finance-growth and macro-financial literature. Rocha and de Souza (2014) investigate causal relationships between the ratios of domestic private credit to GDP and GDP per capita (in constant year 2000 prices) for the US, Japan, France, South Korea, and Japan from 1960 to 2010. They find that financial development Granger-causes economic growth both in the short and long run only in the case of Brazil. This linkage is present in the US and France over short and medium time intervals (up to 10 years) but is missing in the long run. Gómez-González et al. (2014) explore the interaction between credit and business cycles for Chile, Colombia and Peru from 1986, 1978 and 1994 respectively to 2012 on quarterly basis. They conclude that credit cycles Granger cause business cycles for all the three economies. Finally, Croux and Reusens (2013) apply the Breitung-Candelon test to investigate the relationship between national stock indices and economic growth for G-7 countries over 1991Q1–2010Q2 and provide supportive evidence for the long-run causality running from stock market to growth.

[6] A Gretl estimation routine is used to implement the Breitung-Candelon test.

3.2.3 Causal inference based on FMOLS

The *CRED* and *GDP* variables in the VAR models described in Section 3.2.1 can be cointegrated if their orders of integration coincide. Cointegration is generally considered a prerequisite for causality that is tested in the vector error correction (VEC) model framework. It also enables estimation of short- and long-run causal relationships. However, the Johansen (1988) cointegration test is unlikely to yield reliable results in light of the relatively short time series used in this study. To overcome the problem, the fully modified ordinary least squares (FMOLS) technique introduced by Philips and Hansen (1990) seems to offer a viable option. This method is primarily intended for panel cointegration. In this dimension, it has been used in finance-growth causality research, e.g. Christopolous and Tsionas (2004), Bangake and Eggoh (2011). Moreover, given its advantage over the Johansen and Engle-Granger cointegration procedures, it has been implemented in a group time-series setting. The advantage of the FMOLS estimator lies in its robustness to endogeneity bias, serial correlation, and short time series.

Causal inference based on FMOLS involves two steps. First, a number of group unit root tests are run for every country.[7] If the hypothesis of a group unit root cannot be rejected, a cointegrating regression of *CRED*, *SAV,* and *TRADE* and a deterministic trend, if any, on *GDP* are estimated.[8] The residuals from the regressions are examined for stationarity. Cointegration is present if *CRED* is found to be a statistically significant predictor of *GDP*. At the second step, error correction mechanisms are set up to test for short- and long-run causality. They can be represented as follows:

$$\Delta GDP_{it} = c_{1i} + \lambda_{11i} RESID_{it-1} + \gamma_{11i}\Delta GDP_{it-1} + \gamma_{12i}\Delta CRED_{it-1} + \gamma_{13i}\Delta SAV_{it-1} + \gamma_{14i}\Delta TRADE_{it-1} + \varepsilon_{1it} \quad (2a)$$

$$\Delta CRED_{it} = c_{2i} + \lambda_{21i} RESID_{it-1} + \gamma_{21i}\Delta GDP_{it-1} + \gamma_{22i}\Delta CRED_{it-1} + \gamma_{23i}\Delta SAV_{it-1} + \gamma_{24i}\Delta TRADE_{it-1} + \varepsilon_{2it} \quad (2b)$$

$$\Delta SAV_{it} = c_{3i} + \lambda_{31i} RESID_{it-1} + \gamma_{31i}\Delta GDP_{it-1} + \gamma_{32i}\Delta CRED_{it-1} + \gamma_{33i}\Delta SAV_{it-1} + \gamma_{34i}\Delta TRADE_{it-1} + \varepsilon_{3it} \quad (2c)$$

$$\Delta TRADE_{it} = c_{4i} + \lambda_{41i} RESID_{it-1} + \gamma_{41i}\Delta GDP_{it-1} + \gamma_{42i}\Delta CRED_{it-1} + \gamma_{43i}\Delta SAV_{it-1} + \gamma_{44i}\Delta TRADE_{it-1} + \varepsilon_{4it} \quad (2d)$$

[7] The tests of Levin, Lin, and Chu (2002) and Breitung (2002) assume a common unit root process. The test of Im, Pesaran, and Shin (2003), as well as ADF-Fisher and PP-Fisher tests, imply individual unit root processes. An overall judgment on the presence of group unit root is based on the summary of these test statistics.
[8] *CRED* can equally be a dependent variable and *GDP* set as a predictor as the cointegrating relations are bidirectional.

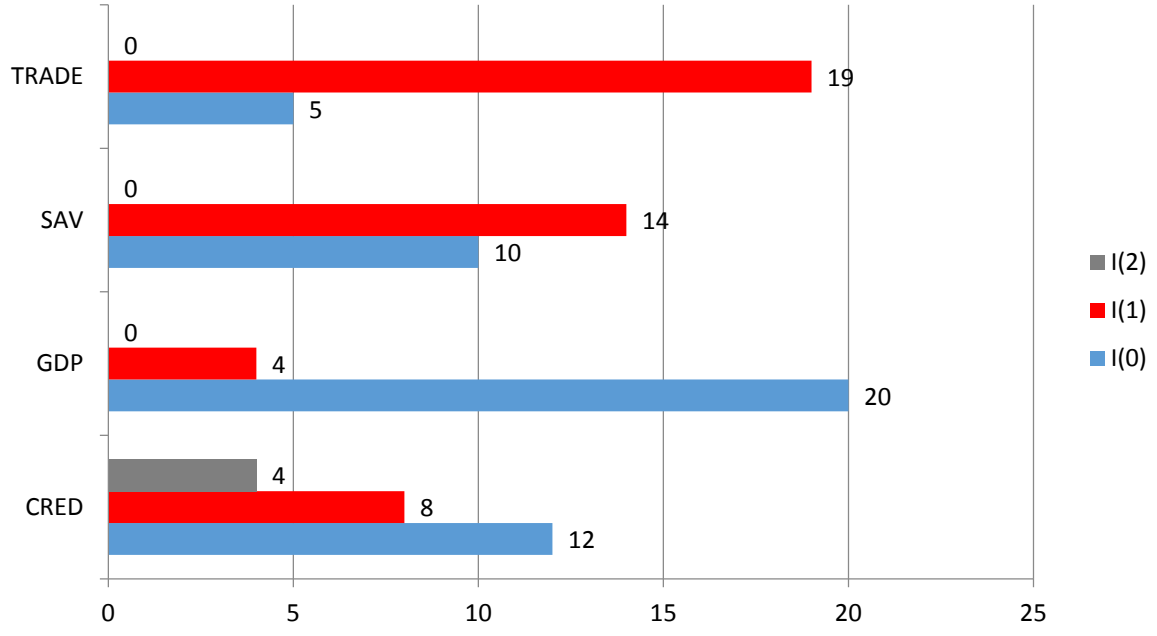
In equations (2a–d), the *RESID* variable represents residuals obtained from the FMOLS cointegrating regressions accounting for a long-run relationship between *CRED* and *GDP*. The error-correction mechanisms also include first-differenced lags of the four variables under consideration, reflecting short-run dynamics. Evidence of Granger causality between domestic private credit to GDP and real GDP per capita growth rate is a joint Wald test on the coefficients $\lambda_{11i} = \gamma_{12i} = 0$ to examine for causality running from credit to growth and on $\lambda_{21i} = \gamma_{21i} = 0$ in the opposite direction. If the null of the test is rejected, it indicates the presence of strong causality encompassing the short and long run. To disentangle them, the Wald tests are conducted separately, i.e. on the coefficient $\lambda_{11i} = 0$ and $\gamma_{12i} = 0$ for short- and long-run causal linkage running from credit to growth.

4 Results and discussion

4.1 VAR and frequency domain Granger causality

The multi-step strategy for unit root testing has uncovered the following patterns in the integration properties of the variables (Figure 2). Appendix Table A1 contains a detailed output of the unit root tests.

Figure 2 Integration properties of the variables.



The number of I(2) series is limited, but they are all variables of domestic private credit to GDP, i.e. I(2) for Germany, the UK, Italy, and Finland. However, half of the credit depth series are stationary. Interestingly, the KSS test indicates that the domestic private credit-to-GDP ratio in the US, Spain, Ireland, Iceland, and Mexico was an I(0) process over the period 1980–2013. The 2007–2009 global financial turmoil and the European debt crisis appear to have no significant effect on the stationarity of the indicator in these economies. Japan, Portugal, Belgium, Denmark, Sweden, and Israel have I(0) domestic private credit to GDP series based on the linear unit root tests. South Korea appears to be the only OECD country in the sample to have all I(0) variables. Therefore, credit depth in these economies exhibited mean reversion during this time span. This reasonably high number of stationary credit depth series suggests that credit cycle dynamics in some OECD countries is actually predictable.

Trade/GDP and gross saving-to-GDP ratios are mostly I(1), while real GDP per capita growth series are predominantly stationary. This finding with respect to the macroeconomic variables resonates with the recent evidence that the number of nonstationary macroeconomic series is smaller than previously thought (see e.g. Aksoy and Leon-Ledesma, 2008; Cuestas and Garrat, 2011).

The knowledge of the orders of integration enables to specify VAR models in conformity with the Toda-Yamamoto approach. Table 1 reports optimal lag length in the VAR models and summary statistics on Granger causality tests in the time and frequency domains.

The VAR Granger causality tests indicate that causal relationships between credit depth and economic growth were generally not widespread for the sample OECD countries in 1980–2013.[9] In those few cases where they are found, causality predominantly runs from credit depth to economic growth. However, only in the case of Switzerland does this linkage hold at the 1 % significance level. For Germany and the Netherlands, credit depth Granger-causes growth at the 5 % significance level, while for the UK, Greece, Australia, and Chile the linkage is significant at 10 %. Iceland is the only economy to show a reverse causal direction running from growth to credit depth.

[9] In light of potential concerns with the over-parameterization of the VAR models, they have been re-estimated as Bayesian VARs (BVAR) with Minnesota/Litterman priors to check for the significance of the coefficients determining causal relationships in the VAR Granger causality tests. The results of the BVAR estimation validate the models in Table 1.

Table 1 Causality tests between credit depth and economic growth for 24 OECD countries in time and frequency domains

Country	Optimal lag length of the VAR model	Toda-Yamamoto correction for exogenous lags	VAR Granger causality/Block Exogeneity Wald test		Breitung-Candelon test (time intervals in years)	
			GDP does not cause CRED (Chi-sq.)	CRED does not cause GDP (Chi-sq.)	GDP does not cause CRED	CRED does not cause GDP
US	VAR(3)	VAR(4)	2.32	1.69	–	–
Germany	VAR(3)	VAR(5)	0.80	9.41**	[17.4;∞)*	–
UK	VAR(1)	VAR(3)	0.51	2.98*	–	[9.8;11.4]* (11.4;17.4]** (17.4;∞)***
Japan	VAR(1)	VAR(2)	0.03	1.12	–	–
France	VAR(1)	VAR(2)	0.44	0.56	–	[2; ∞)***
Italy	VAR(2)	VAR(4)	2.00	4.58	[8.2;17.4]*	–
Spain	VAR(2)	VAR(3)	2.34	2.93	[5.1;5.8]* (5.8;∞)**	[6.6;9.4]* (9.4;17.6]**
Netherlands	VAR(1)	VAR(2)	0.19	3.99**	–	[2; ∞)**
Portugal	VAR(2)	VAR(3)	1.87	3.39	–	–
Greece	VAR(3)	VAR(4)	1.35	6.10*	–	[2;2.9]*** (2.9;4.1]** (4.1; ∞)***
Switzerland	VAR(1)	VAR(2)	1.14	25.42***	–	[2;∞)***
Austria	VAR(3)	VAR(4)	1.34	3.99	–	–
Ireland	VAR(1)	VAR(2)	2.13	0.35	–	[2; ∞)*
Sweden	VAR(1)	VAR(2)	0.53	0.04	–	–
Belgium	VAR(2)	VAR(3)	1.58	2.28	–	[2; ∞)**
Australia	VAR(1)	VAR(2)	0.02	3.33*	–	[2; ∞)**
South Korea	VAR(2)	–	1.62	2.21	–	–
Finland	VAR(1)	VAR(3)	0.58	2.59	[3;4.6]*	[8.5; ∞)***
Denmark	VAR(1)	VAR(2)	0.39	0.03	–	–
Iceland	VAR(2)	VAR(3)	13.80***	2.51	[2; ∞)**	–
Israel	VAR(1)	VAR(2)	1.42	2.48	–	–
Chile	VAR(4)	VAR(5)	3.96	9.41*	[8.8;∞)**	[2.9; 4.4]** (4.4;5.8]* [27.3; ∞)*
Turkey	VAR(2)	VAR(3)	1.04	2.89	–	–
Mexico	VAR(3)	VAR(4)	0.84	4.23	–	–

Notes: * – significant at 10 % level; ** – at 5%; *** – at 1%.

The Breitung-Candelon test identifies more causal links and captures changes in their significance levels at different frequencies. It concerns both causal directions. Causality runs from credit depth to growth for the UK, France, the Netherlands, Greece, Switzerland, Ireland, Belgium, and Australia. Germany, Italy and Iceland exhibit a reverse causal pattern. Causality is bidirectional in case of Spain, Finland, and Chile. It is evenly present over short-

and long-run intervals when it runs from credit depth to growth. For the opposite causal direction and bidirectional linkages, causality is clustered around lower frequencies, i.e. at the medium and long time horizons. For Germany, *GDP* Granger-causes *CRED* at a very long time horizon (over 17 years). Similarly, no causal link is observed for Spain at intervals shorter than five years. Over a longer time span, bidirectional links emerge and tend to strengthen.

In summary, the Breitung-Candelon test largely replicates the main finding of the VAR Granger causality test, with the number of causal relationships remaining quite moderate.[10] The differences that arise between the two approaches are particularly important at long time horizons, emphasizing the need to explore the causal effects further in a cointegrating framework.

4.2 Causality in the FMOLS-based approach

FMOLS cointegrating equations are estimated in line with the methodology described in Section 3.2.3. They are presented in Table 2.

The results show cointegration between *CRED* and *GDP* for 12 economies. The ADF test confirms the stationarity of the cointegrating equation residuals, confirming that the equations are correctly specified and the residuals obtained from them can be used to infer about causal effects.

[10] Unlike the VAR Granger causality test, the *SAV* and *TRADE* variables cannot be endogenized for the Breitung-Candelon test. They are considered genuine conditioning variables, which explains the differences in the results of the two tests. For 16 of 24 countries, however, they coincide in the sense of causality presence and direction.

Table 2 FMOLS cointegrating equations

Country	Group unit root*	No group unit root*	FMOLS cointegrating equation	ADF test for FMOLS cointegrating equation residuals
US	0	12	GDP=0.07CRED+0.96SAV–0.34TRADE+0.25TREND+18.36 (1.15)	I(0)
Germany	6	6	GDP= –0.02CRED+0.84SAV+0.10TRADE–0.20TREND–16.79 (–0.63)	I(0)
UK	3	9	GDP= **–0.04CRED**+1.06SAV–0.15TRADE+0.35TREND–10.48 **(–1.74)**	I(0)
Japan	7	5	GDP= –0.00CRED+0.41SAV+0.19TRADE+0.03TREND–13.51 (–0.22)	I(0)
France	6	6	GDP= –0.01CRED+0.42SAV+0.04TRADE–0.05TREND–6.27 (–0.72)	I(0)
Italy	7	5	GDP= –0.06CRED+0.29SAV+0.07TRADE–0.01TREND–3.83 (–0.80)	I(0)
Spain	6	6	GDP= **–0.03CRED**+0.66SAV+0.02TRADE+0.02TREND–10.53 **(–2.41)**	I(0)
Nether-lands	10	2	GDP= **–0.03CRED**+1.19SAV+0.04TRADE–0.1TREND–28.88 **(–1.71)**	I(0)
Portugal	8	4	GDP= **–0.05CRED**+0.65SAV+0.13TRADE+0.17TREND–14.03 **(–3.03)**	I(0)
Greece	12	0	GDP= **–0.18CRED**+1.35SAV–0.12TRADE+0.80TREND–16.12 **(–9.20)**	I(0)
Switzer-land	2	10	GDP= **0.09CRED**–0.08SAV+0.28TRADE–0.29TREND–21.86 **(2.61)**	I(0)
Austria	5	7	GDP= –0.08CRED+0.55SAV–0.04TRADE+0.06TREND–2.63 (–1.18)	I(0)
Ireland	11	1	GDP= **–0.05CRED**+0.20SAV+0.08TRADE+0.07TREND–7.15 **(–2.24)**	I(0)
Sweden	6	6	GDP= **–0.04CRED**+0.44SAV+0.15TRADE–0.03TREND–14.24 **(–2.61)**	I(0)
Belgium	3	9	GDP= –0.03CRED+0.46SAV+0.00TRADE–0.05TREND–7.01 (–1.51)	I(0)
Australia	5	7	GDP= **–0.10CRED**+0.02SAV+0.30TRADE+0.24TREND–3.59 **(–1.91)**	I(0)
South Ko-rea	5	7	GDP= 0.04CRED+0.48SAV–0.00TRADE–0.41TREND–6.28 (1.23)	I(0)
Finland	7	5	GDP= 0.02CRED+0.46SAV+0.10TRADE–0.05TREND–15.21 (0.30)	I(0)
Denmark	8	4	GDP= **–0.03CRED**+0.20SAV+0.33TRADE–0.01TREND–18.83 **(–3.59)**	I(0)
Iceland	4	8	GDP= 0.01CRED–0.48SAV+0.10TRADE–0.10TREND+7.10 (0.54)	I(0)
Israel	1	11	GDP= **–0.13CRED**+0.20SAV+0.19TRADE+0.07TREND–3.54 **(–3.08)**	I(0)
Chile	7	5	GDP= **–0.36CRED**–0.11SAV+0.16TRADE+0.20TREND+15.04 **(–2.73)**	I(0)
Turkey	6	6	GDP= –0.03CRED+0.07SAV+0.29TRADE–0.20TREND–4.24 (–0.42)	I(0)
Mexico	1	11	GDP= 0.11CRED–0.26SAV+0.13TRADE–0.18TREND+2.06 (1.15)	I(0)

Notes: * Number of group unit roots that do not reject a given hypothesis. t-statistics are reported in parentheses. Statistically significant coefficients and t-statistics are indicated in bold.

The hypothesis that the group series have a unit root cannot be rejected for all the countries with identified cointegrating relationships. This bolsters my argument for the error correction mechanisms in eq. (2a–d) containing lagged values of first-differenced variables rather

than levels. Although examining whether there is a positive or negative causal link between credit depth and growth is beyond the scope of this paper, it is worth noting that, among the significant cointegrating relationships, *CRED* is positively associated with *GDP* only for Switzerland.

Causality testing in the FMOLS-based approach yields the results shown in Table 3.

Table 3 Causal relationships in the FMOLS-based approach

Country	GDP does not cause CRED			CRED does not cause GDP		
	Short-run causality	Long-run causality	Strong causality	Short-run causality	Long-run causality	Strong causality
UK	0.06	0.47	0.49	5.78**	0.69	9.91***
Spain	1.89	3.09*	3.62	2.56	10.85***	14.19***
Netherlands	0.20	0.01	0.45	1.99	1.01	2.19
Portugal	1.46	0.01	2.72	0.75	10.05***	11.90***
Greece	0.01	0.00	0.02	0.00	6.08**	7.32**
Switzerland	0.00	2.28	2.67	16.87***	1.46	23.18***
Ireland	0.72	0.12	1.62	0.06	14.54***	15.96***
Sweden	0.85	0.02	1.25	0.00	1.49	1.49
Australia	1.25	0.44	1.25	12.85***	41.05***	41.07***
Denmark	0.22	1.25	1.34	0.79	3.07*	4.08
Israel	2.98*	0.13	4.45	0.21	17.23***	19.70***
Chile	0.48	0.33	0.51	1.16	25.18***	20.45***

Notes: * – significant at the 10 % level; ** – at 5 %; *** – at 1%.

CRED strongly Granger-causes *GDP* in nine of the 12 countries where cointegrating relationships are found. There is almost no evidence of causality running in the opposite direction. The causal effects exhibit higher significance under this methodology. Long-run causality prevails over short-run causality, with two notable exceptions: the UK and Switzerland. Statistically significant short-run causality underlies the overall effect in these countries. Both forms of causality are found for Australia.

4.3 Discussion

The results of the three causality tests have much in common. Each indicates the presence of causality in about half of the sample countries. The direction of observed causality is mainly from credit depth to GDP growth. Moreover, causality tends to hold in the long run. The tests yield uniform results with respect to the presence (absence) of causality and direction for 12 OECD economies. Its presence is confirmed for the UK, Switzerland, Australia,

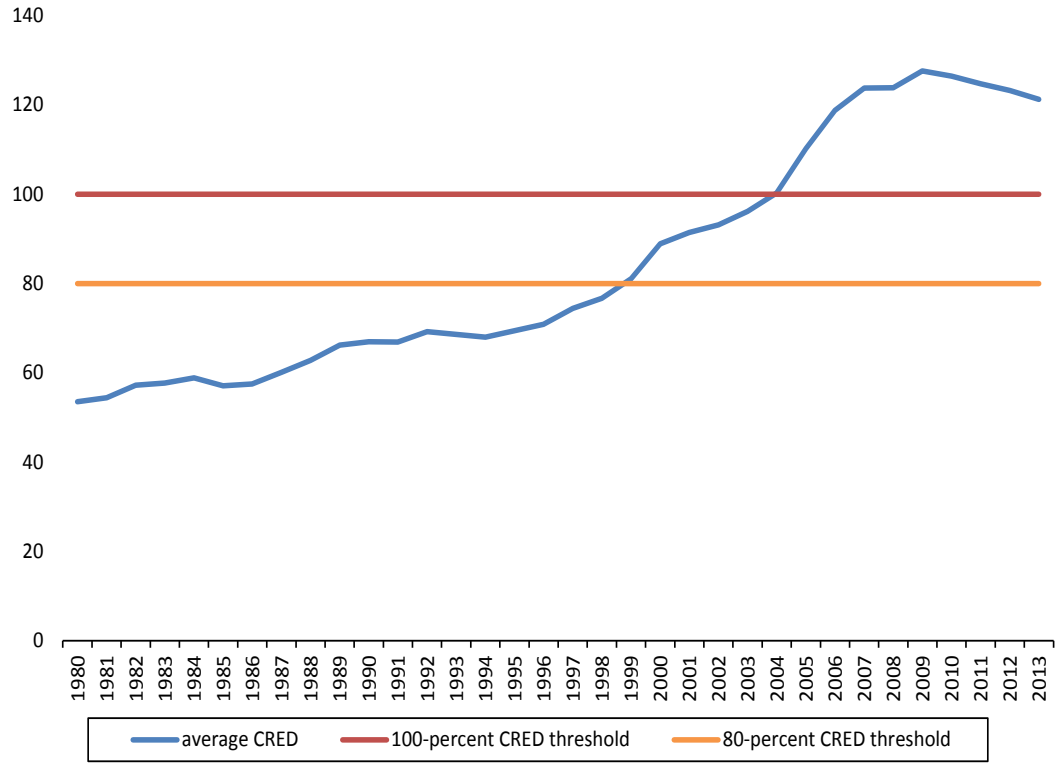
and Greece. No causal evidence is found for the US, Japan, Austria, Sweden, Denmark, South Korea, Turkey, or Mexico. Some countries show largely consistent estimates across tests. The Breitung-Candelon test and FMOLS-based causal approach show that domestic private credit-to-GDP ratio Granger-causes output growth in Ireland. The VAR Granger causality and Breitung-Candelon tests point to the causal link running from growth to credit for Iceland. The causal direction based on the same pair of tests is reverse for the Netherlands. In the case of Chile, the link running from credit to growth is found by the VAR Granger and FMOLS-based tests, while, according to the test in the frequency domain, it is bidirectional. The results are ambiguous for Germany, France, Italy, Spain, Portugal, Finland, Belgium, and Israel.

These findings conflict with the assertion of Patrick (1966) that the supply-leading pattern gives way to a demand-following pattern as economic development advances. Here, the evidence suggests a supply-leading pattern still prevails in OECD countries. That is, in those few countries where robust causal links are found, credit depth Granger-causes economic growth, not vice versa. My overall findings, however, should discourage policymakers from relying on bank-based financial development as a stand-alone growth determinant.

The empirical evidence obtained is related to the literature asserting that high financial depth measures do not correlate (or correlate negatively) with economic growth. The "too much finance" view implies a threshold level of financial development, beyond which the link between finance and growth becomes negative or vanishes altogether. Before policymakers figure out that this threshold has been crossed, the dark side of finance such as credit misallocation and increased opaqueness of financial institutions comes to the fore. Arcand et al. (2012) put the threshold in the range of 80–100 % of domestic private credit relative to GDP. Cecchetti and Kharroubi (2012) find the threshold to be 90 % of the same ratio for a sample of 50 advanced and developing countries. Based on the panel of 87 countries, Law and Singh (2014) provide another estimate also within the Arcand et al range (94 %). Beck et al. (2014) report a somewhat higher threshold (109 %), which they calculate from a sample of more than 100 economies. The non-monotonic link between finance and growth is also found in sector-level studies (Manganelli and Popov, 2013). In the same vein, Ductor and Grechyna (2015) suggest that financial development may have a detrimental impact on real sector growth if the financial sector deepens too rapidly compared to real sector growth rates. Thus, the "too much finance" literature highlights the importance of maintaining an "optimal" level of financial development.

While my aim here is not to establish the optimal level for the sample under investigation, my results are close to or within the range of credit depth to GDP set forth in Arcand et al. (2012). As shown in Figure 3, for the 24 OECD countries studied, the average domestic private credit-to-GDP ratio crosses the "danger zone" 80 % threshold in 1999 and climbs to 100 % in 2004.

Figure 3 Average domestic private credit to GDP dynamics in the 24 OECD countries in 1980–2013 and Arcand et al. (2012) upper and lower thresholds.



This evidence may serve a tentative explanation for the relatively small number of causal linkages between credit depth and growth in the OECD countries in general. It appears that the mechanics of these causal links may to a certain extent follow a pattern described by Bezemer and Grydaki (2014). They investigate the credit-output growth relationship for the US during the Great Moderation (1984–2007) and find that credit decoupled from output dynamics in that period. The much larger share of credit allocated to asset markets during this period accounts for this trend. In other words, causal links in advanced economies may have disappeared or waned years before the arrival of the global 2007–2009 financial crisis.

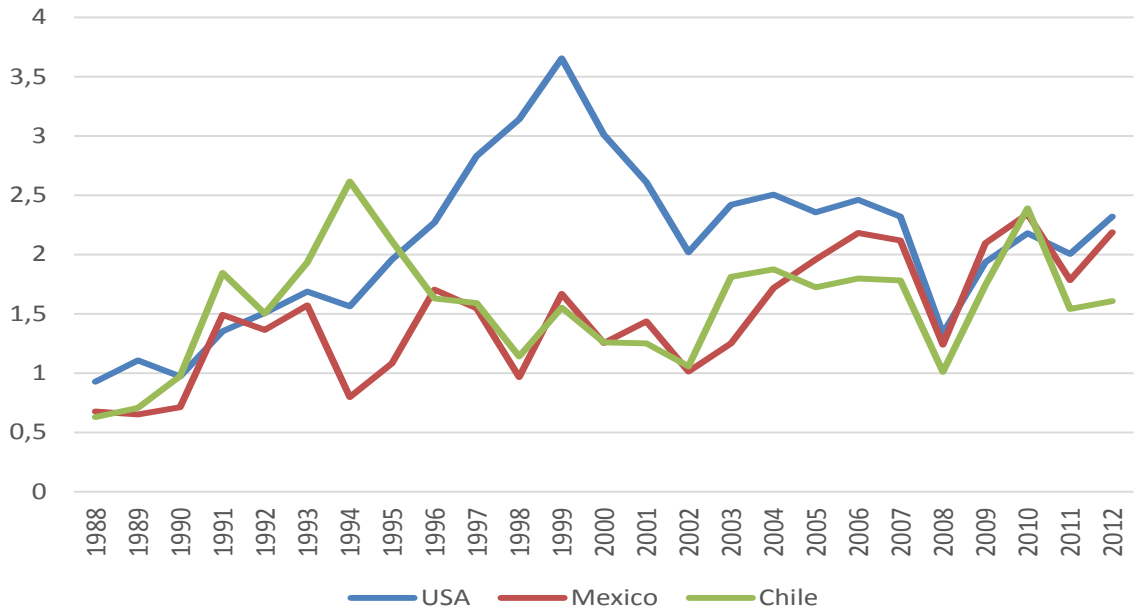
In this regard, the "financial crisis" view on the weakening finance-growth nexus conjectured by Rousseau and Wachtel (2011) may not be relevant for this group of countries. In addition to the US, this may apply to certain European countries with inconsistent causality test results (e.g. Ireland, Italy, Portugal, and Spain) that enjoyed financial tranquility right up to the time of the Great Recession (2008–2009).

The findings of the paper can also be placed into the context of the literature that examines causality between financial structure and growth. Unlike Peia and Roszbach (2014), I assess causal relationships between credit depth and growth, omitting the potential impact of stock market development for data availability reasons.[11] There is little controversy between them regarding the limited presence of causality directed from credit depth to growth. However, in a sharp contrast to Peia and Roszbach (2014), this paper finds only negligible evidence for the causality running from growth to credit depth.

Recent studies generally support the view that market-oriented financial systems tend to produce a stronger effect on economic growth than their bank-based counterparts (Demirgüc-Kunt et al., 2013; Yeh et al., 2013). Thus, the disintermediation of finance can also offer an explanation for the scant evidence of causality between credit depth and growth. As regards the sample under investigation, the trend has been particularly pronounced in the US, Mexico, and Chile. Using the relationship of stock market capitalization to domestic private credit (*SMCAP/CRED*) as a proxy for financial structure, these non-European OECD economies are clearly market-based. The proxy indicator has exceeded 1 for all three countries since early 2000 (Figure 4). My estimations show they have either no (US and Mexico) or inconsistent (Chile) evidence for causality between credit depth and economic growth.

[11] Ratios of stock market capitalization to GDP and stock market volume traded to GDP are available from 1988 for most sample countries. Reconstruction of annual data back to 1980 based on national historical financial statistics is not possible for some countries. For others, e.g. the UK and Sweden, the estimates are inconsistent with the post-1988 trajectories of these indicators.

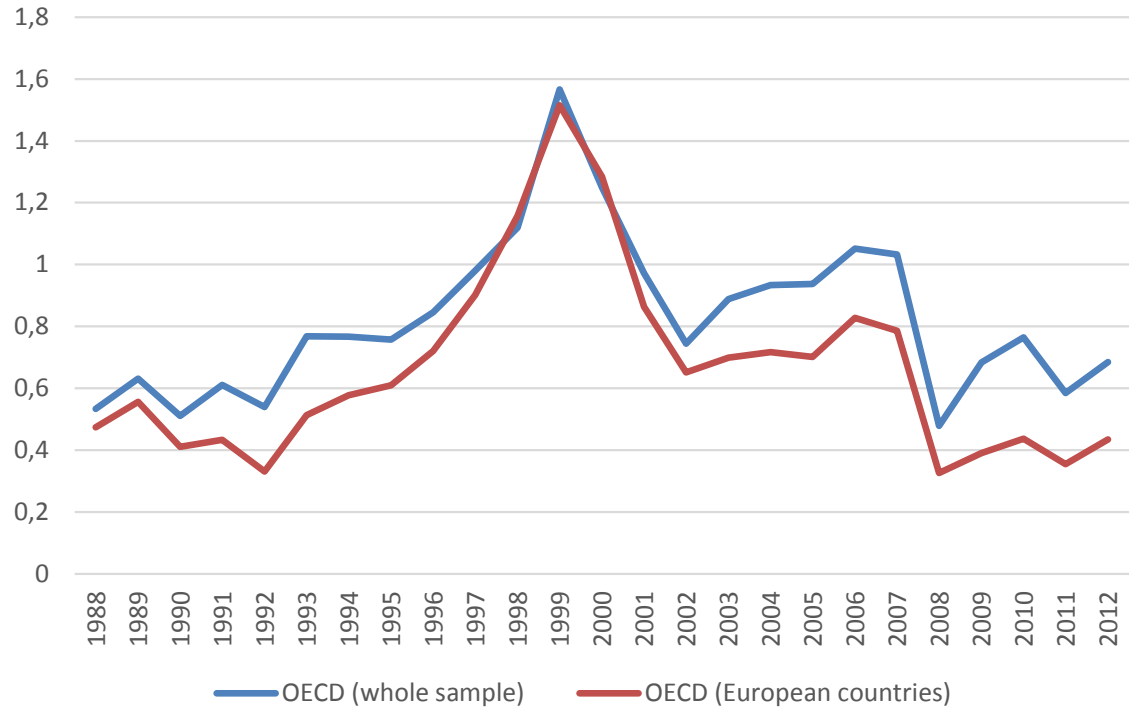
Figure 4 Dynamics of the ratio of stock market capitalization to domestic private credit (SMCAP/CRED) for the US, Mexico, and Chile; 1988–2012.



The disintermediation view does not rule out the possibility that a stronger impact exerted by stock markets can entail increased output growth volatility (Beck et al., 2014). That said, the causal relationship between stock market development and economic growth should not be taken for granted either.

Interestingly, despite the worldwide trend toward disintermediation, the financial structures of the sample countries have tended to become more bank-based in recent years (Figure 5). Stock market capitalization growth outpaced credit depth dynamics throughout the 1990s and the financial structure became market-based. Since then, there has been a substantial reversal. The gap between the ratios of domestic private credit and stock market capitalization to GDP has yawned in the aftermath of the Great Recession. European countries in the sample drove the change. On average, they were more bank-based in 2012 than in 1988, with stock market capitalization equal to only 43 % of domestic private credit.

Figure 5 Dynamics of average stock market capitalization to domestic private credit (SMCAP/CRED) for all OECD countries in the sample and European sample countries; 1988–2012.



This unexpected observation implicitly corroborates the "too much finance" view; the reversal arises from overbanking in the set of sample OECD European countries. As posited by the Advisory Scientific Committee Report to the European Systemic Risk Board (ESRB 2014), banking in Europe has grown too much, creating increased risks to systemic stability and contributing little to growth. Langfield and Pagano (2014) characterize overbanked economies in Europe as "bank biased," arguing that such countries tend to experience lower growth rates, especially during financial crises. This assessment holds in terms of the endogeneity of financial structures, which they instrument with past reforms of financial regulation and characteristics of real economy structure.

If causal linkages between credit depth and economic growth in the UK and Switzerland can persist because of financial center specialization, this outcome is hardly possible for EU economies without such status. Their capacity to absorb credit in a productive way is limited. Beyond some point, credit saturation emerges, resulting in credit booms (Spain, Ireland, Portugal, and Greece) or capital outflows that may mitigate the severity of a domestic banking crisis (Germany, France, and Austria) but still threaten overall stability, being primarily directed to the overheated EU economies.

In addition to offering explanations of general applicability, it is important to recognize country-specific issues. For example, the absence of causality between credit depth and growth in Japan may stem from the persistently negative real interest rates that have suppressed the finance-growth nexus since the 1990s (Chang and Huang, 2010). More country-level case studies are needed to complement this cross-country analysis of causality between credit depth and economic growth.

5 Conclusions

This paper assesses causality between domestic private credit to GDP ratio and real GDP per capita growth in a country-by-country time-series framework for 24 OECD economies over 1980–2013. My threefold methodology to test for causal linkages integrates (i) lag-augmented (LA–VAR) Granger causality tests, (ii) Breitung-Candelon causality tests in the frequency domain, and (iii) testing for causal inference with a FMOLS approach. It is also emphasized that nonlinearities and structural breaks in data needed to be taken into account to determine the order of integration of the variables and accurately specify the underlying VAR models. A recursive unit root testing procedure is proposed to seek this goal.

The three tests confirm that the causal linkages between credit depth and growth in the OECD economies are not widespread. In total, testing on 12 of our 24 sample countries yielded identical results in terms of the presence (absence) of causality and direction. Of the 12 countries, stable causal linkages running from credit depth to growth were found for the UK, Australia, Switzerland, and Greece. The causal linkages are important at both high and low frequencies. However, there is little evidence of reverse causal effects, i.e. stable causal linkages running from growth to credit depth. Thus, these findings contrast with Patrick's (1966) assertion that more advanced economies switch from a supply-leading pattern of financial development to the demand-following modality when changes in output begin to lead finance.

These results are consistent with previous studies on the finance-growth nexus in developed countries. Conceptually, they comport with the "too much finance" view, which suggests there may be a threshold separating benign and detrimental effects of financial development. It may be that the disappearance of causal links between credit depth and growth are evidence of overbanking, i.e. excessive levels of financial intermediation. The Great Re-

cession and subsequent European financial crisis have unveiled credit misallocation, increased opaqueness of financial conglomerates, and exacerbated other previously accumulated frictions and agency problems. The general trend toward disintermediation also appears to play a role. The US, Mexico, and Chile, all of which have market-based financial structures, exhibit no (or inconsistent) evidence of causal links between credit depth and economic growth.

More detailed analysis is required to explain the uncovered country-level causal patterns. In addition to country-level case studies, it may be feasible to test for causality in a time-series framework using alternative econometric techniques. Such analysis would benefit from sophisticated methods of time-series causal investigation such as wavelet spectrum decompositions, as well as techniques that go beyond the notion of Granger causality such as Bayesian causal networks. These constitute avenues for future research.

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Appendix

Table A1 Results of unit root tests

Series	BDS test	KSS test	Unit root tests		Structural breaks (Bai-Perron test)	Unit root tests with structural breaks			**Overall assessment of stationarity**	**Order of integration**
			ADF	KPSS		Zivot-Andrews	Perron	CMR		
US										
CRED	NL	S	–	–	–	–	–	–	***S***	***I(0)***
GDP	L	–	–	–	None	–	–	–	***S***	***I(0)***
SAV	NL	NS	NS	NS	3 (1986; 2001; 2008)	S	NS	NS	***NS***	***I(1)***
TRADE	NL	NS	NS	NS	2 (1995; 2006)	NS	NS	NS	***NS***	***I(1)***
GERMANY										
CRED	NL	NS	NS	NS	1 (1990)	NS	NS	NS	***NS***	***I(2)***
GDP	L	–	S	S	None	–	–	–	***S***	***I(0)***
SAV	NL	NS	NS	NS	1 (1988)	NS	NS	NS	***NS***	***I(1)***
TRADE	NL	NS	NS	NS	2 (2000; 2006)	NS	NS	NS	***NS***	***I(1)***
UNITED KINGDOM										
CRED	NL	NS	NS	NS	3 (1986; 2000; 2006)	NS	NS	NS	***NS***	***I(2)***
GDP	NL	S	–	–	–	–	–	–	***S***	***I(0)***
SAV	NL	NS	S	NS	3 (1991; 2001; 2009)	NS	NS	NS	***NS***	***I(1)***
TRADE	L	–	NS	S	–	–	–	–	***NS***	***I(1)***
JAPAN										
CRED	NL	NS	NS	NS	3 (1987; 1996; 2001)	S	S	S	***S***	***I(0)***
GDP	L	–	S	S	1 (1992)	–	–	–	***S***	***I(0)***
SAV	NL	NS	NS	NS	4 (1988; 1994; 1999; 2009)	NS	NS	NS	***NS***	***I(1)***
TRADE	NL	NS	NS	NS	3 (1986; 2000; 2005)	NS	NS	NS	***NS***	***I(1)***

FRANCE										
CRED	NL	NS	NS	NS	2 (1985; 2007)	NS	NS	NS	***NS***	***I(1)***
GDP	L	–	S	S	–	–	–	–	***S***	***I(0)***
SAV	NL	NS	NS	S	1 (2009)	NS	NS	NS	***NS***	***I(1)***
TRADE	NL	NS	NS	NS	1 (1997)	NS	NS	NS	***NS***	***I(1)***
ITALY										
CRED	NL	NS	NS	NS	3 (1999; 2004; 2009)	NS	NS	NS	***NS***	***I(2)***
GDP	L	–	S	NS	1 (2008)	S	NS	NS	***NS***	***I(1)***
SAV	NL	NS	NS	NS	2 (1999; 2009)	S	NS	NS	***NS***	***I(1)***
TRADE	NL	NS	NS	NS	3 (1986; 1995; 2006)	S	NS	NS	***NS***	***I(1)***
SPAIN										
CRED	NL	S	–	–	–	–	–	–	***S***	***I(0)***
GDP	L	–	NS	NS	1 (2008)	NS	NS	NS	***NS***	***I(1)***
SAV	NL	S	–	–	–	–	–	–	***S***	***I(0)***
TRADE	NL	NS	NS	NS	2 (1995; 2000)	NS	NS	NS	***NS***	***I(1)***
NETHERLANDS										
CRED	NL	NS	NS	NS	3 (1997; 2002; 2007)	NS	NS	NS	***NS***	***I(1)***
GDP	L	–	S	S	1 (2009)	–	–	–	***S***	***I(0)***
SAV	NL	S	–	–	–	–	–	–	***S***	***I(0)***
TRADE	NL	S	–	–	–	–	–	–	***S***	***I(0)***
PORTUGAL										
CRED	NL	NS	NS	NS	2 (1999; 2007)	NS	NS	S	***S***	***I(0)***
GDP	L	–	NS	NS	1 (2009)	S	NS	S	***S***	***I(0)***
SAV	NL	S	–	–	–	–	–	–	***S***	***I(0)***
TRADE	NL	NS	NS	NS	1 (2005)	NS	NS	NS	***NS***	***I(1)***
GREECE										
CRED	NL	NS	NS	NS	2 (2001; 2007)	S	NS	NS	***NS***	***I(1)***
GDP	L	–	NS	NS	2 (1997; 2009)	NS	NS	NS	***NS***	***I(1)***
SAV	NL	S	–	–	–	–	–	–	***S***	***I(0)***
TRADE	L	–	NS	NS	None	–	–	–	***NS***	***I(1)***

SWITZERLAND										
CRED	NL	NS	NS	NS	2 (1987; 2006)	NS	NS	NS	***NS***	***I(1)***
GDP	L	–	S	S	None	–	–	–	***S***	***I(0)***
SAV	NL	S	–	–	–	–	–	–	***S***	***I(0)***
TRADE	NL	NS	NS	NS	1 (2000)	NS	NS	NS	***NS***	***I(1)***
AUSTRIA										
CRED	NL	NS	NS	NS	4 (1985; 1990; 1997; 2005)	NS	NS	NS	***NS***	***I(1)***
GDP	L	–	S	S	None	–	–	–	***S***	***I(0)***
SAV	NL	NS	NS	NS	2 (1988; 1998)	NS	NS	NS	***NS***	***I(1)***
TRADE	NL	NS	NS	NS	2 (1998; 2003)	NS	NS	NS	***NS***	***I(1)***
IRELAND										
CRED	NL	S	–	–	–	–	–	–	***S***	***I(0)***
GDP	L	–	NS	NS	3 (1995; 2001; 2008)	NS	NS	NS	***NS***	***I(1)***
SAV	NL	NS	NS	NS	2 (1988; 1996)	NS	NS	NS	***NS***	***I(1)***
TRADE	NL	NS	NS	NS	2 (1994; 2003)	NS	NS	NS	***NS***	***I(1)***
SWEDEN										
CRED	NL	NS	NS	NS	2 (2001; 2007)	S	S	S	***S***	***I(0)***
GDP	L	–	S	S	None	–	–	–	***S***	***I(0)***
SAV	NL	NS	S	NS	1 (1997)	NS	NS	S	***S***	***I(0)***
TRADE	NL	NS	NS	NS	2 (1994; 2005)	NS	NS	NS	***NS***	***I(1)***
BELGIUM										
CRED	NL	NS	NS	NS	3 (1987; 1992; 2007)	S	S	S	***S***	***I(0)***
GDP	L	–	S	S	1 (2008)	–	–	–	***S***	***I(0)***
SAV	NL	S	–	–	–	–	–	–	***S***	***I(0)***
TRADE	NL	NS	NS	NS	1 (2000)	NS	NS	NS	***NS***	***I(1)***
AUSTRALIA										
CRED	NL	NS	NS	NS	3 (1989; 1998; 2005)	NS	NS	NS	***NS***	***I(1)***
GDP	L	–	S	S	None	–	–	–	***S***	***I(0)***
SAV	NL	NS	NS	NS	2 (1991; 2006)	S	NS	NS	***NS***	***I(1)***
TRADE	NL	NS	NS	NS	2 (1994; 2001)	NS	NS	NS	***NS***	***I(1)***
SOUTH KOREA										
CRED	NL	NS	NS	NS	3 (1996; 2001; 2006)	S	NS	S	***S***	***I(0)***
GDP	L	–	S	S	None	–	–	–	***S***	***I(0)***
SAV	NL	NS	NS	NS	1 (1986)	S	S	S	***S***	***I(0)***
TRADE	NL	S	–	–	–	–	–	–	***S***	***I(0)***

FINLAND										
CRED	NL	NS	NS	NS	4 (1987; 1994; 2004: 2009)	NS	NS	NS	***NS***	***I(2)***
GDP	L	–	S	S	None	–	–	–	***S***	***I(0)***
SAV	NL	NS	NS	S	3 (1991; 1997; 2009)	NS	NS	NS	***NS***	***I(1)***
TRADE	NL	NS	NS	NS	2 (1986; 1994)	NS	NS	NS	***NS***	***I(1)***
DENMARK										
CRED	NL	NS	NS	NS	2 (2000; 2006)	S	S	S	***S***	***I(0)***
GDP	L	–	S	S	1 (2008)	–	–	–	***S***	***I(0)***
SAV	NL	NS	NS	NS	3 (1985; 1999; 2009)	NS	NS	NS	***NS***	***I(1)***
TRADE	NL	S	–	–	–	–	–	–	***S***	***I(0)***
ICELAND										
CRED	NL	S	–	–	–	–	–	–	***S***	***I(0)***
GDP	L	–	S	S	None	–	–	–	***S***	***I(0)***
SAV	NL	NS	NS	NS	3 (1985; 1999; 2008)	NS	NS	NS	***NS***	***I(1)***
TRADE	NL	NS	NS	NS	2 (1988; 2008)	NS	NS	NS	***NS***	***I(1)***
ISRAEL										
CRED	NL	S	–	–	–	–	–	–	***S***	***I(0)***
GDP	L	–	S	S	None	–	–	–	***S***	***I(0)***
SAV	NL	NS	NS	NS	2 (1989; 1995)	S	NS	NS	***NS***	***I(1)***
TRADE	NL	NS	NS	S	3 (1988; 2004; 2009)	NS	NS	NS	***NS***	***I(1)***
CHILE										
CRED	NL	NS	NS	NS	1 (1999)	S	NS	NS	***NS***	***I(1)***
GDP	L	–	S	S	None	–	–	–	***S***	***I(0)***
SAV	NL	S	–	–	–	–	–	–	***S***	***I(0)***
TRADE	NL	S	–	–	–	–	–	–	***S***	***I(0)***
TURKEY										
CRED	NL	NS	NS	NS	2 (2004; 2009)	NS	NS	NS	***NS***	***I(1)***
GDP	L	–	S	S	None	–	–	–	***S***	***I(0)***
SAV	NL	NS	NS	NS	2 (1987; 2003)	S	S	S	***S***	***I(0)***
TRADE	NL	NS	NS	NS	2 (1994; 2004)	S	NS	NS	***NS***	***I(1)***
MEXICO										
CRED	NL	S	–	–	–	–	–	–	***S***	***I(0)***
GDP	L	–	S	S	None	–	–	–	***S***	***I(0)***
SAV	NL	NS	NS	NS	1 (1989)	NS	NS	NS	***NS***	***I(1)***
TRADE	NL	NS	NS	NS	3 (1986; 1995; 2006)	S	NS	S	***S***	***I(0)***

Notes: "NL" denotes nonlinear; "L" – linear; "NS" – nonstationary; "S" – stationary.

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