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Abstract: The main scope of the paper is to investigate the proposition that rising income inequality results in systemic financial instability in developed countries. In particular, 33 OECD (Organisation for Economic Co-operation and Development) countries are studied in a panel VAR framework analysis over 1995-2015. There is a growing literature on the effects of income inequality on financial crises. This study provides significant evidence in favour of a positive relationship between income inequality and financial fragility, when particular factors are controlled for. Complementary findings also suggest that: (i) debt accumulation in the private sector significantly depends on credit expansion, (ii) the debt levels of the private sector and households co-move over time, and (iii) financial deregulation significantly contributes to financial instability. Therefore, policy makers should take into account regulatory reforms that will promote institutional and financial innovations to restrict debt accumulation and render the financial system more robust to destabilising shocks.

Keywords: Financial instability; debt accumulation; income inequality; financial deregulation; OECD.

JEL Classifications: C33, D31, E51, G01.

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1. Introduction

The interactions in the financial markets in recent decades resulted in the eruption of the financial crisis of 2007-2009 emerging in the US and ultimately, spreading across many countries. One of the main reasons for this outcome is the private sector's explosive degree of indebtedness causing the financial markets to destabilise, thus affecting the economy overall (Fisher 1932, 1933). Increasing debt accumulation results in financial instability under which indebted institutions cannot meet their liabilities. This outcome is consistent with the financial instability hypothesis of Minsky (1975, 1982, 1986) where periods of extreme euphoria and growth are followed by financial collapses. This is a result of speculative activities and inefficient investment decisions undertaken by the private sector¹.

The main rationale of this process lies in the assumption that capitalist economies swing between states of extreme robustness and fragility. When the economy is rapidly growing, people and organisations are overwhelmed by euphoria, thus leading to overinvesting and speculative activities in order to maximise their returns given their available resources. However, as such actions do not always follow the efficient market hypothesis (Fama, 1998), misdirected investments generate financial losses for many individuals which subsequently marks the beginning of a potential economic downfall.

This process is extensively described by Kindelberger (1978) under which asset price revaluation marks the pre-phase of a slump as the price of shares of many corporations dramatically exceed their market value. Such investments are driven by credit acquisition which increases net debt exposure of the private sector. For this reason, a sentiment of mania overwhelms investing activities where debt to income ratios increase and capital ratios fall. Ultimately, when an incident occurs exposing asset overvaluation, sentiments of panic arise

¹ Although Minsky did not take into account the debt accumulation process of households, it is supported that it follows the same behaviour with the private sector (Milanovic, 2009).

in which investors withdraw their money, especially from liquid assets, in order to avoid losses. Consequently, asset prices collapse and if investments have been inefficient, then liabilities may not be repaid. Therefore, rapid economic growth results in speculative activities and risk by dramatically increasing the debt to income ratio (Borio and White, 2003; Mendoza and Terrones, 2008)².

An additional factor which has contributed to systemic financial instability refers to income inequality. There is a vast empirical literature providing evidence of a significant positive relationship between credit expansion and income concentration across many countries, supporting that income concentration at the top of the distribution has caused cumulative levels of debt (Fitoussi and Saraceno, 2010, 2011; Atkinson and Morelli, 2010, 2011; Kumhof et al., 2012; Perugini et al., 2015; Kumhof et al., 2015; Yamarik et al., 2016)³. This shows that when income and wealth is concentrated at the hands of few individuals and/or organisations, their investment decisions driven by credit expansion may cause financial destabilisation and thus, crises⁴.

The present study builds on the contribution of Rajan (2010) who argued that political intervention in the US to redistribute income to low-income households has resulted in increased debt exposure and real estate prices leading to the financial crisis of 2007-2009. In accordance with the aforementioned studies, the empirical model tests the relationship between income inequality and financial instability both in the long and in the short run when particular control variables are accounted for.

However, the present empirical analysis departs from the previous studies in the following respects: (i) the debt-to-operating surplus ratio of the private sector is employed as

² In addition, capital flows result in speculative bubbles in the financial and property markets and thus, the Schumpeterian creative destruction runs its course over the period of recession (Reinert and Reinert, 2006).

³ However, Bordo and Meissner (2012) did not report any significant relationship between those measures.

⁴ Piketty and Saez (2003, 2014) and Atkinson et al. (2011) provide additional information on the evolution of income at the top 1% of the distribution over the last 30 years across developed and emerging economies.

a proxy for financial instability instead of credit provision as net debt accumulation is a more accurate indicator, (ii) the income inequality indicator is measured as the ratio of gross operating surplus over labour compensation, thus reflecting the dynamics of capital and labour and whether the earnings of the entrepreneurs have diverged from the earnings of workers (Kumhof et al., 2015; Goda et al., 2017), (iii) the leverage ratio of households and non-profit institutions serving households (NPISHs) is taken into account to test whether a similar pattern persists with the borrowing behaviour of the private sector and (iv) the price of shares indicator is also included in the model as overpriced assets usually signal the beginning of a financial crisis. By utilising these elements, we intend to test Rajan's hypothesis and contribute to the existing literature of financial instability.

Consequently, this study introduces a new debt-oriented indicator of financial instability which is more reliable and accurate than the credit to GDP ratios employed by previous empirical studies (Perugini et al., 2015). Also, a new income inequality indicator is employed capturing the relationship between capital and labour earnings and thus, it allows the investigation of how the dynamics of this ratio tend to influence the private sector's degree of indebtedness. Finally, the range of countries taken into account corresponds to the vast majority of the OECD group, as well as Cyprus, setting the number of countries to 33. This means that a relatively high number of units across the panel sample renders the final estimates more reliable and provide robust results for the effect of income inequality on systemic stability.

The paper is organised as follows: section 2 provides a review on the literature of inequality and financial instability; section 3 develops the empirical model and describes the data employed in this study; section 4 presents the empirical results; and section 5 offers a conclusion.

2. Financial fragility and inequality: theoretical interpretation and empirical evidence

The concept of financial destabilisation has been investigated over the years especially in periods of crises, where it is considered to be the main contributor to this outcome. Many studies have taken into account Minsky's (1975, 1982, 1986) and Kindelberger's (1978) remarks about the dynamics of the financial system that lead to higher indebtedness and possibly, to a Ponzi scheme where individuals and institutions cannot meet their liabilities. One of the main contributing factors to financial instability identified in the literature corresponds to income inequality. The main rationale is that as income and wealth is concentrated amongst few people, investment decisions may not be productive and thus, lead to social inefficiency. For this reason, Rajan (2010) argued that in the US, politicians tried to redistribute income by providing credit access to low and middle-income individuals. However, given the absence of sufficient regulation, such policies resulted in explosive indebtedness because individuals tried to maintain their living standards through borrowing. Consequently, such a bubble resulted in the financial crisis of 2007-09⁵. This means that a strong link persists between the evolution of income inequality and its effect on financial instability through various policies and decisions.

Krugman (2012) argued that the absence of sufficient regulations across the financial markets is an important factor leading to financial crises. In particular, as individuals and institutions are overcome by the speculative motive, their actions create financial bubbles that are doomed to burst. For this reason, financial deregulation also contributes to income and wealth inequality under which people pursue their own self-interest, ignoring the after-effects on the economy. Galbraith (2012) also confirms this intuition as he provides evidence that

⁵ Claessens and Perotti (2007) also mentioned that the quality of institutions is a crucial determinant of financial reforms and credit provision, which can reduce inequality through various policies.

income inequality and financial fragility followed a similar path since the 1970's across the developed economies. The reason for this pattern refers to the change of the global financial structure where financial regulation declined over the years leading to high debt accumulation.

Fitoussi and Saraceno (2010, 2011) and Stiglitz (2012, 2013) built their analysis on the theory of Kalecki (1942) and Kaldor (1955) where income inequality can be also captured by the propensity of consumption. In theory, households with high propensity to consume tend to earn less compared to those households with lower propensity as they can only afford to satisfy their consumption needs and thus, they cannot save or invest. This means that income is redistributed to those households that can already afford to save, meaning that the gap between high and low income individuals widens over time⁶. Consequently, aggregate demand falls as income flows to individuals who already meet their consuming needs, leaving the rest to spend less on consumption and for this reason, they turn to borrowing in order to maintain their current level of expenditure⁷.

Moreover, there has been a significant number of empirical studies on the relationship between income inequality and financial instability. Kumhof et al. (2015) developed a closed-economy dynamic stochastic general equilibrium (DSGE) model showing that income inequality can endogenously lead to higher credit growth, leverage ratios and thus, to an increased probability of a financial crisis. The main assumption of the model refers to the presence of two economic agents: investors, who are identified as the 5% top income earners and thus, they only receive capital gains; and workers, who receive only labour income. The former group includes the owners of capital, meaning that they can consume, save and invest. On the other hand, the latter group can only afford to consume since it faces a minimal level

⁶ However, Krueger and Perri (2006) argue that income inequality may not be an accurate indicator of wealth inequality as part of non-labour income is transitory and does not have any effect on permanent income (Bazillier and Hericourt, 2017).

⁷ According to Dynan et al. (2004), expansionary monetary policies could enhance purchasing power parity; however, as debt level accumulates, a financial crisis would be inevitable and thus, monetary intervention would be ineffective.

of consumption that must be satisfied. For this reason, if labour income does not suffice, borrowing is the only alternative to finance their expenses.

For this reason, workers tend to borrow from investors when real wage growth staggers and investors lend credit out of their capital gains. This behaviour simultaneously boosts the leverage ratio of both groups and ultimately, it increases the probability of a financial crisis. To this end, income inequality is captured by the difference between capital and labour income and credit supply of the former group to the latter⁸.

A similar outcome is obtained by Kumhof et al. (2012) for the UK economy, where their model is opened to the international sector. The main addition of this analysis refers to the current account balance which serves as a proxy for credit demand. Once again, it is shown that income inequality results in credit expansion, increased leverage ratios and current account deficits, signalling an imminent financial crisis. Atkinson and Morelli (2010, 2011) developed a similar model consisting of 25 countries over 1911-2010 in order to validate the causation between increasing income inequality and banking crises. They identified a significant positive relationship in the US economy as the aforementioned studies, but their results are not significant across every constituent country. This shows that the pattern between income inequality and financial instability is not always valid⁹.

On a similar note, Bordo and Meissner (2012) took into account 14 advanced economies between 1920 and 2000 in order to test the long-run causation between income inequality and financial fragility. They showed that there are no general patterns, as a rise in top income shares does not lead to credit booms. Annual banking lending is also not found to be strongly correlated with financial bubbles. The only factor which is found to have an

⁸ In addition, Büyükkarabacak and Valev (2010) found that a credit boom in the private sector is associated with subsequent banking crises, suggesting that the lending decisions of the private sector are crucial to systemic destabilisation.

⁹ However, it should be mentioned that the authors were focused on variables captured by changes instead of levels which might remove part of the explanatory power from the indicators.

important role in this pattern is the changes in interest rate, suggesting a boom-bust pattern of crises.

Belletini and Delbono (2013) conducted a similar study on OECD countries that faced a banking crisis. The main driver of this analysis was the level of income inequality compared to the average level across the OECD group. However, the main difference from the previous study refers to the inclusion of indicators in levels rather than differences in order to increase the explanatory power of the results. Even if no sufficient control variables were included in the model, the findings suggest that countries with higher Gini coefficients tend to be more vulnerable to financial crises. Perugini et al. (2015) also tested this hypothesis across 18 OECD countries over 1970-2007 to investigate the dynamics of income inequality and credit expansion when certain control variables are accounted for¹⁰. For this reason, they took into account the emergence of endogeneity and reverse causation in their model that might be caused due to the inclusion of a credit to GDP ratio as an indicator of financial fragility¹¹. Overall, they found significant evidence of a long-run causation running from income inequality to credit expansion; however, financial deregulation does not significantly contribute to this outcome.

On the contrary, Tridico (2015) suggests that increasing income inequality across the OECD economies is mainly caused by increased financialisation which ultimately leads to financial crises¹². Moreover, the decline of labour bargaining power, the intensification of labour flexibility and the retrenchment of the welfare state have resulted in a widening gap between capital gains and labour income. This gap, as mentioned before, concentrates

¹⁰ Such variables correspond to proxies of business cycles, credit demand, capital formation, monetary aggregates and financial deregulation.

¹¹ Lysandrou (2011) argues that credit supply may be an accurate indicator of fragility as the increase of global savings resulted in accumulation of private wealth, thus enhancing demand for securities funded by additional credit.

¹² According to Shleifer and Vishny (2010), a major impact of financialisation is the behaviour of banks choosing securitisation and derivatives instead of holding cash.

investment opportunities in the hands of the top percentage of the income distribution resulting in imminent financial crises.

The aforementioned studies draw a conclusion that the degree of indebtedness across any economy is a detrimental factor of financial stability enhanced by deregulatory policies. It must be modelled and taken into account in order to study the probability of emerging financial crises and how income inequality plays a crucial role in this process, especially when systemic regulation is limited. Consequently, empirical studies have to incorporate the element of a dynamic capital to labour relationship as an indicator of income inequality which is also related to borrowing decisions undertaken by households and the non-financial private sector. This means that various debt indicators must be employed as they are more reliable compared to credit provision variables.

Yamarik et al. (2016) adopt this rationale as they developed a similar model to Perugini et al. (2015) for the US over 1977-2010. The financial fragility variable of this model is the real estate lending indicator, while income inequality is captured by the top 1% share of the income distribution, the Gini and Theil coefficients. The findings of the model in every case suggest a strong long-run causation running from income inequality to real estate lending, reflecting that income concentration amongst few individuals was one of the main factors that caused the US housing bubble burst in 2007.

Moreover, the studies of Russo et al (2016) and Kirschenmann et al. (2016) identify the presence of a long-run relationship between income inequality and financial instability across many countries. They find that increased levels of systemic fragility suggest the imminence of a financial crisis. As such crises emerge, the degree of indebtedness of households and corporations causes a simultaneous fall in aggregate demand as individuals cannot keep up with their liabilities. For this reason, high levels of debt accumulation reflect

the transition process from booms to bursts, leaving the whole economy vulnerable to Kindelberger's (1978) pattern of mania and panics.

3. Model formulation and data

The theoretical foundations of the model are provided by the analysis of Minsky (1975, 1982, 1986) under which the indebtedness of the private sector and access to liquidity are crucial determinants of operational activities. Constraints in cash flows usually result in diminishing investment decisions and thus, operating surplus as debt repayment becomes more difficult (Toporowski, 2008). Such constraints are subject to two important elements influencing financial activities: financial innovation and institutional evolution that shape restrictions on available loanable funds.

The former factor is characterised by the nature of investments aiming to improve financial transactions and activities and thus, to improve the leverage ratio of corporations. The latter factor includes elements, such as financial deregulation and liberalisation that lower barriers and allow investors to interact in the market with minimum intervention from regulatory institutions (Beck et al., 2010)¹³. According to this rationale, the Minskian framework involves four important factors that can significantly affect the stability of the financial system: the level of cash flow that determines investment opportunities and the degree of indebtedness (cs), the growth rate of investments influenced by the state of business cycles (rg), the leverage ratio which reflects net liabilities of institutions according to their operating surplus (v), and financial and institutional innovations that directly (de)regulate access to credit (fr).

In particular, the level of credit supply that corporations and households have access to significantly influence their investing and consumption decisions, as well as their savings

¹³ However, the authors conclude that the role of institutions is crucial in shaping the effect of financial deregulation on income inequality.

(Kumhof et al., 2015). According to Perugini et al. (2015) the credit-to-GDP ratio is an accurate indicator of financial fragility as it captures the debt dynamics of the private sector that may reflect financial bubbles ready to bust. For this reason, firms can utilise additional funding to establish their presence in particular markets, thus gaining market power allowing them to set a desirable price level¹⁴. On the other hand, households can use credit in order to boost their consumption or to compensate for any loss (current or expected) that might occur due to diminishing labour bargaining power over capital (Fitoussi and Saraceno, 2010, 2011).

Moreover, the leverage ratio is formulated as the ratio of investment (I) financed by external sources (I_x) to investment financed by internal sources (I_n); however, in this study, it is captured by the ratio of debt-to-operating surplus in order to reflect the degree of private sector indebtedness (Schularick and Taylor, 2012). The main assumption of this notation lies in the importance of desired investment opportunities as it depends on the sum of savings (including rents) and additional credit acquired from the financial markets. Consequently, the desired level of savings out of profits depends on entrepreneurial internal savings plus savings out of dividends and interest on income:

$$I^d_t = I_0 + s_\pi(\pi_t - i_t D_t) + i_t D_t \quad (1)$$

$$S^d_t = S_0 + s_\pi(\pi_t - i_t D_t) + s_e[(1 - s_\pi)(\pi_t - i_t D_t) + i_t D_t] \quad (2)$$

where s_π is the proportion of savings invested out of net profits, I_0 and S_0 are constant parameters, $\pi_t - i_t D_t$ is the level of profits after financial charges (expressed as the nominal interest rate multiplied by debt) to invest and s_e is the entrepreneur's propensity to save. Therefore, $(1 - s_\pi)(\pi_t - i_t D_t) + i_t D_t$ reflects the level of profits distributed to the shareholders.

¹⁴ Kalecki (1938) develops a detailed analysis of the effects of monopoly power and imperfect competition on income distribution.

If we take into account Minsky's definition of leverage ratio and the behaviour of workers and entrepreneurs presented by Kumhof et al. (2015), it is obtained

$$v_{w,t} = D_{w,t}/f_w Y_{w,t} \quad (3)$$

$$v_{\pi,t} = D_{\pi,t}/\varphi_{\pi} \pi_t \quad (4)$$

where Y_w is the labour income and f_w and φ_{π} are the shares of labour income and profits respectively available for spending. If we also consider that value added is created through production, then equations (3) and (4) are transformed into

$$v_{w,t} = s_w L_{w,t}/f_w VA_{w,t} \quad (5)$$

$$v_{\pi,t} = s_{\pi} L_{\pi,t}/\varphi_{\pi} VA_{\pi,t} \quad (6)$$

where s_w is the share of labour income in value added. When we finally take into account that labour compensation and profits are inversely related, it can be concluded that an increase in the share of capital would lower the share of labour in value added, thus improving the leverage ratio for entrepreneurs (v_{π}) but deteriorating it for workers (v_w). On the other hand, a redistribution of value added away from profits would raise labour income, affecting the leverage ratio and possibly household debt accumulation if higher labour compensation reduces the tendency of credit demand.

Ultimately, according to the aforementioned theoretical foundations and the empirical contribution of Perugini et al. (2015), the final equation employed in this study is given by:

$$v_{\pi} = f(cs, inq, v_w, rg, fr, p) \quad (7)$$

where v_{π} is the leverage ratio of the non-financial private sector expressed as the debt-to-operating surplus ratio, cs is the credit-to-GDP ratio provided to the private sector by all sectors, inq is the indicator of income inequality expressed as the ratio of gross operating

surplus over labour compensation, v_w is the leverage ratio of households and NPISHs expressed as the debt-to-disposable income ratio, rg is the growth rate of real GDP, fr denotes the indicator of financial deregulation and p refers to the price of shares¹⁵. All variables are expressed as logarithms in order to obtain elasticity values through the estimation process. This particular equation captures the theoretical contribution of Minsky and intends to identify the relationship between financial fragility and income inequality when control variables of business cycles, credit supply and financial changes are taken into account¹⁶.

[Insert Table 1]

The dataset comprises of annual data over 1995-2015 for 33 OECD countries as well as Cyprus¹⁷. In comparison with the datasets of Bordo and Meissner (2012) and Perugini et al. (2015), the time interval is smaller as only 21 annual observations per country are included; however, the constituent countries are 33 when the aforementioned studies include 14 and 18 respectively¹⁸. This addition provides an advantage to the present analysis as it focuses on a wider range of countries across the OECD group over 1995-2015. Within this period the financial crisis occurred and many EU countries were affected by the fiscal and financial crisis across the Eurozone; however, it excludes policies and shocks that occurred over the previous decades such as the role of major institutional changes across the global financial markets. For this reason, the relationship between income inequality and financial fragility

¹⁵ The year base of every indicator is 2010.

¹⁶ It is worth mentioning that the variables of current account and primary balance were included in equation (7); however, they appeared to have an insignificant effect both in the long and in the short-run and hence, they were excluded (see Appendix).

¹⁷ The countries of the sample are Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the UK and the US.

¹⁸ One of the reasons of this limitation refers to the data availability of the top 1% and 5% share of the income distribution in the *World Top Incomes* database.

will be investigated for the constituent countries and conclude whether a significant relationship persists, thus validating the findings of relevant studies.

The indicator of financial fragility corresponds to the leverage ratio of the non-financial private sector expressed as the debt-to-operating surplus ratio obtained by the *OECD statistics and data* and *CEIC* databases. The main rationale of employing this particular indicator refers to its formulation as it reflects the dynamics of debt accumulation and the earnings of the sector, thus providing an accurate measure of net debt exposure (Schularick and Taylor, 2012; Kumhof et al. 2015). Perugini et al. (2015) employ the credit-to-GDP ratio as a measure of financial instability arguing that excess credit to the private sector can be a signal of systemic destabilisation. However, such indicator does not take into account the net position of corporations and thus, it excludes the level of operating surplus that can be used to finance debt¹⁹. Moreover, the leverage ratio is expressed in levels and not in growth rates as in the study of Bordo and Meissner (2012) which is one of the main criticisms and possibly, the reason for the inconclusive outcome between income inequality and financial fragility.

The indicator of income inequality refers to the ratio of gross operating surplus of the private sector over labour compensation obtained by the *OECD statistics*. This particular measure captures the within dynamics between the earnings of capital and labour and thus, the evolution of this relationship over the years. However, the main limitation lies in its omission to reflect different sub-groups amongst workers who are also part of the top share of the income distribution (such as managers). For this reason, its formulation is based on the analyses of Kumhof et al. (2015) and Goda et al. (2017) according to which the top shares of the income distribution consist of capital owners and hence, of entrepreneurs whose returns

¹⁹ Perugini et al. (2015), argued that if the growth rate of credit is accompanied by a similar growth rate of income and/or productivity, then financial destabilisation may not occur as the expansion of the real economy can compensate for excess levels of borrowing.

are reflected by operating surplus. An alternative and more accurate indicator could be the top 1% and 5% shares of the income distribution as employed in many studies (Atkinson and Morelli, 2010, 2011; Kumhof et al., 2012; Perugini et al., 2015; Yamarik et al., 2016) but given the data unavailability for the whole set of the constituent countries, the operating surplus-to-labour compensation ratio is the best available alternative²⁰.

Moreover, the set of inequality indexes presented by Theil (1967) could also explore the aforementioned relationship as they utilise the between and the within group inequality components. Duro and Padilla (2006, 2011) employed two indexes that capture the partial contribution of each inequality-oriented factor in the model reflected as a share of a final intensity index and an interaction term reflecting inter-factorial correlation²¹. The former component is formulated by decomposing intercountry inequality into a sum of individual contributors denoted as a weighted average of internal Theil indexes. The latter component is expressed as a population weighted index that takes into account differences among groups²².

Duro et al. (2013) argued that Theil indexes capture three important parameters reflecting levels of inequality. The first one is individual inequality of each component (regional inequality); the second one is the share of individual inequality to global inequality (weighted inequality); and the last one is the presence of correlation between different factors (group inequality). If these indexes are employed in empirical studies, a whole range of inequality outcomes will be obtained capturing both regional and global effects. Bhattacharya and Sinha (2016) and Sinha (2016, 2017) also adopt this methodological pattern as inequality may be subject to geographical differences across countries due to structural and economic

²⁰ Moreover, Yamarik et al. (2016) employ two additional inequality indicators: the Gini coefficient and the Theil index. Both measures provide similar results with the top 1% share of the income distribution suggesting strong correlation between income inequality and financial fragility.

²¹ The variables included in the model refer to carbon intensity of energy, consumed energy intensity and affluence per capita in order to capture the between and the within group effects.

²² If a subgroup decomposition is added to this index, global inequality is divided between inter-group and intra-group inequality (Duro and Padilla, 2011).

fundamentals²³. Therefore, the operating surplus to labour compensation ratio is a more suitable estimator for this study as it captures the within-effects of the capital and labour dynamics across countries (regions) and ultimately, their role on systemic stability.

The credit-to-GDP ratio is also included in equation (7) as a driver of debt accumulation. The observations have been obtained by the *Bank of International Settlements (BIS)* and the *World Development Indicators*. Perugini et al. (2015) employ this particular variable as an index of financial instability; however, it is unclear whether credit provision contributes to debt accumulation in the private sector. For this reason, it would be important to include credit supply as a control variable and investigate whether it exerts a significant effect on the leverage ratio v_π which is the proxy for financial instability²⁴. Also, this ratio can be viewed as a substitute indicator of the gross capital formation-to-GDP ratio. As capital formation is funded by extra credit, the credit-to-GDP ratio is a more accurate determinant of debt accumulation as it is the main driver of investment decisions and capital formation²⁵.

The next indicator captures the significance of business cycles on debt dynamics and it is reflected by the growth rate of real GDP over 1995-2015. The observations have been acquired by the *OECD Statistics* and the main importance of this rate is to capture debt cyclicity and ultimately, whether Minsky's (1982, 1986) financial instability hypothesis (increasing debt ratios during economic expansions) holds across the constituent countries. This rate could also serve as an indicator of future expected credit demand assuming that economic expansion increase credit provision (Adarov and Tchaidze, 2011).

²³ For instance, figure 3 shows that income inequality appears to be lower across the countries of continental Europe, such as Germany and Finland, and higher across the peripheral countries, such as Greece and Ireland.

²⁴ A positive and significant relationship would verify the aforementioned studies complementing to the argument that additional credit destabilises the financial system because it is a crucial determinant of income inequality (Rajan, 2010; Kumhof et al., 2015).

²⁵ The gross capital formation-to-GDP was also included in equation (7) and its sign and significance is similar to the credit-to-GDP ratio.

In addition, the leverage ratio of households and NPISHs is obtained by the *OECD Statistics and Data* and *CEIC* databases. It is expressed as the debt level of households and NPISHs over the level of disposable income. The formulation of this ratio was based on the studies of Geanakoplos (2010), Mian and Sufi (2010) and Schularick and Taylor (2012) in order to capture net debt accumulation and identify whether the leverage ratio of households tends to behave according to the one of the private sector²⁶.

The variable serving as a proxy of financial change corresponds to the financial deregulation indicator obtained by the *Economic Freedom of the World* database of the Fraser Institute (Gwartney et al., 2010). It ranges between 0 and 10 in ascending order of deregulation and it is an indicator reflecting the following four dimensions: interest rate controls and negative real interest rates; credit provided to the private sector; ownership of banks; and foreign bank competition. This measure has been employed by many studies (Giannone et al., 2011; Stankov, 2012; Perugini et al., 2015) and for this reason it is also included in this analysis²⁷.

Finally, the last variable which can also be viewed as a proxy for financial change is the aggregate price index of common shares of companies traded on national or foreign stock exchanges obtained by the *OECD Statistics*. According to Chipeta and Jardine (2014) and Fox et al. (2014), this measure is a crucial factor of systemic stability. As the price of shares tends to increase above its market value, speculative bubbles are created out of investing euphoria. However, once those bubbles burst, sentiments of panic overflow investing behaviour and thus, investors try to liquefy their shares to avoid any losses (Kindleberger,

²⁶ Schularick and Taylor (2012) formulated a leverage ratio of loans over money for the banking sector but in this study, the same rationale is applied for households and corporations in order to complement the arguments of Fitoussi and Saraceno (2010, 2011) concerning high household debt exposure.

²⁷ An alternative indicator could refer to the credit market regulation index presented by Abiad et al. (2008); however, it extends only up to 2005 and hence, it would impose limitations on the time period of the empirical model.

1978; Reinhart and Rogoff, 2008)²⁸. For this reason, the price of shares is a crucial determinant of financial fragility and it is important to investigate its relationship with the leverage ratio of the non-financial private sector²⁹.

To this end, by employing a range of panel data estimation techniques, we are able to estimate equation (7) by taking into account various issues and control for unobservable factors specific to countries and years.

4. Results and discussion

The first step of the empirical process is to identify the presence of cross-section dependence. If contemporaneous correlation persists across the countries of the sample, the traditional Augmented Dickey-Fuller unit root tests will not result in correct inferences as this particular problem is not taken into account. For this reason, Pesaran's (2004) cross-section dependence tests (Scaled LM and CD tests) are applied in order to investigate the presence of contemporaneous correlation. This particular approach takes into account the average value of all pair-wise correlation coefficients of the OLS residuals obtained by the ADF regression of each constituent variable. Under the null hypothesis, both tests reject the presence of cross-section dependence, thus rendering pooled least squares as a credible estimation technique³⁰.

The results of Pesaran's (2004) Scaled LM and CD tests are presented in Table 2 and provide significant evidence of cross-section dependence in the sample when up to three lags are included in each regression. For this reason, the unit root tests employed in this study correspond to Pesaran's (2007) cross-section ADF tests (CADF) where the initial ADF

²⁸ It is worth mentioning that a substitute for this measure could be the real housing price or the rent price index, as the housing market was one of the main contributors to the financial collapse of 2008. However, given an incomplete data set for Estonia, Hungary and Cyprus, the second best solution was to include the index of share prices, as they are expected to follow the same pattern.

²⁹ Elekdag and Wu (2011) and Perugini et al. (2015) also employ monetary variables, such as the interest rate and M2 money supply index; however, the former variable had an insignificant effect on v_{π} , while the latter one was not available for every country in the sample. Thereby, they have been substituted by the share price index.

³⁰ On the other hand, the presence of cross-section dependence requires alternative estimation techniques, such as the use of random or fixed effects models in order to take this problem into account.

regression is augmented by the cross-section average values of lagged levels and first differences. The results are presented in Table 3 showing that the only non-stationary series at levels is the indicator of income inequality. For this reason, a simple random or fixed effects model cannot be formulated as a panel VAR framework must be implemented in order to consider the presence of non-stationarity.

Subsequently, Westerlund's (2008) cointegration test is employed in equation (7) to investigate the presence of a long-run relationship amongst the constituent variables. The test takes into account the presence of cross-section dependence by utilising the group and the panel Durbin-Hausman test statistics. The null hypothesis of both statistics refers to the absence of a long-run relationship. The main advantage of this approach corresponds to the fact that it is not necessary to know the order of integration of the constituent variables. The presence of cross-section dependence is modelled by a factor model in which the residuals are obtained by common unobservable factors across the constituent countries (Auteri and Constantini, 2010).

Additionally, Westerlund and Edgerton's (2008) cointegration test is used as a robustness check in case any unknown structural breaks emerge across the sample. In particular, this test allows the presence of: (i) heteroskedasticity and serial correlation across the error terms, (ii) unit-specific time trends, (iii) cross-sectional dependence and (iv) multiple unknown structural breaks in both the slope and the intercept of the underlying regression³¹. It employs the LM unit root tests provided by Schmidt and Phillips (1992) and Amsler and Lee (1995). It follows the normal distribution under the null hypothesis which is independent of any nuisance parameters associated with the common factors causing cross-sectional dependence and the presence of structural breaks. Under those assumptions, three

³¹ The mechanics of this test provide a better alternative to Westerlund's (2008) test as the presence of those problems may be located at different dates across different entities.

models are estimated: no break, level break and regime shift in order to investigate the effect of any unknown structural breaks on the significance of cointegration in equation (7). The results are presented in Tables 4a and 4b and suggest the rejection of the null hypothesis at least at the 5% level of significance, thus reflecting the presence of a long-run relationship in equation (7). The only exception is the $Z_{\varphi}(N)$ statistic for the regime shift model which gives an insignificant result³².

[Insert Tables 2, 3, 4a, 4b]

To this end, the presence of cointegration and cross-section dependence across the countries necessitates the investigation of the long-run and short-run effects of income inequality on the private sector's level of indebtedness. The most suitable estimator in this case refers to the Common Correlated Effects (CCE) estimation technique proposed by Pesaran (2006). The formulation of this estimator is similar to the CADF unit root tests where the main regression is augmented by the cross-section averages values of the countries across the 21 years of the study. This approach allows individual specific error terms to be heteroskedastic and serially correlated. Hence, the CCE estimator is preferable compared to the Fully Modified OLS (FMOLS) or the Dynamic OLS (DOLS) estimators as they will result in incorrect inferences under the presence of cross-section dependence (Phillips and Sul, 2003). Moreover, Perugini et al. (2015) argue that endogeneity is an important issue that must be taken into account as the FMOLS and DOLS cannot provide consistent results if this problem persists.

For this reason, the estimation process utilises three estimation techniques: the CCE estimator to take into account the presence of cross-section dependence; the GMM estimator as developed by Hansen (1982) and Arellano and Bover (1995), where the lagged values of

³² However, this outcome may be expected as the $Z_{\varphi}(N)$ statistic works better when the time dimension T increases, while $Z_{\tau}(N)$ works generally better under various model characteristics and assumptions (Westerlund and Edgerton, 2008).

the explanatory variables are used as instruments to control for endogeneity³³; and lastly, an Autoregressive Distributive Lag model (ARDL) is estimated as a check of robustness of the aforementioned results (Pesaran et al., 1999).

[Insert Table 5]

The long-run estimates are presented in Table 5. The results are similar across the three estimation techniques, reflecting that the issue of cross-section dependence does not appear to have a highly significant effect on the final results. In particular, the coefficient of income inequality is positive and significant at every level of significance, an outcome which is consistent with the existing literature (Kumhof et al., 2012; Belletini and Delbono, 2013; Perugini et al., 2015; Kumhof et al., 2015; Kirschenmann et al., 2016; Yamarik et al., 2016; Bazillier and Hericourt, 2017). This implies that as capital returns, expressed as operating surplus, deviate from labour compensation over the years, the non-financial private sector becomes more vulnerable to debt exposure, thus leading to financial fragility. Many of the aforementioned studies employ the credit-to-GDP ratio as the indicator of financial instability; however, this measure does not capture the dynamics of debt over years and hence, the debt-to-operating surplus ratio is a more accurate proxy of systemic fragility.

[Insert Figures 1, 2]

As highlighted by the studies of Kumhof et al. (2015) and Goda et al. (2017), income inequality is reflected by the difference between the earnings of capital and labour; the higher the deviation between these measures, the higher income inequality will tend to be³⁴. The results presented by the estimation techniques enhance the robustness of the argument that income inequality significantly affects private sector indebtedness when particular control

³³ This particular estimator accounts for large N and small T panel datasets to deal efficiently with dynamic panel bias.

³⁴ Even if changes in the gross operating surplus-to-labour compensation ratio are not as volatile as the 1% and 5% top shares of income, the outcome still points to a positive effect on financial instability (see Piketty and Saez, 2014).

variables are accounted for. Thereby, they contradict the findings of Bordo and Meissner (2012)³⁵.

Moreover, the credit-to-GDP ratio, which serves as a cash flow proxy, also provides the expected positive outcome, suggesting that debt accumulation across non-financial corporations is mainly driven by credit expansion (Eichengreen and Mitchener, 2003; Reinhart and Rogoff, 2009). According to Schularik and Taylor (2012), systemic financial instability is caused by excess credit, especially in developed countries. The dynamics of credit growth appear to result in financial crises through booms and busts where global effects are more intensive compared to national effects. For this reason, credit trends serve as accurate predictors of a potential financial crisis which are stronger compared to external shocks. This outcome verifies the argument of Rajan (2010) as access to excess credit by the US households and non-financial corporations caused systemic instability. Consequently, accelerating credit growth across the OECD economies seems to follow the same pattern, thus increasing the private sector's debt accumulation.

Perugini et al. (2015) also identified a significant relationship between credit supply and gross capital formation, mentioning that capital investment is strictly connected to loans through credit provision and ultimately, it tends to increase debt overall. For this reason, debt accumulation through credit acquisition tends to destabilise the financial system as long as Ponzi scheme related behaviour is observed, signalling the transition from boom to bust. This process will increase the probability of a financial crisis as excess liabilities of households and firms may not be fully repaid (Büyükkarabacak and Valev, 2010). The findings of the

³⁵ Nevertheless, one of the limitations of the analysis lies in the availability of additional indicators of income inequality. As there are incomplete datasets for the 1%, 5% top shares of income and Gini coefficients, we cannot accurately reflect their effects on private sector indebtedness. The only attempt was to formulate a complementary indicator *inq_2* expressed as the ratio of gross capital formation over labour compensation but the results were very similar with the *inq* ratio (see Appendix).

present study support the crucial role of credit supply to debt accumulation and thereby, to financial fragility.

[Insert Figure 3]

Moreover, the role of household leverage on the mechanism of instability appears to have a positive and significant effect, verifying the study of Mian and Sufi (2010) who argued that household leverage is a powerful predictor of future financial crises³⁶. In particular, the results presented in Table 5 suggest that the indebtedness level of households and corporations co-move in the long-run, thus increasing the probability of systemic destabilisation. This outcome is also consistent with the study of Martin and Philippon (2014) who argued that household leverage is a very significant factor of both boom and bust systemic dynamics³⁷.

For this reason, Rajan's (2010) argument is validated for the constituent countries of the sample, as credit expansion, mostly driven by government policies, results in increased debt accumulation for households and corporations. As the leverage indicators capture the ratios of debt over revenue, it can be argued that their dynamics suggest an unequal increase of debt compared to operating surplus and disposable income. Consequently, such behaviour tends to destabilise the financial system resulting in imminent busts (Minsky, 1986; Milanovic, 2009; Fitoussi and Saraceno, 2010, 2011).

The following element of equation (7) corresponds to the institutional factors that shape the conditions in the financial system and thus, across the whole economy. The two factors considered in this study refer to the indicators of financial deregulation and the

³⁶ In particular, they showed that the household leverage level of 2006 in the US had a very strong statistical effect on market factors such as housing prices, new housing building permits, unemployment, default rates, and auto sales.

³⁷ The main elements of this model refer to the role of leverages, foreign demand, fiscal and monetary policy. They conclude that sovereign leverage is significant in the case of Greece, while fiscal policy is the main key of macroeconomic dynamics.

aggregate price index of shares in the national stock markets. The former measure was chosen according to the studies of Stankov (2012) and Perugini et al. (2015) in order to capture the degree of regulation in the financial system. The results validate the findings of the aforementioned studies as a positive relationship is identified between market liberalisation and increasing financial instability. As access to credit and private sector debt accumulation become less regulated by the regulatory authorities, systemic fragility intensifies, thus increasing the probability of a financial crisis. This outcome also bolsters the findings of Mendoza and Terrones (2008) and Gosh (2010) as the role and quality of financial institutions can lead investment decisions closer to the market efficiency hypothesis and prevent the materialisation of a potential bust (Claessens and Perotti, 2007).

On the other hand, the share price index serves as a signal of deviation between the price of stocks and the market value of an asset. According to Kindelberger (1978), the euphoria behaviour of investors leads to overvaluation of shares which eventually results in panics, as long as individuals realise that prices have reached their zenith. Subsequently, investors will start liquefying their assets in order to minimise their losses and ultimately, manias will cause the financial system to crash. This behaviour is validated by the significant and positive value obtained in Table 5. As the financial system becomes less regulated, debt accumulation of the private sector tends to increase by signalling systemic destabilisation. Therefore, speculative activities may be captured by fluctuations in the value of shares able to create unstable bubbles which will cause an unexpected crash affecting the whole system (Schularik and Taylor, 2012). Lastly, the growth rate of real GDP, serving as a proxy of business cycles, was found to have an insignificant effect on financial instability, thus suggesting that debt accumulation does not follow a cyclical pattern³⁸.

³⁸ The model was also re-estimated by excluding the period of the global financial crisis (2007-2010). The results remained consistently similar as the signs were the same with the ones presented in Table 5. There were

Overall, the long-run estimates for the 33 countries of this sample provide supporting evidence to the aforementioned studies regarding a strong and positive relationship running from income inequality to the proxy of financial fragility. Three particular estimators have been included in order to take into account problems such as cross-section dependence and endogeneity. All estimators point to the same direction of a significant and positive relationship with the exception of the estimate of business cycles. This shows that the constituent indicators are crucial control variables for the investigation of the effect of income inequality on financial instability.

Moreover, the variables of current account balance, primary balance and interest rate were include in equation (7) to control for foreign demand, fiscal policy and monetary factors (Martin and Philippon, 2014). However, the results were insignificant and also, the significance of the remaining variables was affected. For this reason, those effects were substituted by the institutional factors of financial deregulation and share prices. Therefore, the next and final step would be to obtain the short-run estimates reflecting causation running from one measure to another and conclude, whether the long-run effects also persist in the short-run.

[Insert Table 6]

The short-run results are reported in Table 6 obtained by the heterogeneous panel non-Granger causality test developed by Dumitrescu and Hurlin (2012). This test takes into account stationary series using the fixed coefficients of the constituent variables under a panel VAR framework. The null hypothesis suggests the absence of causality in any cross-section of the panel set obtained by the Wald statistic. In particular, the Wald statistic is calculated for each cross-section and subsequently, the average value of those statistics is

also small variations in the significance level with the exception of the price of shares, which became insignificant. Thereby, the main outcome remains the same reflecting that this particular period did not have any crucial influence on the final results.

formulated³⁹. The main advantage of this test which renders it preferable to Granger's causality test (Granger, 1969), corresponds to the assumption that coefficients are heterogeneous across the constituent units.

The presence of causation between the explanatory variables of equation (7) appears to validate the long-run results, thus reflecting a similar behaviour in the short-run as well. In particular, the debt-to-operating surplus ratio is caused by every parameter except the growth rate of real GDP. This outcome once again validates the a-cyclical pattern of debt across the constituent countries, which is consistent with the findings of Perugini et al. (2015); however, it does not comply with Minsky's hypothesis of debt pro-cyclicality (Minsky, 1982, 1986). On the other hand, the credit-to-GDP ratio, which serves as a cash flow proxy, is not caused by the leverage ratio of the private sector, the growth rate of real GDP and the price of shares. This shows that the private sector creates debt through credit expansion, but the price of stocks does not influence the level of excess credit in the market.

Moreover, the indicator of income inequality is caused by every variable in the model. This provides evidence of a bilateral causality form between financial fragility and income inequality, thus capturing the interdependence of those measures in the short-run. Consequently, the leverage ratios of both households and corporations, along with the institutional factors significantly shape the gap between capital and labour earnings in the economies as a result of intensive financialisation (Tridico, 2015).

The growth rate of real GDP appears to be the weakest predictor in the model, as it causes only the proxies of income inequality and financial deregulation. However, almost every variable exerts a significant effect on the growth rate, thus providing evidence that real GDP growth depends on the decisions of the private sector and households influencing their

³⁹ Dumitrescu and Hurlin (2012) argue that the average value converges to normal distribution under the null hypothesis when N and T tend to infinity.

net debt accumulation. The leverage ratio of households and NPISHs is also caused by credit expansion and the leverage ratio of the private sector. This shows that the dynamics of debt accumulation are interlinked and hence, the borrowing decisions of households follow a similar pattern with the ones of the private sector (Goda et al., 2017).

Finally, the price of shares in national stock markets is caused by every variable, excluding the growth rate, reflecting that investment decisions are significantly driven by debt accumulation, the level of income inequality and the degree of access to financial activities. However, the proxy for financial deregulation is not caused by the leverage ratios and income inequality but rather, by the level of credit expansion. This outcome may reflect the fact that policy makers do not take into account the actual debt level in the economy but instead, they observe supply side factors, such as credit provision in order to set their policies⁴⁰. This means that as credit expands, the price of shares will also increase as individuals invest in the stock market. Subsequently, financial regulation loosens in order to provide additional access to financial markets, as happened in the years prior to the crisis of 2007-08 (Reinhart and Rogoff, 2009). Therefore, investment decisions significantly affect the level of financial instability as they change structural and institutional elements across many economies.

5. Concluding remarks

The present study investigates the effect of income inequality on financial fragility for 33 countries when particular control variables are accounted for. These variables reflect indicators of cash flow, leverage, business cycles and financial innovation as presented in the Minskian framework (Minsky, 1982, 1986). The results suggest the presence of a positive and significant influence of income inequality on the non-financial private sector net

⁴⁰ In particular, Claessens and Perotti (2011) argue that financial liberalisation sometimes results in systemic destabilisation which also increases income inequality.

indebtedness across the constituent countries over 1995-2015. These findings complement many studies across the literature based on the hypothesis of Rajan (2010) that increasing income inequality results in financial instability through excess credit, thus increasing debt accumulation (Büyükkarabacak and Valev, 2010; Atkinson and Morelli, 2010, 2011; Kumhof et al., 2012; Kumhof et al., 2015; Perugini et al., 2015; Yamarik et al.; 2016; Kirschenmann et al., 2016).

In particular, the debt-to-operating surplus ratio is found to be driven by credit expansion, complementing the argument that excess credit increases the probability of a financial crisis (Kumhof et al., 2015). Moreover, the leverage ratio of households and NPISHs exerts a positive relationship on the corresponding ratio of the private sector. This means that both series co-move over time as access to credit is utilised by both sides and so provides evidence that financial instability significantly depends on the degree of debt accumulation.

The institutional factors of financial deregulation and the price of shares in national stock markets also have the expected signs. Both of them have a positive contribution to financial destabilisation as market deregulation allows individuals to undertake risks that do not always comply with the efficient market hypothesis (Fama, 1998). Consequently, such behaviour is partially reflected by the stock market, where the share prices always reach a peak before the emergence of a financial meltdown (Reinhart and Rogoff, 2009). Finally, the financial fragility indicator is found to be a-cyclical as the growth rate of real GDP does not have a significant effect on the debt-to-operating surplus ratio.

According to those results, the present study can complement the literature of financial instability in various ways. Initially, the methodology utilises various estimation techniques that take into account problems such as cross-section dependence and endogeneity.

The results point in the same direction under both cases and thus, the aforementioned issues do not appear to distort the final estimates. Secondly, the dataset consists of 33 countries over 1995-2015 which provides an extended view of the Minskian theoretical framework (Minsky, 1982, 1986) across the OECD group. Moreover, the formulation of the constituent variables is expressed in levels, thus bolstering the explanatory power of the final estimates. Finally, the inclusion of leverage ratios for the non-financial private sector and households allows the study to focus on the dynamics of debt accumulation serving as a very crucial determinant of financial instability. To this end, the relationship between income inequality and financial fragility is accurately reflected when indicators of cash flow, leverage, business cycles and institutional innovation are controlled for.

Nevertheless, there are limitations that could have improved or extended the accuracy of the final estimates. The most important limitation of the model lies in the time period range which consists of 21 annual observations. Compared to the aforementioned studies, the time range is quite limited and thus, it does not take into account the period prior to 1995. That period includes major financial incidents, such as the oil shock of the 1970s, and the euphoria years prior to the dot-com bubble of 1997-2001 as well as the Asian financial crisis of 1997. Had these years been taken into account, the results might have been different and could have improved the significance of the business cycles indicator.

Moreover, the formulation of the income inequality proxy depends on the returns of capital over the returns of labour. It is an indicator that captures the dynamic relationship between these measures and thus an increase of this ratio reflects the increase of income inequality. However, several studies across the literature employ indicators such as the Gini coefficient, the Theil coefficients or the top shares (1% and 5%) of the income distribution. This means that the present analysis would be more related to those studies had those indicators been included in the model; however, as there were many omissions for the

constituent countries, the best alternative was to employ the operating surplus-to-labour returns proxy in order to capture the gap between the earnings of entrepreneurs and employees.

Overall, the findings of the study support the strong relationship between income inequality and financial fragility across the OECD economies over 1995-2015. For this reason, this paper supports the proposition that if policy makers wish to make the financial system more robust to endogenous shocks, they have to impose regulatory reforms and especially, they have to bolster the institutional foundations of the economy. To this end, households and corporations will be protected from excess debt accumulation and consequently, income redistribution policies will reduce the probability of a future financial crisis.

Appendix

[Insert Tables A1, A2]

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