Testing for the Effects of Credit Crunch on Agriculture Investment in the EU.

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Abstract

There are several research papers focusing on the detrimental effects of credit crunch on the economic performance. A sector of the economy where the implications of the credit crunch have not been thoroughly studied is the agriculture. This is surprising given the importance of agriculture for the European economy. We focus on agriculture in fourteen European Union (EU) Member States in the aftermath of the credit crunch. To this end, we employ the micro-econometric data set of Farm Accountancy Data Network (FADN) of EU at NUTS 2 level. From a methodological point of view, we model agriculture investment based on a flexible panel Vector Autoregressive (VAR) model that provides impulse response functions (IRFs) and variance decompositions (VDCs). The empirical estimates indicate that agriculture investment has been constrained by negative shocks in interest paid and total liabilities. Unless those financial constraints are eased, agriculture investment in EU would remain rather sluggish at best.

Keywords: Credit Crunch, EU Agriculture Investment, Endogeneity, panel VAR.

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1. Introduction

There has been a strong interest from an economic policy and an academic point of view alike to investigate the impact of the credit crunch on the EU economy (Antoshin et al. 2017; Bernhard and Ebner, 2017; Petrick and Kloss, 2013; European Commission, 2012). A sector of the real economy that has been rather neglected, despite its importance, is the agriculture sector. Alas, it is clear that agriculture has been also affected by the credit crunch. It does come, therefore, as a surprise that just a few studies (Petrick and Kloss, 2013; Petrick and Kloss, 2012 and Pietola, et al. 2011) examine the impact of credit crunch on agriculture.

This paper offers to bridge the gap in the literature by examining the underlying causal relationships between the agriculture investment and financial conditions for fourteen EU Member States, including Member States in the periphery of the Euro area that have received financial assistance to overcome the financial crisis. This study comes in a timely manner as ten years after the financial crisis the economic recovery in EU is still rather anaemic. Antoshin et al. (2017) report that the EU recovery is sluggish at best, mainly due to the observed double dip recession in many of the EU Member States in the last decade. The authors argue that bank lending and credit constraints are responsible for the observed slow EU recovery. Along these lines, Petrick and Kloss (2013) show that agriculture productivity in the EU has been severely undermined by the financial crisis. Petrick and Kloss (2013) emphasise the detrimental role that the chronic underinvestment in agriculture in the EU has for the low potential output and productivity of the sector. Herein, following Petrick and Kloss (2013) we extend on Benjamin and Phimister (2002) so as to study the underlying dynamic interactions between financial constraints and agriculture investment in the aftermath of the credit crunch in 2009.

The importance of agriculture for the EU economy is unequivocal. One needs to look no further than the EU's Common Agricultural Policy (CAP) , that covers 37% of the EU budget in 2017, to understand the significance of agriculture for the EU economy. The share of CAP is the biggest within the EU budget, suggesting that the agriculture sector has a significant weight for the EU economy. This is justified as the EU agriculture and the food related industries and services together provide 44 million jobs in the EU contributing to 10.5% of employment and 8.5% of total value added in 2017. Also, the agriculture sector has a very strong export performance. The EU agriculture and food net exports grow by 5.1% in 2017 with a generating surplus of €21.5 billion. And, EU agriculture is crucially contributing towards the developing of rural regions (European Commission, 2012). Given the significance of the EU agriculture we shall examine its investment. It might be the case that the EU agriculture investment is the missing link when it comes to the EU recovery, also in light of the resources that this sector is allocated within the EU budget.

The purpose of this paper is, thus, fourfold: (i) to model agriculture investment in EU so as to examine the impact of shocks in interest paid and total liabilities; (ii) to treat for endogeneity within a flexible panel Vector Autoregressive (VAR) model in which all variables are endogenous; (iii) to consider fourteen EU Member States, including some large Member States such as Germany, France and the UK, but also the EU periphery where financial assistance due to the financial crisis has been provided; and lastly to derive some policy implications.

Results show that agriculture investment has been subject to much variability over time and across countries in the EU. Negative shocks in interest paid and total liabilities have severely undermined the economic activity of the sector. Our results would imply that traditional EU agriculture policies of subsidies might not be as effective as some policy makers might consider given that the sector has been facing strong financial constraints. Instead, providing low interest paid loans to agriculture would boost investment so as to address some chronic disinvestment.

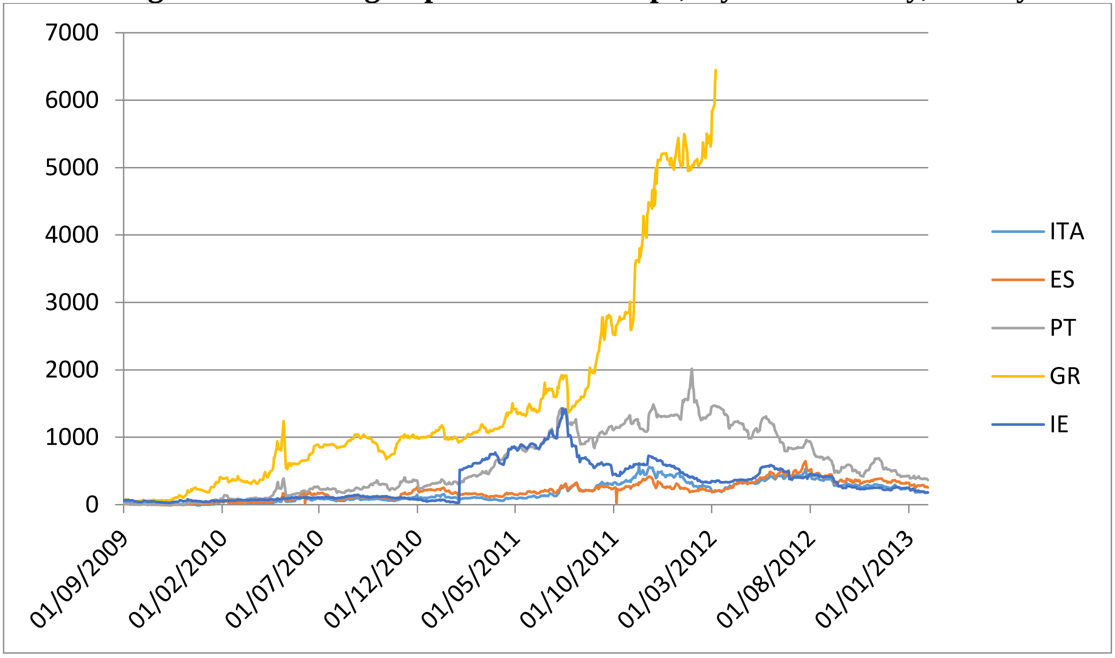
The remainder of the paper is organised as follows; section 2 presents stylised facts of the credit crunch in the EU and the conceptual framework, while section 3 reports the methodology. Section 4 discusses the data set and the estimation procedure, whereas section 5 reports the main empirical findings. Lastly, section 6 includes concluding remarks and economic policy implications derived from the empirical findings.

2. Stylised facts of the credit crunch in the EU and the conceptual framework

The impact of financial crisis in 2008 on the EU's economy has been previously documented (Bernhard and Ebner, 2017; European Commission, 2010 and 2012). It seems that the EU's response to the financial crisis had been rather sluggish at first as the EU was caught unguarded against the severity of the financial meltdown. The EU lacked the tools to deal with the severity of the crisis. It took some time before EU offered some financial assistance to Member States that had been hit harder by the crisis, notably Ireland, Spain, Portugal, Cyprus, Greece and Italy but also to Netherlands and Belgium. And this financial assistance was also a joined initiative with the IMF.

In some detail, the financial crisis in the EU took the form of a major banking crisis in 2009 whereby big banks had to be bailed out by governments in countries such as the Netherlands, Belgium, the UK and Ireland. The banking crisis with severe consequences spread across the EU periphery, such as Portugal, Spain, Greece, Cyprus and Italy, in the years that follow. The bail out of banks led to major sovereign debt crisis in the EU. Note, though, the case of Greece is different as the sovereign debt crisis triggered the banking crisis. Evidence of the hard times in the EU economy could be traced in sovereign bonds spreads in the EU periphery. Diagram 1 provides sovereign spreads over swaps for 5 years maturity on weekly frequency during the crisis period 2009 to 2013.

Diagram 1: Sovereign Spreads over Swaps, 5 years maturity, weekly.



Source: Bloomberg. ITA notes Italy, ES is Spain, PT Portugal, GR Greece, and IE Ireland.

Early in 2009 the yields of sovereign bonds across EU Member States in the periphery appeared to be rather stable. Alas, as the financial crisis hit the EU, the EU periphery borrowing costs hiked. The Greek sovereign bonds spread over five years maturity reached 215 basis points above the swap rate at the end of December 2009. The equivalent spread for Ireland was about 45 basis points and 28 basis points for Portugal. In spring 2010, Greece exited the financial markets and spreads rose to record high levels (see the pick in Diagram 1). As a result, in May 2010, when Greece applied for financial assistance to the EU and the IMF, the spread of a 5-year Greek sovereign bond rose higher than 1100 basis points. Financial assistance was also eventually offered to Ireland, Portugal, Spain, Italy and Cyprus in the coming years.

The EU formed the European Financial Stability Facility (EFSF) in June 2010 so as to provide financial assistance to Greece, Italy, Spain, Ireland and Portugal. During the early days of the EFSF, financial assistance was based on conditionality in close collaboration with IMF. The EFSF progressed to what is now the European Stability Mechanism (ESM), a new EU financial institution that provides financial assistance.

In parallel, but somewhat with lags, the European Central Bank (ECB) also responded to the crisis with monetary policy interventions. The monetary policy in EU was relaxed, both in terms of conventional measures, such as lowing interest rates, but also in terms of unconventional measures, such asset purchasing programmes from the sovereign. Despite the response of EU to financial crisis has been documented (Bernhard and Ebner, 2017), there is little discussion on the impact of the crisis to the EU agriculture investment.

The main focus of this paper is to provide the missing evidence. Our focus is on whether interest paid by the agriculture sector would have had an impact upon agriculture investment. For example, one would expect that a loose monetary policy would lead to lower agriculture interest payments as the central interest rate falls. Alas, countries in the periphery of the EU, such as Ireland, Portugal, Spain, Italy, Portugal and Greece, have experienced higher interest payments as a result of a joined banking and sovereign debt crisis that led to credit crunch. It is worth noting that, for example, in the case of the Greek economy both the public and the private sector did not have access to market-based finance from 2010 to 2015. The Greek economy had to rely on financial assistance from the EU and IMF that was mostly directed towards serving current sovereign debt payments. As a result, Greek agriculture firms did face major financial constraints and high interest payments. In addition, the Greek economy was hit by capital controls in autumn 2015 that have been only recently withdrawn. At the same period, a negative spiral in the EU economy is observe whereby the major slow-down of economic activity led to recession and numerous firm bankruptcies. In turn, non performing bank loans rose and contributed further to financial and banking instability and thereafter to fiscal imbalances as governments funds were used to recapitalise ailing banks (Michaelis and Watzka, 2017). As a response to fiscal imbalances severe fiscal consolidation took place in the EU so as to control increasing sovereign debts. This draconian fiscal consolidation, in a vicious cycle, have further contributed to reducing economic activity in the EU, and in particular in the periphery where austerity has been more severe. However, note that there is some heterogeneity across Member States in the EU as some countries, like Germany and France, show somewhat positive growth rates. However, such growth performance is far from being characterised as a strong one. On factual observation the EU economy has not recovered from the financial crisis, more than ten years since the crisis. The EU agriculture is also not recovered from the financial crisis.

There a few studies that look at the impact of financial crisis on agriculture (Clapp 2012; Fuchs et al. 2013; Fairbairn 2014; Isakson 2014). These studies show that agriculture output and productivity have been severely hit by the crisis. Herein, we investigate two channels: (i) the first channel looks at whether the credit crunch may have directly reduced agricultural investment through a negative shock from interest paid hikes[1]; (ii) while the second channel focuses on whether the credit crunch could have raised total liabilities in agriculture as lower economic activity and recession led

[1] Countries in the periphery of the EU faced either no access to market-based finance (see Greece) or severe financial constraints. Thus, they had to rely on financial assistance from EU. However, despite the EU's financial assistance and the the loose monetary policy of the ECB it seems that interest payments in agriculture hiked in the aftermath of the crisis.

to agriculture firms insolvency. In addition, we shall investigate whether agriculture output and also employment did interact with agriculture investment.

3. The agriculture investment function: a flexible panel VAR model

To this end, following Benjamin and Phimister (2002), who comment on the detrimental impact of financial constraints on agriculture investment (see also Petrick, 2005; Petrick and Kloss 2013; Hubbard 1998), we opt for a flexible agriculture investment which is a function of interest payments and the degree of indebtedness of agriculture holdings, as measured by total liabilities in agriculture.[2] Thus, a flexible agriculture investment function is opted:

$I_{i,j,t} = A(R_{i,j,t}, TL_{i,j,t}, TA_{i,j,t}, L_{i,j,t}, Y_{i,j,t},) \Rightarrow$

$I_{i,j,t} = \mu_i + v_t + \beta_1 R_{i,j,t} + \beta_2 TL_{i,j,t} + \beta_3 TA_{i,j,t} + \beta_4 L_{i,j,t} + \beta_5 Y_{i,j,t} + e_{i,j,t}$, (1)

where $\forall$ i =1,…, N, t=1,…,T, $j=1,\ldots,Z$; μ_i is a vector of μ individual country fixed effects while v_t individual time specific effects and $e_{i,t}$ is a multivariate white-noise vector of residuals. $I_{i,j,t}$ *is* net investment, interest paid is $R_{i,j,t}$, total liabilities is $TL_{i,j,t}$ (including short term, medium term and long term liabilities), total assets is $TA_{i,j,t}$, $L_{i,j,t}$ is employment in agriculture holdings, and total agriculture output is $Y_{i,j,t}$. i notes countries. As we employ firm level data, $j=1,\ldots,Z$ that would counts for agriculture firm j (thereafter to simplify the notation we drop j); and t for time.

We opt for the panel VAR that treats all variables as endogenous within a system of equations, while allows for unobserved individual heterogeneity. A first order panel VAR model is as follows:

$w_{it} = \mu_i + \Phi w_{it-1} + e_{i,t}$, i =1,…, N, t=1,…,T. (2)

[2] Hubbard (1998) emphasises the importance of capital markets for reaching the optimal level of investment while Petrick and Kloss (2013) argue that imperfections in capital markets may have had an aggravated negative impact on agriculture investment in the EU in the aftermath of the financial crisis.

where w_{it} is a vector of (for simplicity of the exposition we report a 2x2 VAR) two random variables, Φ is an 2x2 matrix of coefficients, μ_i is a vector of μ individual country fixed effects and $e_{i,t}$ is a multivariate white-noise vector of residuals. As with standard VAR models, all variables depend on the past of all variables in the system, the main difference being the presence of the individual country specific terms μ_i (in the empirical estimation we also consider time fixed effects).[3]

In detail, we model agriculture investment (I_{it} thereafter) and interest paid (R_{it}) in two-equations VAR with the following structure:

$$\begin{aligned} I_{it} &= \mu_{1i0} + \mu_{10t} + \sum_{j=1}^{J} a_{11} I_{it-j} + \sum_{j=1}^{J} a_{12} R_{it-j} + e_{1i,t} \\ R_{it} &= \mu_{2i0} + \mu_{20t} + \sum_{j=1}^{J} a_{21} I_{it-j} + \sum_{j=1}^{J} a_{22} R_{it-j} + e_{2i,t} \end{aligned} \qquad (3)$$

Here, I_{it} and R_{it} capture the agriculture investment and interest paid respectively, and μ_{i0} and μ_{0t} are the country and time fixed effects respectively.[4]

This panel VAR specification would reveal whether shocks to the interest paid would have an effect on agriculture investment, whereas agriculture investment would be also allowed to have an effect on interest paid with a lag.[5] To this end, investment may be the most endogenous variable in the panel VAR (see Benjamin and Phimister 2002),

[3]The ordering of variables that enter the VAR is selected so as that an exogenous variable would impact first on an endogenous variable. This implies a recursive orthogonal structure in the shocks $e_{i,t}$. In what follows as the interest paid, that is net of any interest subsidies, by agriculture holdings is outside their control it is treated as more exogenous compared to agriculture investment. The reverse causation would be also tested. It is worth noting that the ordering of variables is not of importance if the estimated covariances between the errors across equations are low, as it is the case herein.

[4] Sims argue that the importance lies with the error terms of (2) as one could employ them to estimate IRF and VDC. To this end, we solve herein the estimated system of equations (2) to get its underlying moving average (MA) representation. Note, that this approach depends crucially on the assumption that the underlying data generating process of our variables is stationary. Preliminary results show that our variables are stationary. This is true given that the time series dimension of our series is rather limited. Nevertheless, unit roots tests were carried out for all data, providing evidence of strong stationarity (results are available under request). Further information on VAR specification is available under request.

[5] Petrick and Kloss (2013) discuss in some detail why the interest paid by agriculture in the EU is primarily based on the developments that are commonly taken as exogenous to the individual farmer.

thus capturing all available information, i.e. all the contemporaneous shocks to the interest paid.[6] Note that from the panel VAR we derive Impulse Response Functions (IRFs thereafter) and Variance Decompositions (VDCs). The estimation method is GMM and we employ lagged regressors as instruments.

4. Data on agriculture investment in EU-14

We opt for micro-econometric data set as reported in the public Farm Accountancy Data Network (FADN) of EU at NUTS 2 level. The FADN provides on an annual base accountancy data from a sample of the agricultural holdings of the Member States of the EU. This is the first time that a panel VAR model is applied to EU agriculture investment that takes fully into account the microeconomic data set of FADN, so as to be able to identify the underlying short-run dynamics.

Our data comprises of fourteen EU Member States (EU-14 thereafter), namely Austria, Belgium, Denmark, France, Finland, Germany, Greece, Netherlands, Ireland, Italy, Portugal, Spain, Sweden, and the UK over the period 2004 to 2015. The data set comes from the public Farm Accountancy Data Network (FADN) of the EU and include the following variables (mostly financial): net investment, interest paid, total assets, total liabilities (including short term, medium-term and long-term liabilities) and total assets.[7] Total assets include assets in ownership. Total liabilities include value at closing valuation of total of (long- term, medium-term or short-term) loans still to be

[6] Note that in order to test whether a specific ordering drives our results we also apply the reverse ordering. The investment is considered as the most exogenous variable.

[7] It is worth noting that the FADN survey on an annual base assembles a data set of accountancy data from around 60.000 agricultural holdings from the Member States of the EU. The FADN collects the data from national surveys of the Member States and then harmonises the data set across countries. To this end, the accounting bookkeeping principles do not differ across countries. Note that the FADN does not cover all agriculture firms in the EU but based in sampling plans as set as each region of EU it selects agriculture firms that their size allows that to rank as commercial firms. This is essential for having a harmonised micro-econometric data set across the Member States of the EU. From this survey that FADN publishes a data set at country level that is fully harmonised per country. To this end, the data set herein is at country level.

repaid. We also include employment measured as by total number of hours of labour input and also agriculture output.

Interest paid is interest and financial charges paid on loans obtained for the purchase of land, buildings, machinery and equipment, livestock, circulating capital, and interest and financial charges on debts. Note that interest subsidies are deducted. On the interest paid as it is farm and sector specific, it is worth noting that it captures credit constraints faced by agriculture firms at micro-econometric farm level (Erdeneba et al. 2019; Laborda and Olmo 2019). Previous empirical studies of FADN sample (Petrick and Kloss, 2013; Petrick and Kloss, 2012 and Pietola, et al. 2011) employ interest rate as the variable that captures the price of capital at farm level and thereby the credit conditions at micro level. In addition, Bernhard and Ebner, (2017) and Michaelis and Watzka, (2017) emphasise the role of interest and interest paid for investment in the aftermath of financial crisis, arguing that despite the low interest rates of quantitative easing loan interest payments were not falling. Jansson, et al. (2013) discuss the constraints faced by the EU agriculture in the aftermath of the financial crisis and argue that interest paid is a detrimental factor for investment activity in the sector.[8]

Table 1 provides descriptive statistics of the variables used in this study for the overall sample over the period 2004-2015 that includes 168 balanced panel observations.

Table 1: Descriptive Statistics of the Main Variable.

Variable	Obs	Mean	Std. Dev.	Min	Max
INV	210	7608.69	12889.83	-10373	67915
INT	210	7012.352	13372.58	0	92243
TL	210	221008.4	346702.1	12	1510409
TA	210	808277.4	677643.5	78299	2726002

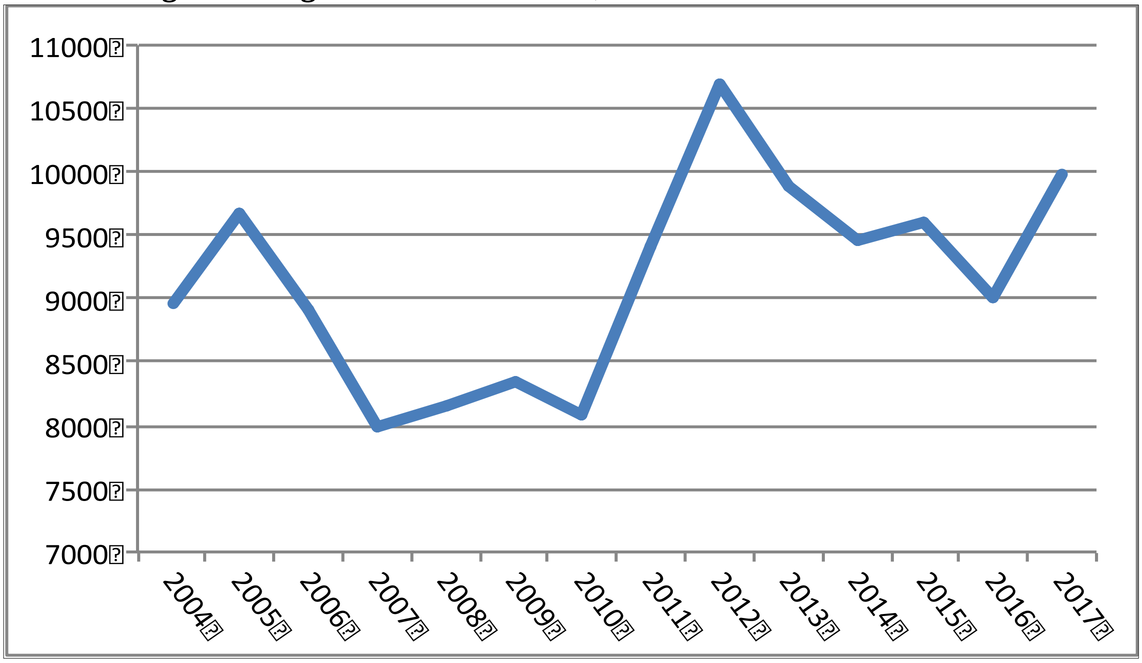
[8] It is worth noting that spreads based on interest rates can be also employed as variables reflecting credit conditions. For example, GZ index could be of use. However, such spreads are based on corporate bond credit spreads, and are mainly referring to US corporate economy. In the case of EU agriculture there are no available data for credit spreads.

L	210	3626.917	1011.096	2343.11	6087.45
Y	210	155616.7	122792.7	20045	523548

Note: net investment is INV, interest paid is INTt, total liabilities is TL (including short term, medium term and long term liabilities), total assets is TA, L is employment in agriculture holdings, and total agriculture output is Y. All variables are in EUR, but employment which shows time worked in hours by total labour input in agriculture holdings.
Source: Farm Accountancy Data Network (FADN) at NUTS 2 level, EU Commission.

Regarding agriculture net investment, Diagram 2 demonstrates that there is quite some variation over time. Clearly, around the period of financial crisis in 2008, 2009 and 2010 agriculture investment was at a low trajectory, following the negative trend in 2006 and 2007. It appears that agriculture investment recovered from 2011 to 2012, but this recovery was short-lived as the financial crisis eventually caught up with the EU. In 2013, 2014, 2015 and 2016 net investment dipped again. This double dip in agriculture investment is also observed at the level of aggregate EU output, and it has raised concerns over the ability of the EU economy to recover (Antoshin, et al 2017). In fact, Antoshin et al. (2017) argues that the recovery has been weaker in Europe due to the double-dip recession. The authors suggest that credit constraints could be held, also, responsible for the sluggish EU recovery.

Diagram 2: Agriculture investment, measured as net investment.



Note: Agriculture Net Investment is in EUR and it is gross investment minus depreciation. The sample includes fourteen Member States of the EU: namely Austria, Belgium, Denmark, France, Finland, Germany, Greece, Netherlands, Ireland, Italy, Portugal, Spain, Sweden, and the UK.
Source: Farm Accountancy Data Network (FADN) at NUTS 2 level, EU Commission.

In an earlier research, Jansson, et al. (2013) and Antoshin, et al (2017) highlight the detrimental role of and low bank lending for low investment in the EU. Note, that there is some variability across EU with the periphery being most severely affected by the credit crunch where as some large Member States, (i.e. France and Germany) exhibited moderate positive performance in investment. The panel VAR would adequately address the observed heterogeneity across countries of the EU by setting country specific fixed effects terms. As part of sensitivity analysis we also identify sub-sables where there is enhanced homogeneity across countries.

5. Results: panel VAR estimations

Prior to the estimation of the panel VAR we have to decide the optimal lag order *j* of the right-hand variables in the system of equations in (2). To do so, we opt for the Arellano-Bover GMM estimator for the lags of j=1,…,3. Thus, we estimate the reduced form panel VAR for different lag orders. The Sargan tests show that for lag order one, we cannot reject the null hypothesis. The Arellano-Bond AR tests show that the maximum lag order is one. [9] All variables in the panel VAR estimations would be in logs to facilitate the interpretation across various IRFs and VDCs. As the parameter estimates from the panel-VAR are relative of limited importance, in the rest of the paper we would provide IRFs and VDCs.

5.1. IRFs and VDCs for agriculture investment.

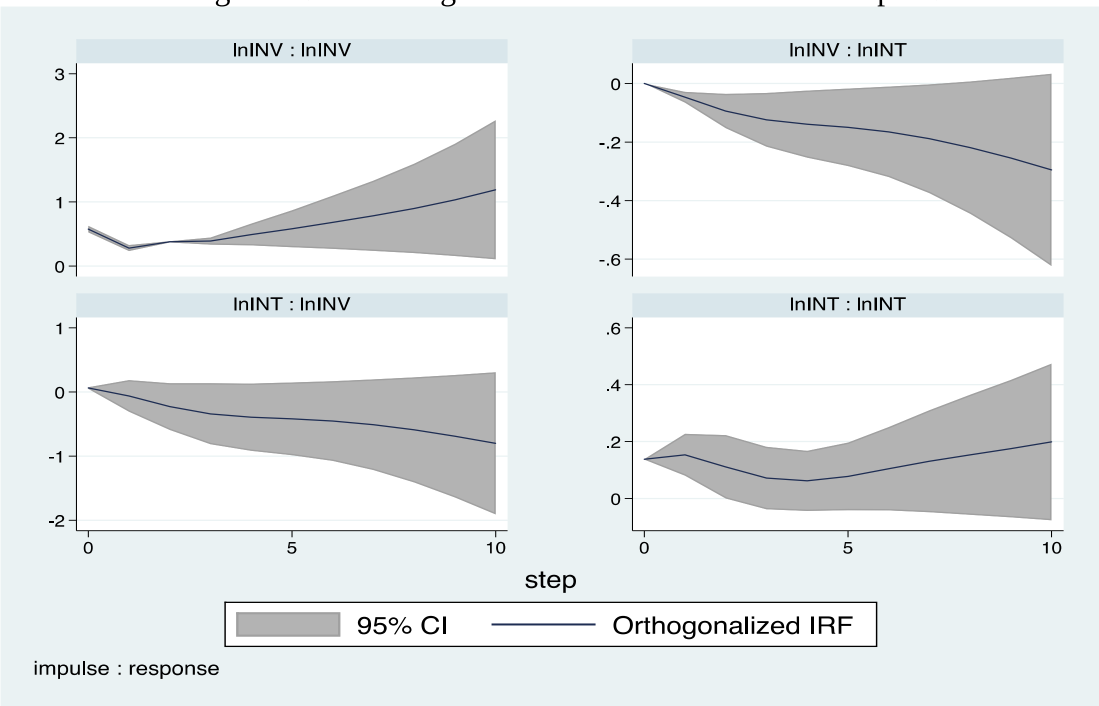
Diagram 3 presents the IRFs results for the case of a 2x2 panel-VAR, that is for the vector of variables: agriculture investment and interest paid. The latter variable captures the cost associated with the credit crunch. In addition, note that to analyse the impulse-response functions we need an estimate of their confidence intervals. Since the matrix of impulse-response functions is constructed from the estimated panel VAR coefficients, their standard errors need to be taken into account. Herein, we estimate standard errors of the impulse response functions and generate confidence intervals using 200 Monte Carlo replications.

From the first row, see sub-diagram titled ‘lnINV: lnINT’, the effect of one standard deviation shock in interest paid on agriculture net investment is negative and not small in magnitude, close to -0.2 after two periods. The peak negative response of agriculture investment to a shock in the interest paid takes place after five periods. This negative response implies that a unit negative shock in interest paid innovation causes a 0.2 reduction in agriculture investment. Although, this response further aggravates in magnitude thereafter the widening bounds of standard errors at 5% as generated by

[9] A common method for estimating the optimal lag length for a VAR is the Akaike information criterion. In addition, the usual diagnostic checks need to be made, to ensure the VAR is well specified. If there is evidence of autocorrelation, more lags need to be added until the autocorrelation has been removed.

Monte Carlo 200 replications would imply that this response must be interpreted with caution.

Diagram 3: IRFs of agriculture investment and interest paid.



Note: lnINV is agriculture investment, whilst lnINT is the interest paid. Shading area up and down the principal line represent 95% confidence interval (CI) as generated by 200 Monte Carlo replications. Thus, widening bounds of confidence interval would imply that the corresponding response is not significant. All variables are in logs. Horizontal axis indicates periods ahead. For simplicity we present 0 to 10 periods, steps, ahead.

On the other hand, the response of the interest paid to agriculture investment's innovation is very close to zero for the first period or so, then becomes negative but is rather insignificant as standard errors cross the zero line. Effectively this outcome suggests that there exists a causal relationship from the interest paid to agriculture investment, but not the other way around.

We also present variance decompositions (VDCs), which show the percentage of the forecast error variance in agriculture investment that is explained by the shock in the interest paid. The variance decompositions show the magnitude of the total effect. We report the total effect accumulated over the 10 and 20, but longer time horizons produced equivalent results. Table 3 presents the VDC estimations that come in agreement with the ones reported by the IRF, and provide further evidence of the importance of the interest paid in explaining the variation of agriculture investment. Specifically, 32% (39%) of agriculture investment's forecast error variance after ten (twenty) years is explained by interest paid shocks. On the other hand, a small part, around 15%, of the variation of interest paid is explained by the agriculture investment.

Table 3: VDCs for agriculture investment and interest paid.

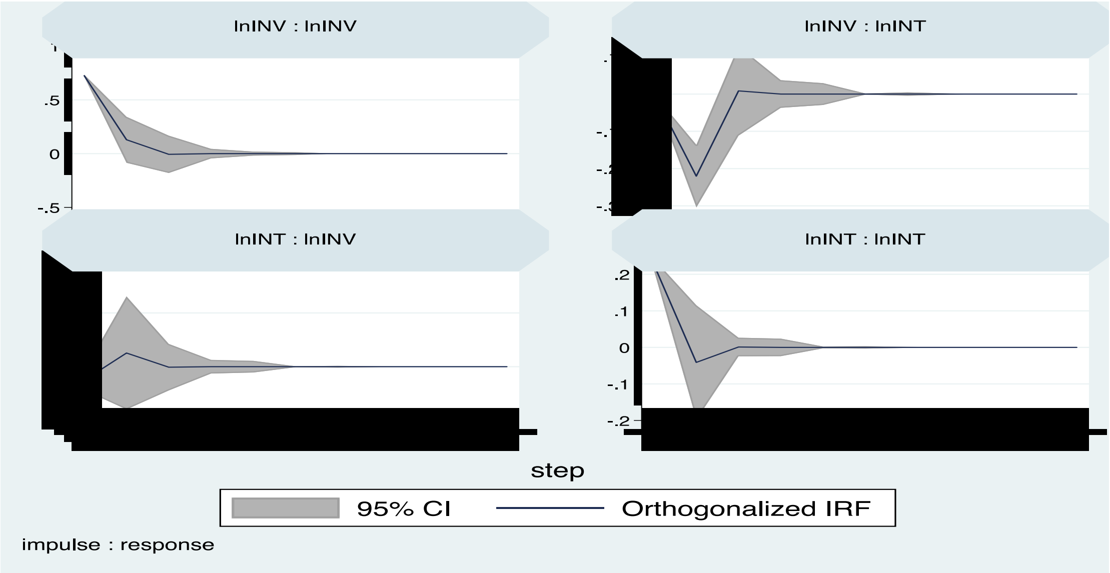
	s	lnINV	lnINT
lnINV	10	.6704512	.3295488
lnINT	10	.3505879	.6494121
lnINV	20	.6068356	.3931644
lnINT	20	.5233502	.4766498

Note: lnINV is agriculture investment, whilst lnINT is the interest paid. All variables are in logs. We present 0 to 20 periods, steps, ahead.

The financial crisis reduced investment in agriculture due to lower levels of supply of bank loans as banks were more reluctant to lend out money (see Petrick and Kloss, 2013). The results above show that higher interest rates for agriculture bank loans have had a detrimental effect on agricultural investment, negatively contributing to the recovery of the EU economy. Given the present results, we demonstrate that a key to boost agriculture investment is to improve financial conditions for agriculture by lowering interest payments.

As part of sensitivity analysis we proceed with estimating panel VAR in the aftermath of the financial crisis, that is for the period from 2010 to 2017. Diagram 4 provides the IRFs where it becomes apparent that the response of agriculture to interest paid is negative in the first two periods and thereafter converges to zero.

Diagram 4: IRFs of agriculture investment and interest paid for the period 2010 to 2017.



Note: lnINV is agriculture investment, whilst lnINT is the interest paid. Shading area up and down the principal line represent 95% confidence interval (CI) as generated by 200 Monte Carlo replications. Thus, widening bounds of confidence interval would imply that the corresponding response is not significant. All variables are in logs. Horizontal axis indicates periods ahead. For simplicity we present 0 to 10 periods, steps, ahead.

Table 4 presents the VDC estimations for the period of the aftermath of the financial crisis, confirming earlier findings in Table 3. In some detail, 25% (29%) of agriculture investment's forecast error variance after ten (twenty) years is explained by interest paid shocks.

Table 4: VDCs for agriculture investment and interest paid.

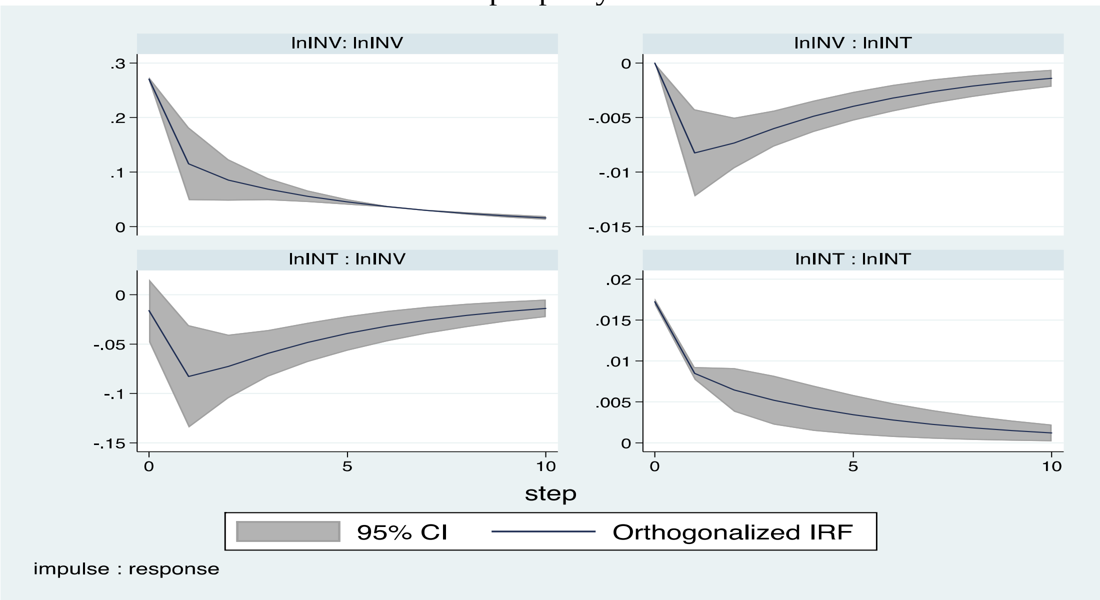
	s	lnINV	lnINT
lnINV	10	.741325	.258675
lnINT	10	.416539	.583461
lnINV	20	.7023608	.2976392
lnINT	20	.6152624	.3847376

Note: lnINV is agriculture investment, whilst lnINT is the interest paid. All variables are in logs. We present 0 to 20 periods, steps, ahead.

5.2.1 IRFs and VDCs for the Euro area periphery: Greece, Portugal, Spain, Italy and Ireland.

To control for heterogeneity across EU countries we shall now focus on the Euro-area periphery, in particular considering countries that received financial assistance from the EU. Diagram 5 presents the IRFs for the Euro area periphery, that is: Greece, Ireland, Portugal, Spain and Italy. The interest paid asserts a negative and significant impact on agriculture investment of around 0.1 after two periods. After the first three periods the response of agriculture investment to interest paid in the EU periphery remains negative and the standard errors bound show significance but it converges to zero beyond the fourth period.

Diagram 5: IRFs of agriculture investment and interest paid in the Euro area periphery.



Note: lnINV is agriculture investment, whilst lnInterest is the interest paid. Shading area up and down the principal line represent 95% confidence interval (CI) as generated by 200 Monte Carlo replications. Thus, widening bounds of confidence interval would imply that the corresponding response is not significant. All variables are in logs. Horizontal axis indicates periods ahead. For simplicity we present 0 to 10 periods, steps, ahead.

Interestingly, compared with the results of the whole sample, some evidence of reverse causality is observed, from agriculture investment shocks to interest paid, in the first period. This reverse causality would imply that a type of negative spiral is in operation in the periphery, whereby the negative impact from a shock in interest paid on agriculture investment is reinforced by the effect of agriculture investment to interest paid.

We also present VDCs estimations. These results come in agreement with the ones reported by the IRFs, and provide further evidence favouring the importance of interest paid in explaining the variation of agriculture investment. Specifically, Table 5 shows that 15% to 17% of agriculture investment forecast error variance after ten to twenty years is explained by shocks in interest paid in the periphery. On the other hand, 28% (31%) of the interest paid is explained by agriculture investment after ten (twenty) years, insinuating that in the case of the periphery there might be two causality channels in operation.

Table 5: VDCs for agriculture investment in the Euro area periphery

	s	lnINV	lnINT
lnINV	10	.8478212	.1521788
lnINT	10	.2849857	.7150143
lnINV	20	.8281391	.171861
lnINT	20	.3135144	.6864856

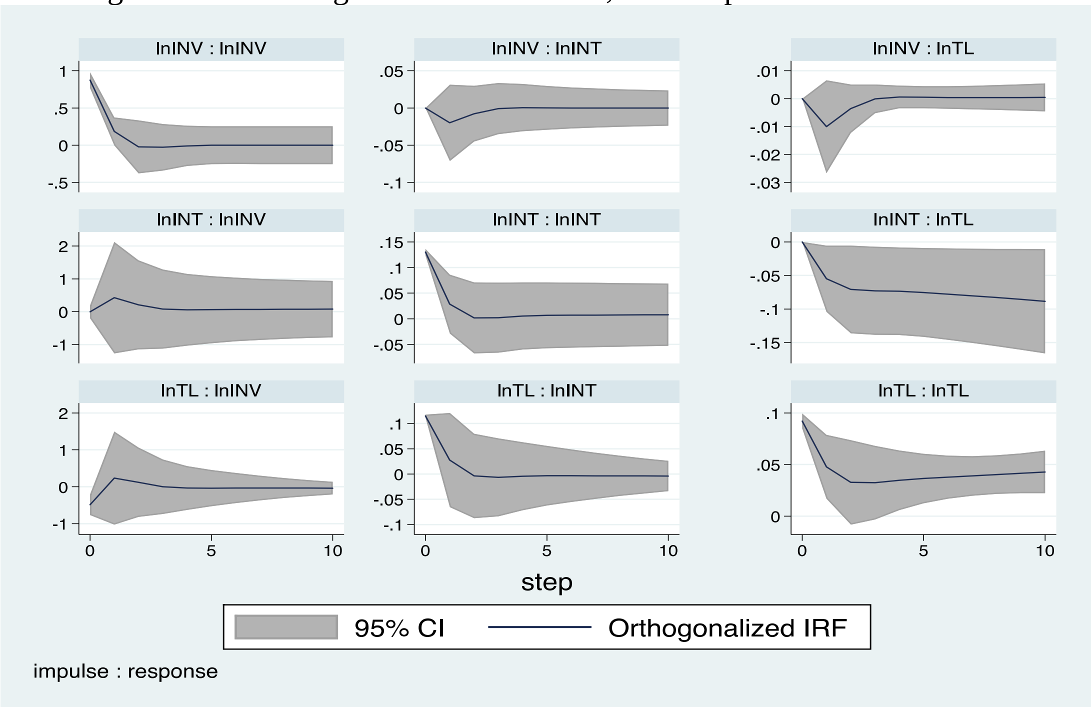
Note: lnINV is agriculture investment, whilst lnINT is the interest paid by agriculture holdings. All variables are in logs. We present 0 to 20 periods, steps, ahead.

5.2.2 IRFs and VDCs agriculture investment, interest paid and total liabilities

As the credit crunch is associated with higher levels of debt (Petrick and Kloss, 2013; Petrick and Kloss, 2012 and Pietola, et al. 2011), next we report IRF's derived from an unrestricted 3x3 panel-VAR with total liabilities that measure total debt in agriculture. Similarly, to previous evidence, the effect of one standard deviation shock of interest paid on agriculture investment is negative and significant for the first two periods before converging to zero thereafter (see Diagram 6). Shocks in total liabilities in agriculture have also a negative impact in agriculture investment, though the magnitude is less than the one of interest paid and the significance is not high as standard errors increase after the first period. On the other hand, the response of interest paid to investment's innovation is estimated equal to zero for the whole period. Note that the response of total liabilities to a shock in agriculture investment is negative and high in magnitude, but it rather dies out quickly within one period. The response of total liabilities to interest paid is positive but converges to zero within a period. Effectively the reported

IRFs confesses that there exists a main causal relationship from interest paid and total liabilities to agriculture investment. Some reverse causality might be present as total liabilities respond to shocks in agriculture investment but for a very short period of time.

Diagram 6: IRFs of agriculture investment, interest paid and total liabilities.



Note: lnINV is agriculture investment, lnINT is the interest paid, and lnTL is total liabilities. Shading area up and down the principal line represent 95% confidence interval (CI) as generated by 200 Monte Carlo replications. Thus, widening bounds of confidence interval would imply that the corresponding response is not significant. All variables are in logs. Horizontal axis indicates periods ahead. For simplicity we present 0 to 10 periods, steps, ahead.

Table 6 presents the VDC estimations. The reported results come in agreement with the ones reported by the IRF, and provide further evidence favouring the importance of interest paid, but also total liabilities, in explaining the variation of agriculture investm-ent. More specifically, 23% (22%) of agriculture investment's forecast error variance after ten (twenty) years is explained by shocks in interest paid. 17% (18%) of agriculture investment's forecast error variance after ten (twenty) years is explained by shocks in total liabilities. These results highlight the importance of total liabilities, that is the indebtedness of agriculture holdings, for agriculture investment. Agriculture holding would put on hold further investment projects as their underlying total liabilities rise.

Table 6: VDCs for agriculture investment, interest paid and total liabilities.

	S	lnINV	lnINT	lnTL
lnINV	10	.5974906	.2301899	.1723195
lnINT	10	.0141091	.5496379	.4362531
lnTL	10	.0034396	.4282035	.5683568
lnINV	20	.5825804	.2298527	.1875668
lnINT	20	.4337538	.5522772	.0139691
lnTL	20	.0015675	.2977267	.7007058

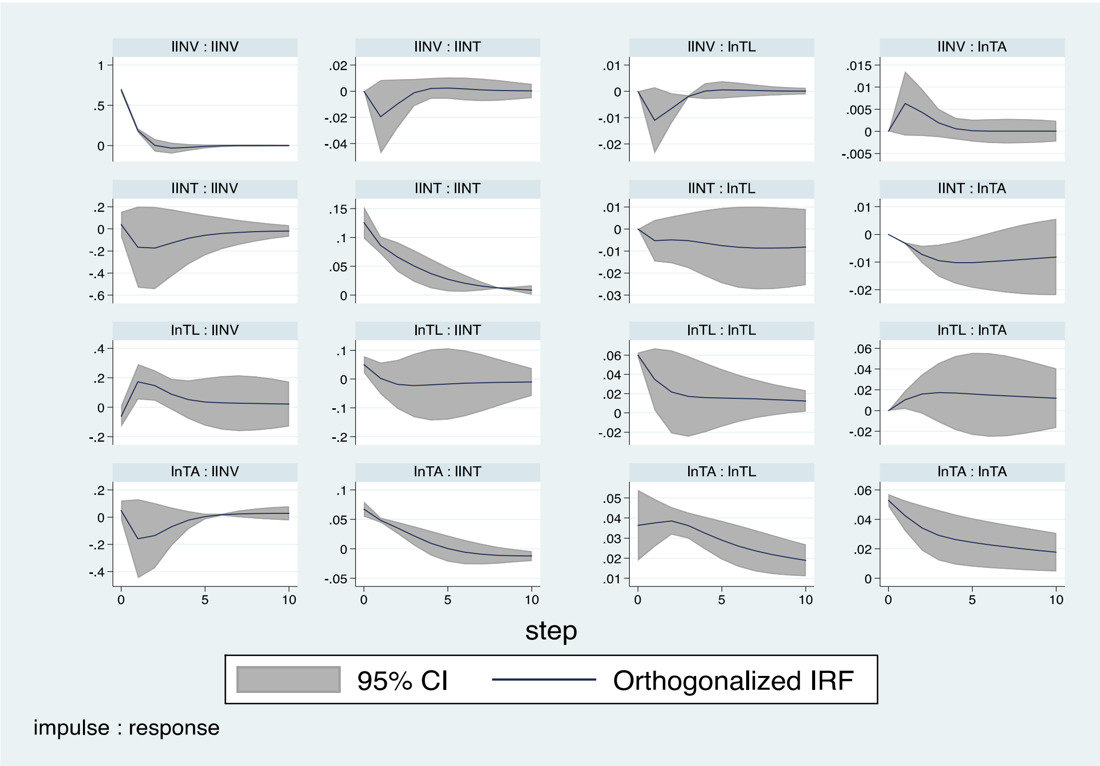
Note: lnINV is agriculture investment, lnINT is the interest paid, and lnTL is total liabilities. All variables are in logs. We present 0 to 20 periods, steps, ahead.

On the other hand, 0.14% of the variation of interest paid is explained by agriculture investment and 43% by total liabilities after ten periods. This last evidence show that a reverse causality, total liabilities to interest paid, might also be at place. This potentially would imply that there might be in operation spirals that could further destabilise agriculture investment. These results show that traditional EU agriculture policies aiming to subside agriculture output would not be as effective to combat the effects of the financial crisis as it would be, for example, to ease credit constraints faced by the sector.

5.3. IRFs and VDCs for agriculture investment, interest paid, total liabilities, and total assets.

The role of total assets in agriculture has been well acknowledged (Petrick and Kloss, 2013; Petrick and Kloss, 2012; Mamatzakis, 2003). To take into account this point, we extend our panel VAR formulation to 4x4 where the agriculture total assets is introduced as an endogenous variable. Interestingly, the IRFs bellow (see Diagram 7) show that the impact of one standard deviation shock of total assets in agriculture on investment is positive and significant over the first two periods and thereafter it hovers around the zero line. This result shows that supporting the asset accumulation process in agriculture would positively affect investment through easing financial constraints. On the other hand, the response of investment to innovations in total liabilities is negative and significant for the first period. These results suggest that boosting agriculture assets could also boost investment, whereas total liabilities curb investment. Some reverse causality channels are detected as it appears that shocks in agriculture investment would increase total liabilities in the first two period before converging thereafter. A similar response stands between total assets and total liabilities. Although, predominantly, IRFs show that the causality runs from total assets and total liabilities to agriculture investment.

Diagram 7: IRFs of agriculture investment, interest paid, total liabilities, and total assets.



Note: lnINV is agriculture investment, lnINT is the interest paid, lnTL is total liabilities, and lnTA is total assets in agriculture. Shading area up and down the principal line represent 95% confidence interval (CI) as generated by 200 Monte Carlo replications. Thus, widening bounds of confidence interval would imply that the corresponding response is not significant. All variables are in logs. Horizontal axis indicates periods ahead. For simplicity we present 0 to 10 periods, steps, ahead.

Table 7 presents the VDCs estimations. These results provide evidence favouring the importance of total assets in explaining the variation of investment compared to total liabilities. Total assets explain some 0.72% of agriculture investment's forecast error variance after ten, rising to 0.74% after twenty years, whereas total liabilities explain 0.92% (0.96%) of agriculture investment in ten (twenty) years. On the other hand, not a substantial part of the variation of total assets is explained by agriculture investment close to 0.07% compared to 0.29% of total liabilities and to 11% of interest paid. Thus, the VDCs show that total liabilities and interest paid are of importance for the forecast error variance of total assets. These results show further that shocks in interest paid and total liabilities would persist over time.

Table 7: VDCs for of agriculture investment, total liabilities, and total assets.

		lnINV	lnINT	lnTL	lnTA
lnINV	10	0.7192449	0.1159711	0.0921946	0.0725894
lnINT	10	0.7081016	0.0848183	0.1962642	0.0108159
lnTL	10	0.0095391	0.4589646	0.5183643	0.013132
lnTA	10	0.0072736	0.1107854	0.0299787	0.8519623
lnINV	20	0.7058133	0.1235974	0.0960936	0.0744956
lnINT	20	0.1918146	0.6990117	0.098813	0.0103607
lnTL	20	0.0275288	0.4030413	0.5596071	0.0098226
lnTA	20	0.0050476	0.159119	0.0568733	0.7789602

Note: lnINV is agriculture investment, lnINT is interest paid, lnTL is total liabilities, and lnTA is total assets in agriculture. All variables are in logs. We present 0 to 20 periods, steps, ahead.

As part of sensitivity analysis, we also estimate a general panel VAR that includes agriculture investment, interest paid, employment, output, total liabilities, and total assets as endogenous variables within a 6x6 system of equations similar. The reported VDCs (available under request) confirm our findings above as they show that around 23% (33%) of the forecasts error variance of the EU-14 agriculture investment is due to interest paid in ten (twenty) years. Total liabilities also show to explain some significant (around 14%) forecast error variation of agriculture investment in ten years.

6. Conclusions

Our results show that shocks in interest paid and total liabilities are associated with lower agriculture investment, whereas total assets boost investment. The reverse causal relationship is not excluded, but the evidence is weaker. Alas, for the Euro area periphery where financial assistance has been provided to deal with the crisis, the reverse causality is more apparent, insinuating the existence of a negative spiral between financial conditions and agriculture investment. This paper shows that providing low interest paid credit to agriculture may be key to recovery as it would provide the necessary boost to enhance economic activity.

Therefore, as a policy implication, and in light with the reform of CAP (EU Commission 2010 and 2012), one would propose to raise investment in agriculture by providing low interest loans. The European Economic Recovery Plan (EERP) of the EU is in line with such policy and it is designed to provide a stimulus package so as to mitigate the consequences of the global financial crisis in the EU. Another way to boost agriculture investment is through the credit channel of the on-going quantitative easing of the ECB, whereby unconventional monetary policy is aiming to support the growth prospect of the Euro area. Although the present results raise some scepticism about the effectiveness of the unconventional monetary policy as shocks in interest paid is negatively affecting agriculture investment. Nevertheless, EU policies ought to focus on financial conditions of the sector and this might imply departure from traditional ways of providing assistance to EU agriculture. The integration of EU financial market could be the key. Enhancing financial integration within the EU would lower interest paid across all countries, and in particular in the Euro area periphery, and thereby assist the credit expansion in agriculture.

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