ECONSTOR
Make Your Publications Visible.

A Service of
ZBW
Leibniz-Informationszentrum Wirtschaft
Leibniz Information Centre for Economics

Seven, Unal; Tumen, Semih

Working Paper

Agricultural Credits and Agricultural Productivity: Cross-Country Evidence

IZA Discussion Papers, No. 12930

Provided in Cooperation with:
IZA – Institute of Labor Economics

Suggested Citation: Seven, Unal; Tumen, Semih (2020) : Agricultural Credits and Agricultural Productivity: Cross-Country Evidence, IZA Discussion Papers, No. 12930, Institute of Labor Economics (IZA), Bonn

This Version is available at:
https://hdl.handle.net/10419/215326

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

WWW.ECONSTOR.EU

Mitglied der Leibniz-Gemeinschaft

I Z A Institute
of Labor Economics
Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 12930

Agricultural Credits and Agricultural Productivity: Cross-Country Evidence

Unal Seven
Semih Tumen

JANUARY 2020

I Z A Institute
of Labor Economics

Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 12930

Agricultural Credits and Agricultural Productivity: Cross-Country Evidence

Unal Seven
Central Bank of the Republic of Turkey

Semih Tumen
TED University, IZA and ERF

JANUARY 2020

Any opinions expressed in this paper are those of the author(s) and not those of IZA. Research published in this series may include views on policy, but IZA takes no institutional policy positions. The IZA research network is committed to the IZA Guiding Principles of Research Integrity.

The IZA Institute of Labor Economics is an independent economic research institute that conducts research in labor economics and offers evidence-based policy advice on labor market issues. Supported by the Deutsche Post Foundation, IZA runs the world's largest network of economists, whose research aims to provide answers to the global labor market challenges of our time. Our key objective is to build bridges between academic research, policymakers and society.

IZA Discussion Papers often represent preliminary work and are circulated to encourage discussion. Citation of such a paper should account for its provisional character. A revised version may be available directly from the author.

ISSN: 2365-9793

IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Agricultural Credits and Agricultural Productivity: Cross-Country Evidence*

We present cross-country evidence suggesting that agricultural credits have a positive impact on agricultural productivity. In particular, we find that doubling agricultural credits generates around 4-5 percent increase in agricultural productivity. We use two different agricultural production measures: (i) the agricultural component of GDP and (ii) agricultural labor productivity. Employing a combination of panel-data and instrumental- variable methods, we show that agricultural credits operate mostly on the agricultural component of GDP in developing countries and agricultural labor productivity in developed countries. This suggests that the nature of the relationship between agricultural finance and agricultural output changes along the development path. We conjecture that development of the agricultural finance system generates entry into the agricultural labor market, which pushes up the agricultural component of GDP and keeps down agricultural labor productivity in developing countries; while, in developed countries, it leads to labor-augmenting increase in agricultural production. We argue that replacement of the informal credit channel with formal and advanced agricultural credit markets along the development path is the main force driving the labor market response.

JEL Classification: J43, Q14, Q18, O47

Keywords: agricultural credits, productivity, labor markets, financial development

Corresponding author:
Semih Tumen
Department of Economics
TED University
Ziya Gokalp Caddesi No.48
06420 Kolej
Ankara
Turkey

E-mail: semih.tumen@tedu.edu.tr

* We thank Yiu Por Chen, Jacques Silber, Guanghua Wan, three anonymous referees, seminar participants at the Social Sciences University of Ankara, and the participants of the "Workshop on Poverty-Growth-Inequality Triangle in China and Other Countries" hosted by the Zhongnan University of Economics & Law in Wuhan for very useful comments and suggestions. The views expressed here are of our own and do not necessarily reflect those of the Central Bank of the Republic of Turkey. All errors are ours.

1 Introduction

Agricultural production is typically associated with a substantial time gap between cultivation—or, more generally, the period during which initial investments are made and inputs are purchased—and harvesting/marketing the output. Several layers of risk and uncertainty are also involved in the production process. Thus, access to credit markets potentially plays a crucial role in smoothing out these risks, achieving sustainable agricultural productivity growth, and supporting more efficient production decisions (Eswaran and Kotwal, 1986). Although there is a large literature investigating the impact of micro-credit on farm-level productivity, the results are mixed and do not provide a comprehensible picture for policy making.[1] The existence of informal agricultural credit channels in less developed and developing countries highlights the need for a broader assessment of the merits of a well-functioning formal agricultural credit market.[2] A more general perspective is needed for evaluating the nature of the link between agricultural credits and agricultural productivity as well as understanding the main underlying mechanisms.[3]

This paper has three main goals. *First*, we estimate the effect of agricultural credits on agricultural productivity using a rich country-level panel data set. We employ various methods and exploit data availability as much as possible to obtain a convincing and robust set of estimates. *Second*, we check whether or not there is any potential reverse causality—i.e., whether or not countries with higher agricultural productivity have more developed agricultural finance systems—that can contaminate our estimates. *Finally*, we try to understand the underlying mechanisms driving our results by focusing on alternative agricultural productivity measures and narrowing our attention to particular country groups. For the empirical analysis, we construct a panel of 104 countries observed over 24 years, and the main data sources are the Food and Agriculture Organization

[1] Papers including Carter (1989), Feder et al. (1990), Kochar (1997), Petrick (2004a), Briggeman et al. (2009), Reyes and Lensink (2011), Weber and Musshoff (2012), and Narayanan (2016) report only weakly positive or statistically insignificant association between micro-credit and farm-level productivity. See Carter and Wiebe (1990), Sial and Carter (1996), Zeller et al. (1998), Foltz (2004), Petrick (2004b), Blancard et al. (2006), Guirkinger and Boucher (2008), Boucher et al. (2009), Zinych and Odening (2009), Fletschner et al. (2010), Rui and Xi (2010), Ciaian et al. (2012), Dong et al. (2012), Weber and Musshoff (2013), and Ali et al. (2014) for results suggesting a strongly positive association between micro-credit availability and farm outcomes. See Browning and Lusardi (1996), Barry and Robison (2001), Petrick (2005), Conning and Udry (2007), and Karlan and Murdoch (2010) for comprehensive reviews of the related literature.

[2] See, e.g., Dasgupta (1989), Aleem (1990), Udry (1994), Townsend (1995), Banerjee and Duflo (2007), Banerjee and Duflo (2010), and Banerjee et al. (2015).

[3] The idea that transactions in the agricultural land, labor, and credit markets are interlinked goes back to early theoretical work in the contract theory literature. Some relevant examples include Bell and Srinivasan (1989), Bell et al. (1997), and Bell and Clemenz (2006).

(FAO) and the World Bank (WB). We perform several cross-sectional, fixed-effects panel, IV-2SLS, and GMM regressions to test and verify the sensitivity of our estimates to alternative specifications.

Our main findings can be listed as follows:

1. The basic cross-sectional OLS estimates are much larger than the fixed-effects panel, IV-2SLS, and GMM estimates, which are employed to control for the potential endogeneities. This means that countries with better agricultural credit systems tend to have more productive agricultural sectors due to unobserved reasons and this unobserved correlation generates an upward bias in the OLS estimates.

2. Based on the fixed-effects panel, IV-2SLS, and GMM regressions, which provide our benchmark results, doubling agricultural credits generates around 4-5 percent increase in agricultural productivity on aggregate. Although this is a relatively smaller magnitude than the ones reported in the agricultural micro-credit literature, the aggregate nature of the analysis highlights the economic significance of the estimates. This result suggests that agricultural credits still positively affect agricultural productivity in a meaningful way even after correcting for the upward bias.

3. Two distinct measures of agricultural production are used: the agricultural component of GDP and agricultural labor productivity (defined as agricultural productivity per agricultural worker). The estimates are slightly higher for the agricultural component of GDP (5 percent) than those for agricultural labor productivity (around 4 percent)—though the difference seems to be statistically and economically insignificant.

4. This seemingly homogenous aggregate estimates substantially changes, when we perform separate regressions for developing versus developed economies. In particular, the effect of agricultural credits on agricultural productivity operates mostly through the agricultural component of GDP in developing countries, while it operates through agricultural labor productivity in developed ones. This has interesting implications on the patterns of change in agricultural productivity along the development path—see the discussion below.

5. Using cross-country variation in annual rainfall as an instrument, we document that there is no reverse causality operating from agricultural productivity toward agricultural credits. The instrumentation relies on the assumption that the amount of rainfall affects agricultural credits only through its impact on agricultural productivity.[4] This finding suggests that, if there is any causal relationship between agricultural credits and agricultural productivity, it is from the former toward the latter.

Overall, these results suggest that the existence of a developed agricultural finance system positively affects aggregate agricultural productivity. Most importantly, the nature of this positive relationship is different across developed and developing countries. In the developing world, an increase in agricultural credits increases agricultural productivity through its impact on agricultural production and *not* on agricultural labor productivity. However, the opposite holds for the developed countries. The most plausible explanation is that development of the agricultural finance system initially generates entry into the agricultural labor market which pushes up the agricultural component of GDP and keeps down agricultural labor productivity, while in the developed countries it leads to labor-augmenting increase in agricultural production. It is well-known that informal agricultural credit and labor markets extensively exist in developing countries. We argue that replacement of the informal credit channel with formal agricultural credit markets along the development path is the main force driving the labor market response. Diffusion of advanced production technologies through credit-financed investments likely generates labor-augmenting increase in agricultural production at the later stages development. This is supported by the general observation that agricultural banking services are mostly in the form of designing customer-specific credits for the purpose of boosting productivity; while bulk credit extensions by state banks without paying particular attention to any micro-level productivity measure are mostly seen in the less developed world. The whole picture suggests a transition from a closed agrarian society toward an economy with a financially developed and industrialized agricultural sector.

Our findings can be related to several key ideas cultivated in the literature. Aghion and Bolton

[4] See Miguel et al. (2004), Barrios et al. (2010), and Dell et al. (2012) for some examples of the use of climate shocks as instrumental variables.

(1997) argue that accumulation of resources by the rich along the development path pushes down the interest rates and enables poor to ease out their financing needs, which relates to our idea of a switch from a closed agricultural society into a developed agricultural production system. Claessens and Feijen (2006, 2007) show that financial sector development has a significant impact on reducing hunger and this effect mostly operates through the productivity channel.[5] Honohan (2004b) and Claessens (2006) report that access to finance reduces aggregate poverty. Overall, the main consensus in the literature is that access to finance has a potential to reduce poverty and hunger significantly. Our paper conveys a similar message in the sense that we propose a mechanism explaining the link between financial development and productivity in the agricultural sector. The distinguishing feature of our paper is that we highlight the interaction between the credit and labor markets in explaining the effect of agricultural credits on agricultural productivity as well as the evolution of this effect along the development path.

Whether increased credit availability generates an expansion in agricultural labor in the less developed world or not has also been tested by experimental studies. When farmers are credit constrained, they smooth their consumption and finance farm investments by switching their labor effort "off the farm"—mostly toward the informal sector [Kochar (1995, 1999); Rose (2001); Ito and Kurosaki (2009)]. This implies that off-farm labor may be a source of labor market friction reducing efficiency in the labor market. Several studies have implemented field experiments relaxing those credit constraints with the ultimate goal of estimating the impact of credit expansion on agricultural labor supply. The main finding from those experiments is that increased credit availability reduces off-farm employment significantly, and lead farmers to optimally allocate/shift their labor effort to agricultural activities—both at the extensive and intensive margins of employment. Moreover, increased credit availability also support the seasonal employment volume my increasing migration-induced agricultural labor.[6] The level and the elasticity of wages also increase in the agricultural labor market and wage volatility declines as credit constraints are removed [Jayachandran (2006); Mobarak and Rosenzweig (2014)].

[5] For additional papers on the relevance of financial development channel, see Honohan (2004a) and Beck et al. (2005).

[6] See Fink et al. (2014) for a recent study describing this mechanism. Other relevant studies testing various aspects of this mechanism include Kerr (2005), Orr et al. (2009), and Cole and Hoon (2013).

The plan of the paper is as follows. Section 2 describes our data and provides preliminary visual evidence for the hypothesis we test. Section 3 explains the details of the empirical strategy and econometric models we use. Section 4 discusses/interprets the empirical results and presents robustness analysis. Section 5 concludes.

2 Data description

We combine country-level annual data gathered from two sources: FAO data set and WB World Development Indicators. The sample consists of 104 developed and developing countries covering 24 consecutive years—i.e., the period between 1991 and 2014. The choices of the country set and data period are mostly shaped by data availability concerns. In particular, we focus on the countries having at least four observations over time. We use the definition of FAO for income groups to construct our sub-samples.[7] FAO defines developed countries as all industrialized countries and countries in transition, while developing countries are defined as all countries other than developed countries.

Our econometric analysis is based on three main variables: (*i*) agricultural component of GDP (AC), (*ii*) agricultural labor productivity (APW), and (*iii*) agricultural credits (ACR).[8] The agriculture component of GDP is used in our analysis as a proxy for agricultural production. The data source for this variable is the WB World Development Indicators. The agricultural labor productivity variable is used as a measure of agricultural productivity and calculated as the ratio of the agricultural component of GDP to the total number of workers employed in agriculture. The data source is again the WB World Development Indicators. We should note that the agricultural component of GDP is expressed in constant 2010 USD; thus, the empirical analysis is performed

[7] *Developing countries:* Antigua and Barbuda, Argentina, Armenia, Azerbaijan, Bahrain, Bangladesh, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Burkina Faso,Burundi, Cabo Verde, Cambodia, Congo Dem. Rep., Costa Rica, Cote d'Ivoire, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Gabon, Georgia, Ghana, Grenada, Guatemala, Guinea-Bissau, Guyana, Honduras, India, Indonesia, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kyrgyz Republic, Lebanon, Liberia, Malaysia, Maldives, Mali, Mexico, Morocco, Mozambique, Namibia, Nepal, Nicaragua, Niger, Nigeria, Oman, Pakistan, Panama, Peru, Philippines, Russian Federation, Rwanda, Senegal, Serbia, Seychelles, Sri Lanka, St. Lucia, St. Vincent and the Grenadines, Sudan, Suriname, Tajikistan, Tanzania, Thailand, Timor-Leste, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, United Arab Emirates, Uruguay, Vanuatu, Vietnam, Zambia. *Developed countries:* Albania, Australia, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Cyprus, Czech Republic, Estonia, France, Germany, Greece, Hungary, Italy, Moldova, New Zealand, St. Kitts and Nevis, Ukraine, United States.

[8] In a robustness analysis, we use the "agriculture, forestry, and fishing value added (% of GDP)" as an alternative outcome variable. The data source for this variable is the WB World Development Indicators, Agriculture and Rural Development Statistics. See Section 4.3 for details.

in real terms. Our main explanatory variable is the total amount of credit given to agriculture, forestry, and fishing expressed in million USD. The data source for the agricultural credit variable is FAO.

It would be helpful to summarize the content of the data to better understand the structure of the FAO data on agricultural credits. FAO has constructed long series on credit to agriculture for both developed and developing countries. Credit to agriculture measures loans to agriculture producers provided by commercial banks, and it is built by compiling official country data published on-line by national central banks in their monetary and financial statistics publications—either through annual or quarterly reports. Moreover, total credit measures the credit to total economy. Three other explanatory variables are used in the regressions. The first is the total arable land, which is obtained from the World Development Indicators data set and is used to control for the availability of land resources to be used in agriculture. The World Development Indicators database explains arable land (in hectares) as "land defined by the FAO as land under temporary crops, temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow, excluding land abandoned as a result of shifting cultivation." This variable aims to control for the potential effects coming from: (1) the availability of land resources, (2) the change in the amount of arable land over time, and (3) the cross-country variation in the timing and magnitude of this change. The second variable is the lending interest rate, the source of which is also the WB World Development Indicators. Lending interest rate represents the bank rate that usually meets the short- and medium-term financing needs of the private sector. This variable is used to control for the potential effects due to country-year variation in pricing of credits. The third variable is rainfall. The data source is the Climate Change Knowledge Portal of the World Bank. The rainfall variable is originally provided at monthly frequency. We annualize this variable for the purpose of achieving consistency with our main variables of interest. The data set is produced by the Climatic Research Unit (CRU) of University of East Anglia, and reformatted by the International Water Management Institute (IWMI).

Tables (1) and (2) present the descriptive statistics and the correlation matrix for the variables used in our empirical analysis. There is considerable cross-country variation in most of our variables.

For example, agricultural credit ranges from a low of 0 to 115,889 million USD. The agriculture component of GDP and its per worker also exhibit significant variation in constant 2010 (million) USD terms, with AC ranging from 9,644,551 to 3.11E+11 and APW from 197 to 94,952. Figure (1) displays the visual evidence representing the raw correlations between our main explanatory variable (agricultural credits) and the two dependent variables (agricultural component of GDP and agricultural labor productivity). In general, the correlation between credits and productivity variables are high and the signs of the correlation coefficient are as expected. For the reverse causality analysis, we use country-level annual rainfall as the instrumental variable.

3 Empirical strategy

The goal is to develop an empirical strategy that would enable us to estimate the effect of agricultural credits on agricultural productivity given the country-level data set we have. Agricultural credits can be directly and uniquely measured, while several alternative measures of agricultural production/productivity can be used in the analysis. We prefer to focus on two different measures of agricultural production, which are also the measures most commonly used in the literature: agricultural component of GDP and agricultural labor productivity.[9] The basic regression model that we aim to estimate can be expressed as follows:

$$\ln[PA_{j,t}] = \beta_0 + \beta_1 \ln[CA_{j,t}] + \boldsymbol{\beta}_2' \boldsymbol{X}_{j,t} + f_j + f_t + \epsilon_{j,t}, \tag{1}$$

where j and t are country and time indices, $PA_{j,t}$ represents the agricultural productivity measure, $CA_{j,t}$ describes the aggregate agricultural credits, $\boldsymbol{X}_{j,t}$ is the vector of control variables, f_j and f_t denote country and time fixed effects, respectively, and $\epsilon_{j,t}$ is an error term. The control variables include the lending interest rates, the natural logarithm of arable land, and the natural logarithm of rainfall. The former aims to control for the potential effects of general financial conditions in the specific country and time; while the latter aims to control for the productivity effects potentially coming from the changes in availability of land resources. Our main parameter of interest is β_1, which approximately describes the change in agricultural productivity measure in percentage terms

[9] See Section 2 for detailed definitions of the variables used in the empirical analysis.

in response to one percent increase in agricultural credits.

There are two main identification issues that one needs to pay attention: endogeneity and reverse causality. *First*, it may be the case that the observed correlation between agricultural credits and agricultural productivity is contaminated by an effect coming from a factor, which is unobserved and, therefore, cannot be directly controlled for in regression analysis. For example, countries with more productive agricultural sectors may have stronger institutions facilitating agricultural production and those better institutions may also be generating stronger banking practices allowing for better allocation of credits to the producers in the agricultural sector. To resolve this potential problem, we follow a three-stage approach. The first stage performs cross sectional OLS regressions for the purpose of setting a benchmark model possibly plagued with all the potential biases. This will enable us to detect the magnitude and direction of the bias. At the second stage, we perform fixed-effects panel regression to control for any time-invariant unobserved heterogeneity that would bias the basic OLS results. Finally, we perform instrumental-variable methods—by performing both the IV-2SLS and GMM—to address the potential endogeneity issues that may or may not be captured by the fixed-effects panel data methods. Following the convention in the literature, we use the lagged values of the main independent variable as instruments [see, e.g. Claessens and Feijen (2006)]. A comparison of the OLS, fixed-effects panel, IV-2SLS, and GMM estimates will give us the magnitude of the bias that would potentially be associated with the OLS estimation of the Equation (1).

Second, it may also be case that the estimates of β_1 is contaminated by a potential reverse causality running from agricultural productivity toward agricultural credits. In other words, one may also think that agricultural credits are extended more aggressively in countries with more productive agricultural systems. To test the existence of reverse causality, we devise an instrumental variables (IV-2SLS) strategy in which a variable denoting annual variation in cross-country rainfall is used as the instrument. The main identification assumption is that rainfall affects agricultural credits only through its impact on agricultural yield—see Section 4.3 for the rest of the details on our reverse causality discussion.

To identify the main mechanisms at work, Equation (1) is separately estimated for developing versus developed countries. All the tests and robustness checks are repeated also for those two sub-regressions.

4 Results and discussion

4.1 Main results

Our main results are presented in Tables (3)-(6). We report the results from four different estimation methods and specifications in those four tables: OLS (columns 1-2), fixed-effects panel (columns 3-4), IV-2SLS (columns 5-6), and GMM (columns 7-8). Since the econometric identification relies mainly on cross-country differences, standard errors are clustered at the country level in all of the regressions. The fixed-effects panel, IV-2SLS, and GMM regressions include country and year fixed effects in all specifications. Natural logarithms of the agricultural component of GDP, agricultural labor productivity, agricultural credits, lending interest rate, arable land, and rainfall variables are used in the regressions. The time period is 1991-2014 and the total number of countries in the data set is 104.

Notice that the number of observations collapses into the number of countries in our sample for the basic OLS regressions. The main reason is that our OLS analysis uses variables averaged over the observation time horizon for all countries. The purpose is to get rid of the additional bias due to cyclical variation in the aggregate variables.[10] The fixed-effects panel, IV-2SLS, and GMM regressions utilize the whole cross-country and time-series variation inherent in our data.

We start discussing our estimates with Table (3), which presents the results of the regression of log agricultural component of GDP on log agricultural credits—along with the controls. The basic OLS regression without controls suggests implausibly high estimates—in the order of 44.6 percent. After adding the controls, the coefficient goes down to 15.1 percent, which is still high. The inflated coefficients along with high variation in estimates across specifications suggest that the OLS estimates may be highly biased due to unobserved reasons. The fixed-effects panel, IV-

[10] See Claessens and Feijen (2006) for a similar approach.

2SLS, and GMM estimates confirm the validity of this conjecture. Controlling for the potential endogeneities yields statistically significant estimates around 5 percent. In other words, doubling agricultural credits generates a 5 percent increase in agricultural production measured in terms of the agricultural component of GDP.

Table (4) refines the results presented in Table (3) by focusing on developed versus developing country sub-samples. Controls are used in all specifications. The OLS estimates suggest that a statistically meaningful positive correlation between the agricultural component and credits exists only for developing countries. A similar result also holds for the fixed-effects panel, IV-2SLS, and GMM regressions—except that a significant but smaller coefficient is reported for developed countries in the IV-2SLS estimation. The main consensus is that the positive effect of credits on productivity (measured in terms of the agricultural component of GDP) is strongly documented in developing countries, while it is hard to argue that such a relationship consistently holds in developed countries.

The dependent variable is agricultural labor productivity—measured as the ratio of agricultural component of GDP to the number of individuals employed in agriculture—in Table (5), but the analysis is very similar to the one executed in Table (3). Similar to Table (3), the basic OLS estimates yield quite high coefficients—in the range of 15.6 to 17.2 percent. The fixed-effects panel, IV-2SLS, and GMM estimates again suggest that the OLS estimates are upward biased. The fixed-effects panel estimates are in the range of 2.5-4.5 percent, while the IV-2SLS and GMM estimates lie in the interval 2.7-4.8 percent—all statistically significant. The simple average of the mid-points of these intervals suggest that a reliable estimate would be slightly less than 4 percent. In other words, doubling agricultural credits rises agricultural labor productivity by slightly less than 4 percent.

Table (6) refines the results reported in Table (5) again by focusing on developed versus developing countries. Although the OLS estimates are statistically significant only for developing countries, the picture is reversed once we control for potential endogeneities by implementing fixed-effects panel, IV-2SLS, and GMM regressions. Specifically, the fixed-effects panel, IV-2SLS, and GMM

regressions yield statistically significant and positive coefficients in the range of 7.6-9.3 percent for the developed country sub-sample, while statistically insignificant estimates are reported for the developing country sub-sample.

Overall, we detect certain patterns that would elucidate the general interpretation of our estimates. The OLS estimates are higher than the fixed-effects panel, IV-2SLS, and GMM estimates. This suggests that the OLS procedure yields upward-biased estimates, which can be interpreted as the evidence of an unobserved correlation between credits and productivity in the agricultural sector that causes endogeneity. The fixed-effects panel, IV-2SLS, and GMM estimates are consistently similar and statistically significant, which jointly mean that the endogeneity-corrected estimates are credible.

4.2 A test for reverse causality

One potential problem with our main estimating equation (1) is that the estimates for β_1 may be contaminated by the reverse causality issues. In particular, it may be the case that agricultural finance system may be much more developed in countries with more productive agricultural sectors; that is, the direction of causality may be running from productivity to credits, unlike the direction posed in Equation (1). Under such a scenario, the regression equation can be set as:

$$\ln[CA_{j,t}] = \theta_0 + \theta_1 \ln[PA_{j,t}] + \boldsymbol{\theta}_2' \boldsymbol{X}_{j,t} + f_j + f_t + \eta_{j,t}, \tag{2}$$

where the definitions of variables are identical to those presented in Section 3. In this alternative equation, the main parameter of interest is θ_1. This setting allows us to implement a slightly different identification method than we use in estimating Equation (1). The motivation again comes from an IV strategy. To have unbiased estimates of θ_1, we need an instrumental variable correlated with PA, but uncorrelated with η. In other words, we need to find an instrument affecting CA only through its impact on PA.

Cross-country annual rainfall variable satisfies the conditions for a suitable instrument and, therefore, can be used to estimate Equation (2). There are many studies in the development economics

literature using rainfall and also other climate shocks as instruments to identify the main causal mechanism at work. The main motivation is that sharp changes in climate conditions and abrupt shifts in the cross-country climate developments are mostly exogenous to economic fundamentals, and, therefore, can be used as viable instruments.[11] In our case, the main identifying assumption is that cross-country annual rainfall affects agricultural credits only through its impact on agricultural productivity. If rainfall directly affects agricultural credits, then IV validity will be questionable. In fact, rainfall may be endogenous to global warming, which may directly affect the outcome of interest, in some growth econometrics settings. Our dependent variable is different and it is plausible to assume that any impact of global warming would also operate through the productivity channel.[12]

Table (7) reports the results of the reverse-causality test. The first and second columns report the first- and second-stage results of the IV-2SLS procedure, respectively. The rainfall IV passes the first stage by suggesting that there is a strongly positive and statistically significant relationship between the agricultural productivity and rainfall. The results of the second stage of our regression yield a statistically insignificant coefficient estimate for θ_1; in other words, there is not a reverse-causal link operating from agricultural productivity toward agricultural credits.

4.3 Agricultural value added as an alternative outcome variable

As a robustness exercise, we use a measure of agricultural value added as an alternative outcome variable, which is also used in the literature as a proxy for agricultural productivity. Agricultural value added is typically defined as the net agricultural output—intermediate inputs subtracted from the output. The WB World Development Indicators data set includes an agricultural value added variable named as "agriculture, forestry, and fishing value added (% of GDP)."[13] It is

[11] See Sarsons (2015) for a cautionary note. The main critics of this approach argue that one should be careful in using this instrument for country-level studies relying on monthly data for two reasons: (*i*) rainfall may not represent a region-specific shock within a country, as the lack of rainfall in a certain region may affect the overall economic activity in a given country and (*ii*) seasonal patterns may wildly vary across years in a given country, so additional caution should be exercised in country-level studies relying on data in monthly frequency. For these two reasons, the rainfall variable is regarded to be a plausible IV for cross-country studies relying on data in annual frequency. This is what we use in our analysis.

[12] That said, similar to almost all instruments, it is always possible to argue against IV validity based on some scenarios. For example, global warming may shift economic activity from agricultural sector toward other sectors through its impact on societal forces other than agricultural productivity. Confirming and/or discrediting such scenarios are beyond the scope of this paper. We proceed by assuming that productivity is the main mechanism at work and the rainfall IV is plausibly exogenous.

[13] See https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?view=chart.

compiled from the World Bank and OECD national accounts data files. The values are provided as percentage of GDP. To maintain consistency with the baseline estimates, we multiply those values with the GDP figures and obtain the agricultural value added component of GDP. We also construct the "per worker" version of the value added component by dividing it into the total number of workers employed in agriculture. Both variables are used in natural logarithms form in the regressions.

The regressions mimic the empirical analysis performed in our baseline estimations. The sample and the explanatory variables are basically the same. Table (8) reports the estimates for both dependent variables—agricultural value added and agricultural value added per worker. Rows [1] and [2] report the results of the regressions in which we use log of agricultural value added and log of agricultural value added per worker as the dependent variable, respectively. The qualitative nature of the results are almost unchanged, while there are some quantitative differences from the baseline results reported in Tables (3)-(6). Specifically, the estimated coefficients are larger for both regressions, which is potentially due to the fact that the dependent variables are smaller in magnitude than the ones used in the baseline analyses and, therefore, they likely exhibit larger variation in logs over time. These results confirm that using the agricultural value added component of GDP—instead of directly using the agricultural component of GDP—does not significantly change the main picture.

4.4 The underlying mechanisms

In this sub-section, we provide a broad interpretation of our estimates by focusing on the possible underlying mechanisms. Our main result is that increasing the agricultural credits generates an increase in agricultural productivity. Specifically, doubling agricultural credits increases agricultural productivity by 4-5 percent. In this sense, our results are in agreement with the strand of the agricultural micro-finance literature documenting a positive relationship between micro credits and farm productivity. The agricultural micro-finance literature focuses almost exclusively on small-scale experimental studies or micro-level country case studies carried out with survey data. The cross-country nature of our analysis suggests that it is also possible to talk about an aggregate

link—as well as a micro-level link—between credits/finance and productivity in the agricultural sector.

An important note one should pay attention to is that informal agricultural credit markets pervasively operate in most underdeveloped economies. Since such credits are informal, the official figures do not include them by definition. We know from the findings in the agricultural microfinance literature that, as the volume of formal agricultural credits increases, a substitution from informal to formal credits is observed; but the size of this substitution is smaller than the total increase in formal credits. In other words, the development of the agricultural finance system has two components: (i) new demand for formal credits and (ii) switch from informal to formal credits. This suggests that a more developed agricultural finance system has a potential to generate new entry into the agricultural sector in addition to triggering a sizable switch from informal to formal sector.

Our results for developed and developing countries have a dual nature. Using two different agricultural production measures (agricultural component of GDP and agricultural labor productivity), we show that increasing agricultural credits generates an increase in agricultural component of GDP in developing countries, while it leads to an increase in agricultural labor productivity in developed countries. This implies that increased agricultural credits creates vast entry into the agricultural labor markets in developing countries, while such a labor market effect does not exist for developed economies. It is possible to interpret this picture over the development path. In this respect, our results imply that as agricultural credits increase along the development path, the quantity of agricultural credits increase and the initial response is a surge in agricultural labor. The agricultural component of GDP increases significantly, but agricultural labor productivity remains unchanged due to a simultaneous increase in labor supply. The informal credit ratio also declines at this stage. Increased depth of formal credit market makes access-to-credit easier for everyone in the agricultural sector. The informal credit channel operates locally and the increased opportunities for getting formal credit leads to increased agricultural labor supply. At later stages of development, informal credit channels mostly disappear and further development of the agricultural finance system comes in the form of increased quality of services. For example, targeted

credits are designed for the specific needs of the farmer to increase productivity and maximize yield given the resources at hand. Most of the time such specialized credits allow the farmers to invest in new technologies and these technologies increase agricultural productivity in a labor-augmenting way.

The mechanism we describe above suggests that there is a strong positive association between agricultural credits and agricultural productivity; and the nature of this positive association changes along the development path. This paper fills an important gap in the literature in the sense that (*i*) it robustly presents the magnitude of the econometric relationship between credits and productivity in the agricultural sector and (*ii*) it explains the mechanisms underlying this positive correlation by taking into account the potential cross-country differences.

Before we conclude, we would like to discuss a number of remaining issues. Following Claessens and Feijen (2006), we do not directly include physical capital into our empirical analysis. The main reason is the lack of appropriate cross-country data on physical capital allocated to agricultural sector.[14] Instead, we use country-year variation in lending interest rates as a proxy for the link between financial development, technology diffusion, and agricultural investments. Country-specific time-invariant productivity differences are captured by country-fixed effects. Aggregate trends and other time-varying common variables—such as commodity prices—are captured by year fixed effects. As Claessens and Feijen (2006) suggest, agricultural credits enhance agricultural productivity through acquisition of modern equipments, fertilizers, and know-how. Therefore, our estimates also embody better utilization of productive resources, assets, technology, and capital in agricultural production.

5 Concluding remarks

There are numerous studies investigating the relationship between the volume of household-level micro-credit and agricultural productivity. Some of these studies are based on field experiments, while others employ country-specific micro-survey designs to uncover the role of finance in poverty-

[14] Data on aggregate capital stock are available from standard sources—such as the Penn World Tables. However, higher aggregate physical capital stock does not necessarily proxy physical capital allocated to agricultural activities as well as the link between financial deepening and agricultural credits.

reduction efforts. Although the related literature is vast, it is not easy to extract a strong message on the role of agricultural finance in improving agricultural productivity. The main purpose of this paper is to take one-step backward and use country-level data (covering 104 countries for the 1991-2014 period) to understand the aggregate linkages between finance and productivity in the agricultural sector. One potential pitfall in this type of an analysis is that it is common to end up with estimates plagued with biases stemming from certain types of endogeneity and reverse causality problems. Our analysis pays special attention to econometric identification issues and aims to present robust estimates pertaining to the role of agricultural credits in increasing agricultural productivity.

Our main finding is that doubling agricultural credits increases agricultural productivity by 4-5 percent, on average. This suggests that countries with low levels of financial development in the agricultural sector can experience high agricultural growth rates by implementing policies encouraging agricultural credit expansion. We also find that the impact of agricultural credits on agricultural productivity differs substantially across developing versus developed countries. In particular, we document an increase in the agricultural component of GDP as a response to an increase in agricultural credits in developing countries, while there is no meaningful change in agricultural labor productivity. In developed countries, on the other hand, agricultural labor productivity goes up, while the agricultural component does not change. This suggests that the nature of the relationship between agricultural credits and agricultural productivity changes along the development path.

One potential explanation is that agricultural employment also increases along with increased productivity as a response to agricultural credit expansion in developing countries, while there is no such response in developed countries. This may be due to the transition from informal to formal agricultural finance in developing countries, while more developed banking practices encouraging labor-saving agricultural production technologies are adopted in developed countries. In terms of policy, our results suggest that credit expansion programs in the less developed or developing countries might be complemented by labor market policies designed to achieve sustained labor productivity improvements and, therefore, increased returns to employment in the agricultural

sector (or farms).

References

Aghion, P. and P. Bolton (1997): "A Theory of Trickle-Down Growth and Development," *Review of Economic Studies*, 64, 151–172.

Aleem, I. (1990): "Imperfect Information, Screening, and the Costs of Informal Lending: A Study of a Rural Credit Market in Pakistan," *World Bank Economic Review*, 4, 329–349.

Ali, D. A., K. Deininger, and M. Duponchel (2014): "Credit Constraints and Agricultural Productivity: Evidence from Rural Rwanda," *Journal of Development Studies*, 50, 649–665.

Banerjee, A. V. and E. Duflo (2007): "The Economic Lives of the Poor," *Journal of Economic Perspectives*, 21, 141–167.

——— (2010): "Giving Credit Where It Is Due," *Journal of Economic Perspectives*, 24, 61–79.

Banerjee, A. V., E. Duflo, R. Glennerster, and C. Kinnan (2015): "The Miracle of Microfinance? Evidence from a Randomized Evaluation," *American Economic Journal: Applied Economics*, 7, 22–53.

Barrios, S., L. Bertinelli, and E. Strobl (2010): "Trends in Rainfall and Economic Growth in Africa: A Neglected Cause of the African Growth Tragedy," *Review of Economics and Statistics*, 92, 350–366.

Barry, P. J. and L. J. Robison (2001): "Agricultural Finance: Credit, Credit Constraints, and Consequences," in *Handbook of Agricultural Economics*, ed. by K. J. Arrow and M. D. Intriligator, New York, NY: Elsevier, vol. 1A, 513–571.

Beck, T., A. Demirguc-Kunt, and R. Levine (2005): "SMEs, Growth, and Poverty: Cross-Country Evidence," *Journal of Economic Growth*, 10, 199–229.

Bell, C. and G. Clemenz (2006): "The Desire for Land: Strategic Lending with Adverse Selection," *Journal of Development Economics*, 79, 1–25.

Bell, C. and T. N. Srinivasan (1989): "Interlinked Transactions in Rural Markets: An Empirical Study of Andhra Pradesh, Bihar, and Punjab," *Oxford Bulletin of Economics and Statistics*, 51, 73–83.

Bell, C., T. N. Srinivasan, and C. Udry (1997): "Rationing, Spillover, and Interlinking in Credit Markets: The Case of Rural Punjab," *Oxford Economic Papers*, 49, 557–585.

Blancard, S., J.-P. Boussemart, W. Briec, and K. Kerstens (2006): "Short- and Long-Run Credit Constraints in French Agriculture: A Directional Distance Function Framework Using Expenditure-Constrained Profit Functions," *American Journal of Agricultural Economics*, 88, 351–364.

Boucher, S. R., C. Guirkinger, and C. Trivelli (2009): "Direct Elicitation of Credit Constraints: Conceptual and Practical Issues with an Application to Peruvian Agriculture," *Economic Development and Cultural Change*, 57, 609–640.

Briggeman, B. C., C. A. Towe, and M. J. Morehart (2009): "Credit Constraints: Their Existence, Determinants, and Implications for U.S. Farm and Nonfarm Sole Proprietorships," *American Journal of Agricultural Economics*, 91, 275–289.

Browning, M. and A. Lusardi (1996): "Household Saving: Micro Theories and Macro Facts," *Journal of Economic Literature*, 34, 1797–1855.

Carter, M. R. (1989): "The Impact of Credit on Peasant Productivity and Differentiation in Nicaragua," *Journal of Development Economics*, 31, 13–36.

Carter, M. R. and K. D. Wiebe (1990): "Access to Capital and Its Impact on Agrarian Structure and Productivity in Kenya," *American Journal of Agricultural Economics*, 72, 1146–1150.

Ciaian, P., J. Falkowski, and D. Kancs (2012): "Access to Credit, Factor Allocation, and Farm Productivity: Evidence from the CEE Transition Economies," *Agricultural Finance Review*, 72, 22–47.

Claessens, S. (2006): "Access to Financial Services: A Review of the Issues and Public Policy Objectives," *World Bank Research Observer*, 21, 207–240.

Claessens, S. and E. Feijen (2006): "Finance and Hunger: Empirical Evidence of the Agricultural Productivity Channel," World Bank Policy Research Working Paper #4080.

——— (2007): "From Credit to Crops," *Finance and Development*, 44, 35–37.

Cole, S. M. and P. N. Hoon (2013): "Piecework (Ganyu) as an Indicator of Household Vulnerability in Rural Zambia," *Ecology of Food and Nutrition*, 52, 407–426.

Conning, J. and C. R. Udry (2007): "Rural Financial Markets in Developing Countries," in *Handbook of Agricultural Economics*, ed. by R. Evenson and P. Pingali, New York, NY: Elsevier, vol. 3, 2857–2908.

Dasgupta, A. (1989): *Reports on Informal Credit Markets in India: Summary*, New Delhi: National Institute of Public Finance and Policy.

Dell, M., B. F. Jones, and B. A. Olken (2012): "Temperature Shocks and Economic Growth: Evidence from the Last Half Century," *American Economic Journal: Macroeconomics*, 4, 66–95.

Dong, F., J. Lu, and A. M. Featherstone (2012): "Effects of Credit Constraints on Household Productivity in Rural China," *Agricultural Finance Review*, 72, 402–415.

Eswaran, M. and A. Kotwal (1986): "Access to Capital and Agrarian Production Organisation," *Economic Journal*, 96, 482–498.

Feder, G., L. J. Lau, J. Y. Lin, and X. Luo (1990): "The Relationship between Credit and Productivity in Chinese Agriculture: A Microeconomic Model of Disequilibrium," *American Journal of Agricultural Economics*, 72, 1151–1157.

Fink, G., B. K. Jack, and F. Masiye (2014): "Seasonal Credit Constraints and Agricultural Labor Supply: Evidence from Zambia," NBER Working Paper #20218.

Fletschner, D., C. Guirkinger, and S. Boucher (2010): "Risk, Credit Constraints, and Financial Efficiency in Peruvian Agriculture," *Journal of Development Studies*, 46, 981–1002.

Foltz, J. D. (2004): "Credit Market Access and Profitability in Tunusian Agriculture," *Agricultural Economics*, 30, 229–240.

Guirkinger, C. and S. R. Boucher (2008): "Credit Constraints and Productivity in Peruvian Agriculture," *Agricultural Economics*, 39, 295–308.

Honohan, P. (2004a): "Financial Development, Growth and Poverty: How Close are the Links?" in *Financial Development and Economic Growth*, ed. by C. A. E. Goodhart, Palgrave Macmillan, 1–37.

——— (2004b): "Financial Sector Policy and the Poor: Selected Findings and Issues," World Bank Working Paper #43.

Ito, T. and T. Kurosaki (2009): "Weather Risk, Wages in Kind, and the Off-farm Labor Supply of Agricultural Households in a Developing Country," *American Journal of Agricultural Economics*, 91, 697–710.

Jayachandran, S. (2006): "Selling Labor Low: Wage Responses to Productivity Shocks in Developing Countries," *Journal of Political Economy*, 114, 538–575.

Karlan, D. and J. Murdoch (2010): "Access to Finance," in *Handbook of Development Economics*, ed. by D. Rodrik and M. Rosenzweig, New York, NY: Elsevier, vol. 5, 4703–4784.

Kerr, R. B. (2005): "Informal Labor and Social Relations in Northern Malawi: The Theoretical Challenges and Implications of Ganyu Labor for Food Security," *Rural Sociology*, 70, 167–187.

Kochar, A. (1995): "Explaining Household Vulnerability to Idiosyncratic Income Shocks," *American Economic Review*, 85, 159–164.

——— (1997): "An Empirical Investigation of Rationing Constraints in Rural Credit Markets in India," *Journal of Development Economics*, 53, 339–371.

——— (1999): "Smoothing Consumption by Smoothing Income: Hours-of-work Responses to Idiosyncratic Agricultural Shocks in Rural India," *Review of Economics and Statistics*, 81, 50–61.

Miguel, E., S. Satyanath, and E. Sergenti (2004): "Economic Shocks and Civil Conflict: An Instrumental Variables Approach," *Journal of Political Economy*, 112, 725–753.

Mobarak, A. M. and M. Rosenzweig (2014): "Risk, Insurance, and Wages in General Equilibrium," NBER Working Paper #19811.

Narayanan, S. (2016): "The Productivity of Agricultural Credit in India," *Agricultural Economics*, 47, 399–409.

Orr, A., B. Mwale, and D. Saiti-Chitsonga (2009): "Exploring Seasonal Poverty Traps: The 'Six-week Window' in Southern Malawi," *Journal of Development Studies*, 45, 227–255.

Petrick, M. (2004a): "Farm Investment, Credit Rationing, and Governmentally Promoted Credit Access in Poland: A Cross-Sectional Analysis," *Food Policy*, 29, 275–294.

——— (2004b): "A Microeconometric Analysis of Credit Rationing in the Polish Farm Sector," *European Review of Agricultural Economics*, 31, 77–101.

——— (2005): "Empirical Measurement of Credit Rationing in Agriculture: A Methodological Survey," *Agricultural Economics*, 33, 191–203.

Reyes, A. and R. Lensink (2011): "The Credit Constraints of Market-Oriented Farmers in Chile," *Journal of Development Studies*, 47, 1851–1868.

Rose, E. (2001): "Ex Ante and Ex Post Labor Supply Response to Risk in a Low-income Area," *Journal of Development Economics*, 64, 371–388.

Rui, L. and Z. Xi (2010): "Econometric Analysis of Credit Constraints of Chinese Rural Households and Welfare Loss," *Applied Economics*, 42, 1615–1625.

Sarsons, H. (2015): "Rainfall and Conflict: A Cautionary Tale," *Journal of Development Economics*, 115, 62–72.

Sial, M. H. and M. R. Carter (1996): "Financial Market Efficiency in an Agrarian Economy: Microeconometric Analysis of the Pakistani Punjab," *Journal of Development Studies*, 32, 771–798.

Townsend, R. M. (1995): "Financial Systems in Northern Thai Villages," *Quarterly Journal of Economics*, 110, 1011–1046.

Udry, C. (1994): "Risk and Insurance in a Rural Credit Market: An Empirical Investigation in Northern Nigeria," *Review of Economic Studies*, 61, 495–526.

Weber, R. and O. Musshoff (2012): "Is Agricultural Microcredit Really More Risky? Evidence from Tanzania," *Agricultural Finance Review*, 72, 416–435.

——— (2013): "Can Flexible Microfinance Loans Improve Credit Access for Farmers?" *Agricultural Finance Review*, 73, 255–271.

Zeller, M., A. Diagne, and C. Mataya (1998): "Market Access by Smallholder Farmers in Malawi: Implications for Technology Adoption, Agricultural Productivity, and Crop Income," *Agricultural Economics*, 19, 219–229.

Zinych, N. and M. Odening (2009): "Capital Market Imperfections in Economic Transition: Empirical Evidence from Ukrainian Agriculture," *Agricultural Economics*, 40, 677–689.

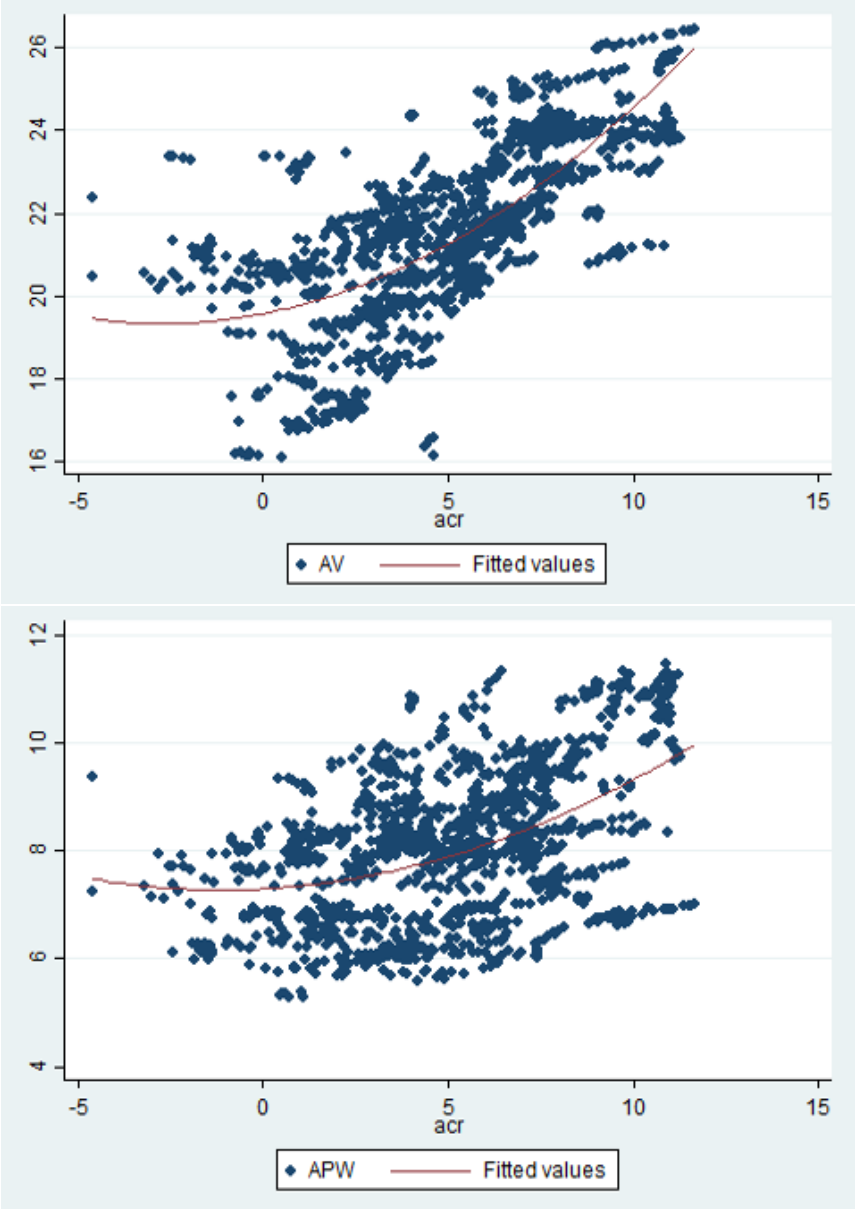

Figure 1: Visual evidence. The figures provide a visual representation of the unconditional relationship between the agricultural component of GDP and agricultural credits in the upper panel, and agricultural labor productivity and agricultural credits in the lower panel. Both figures suggest a positive relationship.

Variable	**# of obs.**	**Mean**	**Std. dev.**	**Min.**	**Max.**
Agr. credit (billion USD)	1,440	4.44	12.84	0	115.89
Total credit (billion USD)	1,436	162.02	688.72	0	7,575.59
Arable land (million hectares)	1,375	11.70	29,400	0.001	186
Agr. AC (real-million USD)	1,366	14,400	34,500	9.65	311,000
Agr. AC per worker (real)	1,366	8,705.17	14,776.60	197.02	94,951.73
Agr. AC per land unit (real)	1,302	4,909.01	16,466.76	128.74	343,891.10
Lending interest rate (%)	1,108	14.68	11.16	2.40	143.56
Rainfall (mm)	1,261	1,154.45	847.40	23.70	4,469.95

Table 1: Descriptive Statistics. AC corresponds to "Agricultural Component of GDP." The real AC variables are in terms of constant 2010 USD. The land unit is in hectares.

	ACR	AC	ACPW	Land	Interest	TCR
ACR	1.00					
AC	0.49	1.00				
ACPW	0.67	0.19	1.00			
Land	0.68	0.34	0.89	1.00		
Interest	-0.17	-0.21	-0.11	-0.12	1.00	
TCR	0.69	0.48	0.50	0.67	-0.14	1.00

Table 2: Correlation matrix. ACR: Agricultural credits; AC: Agricultural component of GDP; ACPW: Agricultural component per worker; TCR: Total credits; Land: Arable land; Interest: Lending interest rate.

Dependent variable: Log of agricultural component of GDP

	Cross-section		Panel-FE		IV-2SLS		GMM	
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Log of agricultural credits	0.446***	0.151***	0.039***	0.051***	0.051***	0.050***	0.048***	0.052***
	(0.086)	(0.048)	(0.012)	(0.018)	(0.007)	(0.011)	(0.011)	(0.013)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Constant term	19.325***	12.271***	21.607***	18.632***	21.279***	18.792***	16.653***	15.211***
	(0.539)	(0.450)	(0.075)	(0.920)	(0.060)	(0.372)	(0.165)	(1.221)
R^2	0.44	0.88	0.21	0.88	0.99	0.99	0.87	0.92
F-test	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
# of observations	104	90	1,357	1,005	1,149	847	1,149	847

Table 3: Agricultural component of GDP (1991-2014). ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively. F-test indicates the p-value of the test with the null that the excluded exogenous variables do not explain cross-country variation in agricultural credit in the first stage estimation. Standard errors are clustered at the country level. Controls include lending interest rates, the log of arable land, the log of rainfall. The IV-2SLS and GMM estimations use the second lag of the log agricultural credits variable as an instrument for log agricultural credits. Country and year fixed effects are used in columns (3)-(8). See Section 2 for a detailed description of all the variables.

Dependent variable: Log of agricultural component of GDP

	Cross-section		Panel-FE		IV-2SLS		GMM	
	[Developing]	[Developed]	[Developing]	[Developed]	[Developing]	[Developed]	[Developing]	[Developed]
Log of agricultural credits	0.254***	0.023	0.054**	0.030	0.056***	0.039**	0.051***	0.031
	(0.043)	(0.041)	(0.026)	(0.019)	(0.012)	(0.017)	(0.011)	(0.028)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant term	12.749***	11.330***	18.696***	20.559***	18.756***	23.434***	15.641***	17.213***
	(0.331)	(1.327)	(1.076)	(0.764)	(0.406)	(1.054)	(0.603)	(1.782)
R^2	0.91	0.86	0.89	0.78	0.99	0.99	0.81	0.79
F-test	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
# of observations	71	19	795	210	671	176	671	176

Table 4: Agricultural component of GDP (1991-2014)–Developed vs developing countries. ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively. F-test indicates the p-value of the test with the null that the excluded exogenous variables do not explain cross-country variation in agricultural credit in the first stage estimation. Standard errors are clustered at the country level. Controls include lending interest rates, the log of arable land, and the log of rainfall. The IV-2SLS and GMM estimations use the second lag of the log agricultural credits variable as an instrument for log agricultural credits. Country and year fixed effects are used in columns (3)-(8). See Section 2 for a detailed description of all the variables.

Dependent variable: Log of agricultural labor productivity

	Cross-section		Panel-FE		IV-2SLS		GMM	
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Log of agricultural credits	0.156***	0.172*	0.025**	0.045**	0.033***	0.042***	0.027*	0.048***
	(0.055)	(0.098)	(0.012)	(0.018)	(0.007)	(0.011)	(0.018)	(0.013)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Constant term	7.337***	9.124***	8.151***	6.546***	6.461***	4.708***	4.201***	3.698***
	(0.308)	(0.693)	(0.075)	(0.582)	(0.143)	(0.384)	(0.124)	(0.245)
R^2	0.12	0.19	0.37	0.40	0.99	0.99	0.77	0.82
F-test	0.006***	0.036***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
# of observations	104	90	1,357	1,005	1,149	847	1,149	847

Table 5: Agricultural labor productivity (1991-2014). ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively. F-test indicates the p-value of the test with the null that the excluded exogenous variables do not explain cross-country variation in agricultural credit in the first stage estimation. Standard errors are clustered at the country level. Controls include lending interest rates, the log of arable land, and the log of rainfall. The IV-2SLS and GMM estimations use the second lag of the log agricultural credits variable as an instrument for log agricultural credits. Agricultural labor productivity is defined as the agricultural component per worker employed in agriculture. Country and year fixed effects are used in columns (3)-(8). See Section 2 for a detailed description of the rest of the variables.

Dependent variable: Log of agricultural labor productivity

	Cross-section		Panel-FE		IV-2SLS		GMM	
	[Developing]	[Developed]	[Developing]	[Developed]	[Developing]	[Developed]	[Developing]	[Developed]
Log of agricultural credits	0.258***	0.032	0.026	0.076***	0.018	0.093***	0.023	0.089***
	(0.061)	(0.041)	(0.020)	(0.014)	(0.013)	(0.018)	(0.019)	(0.022)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant term	10.026***	8.176***	5.993***	5.807***	4.574***	6.372***	3.879***	4.718***
	(0.700)	(1.053)	(0.622)	(1.227)	(0.417)	(1.103)	(0.322)	(0.997)
R^2	0.25	0.70	0.38	0.74	0.99	0.99	0.76	0.91
F-test	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
# of observations	71	19	795	210	671	176	671	176

Table 6: Agricultural labor productivity (1991-2014)–Developed vs developing countries. ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively. F-test indicates the p-value of the test with the null that the excluded exogenous variables do not explain cross-country variation in agricultural credit in the first stage estimation. Standard errors are clustered at the country level. Controls include lending interest rates, the log of arable land, and the log of rainfall. The IV-2SLS and GMM estimations use the second lag of the log agricultural credits variable as an instrument for log agricultural credits. Agricultural labor productivity is defined as the agricultural component per worker employed in agriculture. Country and year fixed effects are used in columns (3)-(8). See Section 2 for a detailed description of the rest of the variables.

A Test of Reverse Causality: IV-2SLS Regressions

	1st stage	**2nd stage**
Rainfall	0.122**	-
	(0.061)	
Log of agricultural labor productivity	-	2.267
		(1.383)
Controls	Yes	Yes
Constant term	5.821***	-9.138
	(0.432)	(9.213)
R^2	0.99	0.93
F-test	67.61	-
Wald χ^2	-	106.24
# of observations	1,181	1,181

Table 7: Reverse causality–IV strategy (2SLS). ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively. The F-statistic indicates the p-value of the F test with the null that the excluded exogenous variables do not explain cross-country variation in agricultural credit in the first stage estimation. Standard errors are clustered at the country level. Controls include year and country fixed effects. The IV-2SLS estimations use the rainfall variable as an instrument for log agricultural labor productivity. Agricultural labor productivity is defined as the agricultural component per worker employed in agriculture. See Section 2 for a detailed description of the rest of the variables.

Dependent variables: Log of agricultural value added [1] and log agricultural value added per worker [2]

	Cross-section		**Panel-FE**		**IV-2SLS**		**GMM**	
	[Developing]	[Developed]	[Developing]	[Developed]	[Developing]	[Developed]	[Developing]	[Developed]
Log of agricultural credits [1]	0.366***	0.084	0.076***	0.026	0.081***	0.044*	0.086***	0.033
	(0.088)	(0.091)	(0.019)	(0.021)	(0.014)	(0.025)	(0.019)	(0.027)
Log of agricultural credits [2]	0.398***	0.094	0.048	0.099***	0.051*	0.132***	0.061*	0.126***
	(0.092)	(0.089)	(0.034)	(0.024)	(0.026)	(0.022)	(0.033)	(0.021)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 8: Agricultural value added (1991-2014)–Developed vs developing countries. ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively. Standard errors are clustered at the country level. Controls include lending interest rates, the log of arable land, and the log of rainfall. The IV-2SLS and GMM estimations use the second lag of the log agricultural credits variable as an instrument for log agricultural credits. Country and year fixed effects are used in columns (3)-(8). See Sections 2 and 4.3 for a detailed description of the rest of the variables.