Does financial literacy improve financial inclusion? Cross country evidence

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ARTICLE INFO

ABSTRACT

While financial inclusion is typically addressed by improving the financial infrastructure, we show that a higher degree of financial literacy also has a clear beneficial effect. We study this effect at the cross-country level, which allows us to consider institutional variation. Regarding "access to finance", financial infrastructure and financial literacy are mainly substitutes. However, regarding the "use of financial services", the effect of higher financial literacy strengthens the effect of more financial depth. The causal interpretation of these results is supported by IV-regressions. Moreover, the positive impact of financial literacy holds across income levels and several subgroups within countries.

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1. Introduction

Lack of financial inclusion is still a far reaching problem. The Findex data for 2014 show that 2 billion adults are unbanked; this number fell to 1.7 billion in 2017, still representing almost 40 percent of adults in the world (Demirguc-Kunt, Klapper, Singer, & Van Oudheusden, 2015, Demirgüç-Kunt, Klapper, Singer, Ansar, & Hess, 2018). Thus, financial inclusion, measured as access to and use of financial services, is an important goal of economic and, in particular, financial development; accordingly it has been argued to be an important policy tool that can help to achieve the Sustainable Development Goals (SDGs) (Klapper, El-Zoghbi, & Hess, 2016). It is hence of high interest for policy makers to learn about drivers of financial inclusion and how these can be influenced by national policies.

The positive impact of financial depth on growth and (less income) inequality has been well established in the literature (Beck, Demirguc-Kunt, & Peria, 2007; Levine, Loayza, & Beck, 2000). By contrast, there is less evidence for a link between financial inclusion and economic growth or inequality, but existing evidence points into this direction (Demirguc-Kunt, Klapper, & Singer, 2017). For example, improved financial inclusion can decrease rural poverty (Burgess and Pande, 2005), increase employment (Bruhn and Love, 2014), expenditures (Dupas and Robinson, 2013) and savings (Brune, Giné, Goldberg, & Yang, 2016). Hence, better financial inclusion can have welfare effects that extend beyond benefits in the financial realm to the real economy.

Research at the country level documents the state of access to financial services (Beck et al., 2007): It shows that better financial inclusion is related to country and institutional characteristics, such as more financial depth, physical proximity of financial institutions, low costs for financial accounts, or a strong legal system (Allen, Demirguc-Kunt, Klapper, & Peria, 2016). Thus, country studies on financial inclusion so far focus on the supply side of financial markets. However, shouldn't financial development consider more than the various aspects of financial infrastructure and legal background? Which role does the demand side play? It seems plausible that functioning financial markets do not only need good infrastructure but also informed customers, i.e. customers with a higher degree of financial literacy. Informed customers make better financial decisions for themselves and for their businesses, they support the effectiveness of the financial system by demanding more sophisticated financial services and they will demand financial inclusion. If, indeed, the degree of financial literacy makes a difference for financial inclusion, this seems to have a clear policy message.

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Despite this almost natural line of argument, we provide the first empirical study at the country level examining the relation between financial literacy and financial inclusion. This has become possible due to a new dataset documenting the degree of financial literacy for 143 countries as described in Klapper, Lusardi, and van Oudheusden (2015). These novel data complement the World Bank's Findex data on the access to and use of financial services (2013; Demirguc-Kunt and Klapper, 2012; Demirguc-Kunt et al., 2015), and, of course, earlier data on financial and institutional country characteristics. These data allow us to contribute to the literature on financial inclusion in two major ways:

First, we establish the stylized fact that higher financial literacy is systematically related to better financial inclusion at the country level. We show this relationship for four measures of financial inclusion. These relations provide the first cross country evidence, extending studies with specific samples from single countries, thereby demonstrating a high external validity of this relationship. Of course, financial development is a comprehensive process so that the stylized fact of a relation between financial literacy and financial inclusion should be controlled for by potentially confounding country characteristics. Thus, we use a large set of variables which have been introduced in the literature, including relevant general country characteristics, such as GDP per capita and the level of education, and standard variables of financial infrastructure (see e.g. Allen et al., 2016). When adding these variables to the main relation of interest, we show that these variables reduce the coefficient on financial literacy but none of them eliminates the significant relation between financial literacy and financial inclusion. This suggests that financial literacy (demand side) has the expected influence on financial inclusion, independent from the known positive influence of financial infrastructure, i.e. the supply side (Beck and de la Torre, 2007).

In addition, it seems interesting to examine the relation of financial literacy and infrastructure to each other: Do demand and supply act rather as substitutes or complements? We find that the answer depends on the type of financial inclusion, which is our second major contribution. For access to financial services, in particular having a bank account, the marginal benefit of financial literacy decreases with higher financial depth, indicating that the two are mainly substitutes. If inclusion is about the use of financial services, however, and in this sense more advanced, financial literacy has a complementary effect on financial depth, so that the two even reinforce each other. Economically, it makes sense, for example, that active use of a bank account requires both, infrastructure and understanding about the infrastructure.

While a causal interpretation of these results with the effect going from financial literacy to financial inclusion seems to be logical, there is also more direct evidence for this. Such evidence with high internal validity is provided by micro-based studies, such as Cole, Sampson, and Zia (2011), Doi, McKenzie, and Zia (2014), and Jamison, Karlan, and Zinman (2014). These studies hint at the positive role of financial literacy for financial inclusion. However, the samples and designs of these studies are specific so that it remains unclear to which extent results can be generalized. Thus we propose, in addition to our OLS results, an instrumental variable approach allowing for causal inference in our regressions.

We use the level of numeracy of primary school children as a conventional external instrument. As numeracy is a precondition for financial literacy, numeracy and financial literacy are indeed highly correlated. Moreover, we argue that numeracy only affects financial inclusion through financial literacy as this financial understanding is needed on top of mathematical ability for the decision to, for example, open an account. Reassuringly, it is indeed exactly the numeracy aspect of education that matters because reading ability, for example, does not pass the test for an instrument. This divergence between numeracy and reading ability is relevant for our case as it indicates that the numeracy measure does not just capture cognitive ability or general educational quality. Thus, using numeracy of children as an instrument for financial literacy of adults also supports the causal interpretation of financial literacy on financial inclusion. We show that our results hold for both men and women, furthermore in robustness tests we show that main results hold for various sub-groups of income levels, i.e. samples of the poorest 40% and richest 60% of the population within a country.

As a further robustness check, we also apply the instrumental variable method developed by Lewbel (2012) in addition to conventional IV methods. This method does not rely on an external instrument, but instead uses heterogeneity in the error term of the first stage regression to generate instruments from within the existing model. Results also confirm those based on our OLS regressions. Leading on from these results we argue that improving financial literacy would be beneficial for all countries at different stages of economic and financial development.

Literature: Our research is related to three strands of literature, i.e. on (i) financial inclusion at the country level, (ii) financial inclusion in micro studies and (iii) financial literacy. (i) Recent studies measure and explain financial access as a measure of outreach and inclusion. Beck et al. (2007) present a dataset designed to measure financial outreach by looking at both elements of physical access to banking infrastructure and deposit and credit use per capita. They show that these measures of financial access are not determined by the same indicators as financial depth (see Levine et al., 2000). Neither religion nor (French) legal origin (LaPorta, Lopez-de-Silanes, & Shleifer, 2008) are significantly correlated with these variables.

When researching the barriers to financial inclusion, a number of supply side factors have been studied. Factors such as high transaction costs, uncertainty, asymmetric information or a lack of physical access are often discussed as hindering the efficient use of financial services (Armendariz de Aghion and Morduch, 2005; Beck, Demirguc-Kunt, & Peria, 2008; Karlan and Morduch, 2009). Hence, these are supply-side reasons why formal banks and other financial institutions may not give credit or offer a savings account to clients. Klapper et al. (2016) elaborate on how lifting these barriers promote financial inclusion. Thus, providing access and promoting the use of financial services, may directly reduce extreme poverty (Jack and Suri, 2014; Karlan, Ratan, & Zinman, 2014; Pande, Cole, Sivasankaran, Bastian, & Durlacher, 2012).

(ii) The findings from cross-country studies are largely supported by a number of micro-studies that assess the causes of financial inclusion by looking at the individual or household level via surveys or by running a randomized controlled trial. Allen et al. (2016) show that women, the poor and those living in rural areas tend to be financially excluded. Similarly, Ghosh and Vinod (2017), using data from India, show that women are still more likely to be financially excluded. Further, a growing body of evidence suggests that providing access to bank accounts increases take-up rates of these accounts, household savings (Brune et al. 2016; Somville and Vandewalle, 2016), labor market activity (Bruhn and Love, 2014), income (Bruhn and Love, 2014), private and business expenditures (Ashraf, Karlan, & Yin, 2010; Dupas and Robinson, 2013) and decreases rural poverty (Burgess and Pande, 2005). Particularly, the effect of providing savings accounts seems to be robust as people shift away from storing money at home or holding it in the form of livestock or jewelry (Demirguc-Kunt et al., 2017). While Cole et al. (2011) also find that subsidized bank accounts have a positive effect on bank account take-up, even very short financial literacy trainings can have a (smaller) desired effect, in particular for poor households. Beyond the provision of bank accounts, mobile money may support inclusion in other

dimensions (e.g. Demirguc-Kunt et al., 2017). For example, Aker, Boumnijel, McClelland, and Tierney (2016) find significant effects of digitized transfers on households' diet and food intake.

A few studies question strong results of having a bank account for downstream behaviors. Prina (2015) finds that providing zero cost bank accounts and prevalence of local banks increase take up of these bank accounts, but the author does not find an effect on asset accumulation. Dupas, Karlan, Robinson, and Ubfal (2016) present evidence from Chile, Malawi, and Uganda to show that providing only basic bank accounts does not result in significantly higher savings or other downstream outcomes.

(iii) Studies on financial literacy typically examine the relationship between financial literacy and good financial decision making (see, e.g., Lusardi and Mitchell, 2014). They show, for example, that financial literacy supports financial inclusion, such as savings accumulation (Jamison et al., 2014, Berry, Karlan, & Pradhan, 2018), wealth (van Rooij, Maarten, Lusardi, & Alessie, 2012), or microentrepreneurs' financial practices (Drexler, Fisher, & Schoar, 2014). The advantage of these micro-based studies is their clear identification, ensuring that indeed an increase in financial literacy improves financial behavior (e.g., Miller, Reichelstein, Salas, & Zia, 2015; Kaiser and Menkhoff, 2017).

The only study we are aware of, which analyzes "economic literacy" in a cross-country setting is Jappelli (2010). While he shows several interesting relations, he does not study financial inclusion. Thus, summarizing the state of the literature, we add to it by looking at financial literacy and financial inclusion at a cross country basis.

Our study proceeds with five sections: Section 1 describes the empirical approach and data, Section 2 provides main results. Results for IV-regressions are shown in Section 3, while robustness checks are documented in Section 4 and conclusions in Section 5. This section provides information about the foundations of our empirical study. Section 1.1 introduces the methods used, Section 1.2 documents the data and their definitions and Section 1.3 presents descriptive statistics.

2. Method

This research aims to explain financial inclusion by a demand side variable, i.e. financial literacy, together with the supply of financial services. The most prominent measure of financial inclusion that is studied in the literature (as LHS-variable) is "having a bank account". Among the RHS variables, the demand for financial services is provided by the degree of financial literacy, while supply of financial services is measured by variables such as the size of the financial sector, strength of legal rights and bank branches per square km. These supply-side variables have been previously analyzed in the literature on financial inclusion (Allen et al., 2016; Beck et al., 2007).

We start our analysis with a simple OLS regression (with robust standard errors) in order to ease interpretation. We also use various IV-regressions and fractional response regressions and show the results later on. This OLS regression takes the following form:

$$Y = \beta_1 FL + \beta_2 \mathbf{X} + u$$

Our main variable of interest is FL, the level of financial literacy in a country. $\mathbf{X}$ is a matrix of country and institutional specific control variables, details of which are discussed in the data section below.

2.1. Data

The data needed for our research result from the above sketched literature and contain six groups of variables: (i) financial literacy, financial inclusion measured as (ii) access to finance and (iii) use of financial services, and three groups of country control variables, i.e. (iv) general country characteristics, (v) financial infrastructure of a country and (vi) institutional country characteristics.

2.1.1. Financial literacy

The variable "financial literacy" is made up of five survey items. These survey items are collected by Gallup, together with the World Bank, and the Global Financial Literacy Center in a representative survey of more than 1000 adults per country in 143 countries of the world in 2014. The items ask questions on four concepts, i.e. risk diversification, inflation, interest rate and interest compounding. The financial literacy score proposed in Klapper et al. (2015), which is used here is a dummy variable, giving a "1" if questions on at least three out of four financial literacy concepts are answered correctly by a person. The score per country is the proportion of 1000 people asked that can answer questions on three out of four concepts correctly.

These questions have been commonly used in the literature to measure financial literacy with only small variations (Lusardi and Mitchell, 2014; Xu and Zia, 2012). To provide an example, the question to address the understanding of interest, is: "Suppose you need to borrow USD 100. Which is the lower amount to pay back: USD 105 or USD 100 plus three percent?" The response categories are: "a) 105 USD, b) 100 USD plus three percent, c) don't know, d) refuse". 50 percent of all respondents across the world give the right answer "b", while the remaining 50 percent say either "a", "c" or "d". The full set of questions and response categories is provided in Appendix Table A1.

While Klapper et al. (2015) do not explicitly discuss the exact origins of their survey questions, it is quite obvious that the three questions on risk diversification, inflation and interest compounding are slight variations of the standard items used in the literature (see Lusardi and Mitchell, 2014). The item on risk diversification has been simplified, probably to reflect the wider coverage of countries beyond advanced economies. The item on interest has been added in an adapted form from Cole et al. (2011). Thus, there are five items in total which inform about the degree of financial literacy. Obviously, this measure is imperfect but it is in line with the literature. Ideally, one would like to know more about people's financial literacy, including questions which fit to the institutional circumstances in each country which is impossible in a worldwide survey. Thus, there will be quite some error in measuring the degree of financial literacy which makes it harder to assess the exact impact of financial literacy on financial inclusion.

2.1.2. Access to finance

We measure financial inclusion by studying four different outcome variables. First, we look at the proportion of the population that has a simple bank account at a formal financial institution, including mobile money accounts. Having a bank account is the basis for a large number of financial transactions and it makes holding as well as handling money easier and safer. This is a simple measure of access to financial services and has been used in a large number of studies (e.g., Karlan and Morduch, 2009; Brune et al., 2016). It measures the most basic form of financial inclusion. In addition, we consider one more measure of access to financial inclusion that is the proportion of adults in a country that has a debit card. Having a debit card is a more sophisticated form of financial inclusion than simply having a bank account. At the same time, having a debit card is clearly beneficial to those that hold it. It is both a more convenient and safer form of payment than cash. We expect these two measures of financial inclusion to be positively affected by financial literacy, as a good level of financial knowledge is needed to make sophisticated financial decisions.

2.1.3. Use of financial services

Furthermore, we also look at two variables that are designed to measure the use of financial services rather than just simple access to financial services. The first variable is the proportion of respondents that use a bank account to save. Saving at a formal institution is beneficial for bank customers for safety reasons. It can also play an important role in impulse control, as money is not being stored in an available form. Lastly, we also study the use of debit cards, because the benefits from debit cards can only really be reaped if they are used. Our fourth outcome variable is, therefore, the proportion of the population that used a debit card during the last year, conditional on having such a card.

2.1.4. General country characteristics

To get a meaningful result about the relationship between financial literacy and financial inclusion at the country level, we control for a set of variables that have been shown to be related to financial literacy in a large number of micro studies (Lusardi and Mitchell, 2014). Variable descriptions as well as respective summary statistics are shown in Table A2 in the Appendix. These variables can be grouped into three: country compositional characteristics that include the log of GDP per capita to control for income levels and the proportion of the population that is between 15 and 64, because people of working age have higher financial literacy than others (Klapper et al., 2015). Furthermore, we use a measure of educational attainment in the country in the form of the proportion of people that have completed secondary or tertiary education.

2.1.5. Financial infrastructure

The next group of variables describes financial characteristics of a country. Here we control for variables that measure the depth and breadth of the financial system. We include the private credit to GDP ratio as a measure of financial depth and so financial sector development. Moreover, we control for a variable that measures physical access to financial services: bank branch penetration per 1000 km^2.

2.1.6. Institutional characteristics

In explaining financial inclusion further, we follow Allen et al. (2016) and use two variables that can be considered to measure country institutional characteristics which are robustly significant in their study. These are the strength of legal rights index, which measures the legal protection of borrowers and lenders in the country. We also include the ease of doing business index. This variable controls for how easy it is for a firm to operate in a country. In robustness checks, we also control for further variables which have been suggested in the literature. Correlations between the control variables are given in Table A3. In order to be consistent with the data about financial literacy, all other data used in this study also take the 2014 values. A list of countries included in this study is shown in Table A4 in the Appendix.

2.2. Descriptive statistics

The descriptive statistics about the main explanatory variable, i.e. "financial literacy", are provided in Panel A of Table 1. The variable is measured as a score over four items. The average score of the world is an unweighted average across all countries, which is 36.6. That means less than 37 percent of the survey participants provided three or four correct answers on four items capturing the dimensions of financial literacy. We also include an average that has been weighted by the population and that is even lower: 32 percent are considered financially literate.

However, there is enormous heterogeneity. The score per country varies between 13 percent (Yemen) and 71 percent (Norway). Of course, there are some patterns in this data to be expected from the literature (Lusardi and Mitchell, 2014). The financial literacy score is higher in richer countries as can be seen from the World Bank classification of countries according to four income groups. This applies to each of the questions (Fig. 1). It is noticeable that the average score is almost the same for lower middle and upper middle income countries on two of the questions. People in low income countries do better than in middle income countries in a

Table 1
Summary statistics.

	Mean	SD	Min	Max	Weighted Mean	Weighted SD
Panel A: Financial literacy summary statistics						
Financial literacy	36.60	13.79	13	71	32.00	11.45
Financial literacy, poorest 40%	31.72	13.15	7	67	27.00	10.51
Financial literacy, richest 60%	39.92	14.66	14	76	35.40	12.36
Financial literacy, men	39.86	14.39	15	77	35.06	12.07
Financial literacy, women	33.51	13.61	8	70	29.00	11.36
Risk diversification	41.48	16.09	11	78	34.90	16.80
Inflation	52.62	12.45	17	78	49.95	10.71
Interest	49.75	11.77	16	79	48.10	8.46
Interest compounding	46.35	11.88	22	74	45.18	8.26
Observations	143					

Notes: Financial literacy is the proportion of the adult population that can answer at least three out of four questions correctly. Financial literacy, bottom 40% and 60%, report the same for the bottom 40% and top 60% of the income distribution. Financial literacy of men and women is the proportion of men and women in a country that can answer at least 3 out 4 questions correctly. Risk diversification, inflation, interest and interest compounding depict the proportion of the population that answered each respective question correctly. Weighted means were weighted by the population.

	Mean	SD	Min	Max	Weighted Mean	Weighted SD
Panel B: Access and use of financial services summary statistics						
Account ownership	54.78	30.81	2	100	58.63	25.74
Debit card ownership	39.29	30.76	0	99	37.82	24.96
Saved at formal fin. institution	22.46	18.81	1	78	25.33	17.17
Used debit card in the last year	28.30	28.74	0	96	22.03	22.28
Observations	143					

Notes: Account ownership at formal financial institution denotes the proportion of the population that has an account at a formal financial institution, including mobile money accounts; debit card ownership depicts the proportion of the population that has a debit card; Saved at a formal financial institution is the proportion of the population that saved at a formal financial institution in the past 12 months; used debit card is the proportion of the population that used a debit card during the last year. Weighted means were weighted by the population.
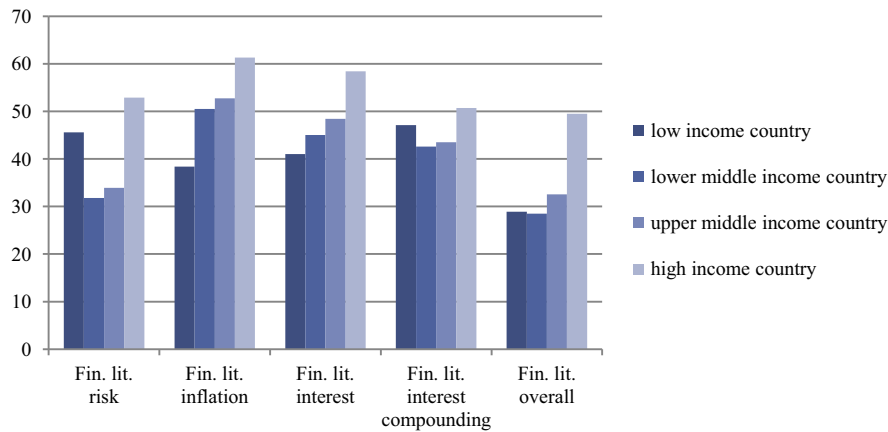
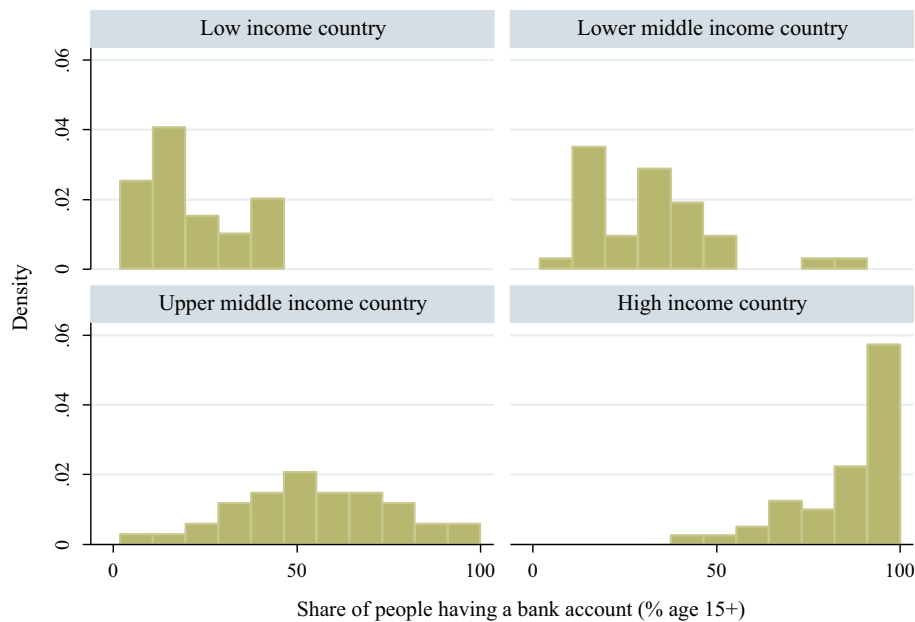**Fig. 1.** Financial literacy concepts at income groupings.

Fig. 2. Having a bank account by World Bank income classification.

few cases. Only the high income countries have a significantly higher average score for all questions (Fig. 2). Moreover, income is related to financial literacy within countries. The richest 60 percent of adults have an eight percentage points higher degree of financial literacy than the poorest 40 percent on average. Finally, on average, 6.3 percentage points more men than women are considered financially literate.

Regarding the indicators which measure financial inclusion, Panel B of Table 1 provides descriptive statistics. In our sample, 54.7 percent of all adults being captured by the survey have a simple bank account. This is slightly higher when looking at the average weighted by population size. Here 58.6 percent of the population has a bank account. The variation across countries is even larger than for financial literacy, as it ranges from 2 percent to 100 percent, indicating that the broad population – in the extreme country cases – does either have hardly any account access or basically everyone has an account. As a second indicator for financial access we choose a more advanced product, i.e. owning a "debit card". This applies to 39.3 percent (or 37.8 percent weighted by population) of the world population, with a range from zero percent to 99 percent.

Regarding the use of financial services, our first indicator is "saved at a financial institution last year" which applies to 22.4 percent of the covered population and 25.3 percent when weighted. The second indicator is "debit card used in the last year" which 28.3 percent of respondents that hold a debit card agree to (22.0 percent weighted by population).

Finally, we provide raw correlations between the degree of financial literacy, its underlying questions and the measures of financial inclusion (see Appendix Table A5). While the degree of financial literacy is clearly correlated to each of the four questions forming the overall measure (coefficients of correlation between 0.64 and 0.74), the correlation between the four questions is smaller, ranging from 0.13 to 0.59. The correlation between financial literacy and the four measures of financial inclusion is again clearly visible (0.65–0.75) and lastly those between the measures of financial inclusion is very high (0.83–0.96).

Overall, we see that just over half of the world population has access to a formal financial account and even fewer hold a more sophisticated debit card. The share of people that actively use a financial product is obviously lower again than the share of product owners.

3. Main results

This section presents results for the effects of financial literacy on financial inclusion in four steps. Regarding direct effects, these are shown for access to formal financial services (Section 2.1) and the use of this access (Section 2.2). Regarding interaction effects, these are given for financial depth (Section 2.3). Finally, we show effects separated for women and men (Section 2.4).

3.1. Access to financial services

We start our analysis by examining the most basic measure of financial inclusion – the proportion of the population that has a bank account. To explain account penetration, we begin by using only financial literacy as a RHS variable and find a highly significant positive relationship (see column 1 in Table 2).

However, financial inclusion is expected to also depend on other characteristics of development, in particular on the state of financial infrastructure. Hence, we control for the three sets of variables described above: in specification 2 we consider country characteristics, and in specification 3 we also consider financial and institutional characteristics. In column 2, the results show a positive and significant relationship between financial literacy and the proportion of the population that has a bank account. In addition, and as expected, log GDP per capita has a positive and significant effect on bank account ownership. The education variables do not turn significant because their potential impact is crowded out by the correlated GDP variable; if we take out the GDP variable (in unreported regressions), then the education variables become significant with a positive coefficient in some of the regressions.

Coming to the full specification in column 3, we see that there is indeed the expected significant positive relationship between financial depth (private credit to GDP) and financial inclusion. Moreover, the indicator for bank branch penetration and the ease of doing business variable have significant coefficients with the expected sign. Due to the ranking nature of the latter variable,

the regulatory business environment has a negative sign, i.e. this should be interpreted as a supportive effect of the ease of doing business on access to financial services. It seems plausible that the consideration of further variables, which are related to the development process and its financial aspects, reduces the coefficient of financial literacy. However, the fact that this coefficient remains highly significant is crucial. Other things equal, a one percentage point increase in the proportion of financial literate people in a country, increases the rate of account ownership among the population by 0.511 percentage points. These results indicate that both – demand and supply in financial services – contribute to improving financial inclusion.

Next, we take the analysis one step further, by not simply looking at the "banked" population, but also at having a more sophisticated financial product. In columns 4 to 6 we run the same regressions as before, but this time explaining the proportion of the population that has a debit card as the outcome variable. We find the same pattern. There is a large and significant relation between financial literacy and the proportion of the population that has a debit card. This indicates that a one percentage point increase in the share of people knowledgeable about financial literacy increases the share of the population having a debit card by 0.518 percentage points (column 6). GDP per capita is another important correlate, and – according to column 6 – financial depth, bank branch penetration and ease of doing business are further significant variables in the regressions. An increase of financial depth by one standard deviation is associated with the proportion of people that have a debit card increasing by 4.46, an extra bank branch per 100 km^2 is linked to the proportion of people that have a debit card increasing by 0.03 and a worsening on the ease of doing business index by one position is associated with the proportion of people having a debit card being 0.1 lower. Hence comparatively, the effect associated with financial literacy is relatively high.

These results for both indicators of access to finance provide clear evidence that the demand side, in the form of financial literacy, plays an important role when it comes to understanding

Table 2
Financial literacy and access to finance – OLS results.

	(1) Account ownership OLS	(2) Account ownership OLS	(3) Account ownership OLS	(4) Debit card ownership OLS	(5) Debit card ownership OLS	(6) Debit card ownership OLS
Financial literacy	1.441***	0.712***	0.511***	1.522***	0.687***	0.518***
	(0.101)	(0.143)	(0.140)	(0.125)	(0.141)	(0.154)
Log GDP p.c. (PPP)		15.418***	13.223***		15.876***	13.943***
		(2.414)	(2.798)		(2.071)	(2.550)
Population share between 15 and 64		0.277	−0.239		−0.037	−0.482
		(0.389)	(0.342)		(0.334)	(0.305)
Secondary education		−0.007	0.018		0.010	0.028
		(0.108)	(0.106)		(0.098)	(0.102)
Tertiary education		0.050	−0.151		0.230*	0.031
		(0.145)	(0.137)		(0.137)	(0.150)
Private credit to GDP			0.130***			0.093**
			(0.031)			(0.044)
Bank branches per 1000 km^2			0.058***			0.034**
			(0.017)			(0.017)
Strength of legal rights index			0.309			−0.002
			(0.542)			(0.509)
Ease of doing business index			−0.102**			−0.105*
			(0.049)			(0.053)
Constant	1.38	−132.72***	−71.89***	−16.77***	−134.95***	−77.52***
	(4.318)	(16.349)	(25.653)	(4.572)	(13.957)	(24.802)
R^2	0.424	0.741	0.803	0.469	0.795	0.816
Observations	141	136	119	141	136	119

Notes: The table reports OLS regression results with robust standard errors in parentheses. Columns (1)–(3) show results with the proportion of the population that have a bank account as the outcome variable. Column (4)–(6) show results with the proportion that have a debit card as the outcome variable. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

access to finance. This role seems to be additional to the contribution from general economic development and improvements in financial infrastructure.

3.2. Use of financial services

In this section we extend the analysis and do not just study the effect of financial literacy on having a certain financial product, but analyze the effect of financial literacy on using that product. We here consider two different types of use of financial products. First, we study the proportion of the general population that has saved at a formal financial institution. Second, we study the proportion of a population that has used their debit card during the last year. Results are developed in the same steps as in Section 2.1 (see Table 2) and are shown in Table 3.

Column 1 studies the link between the proportion of the population that is financially literate and the proportion that has saved in a formal financial institution; the coefficient is positive as expected and statistically highly significant. When we also consider general country characteristics in column 2, GDP per capita is positively correlated with the proportion that has saved at a formal financial institution. Considering further financial country characteristics in column 3 we find that financial depth and – plausibly – bank branch penetration have positive relations with financial inclusion. The negative coefficient on the share of the adult population seems difficult to interpret economically.

Moreover, we study the relationship between the financial literacy level and debit card use in the last year. As before, column 4 shows a significant relation between financial literacy and debit card use within the last year. Further regressions in columns 5 and 6 present the same pattern as in columns 2 and 3 before with one exception: bank branch penetration becomes insignificant but higher education turns significant which makes sense for the relatively more complex financial product.

3.3. Financial literacy and different levels of financial depth

We here study how financial depth and financial literacy interact to affect access to and use of financial services. The purpose is to learn about how policies aiming at the supply and the demand side of financial development impact financial inclusion. Therefore, we extend the above introduced analyses by including an interaction term between financial literacy and private credit to GDP (as a measure of financial depth) in the regressions (Table 4); we also show the average marginal effect graphically in Fig. 3. Both interacted variables are centered at their means for ease of interpretation.

The interaction results show that the average marginal effect of financial literacy on the proportion of the population that has a bank account is higher for countries that have lower private credit to GDP ratios (column 1). However, there is no significant difference across different levels of financial depth in the marginal effect of financial literacy on the proportion of the population that has a debit card (column 2). In contrast to these results, the average marginal effect of financial literacy on savings at a formal financial institution (column 3) and using a debit card during the preceding year (column 4) are higher in countries that have higher private capital to GDP ratios.

These results suggest that increasing financial literacy in a population would increase account ownership, and the effect is largest in countries with low levels of financial depth. In these latter countries high levels of financial literacy can make up for the lack of financial infrastructure. On the other hand, the average marginal effects of increasing financial literacy on the use of financial services in the form of savings at a formal financial institution and use of debit cards are highest in countries that have high levels of financial depth. Thus, financial literacy education improves financial inclusion under "all" circumstances: at lower levels of financial depth (early stages of financial development) literacy

Table 3
Financial literacy and use of financial services – OLS results.

	(1) Saved at formal fin. institution OLS	(2) Saved at formal fin. institution OLS	(3) Saved at formal fin. institution OLS	(4) Used debit card in the last year OLS	(5) Used debit card in the last year OLS	(6) Used debit card in the last year OLS
Financial literacy	1.022*** (0.072)	0.664*** (0.089)	0.529*** (0.086)	1.526*** (0.127)	0.809*** (0.140)	0.687*** (0.155)
Log GDP p.c. (PPP)		7.896*** (1.547)	6.238*** (1.518)		12.052*** (1.991)	12.207*** (2.391)
Population share between 15 and 64		−0.380 (0.240)	−0.616*** (0.217)		−0.341 (0.277)	−0.719** (0.301)
Secondary education		−0.108 (0.072)	−0.053 (0.068)		−0.004 (0.087)	−0.031 (0.094)
Tertiary education		0.124 (0.108)	0.026 (0.107)		0.420*** (0.128)	0.241* (0.142)
Private credit to GDP			0.114** (0.045)			0.046 (0.041)
Bank branches per 1000 km²			0.033* (0.018)			0.029 (0.018)
Strength of legal rights index			0.146 (0.410)			0.332 (0.498)
Ease of doing business index			−0.030 (0.040)			−0.074 (0.059)
Constant	−15.105*** (2.480)	−47.236*** (11.256)	−18.961 (19.067)	−27.818*** (4.326)	−98.05*** (11.986)	−65.957** (29.774)
R²	0.565	0.683	0.737	0.539	0.779	0.779
Observations	141	136	119	141	136	119

Notes: The table reports OLS regression results with robust standard errors in parentheses. Columns (1)–(3) show results with the proportion of the population that saved at a formal financial institution in the last year. Column (4)–(6) show results with the proportion that has used their debit card within the last year. ***, ** and *denote significance at the 1%, 5% and 10% levels, respectively.

Table 4
Financial literacy, financial depth and their interaction.

	(1) Account ownership	(2) Debit card ownership	(3) Saved at formal fin. institution	(4) Used debit card in the last year
Financial literacy	0.537***	0.504***	0.505***	0.649***
	(0.143)	(0.155)	(0.079)	(0.152)
Private credit to GDP	0.146***	0.085**	0.098**	0.023
	(0.033)	(0.042)	(0.042)	(0.036)
Interaction financial literacy	−0.004**	0.002	0.004**	0.006***
and private credit to GDP	(0.002)	(0.002)	(0.002)	(0.002)
Log GDP p.c. (PPP)	13.846***	13.610***	5.643***	11.259***
	(2.781)	(2.599)	(1.472)	(2.333)
Population share between 15 and 64	−0.414	−0.388	−0.448**	−0.451
	(0.360)	(0.336)	(0.214)	(0.339)
Secondary education	0.026	0.024	−0.061	−0.042
	(0.103)	(0.104)	(0.068)	(0.093)
Tertiary education	−0.101	0.004	−0.021	0.166
	(0.132)	(0.162)	(0.114)	(0.153)
Bank branches per 1000 km^2	0.055***	0.036**	0.036*	0.034**
	(0.017)	(0.016)	(0.019)	(0.017)
Strength of legal rights index	0.473	−0.090	−0.011	0.082
	(0.561)	(0.525)	(0.397)	(0.471)
Ease of doing business index	−0.093*	−0.110**	−0.039	−0.089
	(0.051)	(0.053)	(0.037)	(0.056)
Constant	−42.061	−55.322**	3.247	−43.977
	(26.212)	(24.754)	(17.150)	(28.815)
R^2	0.809	0.817	0.750	0.793
Observations	119	119	119	119

Notes: The table shows the effect of financial literacy, private credit to GDP and their interaction on different measures of financial inclusion, including access to and use of financial services. Robust standard errors in parentheses. The interacted variables were centered at their means which correspond to 57.31% of GDP for financial depth and 36.4% for financial literacy. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.
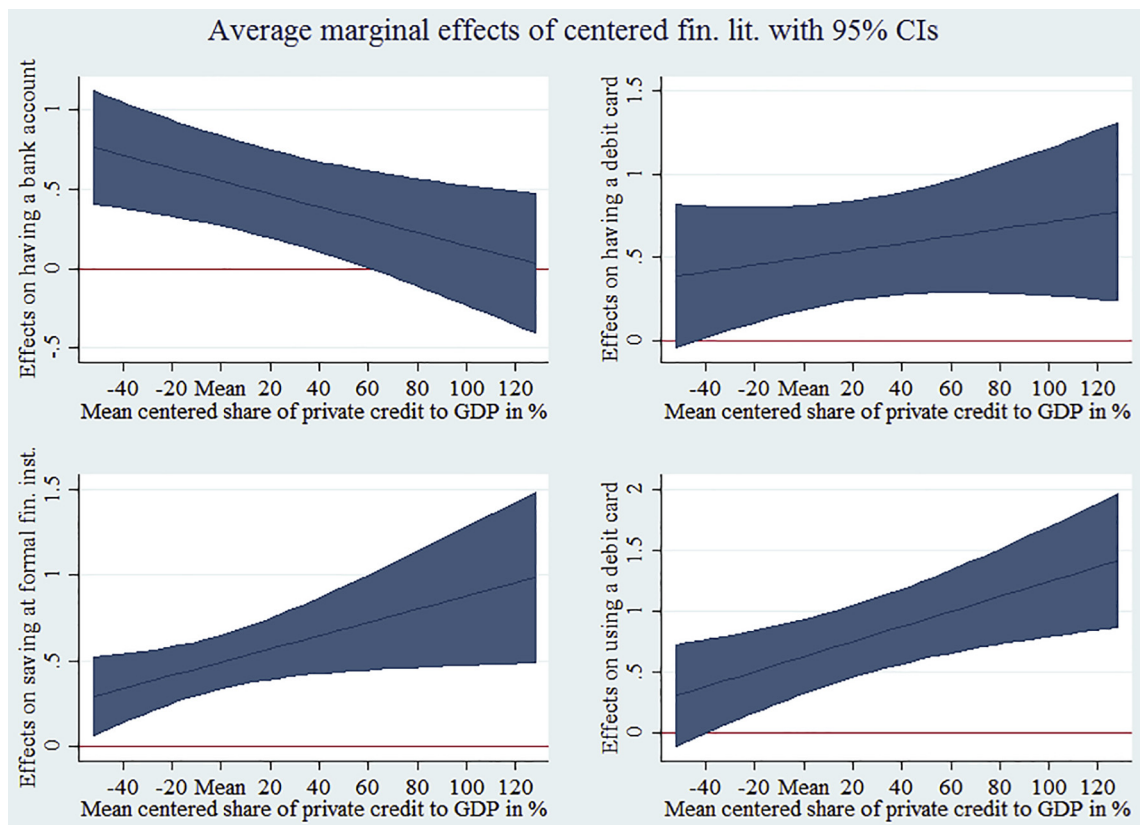
Fig. 3. Average marginal effects of financial literacy on four measures of financial inclusion at different levels of private credit to GDP.

works rather as substitute to financial depth, at higher levels literacy becomes a kind of necessary complementary factor.

We also find a similar pattern for the interactions between financial literacy and GDP per capita, while the degree of bank branch penetration does not seem to be too crucial for the impact of financial literacy on financial inclusion; detailed results on these interaction effects are shown in the Appendix B1.

3.4. Financial literacy of women and men

We repeat the exercises conducted in Sections 2.1 and 2.2 for the proportion of women and men who are financially literate and for the proportion of women and men who have access to and use financial services. Results are shown in Table 5. We see that the coefficient of the proportion of women who are financially literate is consistently and considerably larger than the coefficient on the proportion of men who are financially literate. This cautiously indicates that women might benefit more from an increased level of financial literacy. However, this effect may be mainly driven by the lower degree of financial literacy that is found for women relative to men (see Table 1). Moreover, the difference across gender is not too strong; it is statistically significant for owning a debit card and for saving at a formal financial institution at a 10 percent level, only.

Overall, the regressions described in this Section show for a large country sample what findings based on microdata have indicated: people with higher financial literacy are more financially included (Cole et al., 2011; Doi et al., 2014; Drexler et al., 2014; Jamison et al., 2014). An advantage of the cross-country study is – beyond its external validity – that we are able to control for a number of institutional variables and study interactions with

these, which is typically impossible in work based on microeconomic data. Thus, we see that an improvement in financial literacy by the general population has heterogeneous effects, depending on the kind of financial inclusion: regarding access to finance, the effect of financial literacy is stronger at low levels of financial inclusion (at least when looking at bank account ownership), but regarding the use of financial services, more financial literacy seems to strengthen the effect of financial infrastructure.

4. Instrumental variable regressions

In order to test whether the relationship between financial literacy and financial inclusion is causal we employ an instrumental variable approach. In addition, we perform a number of additional checks that confirm the results of our preferred IV model.

4.1. Numeracy as an instrument

We first look at teaching of numeracy in primary school as instrument for financial literacy. A good instrument needs to be highly correlated with financial literacy, but must not have any direct effects on financial inclusion. The kind of numerical skills that provide the foundations of good financial literacy are quite basic and are learned early on in life. It is highly likely that if the population of a country has good foundations in numeracy that it will also have higher levels of financial literacy. Indeed, good numeracy (Sekita, 2011) and education dedicated to economics (van Rooij et al., 2012) have previously been used in microdata studies on financial literacy to instrument for financial literacy.

Table 5
Financial literacy and financial inclusion for women and men.

	(1) Account ownership Women	(2) Account ownership Men	(3) Debit card ownership Women	(4) Debit card ownership Men	(5) Saved at formal fin. institution Women	(6) Saved at formal fin. institution Men	(7) Used debit card in the last year Women	(8) Used debit card in the last year Men
FL – women	0.556*** (0.146)		0.578*** (0.138)		0.475*** (0.147)		0.685*** (0.140)	
FL – men		0.434*** (0.132)		0.417*** (0.126)		0.346** (0.143)		0.619*** (0.130)
Log GDP p.c. (PPP)	12.489*** (2.823)	14.200*** (2.708)	12.793*** (2.673)	15.482*** (2.592)	1.823 (2.843)	3.912 (2.934)	11.888*** (2.715)	13.049*** (2.675)
Population share between 15 and 64	−0.325 (0.336)	−0.251 (0.316)	−0.614* (0.318)	−0.466 (0.302)	−0.791** (0.339)	−0.855** (0.342)	−0.871*** (0.323)	−0.698** (0.312)
Secondary education	0.062 (0.111)	−0.014 (0.105)	0.054 (0.105)	0.016 (0.101)	0.010 (0.112)	−0.056 (0.114)	−0.015 (0.107)	−0.033 (0.104)
Tertiary education	−0.151 (0.155)	−0.186 (0.147)	0.039 (0.146)	−0.018 (0.140)	0.068 (0.156)	0.033 (0.159)	0.272* (0.149)	0.183 (0.145)
Private credit to GDP	0.140*** (0.041)	0.126*** (0.039)	0.104*** (0.039)	0.089** (0.037)	0.125*** (0.041)	0.110*** (0.042)	0.059 (0.039)	0.040 (0.038)
Bank branches per 1000 km²	0.063** (0.031)	0.057* (0.029)	0.034 (0.029)	0.038 (0.028)	0.017 (0.031)	0.025 (0.032)	0.030 (0.030)	0.032 (0.029)
Strength of legal rights index	0.381 (0.572)	0.292 (0.545)	0.137 (0.542)	−0.076 (0.521)	0.640 (0.576)	0.746 (0.590)	0.521 (0.550)	0.205 (0.538)
Ease of doing business index	−0.123** (0.055)	−0.088* (0.051)	−0.120** (0.052)	−0.095* (0.049)	0.034 (0.055)	0.029 (0.056)	−0.076 (0.053)	−0.081 (0.051)
Constant	−63.833** (30.229)	−74.712*** (28.461)	−62.945** (28.622)	−86.730*** (27.242)	52.539* (30.444)	47.549 (30.837)	−55.676* (29.070)	−70.451** (28.115)
Test women = men (p–values)	0.1916	0.0791*	0.0879*	0.3929				
R²	0.800	0.791	0.805	0.811	0.358	0.318	0.769	0.774
Observations	119	119	119	119	119	119	119	119

Notes: The table shows OLS results with standard errors in parentheses. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively.

At the same time, we argue that the quality of numeracy education in primary school has no direct effect on financial inclusion. First, as only adults are included in our financial inclusion variables, numeracy of children has no direct effect on this outcome. Indeed, the indicators that we use in our regression measure financial inclusion for the population above the age of 15. We are hence looking at two different sets of people. Second, basic numeracy skills alone such as those taught in primary schools should not have direct effect on financial inclusions. Being able to do basic calculations is quite different, for example, from knowing the value of a bank account. Therefore, we believe that good basic numeracy skills such as those taught in primary schools, only effect financial inclusion through financial literacy. However, we discuss possible qualifications later.

We here use the quality of mathematics education in primary school as it is measured by the EDSTAT data (see Angrist, Patrinos, & Schlotter, 2013, for details of data generation). This dataset makes educational achievement test scores comparable for a larger number of countries. Studies that are designed to test international achievements such as the PISA or the TIMSS survey usually do not include many developing countries. Fortunately, Angrist et al. (2013) also include countries that are only part of regional educational comparisons survey such as the LLECE, which covers countries in Latin America. Similarly, the SACMEQ only covers countries in Africa. The authors anchor these international and regional surveys to the US in order to make them comparable.

There is, however, still the problem in this data that numeracy scores in primary school are not available for all countries. In this case we impute numeracy scores in primary school using numeracy scores in secondary school. If this information was also not available, we record the data point as missing. The imputation is described in Table A6 in the Appendix. Hence our sample size, covering 93 countries, is smaller for the instrumental variable regression than for the OLS regression. For this reason, we rerun all OLS regression only using the 93 countries for which we have a numeracy score. The coefficient remains significant. These results, together with results for IV regressions are shown in Tables A8 and A9 in the Appendix.

First stage regression results are shown in Table A7 in the Appendix. Stock-Yogo F-statistics are at 9.67 proving that the instrument is not weak. This can also be inferred by looking at the F-statistic for the first stage, which is 15.24 and so far above the commonly used cut off of 10. Together these tests indicate that numeracy in primary school is a valid instrument for financial literacy in our study. As we are only using one instrument, overidentification cannot be tested.

We repeat all OLS regressions shown in Table 2, using an IV-approach with the quality of numeracy education in primary school as an instrument. Results are depicted in Table 6. Column (1) shows the relationship without any control variables. The positive and significant relationship between the level of financial literacy and the proportion that has access to a bank remains and even gets larger. As before, we add control variables in two steps and confirm our previous results: financial literacy has a strong and significant effect on having a bank account. The high significance levels of the IV regressions indicate to us that this relationship is causal. We also find this pattern when looking at the proportion of people that have debit card as an outcome variable.

As before, we also examine financial literacy and the use of financial services by IV regression analysis. Results are presented in Table 7. The patterns are the same as for access to financial services. The effect of financial literacy on the use of financial services remains significant and the coefficient gets even larger. Hence, we find that financial literacy also has a significant and causal relationship on the use of financial services.

4.2. Discussion

While we are convinced about the usefulness of the instrument, which has been used before and is supported by available tests, it is methodologically impossible to show that it is water-proof. Indeed, there are reasonable arguments that governments might follow policies which improve numeracy and financial inclusion at the same time without any causal link via financial literacy, indicating that we observe spurious correlations. For example, governments might support education in scientific or technological subjects

Table 6
Financial literacy and access to financial services – IV results.

	(1) Account ownership IV	(2) Account ownership IV	(3) Account ownership IV	(4) Debit card ownership IV	(5) Debit card ownership IV	(6) Debit card ownership IV
Financial literacy	2.570***	2.376***	1.885***	2.50***	1.910***	1.636***
	(0.318)	(0.679)	(0.688)	(0.281)	(0.480)	(0.522)
Log GDP p.c. (PPP)		3.171	2.686		7.818	6.230
		(8.302)	(8.298)		(5.628)	(5.903)
Population share between 15 and 64		1.904*	1.063		1.161	0.621
		(0.995)	(0.926)		(0.709)	(0.719)
Secondary education		−0.204	−0.089		−0.098	−0.011
		(0.198)	(0.179)		(0.171)	(0.171)
Tertiary education		−0.552**	−0.364*		−0.295	−0.233
		(0.267)	(0.188)		(0.213)	(0.185)
Private credit to GDP			0.119**			0.076*
			(0.049)			(0.044)
Bank branches per 1000 km^2			0.064			0.030
			(0.061)			(0.057)
Strength of legal rights index			−1.078			−1.162
			(1.028)			(0.818)
Ease of doing business index			−0.048			−0.064
			(0.096)			(0.089)
Constant	−37.54***	−164.84***	−96.14**	−50.55***	−167.78***	−107.91***
	(12.010)	(27.857)	(42.738)	(11.281)	(21.879)	(39.002)
R^2	0.186	0.453	0.640	0.291	0.648	0.702
Observations	100	98	93	100	98	93

Notes: The table reports IV regression results with robust standard errors in parentheses. Columns (1)–(3) show results with the proportion of the population that has a bank account as the outcome variable. Column (4)–(6) show results with the proportion that has a debit card as the outcome variable. Numeracy in primary schools acts as an instrument in these regressions. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 7
Financial literacy and use of financial services – IV results.

	(1) Saved at formal fin. institution IV	(2) Saved at formal fin. institution IV	(3) Saved at formal fin. institution IV	(4) Used debit card in the last year IV	(5) Used debit card in the last year IV	(6) Used debit card in the last year IV
Financial literacy	1.513***	1.439***	1.117***	2.367***	1.759***	1.630***
	(0.187)	(0.444)	(0.410)	(0.246)	(0.389)	(0.505)
Log GDP p.c. (PPP)		2.656	1.388		6.305	5.520
		(4.885)	(4.773)		(4.651)	(5.096)
Population share between 15 and 64		0.374	−0.114		0.600	0.326
		(0.675)	(0.601)		(0.606)	(0.739)
Secondary education		−0.168	−0.042		−0.060	−0.019
		(0.140)	(0.127)		(0.144)	(0.151)
Tertiary education		−0.137	−0.059		0.013	0.030
		(0.194)	(0.147)		(0.191)	(0.182)
Private credit to GDP			0.101**			0.030
			(0.041)			(0.042)
Bank branches per 1000 km²			0.075*			0.016
			(0.040)			(0.058)
Strength of legal rights index			−0.486			−0.611
			(0.735)			(0.799)
Ease of doing business index			−0.011			−0.038
			(0.059)			(0.091)
Constant	−33.12***	−68.54***	−25.66	−58.33***	−130.99***	−99.82**
	(7.122)	(20.657)	(27.199)	(9.854)	(19.254)	(43.958)
R²	0.505	0.570	0.675	0.456	0.706	0.698
Observations	100	98	93	100	98	93

Notes: The table reports IV regression results with robust standard errors in parentheses. Columns (1)–(3) show results with the proportion of the population that saved at a formal financial institution in the last year as the outcome variable. Column (4)–(6) show results with the proportion that used their debit card in the last year as an outcome variable. Numeracy in primary schools acts as an instrument in these regressions. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

(and thus mathematics) and financial innovations (improving financial inclusion). Clearly, such cases may exist, and we try to consider them in further checks below. However, we argue that they do not drive the cross-country relations of interest. At the same time our line of argument – from numeracy via financial literacy to financial inclusion – is strongly supported by many micro-based studies.

4.3. Placebo IV regressions

Some may argue that numeracy levels of primary school children are not a suitable instrument for financial literacy. The exclusion restriction could potentially be violated. One could imagine that certain types of government, for example, are particularly interested in reducing poverty and so increase education and financial inclusion at the same time. If this were the case, it should also be possible to use other measures of educational quality, such as performance on literacy, as an instrument for financial literacy. The first stage regression is shown in Table A10, whereas the second stage regression is shown in Table A11. We can see from the first stage regression that literacy levels do not work as an instrument for financial literacy, as the F-statistics for weak instrument test is only 0.77 and hence far below the rule of thumb value of 10. At the second stage financial literacy no longer explains financial inclusion when instrumented with literacy levels in primary school. Hence we show that numeracy, but not performance on general literacy, works as an instrument for financial literacy. This indicates to us that the exclusion restriction is not violated in the IV regressions that use numeracy as an instrument.

4.4. Additional control variables

It is further possible that a government that wants to promote financial inclusion particularly invests in numeracy education in primary schools and at the same time supports operations of state owned banks. In this case the exclusion restriction of our IV would also be violated. In order to examine this, we add the proportion of

assets at state owned banks in relation to all bank assets as a control variable. Results are presented in Table A12. They show no change in the significance levels of the financial literacy coefficient and the size of the coefficient is similar.

In an alternative approach to test the same concern as above we split the main sample at the median of the share of assets held at state-owned banks in a country. Thus, we get a sub-sample of 45 countries without or with a small presence of state-owned banks whose operations should not drive the results (if one is concerned about this). Results in Table A13 show that the qualitative pattern between financial literacy and inclusion remains unchanged.

To examine this potential violation of the exclusion restriction further, we control for government consumption expenditure and for government expenditure on education (see Table A14). Again, our previous results remain robust and coefficients have roughly the same size.

4.5. Historic numeracy as an instrument

Further it is possible that in a country with an inclusive financial system, greater emphasis is put on teaching numeracy early on, e.g. as to create a workforce of the new financial sector. In order to check if this drives our IV results above, we also use numeracy levels for the cohort born in 1960 as an instrument. This group of people would have gone to school in the 1970s. The data uses "age heaping" – the tendency of people in countries without formal records to estimate their age – to estimate numeracy skills. Hence, the extent to which ages ending in 5 or 0 are over reported in self-reported age data is used as an estimate for numeracy in that country at the time (A'Hearn, Baten, & Crayen, 2009). The database uses a large number of publically available records to gather data on age heaping. Hence, the data used to estimate numeracy differ between countries. The sample for numeracy levels in 1960 is relatively small. Where available we impute 1960 numeracy with 1950 numeracy levels and thus end up with a sample of 47 countries. The F-statistic of the first stage is above 10, indicating that the instrument is not weak. The first and second stage regressions

are shown in Tables A15 and A16, respectively. There is a positive relationship between financial literacy and financial inclusion, however, the coefficients are not significant. This may be due to small sample size or due to other sources of noise in the measurement of numeracy and the relationship between numeracy for people born in 1960 and financial inclusion in 2014.

5. Robustness

The robustness section here presents just a few highlights of all tests which are available in Appendix B. Robustness checks address four issues: they provide evidence that our results are causal (Section B1), that our main findings also hold for various subgroups within countries (Section B2), that they are robust to various changes in variable definitions or considerations (Section B3), and that different estimation techniques confirm results (Section B4).

As potentially interesting results we mention a few findings from Sections B1 and B2. First, we ran the Lewbel (2012) model on all our previous regressions. This uses instruments that are generated from within the model. The results confirm our findings that use the conventional IV method.

In Section B2 we test whether financial literacy works differently for various groups across and within countries. We find that increasing the level of financial literacy in the population has heterogeneous effects for countries with different levels of GDP per capita and that this pattern is qualitatively the same as for financial depth presented in Section 2.3. Accordingly, the effect of increasing financial literacy on access to finance would have the largest effect in countries with low levels of GDP per capita. The effect of increased financial literacy on use of financial services, however, is larger at higher levels of GDP per capita.

Moreover, we test whether the link between financial literacy and financial inclusion is stronger for certain groups of the population than for other ones. To do this, we use data that show the proportion of the poorest 40 percent and richest 60 percent of the country that can answer questions on three out of four financial literacy concepts correctly. As the outcome variable we use respective measures of financial inclusion, i.e. also of the poorest 40 percent and richest 60 percent of the population. We rerun the regressions above, but this time broken down by within country income groups. Results do not really indicate that the link between financial literacy and financial inclusion is stronger for the richer part of the population, because the difference between coefficients is always far away from statistical significance.

We also rerun our main regression, but exclude countries where more than half of the population is Muslim (Maoz and Henderson, 2013). As three out of the five questions asked regard interest and interest compounding, excluding Islamic countries may affect the outcome. Indeed, financial literacy at 28.4 percent is slightly worse in the 40 countries that have more than 50 percent Muslims than the worldwide average. However, when we exclude these countries from our standard regressions, the results remain the same, both regarding significance of coefficients and their economic importance.

6. Conclusion

We know that good financial literacy contributes to good financial decision making. However, to the best of our knowledge, this is the first study that examines the link between financial literacy and financial inclusion at the country level. This comes with the advantage that contrary to individual level studies we can control for a large number of country, institutional, and financial characteristics. Further, we are able to study the heterogeneous effects of financial literacy in relation to these financial institutions. Knowing whether financial literacy affects financial inclusion and how this effect differs for country specific variables is crucial for policy makers aiming for increasing financial inclusion. At the same time, studying financial literacy and financial inclusion on a cross country level provides more external validity compared to papers using country specific data.

We start our analysis by looking at the relationship between the proportions of people in a country that can be considered financially literate and four measures of financial inclusion. We find a positive and significant relationship between financial literacy and all four measures of financial inclusion. This result holds when controlling for a large number of country, financial and institutional characteristics. Moreover, we confirm the causal interpretation of all our results using a conventional IV strategy and conducting a large set of robustness checks, including the more recent IV-approach developed by Lewbel (2012). Hence, results suggest a clear policy message: Improving financial literacy is a worthwhile option, also at the macro level, i.e. financial education could be an important instrument of financial development in addition to the more conventional policy of expanding financial infrastructure. This is because both, the demand for financial services in the form of financial literacy and the supply of financial services, are important for financial inclusion.

We further study the heterogeneous effects of financial literacy for different institutional backgrounds. We find that the marginal effect of financial literacy on *access* to finance is larger at low levels of financial depth, but the marginal effect of financial literacy on the *use* of financial services is larger at high levels of financial depth. Thus, from a policy perspective, at all levels of financial depth, improving financial literacy is useful for improving financial inclusion. The country data suggest that at early stages of financial development literacy may be seen to some extent as alternative to increasing financial depth (representing infrastructure); at later stages of financial development, however, financial literacy seems to be a necessary ingredient in order to make full use of available infrastructure. Obviously, more research investigating these newly uncovered relations would be beneficial.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.worlddev.2018.06.020.

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