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Too much finance?

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Abstract This paper examines whether there is a threshold above which financial depth no longer has a positive effect on economic growth. We use different empirical approaches to show that financial depth starts having a negative effect on output growth when credit to the private sector reaches 100 % of GDP. Our results are consistent with the "vanishing effect" of financial depth and that they are not driven by endogeneity, output volatility, banking crises, low institutional quality, or by differences in bank regulation and supervision.

Keywords Finance · Growth · Financial crises · Non-linearities

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..we are throwing more and more of our resources, including the cream of our youth, into financial activities remote from the production of goods and services, into activities that generate high private rewards disproportionate to their social productivity.

James Tobin (1984)

1 Introduction

This paper reexamines the relationship between financial depth and economic growth. It reproduces the standard result that, at intermediate levels of financial depth, there is a positive relationship between the size of the financial system and economic growth, but it also shows that, at high levels of financial depth, more finance is associated with less growth.

The idea that a well-working financial system plays an essential role in promoting economic development dates back to Bagehot (1873) and Schumpeter (1911). Empirical evidence on the relationship between finance and growth is more recent. Goldsmith (1969) was the first to show the presence of a positive correlation between the size of the financial system and long-run economic growth. He argued that this positive relationship was driven by financial intermediation improving the efficiency rather than increasing the volume of investment (this is also the channel emphasized by Grenwood and Jovanovich 1990, and Bencivenga and Smith 1991). However, Goldsmith made no attempt to establish whether there was a causal link going from financial depth to economic growth.[1]

In the early 1990s, economists started working towards identifying a causal link going from finance to growth. King and Levine (1993) were the first to show that financial depth is a predictor of economic growth and Levine and Zervos (1998) showed that stock market liquidity (but not the size of the stock market) predicts GDP growth. More evidence in this direction came from Levine et al. (2000) and Beck et al. (2000) who used different types of instruments and econometric techniques to identify the presence of a causal relationship going from finance to growth.[2] Rajan and Zingales (1998) provided additional evidence for a causal link going from financial to economic development by showing that industrial sectors that, for technological reasons, are more dependent on external finance grow relatively more in countries with a larger financial sector.[3]

[1] Several economists thus remained of the view that a large financial system is simply a by-product of the overall process of economic development. Among the remaining skeptics, Levine (2005) cites Robert Lucas (1988). Rodrik and Subramanian (2009) also suggest that economists may overemphasize the role of finance in economic development. Demetriades and Hussein (1996) apply time series techniques to a sample of 16 countries and find no evidence of a causal relationship going from finance to growth. Arestis and Demetriades (1997) and Arestis et al. (2001) discuss how institutional factors may affect the relationship between finance and growth and warn against the one-size-fits-all nature of cross-sectional exercises. Demetriades and Law (2006) show that financial depth does not affect growth in countries with poor institutions and Rousseau and Wachtel (2002) find that finance has no effect on growth in countries with double digit inflation. De Gregorio and Guidotti (1995) show that in high-income countries financial depth is positively correlated with output growth over the 1960–1985 period but that the correlation between financial depth and growth becomes negative for the 1970–1985 period. They suggest that high-income countries may have reached the point at which financial depth no longer contributes to increasing the efficiency of investment. Rousseau and Wachtel (2011) also find a vanishing effect of financial depth and show that credit to the private sector has no statistically significant impact on GDP growth over the 1965–2004 period. For surveys with more details on causality see Levine (2005) and Panizza (2013).

[2] Levine et al. (2000) instrumented their cross sectional regressions with legal origin (Porta et al. 1998) and Beck et al. (2000) argued for causality by using the dynamic panel data estimators developed by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998).

[3] While the Rajan and Zingales (1998) approach can only be used to evaluate the relative effect of financial development, it does provide strong support for a channel through which finance could affect growth.

These efforts notwithstanding, the causality issue has not been fully resolved. Our paper is thus subject to the same types of criticism that have been levied against the existing literature on finance and growth. However, we think that our exploration of non-monotonicities in the link between finance and growth is relevant because, even though no single paper by itself demonstrates that finance has a causal effect on growth, we agree with Levine's (2005, p. 867) assessment that: "While subject to ample qualifications (…) the preponderance of evidence suggests that both financial intermediaries and markets matter for growth even when controlling for potential simultaneity bias."

We also contribute to the literature on causality by using an identification strategy which, to the best of our knowledge, has not yet been used to analyze the finance-growth nexus. In the presence of heteroskedasticity in the regression's residual, this methodology allows identifying causal relationships even in the absence of external instruments (Rigobon 2003; Lewbel 2012). We provide a non-technical explanation of identification through heteroskedasticity and then show that our results are robust to controlling for endogeneity with this novel technique.

While most empirical papers study the relationship between financial depth and steady state growth, Aghion et al. (2005) develop and test a theory in which financial depth can speed convergence to the steady-state but has a limited effect on long-run growth.[4] We show that the presence of a non-monotonic relationship between finance and growth is robust to controlling for the convergence effect of financial depth.

There seems to be a contradiction between the empirical literature that finds a positive effect of financial depth on economic development and the literature that has shown that credit growth is a predictor of banking and currency crises (e.g., Kaminsky and Reinhart 1999; Schularick and Taylor 2012). However, the fact that a large financial sector may increase volatility does not necessarily mean that large financial systems are bad. It is possible that countries with large financial sectors pay a price in terms of volatility but are rewarded in terms of higher growth (Ranciére et al. 2008). Loayza and Ranciere (2006) reconcile these two findings by using a panel error correction model to jointly estimate the short- and long-run effects of financial depth. They find that a positive long-run relationship between financial depth and economic growth coexists with a negative short-run relationship between these two variables, and that this negative short-run relationship is mostly driven by financial crises. These authors, however, do not allow for a non-monotonic effect of financial depth.

In this paper, we use different datasets and empirical approaches to show that the marginal effect of financial depth on output growth becomes negative when credit to the private sector reaches 80–100 % of GDP. This result is consistent across different types of estimators (simple cross-sectional and panel regressions as well as semi-parametric estimators) and data (country-level and industry-level).

When our paper was first circulated there was limited work which considered a non-monotonic relationship between financial and economic development.[5] Our result of a non-monotonic relationship between finance and growth has been corroborated by many

[4] Gaytan and Rancière (2004) develop and test a model in which the contribution of finance to growth is increasing in national wealth.

[5] Deidda and Fattouh (2002) used cross-country data and a threshold regression model to show that financial depth has a positive but statistically insignificant impact on output growth in countries with low level of economic development or financial depth and that financial depth has a positive and statistically significant impact on growth in countries with higher levels of economic development and financial depth. Rioja and Valev (2004) divided a panel of 72 countries into three groups and showed that there is no statistically significant relationship between finance and growth at low levels of financial depth, there is a strong and positive relationship at intermediate levels of financial depth, and a weaker but still positive and statistically significant effect of finance at higher levels of financial depth.

other authors who estimated models similar to ours by using different datasets, empirical methodologies, and studied productivity growth instead of GDP growth (papers that broadly support our findings include Cecchetti and Kharroubi 2012; Pagano 2012; Eugster 2013; Law and Singh 2014; Aizenman et al. 2015).

The threshold at which we find that financial depth starts having a negative effect on growth is similar to the threshold at which Easterly et al. (2000) find that financial depth starts having a positive effect on volatility. This finding is consistent with the literature on the relationship between volatility and growth (Ramey and Ramey 1995) and that on the persistence of negative output shocks (Cerra and Saxena 2008). However, our results are not purely driven by crises and volatility. We show that our finding of a non-monotonic relationship between financial depth and economic growth is robust to controlling for macroeconomic volatility, banking crises, and institutional quality.

Our results differ from those of Rioja and Valev (2004) who find that, even in their "high region," finance has a positive, albeit small, effect on economic growth. This difference is due to the fact that their threshold for the "high region" is set at 37 % of GDP. The threshold is thus much lower than the level of financial depth at which we find that finance starts having a negative effect on growth.

Our results are instead consistent with the "vanishing effect" of financial depth found by Rousseau and Wachtel (2011). If the true relationship between financial depth and economic growth is non-monotonic, models that do not allow for non-monotonicity will lead to a downward bias in the estimated relationship between financial depth and economic growth. We use a standard bias formula and a simple Montercarlo simulation to show that this downward bias increases with the size of the financial sector. Over the last twenty years financial sectors have grown rapidly. Therefore, it is not surprising that exercises that use recent data find a vanishing effect of financial depth.

Our argument is that this vanishing effect is not driven by a change in the fundamental relationship between financial depth and economic growth, but by the fact that models that do not allow for a non-monotone relationship between financial depth and economic growth are misspecified.

2 Theoretical considerations

Levine (2005) provides an extensive survey of the theoretical literature that describes how the services provided by the financial sector can contribute to economic growth by: (i) producing ex-ante information about investment opportunities; (ii) improving ex-post monitoring of investment and exerting corporate governance; (iii) facilitating risk management and diversification; (iv) mobilizing and pooling savings; and (v) easing the exchange of goods and services.

In the presence of high levels of inequality, credit market imperfections can also have a negative effect on growth (and perpetuate inequality) because they prevent the poor from accumulating human capital which, unlike physical capital, needs to be spread throughout the population (Galor and Zeira 1993; Galor and Moav 2004).

This section surveys theories that are consistent with our finding that at high levels of financial depth more credit is associated with less economic growth. Before doing so, we need to clarify that, while the concept of financial development relates to the financial system's overall ability to reduce the information, transaction, and enforcement costs associated with the intertemporal nature of financial contracts, we focus on a much narrower definition of financial depth which is an imperfect proxy for the much broader concept of financial development.[6] Specifically, we use credit to the private sector over GDP as an empirical proxy for financial development. Credit to the private sector was first used as a measure of financial depth by King and Levine (1993). It has now become one of the most commonly used measures of financial depth because the amount of credit allocated to the private sector is likely to be positively associated with the five financial functions described above (Levine 2005).

The first possible explanation for our empirical results relates to theories which focus on the evolving role of banks and security markets in the process of economic development. Demirgüç-Kunt et al. (2013) review a vast body of theoretical work suggesting that decentralized markets have a comparative advantage in designing customized products that can finance high-risk long-term projects with limited collateral and that banks, instead, are better suited to provide low-cost standardized products that can finance lower risk projects. In advanced economies, entrepreneurs are more likely to need a rich set of risk management tools and vehicles for raising capital (Levine 2005) and securities markets become more important for reducing market frictions associated with complex and risky projects that require non-standard financial arrangements.

While the empirical evidence suggests that, other things equal, countries with bank-based financial systems are comparable in terms of economic growth with countries with market-based financial systems (Levine 2002, provides cross-country evidence; Beck and Levine 2002, and Demirgüç-Kunt and Maksimovic 2002, corroborate Levine's results using industrial sectors and firm-level data), Demirgüç-Kunt and Levine 2001) show that, as countries become richer, their domestic financial systems tend to become more market-based. Moreover, Demirgüç-Kunt et al. (2013) show that the positive correlation between economic growth and bank credit is decreasing in the level of economic development (measured by GDP per capita) and that the (also positive) correlation between different measures of the importance of security markets and economic growth is increasing in the level of economic development. While Demirgüç-Kunt et al. (2013) make no claim concerning causality, their findings are consistent with theories suggesting that the services provided by banks become less important when economies become richer.

If the optimal structure of the financial system evolves with the level of economic development, our main result may indicate that certain countries have too much credit and not enough financial services provided by different components of the financial system. In this case, the problem would not be one of "too much finance" (as we, provocatively titled our paper), but one of the wrong type of finance.[7] Theories that highlight the evolving role of banks and security markets would also be consistent with the finding that as countries become richer, credit to the private sector is no longer an important positive factor in explaining economic growth, albeit not necessarily a negative factor. This interpretation is also consistent with our finding. As we add more and more years to our regressions, we find that the share of observations which are below the threshold under which credit to the private sector is positively and significantly associated with economic growth goes from 96 to 34 % of our sample.

An alternative set of explanations relates to risk-taking and volatility. Minsky (1974) and Kindleberger (1978) emphasized the relationship between finance and macroeconomic volatility and wrote extensively about financial instability and financial manias. More recently, in a paper that seemed controversial then, and looks prophetic now, Rajan (2005)

6 For a discussion of the concept and process of financial development per se, see also de la Torre et al. (2011).

7 We would like to thank an anononymous referee for helping us in thinking through this interpretation of our results.

discussed the dangers of financial development suggesting that the presence of a large and complicated financial system had increased the probability of a "catastrophic meltdown." Easterly et al. (2000) empirically show that there is a convex and non-monotonic relationship between financial depth and the volatility of output growth. Their point estimates suggest that output volatility starts increasing when credit to the private sector reaches 100 % of GDP.

A large financial sector may also lead to a suboptimal allocation of talents. Tobin (1984), for instance, suggested that the social returns of the financial sector are lower than its private returns and worried about the fact that a large financial sector may "steal" talents from the productive sectors of the economy and therefore be inefficient from society's point of view. Kneer (2013), Philippon and Reshef (2013), and Cecchetti and Kharroubi (2015) provide evidence which is consistent with this view.[8] Since finance is now a traded sector it may make sense for certain countries (or cities) to specialize in providing financial services to the rest of the world. If this were the case, there would not be any misallocation but just some form of optimal international division of labor. Beck et al. (2014) explore the 'financial center view' based on the idea that large financial sectors arise as export sectors in response to specific comparative advantages and find that, while intermediation activities have a positive effect on growth, an expansion of the financial sectors along other dimensions increases volatility without benefitting long-run growth.

The way in which finance impacts economic growth may also depend on whether lending is used to finance investment in productive assets or to feed speculative bubbles. It is thus possible that the non-monotonic relationship between financial depth and economic growth is driven by excessive household (especially mortgage) lending. Using data for 45 countries for the period 1994–2005, Beck et al. (2012) show that enterprise credit is positively associated with economic growth but that there is no correlation between growth and household credit.

Finally, decreasing returns to financial depth may be linked to the increasing importance of credit transfer and repackaging versus credit origination. In the discussions that followed the recent crisis it has been argued that derivative instruments and the "originate and distribute" model, which by providing hedging opportunities and allocating risk to those better equipped to take it were meant to increase the resilience of the banking system, actually reduced credit quality and increased financial fragility. According to several authors, complex financial products may increase financial fragility without contributing to economic growth. For instance, Coval et al. (2009) describe the role of complex structured products in the US financial crisis and Gennaioli et al. (2010) develop a theory in which the presence of some neglected tail risk coupled with financial innovation can increase financial fragility even in the absence of leverage.

In the concluding section of the paper, we discuss how our results relate to these various theories.

3 Country-level data

We build on the large literature that uses country-level data to show the presence of a positive relationship going from financial depth to economic growth (Levine 2005) and use parametric

[8] There are two distortions that may create a wedge between private and social returns: bank bailouts and the remuneration structure of bank managers (Rajan 2010; Crotty 2009). The second distortion may also lead to a reduction of shareholder value. Deidda (2006) develops a model in which the financial sector can have a negative effect on growth because it subtracts resources from the productive sectors.

and semi-parametric techniques to study what happens if we allow for a non-monotonic relationship between financial depth and economic growth.[9]

To compare our results with the existing literature, we build on the empirical exercises of a paper that summarizes the main findings on financial depth and economic growth by two leading scholars in the field (Beck and Levine 2004). As in most of the literature that looks at the relationship between finance and growth, we quantify financial depth by using credit to the private sector. The use of this variable is usually justified with the argument that a financial system that lends to private firms is more likely to stimulate growth through its risk evaluation and corporate control capacities than a financial system that only provides credit to the government or state-owned enterprises (King and Levine 1993). There are many reasons why this variable, which only captures quantities, is an imperfect measure of financial development (for a discussion, see Levine 2005), but at this stage it remains the best indicator of financial depth which is available for a large cross-section of countries.

In measuring credit to the private sector, we depart from Beck and Levine (2004) and use total credit to the private sector extended by deposit banks and other financial institutions (this is the same variable used by King and Levine 1993) instead of using total credit to the private sector extended by deposit banks only. Until the late 1990s, bank credit to the private sector was almost identical to total credit to the private sector. Since most papers that study the relationship between financial depth and growth use data that end in the year 2000, the choice between these two variables did not really matter. However, the two series started diverging at the beginning of the new millennium and there are now several countries in which total credit to the private sector is much larger than bank credit to the private sector. In the United States, for instance, the creation of a "shadow banking system" has led to a situation in which total credit to the private sector is almost four times larger than credit extended by deposit-taking banks. Moreover, since we are attempting to assess the impact of financial depth in countries where the sector is particularly large, it is arguably wiser to use a measure of financial depth that is more in tune with our hypothesis of there being potentially "too much" finance. Note, however, that we also report results for bank credit only and show that our results are robust to this alternative measure of financial depth.[10]

In a previous version of this paper (Arcand et al. 2011), we followed Beck and Levine (2004) and used the turnover ratio in the stock market as a second indicator of financial depth. However, controlling for the turnover ratio imposes severe constraints in terms of country and time coverage. Therefore, we now concentrate on credit to the private sector. The results described below are robust to controlling for the turnover ratio.[11]

[9] Most studies use the log of financial depth and therefore allow for a non-linear relationship between financial development and economic growth. However, they do not include higher polynomial terms and thus they do not allow for a non-monotonic relationship between these two variables.

[10] Another issue that could affect our results in terms of the validity of our measure of financial depth is that of bond financing. Data on the size of the corporate bond market are available from the BIS. However, the sample starts in 1989 and only covers 33 countries. Coverage has increased over time. By 2005 the BIS sample included 42 countries. Capitalization is small. In 2005, average capitalization for the 42 countries for which data are available was 6 % of GDP. Only 12 countries have a capitalization greater than 10 % of GDP (Canada, Chile, Iceland, Italy, Japan, South Korea, Malaysia, Malta, Portugal, Taiwan Province of China, Thailand, and the United States) and 22 countries had a capitalization lower than 5 % of GDP. It is thus highly likely that this source of finance is at most marginal for the broad sample of countries that we consider.

[11] The results are in Arcand et al. (2011). In the regressions that include turnover we find that there is a positive and monotonic relationship between the turnover ratio and economic growth, and that the non-monotone relationship between credit to the private sector and economic growth is robust to controlling for the turnover ratio.

As is standard in the literature on financial depth and economic growth, all of our regressions include the log of initial GDP per capita to control for convergence, the initial stock of human capital, trade openness, inflation, and the ratio of government expenditures to GDP. Our data cover the period 1960–2010 and we estimate models for different sub-periods.[12]

3.1 Cross-sectional regressions

We follow Beck and Levine (2004) and start our analysis with a set of simple cross-country regressions in which we regress average GDP per capita growth for the different time periods over the set of variables described above. While we are aware of the fact that there are endogeneity problems with the simple cross-sectional regressions of this section, we think that there is some value in this exercise as simple OLS is a transparent way to describe the data.

Column 1 of Table 1 estimates a specification similar to that used by Beck and Levine (2004). Even though we use a slightly different time period (1970–2000 instead of 1975–1998), we reproduce their result of a positive and statistically significant correlation between GDP growth and the log of credit to the private sector over GDP.

In column 2, we start exploring the "too much" finance hypothesis by replacing the log of credit to the private sector with the level of credit to the private sector (PC) and a quadratic term in this variable (PC^2). We find that both PC and PC^2 are statistically significant. While the coefficient associated with the linear term is positive, the quadratic term is negative, indicating a concave relationship between credit to the private sector and GDP growth. The last row of the table indicates that financial depth starts yielding negative returns when credit to the private sector reaches 82 % of GDP. The great majority of observations (89 % of the total) are below this 82 % threshold and two-thirds of observations are under the 65 % threshold below which the marginal effect of financial depth is both positive and statistically significant. About half of the remaining observations (5 % of the total number of observations) belong to the part of the distribution for which the marginal effect of financial depth is both negative and statistically significant (see Table 17 in the Appendix).

In columns 3 and 4, we estimate the same models as in columns 1 and 2, now focusing on the 1970–2005 period. Again, we find a positive correlation between the log of credit to the private sector and GDP growth (column 3) and the linear and quadratic terms of column 4 still indicate that the marginal effect of credit to the private sector becomes negative at 82 % of GDP. When we estimate the model for the 1970–2010 period we obtain similar results (columns 5 and 6 of Table 1).[13]

We obtain similar results when we move our starting year to 1980 and estimate the model for the 1980–2010 period (columns 1 and 2 of Table 2). However, if we estimate the model for the 1990–2010 period, we find that the coefficient associated with the log of credit to the private sector is no longer statistically significant (column 3). This is consistent with Rousseau and Wachtel's (2011) vanishing effect. However, the vanishing effect does not apply to the quadratic model of column 4. In this case, both coefficients remain statistically significant and imply a threshold when credit to the private sector approaches 95 % of GDP. In this sample, more than 20 % of observations belong to the part of the distribution of credit to the private sector for which the marginal effect of financial depth is negative (see Table 17 in the Appendix). This increasing share of observations above the threshold is consistent

[12] Table 14 in the Appendix describes all the variables used in the empirical analysis and provides a list of sources. Table 15 in the Appendix reports the summary statistics.

[13] In the last two columns of Table 1, we lose three observations for which we do not have recent GDP data. The results are unchanged if we estimate all regressions using the 64 observations sample of these columns.

Table 1 Cross-country OLS regressions

	(1)	(2)	(3)	(4)	(5)	(6)
LGDP(t − 1)	−0.544***	−0.521***	−0.542***	−0.541***	−0.624***	−0.611***
	(0.199)	(0.194)	(0.183)	(0.171)	(0.179)	(0.173)
LPC	0.719**		0.647**		0.697**	
	(0.343)		(0.313)		(0.298)	
PC		5.545**		6.017***		5.608***
		(2.243)		(1.939)		(1.738)
PC2		−3.362**		−3.675***		−3.202***
		(1.492)		(1.259)		(1.075)
LEDU	1.428***	1.457***	1.421***	1.414***	1.318**	1.314**
	(0.437)	(0.422)	(0.459)	(0.427)	(0.530)	(0.501)
LINF	−0.308**	−0.358***	−0.256*	−0.301**	−0.126	−0.165
	(0.127)	(0.123)	(0.130)	(0.125)	(0.140)	(0.139)
LOPEN	0.0655	−0.0723	0.0242	−0.147	0.116	−0.0171
	(0.278)	(0.275)	(0.277)	(0.265)	(0.263)	(0.257)
LGC	−0.219	−0.495	−0.424	−0.807	−0.385	−0.796
	(0.566)	(0.554)	(0.537)	(0.509)	(0.513)	(0.519)
Cons.	5.488***	4.441**	5.962***	5.522***	5.905***	5.257***
	(1.962)	(1.743)	(1.911)	(1.695)	(1.806)	(1.667)
N. Obs	67	67	67	67	64	64
R^2	0.437	0.458	0.420	0.471	0.357	0.406
Period	1970–2000		1970-2005		1970-2010	
dGR/dPC = 0		0.82		0.82		0.88
CI (90 %)		0.65 − 1.24		0.68 − 1.04		0.74 − 1.12

This table reports the results of a set of cross-country OLS regressions in which average real per capita GDP growth over different time periods is regressed on the log of initial GDP per capita ($LGDP$), the log of total credit to the private sector over GDP (LPC), the level of credit to the private sector over GDP (PC), the square of the level of the level of credit to the private sector over GDP (PC^2), the log of average years of education ($LEDU$), the log of government consumption over GDP (LGC), the log of trade openness ($LOPEN$), and the log of inflation ($LINF$). Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

with our hypothesis that the vanishing effect is due to an increasing downward bias in a misspecified regression in which financial depth only enters linearly (we discuss the origin of the bias in greater details in Sect. 3.2.1).

Figure 1 plots the marginal effect of credit to the private sector on growth based on the estimates of column 6, Table 1. It shows that the positive effect of financial depth is no longer statistically significant when credit to the private sector reaches 72 % of GDP (about 30 % of the observations in our sample are above this threshold) and that the effect of financial depth becomes negative and statistically significant when credit to the private sector is greater than 110 % of GDP (11 % of the observations are above this threshold).

Figure 1 shows that the correlation between credit to the private sector and economic growth is positive and statistically significant when financial depth is low and negative and statistically significant when financial depth is high. These are necessary but not sufficient

Table 2 Cross-country OLS regressions

	(1)	(2)	(3)	(4)
LGDP(t − 1)	−0.768***	−0.789***	−0.507*	−0.509*
	(0.201)	(0.189)	(0.293)	(0.278)
LPC	0.728**		0.624	
	(0.293)		(0.379)	
PC		5.318***		5.766***
		(1.861)		(2.071)
PC2		−2.737**		−3.077***
		(1.090)		(0.971)
LEDU	2.017***	1.967***	1.302**	1.209**
	(0.512)	(0.536)	(0.535)	(0.513)
LINF	−0.321**	−0.314**	−0.0583	−0.0347
	(0.142)	(0.156)	(0.229)	(0.234)
LOPEN	−0.234	−0.274	0.0411	−0.0769
	(0.325)	(0.333)	(0.363)	(0.338)
LGC	−0.842*	−1.021*	−1.337***	−1.532***
	(0.504)	(0.542)	(0.493)	(0.506)
Cons.	8.606***	7.167***	7.640**	6.528**
	(2.220)	(1.885)	(2.996)	(2.488)
N. Obs	88	88	101	101
R2	0.408	0.436	0.211	0.273
Period	1980–2010		1990–2010	
dGR/dPC = 0		0.97		0.94
CI (90 %)		0.8 − 1.40		0.72 − 1.1

This table reports the results of a set of cross-country OLS regressions in which average real per capita GDP growth over different time periods is regressed on the log of initial GDP per capita ($LGDP$), the log of total credit to the private sector over GDP (LPC), the level of credit to the private sector over GDP (PC), the square of the level of the level of credit to the private sector over GDP (PC^2), the log of average years of education ($LEDU$), the log of government consumption over GDP (LGC), the log of trade openness ($LOPEN$), and the log of inflation ($LINF$). Robust standard errors in parentheses
*** p < 0.01, ** p < 0.05, * p < 0.1

conditions for the presence of a non-monotonic relationship between credit to the private sector and economic growth.

Given a model of the form $y_i = PC_i\alpha + PC_i^2\beta + Z_i\gamma + u_i$, Lind and Mehlum (2011) show that a test for the presence of an inverted-U relationship needs to be based on the following joint null hypotheses:

$$H_0 : (\alpha + 2\beta PC_{\min} \leq 0) \cup (\alpha + 2\beta PC_{\max} \geq 0), \quad (1)$$

against the alternative:

$$H_1 : (\alpha + 2\beta PC_{\min} > 0) \cap (\alpha + 2\beta PC_{\max} < 0), \quad (2)$$

where $PC_{\min}$ and $PC_{\max}$ are the minimum and maximum values of credit to the private sector, respectively. The test described in (1) and (2) is non-trivial because of the presence

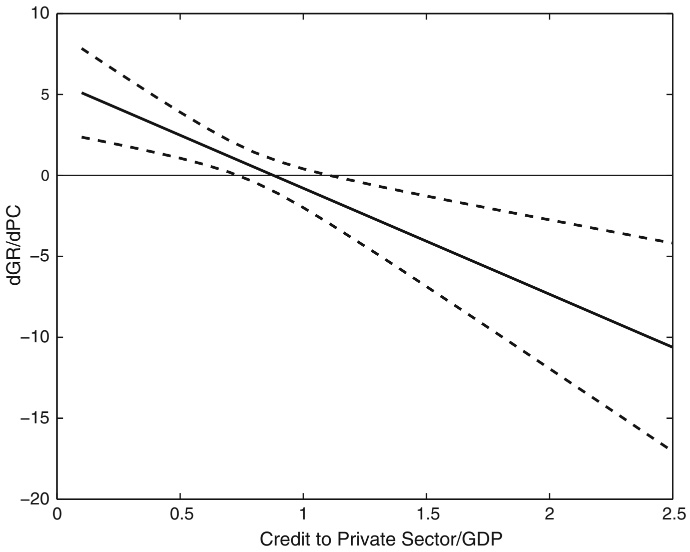

Fig. 1 Marginal effect using cross-country data. This figure plots the marginal effect of credit to the private sector on growth obtained from the regression of Table 1, column 6

of inequality constraints. Lind and Mehlum (2011) use Sasabuchi's (1980) likelihood ratio approach to build a test for the joint hypotheses given by Eqs. (1) and (2).

The first column of Table 3 reports the results of the Sasabuchi–Lind–Mehlum (SLM) test based on the results of column 2 of Table 1. The top panel of the table shows that the marginal effect of credit to the private sector is positive and statistically significant at $PC_{\min}$ and negative and statistically significant at $PC_{\max}$. The bottom panel of the table shows that the SLM test rejects H_0 and thus indicates that our results are consistent with the presence of an inverted$-U$ relationship between credit to the private sector and economic growth. The last row of Table 3 reports a 90 % Fieller interval and shows that the relationship between credit to the private sector and economic growth is not statistically significant when PC ranges between 65 and 124 % of GDP. The second and third columns of Table 3 show that the SLM test yields even stronger results when we base it on regressions using more recent data.

3.1.1 Semi-parametric estimations

The OLS regressions of Table 1 support the idea that the square of credit to the private sector belongs in the regression model and that the effect of credit to the private sector on growth is concave and non-monotone. Our results differ from those of Rioja and Valev (2004) who find an *S*-shaped relationship between financial depth and economic growth which could be better described by a different functional form. Our results could thus be spurious and driven by the specific parametric relationship that we implement. To uncover the true nature of the non-linearity in the relationship between financial depth and economic growth, we estimate a set of semi-parametric regressions which allow financial depth to take an unrestricted functional form.

Formally, we use the differencing procedure suggested by Yatchew (2003) and approximate the functional space with a penalized spline smoother (Wand 2005) to estimate different

Table 3 Tests for an inverse U-shape

	(1)	(2)	(3)	(4)	(5)
Slope at PC_{min}	3.52***	3.68***	3.91***	3.61**	7.20***
	(1.41)	(1.13)	(1.51)	(1.73)	(2.01)
Slope at PC_{max}	−4.19**	−3.13***	−4.14***	−7.27***	−16.63***
	(2.17)	(1.19)	(1.24)	(2.38)	(4.53)
SLM test for inverse U shape	1.83	2.26	2.59	2.10	3.60
p value	0.04	0.01	0.01	0.02	0.00
Fieller 90 % confidence interval	[0.64; 1.27]	[0.73; 1.11]	[0.72; 1.08]	[0.42; 1.13]	[0.68; 0.97]

This table reports the results of the Sasabuchi–Lind–Mehlum test for an inverse U-shaped relationship. The first two columns are based on the estimates of columns 2 and 6 of Table 1, the third column is based on the estimates of column 4 of Table 2, the fourth column is based on column 4 of Table 6, and the fifth column is based on the estimates of column 4 of Table 8. Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

variants of the following model:

$$GR_i = \beta_0 + X_i\beta + f(PC_i) + \varepsilon_i. \quad (3)$$

When we estimate the model of column 6, Table 1, by allowing credit to the private sector to take a general form, we find that the relationship between PC and GDP growth is concave and non-monotone. The semi-parametric fit given by the solid black line in Fig. 2 shows that GDP growth reaches a maximum when credit to the private sector is at 76 % of GDP. This threshold is slightly lower but similar to the one obtained with the quadratic model. The figure also shows that the quadratic fit (the solid light line) obtained from Table 1 is a good approximation of the semi-parametric fit.

In sum, preliminary analysis based on cross-sectional data suggests that there is a non-monotonic, concave relationship between private credit and GDP growth and that a quadratic functional form does a good job at approximating this non-linear relationship.

3.1.2 Endogeneity

The literature on finance and growth has addressed reverse causality by instrumenting financial depth with legal origin in "pure" cross-country regressions (e.g., Levine et al. 2000), by using lagged variables as internal instruments in panel regressions (e.g., Beck et al. 2000), and with differences-in-differences models applied to industry-level data (e.g., Rajan and Zingales 1998).

In Sects. 3.2 and 7 below we will use the same estimators used by Beck et al. (2000) and Rajan and Zingales (1998). However, standard specifications tests find that legal origin is not a good instrument in a model that includes both the level and the square of credit to the private sector as endogenous variables.[14] To address causality in our purely cross-

[14] A weak identification test signals that the instruments are weak (the Kleibergen–Paap weak instrument Wald F statistic is 0.583) and Hansen's J tests rejects the overidentifying restrictions with a p value of 0.01. We face the same problems if we use the same sample and data as Levine et al. (2000).

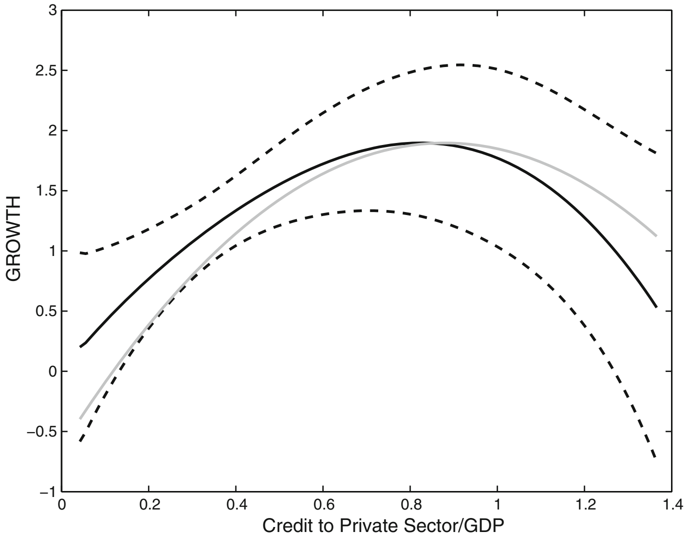

Fig. 2 Semi-parametric regressions. The *solid black line* plots the relationship between credit to the private sector obtained by allowing credit to the private to take a generic functional form. The *dotted lines* are 90 % confidence intervals and the *light solid line* plots the quadratic fit of columns 6, Table 1

sectional country-level dataset we thus use internal instruments which exploit the presence of heteroskedasticity in the model's residuals.

The possibility of identifying causal relationships through heteroskedasticity was already mentioned in Wright's (1928) pioneering work on instrumental variables. More recently, Rigobon (2003) and Lewbel (2012) developed estimators that allow one to identify causal relationships through heteroskedasticity. Specifically, Rigobon (2003) shows that it is possible to identify causal relationships by exploiting the existence of discrete regimes with different levels of heteroskedasticity. Lewbel (2012) generalizes Rigobon's approach and builds an estimator that does not require the use of discrete regimes.

In this section, we use Lewbel's estimator to identify the effect of financial depth on economic growth. As identification through heteroskedasticity is not well-known, we start by providing the intuition for this estimation technique (full details and derivations are in Lewbel 2012). Assume that we are interested in estimating the model:

$$Y_1 = a + \beta_1 X + \gamma_1 Y_2 + \varepsilon_1,$$

but have an endogeneity problems because $Y_2 = a + \beta_2 X + \gamma_2 Y_1 + \varepsilon_2$. Besides the standard assumptions that $E(X\varepsilon_1) = E(X\varepsilon_2) = cov(X, \varepsilon_1\varepsilon_2) = 0$, further assume that there is heteroskedasticity in the data (i.e., $cov(X, \varepsilon_2^2) \neq 0$). Then, $X\varepsilon_2$ can be used as an instrument for Y_2 (Lewbel actually uses $[X - E(X)]\varepsilon_2$). This is a good instrument because the assumption that $cov(X, \varepsilon_1\varepsilon_2) = 0$ guarantees that $X\varepsilon_2$ is uncorrelated with ε_1, and the presence of heteroskedasticity ($cov(X, \varepsilon_2^2) \neq 0$) guarantees that $X\varepsilon_2$ is correlated with ε_2 and thus with Y_2. If X includes more than one variable, the condition $cov(X, \varepsilon_2^2) \neq 0$ needs to hold only for a subset Z of the X matrix. If this subset Z includes more than one element, the model will be overidentified and can be efficiently estimated with GMM.

Note that the assumptions $E(X\varepsilon_1) = E(X\varepsilon_2) = cov(X, \varepsilon_1\varepsilon_2) = 0$ are standard (and their validity can be tested with Hansen's J test). The only non-standard assumption required for

Table 4 Cross-country IH regressions

	(1)	(2)	(3)	(4)	(5)
LGDP(t − 1)	−0.611***	−0.637***	−0.702***	−0.701***	−0.564**
	(0.199)	(0.161)	(0.146)	(0.173)	(0.247)
PC	8.764***	10.15***	8.849***	6.239**	6.996**
	(2.369)	(2.044)	(1.937)	(2.480)	(3.359)
PC2	−4.489***	−5.282***	−4.457***	−3.227**	−3.378**
	(1.420)	(1.227)	(1.117)	(1.349)	(1.462)
LEDU	1.018***	0.789**	0.785*	1.569***	0.905**
	(0.321)	(0.313)	(0.408)	(0.527)	(0.431)
LINF	−0.131	−0.0101	0.115	−0.235*	0.200
	(0.114)	(0.114)	(0.136)	(0.136)	(0.217)
LOPEN	−0.0100	0.0284	0.169	−0.205	−0.0419
	(0.243)	(0.234)	(0.216)	(0.289)	(0.250)
LGC	−0.466	−0.948**	−0.867*	−1.419***	−1.781***
	(0.513)	(0.475)	(0.481)	(0.431)	(0.354)
Cons.	3.844**	4.894***	4.551***	7.537***	7.095***
	(1.536)	(1.449)	(1.365)	(1.500)	(1.587)
N. Obs	67	67	64	88	101
OID	9.84	8.87	7.73	14	14.7
p value	0.28	.353	.461	.08	0.7
Period	1970–2000	1970–2005	1970–2010	1980–2010	1990–2010
dGR/dPC = 0	0.97	0.96	0.99	0.97	1.03

This table reports the results of a set of cross-country IV regressions in which average real per capita GDP growth over different time periods is regressed on the log of initial GDP per capita ($LGDP$), the level of credit to the private sector over GDP (PC), the square of the level of the level of credit to the private sector over GDP (PC^2), the log of average years of education ($LEDU$), the log of government consumption over GDP (LGC), the log of trade openness ($LOPEN$), and the log of inflation ($LINF$). The causal effect of credit to the private sector (and its square) is identified using identification through heteroskedasticity (Lewbel 2012). Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

identification is the presence of heteroskedasticity ($cov(X, \varepsilon_2^2) \neq 0$). If $cov(X, \varepsilon_2^2)$ is close to zero, then $X\varepsilon_2$ is a weak instrument, leading to imprecise estimates.

Table 4 reports the estimates of the models of Tables 1 (columns 2, 4, and 6) and 2 (columns 2 and 4) using identification through heteroskedasticity (IH).[15] As in the OLS estimations of Tables 1 and 2, we find a non-monotonic relationship between financial depth and economic growth. The only difference is that the IH regressions imply that the marginal effect of financial depth becomes negative when credit to the private sector ranges between 97 and 103 % of GDP, whereas, the OLS estimations find slightly lower turning points (with the marginal effect of financial depth becoming negative when credit to the private sector ranges between 82 and 97 % of GDP). The coefficients associated with PC and PC^2 are precisely estimated, suggesting that $cov(X, \varepsilon_2^2)$ is not close to zero and the Hansen's J test fails to reject the overidentifying restrictions at the 5 % confidence level.

[15] We estimate the models by using all available observations. We obtain similar results if we use a constant sample of countries.

3.2 Panel regressions

Having established the presence of a non-monotonic relationship between credit to the private sector and economic growth using cross-sectional data, we now exploit the time variation of our sample by splitting our 30 years of data into 6 non-overlapping 5-year periods.

As is now standard, we estimate our model using the GMM system estimator originally proposed by Arellano and Bover (1995) and Blundell and Bond (1998). In all of our regressions we use the two-step procedure proposed by Arellano and Bond (1991) and obtain robust standard errors using the Windmeijer (2005) finite sample correction.[16]

As in the cross country analysis, we start by replicating the standard model that imposes a monotonic relationship between financial depth and economic growth. In the first four columns of Table 5, we measure financial depth using the log of credit to the private sector over GDP (this is the same variable used by, among others, Beck and Levine 2004) and in the last four columns we use the level of credit to the private sector over GDP. Besides the lagged value of credit to the private sector over GDP (or the log of this variable), all regressions include time fixed effects and the lagged values of the controls that are normally used in the literature that studies the link between financial development and economic growth: initial GDP per capita; average years of education; government consumption over GDP; trade openness; and inflation.[17] The bottom panel of the table reports the standard specification tests and show that all regressions reject the null of no first order autocorrelation, and that most models do not reject the null of no second order autocorrelation (the exception is column 4, where the AR2 coefficient is marginally significant with a p value of 0.09). The Hansen tests of the overidentifying restrictions never reject the null.[18]

The first column of Table 5 estimates the model for the 1960–1995 period and confirms the presence of a positive and statistically significant correlation between the log of financial depth and economic growth. Our point estimate of 1.9 is close to that found by Beck and Levine (2004) who, in their system estimations, find coefficients that range between 1.7 and 2.2. When we estimate the model for the period 1960–2000 (column 2), we still find a positive and statistically significant correlation between financial depth and economic growth. However, the coefficient is now much smaller (about one-third of that of column 1) and is estimated less precisely. If we use even more recent data (1960–2005 in column 3 and 1960–2010 in column 4), we find even smaller coefficients which are no longer statistically significant. The last four columns of Table 5 show the same pattern using the level (instead of the log) of financial depth: the correlation between financial depth and growth decreases when we add more data and is not statistically significant for the 1960–2005 and 1960–2010 periods.

The estimates of Table 5 display the vanishing effect of financial deepening documented in great detail by Rousseau and Wachtel (2011). The fact that using more recent data weakens

[16] Our regressions use all available lags as instruments, but the results are robust to different lag lengths. One source of concerns when estimating fixed effect models is that the limited within-country variability of the data tends to amplify the attenuation bias brought about by the presence of measurement errors. However, our variables of interest display substantial cross-country and within-country variation. Credit to the private sector, for instance, has a between-country standard deviation of 0.30 and a within-country standard deviation of 0.22 (the overall standard deviation is 0.37).

[17] As in Beck and Levine, we take logs of all these variables. We deal with zero values by applying the inverse hyperbolic sine transformation ($\widehat{x} = \ln(x + \sqrt{x^2 + 1})$) described by Burbidge et al. (1988).

[18] The high p values of the OID test, however, suggest that we might be overfitting the model. By reducing the number of lags in the set of instruments, we find results which are similar to those of Table 5, but with slightly lower values of the OID test.

Table 5 Panel estimations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LGDP(t − 1)	−0.748*	−0.315	−0.820**	−0.914***	−0.688*	−0.828**	−0.800**	−0.770**
	(0.408)	(0.305)	(0.346)	(0.317)	(0.376)	(0.417)	(0.330)	(0.340)
LPC(t − 1)	1.882***	0.637*	0.479	0.353				
	(0.547)	(0.368)	(0.373)	(0.389)				
PC(t − 1)					5.429***	3.652***	1.063	0.072
					(1.570)	(1.239)	(0.745)	(0.747)
LEDU(t − 1)	1.340*	1.714**	2.803***	2.810***	1.343*	2.008***	2.780***	2.833***
	(0.785)	(0.732)	(0.624)	(0.541)	(0.753)	(0.716)	(0.652)	(0.635)
LGC(t − 1)	−2.833***	−1.888**	−1.978***	−1.920***	−3.208***	−2.625***	−1.722***	−1.744***
	(0.798)	(0.772)	(0.562)	(0.613)	(0.789)	(0.727)	(0.581)	(0.564)
LOPEN(t − 1)	1.006	0.689	1.138**	1.618***	1.590**	1.615***	1.444***	1.666***
	(0.655)	(0.738)	(0.510)	(0.569)	(0.738)	(0.595)	(0.540)	(0.543)
LINF(t − 1)	−0.056	0.050	−0.269*	−0.178	0.075	−0.014	−0.262	−0.229
	(0.177)	(0.201)	(0.160)	(0.184)	(0.192)	(0.178)	(0.176)	(0.184)
Cons.	9.914***	3.209	3.389	0.890	2.956	2.257	0.264	−1.292
	(3.659)	(3.243)	(3.279)	(3.665)	(3.283)	(3.195)	(3.062)	(3.212)
N. Obs.	549	675	798	917	549	675	798	917
N. Cy.	107	127	131	133	107	127	131	133
AR1	−3.81	−4.35	−5.04	−5.41	−3.76	−4.44	−4.99	−5.36
p value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AR2	−0.35	−0.85	−0.83	−1.68	−0.44	−1.12	−0.87	−1.71
p value	0.730	0.397	0.407	0.0932	0.657	0.265	0.385	0.0879
OID	90.23	102.1	113.6	121.5	85.70	96.23	115.0	126.8
p value	0.95	0.78	1	1	0.98	1	1	1
Period	1960–1995	1960–2000	1960–2005	1960–2010	1960–1995	1960–2000	1960–2005	1960–2010

This table reports the results of a set of panel regressions aimed at estimating the effect of credit to the private sector on economic growth. All regressions consist of 5-year non-overlapping growth spells and are estimated using System GMM with all available lags used as instrument. The set of controls includes time fixed effects and the lags of: log initial GDP per capita ($LGDP$); the log of credit to the private sector (LPC); the level of credit to the private sector (PC); the log of average years of education ($LEDU$); the log of government consumption over GDP (LGC); the log of trade openness ($LOPEN$); and the log of inflation ($LINF$). The bottom panel of the table reports the standard system GMM specification tests. Robust (Windmeijer) standard errors in parenthesis

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

the relationship between financial depth and growth is also consistent with De Gregorio and Guidotti's (1995) finding that the positive correlation between credit to the private sector and GDP growth weakened after the 1970s.

3.2.1 The origins of the vanishing effect

There are two possible explanations for the vanishing effect documented in Table 5. One possibility is that something has changed in the fundamental relationship between financial depth and economic growth. The second explanation has to do with the fact that (for the reasons discussed in Sect. 2) the true relationship between financial development and economic growth is non-monotonic and the models of Table 5 are misspecified.

In order to understand this potential source of bias, consider the following stylized OLS regression specification. Suppose that the true relationship between the left-hand-side variable and the explanatory variable is given by:

$$y = x\alpha + z\beta + \varepsilon, \tag{4}$$

whereas one estimates:

$$y = x\alpha + u. \tag{5}$$

z is therefore an omitted variable. The standard formula for omitted variable bias in α is:

$$\text{bias} = E\left[\alpha_{OLS} - \alpha\right] = \frac{cov[x, z]}{var[x]}\beta. \tag{6}$$

In the present case, where x is credit to the private sector and y is economic growth, $z = x^2$, and we know from our empirical results that $\alpha > 0$ and more importantly that $\beta < 0$. Since $cov[x, z] = cov[x, x^2] > 0$ for $x > 0$ (which is the case here), it is immediate that:

$$\text{bias} = E\left[\alpha_{OLS} - \alpha\right] < 0. \tag{7}$$

But why should the magnitude of this bias increase over time, leading to the "vanishing effect" phenomenon? To see why, add a time index to the variables and suppose that credit to the private sector grows at a strictly positive rate θ, namely $x_{t+1} = (1 + \theta)x_t$. Then the bias at time $t + 1$ is given by:

$$\text{bias}_{t+1} = \frac{(1+\theta)cov[x_t, x_t^2]}{var[x_t]}\beta.$$

It follows that:

$$\frac{\text{bias}_{t+1}}{\text{bias}_t} = 1 + \theta > 1, \tag{8}$$

so that bias is *increasing* in absolute value over time, as credit to the private sector increases.

This downward bias is likely to be small for regressions that include relatively few country-periods with high levels of financial development. However, financial sectors grew rapidly over the 2000–2010 period, with the cross-country average of credit to the private sector going from 36 % of GDP in 1985 to 55 % of GDP in 2005 (left panel of Fig. 3). Over the same period, the number of countries in which private credit was greater than 90 % of GDP increased from 4 to 22 % of the total (right panel of Fig. 3). As a consequence, the regressions of columns 1 and 5 of Table 5 include 27 observations (5 % of the total) for which PC is greater than 90 % of GDP, but the regressions of columns 4 and 8 include 99 observations (11 % of the total) for which PC is greater that 90 % of GDP. Alternatively, in regressions that focus on the 1960–1995 period 99 % of observations are below the threshold at which the marginal effect of financial depth becomes negative. In regressions that cover the 1960–2010 period, more than 15 % of observations are above the threshold (Table 17).

If the relationship between financial depth and growth is indeed non-monotonic, the increase in the share of observations with a large financial sector must have played a role in amplifying the downward bias of the misspecified regressions of Table 5, as shown in Eqs. (7) and (8). This would lead to the low and insignificant point estimates of columns 3–4 and 7–8. The upshot is that, despite being misspecified, the standard linear equation without a quadratic term worked well with smaller financial sectors.

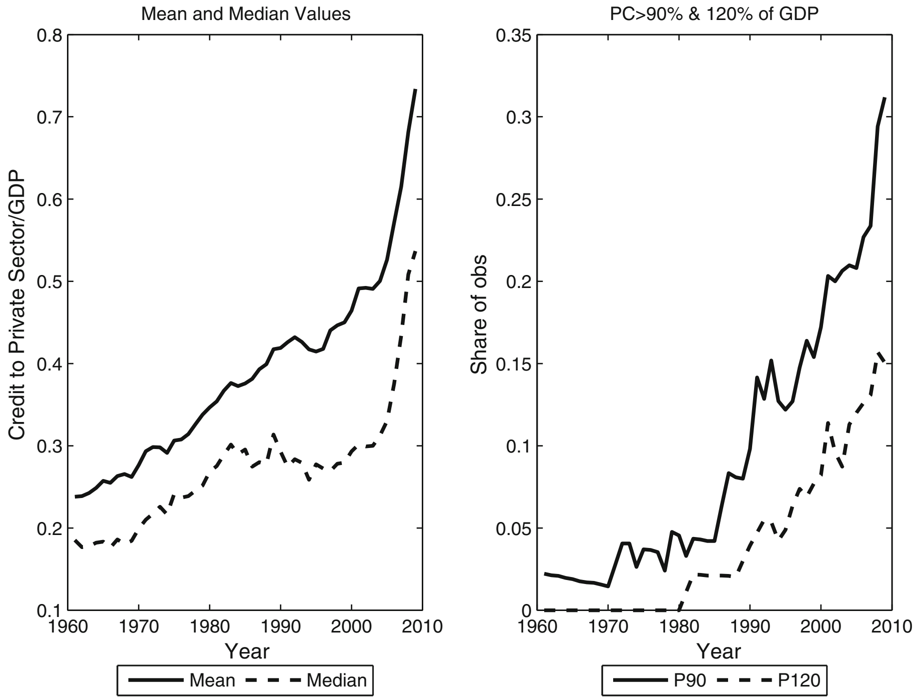

Fig. 3 Credit to the private sector. This figure plots the evolution of credit to the private sector over GDP (PC) for the sample of countries included in the regressions of Table 5. The *left panel* plots the mean and median values of PC. The *right panel* plots the share of observations for which PC $> 90\,\%$ (*solid line*) and PC $> 120\,\%$ (*dashed line*)

We illustrate the empirical consequences of this misspecification with a simple Monte Carlo simulation. Assume that the "true" specification is given by $y = 4x - 2x^2 + \varepsilon$, where the parameters are chosen to be roughly in line with the cross sectional results of Table 5. We fix the standard deviation of x at 0.34 (its value in the cross-sectional data), set the variance of ε so as to obtain roughly the same R^2 as in our empirical results using the quadratic specification, allow the mean of x (μ_x) to vary from 0.15 to 0.85 by 0.025 steps, and estimate the misspecified. relationship given by $y = \alpha \ln x + \varepsilon$, with 200 replications for each value of μ_x. As is evident in Fig. 4, which plots the OLS estimate of α along with the associated 95 % confidence interval against μ_x, the point estimate of α falls as μ_x increases, and eventually becomes statistically indistinguishable from zero: this is the vanishing effect. Similar behavior obtains when one replaces $\ln x$ with x, as in the analytical argument given above.

3.2.2 Non-monotonicity with panel data

In Table 6 we explore non-linearities by using the same approach that we used with the cross-sectional regressions of Table 1. Specifically, we augment the model of the last 4 columns of Table 5 with the square of credit to the private sector over GDP and check for the presence of a non-monotonic relationship between credit to the private sector and GDP growth. We find that both the linear and quadratic terms are always statistically significant. The point

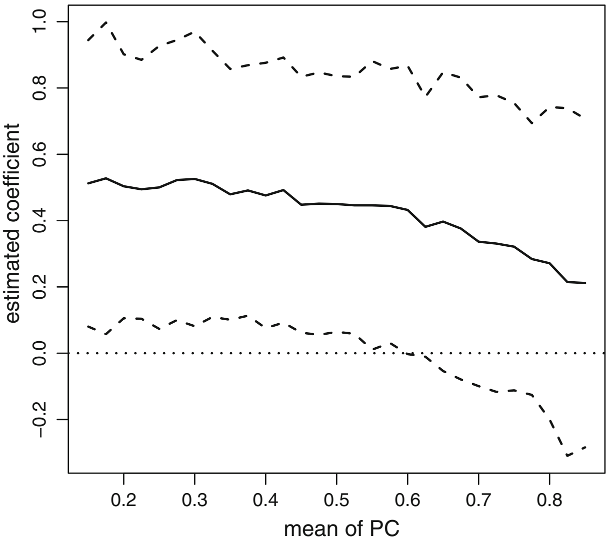

Fig. 4 A Monte Carlo illustration of the "vanishing effect". The "true" specification is given by $y = 4x - 2x^2 + \varepsilon$, whereas we plot the estimates of $y = \alpha \ln x + \varepsilon$. The *solid line* is the OLS estimate of α, while the *dotted lines* are 95 % confidence intervals (200 replications for each value of the mean of PC in the sample)

estimates of the regressions that use data for the period 1960–1995 and 1960–2000 (columns 1 and 2) suggest that the marginal effect of financial depth becomes negative when credit to the private sector reaches 140 % of GDP (last row of Table 6). Including more recent data lowers this threshold to 100 % (for the 1960–2005 period, column 3) and 90 % (for the 1960–2010 period, column 4). Using more recent data also leads to more precise estimates of the quadratic term. This is consistent with the idea that using more recent data amplifies the downward bias of the misspecified models of Table 5.[19]

Figure 5 plots the marginal effect of credit to the private sector on economic growth. It shows that the positive effect of financial depth is no longer statistically significant when credit to the private sector reaches 42 % of GDP (more than 30 % of the observations in the regression of column 4 are above this threshold), it becomes negative when PC is at 90 % of GDP (11 % of the observations in the regression of column 4 are above this threshold), and negative and statistically significant when financial depth reaches 113 % of GDP (6 % of the observations in the regression of column 4 are above this threshold). In 2006, there were 68 countries above the 42 % threshold, 27 countries above the 90 % threshold, (these are the countries included in Fig. 6), and 17 countries above the 110 % threshold.

Column 4 of Table 3 shows that the SLM test rejects H_0 and thus supports the presence of a non-monotonic relationship between financial depth and economic growth.

[19] As in the regressions of Table 5, we find very high p values for the overidentification tests, an indication that we may be overfitting our first stage. The results are robust to reducing the number of lags in the set of instruments. For instance, if we re-estimate the models of columns 1–4 (Table 6), we always find that both the linear and quadratic terms are statistically significant, with turning points which are lower than those of Table 6 (97 vs 144 %, 110 vs 137%, 95 vs 103 %, and 76 vs 90 %). When we use a smaller number of lags, the p values of the OID tests drop to 0.29, 0.38, 0.72, and 0.92 (full regression results available upon request). Results are sensitive to the choice of lag length and, since this choice may introduce some arbitrariness, we decided to report results based on regressions that use the default of including all lags in the set of instruments.

Table 6 Panel estimations (cont.)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LGDP(t − 1)	−0.713*	−0.751*	−0.767**	−0.728**	−0.579	−0.746**	−0.688**
	(0.385)	(0.401)	(0.342)	(0.310)	(0.364)	(0.346)	(0.340)
PC(t − 1)	8.724***	5.427***	3.646**	3.628**	5.074**	3.655*	3.128*
	(2.778)	(2.069)	(1.853)	(1.726)	(2.063)	(2.042)	(1.714)
PC2(t − 1)	−3.026*	−1.975*	−1.774*	−2.021***	−3.666***	−2.264*	−1.755**
	(1.641)	(1.137)	(1.013)	(0.729)	(1.288)	(1.222)	(0.744)
LEDU(t − 1)	0.982	1.659**	2.529***	2.270***	2.044***	2.488***	2.119***
	(0.758)	(0.692)	(0.652)	(0.615)	(0.671)	(0.683)	(0.621)
LGC(t − 1)	−2.757***	−2.057***	−1.720***	−1.461**	−1.605**	−1.410**	−1.414**
	(0.652)	(0.712)	(0.547)	(0.742)	(0.719)	(0.686)	(0.672)
LOPEN(t − 1)	1.781***	1.649***	1.235***	1.087**	1.566***	1.201***	1.393**
	(0.593)	(0.612)	(0.478)	(0.511)	(0.469)	(0.465)	(0.557)
LINF(t-1)	0.010	−0.024	−0.211	−0.273	−0.119	−0.174	−0.256
	(0.218)	(0.172)	(0.160)	(0.210)	(0.191)	(0.178)	(0.196)
Cons.	1.750	0.743	0.930	0.920	−1.830	−0.302	−0.500
	(3.121)	(3.211)	(2.613)	(3.539)	(3.246)	(2.781)	(3.189)
N. Obs.	549	675	798	917	859	879	912
N. Cy.	107	127	131	133	127	129	133
AR1	−3.75	−4.38	−4.97	−5.39	−5.21	−5.29	−5.96
p value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AR2	−0.36	−1.04	−0.80	−1.61	−1.22	−1.44	−1.92
p value	0.717	0.298	0.421	0.108	0.221	0.149	0.055
OID	86.93	97.47	116.6	118.8	116.5	121.4	118.7
p value	0.99	1	1	1	1	1	1
Period	1960–1995	1960–2000	1960–2005	1960–2010	1960–2010[a]	1960–2010[b]	1960–2010[c]
dGR/dPC = 0	1.44	1.37	1.03	0.90	0.69	0.81	0.89
CI (90)	1.00–2.03	0.94–1.97	0.62–1.87	0.18–1.18	0.36–1.84	0.28–1.64	0.26–1.14

This table reports the results of a set of panel regressions aimed at estimating the effect of credit to the private sector on economic growth. All regressions consist of 5-year non-overlapping growth spells and are estimated using System GMM with all available lags used as instrument. The set of controls includes time fixed effects and the lags of: log initial GDP per capita ($LGDP$); the level of credit to the private sector (PC) and its square (PC^2); the log of average years of education ($LEDU$); the log of government consumption over GDP (LGC); the log of trade openness ($LOPEN$); and the log of inflation ($LINF$). The bottom panel of the table reports the standard system GMM specification tests. Robust (Windmeijer) standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

[a] Excludes all the countries where PC was ever larger than 1.65

[b] Excludes USA, IRL, ESP and ISL

[c] This regression drops the top and bottom 1 % of the dependent variable

Although empirical growth models are seldom used for forecasting purposes, it is interesting to note that the quadratic model of column 3 in Table 6 (that is, the model estimated over the 1960–2005 period) does a better job at forecasting output growth over the period 2005–2010 than the linear model of column 7 of Table 5 (the mean squared errors (MSE) of the out-of-sample forecast for GDP growth over 2005–2010 of the two models are 5.6

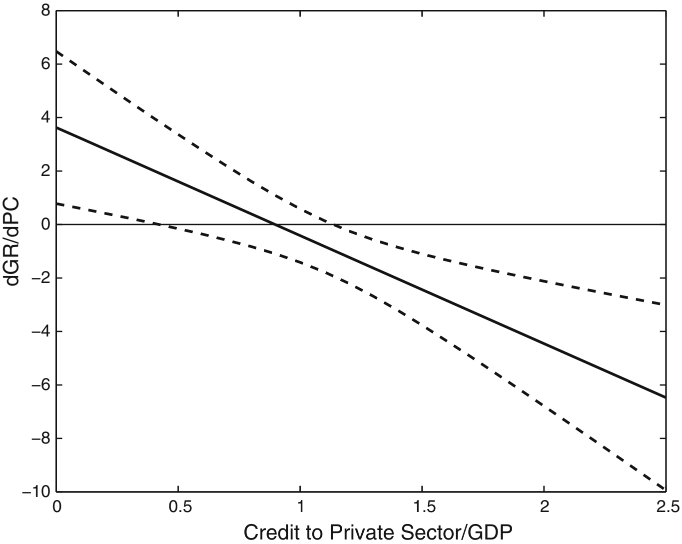

Fig. 5 Marginal effect using panel data. This figure plots the marginal effect of credit to the private sector on growth obtained from the regression of Table 6, column 4

and 6.4, respectively). The same applies if we use the model estimated over 1960–2000 to forecast growth over 2005–2010. In this case, the MSE of the quadratic model is 6.3 and that of the linear model is 9.4.[20]

The remaining three columns of Table 6 show that our results are robust to controlling for different types of outliers. In column 5, we exclude those countries with a very large financial sector (in particular, we exclude six countries that at any point in time had a level of credit to the private sector greater than 165 % of GDP). The results are similar to those for the full sample of column 4. If anything, we now find a lower threshold (69 % of GDP) above which the marginal effect of credit to the private sector becomes negative. Next, we exclude the United States, Iceland, Spain, and Ireland (column 6). We find that our results are robust to dropping these countries that have a large financial sector and were severely affected by the recent financial crisis (we explore the effect of banking crises in Sect. 4). Our results are also robust to dropping the top and bottom 1 % of the distribution of the dependent variable (in particular, column 7 drops all observations for which annual average GDP growth over any given 5 year period is lower than −10 % and greater than 11 %). We also estimate the models of columns 2–4 of Table 6 by only using observations for the countries included in the first column of the Table and find results which are close to those of Table 6.[21]

3.2.3 Semi-parametric estimations

Next, we check whether our results are robust to using the same semi-parametric estimator that we used with the cross-country data. When we estimate the model of column 7, Table 6, by allowing credit to the private sector to take a general form, we find that the relationship

[20] In fact, a quadratic model without controls yields better out-of-sample forecasts ($MSE = 5.7$, when we use 1960–2005 to forecast 2005–2010) than the linear model with the full set of controls used in Table 5 ($MSE = 6.4$, when we use 1960–2005 to forecast 2005–2010).

[21] Full regression results are available upon request.

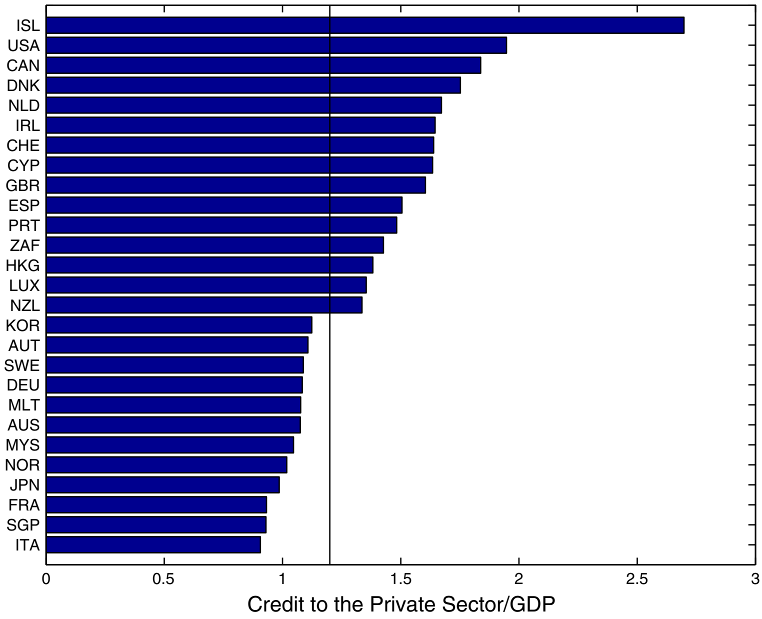

Fig. 6 Countries with large financial sectors (2006). This figure plots the 2006 level of credit to the private sector over GDP (PC) for all countries that in 2006 had values of PC $> 90\,\%$. The *vertical line* is at PC $= 110\,\%$

between PC and GDP growth is concave and non-monotonic. While at very low levels of financial depth ($PC < 10\,\%$ of GDP) the relationship between these two variables is fairly flat (a fact which is partly consistent with the findings of Rioja and Valev 2004), at higher levels of financial development we find a curvature which is consistent with a quadratic relationship.[22]

The semi-parametric estimator plotted by the solid black line in Fig. 7 shows that GDP growth reaches a maximum when credit to the private sector is at 76 % of GDP. This threshold is consistent with what we obtained in Table 6 (using the data for 1960–2010, the last three columns of Table 6 find thresholds that range between 69 and 90 %). The figure also shows that the quadratic fit (the solid light line) obtained from column 7 of Table 6 is a good approximation to the semi-parametric fit.

As in the case of the cross-country analysis, panel data suggest that there is a concave non-monotonic relationship between credit to the private sector and GDP growth which is well approximated by a quadratic functional form.

4 More robustness checks

This section shows that our results are robust to different specifications, different length of growth spells, different definitions of financial depth, and to controlling for the convergence effect of financial depth.

[22] Note that our sample includes 24 LDCs, for a total of 136 observations, and that these are all countries with very low levels of financial depth. If we restrict our analysis to LDCs, the relationship between finance and growth (either linear or quadratic) is never statistically significant. If we drop the LDCs from the sample our results become even stronger.

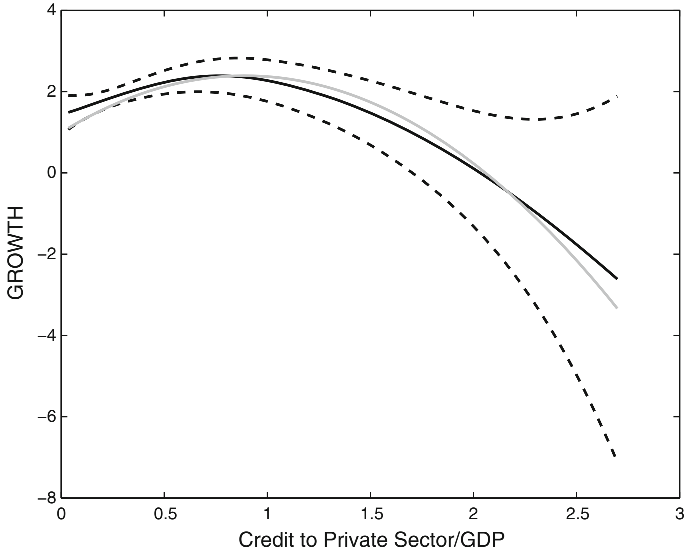

Fig. 7 Semi-parametric regressions using panel data. The *solid black lines* plot the relationship between credit to the private sector obtained by allowing credit to the private to take a generic functional form and using the model of column 7, Table 6. The *dotted lines* are 95 % confidence intervals and the *light solid lines* plot the quadratic fits of column 7 of Table 6

4.1 Linear spline regressions

We run separate regressions for country-years with credit to the private sector below and above 90 %. We find that the coefficient associated with credit to the private sector is always positive (and often statistically significant) in the regressions that only include observations with $PC < 90\,\%$ and always negative (and often statistically significant) in the regressions that only include observations with $PC > 90\,\%$. When we split the sample for the model of column 4, Table 6, we obtain a point estimate of 2.77 (p value: 0.03) for the low financial depth subsample and a point estimate of -1.80 (p value: 0.01) for the high financial depth subsample.[23]

To probe further, we run a set of spline regressions in which we allow for different slopes associated with financial depth when credit to the private sector is above and below 90 % of GDP (Table 7). We find that financial depth is always positively and significantly correlated with economic growth when credit to the private sector is below 90 % of GDP and that financial depth is negatively correlated with economic growth when credit to the private sector is above 90 % of GDP. The difference in slopes is always statistically significant and the negative effect for the above 90 % coefficient is negative and statistically significant in the sample that covers the full 1960–2010 period. While we use an exogenous threshold, Law and Singh (2014) estimate a model with endogenous thresholds and find results which are similar to our findings.

[23] In this regression, we have 818 observations with $PC < 90\,\%$ and 99 observation with $PC > 90\,\%$. Full regression results are available upon request.

Table 7 Panel spline estimations

	(1)	(2)	(3)
LGDP(t − 1)	−0.811**	−0.793**	−0.862***
	(0.323)	(0.330)	(0.331)
PC(t-1t − 1)	3.446**	2.516*	2.738**
	(1.426)	(1.356)	(1.342)
PC(t − 1) * D90	−4.040*	−3.582**	−4.745***
	(2.086)	(1.781)	(1.600)
LEDU(t − 1)	2.074***	2.653***	2.516***
	(0.613)	(0.674)	(0.655)
LGC(t − 1)	−1.938**	−1.648**	−1.744***
	(0.863)	(0.684)	(0.657)
LOPEN(t − 1)	1.504**	1.095*	1.351***
	(0.723)	(0.583)	(0.501)
LINF(t − 1)	−0.101	−0.279*	−0.359*
	(0.175)	(0.170)	(0.208)
D90	3.455	2.186	3.237
	(2.329)	(1.604)	(2.523)
Cons.	1.106	1.584	1.114
	(3.411)	(3.295)	(3.350)
N. Obs.	675	798	917
N. Cy	127	131	133
AR1	−4.42	−4.92	−5.33
p value	0.00	0.00	0.00
AR2	−1.15	−0.97	−1.93
p value	0.251	0.331	0.05
OID	97.5	113.9	118.16
p value	0.99	0.99	0.99
OID	97.5	113.9	118.16
p value	0.99	0.99	0.99
PC(t − 1) + PC(t − 1) * D90	−0.59	−1.07	−2.01
p value	0.72	0.45	0.03
Period	1960–2000	1960–2005	1960–2010

This table reports the results of a set of panel regressions aimed at estimating the effect of credit to the private sector on economic growth. All regressions consist of 5-year non-overlapping growth spells and are estimated using System GMM with all available lags used as instrument. The set of controls includes time fixed effects and the lags of: log initial GDP per capita ($LGDP$); the level of credit to the private sector (PC); a dummy variable that takes a value of one when $PC > 0.9$ ($D90$); the interaction between PC and $D90$ ($PC * D90$); the log of average years of education ($LEDU$); the log of government consumption over GDP (LGC); the log of trade openness ($LOPEN$); and the log of inflation ($LINF$). The bottom panel of the table reports the standard system GMM specification tests. Robust (Windmeijer) standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

4.2 Ten-year growth spells

The literature that uses panel data to study the relationship between financial depth and economic growth has traditionally focused on 5-year growth spells. Since Loayza and Ranciere (2006) find that credit expansion may have a negative short-run and a positive long-run impact on growth, it is interesting to check whether our findings are robust to using longer growth spells.

In the cross-country estimations of Tables 1 and 4, we already showed that our results hold when we use 30, 35, and 40-year growth spells. Since we have observations for the 1960–2010 period, we can also use panel data to study the relationship between financial depth and economic growth using 10-year growth episodes. We start with a linear specification similar to that of Table 5 and find that credit to the private sector is significantly correlated with economic growth when we use data for the 1960–2000 period (column 1 of Table 8). However, the vanishing effect is also at work for the 10-year panel, and we find that the correlation between financial depth and growth is no longer statistically significant when we use data for the 1960–2010 period (column 2 of Table 8; the specification tests in the bottom panel of the table suggest that there may be problems with the exclusion restrictions of column 2). When we use the quadratic model, however, we find that the coefficients are statistically significant in both sub-periods (columns 3 and 4 of Table 8). The point estimates of columns 3 and 4 suggest that the marginal effect of financial depth becomes negative when credit to the private sector is between 80 % and 90 % of GDP. Moreover, the SLM test supports the hypothesis of a non-monotonic relationship between financial depth and economic growth (column 5 of Table 3).

4.3 The convergence effect of financial depth

Aghion et al. (2005) build a multi-country Schumpeterian growth model showing that financial depth can affect the speed of convergence towards the world technology frontier but has no effect on steady-state growth. Aghion et al. (2005) test their theory by estimating variants of the following cross-sectional model:

$$GR_i = \alpha_0 + \alpha_1 Y_i + \alpha_2 (Y_i \times PC_i) + \alpha_3 PC_i + X_i \Gamma + \varepsilon_i$$

where GR is the growth rate of GDP per capita, Y is initial GDP per capita, PC is credit to the private sector, and X is a set of covariates.[24] They find that α_3 is never statistically significant and that α_2 is always negative and statistically significant. Taken together these results are in line with the prediction of the theoretical model that financial depth is relevant for the speed of convergence but has no effect on long-run growth.

We follow Aghion et al. (2005) and use purely cross-sectional data to check whether our baseline result is robust to controlling for the interaction of initial GDP and financial depth by augmenting the model of Aghion et al. (2005) with the square of financial depth.[25] The results of Table 9 corroborate Aghion et al.'s (2005) findings that financial depth has a positive effect on convergence (the interaction term is always negative and is statistically significant in 3 of the five regressions of Table 9), but they also show that there is a non-monotonic and statistically significant relationship between financial depth and long-run economic growth.

The results of Table 9 are also consistent with the findings of Demirgüç-Kunt et al. (2013), as they show that the relationship between growth and financial depth is decreasing in the

[24] Aghion et al. (2005) measure growth and GDP per capita as deviation with respect to the United States.

[25] Aghion et al. (2005) instrument financial depth with legal origin. Since legal origin is not a good instrument for the square of financial depth, we use identification through heteroskedasticity.

Table 8 Panel Estimations: 10-year Growth Episodes

	(1)	(2)	(3)	(4)
LGDP(t – 1)	−0.024	−0.323	−0.169	−0.333
	(0.477)	(0.405)	(0.474)	(0.344)
PC(t – 1)	2.832*	0.540	6.965**	7.270***
	(1.653)	(0.991)	(2.821)	(2.016)
PC2(t – 1)			−3.912**	−4.430***
			(1.663)	(1.181)
LEDU(t – 1)	1.044	2.226**	1.217	1.571*
	(1.018)	(0.988)	(1.201)	(0.811)
LGC(t – 1)	−2.375**	−3.159***	−1.398	−2.443**
	(1.119)	(1.087)	(1.094)	(1.026)
LOPEN(t – 1)	0.504	1.295	−0.300	0.319
	(0.935)	(0.805)	(0.769)	(0.585)
LINF(t – 1)	−0.163	−0.957**	−0.401	−0.582
	(0.368)	(0.400)	(0.384)	(0.365)
Cons.	2.303	4.034	3.947	5.644*
	(3.507)	(4.441)	(2.836)	(3.035)
N. Obs.	360	479	360	479
N. Cy.	127	133	127	133
AR1	−3.30	−3.11	−3.14	−3.50
p value	0.00	0.00	0.00	0.00
AR2	1.17	−0.01	0.71	−1.02
p value	0.244	0.991	0.476	0.306
OID	30.96	64.49	30.44	56.77
p value	0.155	0.0561	0.342	0.446
Period	1960–2000	1960–2010	1960–2000	1960–2010
dGR/dPC = 0			0.89	0.82

This table reports the results of a set of panel regressions aimed at estimating the effect of credit to the private sector on economic growth. All regressions consist of 10-year non-overlapping growth spells and are estimated using System GMM with all available lags used as instrument. The set of controls includes time fixed effects and the lags of: log initial GDP per capita ($LGDP$); the level of credit to the private sector (PC) and its square (PC^2); the log of average years of education ($LEDU$); the log of government consumption over GDP (LGC); the log of trade openness ($LOPEN$); and the log of inflation ($LINF$). The bottom panel of the table reports the standard system GMM specification tests. Robust (Windmeijer) standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

level of economic development. However, they also indicate that our non-monotonicity result is robust to controlling for this effect.

4.4 Bank credit versus total credit

We also check whether our results are robust to using bank credit. Table 10 estimates the same models of the first four columns of Table 6 by using bank credit to the private sector instead of total credit to the private sector and shows that our results are not dependent on using our preferred measure of financial depth. Regressions that use bank credit still find

Table 9 Finance and convergence: cross-country IH regressions

	(1)	(2)	(3)	(4)	(5)
LGDP(t − 1)	−0.846***	−1.014***	−1.016***	−0.817***	−0.485**
	(0.259)	(0.215)	(0.214)	(0.176)	(0.223)
LGDP(t − 1) * PC	−0.157	−0.307**	−0.242*	−0.189*	−0.143
	(0.167)	(0.135)	(0.135)	(0.101)	(0.129)
PC	12.71***	16.04***	13.97***	12.10***	8.417*
	(4.601)	(3.381)	(3.573)	(3.251)	(4.304)
PC2	−5.833***	−6.627***	−5.775***	−5.049***	−3.418**
	(1.761)	(1.263)	(1.286)	(1.213)	(1.485)
LEDU	1.298***	1.474***	1.351***	1.332***	0.986**
	(0.369)	(0.399)	(0.477)	(0.366)	(0.413)
LINF	−0.197*	−0.205*	−0.0430	−0.131	0.0801
	(0.110)	(0.116)	(0.134)	(0.116)	(0.192)
LOPEN	−0.0258	−0.0946	−0.00234	−0.109	−0.00271
	(0.238)	(0.230)	(0.222)	(0.251)	(0.214)
LGC	−0.272	−0.448	−0.518	−1.439***	−1.795***
	(0.520)	(0.449)	(0.437)	(0.373)	(0.382)
Cons.	2.419	1.820	2.455	4.759***	4.677***
	(2.076)	(1.747)	(1.649)	(1.537)	(1.647)
N. Obs	67	67	64	88	101
OID	14.8	10.6	8.48	16.7	14.9
p value	.253	.57	.75	.161	.248
Period	1970–2000	1970–2005	1970–2010	1980–2010	1990–2010

This table reports the results of a set of cross-country IV regressions in which average real per capita GDP growth over different time periods is regressed on the log of initial GDP per capita ($LGDP$), the level of credit to the private sector over GDP (PC), the interaction between initial GDP per capita and the level of credit to the private sector over GDP ($LGDP * PC$), the square of the level of the level of credit to the private sector over GDP (PC^2), the log of average years of education ($LEDU$), the log of government consumption over GDP (LGC), the log of trade openness ($LOPEN$), and the log of inflation ($LINF$). The causal effect of credit to the private sector (and its square) is identified using identification through heteroskedasticity (Lewbel 2012). Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

a non-monotonic relationship between financial depth and economic growth with a turning point which is even lower than what we find when we use total credit.

5 Volatility, crises, and heterogeneity

Section 2 surveys several reasons why financial depth may eventually display negative returns. One often mentioned explanation is that rapid credit growth can increase macroeconomic volatility or lead to financial and banking crises (Kaminsky and Reinhart 1999; Schularick and Taylor 2012) which, in turn, may have a negative effect on growth. Rousseau and Wachtel (2011) suggest that banking crises are the culprits that lie behind the vanishing effect. Such an explanation would also be consistent with the fact that the threshold for which we find

Table 10 Panel estimations: bank credit instead of total credit

	(1)	(2)	(3)	(4)
LGDP(t − 1)	−0.647*	−0.584	−0.680**	−0.732**
	(0.339)	(0.356)	(0.316)	(0.310)
BC(t − 1)	9.630***	6.363***	4.287**	3.743**
	(2.630)	(2.172)	(1.783)	(1.794)
BC2(t − 1)	−4.156***	−2.806**	−2.428**	−2.363**
	(1.547)	(1.257)	(1.083)	(0.927)
LEDU(t − 1)	0.997	1.470**	2.247***	2.396***
	(0.694)	(0.649)	(0.609)	(0.651)
LGC(t − 1)	−2.435***	−2.369***	−1.698***	−1.449**
	(0.638)	(0.827)	(0.580)	(0.605)
LOPEN(t − 1)	1.437**	1.539***	1.098**	1.003**
	(0.599)	(0.496)	(0.437)	(0.456)
LINF(t − 1)	−0.132	−0.119	−0.246	−0.245
	(0.180)	(0.177)	(0.162)	(0.198)
Cons.	2.268	1.417	1.499	1.000
	(2.799)	(3.214)	(2.686)	(2.826)
N. Obs.	549	675	798	917
N. Cy.	107	127	131	133
AR1	−3.79	−4.41	−4.96	−5.39
p value	0.00	0.00	0.00	0.00
AR2	−0.40	−1.18	−0.84	−1.53
p value	0.688	0.237	0.402	0.126
OID	89.42	93.7	111.62	120.01
p value	.99	.99	.99	.99
Period	1960–1995	1960–2000	1960–2005	1960–2010
dGR/dBC = 0	1.16	1.13	0.88	0.79

This table reports the results of a set of panel regressions aimed at estimating the effect of bank credit to the private sector on economic growth. All regressions consist of 5-year non-overlapping growth spells and are estimated using System GMM with all available lags used as instrument. The set of controls includes time fixed effects and the lags of: log initial GDP per capita ($LGDP$); the level of bank credit to the private sector (BC) and its square (BC^2); the log of average years of education ($LEDU$); the log of government consumption over GDP (LGC); the log of trade openness ($LOPEN$); and the log of inflation ($LINF$). The bottom panel of the table reports the standard system GMM specification tests. Robust (Windmeijer) standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

that credit to the private sector starts having a negative marginal effect on growth is similar to the threshold for which Easterly et al. (2000) find that financial depth starts having a positive effect on macroeconomic volatility.

An alternative explanation has to do with the presence of heterogeneity in the relationship between financial depth and economic growth. According to this view, large financial sectors are growth-promoting in the presence of a good institutional and regulatory framework, but could be damaging in countries that lack an appropriate regulatory infrastructure.

In this section, we check whether our results are driven by macroeconomic volatility, banking crises, or poor institutional and regulatory frameworks. We start by looking at the effect of macroeconomic volatility. We define volatility as the within-country standard deviation of annual output growth for each of our 5-year periods and then create a dummy variable ($HVOL$) that is equal to one for country-periods in which volatility is greater than the sample average of 3.5, and zero when volatility is below this threshold.

Next, we augment our baseline model with this measure of volatility and find that volatility is negatively correlated with growth (column 1 of Table 11). We thus establish that our data can reproduce the well-known finding of Ramey and Ramey (1995). We also find that the linear and quadratic terms in PC remain statistically significant and that their point estimates indicate that the marginal effect of financial depth becomes negative when credit to the private sector surpasses 74 % of GDP.

To test for the presence of heterogeneous effects in the relationship between financial depth and economic growth, we now estimate the following model:

$$GR_{i,t} = PC_{i,t-1}\beta_0 + PC_{i,t-1}^2\beta_1 + (PC_{i,t-1}b_0 + PC_{i,t-1}^2 b_1 + \delta) \times HVOL_{i,t} + X_{i,t-1}\Gamma + \alpha_i + \tau_t + \varepsilon_{i,t}. \quad (9)$$

In this set-up, β_0 and β_1 measure the relationship between financial depth and economic growth in low-volatility country-periods and $(\beta_0 + b_0)$ and $(\beta_1 + b_1)$ capture the relationship between financial depth and economic growth in high-volatility country-periods.[26]

Column 2 of Table 11 reports the results. We start by noting that the coefficients associated with PC and PC^2 are statistically significant and those associated with the interacted variables are not statistically significant and have the opposite sign with respect to the main effects. However, the point estimates of the interacted terms are smaller (in absolute value) than those of the main effects. Since $\beta_0 > 0$, $(\beta_0 + b_0) > 0$, $\beta_1 < 0$, and $(\beta_1 + b_1) < 0$, the relationship between private credit and GDP growth is concave in both low and high-volatility country-periods, but possibly not statistically significant in the high-volatility subsample. The point estimates indicate that the threshold at which the marginal effect of private credit becomes negative is slightly smaller in the high volatility group.

A plot of the marginal effect of credit to the private sector obtained from the regression of column 2 shows that in low volatility country-periods financial depth has a positive and statistically significant effect on GDP growth when credit to the private sector is below 40 % of GDP, becomes negative at 70 % of GDP and negative and statistically significant at 110 % of GDP (left panel of Fig. 8). In the high-volatility group, on the other hand, the effect of credit to the private sector is never statistically significant (right panel of Fig. 8).

Our results are thus consistent with the idea that financial depth has no positive impact on output growth in periods of high economic volatility. However, the results plotted in the left-hand panel of Fig. 8 confirm that our finding of a non-monotonic relationship between financial depth and economic growth is not due to the fact that large financial sectors are associated with higher macroeconomic volatility.

Next, we repeat the experiment by substituting the high volatility dummy variable with a banking crisis dummy. In particular, we set $BKCR = 1$ in country-periods for which the Laeven and Valencia (2010) database signals the presence of a banking crisis and $BKCR = 0$ in tranquil periods. The results are reported in the last two columns of Table 11 (the sample starts in 1970 because we do not have data on banking crises for earlier periods). Column

[26] While in (9) we describe our estimating equation by using the standard fixed effects approach, we are actually estimating it with a system GMM in which time-invariant heterogeneity is controlled for through first-differencing.

Table 11 Volatility and banking crises

	(1)	(2)	(3)	(4)
LGDP(t − 1)	−0.356	−0.347	−0.693**	−0.548*
	(0.268)	(0.268)	(0.325)	(0.280)
PC(t − 1)	2.925*	2.999**	3.334*	3.957**
	(1.640)	(1.453)	(1.734)	(1.859)
PC2(t − 1)	−1.982**	−2.104**	−1.577*	−2.431**
	(0.806)	(0.886)	(0.812)	(1.073)
HVOL	−1.326***	−1.076**		
	(0.288)	(0.529)		
PC(t − 1) × HVOL		−1.399		
		(2.062)		
PC2(t − 1) × HVOL		0.868		
		(1.323)		
BKCR(t)			−1.898***	−2.134**
			(0.448)	(0.837)
PC(t − 1) × BKCR(t)				−0.013
				(2.855)
PC2(t − 1) × BKCR(t)				0.689
				(1.534)
LEDU(t − 1)	1.570**	1.726***	2.155***	1.871***
	(0.626)	(0.567)	(0.643)	(0.592)
LGC(t − 1)	−1.734***	−1.570***	−1.709***	−1.843***
	(0.644)	(0.553)	(0.639)	(0.597)
LOPEN(t − 1)	1.323***	1.041***	1.008**	0.999**
	(0.418)	(0.399)	(0.467)	(0.477)
LINF(t − 1)	−0.133	−0.032	−0.010	−0.032
	(0.187)	(0.144)	(0.173)	(0.166)
Cons.	−0.074	0.070	1.604	1.590
	(2.609)	(2.265)	(2.497)	(2.317)
N. Obs.	917	917	872	872
N. Cy.	133	133	133	133
AR1	−5.12	−5.11	−4.95	−4.87
p value	0.00	0.00	0.00	0.00
AR2	−1.34	−1.27	−1.02	−1.18
p value	0.180	0.203	0.307	0.236
OID	119.5	122.7	126.3	122.4
p value	1	1	1	1

Table 11 continued

	(1)	(2)	(3)	(4)
Period	1960–2010	1960–2010	1970–2010	1970–2010
dGR/dPC = 0	0.74	0.71	1.06	0.81
dGR/dPC = 0 (HV or BC)		0.65		1.13

This table reports system GMM estimations of 5-year non-overlapping growth spells with all available lags used as instruments. The set of controls includes lags of the level of credit to the private sector (PC) and its square (PC^2); a dummy variable that takes a value of one for high volatility periods ($HVOL$); a dummy variable that takes a value of one in country-periods with banking crises ($BKCR$); and the interaction between PC and PC^2 and each of $HVOL$ and $BKCR$. The remaining controls are the same as those of Table 6. Robust (Windmeijer) standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

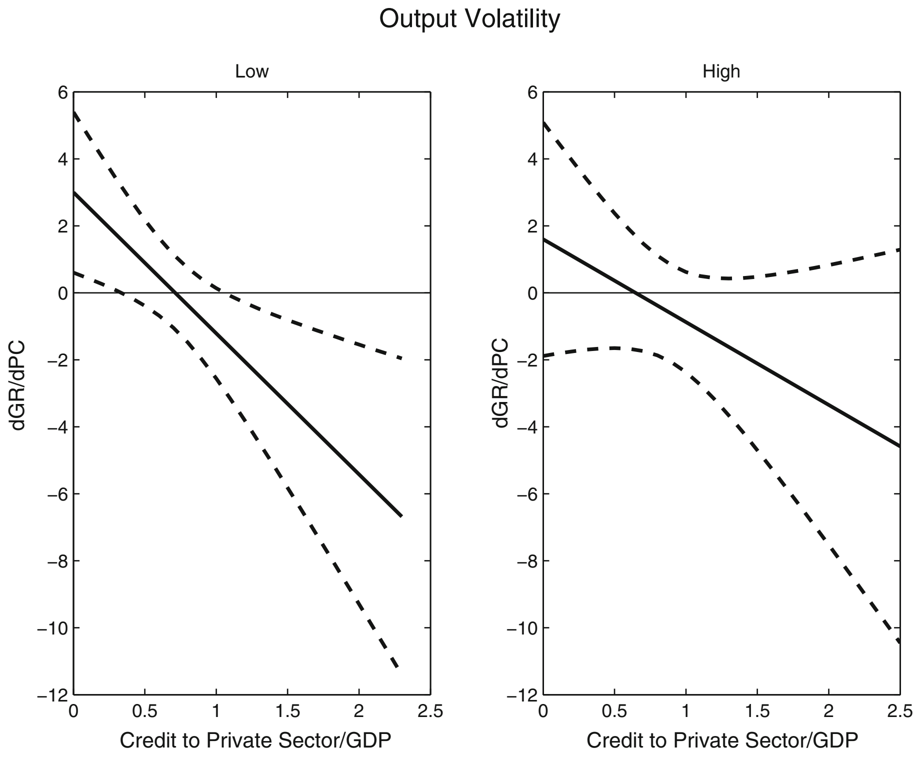

Fig. 8 The marginal effect of credit to the private sector with high and low output volatility. This figure plots the marginal effect obtained from the regression of column 2 Table 11. The *left panel* is based on the coefficients associated with PC and PC^2 and the *right panel* is based on the coefficients associated with $PC + HVOL * PC$ and $PC^2 + HVOL * PC^2$

3 yields the expected result that banking crises are negatively correlated with GDP growth, but also shows that controlling for banking crises does not affect our baseline result of a non-monotonic relationship between financial depth and GDP growth (however, it increases the threshold at which the marginal effect of PC becomes negative to 105 % of GDP). Next, we interact PC and PC^2 with $BKCR$ (column 4). Again, we find that the main effects are statistically significant and that the interacted terms are insignificant, smaller (in absolute value) than the main effects, and display the opposite sign.

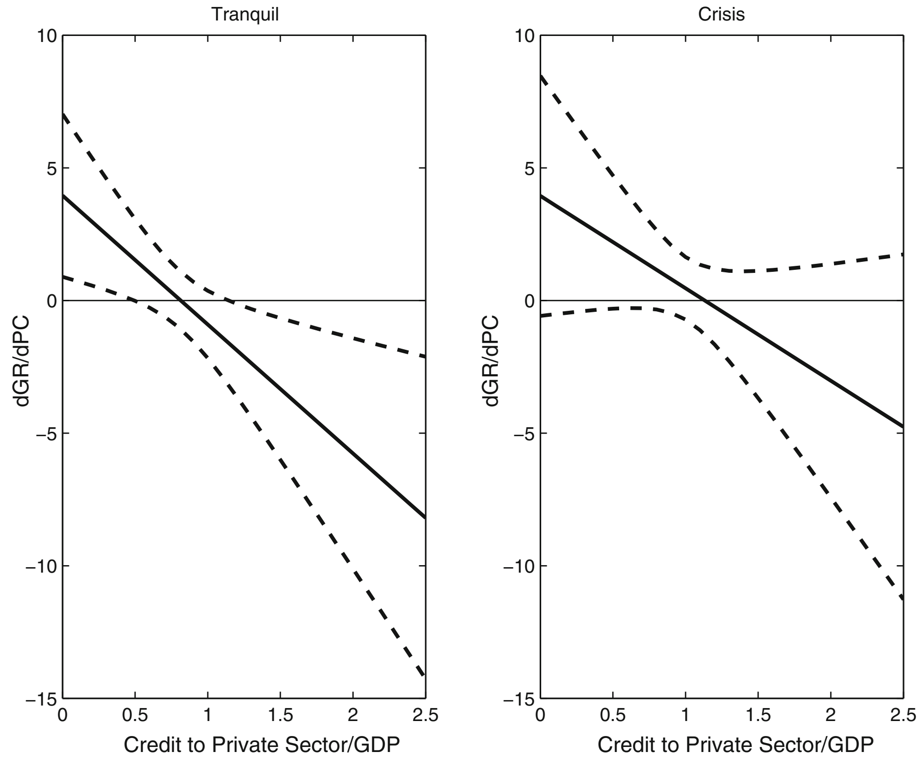

Fig. 9 The marginal effect of credit to the private sector during tranquil and crisis periods. This figure plots the marginal effect obtained from the regression of column 4 Table 11. The *left panel* is based on the coefficients associated with PC and PC^2 and the *right panel* is based on the coefficients associated with $PC + BKCR * PC$ and $PC^2 + BKCR * PC^2$

The left panel of Fig. 9 shows that in tranquil periods financial depth has a positive and statistically significant effect on GDP growth when credit to the private sector is below 60 % of GDP, becomes negative at 80 % of GDP and is negative and statistically significant at 180 % of GDP. The right-hand panel shows that the effect of financial depth is never statistically significant during crisis periods.[27]

The results of Table 11, therefore, suggest that macroeconomic volatility and banking crises are not driving our finding of a non-monotone relationship between financial depth and economic growth. The negative relationship between financial depth and economic growth may be driven by the fact that credit growth is a good crisis predictor and our strategy of interacting private credit with a banking crisis does not take into account the timing difference in rapid credit growth and banking crises. We tested for this possibility and found that our results are robust to directly controlling for credit growth and also interacting credit growth with the level and the square of financial depth.[28]

27 Eichengreen et al. (2011) find the same result when they look at the effect of capital account and financial liberalization.

28 We would like to thank an anonymous referee for suggesting this specification. Full regression results are available from the authors.

We also test for the role of institutional quality by interacting credit to the private sector (and its square) with the ICRG index of the quality of government. We find that when institutional quality is high, financial depth has a positive and statistically significant effect on GDP growth when credit to the private sector is below 20 % of GDP; the effect becomes negative at 70 % of GDP, and is negative and statistically significant at 95 % of GDP. As in Demetriades and Law (2006), we find that when institutional quality is low, credit to the private sector is never statistically significant. We also show that our results are robust to interacting credit to the private sector (and its square) with a set of variables that measure cross-country differences in bank supervision and regulation (Barth et al. 2008).[29]

The upshot of the results described in this section is that accounting for multiplicative effects involving macroeconomic volatility, banking crises or poor institutional or regulatory frameworks does not fundamentally alter our basic result that there exists a threshold of financial depth above which credit to the private sector negatively affects economic growth. While we have documented a degree of heterogeneity in the impact of financial depth on growth, it remains that the inverse U-shaped relationship between financial depth and economic growth provides the most compelling empirical representation of the data, and is able, to a remarkable extent, to account for the "vanishing effect" of finance reported in the literature.

6 Household credit versus firm credit

Theories that explain how financial development may affect economic growth tend to focus on how the financial sector can reduce credit market frictions faced by enterprises that want to finance their production or investment projects (Beck et al. 2012). However, the empirical literature tends to use aggregate measures, such as total credit to the private sector, that jointly consider credit to households and enterprises. Household credit has grown rapidly in recent years (this is especially the case for mortgage lending), in many countries much more rapidly than total credit, and there is evidence that booms in mortgage lending are associated with housing bubbles and financial crises (Jordà et al. 2014).

It is thus possible that our results are not driven by the overall size of the financial sector, but by the increasing importance of household credit. This finding would be consistent with Beck et al.'s (2012) finding that enterprise credit is positively associated with economic growth whereas household credit is not. We test this hypothesis by using data from Beck et al. (2012) which cover 45 countries for the 1994–2005 period. We start by showing that if we use total bank credit our result of a non-monotonic relationship between financial depth and economic growth is robust to using the sample of Beck et al. (2012).[30] Specifically, we find that both the linear and quadratic terms are statistically significant, with coefficients indicating that economic growth reaches a maximum when credit to the private sector is close to 100 % of GDP (column 1, Table 12). When we focus on household credit (column 2, Table 12) we also find a strong and statistically significant non-monotonic relationship, indicating that growth is maximized when household credit reaches 50 % of GDP. Focusing on firm credit, we still find a non-monotonic relationship suggesting that growth reaches a maximum when firm credit is at 80 % of GDP (column 3, Table 12). However, we now find that the quadratic term is no longer statistically significant. If we jointly test the importance of household and firm credit, we find that the positive linear term is statistically significant

[29] Details and regression results are available in Arcand et al. (2012).

[30] We are grateful to the authors for sharing their data on household and firm credit.

Table 12 Firm credit versus household credit

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LGDP(t − 1)	−0.111	−0.0804	−0.0493	−0.0885	−0.0473	−0.159	−0.0748
	(0.224)	(0.247)	(0.263)	(0.250)	(0.267)	(0.219)	(0.266)
PC	5.798***						
	(1.897)						
PC2	−3.022**						
	(1.132)						
HC		7.182**		4.700	5.397*		2.415
		(3.025)		(3.312)	(3.134)		(3.229)
HC2		−7.212**		−5.644*	−4.952*		−2.918
		(2.808)		(2.988)	(2.762)		(2.700)
FC			4.236*	4.293*		5.369**	5.060**
			(2.413)	(2.359)		(2.296)	(2.388)
FC2			−2.540	−2.812		−3.820*	−3.573*
			(2.398)	(2.111)		(2.194)	(2.053)
LEDU	0.000494	0.00155	0.00681	0.00532	−0.000910	0.00104	0.00208
	(0.00780)	(0.00795)	(0.00859)	(0.00776)	(0.00783)	(0.00728)	(0.00738)
LINF	0.497	−0.560	−0.568	0.0575	−1.103	−1.047	−0.579
	(2.007)	(2.162)	(2.349)	(2.139)	(2.341)	(2.396)	(2.319)
LOPEN	0.487*	0.629**	0.349	0.466*	0.655**	0.456*	0.483*
	(0.262)	(0.250)	(0.253)	(0.258)	(0.257)	(0.252)	(0.264)
LGC	−2.191***	−2.334***	−2.041**	−2.200***	−2.603***	−2.631***	−2.529***
	(0.727)	(0.700)	(0.920)	(0.761)	(0.729)	(0.808)	(0.790)
Constant	5.122***	5.473**	5.136**	5.023**	5.502**	5.019**	4.987**
	(1.752)	(2.214)	(1.899)	(2.140)	(2.239)	(1.920)	(2.160)
Observations	45	45	45	45	44	44	44
R^2	0.419	0.381	0.327	0.437	0.395	0.443	0.460
Sample	All	All	All	All	Excl CH	Excl CH	Excl CH
dGR/dPC = 0	0.97						
dGR/dHC = 0		0.51		0.42	0.55		0.41
dGR/dFC = 0			0.80	0.75		0.71	0.71

This table reports cross-country OLS estimations that, besides using total bank credit, also use bank credit to households (HC and HC^2) and bank credit to firms (FC and FC^2). All regressions control for education, government consumption, openness, and inflation. Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

for firm credit and the negative quadratic term is statistically significant for household credit (column 4, Table 12).

Taken together, the results of columns 2–4 of Table 12 are consistent with the idea that non-monotonicity in the relationship between financial depth and economic growth may be driven by excessive lending to households. The evidence in this direction, however, remains speculative because the small sample of countries and short time span for which we have data does not allow us to conduct extensive robustness tests. For instance, excluding a single observation (Switzerland) from the sample yields stronger evidence in favor of non-monotonicity for firm credit than for household credit (columns 5–7, Table 12).

7 Industry-level data

An influential paper by Rajan and Zingales (1998) provides strong evidence of a causal relationship going from finance to growth by showing that industrial sectors that, for technological reasons, need more financial resources, have a relative advantage in countries with large domestic financial markets. This approach provides a test of a specific mechanism through which financial depth matters (namely, by relaxing financing constraints) and has the advantage of addressing the reverse causality problem because it is plausible to assume that the growth of a specific industry will not affect financial depth in a country as a whole.

In this section, we use the Rajan and Zingales (1998) approach to examine whether industry-level data support our previous finding of a threshold above which finance starts having a negative effect on growth. As in the previous sections, we follow the existing literature but allow for non-linearities in the relationship between financial and economic development. In particular, we estimate the following model:

$$VAGR_{i,j} = SHVA_{i,j}\alpha + EF_j \times (PC_i\beta + PC_i^2\gamma) + \lambda_j + \mu_i + \varepsilon_{i,j}, \qquad (10)$$

where $VAGR_{i,j}$ is real value-added growth in industry j in country i over the 1990–2000 period; $SHVA_{i,j}$ is the initial share of value-added of industry j over total industrial value-added in country i; EF_j is the Rajan and Zingales (1998) index of external financial dependence for industry j in the 1990s; PC_i is credit to the private sector in country i in the 1990s; and λ_j and μ_i are a set of industry and country fixed effects. Because of standard convergence arguments, we expect $\alpha < 0$. A concave relationship between financial depth and industry growth corresponds to $\beta > 0$ and $\gamma < 0$.

While Rajan and Zingales (1998) considered the 1980s, we focus on the 1990s. We choose a different period because, as argued earlier, financial systems grew substantially during the past two decades. In 1985 there were only three countries in which credit to the private sector was greater than 100 % of GDP (Singapore, Switzerland, and Japan; at 99 % of GDP, the US value was close to but below this threshold). By 1995 there were 14 countries in which credit to the private sector was larger than GDP.

We begin by setting $\gamma = 0$ and show that we can use our 1990s data to reproduce Rajan and Zingales's (1998) original result that industries that need more external financial resources have a relative advantage in countries with larger financial sectors (column 1 Table 13).[31] Next, we introduce the quadratic term and find that both interactive terms are statistically significant at the 5 % level of confidence with $\beta > 0$ and $\gamma < 0$ (column 2 of Table 13). The point estimates suggest that financial depth starts having a negative effect on relative industry-level growth when credit to the private sector reaches 120 % of GDP. This threshold is surprisingly close to what we found in the country-level panel regressions of Table 6. Our results are also consistent with the findings of Coricelli et al. (2012) who find a non-monotonic relationship between leverage and productivity growth in a sample of Central and Eastern European firms.

In columns 3 and 4, we check whether our results are driven by the correlation between financial depth and GDP per capita. We find that controlling for the interaction between external dependence and GDP per capita does not change our results (column 3). The same holds if we augment our model with the interaction between external dependence and the

[31] We find an impact which is quantitatively smaller than that found by Rajan and Zingales (1998). In their estimations, the differential in growth between an industry at the 75th percentile level of external dependence with respect to an industry at the 25th percentile level when it is located in a country at the 75th percentile of credit to the private sector rather than in a country at the 25th percentile was about 1 % point. In our estimates, this differential in growth is approximately 0.4 % points.

Table 13 Rajan and Zingales estimations

	(1)	(2)	(3)	(4)	(5)	(6)
$SHVA_{t-1}$	−2.069**	−2.059**	−2.063**	−2.061**	−0.645	−2.217**
	(0.879)	(0.877)	(0.879)	(0.878)	(0.425)	(0.893)
EF × PC	0.0180*	0.0742**	0.0696**	0.0654*	0.0508**	
	(0.0106)	(0.029)	(0.0336)	(0.0337)	(0.0236)	
EF × PC^2		−0.0300**	−0.0284**	−0.0265*	−0.0227*	
		(0.0129)	(0.0139)	(0.014)	(0.0119)	
EF × Y			0.000945	0.0309		
			(0.00398)	(0.0376)		
EF × Y^2				−0.00181		
				(0.00227)		
OEF × PC						0.169***
						(0.0452)
OEF × PC^2						−0.0694***
						(0.02)
Constant	0.0648***	0.0681***	0.0691***	0.0869***	0.0508***	0.0510**
	(0.0248)	(0.0248)	(0.0253)	(0.0334)	(0.0171)	(0.0248)
PC thresh.		1.237	1.225	1.234	1.119	1.218
N. Obs.	1252	1252	1252	1252	1252	1252
R^2	0.336	0.338	0.338	0.338	0.433	0.343

This table reports the results of a set of regressions in which the dependent variable is real industry-level value added growth over the 1990–2000 period. The set of controls includes the initial share of each industry value added over total value added ($SHVA$); the interaction between the Rajan and Zingales index of external financial dependence measured for the 1990s and total credit to the private sector ($EF \times PC$); the interaction between the Rajan and Zingales index of external financial dependence and the square of total credit to the private sector ($EF \times PC^2$); the interaction between the Rajan and Zingales index of external financial dependence and the square of total credit to the private sector ($EF \times PC^2$); the interaction between the Rajan and Zingales index of external financial dependence and GDP per capita ($EF \times Y$); the interaction between the Rajan and Zingales index of external financial dependence and the square of GDP per capita ($EF \times Y^2$); the interaction between the Rajan and Zingales index of external financial dependence measured for the 1980s and total credit to the private sector ($OEF \times PC$); and the interaction between the Rajan and Zingales index of external financial dependence measured for the 1980s and the square of total credit to the private sector ($OEF \times PC^2$). All regressions include country and industry fixed effects. The regression of column (5) is estimated using Stata's robust regression routine. The bottom panel of the table reports the threshold at which the marginal effect of credit to the private sector becomes negative. Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

square of GDP per capita (column 4). In column 5, we a use a robust regression routine to check whether our results are driven by outliers and find results which are essentially identical to those of column 2. If anything, we now find a lower turning point (110 % of GDP instead of 120 %).

Finally, we substitute the 1990s index of external dependence with Rajan and Zingales's (1998) original index for the 1980s. We do this to check whether our results are robust to using the index which is most commonly used in the literature on external financial dependence and growth, but also to allow for the possibility that US industries use technologies that are more advanced with respect to the technologies adopted by the average country in our sample.

When we use data for the 1980s, our results become stronger (β and γ become statistically significant at the 1 % level) and still show that credit to the private sector starts having a negative effect on industry-level growth when it reaches 120 % of GDP (column 6 of Table 13).

8 Conclusions

This paper shows that in countries with very large financial sectors there is no positive correlation between financial depth and economic growth. In particular, we find that there is a positive and robust correlation between financial depth and economic growth in countries with small and intermediate financial sectors, but we also show that there is a threshold (which we estimate to be at around 80–120 % of GDP) above which finance starts having a negative effect on economic growth. We show that our results are robust to using different types of data and estimators. We also show that our results are consistent with the "vanishing effect" of finance reported by various authors using recent data. We do so by demonstrating that when a specification which omits the quadratic term is misspecified, and the "true" relationship is indeed quadratic, the downward bias in the linear term will increase as more and more observations are associated with countries with particularly large financial sectors.

There are several possible reasons why large financial systems may have a negative effect on economic growth. The first has to do with the evolving role of credit and security markets (Demirgüç-Kunt et al. 2013). This argument suggests that, as economies develop, credit markets become less important for economic development and market-based financial intermediation becomes more important. We show that the marginal effect of financial depth on growth is indeed decreasing in the level of economic development, but we also find that non-monotonicity in the relationship between financial depth and economic growth is robust to controlling for the interaction between financial depth and economic development.

A second set of explanations has to do with economic volatility and the increased probability of economic crashes (Minsky 1974; Kindleberger 1978). Rajan (2005) and de la Torre et al. (2011) provide numerous insights on the dangers of excessive financial depth, but they mostly focus on the finance-crisis nexus. The discussion of the "Dark Side" of financial development by de la Torre et al. (2011) is particularly illuminating (pun intended). They point out that the "Too much finance" result may be consistent with positive but decreasing returns of financial depth which, at some point, become smaller than the cost of instability brought about by the dark side. While this may be true, our results are robust to restricting the analysis to tranquil periods. This suggests that volatility and banking crises are only part of the story. Of course, it would be possible that in the presence of decreasing returns to financial development the marginal cost of maintaining financial stability becomes higher than the marginal return of financial development (de la Torre et al. 2011, make this point). In this case, however, the explanation for our findings would not be one of financial crises and volatility (which do not necessarily happen in equilibrium) but one of misallocation of resources.

A third set of explanations relate to Tobin's (1984) suggestion that a large financial sector may cause a brain drain from the productive sectors of the economy. We do not test this hypothesis but there is empirical evidence which is consistent with this view. Philippon and Reshef (2013) show that the size of the financial sector is positively correlated with the presence of rents associated with working in this sector. Kneer (2013) shows that a large financial sector hurts industries that, for technological reasons, need skilled workers.

Cecchetti and Kharroubi (2015) develop a model which is consistent with the findings of Kneer (2013) and run a battery of tests which corroborate her results.

The relationship between finance and growth could also depend on whether lending is used to finance investment in productive assets or household consumption (Beck et al. 2012). We provide evidence in support of this idea by showing that the non-monotonic relationship between financial depth and economic growth is stronger for household credit than for firm credit. However, data limitation prevents us from testing the robustness of this finding.

Beck et al. (2014) show that while intermediation is important for growth, an expansion of the financial sectors along other dimensions has no effect on growth. Therefore, the relationship between financial depth and economic growth could depend upon the manner through which finance is provided. Non-monotonicities might be driven by the increasingly important role of derivative financial products and the rise of a shadow banking system. Because of lack of data, we cannot test this hypothesis. However, we find comparable results when we run tests which include total credit to the private sector (and therefore should include the shadow banking system) and tests which only use bank lending to the private sector (and, therefore, should not include the shadow banking system). Specifically, we find that the non-monotonic relationship between financial depth and growth is robust to restricting the analysis to bank credit.

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Conflict of interest The authors declare that they have no conflict of interest.

Appendix

See Tables 14, 15, 16 and 17.

Table 14 Data description and sources

Variable	Description and sources
Growth	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2000 U.S. dollars. Source: World Bank World Development Indicators (WDI) (2011)
PC	Claims on private sector by deposit money banks and other financial institutions divided by GDP. Source: Beck et al. (November 2010 update) and Beck et al. (2000) when Beck et al. (2010) has missing data (LPC and PC^2 are the log and the square of PC)
EDUC	Average years of schooling of males and females above 25 years of age (the regressions use the log of this variable). Source: Barro and Lee (2010)
GC	General government final consumption expenditure as a percentage of GDP (the regressions use the log of this variable). Source: WDI (2011)
OPEN	Trade openness (calculated as exports plus imports divided by GDP) (the regressions use the log of this variable). Source: WDI (2011)

Table 14 continued

Variable	Description and sources
INFL	Inflation as measured by the consumer price index (annual %). We drop all observations for which inflation is less than −10 % and then set to zero all the observations for which inflation takes on negative value and apply the inverse hyperbolic sine transformation ($LINFL = \ln(INFL + \sqrt{INFL^2 + 1})$). Source: WDI 2011
HVOL	Dummy variable that takes a value of one in country-periods for which the standard deviation of annual GDP growth (measured in constant US dollars) is greater than 3.5 %. Source: own calculations based on WDI (2011)
FC	Credit to enterprises over GDP. Source: Beck et al. (2012)
HC	Credit to households over GDP. Source: Beck et al. (2012)
VAGR	Real value-added growth in industry i, country, c, over the period 1990–2000. Source: own computations based on UNIDO Industrial Statistics Database, 2006; Revisions 2 and 3. The CPI data used to deflate value added are from the IMF International Finance Statistics
SHVA	Share of sector i's value-added in total manufacturing value-added of country c in 1990. Source: own computations based on UNIDO data (see VAGR)
EF * PC	Index of External Financial Dependence for the US manufacturing sector in the 1990s interacted with credit to the private sector in the 1990s. Source: the index of external financial dependence is from Eichengreen et al. (2011), for credit to the private sector see PC
EF * Y	Index of External Financial Dependence for the US manufacturing sector in the 1990s interacted with GDP per capita. Sources: see above
OEF * PC	Index of External Financial Dependence for the US manufacturing sector in the 1980s interacted with credit to the private sector in the 1990s. Source: the index of external financial dependence is from Rajan and Zingales (1998); for credit to the private sector see PC

Table 15 Summary statistics

	N. Obs	Mean	SD	Min	Max
Cross-sectional 1980–2010					
Growth	88	1.35	1.34	−4.20	4.53
LGDP	88	7.77	1.51	4.91	10.26
PC	88	0.49	0.37	0.04	1.50
LEDU	88	1.71	0.54	−0.17	2.53
LGC	88	2.72	0.34	0.56	3.28
LINF	88	2.25	1.33	0.04	6.85
LOPEN	88	4.21	0.52	3.01	5.42
5-year panel 1960–2010					
Growth	917	1.79	3.03	−20.01	13.86
LGDP	917	7.80	1.55	4.61	10.89
PC	917	0.39	0.37	0.01	2.70
LEDU	917	2.28	0.67	0.27	3.27
LGC	917	2.65	0.39	1.17	3.83
LINF	917	2.49	1.21	−3.56	6.91
LOPEN	917	4.12	0.60	2.05	6.08
Industry-level data					
VA growth	1252	0.041	0.115	−0.476	1.05
Ext. Dep.'90s	36	0.014	0.566	−1.14	2.43
Ext. Dep.'80s	36	0.319	0.406	−0.451	1.491

Table 16 Credit to the private sector over GDP (selected years)

Country	1966	1986	1996	2006	Country	1966	1986	1996	2006
Albania			0.03	0.18	Lesotho		0.15	0.17	0.08
Algeria		0.68	0.05	0.11	Liberia		0.07		
Argentina	0.11		0.2	0.11	Lithuania			0.12	0.43
Armenia			0.06	0.08	Luxembourg	0.62	0.93	0.85	1.35
Australia	0.2	0.36	0.68	1.08	Malawi		0.14	0.06	0.1
Austria	0.4	0.77	0.93	1.11	Malaysia	0.13	1.01	1.24	1.05
Bahrain		0.51	0.54	0.66	Mali			0.11	0.16
Bangladesh		0.17	0.26	0.33	Malta		0.55	0.89	1.08
Barbados		0.36	0.48		Mauritania		0.26	0.17	
Belgium	0.13	0.26	0.74	0.76	Mauritius		0.26	0.43	0.72
Belize		0.34	0.4	0.57	Mexico	0.25	0.11	0.21	0.17
Bolivia		0.11	0.48	0.38	Mongolia			0.09	0.28
Botswana		0.08	0.11	0.19	Morocco	0.13	0.19	0.42	0.53
Brazil		0.12	0.41	0.34	Mozambique			0.08	0.12
Bulgaria			0.35	0.42	Namibia			0.48	
Burundi	0.02	0.08	0.18	0.21	Nepal		0.09	0.22	0.37
Cambodia			0.04	0.1	Netherlands	0.49	0.78	1.5	1.67
Cameroon		0.22	0.08	0.09	New Zealand		0.38	0.93	1.34
Canada	0.24	0.77	0.93	1.84	Nicaragua		0.15	0.3	
Central Afr. Rep.		0.1	0.05		Niger		0.18	0.04	
Chile	0.09	0.48	0.6	0.74	Norway	0.69	0.86	0.81	1.02
China			0.84		Pakistan		0.28	0.23	0.27
Colombia	0.18		0.34	0.31	Panama		0.46	0.65	0.77
Congo, Rep.	0.19	0.32	0.07	0.02	Papua NG		0.27	0.14	0.15
Costa Rica	0.27	0.17	0.11	0.34	Paraguay	0.1	0.13	0.27	0.16
Cote d'Ivoire	0.17	0.34	0.18	0.13	Peru	0.17	0.11	0.18	0.17
Croatia			0.29	0.63	Philippines	0.23	0.21	0.46	0.29
Cyprus		0.58	1.25	1.63	Poland			0.16	0.3
Czech Rep.			0.66	0.38	Portugal	0.55	0.6	0.73	1.48
Denmark	0.28	0.32	0.3	1.75	Romania				0.21
Dominican Rep.	0.07	0.26	0.19	0.18	Russian Fed.			0.08	0.26
Ecuador	0.16	0.26	0.26	0.22	Rwanda	0.01	0.09	0.07	
Egypt	0.14	0.27	0.33	0.47	Saudi Arabia		0.73	0.51	0.48
El Salvador	0.19	0.36	0.35	0.41	Senegal		0.27	0.15	0.2
Estonia			0.17	0.72	Sierra Leone	0.06	0.03	0.02	0.04
Fiji		0.27	0.41	0.43	Singapore				0.93
Finland	0.39	0.6	0.59	0.75	Slovak Rep.			0.38	0.35
France	0.26	0.73	0.84	0.93	Slovenia			0.25	0.59
Gabon	0.14	0.27	0.07	0.08	South Africa	0.66	0.68	1.13	1.43
Gambia, The		0.21	0.09	0.14	Spain	0.5	0.64	0.71	1.51
Germany		0.88	1.03	1.08	Sri Lanka	0.09	0.19	0.29	0.31
Ghana	0.07	0.03	0.05	0.16	Sudan	0.09	0.12	0.02	0.11

Table 16 continued

Country	1966	1986	1996	2006	Country	1966	1986	1996	2006
Greece	0.12	0.39	0.29	0.77	Swaziland		0.15	0.14	0.21
Guatemala	0.13	0.15	0.18	0.29	Sweden	0.72	0.93	1.02	1.09
Guyana	0.09	0.38	0.34		Switzerland	1.02	1.34	1.62	1.64
Haiti			0.12	0.12	Syria	0.2	0.07	0.1	0.14
Honduras	0.14	0.33	0.24	0.41	Tanzania			0.04	0.1
Hong Kong			1.47	1.38	Thailand	0.14	0.56	1.37	0.87
Hungary		0.21	0.21	0.51	Togo		0.22	0.16	0.17
Iceland	0.31	0.31	0.47	2.7	Tonga		0.24	0.44	0.57
India	0.1	0.26	0.22	0.4	Trinidad and Tobago	0.12	0.62	0.39	0.33
Indonesia		0.19	0.51	0.23	Tunisia			0.62	0.62
Iran	0.23		0.2	0.4	Turkey		0.17	0.16	0.22
Ireland	0.32	0.61	0.71	1.65	Uganda		0.02	0.04	0.06
Israel	0.21	0.45	0.61	0.87	United Kingdom	0.2	0.63	1.11	1.6
Italy	0.65	0.48	0.54	0.91	United States		1.07	1.35	1.95
Jamaica	0.17	0.22	0.22		Uruguay	0.09	0.33	0.23	0.23
Japan	0.76	1.39	1.8	0.99	Venezuela	0.24	0.51	0.08	0.13
Jordan		0.61	0.74	0.84	Vietnam			0.17	0.64
Kazakhstan			0.06	0.37	Zambia		0.07	0.08	0.08
Kenya	0.12	0.28	0.25	0.25	Zimbabwe		0.14	0.28	
Korea		0.72	1.12	1.12	Mean	0.25	0.38	0.42	0.58
Kuwait			0.34	0.52	Median	0.18	0.27	0.28	0.39
Kyrgyz Rep.			0.09	0.09	St dev	0.22	0.29	0.39	0.53
Latvia			0.07	0.71					

Table 17 Share of observations above and below thresholds

	dGR/dPC > 0		dGR/dPC < 0	
	Stat. Sig. (%)	Not Stat. Sig. (%)	Not Stat. Sig. (%)	Stat. Sig. (%)
Cross-country 1970–2000	77	12	6	5
Cross-country 1970–2005	75	11	9	5
Cross-country 1970–2010	75	9	10	6
Cross-country 1980–2010	75	10	9	6
Cross-country 1990–2010	72	7	10	11
Panel 1960–1995	96	3	1	0
Panel 1960–2000	94	4	2	0
Panel 1960–2005	70	20	6	4
Panel 1960–2010	34	50	9	7

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