Too Much Finance?

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Abstract

This paper examines whether there is a threshold above which financial development no longer has a positive effect on economic growth. We develop a simple model in which the expectation of a bailout may lead to a financial sector which is too large with respect to the social optimum. We then use different empirical approaches to show that there can indeed be "too much" finance. In particular, our results suggest that finance starts having a negative effect on output growth when credit to the private sector reaches 110 percent of GDP. We conclude by showing that the size of the financial sector was a significant amplifying factor in the global crisis that followed the collapse of Lehman Brothers in September 2008.

> *..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 provides a fresh look at the relationship between financial development and economic growth. It reproduces the standard result that, at intermediate levels of financial development, 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 development, more finance is associated with less growth. This non-monotone relationship between economic growth

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and the size of the financial sector is consistent with the hypothesis that there can be "too much" finance.

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 the fact that financial intermediation improves the efficiency rather than the volume of investment (this is also the channel emphasized by Greenwood and Jovanovich, 1990, and Bencivenga and Smith, 1991).[1] However, Goldsmith made no attempt to establish whether there was a causal link going from financial development to economic growth. Several economists remained thus of the view that a large financial system is simply a by-product of the overall process of economic development. This position is well-represented by Joan Robinson's (1952) claim that: "where enterprise leads, finance follows."

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 development 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, Loayza, and Beck (2000) and Beck, Levine, and Loayza (2000) who used different types of instruments and econometric techniques to identify the presence of a causal relationship going from finance to growth.[2] Finally, 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 finance grow relatively more in countries with a larger financial sector.[3] There is by now an enormous literature showing that finance does indeed play a positive role in promoting economic development and few economists now doubt the existence of such a causal link (Levine, 2005).[4]

The recent crisis has however raised concerns that some countries may have financial systems which are "too large" compared to the size of the domestic economy.[5] In fact, the idea that there could be a threshold above which financial development hits negative social returns is hardly new. 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

[1]There is limited empirical support for the Shaw (1973) and McKinnon (1973) view that finance affects growth because it mobilizes savings and thus increases the quantity (rather than the quality) of investment.

[2]Levine, Loayza, and Beck (2000) instrumented their cross sectional regressions with legal origin (La Porta et al., 1998) and Beck, Levine, and Loayza (2000) argued for causality by using the GMM 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 the main channel through which finance should affect growth.

[4]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.

[5]Wolf (2009) noted that over the last three decades the US financial sector grew six times faster than nominal GDP and argued that there is something wrong with a situation in which: "instead of being a servant, finance had become the economy's master." Rodrik (2008) asked whether there is evidence that financial innovation has made our lives measurably and unambiguously better.

prophetic now, Rajan (2005) 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." In an even more recent paper, Gennaioli, Shleifer, and Vishny (2010) show that in the presence of some neglected tail risk financial innovation can increase financial fragility even in the absence of leverage.

Besides increasing volatility, 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.[6]

On the empirical side, Easterly, Islam, and Stiglitz (2000) show that there is a convex and non-monotone relationship between financial development 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. 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. This, for instance, is the message of Rancière, Tornell, and Westermann's (2008) paper on the effects of financial liberalization. In order to ascertain whether there can be "too much" finance, it is thus necessary to test whether there is a threshold above which financial development starts having a negative impact on growth.

To the best of our knowledge, Deidda and Fattouh (2002) and Rioja and Valev (2004) are the only authors who consider a non-monotone relationship between financial and economic development. Deidda and Fattouh (2002) start their analysis with a simple theoretical model where the presence of fixed transaction costs in the financial sector lead to a situation in which incipient financial systems may actually reduce growth. Next, they test their model using King and Levine's (1993) cross-country data and a threshold regressions model. They find that financial development has a positive but statistically insignificant impact on output growth in countries with low level of economic or financial development and that financial development has a positive and statistically significant impact on growth in countries with higher levels of economic and financial development.

Rioja and Valev (2004) split their panel of 72 countries into three regions and show that there is no statistically significant relationship between finance and growth at low levels of financial development, there is a strong and positive relationship at intermediate levels of financial development, and that there is a weaker but still positive and statistically significant effect of finance at higher levels of financial development.

Another paper which is closely related to our work is De Gregorio and Guidotti (1995) who show that in high income countries financial development is positively correlated with output growth over the 1960-1985 period but that the correlation between financial development and growth becomes negative for the 1970-85 period. De Gregorio and Guidotti (1995) suggest that this result may be due to the fact that high income countries have reached the point in which financial development no longer contributes to increasing the efficiency of investment.

[6]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.

The same authors show that a panel of 12 Latin American countries over the 1950-1985 period yields a strong negative correlation between financial development and growth. This negative correlation is mostly driven by what happened between 1974 and 1985, a period during which many Latin American countries liberalized their financial sectors without having a proper regulatory system (Díaz-Alejandro, 1985). Based on this observation, De Gregorio and Guidotti (1995) relate their empirical results to a simple model in which the presence of a government bailout and a poor regulatory framework lead to suboptimal screening and excessive lending.

We contribute to the literature on financial development and economic growth in three distinct ways. First, we build a simple model in the spirit of Stiglitz and Weiss (1981) which finds that, even in the presence of credit rationing, the expectation of a bailout may lead to a financial sector which is too large with respect to the social optimum.

Second, we use different datasets (both at the country and industry-level) and empirical approaches (including semi-parametric estimations) to show that there can indeed be "too much" finance. In particular, our results show that the marginal effect of financial development on output growth becomes negative when credit to the private sector surpasses 110% of GDP. This result is surprisingly consistent across different types of estimators (simple regressions and semi-parametric estimations) and data (country-level and industry-level). The threshold at which we find that financial developement starts having a negative effect on growth is similar to the threshold at which Easterly, Islam, and Stiglitz (2000) find that financial development 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). 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 probably due to the fact that they set their threshold for the "high region" at a level of financial development which is much lower than the level for which we start finding that finance has a negative effect on growth.[7] Moreover, our sample include many observations for which financial development is above the threshold at which finance starts having a negative effect on growth.

Finally, we discuss how our results relate to the current crisis and show that all the advanced economies that are now facing serious problems are located above our "too much" finance threshold. We also run a battery of tests showing that the size of the financial sector played an important role in amplifying the effects of the global recession that followed the collapse of Lehman Brothers in September 2008. While most of the recent discussion on the negative effects of financial development concentrates on the advanced economies, we show that during the recent crisis the amplifying role of the financial sector was also important for developing countries.

The rest of this paper is organized as follows. Section 2 develops a simple model of financial and economic development, based on a Stiglitz-Weiss type model of the demand for credit by firms. Section 3 looks at the relationship between financial development and economic

[7] In Rioja and Valev (2004) the highest threshold for credit to the private sector is 37 percent of GDP. Our result also differ from those of Deidda and Fattouh (2002) who, however, concentrate on non-linearities at the bottom of the distribution of the financial development variable.

growth using country-level data. Section 4 investigates non-linearities using industry-level data and the Rajan and Zingales (1998) approach. Section 5 discusses the role of financial development in the global crisis that erupted after the collapse of Lehman Brothers. Section 6 concludes.

2 A Model of Financial and Economic Development

We set the stage for the empirical analysis with a simple partial equilibrium model which analyzes the relationship between financial and economic development. In particular, we consider a one-period economy where production takes place in two sectors, and where individuals supply labor inelastically and never save. Given our zero saving assumption, firms finance investment by borrowing abroad. The only role of the competitive financial sector is to screen projects and use its screening technology to intermediate foreign loans. In particular, the financial sector borrows abroad at the international interest rate R and lends domestically at a rate $r \geq R$.[8] We show that in the presence of market imperfections, even this simple characterization of the financial sector can yield a situation in which there is "too much" finance.

The first sector is composed of a large number of competitive firms with a standard constant returns to scale technology: $y_c = F(K, L)$ (with $F_K > 0$, $F_L > 0$, $F_{KK} < 0$ and $F_{LL} < 0$). As output is non-stochastic, we assume that firms can post collateral, guaranteeing that they will always repay their loans. Since loans to these firms carry no risk, the competitive banking sector will charge them an interest rate $r_c = R$ (with $F_K = r_c$, and $F_L = w$; where w is the wage rate).

Next, we build on Stiglitz and Weiss's (1981) credit rationing model and assume that the second sector is composed of monopolistic firms with the following stochastic production function:

$$y = \theta\sqrt{D}, \tag{1}$$

where D is the firm's stock of debt and θ is a random variable distributed according to the uniform density over $[0, N]$. Given stochastic production, loans to firms in this sector are risky and the banks will charge an interest rate $r > R$.

Total production is thus given by $Y = y_c + y$ and GNP is equal to $Y - (1 + R)(K + D)$, where $K+D$ is the size of the financial sector. Since the contribution to domestic value added of the first sector is fully determined by the exogenous labor supply and foreign interest rate, from now on we will only concentrate on the second sector.

2.1 Social Planner

The optimal size of the financial sector is equal to the level of investment that maximizes domestic value added. Thus, the social planner's problem is:

$$\max_{\{D\}} \frac{1}{N} \int_0^N \theta\sqrt{D}d\theta - (1 + R)D. \tag{2}$$

[8] We rule out any concerns related to the behavior of the exchange rate by assuming a common currency. We also assume, without loss of generality, no cost associated with screening projects.

The solution to this problem yields a level of debt and investment that maximizes social welfare, and which is equal to:

$$D^{**} = \frac{N^2}{16(1+R)^2}. \tag{3}$$

The optimal level of debt is a negative function of the cost of funds R, and a positive function of productivity which, in turn, is determined by the upper bound of the distribution of θ.

2.2 Decentralized Equilibrium

Because of limited liability and the assumption that entrepreneurs have no equity capital, the profit of the representative entrepreneur is given by: $\pi = \max\left[\theta\sqrt{D} - (1+r)D, 0\right]$. Given the uniform distribution of θ, this yields an expected profit of:

$$E(\pi) = \frac{1}{N}\int_{\theta^*}^{N}\left[\theta\sqrt{D} - (1+r)D\right]d\theta, \tag{4}$$

where $\theta^* = (1+r)\sqrt{D}$ is the threshold level of the realization of the random variable above which the entrepreneur makes positive profits and is able to repay the loan. Performing the integration we obtain:

$$E(\pi) = \frac{\sqrt{D}}{2N}\left[(1+r)\sqrt{D} - N\right]^2. \tag{5}$$

In order to use equation (5) to find the level of debt that maximizes profit, we need to solve for the endogenous lending rate r. Given our assumption of a competitive banking system, this is the rate that equates a lender's expected profits, $E(L)$, to zero.

$E(L)$ is composed of three elements: (i) full debt repayment times the probability that the project will be successful; (ii) the recovery value times the probability that the investment will be unsuccessful; and (iii) the cost of funds. Formally:

$$\begin{aligned} E(L) &= \frac{1}{N}\int_{\theta^*}^{N}(1+r)Dd\theta + \\ &+\frac{1}{N}\int_{0}^{\theta^*}\left[\theta\sqrt{D} + \gamma\left((1+r)D - \theta\sqrt{D}\right)\right]d\theta - (1+R)D. \end{aligned} \tag{6}$$

The term in the first integral is the repayment if the investment is successful, while the term in the second integral measures what the lenders will recover in case of default; the third term in equation (6) is the cost of lending. If $\gamma \neq 0$, the recovery value in case of default is different from the residual value of the defaulted project. The parameter γ is crucial in our story because it introduces a wedge between the socially optimal level of debt and the market equilibrium. We will show that when $\gamma < 0$ the financial system is too small with respect to the social optimum and when $\gamma > 0$ the financial system is too big with respect to the social optimum.

We can think of γ as a combination of the strength creditor rights (c) and government bailout (b) in case of default. To fix ideas, assume that $\gamma = (c + b - 1)$, with $0 \leq c \leq 1$ and

$0 \leq b < 2$.[9] In this setting, $c = 1$ denotes a situation with perfect creditor rights (lenders can recover the whole residual value of the failed investment project) and $c < 1$ denotes a situation in which lenders can only recover a fraction of the failed investment project. Similarly, $b = 0$ denotes a situation in which the government never bails out lenders, and $b > 0$ denotes a situation in which the government offers a (possibly partial) bailout.

Consider, for instance, the case of a country with no creditor rights and no bailout. In this case, creditors will receive no payments in case of default: $(\theta\sqrt{D}+\gamma[(1+r)D-\theta\sqrt{D}]) = 0$ and $\gamma = -\frac{\theta\sqrt{D}}{(1+r)D-\theta\sqrt{D}} < 0$. With perfect creditor rights ($c = 1$) and no bailout ($b = 0$), instead, we get $\gamma = 0$, and the bank will receive all the residual value of the failed investment project (i.e., $\theta\sqrt{D}$). Note that the presence of a positive bailout ($b > 0$) is a necessary but not sufficient condition for $\gamma > 0$. With a positive bailout ($b > 0$), creditors could receive either less than the recovery value (if $b < 1 - c$) or more than the recovery value (if $b > 1 - c$).

Performing the integration in equation (6), we obtain:

$$E(L) = \frac{D\left[2N(r-R) + (1+r)^2(\gamma - 1)\sqrt{D}\right]}{2N}. \tag{7}$$

Competitive lenders will choose the interest rate that sets expected profits equal to zero. Equation (7) is a quadratic in r and admits two solutions:

$$r_1^* = \frac{N+\sqrt{\psi}}{\sqrt{D}(1-\gamma)} - 1; \quad r_2^* = \frac{N-\sqrt{\psi}}{\sqrt{D}(1-\gamma)} - 1, \tag{8}$$

where $\psi = N[N - 2\sqrt{D}(1+R)(1-\gamma)]$. For the time being we will assume that $\psi > 0$: we will later show that this condition holds in practice.[10] With $\psi > 0$ it is always true that $r_1^* > r_2^*$.

Since lenders are indifferent between interest rates (they always make zero profits), we pick the one that makes the borrower better off (any lender who charges a different interest rate would lose all customers). By substituting the expressions in (8) into (5) we obtain:

$$E(\pi_1) = \sqrt{D}\frac{\left[\sqrt{\psi}+N\gamma\right]^2}{2N(\gamma-1)^2}; \quad E(\pi_2) = \sqrt{D}\frac{\left[\sqrt{\psi}-N\gamma\right]^2}{2N(\gamma-1)^2}. \tag{9}$$

Since $\psi > 0$, $E(\pi_1) > E(\pi_2)$ if $\gamma > 0$ and $E(\pi_1) < E(\pi_2)$ if $\gamma < 0$ (if $\gamma = 0$, $E(\pi_1) = E(\pi_2)$). Whenever $\gamma > 0$, borrowers will prefer the higher interest rate and when $\gamma < 0$ borrowers will prefer the lower interest rate. The intuition for this is simple: inspection of equation (5) reveals that $E(\pi)$ is quadratic (and $U-$shaped) in r. It is therefore not surprizing that a higher level of the interest rate is entirely compatible with higher borrower welfare.[11]

[9] In order to avoid negative payments or payments which are greater than the original loan, it is also necessary to impose a joint constraint on c and b such that their sum guarantees that $-\frac{\theta\sqrt{D}}{(1+r)D-\theta\sqrt{D}} \leq \gamma < 1$ (we use a strict inequality, $\gamma < 1$, for technical reasons). Note that in case of default the denominator of the lower bound is always positive and $-\frac{\theta\sqrt{D}}{(1+r)D-\theta\sqrt{D}} > -1$.

[10] Our assumption that $\gamma < 1$ is necessary to guarantee that the denominators in the interest rate equations are nonzero.

[11] In turn, the $U-$shape of $E(\pi)$ in (5) stems from the linearity in θ of the integrand in equation (4), combined with the limited liability assumption.

We can now maximize $E(\pi_1)$ and $E(\pi_2)$ with respect to D and solve for the optimal amount of debt. Let us start with the case in which $\gamma > 0$ and expected profits are given by $E(\pi_1)$. In this case, the FOC is given by:

$$\frac{\partial E(\pi_1)}{\partial D} = \frac{\left[\sqrt{\psi} + N\gamma\right]\left[N - 4\sqrt{D}(1+R)(1-\gamma) + \gamma\sqrt{\psi}\right]}{4\sqrt{D}\sqrt{\psi}(\gamma-1)^2} = 0. \tag{10}$$

Given our previous assumptions, when $\gamma > 0$, the first term in square brackets in the numerator and the denominator of (10) are both always positive. Therefore, we can find the optimal value of D by setting the second term in square brackets in the numerator equal to zero. This yields two solutions:

$$D_{11}^* = \frac{N^2\left[8+\gamma^4 - \gamma(4-\gamma^2)\sqrt{8+\gamma^2}\right]}{128(1+R)^2(\gamma-1)^2}; \quad D_{12}^* = \frac{N^2\left[8+\gamma^4 + \gamma(4-\gamma^2)\sqrt{8+\gamma^2}\right]}{128(1+R)^2(\gamma-1)^2}. \tag{11}$$

Since $0 < \gamma < 1$, $\gamma(4-\gamma^2) > 0$, and $D_{12}^* > D_{11}^*$.

At this point, we can substitute D_{11}^* and D_{12}^* into ψ and, after some tedious algebra, show that they satisfy the condition that $\psi > 0$. It is also easy to show that $\frac{\partial^2 E(\pi_1)}{\partial D^2} < 0$ and therefore that our solution satisfies the second order condition for a maximum.[12] The appendix shows that when $\gamma > 0$, expected profits are always higher with D_{12}^* and therefore the borrower always prefers the solution with a higher level of credit.

Summing up, with $\gamma = 0$ the decentralized equilibrium is equal to the social optimum ($D_{11}^* = D_{12}^* = D^{**}$ where D^{**} was given in equation (3)), but for positive values of γ, we find that credit is always above the social optimum ($D_{12}^* > D^{**}$). The presence of a bailout leads to too much risk taking and to a financial sector which is larger than the social optimum (this does not necessarily mean that bailouts are never desirable, more on this below).

We now consider the case with $\gamma < 0$. In this case, $E(\pi_2) > E(\pi_1)$ and the borrowers will choose the lower interest rate r_2^*. Taking the first order condition, we obtain:

$$\frac{\partial E(\pi_2)}{\partial D} = \frac{\left[\sqrt{\psi} - N\gamma\right]\left[N - 4\sqrt{D}(1+R)(1-\gamma) - \gamma\sqrt{\psi}\right]}{4\sqrt{D}\sqrt{\psi}(\gamma-1)^2} = 0. \tag{12}$$

Since $\gamma < 0$, the first expression in square brackets in the numerator is always positive (and so is the denominator). We can thus find that value of D that maximizes profits by setting the second term in the numerator equal to zero. As this term is equal to the one considered earlier (in equation (10)), we obtain the same solutions: $D_{21}^* = D_{11}^*$ and $D_{22}^* = D_{12}^*$. However, γ is now negative and $D_{21}^* > D_{22}^*$. The Appendix shows that with $\gamma < 0$, borrowers always prefer D_{21}^* (again, with $\gamma = 0$ we get $D_{21}^* = D_{22}^* = D^{**}$).

We can now use the expressions in (11) to fully describe the size of the financial sector under positive and negative values of γ.

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[12] Let $A = \left[\sqrt{\psi} + N\gamma\right]$; $B = \left[\psi/N + \gamma\sqrt{\psi}\right]$; and $C = (4\sqrt{D}\sqrt{\psi}(\gamma-1)^2)$. Then $\frac{\partial^2 E(\pi_1)}{\partial D^2} = \frac{(A\frac{\partial B}{\partial D} + B\frac{\partial A}{\partial D})C - \frac{\partial C}{\partial D}AB}{C^2}$. Given that at D^*, B is equal to zero, the SOC simplifies to $\frac{\partial^2 E(\pi_1)}{\partial D^2} = \frac{A}{C}\frac{\partial B}{\partial D}$. Since $A > 0$, $C > 0$, and $\frac{\partial B}{\partial D} < 0$, we get that $\frac{\partial^2 E(\pi_1)}{\partial D^2} < 0$.

$$D^* = \begin{cases} \frac{N^2\left[8+\gamma^4-\gamma(4-\gamma^2)\sqrt{8+\gamma^2}\right]}{128(1+R)^2(\gamma-1)^2} & if \quad \gamma < 0 \\ \frac{N^2}{16(1+R)^2} & if \quad \gamma = 0 \\ \frac{N^2\left[8+\gamma^4+\gamma(4-\gamma^2)\sqrt{8+\gamma^2}\right]}{128(1+R)^2(\gamma-1)^2} & if \quad \gamma > 0 \end{cases} \tag{13}$$

It is easy to show that when $\gamma > 0$, there is always "too much" finance ($D^* > D^{**}$ because $\gamma^4 + \gamma(4-\gamma^2)\sqrt{8+\gamma^2} > 0$ and $(\gamma-1)^2 < 1$).

With $\gamma < 0$, the comparison between D^* and D^{**} is more complicated because γ increases both the numerator and the denominator of D^* (with $\gamma < 0$, $\gamma^4 - \gamma(4-\gamma^2)\sqrt{8+\gamma^2} > 0$ and $(\gamma-1)^2 > 1$). We can however plot the D^*/D^{**}ratio for $\gamma \in [-1, 1)$ and show that when $-1 \leq \gamma < 0$, it is always true that $D^*/D^{**} < 1$ and when $0 < \gamma < 1$, it is always true that $D^*/D^{**} > 1$ (Figure 1). Therefore, when $\gamma < 0$, the financial system is always too small with respect to the social optimum ($D^* < D^{**}$).

Equation (13) shows that bailouts are not necessarily a bad idea. The optimal bailout rule is $b = 1 - c$. Only with perfect creditors rights ($c = 1$) are bailouts never desirable. If $c < 1$ and if we assume that the bailout is financed with lump sum taxes, society will be indifferent between setting $b = 1 - c$ and a reform that improves creditor rights. Improving creditors' rights will be the preferred option only if the bailout is financed with a distortionary tax.

Note, however, that Figure 1 shows that D^* is generally an increasing and convex function of γ. Thus, for any any pair of γs with $|\gamma_i| = |\gamma_j|$ and $\gamma_i < 0$, $\gamma_j > 0$, the deviation from the social optimum is always larger when γ is positive. Therefore, in the presence of uncertainty on the value of c, policymakers should be conservative in offering bailouts because the costs of overshooting are larger than those of undershooting.

It is straightforward to use our model to show that, under certain conditions, a distortionary tax can restore the social optimum. In particular, if $\gamma > 0$ and $c = 1$, a Pigouvian tax equal to the cost of the potential bailout will make entrepreneurs internalize the cost of overborrowing and lead them to choose D^{**}. This is a result similar to that of Jeanne and Korinek's (2010) model of credit booms and busts.

3 Empirical Analysis: Country-Level Data

The model of the previous section showed that imperfect creditor rights and the presence of government bailouts may lead to a situation in which the size of the financial sector is either too small or too large with respect to the social optimum. In the model we kept things simple and focused on the relationship between financial development and the *level* of income. However, we believe that the story told by our model also applies to the relationship between financial development and economic growth.

We now take a fresh look at the literature on the relationship between financial development and economic growth with the objective of seeing if there is a threshold above which financial development starts having a negative effect on economic growth.

We build on the large literature that uses country-level data to show the presence of a causal positive relationship going from financial development to economic growth (Levine,

2005) and use parametric and non-parametric techniques to look at what happens if we allow for a non-monotonic relationship between financial development and economic growth.[13]

In order to compare our results with the existing literature we stay as close as possible to Beck and Levine (2004). We think that this paper is a good benchmark because it is one of the most recent empirical pieces on financial development and economic growth by the two leading scholars in the field and it is thus a good proxy of the consensus in the economics literature. Another advantage of using Beck and Levine (2004) as a benchmark is that all the data are available on Ross Levine's web page, making it easy to reproduce and extend their results.

As in most of the literature that looks at the relationship between finance and growth, we quantify financial development by using credit to the private sector and the turnover ratio in the stock market.

The use of credit to the private sector 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 development 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. 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 development and growth use data that end in the year 2000, the choice between these two variables did not really matter. However, these two measures of financial development 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 development in countries where the sector is particularly large, it is arguably wiser to use a measure of financial development that is more in tune with our hypothesis of there being potentially "too much" finance.

Our second indicator of financial development focuses on the equity market and tries to capture the idea that more liquid markets should promote an efficient allocation of capital. We measure liquidity with the turnover ratio which is equal to the value of the shares traded on a certain stock market divided by total market capitalization.

As is standard in the literature on financial development and economic growth, all of our regressions include initial GDP per capita to control for convergence and average years of schooling to control for human capital accumulation. We also estimate models that include

[13] Most studies use the log of financial development 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.

trade openness, inflation, and the ratio of government expenditures to GDP. With the exception of credit to the private sector, all of our variables match those of Beck and Levine (2004). However, while Beck and Levine's data end in 1998, we use data for the period 1976-2005.[14]

3.1 Cross-Sectional Regressions

We start our analysis by using cross-sectional data to regress average GDP per capita growth for the period 1976-2005 over the set of variables described above.

Column 1 of Table 1 estimates the same OLS specification used by Beck and Levine (2004) and reproduces their result of a positive and statistically significant correlation between GDP growth on the one hand, and the log of credit to the private sector over GDP and the log turnover ratio, on the other.

In Column 2, we replace the logs of credit to the private sector and of the turnover ratio with the corresponding levels and still find a positive and statistically significant relationship. The estimates are, however, less precise. This is not surprising if the relationship between financial development and growth is indeed non-linear.

In Column 3, we start exploring the "too much" finance hypothesis by augmenting the model of Column 2 with a quadratic term in the bank credit variable. We find that the point estimate of the linear term increases substantially and so does the precision of the estimate. Perhaps more interestingly, the quadratic term is also statistically significant but with a negative sign, indicating a concave relationship between credit to the private sector and GDP growth. The point estimates indicate that financial development starts yielding negative returns when credit to the private sector reaches 104% of GDP.

In Column 4, we augment our model with the square of the turnover ratio. We find that the coefficients associated with credit to the private sector are basically identical to those of column 3 but that neither the turnover ratio nor its square are statistically significant. The adjusted R^2 suggests that column 3 yields the best fit.

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. However, our results differ from those of Rioja and Valev (2004) who find an S-shaped relationship between financial development and economic growth which could be better described by a cubic polynomial. Our results could thus be spurious and driven by the particular parametric relationship that we chose to estimate. To address this issue and uncover the true relationship between financial development and economic growth, we estimate a set of semi-parametric regressions which allow financial development to take a general functional form.

Formally, we use the differencing procedure suggested by Yatchew (2003) and a penalized spline smoother (Wand, 2005) to estimate different variants of the following model:

$$gr_i = \beta_0 + lstart_i\beta_1 + lschool_i\beta_2 + f(tor_i) + f(priv_i) + \varepsilon_i. \tag{14}$$

We start by only allowing the private credit variable to take a general form (i.e., we set $f(tor) = tor\beta_3$) and find that the relationship between private credit and GDP growth

[14] Table 7 describes all the variables used in the empirical analysys and provides a list of sources. Table 8 reports the summary statistics.

is concave with a level of private credit that maximizes growth which is almost identical to what we found with the simple quadratic model (Figure 2, panel (a)). Next, we set $f(priv) = priv\beta_4$ and only allow the turnover ratio to take a general form. As in the OLS regressions, we find no evidence of a non-linear relationship between turnover and GDP growth (Figure 2, panel (b)). Finally, we allow both measures of financial development to take a general form and we still find evidence of a quadratic relationship between private credit and GDP growth and a linear relationship between stock market turnover and GDP growth (Figure 2, panels (c) and (d)).

We can use the results of our semi-parametric regressions to plot the marginal effect of private credit on growth. We find that $\frac{\partial gr}{\partial priv}$ becomes negative when private credit reaches 120% of GDP (Figure 3). This threshold is similar to what we found with the OLS regressions of Table 1. Figure 3 also shows that the confidence intervals are quite large, indicating that when credit to the private sector reaches 90% of GDP the relationship between financial development and economic growth is no longer statistically significant.

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

3.2 Panel Regressions

Having established the presence of a non-linear 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.[15] In order to avoid overfitting our models, we collapse the matrix of instruments using the procedure suggested by Roodman (2006).

As in the cross country analysis, we start by replicating the results of Beck and Levine (2004). In the first four columns of Table 2 we estimate their model using our updated dataset. While our results are qualitatively similar to those of Beck and Levine, we find that the coefficients associated with the financial development variables are rarely statistically significant. There are two possible reasons why our results differ. The first has to do with the specification of the System GMM regressions. It is possible, for instance, that Beck and Levine (2004) used a different number of lags in their set of instruments or did not adjust their standard errors using the Windmeijer (2005) correction. Alternatively, the difference between the two sets of results may be due to the fact that we use slightly different data.

[15] One source of concerns when estimating fixed effect model 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 (Table 8). Credit to the private sector, for instance, has a between-country standard deviation of 0.36 and a within-country standard deviation of 0.22 (the overall standard deviation is 0.42). In the case of the turnover ratio, the within-country standard deviation (0.36) is higher than the between-country standard deviation (0.32), the overall standard deviation is 0.48.

While Beck and Levine (2004) measure financial development with bank credit to the private sector, we use total credit to the private sector. Moreover, we have data until 2005, while their sample ends in 1998.

We find that differences in data are indeed important. When we re-estimate our model using Beck and Levine's data for the 1976-98 period, our results are much closer to their original findings (Table 2, columns 5-8).

The fact that using more recent data and a broader definition of financial development weakens the relationship between financial development and growth is 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. Financial sectors grew substantially over the 2000-05 period and our results indicate that a specification that worked well with smaller financial sectors no longer yields statistically significant results in the presence of larger financial sectors and a broader definition of financial development. This finding is consistent with the idea of a non-monotone relationship between financial development and economic growth.

In Table 3 we explore non-linearities using the same approach as in Table 1. We start by replacing the logs of the financial development indicators with their levels and show that while both variables have a positive marginal effect on growth, only private credit does so in a statistically significant manner (Column 1). Next, we introduce the square of private credit and find that both terms are statistically significant and that the coefficient associated with the quadratic term is negative (Column 2). The point estimates suggest that the marginal effect of credit to the private sector becomes negative when this variable reaches 115% of GDP (the point at which the marginal effect becomes negative is reported in the row labeled "Private credit threshold"). The effect of the turnover ratio remains positive, though statistically insignificant.

The remaining three columns of Table 3 show that the results are robust to controlling for government consumption (Column 3) and trade openness (Column 4). When we control for log inflation (Column 5), private credit and its square are no longer significant at conventional levels but they are close to be being statistically significant at the 10% level (the $p-$values are 0.106 and 0.146, respectively). While the turnover ratio is often insignificant, it is significant at the 5.5% level when we control for trade openness (Column 4).

The last four rows of Table 3 report the $p-$values of the standard Arellano and Bond (1991) specification and correlation tests. We report both the Sargan and Hansen test of the overidentifying restrictions because the first has higher power and the second performs better in the presence of heteroskedasticity. We find that the Sargan test does not reject our exclusion restrictions in Columns 1, 2, 4, and 5, and rejects them in Column 3. The Hansen test, for its part, suggests that the only appropriate models are those of Columns 1 and 2.[16] The Arellano and Bond (1991) correlation tests suggest that the residual of our models satisfy the conditions for identification in that they exhibit first order autocorrelation but no second order autocorrelation.

Figure 4 plots the marginal effect of private credit calculated using the specification of column 2 of Table 3. It shows that the relationship between private credit and growth is positive and statistically significant when private credit is smaller than 100% of GDP, while

[16] These rejections could also be due to the low power of the Hansen test.

the relationship becomes negative and statistically significant when private credit surpasses 160% of GDP.

Next, we check whether our results are robust to using the same semi-parametric estimator that we used with the cross-country data. As before, we start by only allowing the private credit variable to take a general form and find that the relationship between private credit and GDP growth is concave with a level of private credit that maximizes growth which is almost identical to what we found with the simple quadratic model (Figure 5, panel (a)). Next, we only allow the turnover ratio to take a general form. Again, we find no evidence of a non-linear relationship between turnover and GDP growth (Figure 5, panel (b)). Finally, we allow both measures of financial development to take a general form and we still find evidence of a quadratic relationship between private credit and GDP growth and a linear relationship between stock market turnover and GDP growth (Figure 5, panels (c) and (d)).

Figure 6 shows that in 2006 there were 21 countries where private credit was larger than GDP (the Figure includes all countries for which we have data on private credit over GDP and not only the 44 countries included in our empirical analysis). The first two vertical lines represent the lowest and highest estimate of the threshold reported in Table 3 (1.04 and 1.19) and indicate that there are 19 countries above the first threshold and 14 countries above the second threshold. The third vertical line is placed at 1.6 which is the point where the estimates of column 2 of Table 3 suggest that the marginal effect of financial development becomes negative and statistically significant. There are 8 countries above this threshold.

The list of ten countries with the largest financial sector includes almost all the countries which have been most affected by the current crisis: Iceland, the United States, Ireland, the United Kingdom, Spain, and Portugal. The exception is Greece, which has a relatively small financial sector but serious public finance problems.

4 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 development matters (namely, by relaxing financing constraints) and has the advantage of addressing the reverse causality problem because it is arguably plausible to assume that the growth of a specific industry will not affect financial development 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 section, we follow the existing literature and allow for non-linearities in the relationship between financial and economic development. In particular, we estimate the following model:

$$VAGR_{i,j} = SHVA_{i,j}\alpha + EF_j \times (PC_i\beta + PC_i^2\gamma) + \lambda_j + \mu_i + \varepsilon_{i,j}, \tag{15}$$

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 development and industry growth would instead be consistent with $\beta > 0$ 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 4).[17] 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 4). The point estimates suggest that financial development starts having a negative effect on relative industry-level growth when credit to the private sector reaches 120% of GDP.[18] This threshold is surprisingly close to what we found in the country-level panel regressions of Table 3.

In Columns 3 and 4, we check whether our results are driven by the correlation between financial development 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 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%).[19]

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 one percent 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

[17] 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 percentage point. In our estimates, this differential in growth is approximatley 0.4 percentage points.

[18] We report the thresholds at which financial development starts having a negative effect on growth in the bottom panel of Table 4.

[19] In particular, we use Stata's rreg routine (see Yaffee, 2002).

of Table 4).

5 Financial Development and the Global Recession

The global recession ignited by the collapse of Lehman Brothers in September 2008 has led to a drastic change in received wisdom concerning the costs and benefits of financial development. Before the crisis there was a near consensus that more finance was always a good thing and that having a large financial sector was a sign of the strength of a country's policies and institutions.[20] Many commentators now argue that the countries at the center of the global recession had financial systems which were too large for their own good. Some even claim that financial systems may have grown too large, not because of the presence of good policies and institutions, but because of poorly-performing or corrupt regulatory systems (Stiglitz, 2008, Johnson, 2009).

Although our sample ends in 2005 and therefore does not include the post-Lehman global recession, we think that the results of our paper are consistent with the view that financial systems can indeed become too large for a country's own good. Indeed, we believe that if the data allowed us to extend our sample to the 2005-2010 period we would find even stronger results. Of course these are only speculations, because we do not have the necessary data to conduct a formal test. However, we do have recent data on GDP and we can use these data to conduct some tests aimed at ascertaining whether the size of the financial sector played an amplifying role in the current recession.

In order to look at the role of financial development during the crisis, we consider whether the size of the financial sector can explain the growth of real GDP per capita over 2008-10, controlling for the best possible *prediction* of GDP growth available *before* the collapse of Lehman Brothers (this forecast should capture all the fundamentals and cyclical factors that explain short-term growth). Formally, we estimate the following cross-country regression:

$$GR0810_i = \alpha + FCGR0810_i\beta + PRIVCR_i\gamma + X_i\theta + \varepsilon_i, \tag{16}$$

where $GR0810_i$ is the growth rate of real GDP per capita (measured in domestic currency) over 2008-10, $FCGR0810$ is the April 2008 IMF World Economic Outlook (WEO) forecast of $GR0810_i$, $PRIVCR_i$ is credit to the private sector over GDP in 2006 (this is the most recent year for which we have complete cross-country data on credit to the private sector), and X_i is a set of controls.[21]

We begin by estimating equation (16) using all the countries for which we have information on GDP growth and credit to the private sector. Column 1 of the top panel of Table 5 shows that growth forecasts play no role in predicting actual growth over the 2008-10 period. If anything, the correlation between expected and actual growth is negative. The coefficient associated with credit to the private sector, for its part, is negative and statistically significant. The point estimate suggests that, controlling for expected growth, a one standard deviation change in the size of the financial sector is associated with a one percentage point drop in annual growth during the crisis. Columns 2 and 3 show that the results are robust to

[20] In the Introduction we mention some exceptions to this commonly held view.

[21] We measure $G0810_i$ using data from the October 2010 WEO. Therefore, we still need to use an estimate for 2010 GDP. However, we do not expect this estimate to be too far from the actual value of 2010 GDP.

dropping low income and OECD countries, and column 4 shows that our results hold when we restrict our analysis to OECD countries.[22]

Next, we augment our regressions with the log of total GDP (measured in US dollar), the value of commodity exports over GDP, the current account balance divided by GDP, and the stock of public debt divided by GDP (all these variables are measured in 2005-06). We include the log of GDP to control for the fact that larger economies tend to be more diversified and therefore better able to absorb shocks. The share of commodity exports is included to control for the fact that the crisis coincided with a period of high commodity prices, and this may have benefitted commodity exporters. The last two variables should capture policy buffers which may have facilitated counter-cyclical macroeconomic policies. The second panel of Table 5 shows that these controls are rarely statistically significant and that, if anything, their inclusion strenghtens the negative conditional correlation between credit to the private sector and growth over the 2008-2010 period.

We also check whether outliers play a role by using a robust regressions routine. The bottom panel of Table 5 shows that the results are basically unchanged. The point estimates are a bit lower than in the OLS regressions but the coefficient associated with credit to the private sector is always negative and statistically significant.

A possible criticism of our empirical approach is that there may be something that systematically biases growth forecasts in favor of countries with large financial sectors. If, for instance, the IMF desk economists in charge of the WEO growth projections believe (or used to believe) that a larger financial sector is indeed a sign of good policies and institutions, they may systematically overestimate growth in countries with large financial sectors. Such systematic forecast error would generate a negative correlation between the size of the financial sector and the residual of a regression of actual GDP growth on expected GDP growth. If this were the case, the results of Table 5 would not have anything to do with the Lehman Brothers shock but would be fully driven by the presence of systematic errors in growth forecasts. We check for this possibility by estimating the following difference-in-differences specification:

$$GR_{i,t} = FGR_{i,t}b + (FGR_{i,t}\beta + PC_i\gamma + X_i\theta + \lambda) \times D2008_t + \alpha_i + \varepsilon_{i,t}, \tag{17}$$

where $GR_{i,t}$ is real GDP per capita growth in country i in period t; α_i is a set of country fixed effects; $FGR_{i,t}$ is the WEO forecast of $GR_{i,t}$; $D2008$ is a dummy variable that is equal to one when t=2008-10; PC_i is credit to the private sector over GDP of country i in 2006; and X_i is a set of controls that includes the log of total GDP, the current account balance over GDP, public debt over GDP, and the share of primary exports over GDP. We estimate equation (17) using two periods: 2005-07 and 2008-10. We cannot use earlier periods because of the lack of WEO forecasts.[23]

[22] We use the country groupings of the World Bank's World Development Indicators.

[23] Note that we estimate equation (17) with time-invariant measures of $PRIVCR$ and the other controls X. In theory, we could use time-varying measures of these variables and estimate a model of the form $GR_{i,t} = FGR_{i,t}b + (FGR_{i,t}\beta + PC_i\gamma + X_i\theta + \lambda) \times D2008_t + PC_ig + X_id + \alpha_i + \varepsilon_{i,t}$. The problem with such a specification is that, since our two periods are very close to each other, all variables would have limited within-country variability which, in turn, would lead to multicollinearity problems driven by the high correlation between the non-interacted variables and the country fixed effects.

Within the setup of equation (17), b measures the correlation between expected and actual growth during the 2005-07 period and $b + \beta$ measures the correlation between expected and actual growth in the 2008-10 period; λ measures the average unexplained growth differential between the two periods; and γ, which is our parameter of interest, tells us whether countries with large financial sectors did relatively better (or worse) than expected during the current crisis with respect to the previous, more tranquil, period.

We start by estimating equation (17) with no controls (i.e., we set $\theta = 0$) and find that growth forecasts are positively (but not significantly) correlated with actual growth in 2005-2007 and negatively correlated with actual growth in 2008-2010 (column 1 of Table 6 shows that $b + \beta < 0$). We also find that average growth in 2008-10 was about 3 percentage points lower than average growth in 2005-2007 (this is the λ coefficient), and that countries with large financial sectors did worse in 2008-10 than in 2005-07. In particular, we find that γ is negative and statistically significant, with a point estimate which is about half of what we found in the cross-country regressions of Table 5.

When we include the interaction with the log of total GDP and thus control for the fact that larger and more diversified economies are in a better position to deal with large shocks, the point estimate of γ increases (in absolute value) from -1.16 to -2.0 and becomes statistically significant at the one percent confidence level (Column 2). Columns 3-5 show that the results are robust to individually controlling for the current account balance, total debt, and the share of commodity exports. However, γ is no longer statistically significant when we introduce all these variables at once (column 6). By looking at the partial scatterplot of $D2008 \times PC$ for the regression of Column 6, we noted several outliers (Armenia, Bahrain, Iceland, Latvia, Lithuania, and New Zealand). Rather than trying to deal with these outliers by arbitrarily dropping them, we address this issue in a systematic manner and re-estimate the model using the same robust regression routine that we used in Tables 4 and 5. Column 7 of Table 6 shows that after controlling for outliers we find that γ is negative and statistically significant with, again, a point estimate which is close to what we found in the cross-country regressions of Table 5.

The results of Table 6 are thus consistent with the idea that it is the size of the financial system and not systematic measurement error that is the key driver of the difference between expected and actual growth in the post Lehman Brothers period.

6 Conclusions

In this paper we reassess the relationship between financial development and economic growth. We find that there is a threshold above which financial development no longer has a positive effect on economic growth. We show that different types of data and econometric techniques yield the consistent message that financial development no longer has a positive effect on growth when credit to the private sector surpasses 100% of GDP. We also show that the financial sector was an important amplifier of the global economic crisis that erupted after the collapse of Lehman Brothers in September 2008.

There are two possible reasons why large financial systems may have a negative effect on economic growth. The first has to do with economic volatility and the increased probability of large economic crashes (Minsky, 1974, and Kindleberger, 1978) and the second relates to the potential misallocation of resources, even in good times (Tobin, 1984). In future work, it would be interesting to move beyond the reduced form regressions of this paper and investigate the channels though which excessive financial development may inhibit economic growth.

In future research it would also be interesting to see whether the relationship between financial development and economic growth depends upon the manner through which finance is provided. 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 (UNCTAD, 2008). It would thus be interesting to separate traditional bank lending from non-bank lending and check whether these types of financial flows have differing effects on economic growth.

We believe that our results have potentially important implications for financial regulation. The financial industry has argued that the Basel III capital requirements will have a negative effect on bank profits and lead to a contraction of lending with large negative consequences on future GDP growth (Institute for International Finance, 2010). While it is far from certain that higher capital ratios will reduce profitability (Admati et al., 2010), our analysis suggests that there are several countries for which tighter credit standards would actually be desirable.

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A Appendix

A.1 Proof that when $\gamma > 0$, the firm will choose D^*_{12} (and when $\gamma < 0$, the firm will choose D^*_{21})

By substitututing D^*_{11} and D^*_{12} into $E(\pi_1)$, we get:

$$E(\pi_1(D^*_{11})) = \frac{N^2\phi_1\left(4\gamma - 2\sqrt{2}\phi_1\right)^2}{256\sqrt{2}(1+R)(\gamma-1)^2}$$

$$E(\pi_1(D^*_{12})) = \frac{N^2\phi_2\left(4\gamma - 2\sqrt{2}\phi_2\right)^2}{256\sqrt{2}(1+R)(\gamma-1)^2}$$

$\phi_1 = \sqrt{8+\gamma^4-\gamma(4-\gamma^2)\sqrt{8+\gamma^2}}$ and $\phi_2 = \sqrt{8+\gamma^4+\gamma(4-\gamma^2)\sqrt{8+\gamma^2}}$. Considering the positive roots, we have $sign(\phi_2 - \phi_1) = sign(\gamma)$. Let us now write:

$$\frac{E(\pi_1(D^*_{11}))}{E(\pi_1(D^*_{12}))} = \frac{\phi_1(4\gamma - 2\sqrt{2}\phi_1)^2}{\phi_2(4\gamma - 2\sqrt{2}\phi_2)^2} = \varphi(\gamma)$$

Figure 7 plots $\varphi(\gamma)$ for $\gamma \in (0,1)$. It shows that $\varphi(\gamma)$ is always smaller than one, indicating that profits are always higher with D^*_{12}.

Given that $E(\pi_2(D^*_{21})) = E(\pi_1(D^*_{12}))$ and $E(\pi_1(D^*_{11})) = E(\pi_2(D^*_{22}))$, it is always true that when $\gamma < 0$, $\frac{E(\pi_2(D^*_{21}))}{E(\pi_2(D^*_{22}))} > 1$ and that the borrower will always prefer D^*_{21} over D^*_{22}.

Table 1: **Cross-Country OLS Regressions**

This table reports the results of a set of cross-country OLS regressions in which average real per capita GDP growth over the period 1976-2005 is regressed over the log of initial GDP per capita (LSTART), the log of average years of education (LEDUC), the log of total credit to the private sector over GDP (LPRIVCR), the log of the stock market turnover ratio (LTURN), the level of credit to the private sector over GDP (PRIVCR), the square of the level of the level of credit to the private sector over GDP (PRIVCR2), the level of the turnover ratio (TURN), and the square of the level of the level of the turnover ratio (TURN2).

	(1)	(2)	(3)	(4)
LSTART	-0.821***	-0.760***	-0.774***	-0.797***
	(0.218)	(0.232)	(0.217)	(0.223)
LEDUC	0.725	0.971	0.667	0.677
	(0.688)	(0.707)	(0.671)	(0.677)
LPRIVCR	1.073***			
	(0.354)			
LTURN	0.522**			
	(0.207)			
PRIVCR		1.617**	6.048***	6.007***
		(0.675)	(1.830)	(1.848)
TURN		1.261**	1.319**	2.271
		(0.552)	(0.516)	(1.774)
$PRIVCR^2$			-2.918**	-2.940**
			(1.132)	(1.143)
$TURN^2$				-0.733
				(1.305)
Constant	8.900***	5.091***	4.469***	4.474***
	(1.434)	(1.178)	(1.127)	(1.137)
N. Obs.	44	44	44	44
R-squared	0.442	0.387	0.478	0.482

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2: **Panel Estimations: Comparsion with Beck and Levine**

This table compares the results obtained using our 1976-2005 dataset (columns 1-4) with those obtained using the Beck and Levine (2004) data for the period 1976-1998 (Cclumns 5-8)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1976-2005 sample				1976-1998 sample			
LSTART	0.500	0.762	-0.0545	0.167	-0.527	-0.387	-0.321	-0.767
	(1.395)	(1.318)	(1.076)	(1.134)	(0.787)	(0.621)	(0.733)	(0.665)
LEDUC	-5.617	-6.100	-1.983	-5.029	-1.154	-2.058	-1.864	-0.883
	(4.776)	(3.714)	(3.191)	(4.586)	(2.842)	(2.218)	(2.986)	(2.613)
LTURN	0.577	0.382	0.580	0.698*	0.962	0.680**	1.250*	1.539***
	(0.508)	(0.420)	(0.453)	(0.383)	(0.748)	(0.324)	(0.623)	(0.382)
LPRIVCR	0.752	0.828	0.185	0.692	1.511*	1.823**	0.889	1.185
	(0.795)	(0.968)	(0.663)	(0.965)	(0.791)	(0.823)	(0.738)	(0.704)
LGOVC		-0.662				-0.124		
		(1.938)				(2.100)		
LOPEN			1.892*				1.478	
			(1.027)				(1.328)	
LINFL				-0.858*				-1.706
				(0.491)				(2.279)
Constant	10.10**	10.47*	-0.702	13.20**	-0.762	0.0872	-5.483	-0.0393
	(4.686)	(6.033)	(7.343)	(5.223)	(1.940)	(4.281)	(5.210)	(2.480)
N. Obs.	245	245	245	244	189	188	188	188
N. countries	44	44	44	44	40	40	40	40

Robust standard errors in parenthesis

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

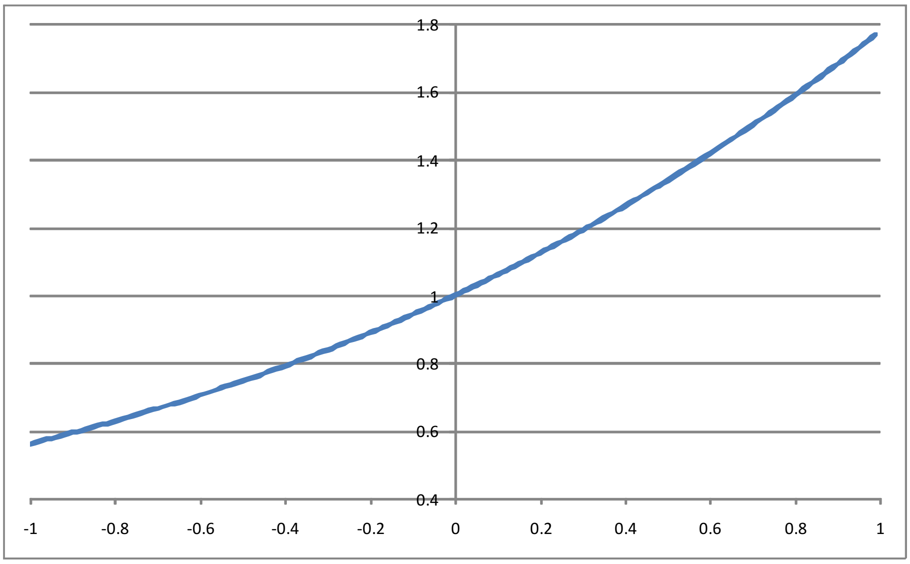

Figure 1: **The Optimal Level of Debt.** This figure plots D^*/D^{**} for $\gamma \in [-1, 1)$. It shows that when $\gamma > 0$, D^* is always greater than D^{**} and when $\gamma < 0$, it is always true that $D^* < D^{**}$.

Table 3: **System GMM Estimations**

This table reports the results of a set of System GMM estimations where the dependent variables measures the growth rate of real per capita GDP in 6 5-year growth episodes over the period 1976-2005. The set of controls include the log of initial GDP per capita (LSTART), the log of average years of education (LEDUC), the level of credit to the private sector over GDP (PRIVCR), the square of the level of the level of credit to the private sector over GDP (PRIVCR2), the level of the turnover ratio (TURN), the log of government consumption over GDP (LGOVC), the log of trade openness (LOPEN), and the log of inflation (LINFL). The middle panel of the table reports the threshold at which the marginal effect of credit to the private sector becomes negative and the bottom panel reports the system GMM standard specification tests. Standard errors are adjusted with Windmeijer's finite sample correction.

	(1)	(2)	(3)	(4)	(5)
LSTART	-0.0722	-0.396	-0.157	-0.308	0.00768
	(1.013)	(0.677)	(0.942)	(0.645)	(0.585)
LEDUC	-2.089	-1.542	-3.595	-1.430	-3.215
	(3.690)	(2.741)	(2.709)	(1.973)	(1.959)
TURN	0.853	0.923	0.674	1.298*	0.869
	(0.920)	(0.701)	(0.683)	(0.658)	(0.705)
PRIVCR	1.977**	9.008***	8.838***	6.071**	5.333
	(0.956)	(2.724)	(2.905)	(2.634)	(3.233)
PRIVCR2		-3.913***	-3.699***	-2.723**	-2.564
		(1.301)	(1.298)	(1.349)	(1.734)
LGOVC			0.503		
			(2.617)		
LOPEN				1.268	
				(1.052)	
LINFL					-0.925**
					(0.352)
Constant	4.366	3.779	4.905	-1.386	7.070*
	(2.660)	(2.310)	(3.537)	(5.480)	(3.574)
PRIVCR threshold		1.151	1.194	1.115	1.040
Sargan test	0.042	0.013	0.129	0.101	0.032
Hansen test	0.020	0.088	0.365	0.291	0.293
A-B test for AR(1)	0.001	0.001	0.000	0.001	0.001
A-B test for AR(2)	0.231	0.215	0.165	0.210	0.058
N. Obs.	245	245	245	245	244
N. countries	44	44	44	44	44

Robust standard errors in parentheses

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

Table 4: **Rajan and Zingales Estimations**

This table reports the results of a set of regressions in which the dependent variable is real industry-level value added growth over the period 1990-2000. The set of controls include the initial share of industry's i 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×PC), the interaction between the Rajan and Zingales index of external financial dependence and the square of total credit to the private sector (EF×PC2), the interaction between the Rajan and Zingales index of external financial dependence and the square of total credit to the private sector (EF×PC2), the interaction between the Rajan and Zingales index of external financial dependence and GDP per capita (EF×Y), the interaction between the Rajan and Zingales index of external financial dependence and the square of GDP per capita (EF×Y2), the interaction between the Rajan and Zingales index of external financial dependence measured for the 1980s and total credit to the private sector (OEF×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×PC2). 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.

	(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)	
$EF\times PC^2$		-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)		
$EF\times Y^2$				-0.00181		
				(0.00227)		
OEF×PC						0.169***
						(0.0452)
$OEF\times PC^2$						-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-squared	0.336	0.338	0.338	0.338	0.433	0.343

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: **Financial Development and Growth During the Crisis.**
This table reports the results of a set of cross-country regressions in which the dependent variable is the growth rate of real per capita GDP over the period 2008-2010. The set of controls include the April 2008 WEO forecast for growth over 2008-2010 (FCAST08), credit to the private sector over GDP in 2006 (PRIVCR), the log of GDP per capita in 2006, the average current account balance over GDP in 2005-2006 (CAB), total public debt over GDP in 2005-2006 (DEBT), and the share of commodity exports over GDP in 2005-2006 (PRIMEXP). The first column includes all countries, the second column excludes low-income countries, the third column excludes OECD countries and the fourth column only includes OECD countries. Panle (c) of the table reports the coefficients of the PRIVCR variable obtained by estimating the same specification of panel (b) with Stata's robust regression routine.

	(1)	(2)	(3)	(4)
	(a) No Controls			
FCAST08	-0.050	-0.034	-0.037	-0.223
	(0.05)	(0.05)	(0.05)	(0.084)**
PRIVCR	-2.256	-1.804	-2.842	-1.398
	(0.363)***	(0.422)***	(0.947)***	(0.808)*
Constant	1.351	0.738	1.581	0.23
	(0.372)***	(0.483)	(0.44)***	(1.02)
N. Obs.	123	98	97	26
R-squared	0.12	0.09	0.07	0.29
	(b) Controls			
FCAST08	-0.055	-0.072	-0.037	-0.173
	(0.05)	(0.05)	(0.05)	(0.079)**
PRIVCR	-2.488	-1.991	-2.87	-1.253
	(0.536)***	(0.531)***	(0.896)***	(0.510)**
LGDP	0.199	0.14	0.58	0.448
	(0.18)	(0.20)	(0.248)**	(0.172)**
CAB	0.087	0.103	0.092	0.053
	(0.048)*	(0.053)*	(0.07)	(0.03)
DEBT	1.79	1.511	4.47	-1.373
	(1.32)	(1.25)	(2.191)**	(0.93)
PRIMEXP	-2.976	-4.233	-3.66	0.634
	(5.44)	(6.03)	(6.53)	(4.80)
Constant	0.173	0.111	-1.96	-2.011
	(1.64)	(1.81)	(2.47)	(1.50)
Observations	92	80	66	26
R-squared	0.24	0.24	0.33	0.5
	(c) Controls and robust regressions			
PRIVCR	-2.249	-1.767	-2.103	-1.18
	(0.636)***	(0.633)***	(1.040)**	(0.657)*
Sample	ALL	NO LIC	NO OECD	OECD

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: **The Amplification Effect of Financial Development**

This table reports the results of a set of regressions in which the dependent variable is the growth rate of real per capita GDP over the periods 2005-2006 and 2008-2010. The set of controls include the two-year ahead forecast of real per capita GDP growth (Forecast), a dummy variable that takes value 1 for the 2006-2008 period (D2008), and the interaction between D2008 and the following variables: (i) Forecast growth (FG); (ii) Credit to the private sector over GDP (PC); (iii) the log of total GDP (LGDP); (iv) public debt over GDP (DEBT); (v) Current account balance over GDP (CAB); and (vi) primary exports over GDP (PEXP). The interacted variables are measured in 2006. All regressions include country fixed effects. Column (7) estimates the model of column (6) using Stata's robust regression routine.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Forecast	0.0345	0.0169	0.0262	0.0004	-0.021	0.0026	-0.0572
	(0.10)	(0.10)	(0.11)	(0.11)	(0.08)	(0.10)	(0.06)
D2008	-3.236***	-3.953***	-5.835***	-3.530***	-4.826***	-6.229**	-4.369***
	(0.78)	(0.89)	(1.67)	(1.05)	(1.24)	(3.10)	(1.33)
D2008*FG	-0.163**	-0.161**	-0.152*	-0.164**	-0.155**	-0.144**	-0.063
	(0.08)	(0.08)	(0.08)	(0.08)	(0.07)	(0.07)	(0.06)
D2008*PC	-1.169*	-1.997***	-1.673**	-1.569*	-2.026**	-0.744	-1.344*
	(0.68)	(0.74)	(0.77)	(0.83)	(0.84)	(0.86)	(0.72)
D2008*LGDP		0.349**	0.351*	0.186	0.474***	0.0968	0.146
		(0.16)	(0.18)	(0.24)	(0.16)	(0.24)	(0.20)
D2008*DEB			2.778			4.580*	1.618
			(1.89)			(2.51)	(1.14)
D2008*CAB				0.0755		0.137*	0.0571
				(0.07)		(0.08)	(0.05)
D2008*PEXP					2.273	-1.296	4.53
					(5.10)	(8.45)	(3.24)
Constant	4.063***	4.023***	4.032***	4.038***	3.943***	4.031***	-0.575
	(0.34)	(0.34)	(0.36)	(0.34)	(0.35)	(0.36)	(2.29)
Observations	226	220	206	213	188	170	170
R-squared	0.716	0.719	0.727	0.71	0.729	0.763	0.865

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: **Data and Sources**

Variable	**Description and Sources**
GDP 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 Devlopment Indicators (WDI), 2007.
LEDUC	Log average years of schooling + 1. Source: WDI 2007.
LTURN	Log stock market turnover ratio. This is the ratio of the value of total shares traded and market capitalization. Source: Beck et al. (2010) merged with Beck and Levine (2004) database.
LPRIVCR	Log claims on private sector by deposit money banks and other financial institutions divided by GDP. Source: Financial Institutions and Markets: Beck et al. (2010) merged with Beck and Levine (2004) database.
LGOVC	Log general government final consumption expenditure, as a percentage of GDP. Source: WDI, 2007.
LOPEN	Log openness (calculated as exports plus imports divided by GDP in national currencies) in current prices. Source: Penn World Table 6.2.
LINFL	Log inflation as measured by the consumer price index (annual %) + 1. Source: WDI, 2007.
Ind. VA Gr.	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 above).
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, Gullapalli and Panizza (2008), for credit to the private sector see above.
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 the source of credit to the private sector see above.
Gr. 2008-10	Real local currency annual GDP growth over 2008-2010. Source: own calculations based on October 2010 IMF World Economic Outlook data.
FCAST08	Two-year ahead forecast of real local currency annual GDP growth over 2008-2010. Source: Own calculations based on IMF data. The forecasted value for GDP in 2010 is from the April 2008 IMF World Economic Outlook. The actual value for 2008 is from on the October 2010 IMF World Economic Outlook.
LGDP	Log total GDP measured in constant US dollar (2006). Source: October 2010 IMF World Economic Outlook.
CAB	Current account balance over GDP (average for 2005 and 2006). Source: October 2010 IMF World Economic Outlook.
DEBT	Total public debt over GDP (average for 2005 and 2006). Source: Abbas et al (2010).
PRIMEXP	Share of primary exports over GDP (2006). Source: Own calculations based on WDI, 2010.
FORECAST	Two-year ahead forecast of GDP growth. Source: own calculations based on IMF data. The 2008-2010 forecast is based on data from the April 2008 World Economic Outlook, the 2005-2007 forecast is based on data from the April 2006 World Economic Outlook.

Table 8: **Summary Statistics.**

Variable		Mean	Std. Dev.	Min	Max	Observations
Cross-Country and Panel Data (vars in levels)						
Initial GDP	overall	10,519	9,704.6	213.25	37,992	N = 264
	between		9,456.2	290.17	30,401	n = 44
	within		2,541.5	1,312.45	20,560	T = 6
Priv. credit	overall	0.624	0.420	1.5e-07	2.09	N = 261
	between		0.363	0.118	1.492	n = 44
	within		0.222	-0.032	1.575	T-bar = 5.93
Inflation	overall	30.683	172.319	-0.437	2,342.22	N = 263
	between		93.607	0.959	466.96	n = 44
	within		147.612	-428.721	1,936.18	T-bar = 5.98
Gov. cons.	overall	16.127	5.945	4.290	37.919	N = 264
	between		5.657	4.712	32.290	n = 44
	within		1.989	9.597	24.401	T = 6
Openness	overall	65.944	54.049	13.064	389.858	N = 264
	between		53.216	18.904	353.729	n = 44
	within		11.965	12.067	124.328	T = 6
Turnover	overall	0.441	0.477	0.005	3.414	N = 245
	between		0.3187	0.037	1.388	n = 44
	within		0.362	-0.684	2.642	T-bar = 5.57
Growth	overall	2.097	2.199	-6.171	11.747	N = 264
	between		1.359	-1.260	5.786	n = 44
	within		1.739	-4.655	11.510	T = 6
Education	overall	6.715	2.712	1.152	12.25	N = 264
	between		2.586	1.983	11.751	n = 44
	within		0.891	4.135	9.109	T = 6
Industry-level Data						
VA Growth		0.041	0.115	-0.476	1.05	N = 1,252
Ext. Dep. '90s		0.014	0.566	-1.14	2.43	N = 36
Ext. Dep. '80s		0.319	0.406	-0.451	1.491	N = 36
Crisis Analysis						
GR 2005-07		4.03	3.36	-4.53	16.01	N = 123
GR 2008-10		0.20	3.43	-13.11	12.49	N = 150
FGR 2005-07		-0.65	6.87	-19.32	17.11	N = 123
FGR 2008-10		1.87	5.97	-19.42	14.06	N = 150
PRIVCR		0.52	0.48	0.02	2.70	N = 153
LGDP		3.14	2.38	-2.21	9.50	N = 169
CAB		-2.02	10.01	-25.64	29.69	N = 162
DEBT		0.58	0.43	0.01	2.82	N = 163
PRIMEXP		0.15	0.15	0.01	0.74	N = 134

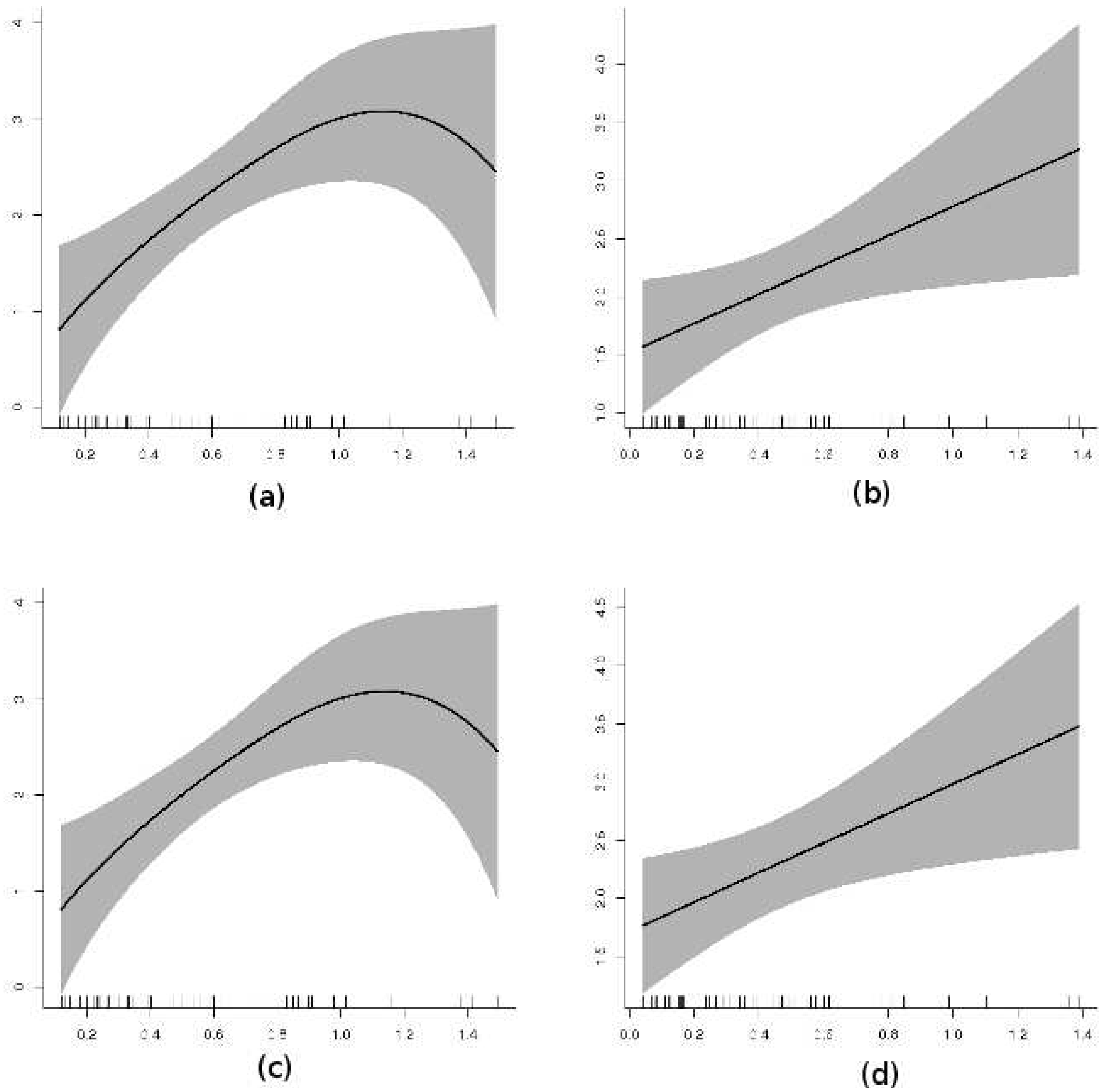

Figure 2: **Semi-Parametric Regressions.** Panel (a) plots the relationship between credit to the private sector and GDP growth when credit to the private sector is the only non-parametric term in the regression. Panel (b) plots the relationship between the turnover ratio and GDP growth when the turnover ratio is the only non-parametric term in the regression. Panels (c) and (d) plot the relationship between GDP growth and each of credit to the private sector and turnover ratio when both variables are allowed to take a generic functional form.

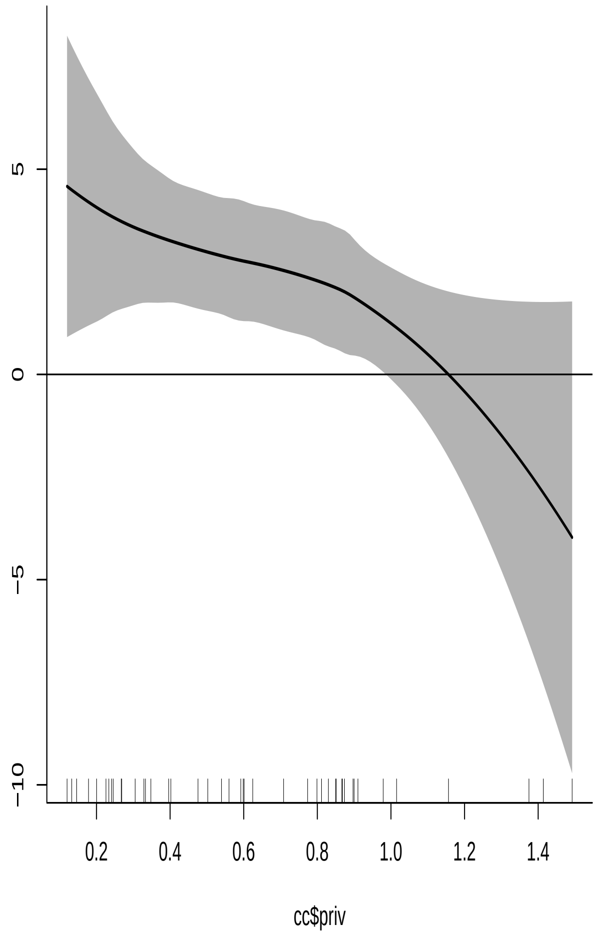

Figure 3: **Marginal Effect Using Cross-Country Data.** This figure shows the marginal effect of credit to the private sector on growth computed by allowing both measures of financial development financial to take a generic form.

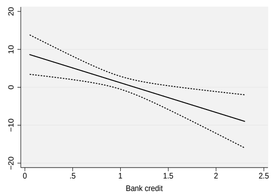

Figure 4: **Marginal Effect with System GMM Estimations.** This figure shows the marginal effect of Credit to the Private Sector on GDP growth obtained with the regression of column 2 of Table 3

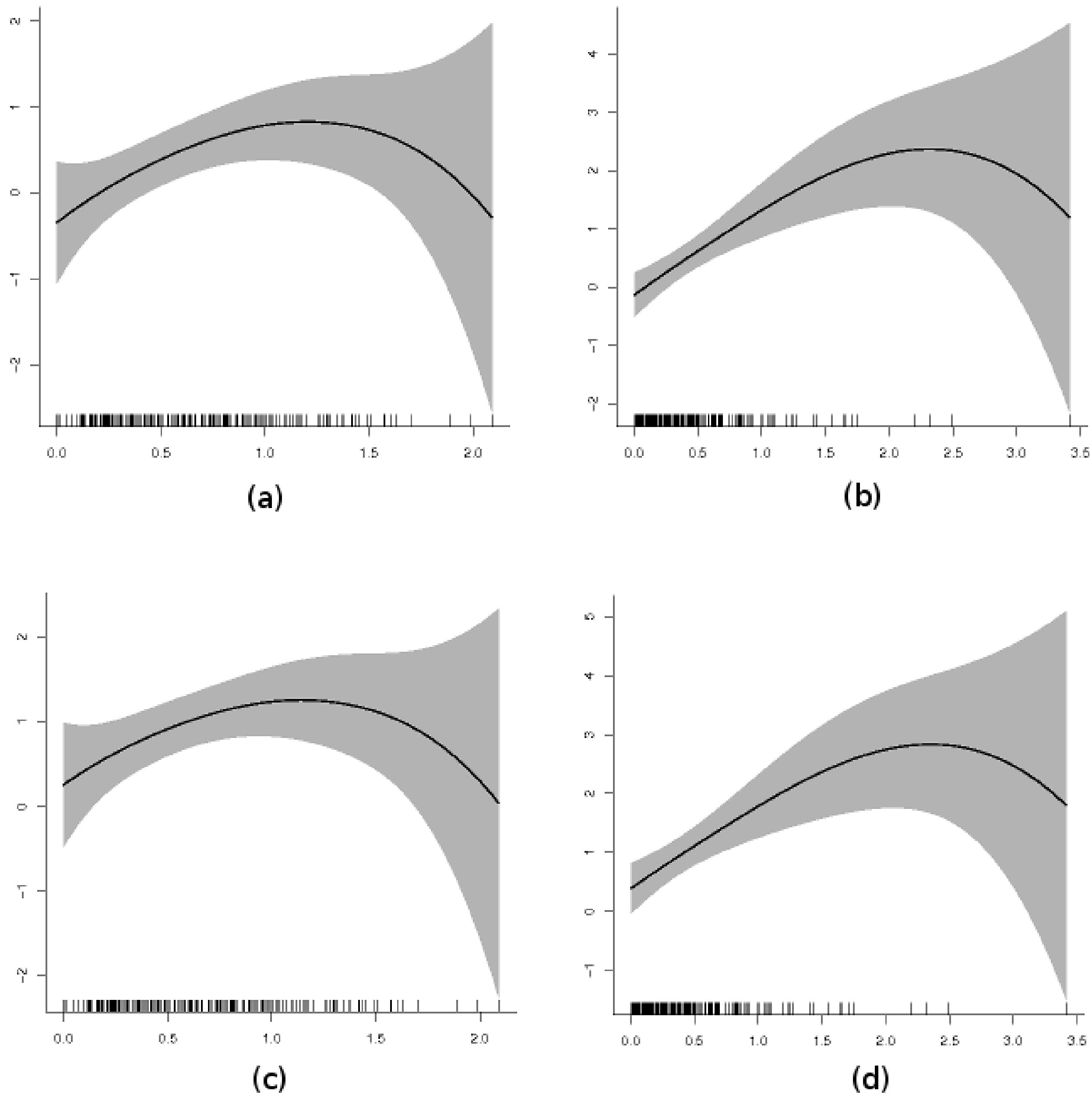

Figure 5: **Semi-Parametric Panel Regressions.** Panel (a) plots the relationship between credit to the private sector and GDP growth when credit to the private sector is the only non-parametric term in the regression. Panel (b) plots the relationship between the turnover ratio and GDP growth when the turnover ratio is the only non-parametric term in the regression. Panels (c) and (d) plot the relationship between GDP growth and each of credit to the private sector and turnover ratio when both variables are allowed to take a generic functional form.

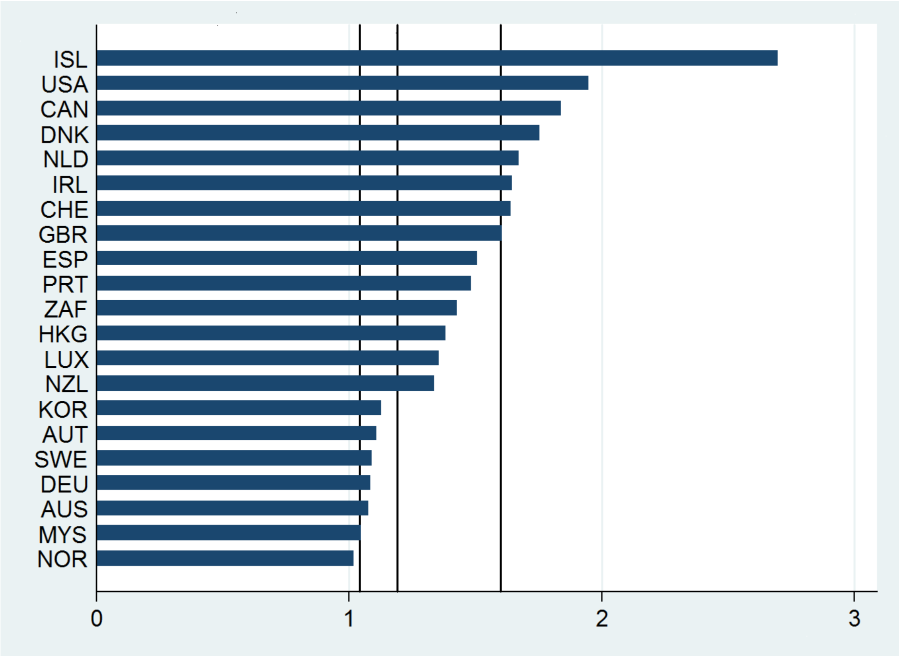

Figure 6: **Countries with large financial sectors (2006).** This figure shows that in 2006 there were 21 countries where credit to the private sector was larger than GDP. The first two vertical lines show the lowest and highest threshold at which the marginal effect of credit to the private sector becomes negative. The third line marks the point at which the negative marginal effects become statistically significant.

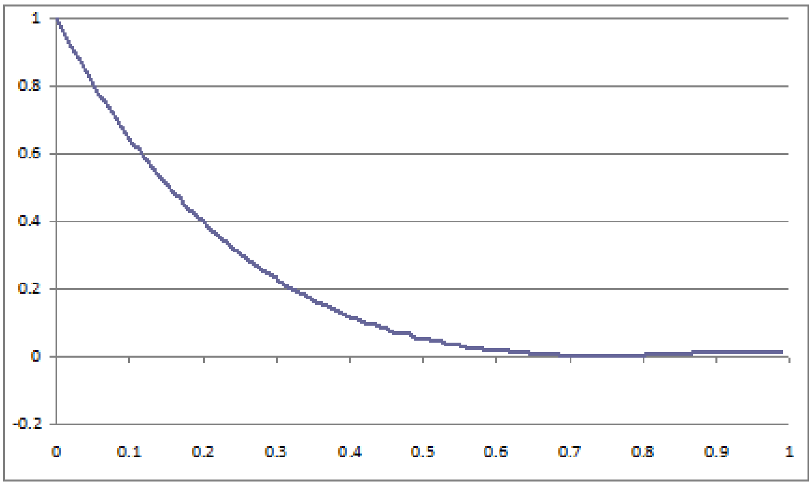

Figure 7: $\varphi(\gamma) = \frac{E(\pi_1(D_{11}^*))}{E(\pi_1(D_{12}^*))}$ **for** $\gamma \in (0, 1)$. The figure shows that, for $\gamma > 0$, $\varphi(\gamma) < 1$. Therefore, the entrepreneur will always choose D_{12}^*.