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Catharsis—The real effects of bank insolvency and resolution

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ABSTRACT

This paper analyzes the impact of rules-based bank insolvency resolution on real economic growth. Resolving insolvent banks can positively affect the real economy by overcoming moral hazard problems and improving banks' credit allocation and monitoring. We propose a new indicator to measure the strength of 'catharsis', i.e., how strictly banks are resolved, and use a large firm-level dataset to test its effect. We find that a relatively stronger implementation of bank resolution rules has a statistically and economically significant positive effect on firm growth – particularly with respect to firms that are structurally more dependent on bank financing. Our findings are robust to various specifications. Investigating the transmission channels of this 'catharsis effect' reveals that it essentially works by means of benefiting higher quality firms (quality channel) and reallocating credit to firms that need it most (quantity channel). Additional analysis suggests that the 'catharsis effect' works best in banking systems that offer access to international financing because such access mitigates the potentially negative credit supply effects of liquidating insolvent banks. Taken together, our findings indicate that more attention should be focused on developing incentive-compatible bank resolution regimes.

1. Introduction

In this paper, we test how strict and rules-based resolution of insolvent banks affects the real economy. Although the theoretical and empirical literature shows that financial intermediation generally has positive effects on the real economy, misled incentives for banks, their creditors, and regulators in connection with bank insolvency may distort banks' credit allocation and monitoring decisions. This may lead to suboptimal real economic performance. A strict and rules-based resolution of insolvent banks, however, might restore incentives in credit allocation and monitoring, which would result in positive effects for the real economy. Such a mechanism would be a manifestation of Schumpeter's concept of creative destruction in the financial sector: Insolvency and resolution regimes promote the efficient reallocation of resources and have a cleansing effect on financial intermediation. Therefore, we argue that insolvency and resolution can be thought of as a form of 'catharsis' in the banking system that cleans out moral hazard problems and distorted incentives.

Based on this rationale, we hypothesize that strict and rules-based regulatory insolvency leads to a 'catharsis effect': When insolvent banks that warrant legal closure in accordance with a prompt resolution rule are led into strict insolvency resolution, incentives in credit allocation are restored, which increases real economic performance. However, the strength and direction of the effect are a priori not obvious because positive real effects of restored incentives might be outweighed by negative credit supply effects of individual bank closures. Moreover, the effect is likely to vary across different types of firms and across different financial systems.

Thus, we subject our hypotheses to empirical testing and investigate whether such 'catharsis' in the banking system has an effect on the real economy and what the mechanisms and conditions of its operation are. We propose a new indicator to measure the strength of 'catharsis', i.e., how strictly insolvent banks are resolved, and use a firm-level dataset with more than 2 million firm-year observations to test its effect on firm growth. However, research into the real economic implications of the financial system is frequently subject to concerns about causality and endogeneity. We attempt to overcome these concerns and to establish causality with a three-step identification strategy. We begin with a regression model that exploits the panel characteristics of our dataset, employ an instrumental variable setup, and finally utilize an interaction approach, which presumes that firms that are more dependent on

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bank financing will experience stronger growth when the resolution regime for insolvent banks is stronger compared with firms that depend less on bank financing.

We find that a relatively stronger implementation of bank resolution rules has a statistically and economically significant positive effect on firm growth – particularly for firms that are structurally more dependent on bank financing. Our findings are robust to various specifications. An investigation of the transmission channels of the 'catharsis effect' reveals that it essentially works by means of benefiting higher quality firms and reallocating credit to firms that need it most. Additional analysis suggests that the 'catharsis effect' works best in banking systems that offer access to international financing because such access mitigates the negative credit supply effects of liquidating insolvent banks.

This paper contributes to the empirical literature at the intersection of three areas of research. First, it augments previous research on the real effects of the structure and conduct of financial intermediation. Significant contributions have thus far evaluated the economic effects of foreign bank entry and financial integration (Giannetti and Ongena, 2009), bank competition (Cetorelli and Strahan, 2006; Cetorelli, 2004), deregulation (Bertrand et al., 2007), bank efficiency (Hasan et al., 2009), and systemic banking crises (Dell'Ariccia et al., 2008; Kroszner et al., 2007; Rancière et al., 2008). To the best of our knowledge, the effects of bank insolvency and resolution regimes on real economic performance have not been empirically evaluated thus far. Second, this paper contributes to the literature on alternative treatments of failing banks. Whereas the effects of various accommodating policies have attracted a significant amount of attention (Black and Hazelwood, 2013; Claessens et al., 2005; Dam and Koetter, 2012; Giannetti and Simonov, 2013; Honohan and Klingebiel, 2003; Laeven and Valencia, 2013), there remains a lack of conclusive empirical evidence about the real effects of cleansing resolution regimes. Third, this paper adds to the literature that evaluates the implications of bank insolvency. Previous research examines the effects of insolvency on bank behavior (Caballero et al., 2008; Peek and Rosengren, 2005; Igan and Tamirisa, 2008), regulatory behavior (Brown and Dinç, 2011; Imai, 2009), and individual bank customers (Djankov et al., 2005). We attempt to complement the empirical literature by testing for the implications of rules-based bank insolvency regimes for firm growth.

The remainder of this paper is organized as follows. Section 2 discusses the related literature from which our motivation and hypotheses result. In Section 3, we introduce our model and identification strategy. The dataset, our proposal of a bank catharsis indicator, and descriptive statistics are presented in Section 4. In Section 5, the results of the analyses are presented along with analytical extensions on the transmission mechanisms and conditions of operation of the 'catharsis effect'. These are complemented with several robustness tests in Section 6. Section 7 concludes.

2. Related literature and hypotheses

Banks generally contribute to the performance of the real economy by collecting, transforming, allocating, and monitoring credit in its most productive uses, thereby improving the efficiency of capital allocation and reducing the cost of external financing (Beck et al., 2000; Levine, 2005). This link between financial intermediation and the real economy has been empirically established in the literature (Fisman and Love, 2007; King and Levine, 1993; Rajan and Zingales, 1998). However, there are sources of market failure in financial intermediation. For example, agency problems and moral hazard distort incentives and lead to economically suboptimal outcomes that materialize in the misallocation of credit or in the inherent fragility of the financial system. One area of particular concern is the treatment of distressed banks, particularly with respect to the resolution of insolvent financial institutions. The previous literature analyzes several dimensions in which the treatment of failed banks can establish or distort incentives and thereby influence the behavior of financial intermediaries, which ultimately has an impact on the real economy:

- First, banks may exhibit distorted incentives arising from their anticipated treatment in the case of insolvency. Because bank failures are associated with strong negative externalities, individual banks may not need to fear bankruptcy but can anticipate a bailout based on implicit or explicit government guarantees. This can lead not only to intentional (excessive) risk-taking (Beltratti and Stulz, 2012; Fortin et al., 2010) and the unsound inflating of balance sheets (Demirgüç-Kunt and Detragiache, 2005) but also to insufficient screening and monitoring of borrowers (Dell'Ariccia and Marquez, 2006) and incentives to create excessive complexity (DeYoung et al., 2013). Consequently, distorted and suboptimal credit allocation and monitoring may result in negative effects on the real economy.
- Second, in addition to individual bank behavior, Acharya and Yorulmazer (2007) and Acharya (2009) model how the time-inconsistency of bank closure decisions can lead to incentives for banks to herd into the same asset classes in an effort to be 'too-many-to-fail' – effectively creating systemic risk. Empirical evidence supports their predictions by showing that governments are less likely to close or take over a bank if the entire banking system is in crisis (Brown and Dinç, 2011; Kasa and Spiegel, 2008) and that banks tend to herd in times of low capitalization (Stever and Wilcox, 2007). Such herding behavior distorts the credit allocation and monitoring functions of financial intermediaries because it leads to a concentration on particular asset classes that may not necessarily be merited by economic considerations.
- Third, incentive distortions that have detrimental effects on the real economy can also arise when a bank is severely undercapitalized or about to fail. In such a situation, a financial intermediary can be seen as an option to its owners that is more or less out of the money and that can only create value through volatility. Thus, the incentives grow to further substitute risk for economic soundness in an effort to 'gamble for resurrection' (Freixas and Rochet, 2008; Marinc and Vlahu, 2011). Distressed banks may also discontinue effective credit monitoring and roll over non-performing loans (Igan and Tamirisa, 2008; Peek and Rosengren, 2005; Rajan, 1994), which will eventually depress economic growth (Caballero et al., 2008), or even engage in 'looting', i.e., channel funds to related firms (Akerlof and Romer, 1993; La Porta et al., 2003). Leaving banks at low net worth could also harm economic growth by raising the agency cost of finance and suppressing investment. Such effects are similar to those described in Bernanke and Gertler's Bernanke and Gertler (1990) concept of financial fragility.
- Fourth, when banks' lending decisions are prone to moral hazard, banks' creditors might be considered a disciplining force. However, little monitoring and disciplining are exerted by depositors that are typically small, dispersed, and properly insured by a deposit insurance system (Demirgüç-Kunt et al., 2008; Demirgüç-Kunt and Huizinga, 2004; Calomiris and Kahn, 1991; Kaufman, 2006). The disciplining role of debtholders is also dubious when the expectation of (implicit) bailout guarantees gives such debtholders little incentive to monitor the banks or to adjust risk premiums accordingly (Acharya et al., 2013; Bliss and Flannery, 2002; Gropp and Richards, 2001; Morgan and Stiroh, 1999). Creditors that share the rents from bank risk-taking may

even collude with the bankers they are supposed to monitor, which sustains the incentive distortions and the negative implications for the real economy.

- Finally, regulators frequently do not prevent distorted credit allocation and monitoring but prefer bailout and support measures for troubled banks that sustain implicit guarantees and incentive distortions. This may result from the time-inconsistency of bank closure decisions, which suggests that regulators are unable to credibly commit ex ante on bank closures (Acharya and Yorulmazer, 2007; Brown and Dinç, 2011; Mailath and Mester, 1994). Alternatively, a lack of appropriate resolution technologies (DeYoung et al., 2013) might simply leave regulators technologically unable to close failed banks without incurring high costs. Finally, regulators may themselves exhibit corrupted incentives or suffer from principal-agent problems that lead to rent-seeking behavior, distorted closure decisions, and collusion with the banking industry (Boot and Thakor, 1993; Brown and Dinç, 2005; Kane, 1990; Imai, 2009), which ultimately sustain banks' moral hazard problems and potentially harm the real economy.

These arguments share the finding that distorted incentives surrounding bank insolvency can corrupt the credit allocation and monitoring functions of financial intermediaries and thus damage real economic performance. This raises the question of which resolution policies are most effective in (re)establishing proper incentives in financial intermediation. In the following, we contrast two stereotypical approaches of how to handle insolvent banks, the 'accommodating' approach and the 'cleansing' approach, which exert different influences on banks' incentive structures and, ultimately, on real economic performance.

Accommodating resolution policies include extensive government interventions in failed banks with the aim of sustaining the specific financial intermediary. Typical bailout instruments include blanket guarantees, open liquidity assistance, recapitalization, or forbearance of regulatory prescriptions. The economic rationale behind these policies is to preserve the charter value, borrower relationships, and growth opportunities of the failed or distressed bank (Cordella and Yeyati, 2003; Djankov et al., 2005). This is argued to protect not only the individual bank but also to shield the real economy from the negative effects of bank failures (such as credit supply shocks) and to prevent contagion effects that threaten financial and economic stability (DeYoung et al., 2013; Kroszner et al., 2007). Recent empirical evidence from Laeven and Valencia (2013) suggests that certain targeted bailout policies, such as bank recapitalizations, can alleviate credit supply frictions and thereby sustain real economic performance. Moreover, accidentally closing an otherwise healthy bank has been shown to have detrimental real economic consequences (Ashcraft, 2005).

However, although they help protect failed banks (and hence preserve credit supply), such accommodating resolution policies are frequently blamed for their distorting effects on incentives. Bagehot (1873) previously warned that liquidity assistance should not be extended to insolvent institutions because this support would sustain or even encourage worse credit allocation decisions. Accommodating policies are sometimes blamed for aggravating incentive distortions that induce banks to externalize their risk-taking to society at large (Calomiris et al., 2005; Kane and Klingebiel, 2004). Additionally, empirical evidence suggests that accommodating policies, particularly when not well executed, frequently do not accelerate financial and economic recovery and do not mitigate the negative effects on the real economy, but instead increase both the cost of banking crises and the risk of moral hazard problems in the long run (Dell'Ariccia et al., 2008; Giannetti and Simonov, 2013; Honohan and Klingebiel, 2003). The Japanese experience of accommodating policies giving rise to 'zombie' banks that led to the creation of artificially surviving and underperforming 'zombie' firms that depressed the real economy provides an illustrative example (Caballero et al., 2008; Peek and Rosengren, 2005). Finally, several recent contributions analyze the effects of bailout policies or (implicit) state guarantees and show that these increase moral hazard problems and bank risk-taking (e.g., Black and Hazelwood, 2013; Dam and Koetter, 2012; Duchin and Sosyura, 2013).

Cleansing resolution policies are characterized by the bank ceasing to exist in its previous form, including wiping out the equity and ousting the management. Such policies focus in particular on straightforward closure and liquidation or on purchase and assumption (P&A), i.e., an assisted merger or acquisition of a failing bank by another viable financial institution. The main argument supporting a policy of strict closure is the reestablishment of incentives: The expectation of cleansing resolution policies in the event of insolvency is intended to reduce moral hazard problems in financial intermediation (Acharya, 2009; Acharya and Yorulmazer, 2007; Davies and McManus, 1991; Panyagometh and Roberts, 2009) and to ensure a competitive, efficient, and sound financial system (Lindgren, 2005). Kane (2002) explicitly formulates the implications of cleansing resolution policies that lead to 'catharsis' in the banking sector and relates these policies to Schumpeter's concept of creative destruction. Empirical evidence tends to support a 'catharsis effect' of bank resolution, i.e., a positive real effect, at least over the long run (Demirgüç-Kunt et al., 2006; Rancière et al., 2008). Thus, prompt closures of insolvent institutions may benefit the real economy by (re)establishing incentives for efficient credit allocation and monitoring.

However, substantial arguments can be made against cleansing resolution policies. As indicated above, bank closure may come at significant cost to the financial and real sectors of the economy, such as through lost charter value and banking relationships, contagion, and interruption of credit supply. Additionally, it can be argued that P&A policies, for example, increase concentration in the banking sector.

Taken together, the literature on the implications of the treatment of failed banks on real economic performance provides several predictions that are empirically testable. First, cleansing resolution policies will reestablish the proper incentive structure and provide for economically superior credit allocation and monitoring. To arrive at this intended result while limiting forbearance caused by self-interested or captured regulators, some authors argue for a rules-based closure policy with little regulatory discretion (Demirgüç-Kunt and Servén, 2010; Dewatripont and Rochet, 2009; Boot and Thakor, 1993). Kaufman (2011, 2006) proposes the regulatory insolvency policy that suggests prompt and non-discretionary legal resolution as soon as a bank falls below a (positive) threshold capital ratio. Based on this rationale, we hypothesize that strict regulatory insolvency will lead to a 'catharsis effect': When insolvent banks that warrant legal closure in accordance with a prompt resolution rule are led into strict insolvency resolution, incentives in credit allocation are reestablished, which increases real economic performance. However, a competing hypothesis may be proposed regarding the direction of the 'catharsis effect'. The positive real effects of reestablished incentives may be outweighed by the negative real effects of individual bank failures that were outlined above. Thus, the direction of the effect is a priori not necessarily obvious. Additionally, the effect is likely to vary across different types of firms (e.g., firms in bank-dependent versus less bank-dependent industries and/or profitable versus unprofitable firms) or across different financial systems (e.g., systems more or less open to alternative sources of financing for the real economy). We subject these hypotheses to empirical tests in the following sections.

3. Methodology and identification strategy

The challenge to identify an effect of bank regulation on real economic growth is structurally similar to the problem that confronts the finance and growth literature in general: Although we can easily detect correlations between certain characteristics of the financial system and real outcomes, establishing a causal link is somewhat more difficult because of the numerous possibilities of endogeneity and omitted variables. At the outset, there is an endogenous relationship between the financial system and economic growth, which must be controlled for: Growth might be caused by financial system characteristics but also vice versa, and there might be other drivers of growth that are closely related to financial system characteristics. Using a post hoc approach, i.e., financial structure and regulation at the beginning of a period, to explain economic growth over that respective period still leaves room for the interpretation that common omitted variables influence both regulation and economic outcomes or that the regulation anticipates future growth and is thus enacted before the growth period – but is nonetheless endogenously related to growth (Levine, 2005).

In attempting to mitigate these problems, we construct a firm-level panel dataset, use instrumental variables, and apply an identification strategy that exploits industry-level differences in bank dependence. Our identification framework is closely related to previous empirical research on the effects of banking sector structure and regulation on the real economy. Essentially, we follow a three-step regression framework suggested by Giannetti and Ongena (2009), who use identification strategies proposed by Rajan and Zingales (1998), La Porta et al. (2003), and others. These three steps are outlined below and constitute the key pillars of our identification strategy.

In the first step, we use a simple regression framework and exploit the nature of our panel dataset that allows us to control for time- and firm-invariant unobserved effects. We test the relationship using the following baseline specification:

$$\Delta \ln(output_{i,t}) = \alpha + \beta * bank\ catharsis\ indicator_{k,t} + X_{i,t} + Z_{k,t} + \sum_i \gamma_i * firm_i + \sum_t \delta_t * year_t + \varepsilon_{i,t} \quad (1)$$

with $i = 1, \ldots, I$ denoting individual firms, $k = 1, \ldots, K$ denoting countries, and $t = 1, \ldots, T$ years. The dependent variable, $\Delta ln(output)$ is a measure of firm output growth (e.g., operating revenue growth). The $bank\ catharsis\ indicator_{k,t}$, which is a proxy for the degree of rules-based resolution of de facto insolvent banks, serves as the main explanatory variable.[1] $Firm_i$ and $year_t$ are two sets of fixed effects that control for unobserved time- and firm-invariant effects in our data. To control for covariates that vary over both the firm and time dimensions, we insert a vector of firm-specific control variables, $X_{i,t}$, and a vector of country-specific control variables, $Z_{k,t}$. $X_{i,t}$ includes observable time-varying firm characteristics, such as size, age, and profitability, and $Z_{k,t}$ includes observable time-varying country characteristics, such as financial development, bank sector capitalization, bank sector concentration, economic development, and institutional quality. All variables are defined in the following section, in which a particular emphasis is given to the conceptualization of the catharsis indicator. Note that the constant α is included in the model but the coefficient estimates are not shown in the tables for brevity.

Although we exploit the panel characteristics of our dataset and attempt to control for the remaining observable variables, it is easy to argue that there are numerous problems that cast doubt on the validity of our results in this first step. On the one hand, not all potentially omitted variables may be captured by the fixed effects and controls. On the other hand, it remains possible to argue for the endogeneity of bank catharsis, which could simply be an answer to past growth or a prelude to expected growth.[2] Thus, we subject this baseline specification to two additional tests in attempting to establish a causal relationship.

In the second step, we use an instrumental variable setup, which assumes that the regulation of bank insolvency and resolution in country k and period t can serve as a valid instrument for actual resolution of insolvent banks as captured by the catharsis indicator. This idea is similar to the identification strategies of earlier research that have employed legal prescriptions for banks and bank regulation as an instrument for the actual characteristics of the banking sector or manifestations of the law in actual policies (Jayaratne and Strahan, 1996; Giannetti and Ongena, 2009). Thus, we utilize (a) the existence of a separate bank insolvency law and (b) the existence of superseding insolvency declaration power of a regulatory body as instruments for the catharsis indicator. A heteroskedasticity-robust GMM estimator is used for the IV estimation (Baum et al., 2007), and we discuss and test for the validity of the instruments (with respect to both the relevance and the exogeneity conditions) in the respective section.

If the validity of the instrumental variable approach continues to not be fully convincing, we resort to the third step in our identification strategy, which was suggested by Rajan and Zingales (1998) and has recently been applied in various attempts to establish causal links between banking and the real economy.[3] The identifying assumption of this approach rests on the presumption that firms that are more dependent on bank financing should experience stronger (or weaker) growth in countries and periods in which the resolution regime for insolvent banks is stronger when compared with firms that depend less on bank financing. Following Rajan and Zingales (1998) and the subsequent applications of their idea, we assume that a firm's dependence on bank financing is a technological or economic characteristic of the industry or sector to which the firm belongs. Under this assumption, bank dependence is relatively stable across countries and over time (at least over short to medium time horizons), but varies with the financial features of an industry, such as its cash-flow and investment structures in the aggregate.[4] Thus, we can compute bank dependence at the industry level and test our presumption by augmenting our baseline specification with an interaction term that accounts for the bank dependence of the firm:

$$\Delta \ln(output_{i,t}) = \alpha + \beta_1 * bankdep_i + \beta_2 * bank\ catharsis\ indicator_{k,t} + \beta_3 * (bankdep_i * bank\ catharsis\ indicator_{k,t}) + X_{i,t} + bankdep_i * Z_{k,t} + \sum_i \gamma_i * firm_i + \sum_{k,t} \delta_{k,t} * country\ year_{k,t} + \varepsilon_{i,t} \quad (2)$$

[1] A detailed explanation of the conceptualization and computation of the bank catharsis indicator is provided in the following section.

[2] It should be noted that endogeneity due to reverse causality is already reduced by employing firm-level data, since it seems implausible that output growth of a single firm affects bank closure policies.

[3] Refer, for example, to Bertrand et al. (2007), Cetorelli (2004), Cetorelli and Strahan (2006), Claessens and Laeven (2005), Dell'Ariccia et al. (2008), Fisman and Love (2007) and Giannetti and Ongena (2009).

[4] For a detailed discussion of the validity of this assumption, refer to Kroszner et al. (2007).

with $i = 1, \ldots, I$ denoting individual firms, $k = 1, \ldots, K$ denoting countries, and $t = 1, \ldots, T$ years. The $bank\,catharsis\,indicator_{k,t}$ is now interacted with$bankdep_i$, which is an index that measures the (industry-specific) bank dependence of a firm. This augmented specification has two key advantages over our baseline specification and the IV approach. First, it allows us to control not only for firm- and year fixed effects but also for country trends, i.e., for country-year fixed effects that would have absorbed the bank catharsis indicator in the baseline specification and could thus not be included before. Hence, we are able to control for a full range of additional unobservables – and are thus closer to controlling for almost any potentially omitted variable. Consequently, this specification should help us overcome endogeneity concerns: Even if firms' average growth rates are correlated with the strength of bank resolution due to reverse causation and/or omitted variables that are not captured by the control variables (or that make the instruments invalid), it is difficult to find an argument for such a variable being able to drive the relationship between firm performance and bank resolution in a systematic way that varies with firms' bank dependence. Second, such an approach provides a more convincing test for establishing causality. In the words of Rajan and Zingales (1998): It provides a 'smoking gun' by testing a specific mechanism through which bank resolution can affect economic growth, namely, by disproportionately benefiting firms more dependent on bank finance.

It should be noted that the simple effects of the $bank\,catharsis\,indicator_{k,t}$ and $bankdep_i$ are absorbed by the fixed effects in the above specification. Additionally, we interact the vector Z with bank dependence to preclude absorption of the country-year specific control variables.

4. Data

4.1. Data and sources

To test the specifications outlined above in Section 3, we construct a new dataset based on several sources. The dataset contains more than 2 million firm-year observations and covers 39 countries between 2003 and 2010. We limited our sample to European countries. As a first restriction, data availability and reliability limit the dataset, excluding most other regions. Although data is available for U.S. firms and banks as well, the variance of the main explanatory variable – the bank catharsis indicator – is presumably low at an interstate level because it is largely governed by a unified federal regulatory framework. This is not the case in Europe. The rules for bank insolvency and, particularly, the individual decisions on actual bank resolution were largely determined by national authorities[5] and thus vary not just over time but also between countries. This setup is beneficial to our identification strategy and suggests a dataset focused on European countries rather than U.S. states. Regarding the timeframe, we aspire to construct the dataset with a minimum number of observations and regional variance for each period and that covers more than a part of the business cycle, including both years with and without the influence of financial and economic crises.

The main firm-level data is taken from Bureau van Dijk's Amadeus database, which provides the largest coverage of data on European firms. Bureau van Dijk also provides data on European banks in its Bankscope database that is used to compute the bank catharsis indicator as described in the following subsection.

[5] Note that this holds for the timespan of our dataset but might eventually change with the introduction of a unified resolution framework currently discussed in the European Union.

Information on bank insolvency legislation and regulation is taken from the Bank Regulation and Supervision dataset published by the World Bank (Barth et al., 2001, 2004; Caprio et al., 2008). Further country-level control variables are constructed from the World Bank Financial Structure dataset (Beck et al., 2009), the World Bank Open Data database, and the Polity IV database provided by Marshall et al. (2011).

Following several authors who use data from similar sources (Bertrand et al., 2007; Giannetti and Ongena, 2009; Klapper et al., 2006), we include only firms that meet one of the following criteria: (a) total assets of minimum USD 20 million, or (b) total operating revenue of at least USD 10 million, or (c) at least 150 employees. This is done mainly due to data availability and the employability of the dataset and leaves us with 443,597 individual (both listed and unlisted) firms that report data for at least part of the sample period, i.e., two consecutive years. A summary table displaying the number of firms in our sample by country and year is provided in Table 10 in the Appendix. For most of the firms below the thresholds discussed above, financial and accounting data are limited or appear to be unreliable. Additionally, the availability of micro and small firm data strongly varies over countries. In order not to make our dataset too unbalanced or inconsistent in coverage, we employ these limits. Doing so should also largely exclude 'phantom' firms that are established only for tax or other purposes.[6] Additionally, we test the robustness of our results by running the analyses on subsamples of the dataset. Nevertheless, this sample restriction should be considered when determining the external validity of our results.

4.2. Conceptualizing a measure for bank catharsis

Our approach depends on a valid and powerful operationalization of the main explanatory variable, the bank catharsis indicator. First, the indicator must capture the idea of how orderly or rules-based failed banks are resolved. Ideally, it should measure the following:

$$bank\,catharsis\,indicator_{k,t} = \frac{Failed\,bank\,assets\,that\,have\,been\,resolved_{k,t}}{Bank\,assets\,that\,should\,have\,been\,resolved_{k,t}} \quad (3)$$

However, there are restrictions imposed by data quality or, more generally, by data availability. Regarding the numerator (i.e., failed bank assets that *have been resolved*), there is often no unified framework for when and how to resolve banks. Accordingly, there is no or only limited regulatory reporting available, which is also not necessarily consistent across countries. With regard to the denominator (i.e., *bank assets that should have been resolved*), we encounter the question of how to define and identify which banks *should have been resolved*. The challenge is to find an approach that correctly identifies failed and to-be-resolved banks (minimizes type I error), while it avoids declaring healthy banks as failed and resolving them accordingly (minimizes or avoids type II error). To overcome these challenges, we suggest a relatively simple indicator that combines sufficient identification power to proxy for the hypothesized 'catharsis' and that can be effectively built for a multitude of countries based on available data and despite inconsistent and incomplete regulatory reporting on bank failures. We conceptualize this indicator in the following.

For the nominator, we require data on failed/resolved banks that are as encompassing as possible. Bureau van Dijk's Bankscope database reports inactive banks, their last account dates and financial data in addition to the reasons for their inactivity (bankruptcy,

[6] Refer to Giannetti and Ongena (2009) for a detailed discussion of the justification for such cutoffs.

in liquidation, dissolved by merger, etc.). Despite valid criticism directed at it, Bankscope is likely the broadest and most representative cross-country database, covering 80% or more of bank assets for a multitude of countries (Bhattacharya, 2003; Detragiache et al., 2008; Shehzad et al., 2009). We assume that Bankscope data is similarly representative for bank closures. In any case, there should be no sampling bias or, at least, no inconsistency between numerator and denominator if the population from which the bank closures are taken (all banks reported in Bankscope) in the numerator is set in relation to a denominator composed of the same population. This is the case with the following matching procedure employed. We define as resolved in insolvency resolution all banks that have (a) fallen below a pre-determined capital ratio threshold in the previous[7] or the current year and (b) ceased existence as a legal entity by ways of purchase and assumption (or M&A) or closure and liquidation. We exclude M&A from this definition as a robustness check.

Concerning the denominator, the preferred option for detecting which banks should be resolved is to test for a regulatory insolvency threshold such as a closure rule at positive capital, i.e., a simple capital ratio (total equity/total assets) as a should-be-resolved-trigger for bank insolvency. This basic principle follows from the literature on bank insolvency, particularly from the suggestions of Kaufman (2011) and Lindgren (2005). A closure rule at positive capital stipulates automatic regulatory intervention and eventually even closure or purchase and assumption of a bank if it falls short of pre-specified positive capital ratios. The main rationale supporting the use of such rules is their simplicity in identifying insolvency, relatively small room for manipulation, and their natural tendency to be biased upwards, i.e., to avoid type II errors rather than type I errors. In fact, the literature on bank insolvency detection also suggests that simple capital ratios score surprisingly well in detecting failure (Arena, 2008; Estrella et al., 2000) and show better results than more complex regulatory capital ratios (such as the tier 1 capital/risk-weighted assets ratio) in predicting failure during the financial crisis (Berger and Bouwman, 2013; Blundell-Wignall and Atkinson, 2010). Thus, we define all banks that fall below a pre-determined, simple capital ratio threshold as failed according to this regulatory definition.

In calculating the numerator and denominator, we take total reported asset values of resolved and failed banks to account for the effect that small banks might be more easily resolved by a regulator, but an orderly closure rule at positive capital should lead to a closure of a de facto failed bank irrespective of bank size.[8] Nevertheless, we compute an alternative catharsis indicator that uses bank numbers instead of assets for a robustness test. The actual measurement and summary statistics of the bank catharsis indicator are presented in the following section.

4.3. Composition of other variables and descriptive statistics

Table 1 reports the sources and summary statistics of the variables used in our analyses. The definitions of the individual variables are given below. It should be noted that we cleaned the dataset from observations that exhibit logically impossible values and obvious data errors. Apart from that action, all cleanings or restrictions on the dataset are reported with the relevant variables or specifications.

Dependent variables

We measure our main dependent variable – firm performance – by the growth of a firm's operating revenue. The operating revenue provides a simple measure of firm performance that is less prone to disturbances, such as extraordinary revenues or non-recurring effects, financial/non-operating business, or accounting and amortization rules that can influence net income or assets.[9] The growth rate of the operating revenue is computed as $\ln(\textit{operating revenue}_{i,t}/\textit{operating revenue}_{i,t-1})$ and denoted $\Delta\ln(\text{OpRev})$ in the following tables. To limit the influence of outliers, we trim the sample at the 1st and 99th percentiles of the growth rates. A robustness check is also undertaken on an untrimmed sample.

In addition to operating revenue growth as a main dependent variable, we analyze how changes in financing structure are influenced by the bank catharsis indicator to assess the channels through which resolution of insolvent banks may influence real economic performance. Essentially, this additional dependent variable allows us to test whether and explain why particular firms experience stronger growth following more rules-based bank insolvency resolution. One potential channel might be the reallocation of bank credit. Thus, we examine changes in financing structures toward debt financing as an additional dependent variable. This is proxied by the change in the financial debt ratio of a firm, denoted Δ debt/assets and computed as $[(\textit{shortterm loans}_{i,t} + \textit{longterm debt}_{i,t}) - (\textit{shortterm loans}_{i,t-1} + \textit{longterm debt}_{i,t-1})]/\textit{non equity liabilities}_{i,t}$.[10] We also trim the sample at the 1st and 99th percentiles to limit the influence of outliers.

Explanatory variables

The bank catharsis indicator as a main explanatory variable is defined and operationalized above. This indicator is computed based on individual bank-year level observations and aggregated at the country-year level. Since we employ the matching procedure described above, all our results are between 0% and 100% by definition.[11]

Because we are calculating the bank catharsis indicator based on a hypothetical closure rule at positive capital, we must determine a cutoff serving as a hypothetical trigger for insolvency resolution according to this rule. We choose to construct the bank catharsis indicator for an 8% capital ratio closure rule. The first reason for this choice is intuitive: 8% is consistent with traditional regulatory requirements – although these are now far more complex in computation than a simple capital ratio – and thus is a logical cutoff for insolvency regulation. The second reason is more quantitative: Among several cutoffs that we computed, the 8% cutoff for the matched catharsis indicator exhibits the best 'detection rate', i.e., it peaks in the average identification of banks that really failed after falling below the threshold scaled by the banks that would have been regarded as failed because they fell below the threshold. Nevertheless, we compute several alternative bank catharsis indicators that are used for robustness checks to determine that our

[7] This allows for a time-lag of regulatory action.

[8] Following the core idea of the catharsis indicator, a country which resolves two small banks that failed according to the rule but supports continued operations of a failed large bank should have a smaller indicator than a country which resolved one small and one large failed bank and forbears on the second small bank that failed. This can be attained by resorting to asset values.

[9] Nevertheless, we test the robustness of our results using net income and asset growth and find directionally similar results for our main regressions. However, these are less stable in their significance, potentially due to these other influences.

[10] Note that we use the change in the debt-to-non-equity-liabilities ratio to make sure that the results are not driven by a loss in equity rather than by an increase in debt finance.

[11] It should be noted that we limit our sample to country-year combinations for which at least ten bank observations are available in order to ensure that our indicator is not driven by extreme observations. In addition, we also trim the sample at the 1st and 99th percentiles of the catharsis indicator for a further robustness test.

Table 1
Summary statistics.
This table reports variable names, sources, means, standard deviations, minimum and maximum values, and the number of firm-year observations for which data is available in our sample. The sources are: Amadeus company database by Bureau van Dijk (AM), Bankscope bank database by Bureau van Dijk (BS), Marshall and Jaggers Polity IV database (P4), World Bank Open Data database (WB OD), World Bank Bank Regulation and Supervision dataset (WB BRS), World Bank Financial Structure dataset (WB FS).

Variable group and name	Source	Mean	SD	Min	Max	*N*
Dependent variables						
Growth oper. revenue (Δln(OpRev))	AM	12.66	(46.50)	−174.11	321.2	1,794,189
Growth debt/asset (Δdebt/assets)	AM	1.18	(17.88)	−95.75	71.59	1,311,729
Explanatory variables						
Catharsis indicator (7% CR)	BS	2.52	(6.49)	0	54.25	2,188,814
Catharsis indicator (8% CR)	BS	2.34	(5.25)	0	44.07	2,192,690
Catharsis indicator (9% CR)	BS	2.23	(4.76)	0	33.24	2,196,761
Catharsis indicator (8% CR, avg)	BS	2.90	(8.38)	0	63.81	1,508,650
Catharsis indicator (8% tier 1)	BS	4.48	(15.37)	0	100.00	1,972,574
Catharsis indicator (8% CR, number)	BS	3.09	(4.5)	0	100.00	2,193,516
Bank dependence (NACE-based)	AM	19.62	(7.03)	0.8	57.68	2,195,945
Bank dependence (SIC-based)	AM	19.56	(6.01)	0.8	51.52	2,195,941
Industry- and firm-level variables						
Share of firm in country-year total assets	AM	0.01	(0.28)	0	100	2,118,478
Firm age (log)	AM	2.54	(0.98)	0	6.8	2,163,383
RoA (profits/assets)	AM	5.64	(11.7)	−43.75	59.07	1,919,068
Firm status	AM	0.96	(0.18)	0	1	2,152,150
Country-level variables						
Financial development	WB FS	109.05	(52.03)	13.24	269.76	1,796,423
Bank system undercapitalization	BS	72.63	(30.54)	0	98.74	2,196,075
Bank concentration CR3	WB FS	62.78	(24.23)	11.9	100	1,882,352
GDP per capita (PPP-adjusted)	WB OD	27,620	(9329)	2192	74,021	2,196,441
Political openness index	P4	9.12	(1.87)	−7	10	2,179,883
Bank insolvency law	WB BRS	0.44	(0.50)	0	1	878,093
Bank insolvency power	WB BRS	0.21	(0.40)	0	1	2,053,421
International debt issues/GDP	WB FS	60.46	(40.39)	0.13	344.39	1,880,281
Loans from non-resident banks/GDP	WB FS	62.22	(84.88)	2.16	1509.92	1,882,619

results are not driven by the choice of the cutoff or the indicator definition. We compute the indicator for 7% and 9% simple capital ratio thresholds (i.e., 1% around the peak and the reference case of 8%). With regard to alternative catharsis indicator definitions, we compute an indicator using average values of capital and assets for the capital ratio and another indicator using tier 1 ratios (tier 1 capital/risk-weighted assets) instead. In addition, we compute a catharsis indicator based on the numbers rather than the asset values of concerned banks. We use these alternative definitions to perform additional robustness checks.

Table 1 shows that the sample mean of the bank catharsis indicators is between 2.2% and 4.5%. These numbers may appear surprisingly low at first glance. However, this finding can be explained by two factors. First, it indicates that regulators frequently put undercapitalized banks on probation rather than resolve them even when their capital ratios drop below certain thresholds. This is generally done to give banks time to recapitalize but may also be due to the limited willingness of regulators to enforce resolution by closure. Second, there are many banks that would be considered to be in healthy financial condition despite their capital ratio dropping below 8%. Whether they are sustainable is a different question. Both rationales – the limited willingness to close banks and the existence of otherwise healthy banks with low capital ratios – drive down the indicator in the aggregate. However, we argue that this phenomenon does not blur the identification power of our indicator because we basically test whether countries that follow a more rules-based insolvency resolution policy (as proxied by closer implementation of the closure rule at positive capital) experience higher growth rates in the real economy. This identification is possible as long as there is some variation in the explanatory variable and assuming that there is some relationship between the health and capital ratio of banks that is somewhat comparable across countries.[12] Although the latter assumption is confirmed by the previous literature (Arena, 2008; Berger and Bouwman, 2013; Estrella et al., 2000), our indicator exhibits considerable variation over time and across countries. Figs. 1 and 2 give an overview of both the variation over time and the distribution of the catharsis indicator on the country-year level. We use this variation as one source of our identification henceforth. In addition, to ensure that this variation is not driven by outliers or by small countries that only have a few bank-year observations available, we conduct robustness tests (a) using a trimmed catharsis indicator and (b) excluding the countries with the lowest number of observations. Finally, by separately controlling for the overall capitalization of the banking system, we ensure that it is not the over- or undercapitalization of banks in general that drives our results.

The index of bank dependence is defined as the ratio of financial debt to total liabilities of a firm, i.e., ($shortterm\ loans_{i,t} + longterm\ debt_{i,t})/total\ liabilities_{i,t}$. This index is computed using firm-level data that are aggregated at the industry level to provide a measure of the technological or economic demand that firms of a specific industry exhibit based on the typical cash-flow and financing structures in that industry (Rajan and Zingales, 1998). We include only industries with more than 30 firms for

[12] A problem of limited identification power could occur if the banks that are closed down are not identifiable by a closure rule at positive capital, for example, if they regularly have more than 8% capital ratio when they fail. To exclude this possibility, we computed unmatched bank catharsis indicators (i.e., we sum all failed banks in the numerator, regardless of their capital ratio) for the 8% cutoff and found that they are not much larger on average. This demonstrates that the matched catharsis indicator should cover most of the banks that have, in fact, failed (and that it is not driven down to a large extent by excluding failed banks due to the matching requirement). It thus exhibits good insolvency detection properties.

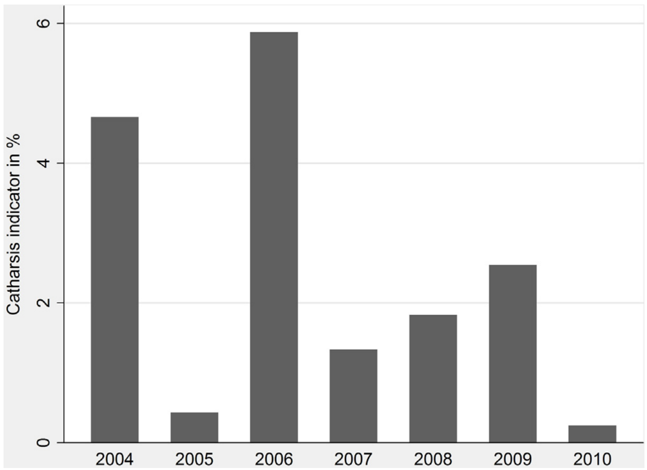

Fig. 1. Variation of the catharsis indicator over time. This figure displays the catharsis indicator over time, averaged across all countries in the dataset.

which all necessary data are available in the calculation to avoid disturbances by outliers and erroneously computed bank dependence indices. The initial index of bank dependence is calculated as a sector average at the NACE-4 industry classification level because this classification is available for the largest number of firms in Amadeus, and it provides bank dependence measures on a fine-grained level for approximately 700 sectors. For robustness, we compute an alternative bank dependence index for industries according to the U.S. SIC classification, which provides a rougher cut on bank dependence by distinguishing approximately 200 sectors.

Other firm-level variables

In order to account for firm characteristics that are not captured by firm fixed effect, i.e., that vary over time for a given firm, and that might influence firm growth (or financing structure), we introduce firm-level covariates. Firm size is typically seen as a determinant of firm growth as smaller firms are expected to growth faster on average. To control for this growth convergence effect (Kroszner et al., 2007), we include the relative size of a firm measured as its lagged share in total assets (on a country-year level to account for diverging economic structures in different countries). Likewise, as young companies are typically expected to grow faster than old ones (Giannetti and Ongena, 2009), we account for this by including firm age as a control variable. As the age effect on firm growth is expected to decline with age, we include the natural logarithm of this variable in our regressions. Finally, we expect that firm profitability also influences firm growth as highly profitable firms might be expected to grow faster than firms that do not perform as well. Hence, we construct a simple profitability measure from the available data that provides a proxy for the return on assets (RoA) and is computed as $profit\ or\ loss_{i,t}/total\ assets_{i,t}$.

Additionally, we run tests for which a firm's activity status is used. Firm status is a dummy variable that takes the value of 1 if a firm is active (i.e., operating/in business) throughout the timespan of our dataset and 0 if a firm has been dissolved or liquidated.

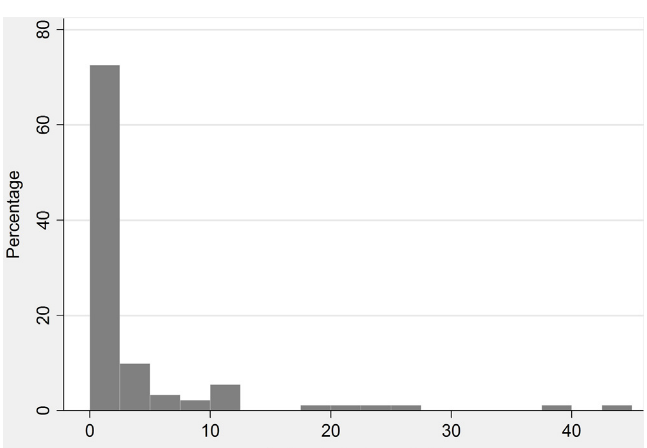

Fig. 2. Distribution of the catharsis indicator. This figure displays the distribution of the catharsis indicator as a histogram of the pooled country-year level catharsis indicators.

Other country-level variables

Although the time-invariant covariates can be controlled for in our regression framework by exploiting the panel character of our dataset, there may nevertheless be other variables that vary by country and year and that are potential determinants of firm growth. For example, it could be argued that our bank catharsis indicator just proxies for other factors that cause comparative differences in firm growth. Thus, we identify five such potential covariates that should be controlled for. First, the strength of bank insolvency resolution could be a mere proxy for the state of the banking system in general, particularly for its capitalization. Therefore, we insert another control variable, undercapitalization of the banking sector, that is computed on a country-year level as the ratio of bank assets of undercapitalized banks (i.e., below a simple capital ratio of 8%) to total bank assets. In addition, competition (or the lack thereof) in the banking sector could play a role for firm growth and the resolution of insolvent banks. For example, the regulator may be less open to a purchase and assumption policy in a country in which the banking sector is already highly concentrated. We control for this by employing a simple CR3 concentration index computed as the ratio of the three largest banks' assets to total banking sector assets. In addition, financial development has been shown to positively impact firm growth in numerous studies[13] and could also potentially be related to the treatment of insolvent banks. Thus, we control for financial development by making use of the usual proxy $bank\ credit_{k,t}/GDP_{k,t}$ that is taken from the latest version of the World Bank Financial Structure dataset (an update to Beck et al., 2009). Finally, we control for a country's overall economic development and institutional quality/political openness by taking the purchasing power parity-adjusted real GDP per capita on a country-year level from the World Bank database as a proxy for economic development. Political openness is proxied by the polity IV index computed and published by Marshall et al. (2011).

The legal provisions for bank insolvency regulation (bank insolvency law) and insolvency declaration power of the regulator (bank insolvency power) are taken from the World Bank's Bank Regulation and Supervision dataset that has been collected over several rounds since 2000 (Barth et al., 2001, 2004; Caprio et al., 2008). Both variables are dummies that indicate the existence of a specific bank insolvency law and the power of a regulator to order insolvency resolution against a bank (even superseding the bank's management or shareholders). For additional tests, we employ data on the access to international finance, namely, international debt issues and loans from non-resident banks as ratios to GDP. These data are also provided by the World Bank Financial Structure dataset on a country-year level.

[13] Refer to Section 2.

5. Results

This section presents and discusses our main results, structured along the three-step analytical framework outlined above. We discuss the results of each step in turn and extend these results into additional analyses on the channels of transmission of the 'catharsis effect' and the conditions under which it works most effectively.

5.1. Simple OLS

In the first step, we estimate the impact of the catharsis indicator on firm growth in a simple OLS model. We also exploit the nature of our panel dataset by controlling for time- and firm-invariant unobserved effects. Moreover, consistent with the literature (e.g., Giannetti and Ongena, 2009), all specifications reported below employ heteroskedasticity and autocorrelation-robust standard errors clustered at the firm-level. However, because of the potential problems with endogeneity discussed in section 3, care should be exercised when interpreting these results. Although one might not be able to attribute causality to these estimates, they nevertheless provide an initial indication of the direction and economic significance of the effect.

Table 2 reports the results. Overall, we posit that these results support our initial hypothesis that the catharsis indicator has a positive and significant effect on firm growth. Model (1) tests for a baseline effect without any controls or fixed effects and finds a positive and highly significant coefficient. However, this effect might potentially be a proxy for other variables that explain the positive relationship. We test for this possibility by including two sets of control variables, one with firm-level controls and one with country-level controls. If the positive effect of the catharsis indicator really proxies for one of these factors, the coefficient on the catharsis indicator would be expected to drop in magnitude or to become insignificant. Neither is the case: Not in model (2), which introduces the firm-level controls, nor in model (3), which controls for the country-level covariates. Even when controlling for both sets of control variables simultaneously in model (4), the coefficient on the catharsis indicator remains statistically significant, as in the baseline specification. Finally, we exploit the full possibilities of our panel dataset by testing two-way fixed effects models that control not just for explicitly included variables but also for year fixed effects and country or firm fixed effects. The columns for models (5) and (6) report the results. The coefficient estimates drop in magnitude, which is not surprising because we are now able to control for a large array of potentially omitted variables that are absorbed by the fixed effects. Most importantly, however, the coefficients remain highly significant statistically.

To provide an impression of the economic significance of these results, we evaluate the statistically significant coefficient on the catharsis indicator by computing a growth rate differential. This measure captures the difference in the growth rate between a firm located in a country half a standard deviation above the mean of the catharsis indicator compared with a firm in a country whose catharsis indicator is half a standard deviation below the mean. Applying this growth rate differential to the results reported in Table 2 yields an impact between 0.5% (model (6)) and 2.2% (model (2)) of operating revenue growth. Taken together, the relationship between growth in operating revenue and the catharsis indicator seems robust to the inclusion of controls and fixed effects and is both statistically and economically significant.

5.2. IV model

This second step is intended to extend our results from showing a positive and significant relationship to demonstrating that this relationship is causal. Thus, we run the same sequence of specifications that was used in the previous OLS analyses in an instrumental variable setup, which employs the regulation of bank insolvency and resolution in country k and period t as an instrument for the catharsis indicator. More specifically, we use two variables from bank insolvency regulation: The existence of a separate bank insolvency law and the bank insolvency declaration power of a regulatory agency. Having two instruments has a particular advantage: We can use overidentification tests as diagnostic tools for the validity of our instrumental variables. However, because only the insolvency declaration variable exhibits sufficient variation over time within the same country, we must rely on one instrumental variable when including country or firm fixed effects in our model. Consequently, we cannot run the overidentification tests for these fixed effects models. All our tests use a heteroskedasticity-robust GMM estimator. The results are reported in Table 3.

All models yield a positive and highly significant coefficient on the catharsis indicator, which confirms our initial findings. To test the necessity of this instrumental variable setup, we employ an endogeneity test that investigates whether the assumed endogenous regressor, our catharsis indicator, is in fact endogenous, recommending the use of IV over simple OLS. We use a heteroskedasticity robust test statistic equivalent to the Durbin-Wu-Hausman test, which tests the null hypothesis that the estimates are not altered by using IV compared with OLS, supporting the assumption that the catharsis indicator is exogenous in our initial models. The null is rejected with low *p*-values, which confirms our initial concerns about the endogeneity of the catharsis indicator.

However, the validity of our instruments rests on two conditions. First, a minimum relevance of bank insolvency law and insolvency declaration power for the catharsis indicator is required. Intuitively, this seems to be the case: Legal prerequisites of bank insolvency are a logical determinant of actual bank resolution. We also find a positive and significant correlation between the catharsis indicator and the suggested instruments. Furthermore, employing a weak instrument diagnostic test confirms the validity of this condition. The Kleibergen-Paap Wald F statistic is generally used to test whether the instrumental variables are sufficiently correlated with the potentially endogenous variables in a heteroskedasticity-robust setup (Baum et al., 2007). The reported values are far above previously tabulated critical values (not reported), and also far above any other rule of thumb.[14] Thus, we have no reason to assume that our initial proposition of regulatory and legal prerequisites of bank insolvency as a determinant of actual bank resolution should be doubted.

The second condition, the exogeneity restriction, is less obvious. It demands the exclusion of any causal relationship of bank insolvency law to firm growth other than through the actual insolvency and resolution of banks – otherwise, the instrument may not be regarded as exogenous. Arguing purely on the grounds of economic theory, it is unlikely that there is any direct effect of bank insolvency law on economic growth not working through actual bank insolvencies. However, considering the interplay between growth, banks, and regulation (e.g., lobbying in favor of some regulatory changes in certain expected economic situations), this argument might be doubted. Thus, we use Hansen's J statistic, which provides a test of overidentifying restrictions to assess the validity of instruments in a robust GMM estimation (Baum et al., 2007). The J statistic essentially tests the exogeneity of the instruments with the null

[14] Baum et al. (2007, 2010), for example, suggest referring to the general rule of thumb of a test statistic larger than ten indicating less concern with weak instruments, as the critical values tabulated by Stock and Yogo are for i.i.d. errors only.

Table 2
Firm growth and bank 'catharsis effect' (OLS models).
This table reports the results from an OLS model using Δln(OpRev), the growth in firm operating revenues, as dependent variable and the catharsis indicator as main explanatory variable. Firm-level and country-level control variables and country, firm and year fixed effects are included as indicated. Robust standard errors are clustered at the firm-level and reported in parentheses, significance levels are indicated by $^{***}p<0.01$, $^{**}p<0.05$, $^{*}p<0.1$.

Model	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	OLS	OLS
Dependent variable	Δln(OpRev)	Δln(OpRev)	Δln(OpRev)	Δln(OpRev)	Δln(OpRev)	Δln(OpRev)
Catharsis indicator (8% CR)	0.344***	0.441***	0.313***	0.399***	0.138***	0.0931***
	(0.00564)	(0.00511)	(0.00672)	(0.00630)	(0.00737)	(0.00725)
Bank dependence		0.0730***		0.132***	0.0961***	
		(0.00614)		(0.00695)	(0.00687)	
Firm age (log)		−0.0733***		−0.0699***	−0.0662***	−0.281***
		(0.000468)		(0.000520)	(0.000520)	(0.00456)
Lagged share of total assets		0.310**		0.0907	−0.241	−0.273
		(0.126)		(0.128)	(0.179)	(0.473)
Profitability		0.459***		0.444***	0.381***	0.801***
		(0.00338)		(0.00376)	(0.00368)	(0.00676)
Financial development			−0.0747***	−0.0709***	−0.0828***	−0.0756***
			(0.00112)	(0.00107)	(0.00417)	(0.00432)
Bank undercapitalization			0.00986***	0.0499***	0.00797**	−0.00623
			(0.00260)	(0.00244)	(0.00381)	(0.00381)
Bank concentration			−0.0149***	−0.0153***	0.0266***	0.0146***
			(0.00222)	(0.00204)	(0.00529)	(0.00521)
GDP per capita			−0.0022***	−0.0019***	−0.0341***	−0.028***
			(0.0001)	(0.00009)	(0.0007)	(0.0007)
Political openness			0.00244***	0.0111***	−0.0235***	0.0163***
			(0.000399)	(0.000365)	(0.00365)	(0.00113)
Year FE	NO	NO	NO	NO	YES	YES
Country FE	NO	NO	NO	NO	YES	NO
Firm FE	NO	NO	NO	NO	NO	YES
Observations	1,792,558	1,555,980	1,440,787	1,252,126	1,252,126	1,252,126
R-Squared	0.002	0.040	0.012	0.045	0.123	0.165

hypothesis that the instruments are uncorrelated with the residual term. Table 3 reports *p*-values for this null hypothesis. In models (1) and (3), with *p*-values of approximately 0.5–0.6, we cannot reject the exogeneity of the instruments. However, low *p*-values in models (2) and (4) raise concerns about the potential endogeneity of the instruments.

When turning to the economic magnitude of the IV estimates, we find considerably higher effects compared with the benchmark estimates in Table 2. Computing the difference in the growth rate as outlined above yields an effect between 1.8% and 5.7% of operating revenue growth. In general, it is not uncommon to find larger estimates in IV estimations due, for example, to heterogeneous treatment effects. Although this might be the case here, the large difference could also be conservatively interpreted as an indication that the instruments are weak or not entirely exogenous. We are thus not able to conclusively rule out the possibility of failing on the conditions underlying IV estimation, particularly regarding the exogeneity condition, due to the large difference in the coefficient estimates and the varying results of the Hansen tests. Therefore, we supplement our results with a further identification idea in the following step of the analysis that is used to trace the causality of the 'catharsis effect'.

5.3. *Interaction approach*

This third step of our identification strategy relies on the identifying assumption that firms that are more dependent on bank financing should experience stronger growth in countries and periods in which the resolution regime for insolvent banks – as measured by the catharsis indicator – is stronger compared with firms in countries and periods in which it is weak. Thus, we exploit industry differences in bank dependence to establish causality. We use the augmented specification presented in Section 3 and continue to employ heteroskedasticity and autocorrelation robust clustered standard errors. The results are reported in Table 4, which only displays the main coefficients of interest and indicates the inclusion of control variables and their interactions in the respective rows for brevity.

The first specification serves as a starting point that can be compared with the results of model (5) in Table 2. Here, we simply add the interaction of the catharsis indicator and bank dependence. Although the coefficient on the level effect of the catharsis indicator becomes insignificant, it is notable that the coefficient on the interaction term is positive and significant. This alludes to a particularly strong effect of bank insolvency resolution for firms that structurally depend more on bank financing. In model (2) we test the interaction term between bank dependence and the catharsis indicator, the level effects, and the sets of control variables. Additionally, where these controls vary only at the country-year level, we also interact them with the bank dependence indicator to ensure that our interaction term of interest does not proxy for other unobserved variables whose influence on firm growth also varies systematically with bank dependence. Both the coefficient on the catharsis indicator and – more notably – the coefficient on the interaction are positive and significant, further corroborating the hypothesized 'catharsis effect', particularly for bank dependent firms.

In models (3) and (4), we exploit the full advantages of the augmented model, which allows us to control for country trends, i.e., for country-year fixed effects that would have absorbed the bank catharsis indicator in the baseline specification. When we include these country-year fixed effects alongside a set of firm fixed effects, we capture unobserved variance in all of these dimensions. We first test this fixed effects model without control variables in model (3).

Table 3
Firm growth and bank 'catharsis effect' (IV models).
This table reports the results from an Instrumental Variable (GMM) model using Δln(OpRev), the growth in firm operating revenues, as dependent variable and the catharsis indicator as main explanatory variable. We use the existence of a separate bank insolvency law and the insolvency declaration power of a regulatory authority as instruments for the catharsis indicator. Firm-level and country-level control variables and country, firm and year fixed effects are included as indicated. When country or firm fixed effects are included, only the insolvency declaration power can be used as an instruments as it exhibits sufficient variation over time. The endogeneity test tests the null hypothesis that the estimation results are not altered by using instrumental variables. The weak instrument test uses the Kleibergen–Paap Wald *F* statistic. The Hansen test tests the null hypothesis that the instruments are uncorrelated with the residual. Robust standard errors are clustered at the firm-level and reported in parentheses, significance levels are indicated by $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Model Dependent variable	(1) IV GMM Δln(OpRev)	(2) IV GMM Δln(OpRev)	(3) IV GMM Δln(OpRev)	(4) IV GMM Δln(OpRev)	(5) IV GMM Δln(OpRev)	(6) IV GMM Δln(OpRev)
Catharsis indicator (8% CR)	1.146***	0.828***	0.364***	0.905***	0.979***	1.151***
	(0.0281)	(0.0239)	(0.0725)	(0.0641)	(0.199)	(0.191)
Bank dependence		0.0666***		0.0675***	0.0884***	
		(0.00997)		(0.00990)	(0.00758)	
Firm age (log)		−0.0734***		−0.0642***	−0.0663***	−0.295***
		(0.000722)		(0.000716)	(0.000571)	(0.00670)
Lagged share of total assets		0.191		−0.538*	−0.444**	−4.046***
		(0.252)		(0.303)	(0.174)	(1.410)
Profitability		0.375***		0.342***	0.386***	0.846***
		(0.00514)		(0.00519)	(0.00399)	(0.00780)
Financial development			0.0674***	0.0839***	−0.200***	−0.214***
			(0.00205)	(0.00201)	(0.0156)	(0.0162)
Bank undercapitalization			−0.123***	−0.0599***	0.0823***	0.109***
			(0.00549)	(0.00490)	(0.0134)	(0.0143)
Bank concentration			0.144***	0.219***	0.0895***	0.0887***
			(0.0118)	(0.0112)	(0.00639)	(0.00642)
GDP per capita			−0.0033***	−0.0038***	−0.0257***	−0.0246***
			(0.0002)	(0.00018)	(0.00082)	(0.00082)
Political openness			−0.0313***	−0.0320***	0.00629*	0.00371
			(0.00135)	(0.00127)	(0.00359)	(0.00316)
Year FE	NO	NO	NO	NO	YES	YES
Country FE	NO	NO	NO	NO	YES	NO
Firm FE	NO	NO	NO	NO	NO	YES
Observations	717,211	612,857	707,328	606,588	1,054,117	1,018,668
R-Squared	0.001	0.039	0.026	0.055	0.116	0.154
Endogeneity test (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000
Weak instrument test (*F*)	7700	4800	4200	3800	2865	2590
Hansen test (*p*-value)	0.567	0.000	0.6	0.000	N/A	N/A

To ensure that the coefficient on the interaction term is not driven by one of the control variables that also influences firm growth systematically varying with bank dependence, we also include the interacted country-level control variables and firm-level controls in model (4). The coefficient on the interaction term remains positive and significant in both specifications.

This step should finally help us to overcome the endogeneity concerns. Because we control for country-time and firm fixed unobservables and a range of potential covariates that may influence firm growth systematically with bank dependence, there is hardly any other channel of endogeneity conceivable. Even if reverse causation or omitted variables drive a correlation between the average

Table 4
Firm growth and bank 'catharsis effect' (Interaction models).
This table reports the results from a regression model using Δln(OpRev), the growth in firm operating revenues, as dependent variable and the catharsis indicator, an indicator of firms' bank dependence (evaluated at the industry level), and the interaction between these two variables as main explanatory variables. Firm-level and country-level control variables (the latter also interacted with bank dependence) and firm, year, and country-year fixed effects are included as indicated. Robust standard errors are clustered at the firm-level and reported in parentheses, significance levels are indicated by $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Model Dependent variable	(1) Δln(OpRev)	(2) Δln(OpRev)	(3) Δln(OpRev)	(4) Δln(OpRev)
Catharsis indicator (8% CR)	−0.00586	0.312***		
	(0.0256)	(0.0251)		
Bank dependence		0.310***		
		(0.0544)		
Catharsis indicator × bank dependence	0.509***	0.429***	0.691***	0.549***
	(0.135)	(0.133)	(0.149)	(0.164)
Firm-level controls	YES	YES	NO	YES
Country-level controls	YES	YES	NO	NO
Country-level controls × bank dependence	NO	YES	NO	YES
Firm FE	YES	NO	YES	YES
Year FE	YES	NO	NO	NO
Country-Year FE	NO	NO	YES	YES
Observations	1,252,126	1,252,126	1,792,441	1,252,126
R-Squared	0.165	0.046	0.398	0.432

growth rates of firms and the strength of 'catharsis', it is difficult to find an argument that would provide that such a variable would do so in a systematic way relating to firms' bank dependence. Consequently, we treat this finding as strong evidence for the causality of the 'catharsis effect' on firm growth.

Interpreting the economic significance of the estimates is slightly more complex for the interaction term models. In these cases, we evaluate the economic significance at one standard deviation around the mean of both variables, i.e., bank dependence and the bank catharsis indicator. According to this evaluation approach, the results shown in model (4) suggest a difference of approximately 0.6% in the growth rate between a firm located half a standard deviation above the mean of bank dependence compared to a firm with a bank dependence measure half a standard deviation below the mean, if located in a country half a standard deviation above the mean of the bank catharsis indicator (i.e., with a relatively strict resolution of failed banks) rather than in a country half a standard deviation below this mean.[15]

Taken together, our results thus far suggest that rules-based bank insolvency resolution has an economically and statistically significant effect on economic growth. Particularly the third step of our identification strategy provides an indication of the specific mechanism by which the 'catharsis effect' influences economic growth, i.e., it disproportionately benefits those firms that depend on bank finance. However, what exactly is the channel of transmission of this effect from the resolution of insolvent banks to firm growth?

5.4. Extension of analyses I – exploring the mechanisms of 'catharsis'

Thus far, we have shown that there is a predominantly positive 'catharsis effect'. However, we are also interested in finding evidence with respect to the transmission channel from bank insolvency resolution to firm growth through which this effect works. Thus, we are essentially searching for a 'smoking gun' that indicates under which conditions or for which firms we find a particularly strong 'catharsis effect'. In this section, we define and test two potential transmission channels.

Starting with the first channel, which could be described as the 'quality effect', we stipulate that the growth effect we find is essentially driven by higher quality firms. Returning to our initial argumentation in support of the 'catharsis effect', we essentially argued that the resolution of insolvent banks reestablishes incentives in financial intermediation and thereby increases the quality of credit allocation decisions. In such an environment, banks prefer high-quality customers to gambling for high volatility. Consequently, firms that offer more attractive (e.g., profitable) investments as opposed to more volatile investments should benefit, in particular, from this shift to quality. If this proposition holds true, we should find a different magnitude or even direction of the 'catharsis effect' for firms of high and low quality. In a nutshell, we expect the quality effect to surface in higher growth of higher quality firms because they should be the beneficiaries of efficient credit allocation decisions.

To test this prediction, we set up two alternative definitions of firm quality. First, we distinguish those firms that went bankrupt over the time horizon of our dataset as low quality, and those firms that continued operations uninterruptedly are defined as high-quality firms. This definition provides rather unbalanced subsamples with approximately 2 million firm-year observations of active firms and less than 100,000 observations of firms that are classified as bankrupt, dissolved, in receivership, or in liquidation. Thus, we apply an alternative definition of firm quality: Firms in the top tercile of firm profitability (as defined by the RoA measure outlined above) are considered high-quality firms, and those in the bottom tercile are defined as 'low quality'. To test whether there is a differential 'catharsis effect' for high- and low-quality firms, we split our main dataset along these definitions of firm quality into subsamples and run our main specification on each.[16]

The results are reported in Table 5 together with the results of our augmented specification as a reference case. For each definition of firm quality, we observe a considerably different 'catharsis effect'. Whereas the coefficient on our main interaction increases only slightly for active firms, it becomes negative, but insignificant, in the sample of firms that went out of business (models (2) and (3)). A test for the equality of the coefficients shows that they are significantly different across subsamples and rejects equality with a p-value of 0.037. It is not surprising that there is only a small increase in the coefficient for the active firm sample insofar as this sample comprises far more than 90% of the observations, and a large move in the coefficient might not be expected. Comparing the models run on the samples split along the top and bottom tercile of profitability, which are reported in columns (4) and (5) of Table 5, we find similar results. The coefficient on the main interaction is significant and economically much larger than in our reference model when the test is run on a sample of high-quality firms only. When we run the model on the subsample of low-quality firms, the coefficient becomes negative but also insignificant. Again, the equality of these coefficients is rejected at a high significance level (p-value of 0.011). These results cast some light on our first transmission channel: The 'catharsis effect' seems to impact economic growth through a positive effect on higher quality firms, and firms with worse performance are not (or are even negatively) affected.

Turning to a second potential transmission channel, which might be described as the 'quantity effect', we suggest that the 'catharsis effect' stimulates a reallocation of credit supply that benefits traditional bank customers at the expense of credit supply to more untraditional bank investments. Although the overall amount of credit supplied to the economy may stagnate or even decrease under a policy of strict bank insolvency resolution, businesses that traditionally depend on credit may see an increase in their credit provision. Theoretically, it could be argued that this result is due to a reestablishment of incentives in the credit allocation channel. Instead of allocating credit where it finds the highest volatility, e.g., outside the traditional lending business (as a gambling bank would do), banks reallocate credit back to their traditional customers. In addition, they particularly allocate it to firms that need bank credit most and are thus presumably willing to pay interest rates that are not excessively high and volatile, but high enough to allow banks to obtain optimal risk-adjusted positive NPVs from

[15] All of the values used for evaluation of economic significance have been tested individually for their statistical significance by marginal evaluation. They are found to be individually significant at least at the 95% level, in most cases even at the 99% level or above. We consistently apply these additional significance tests to all values used for evaluation in all following tables. It should be noted that we correct for scale endpoints (i.e., we do not go beyond realistic endpoints when computing the values for economic evaluation by limiting values to being ≥ 0 for bank dependence as well as for the catharsis indicator). Differences between this method and not correcting for scale endpoints are very marginal, though, and do not exert a large influence on the computed growth differentials.

[16] One could also run models with triple interactions (which yield similar results), but we decided to report the results of the subsamples for simplicity of interpretation.

Table 5
Transmission channel: Firm growth and bank 'catharsis effect' by firm quality.
This table reports the results from a regression model using Δln(OpRev), the growth in firm operating revenues, as dependent variable and the catharsis indicator interacted with an indicator of firms' bank dependence (evaluated at the industry level) as main explanatory variable. All models include both firm-level and country-level control variables (the latter interacted with bank dependence), in addition to firm and country-year fixed effects. Column (1) displays the results from the reference model. Panel B displays the results from the model run on subsamples containing only firms that continued operations uninterruptedly (column (2)) and firms that went bankrupt (column (3)) over the time horizon of our dataset. Panel C displays the results from the model run on subsamples containing firms in the top tercile of profitability (column (4)) and firms in the bottom tercile of profitability (column (5)); profitability being defined as RoA lagged by one year. The growth rate differential evaluates a measure (in % growth) of the difference in the growth rate between a firm located half a standard deviation above the mean of bank dependence as compared to a firm with a bank dependence measure half a standard deviation below the mean, if located in a country half a standard deviation above the mean of the bank catharsis indicator rather than in a country half a standard deviation below the mean. Robust standard errors are clustered at the firm-level and reported in parentheses, significance levels are indicated by $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Model Dependent variable	(1) Δln(OpRev)	(2) Δln(OpRev)	(3) Δln(OpRev)	(4) Δln(OpRev)	(5) Δln(OpRev)
	Panel A	**Panel B: Split sample**		**Panel C: Split sample**	
	Full sample (reference model)	Active firms	Insolvent firms	High pro-fitability firms	Low pro-fitability firms
Catharsis indicator × bank dependence	0.549***	0.604***	-0.999	0.746**	−0.516
	(0.164)	(0.167)	(0.760)	(0.365)	(0.488)
Firm-level controls	YES	YES	YES	YES	YES
Country-level controls × bank dependence	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
Country-Year FE	YES	YES	YES	YES	YES
Test for equality of coefficients (*p*-value)		0.037		0.011	
Observations	1,252,126	1,179,171	44,540	368,497	314,343
R-Squared	0.432	0.428	0.460	0.653	0.616
Growth rate differential (% of firm growth)	0.6	0.7	N/A	0.9	N/A

their lending. Thus, this result would be a quantity effect not in the sense of increasing overall quantity of credit supply but in the sense of increasing credit supply to firms that need credit most. Consequently, we expect to see an increase in loan financing, not necessarily for companies in general, but particularly for firms that depend more on bank finance.[17]

We use an alternative dependent variable, change of debt ratio, to test this prediction. To analyze the effect of the catharsis indicator on this variable, we run three specifications, and the results are presented in Table 6. In the first specification, we regress the change in debt ratio on the catharsis indicator (still without interaction), the full set of controls, and firm and year fixed effects. The coefficient on the catharsis indicator is small and far from significant. This result is not surprising, because the 'catharsis effect' is generally not expected to increase the usage of bank debt in the real economy. On the contrary: While it may be credited with other beneficial effects, an increase in total credit supply is unlikely to be an outcome of a more rules-based resolution of insolvent banks. Rather, it may decrease credit supply when some banks are liquidated. However, our presumption is not focused on a general increase in the usage of bank debt but on an increase in credit provision to firms that need credit as part of their business model, i.e., firms with high structural bank dependence. We test this presumption in model (2) by including interactions of the country-specific variables, and of the catharsis indicator in particular, with bank dependence. Although the level impact of the catharsis indicator now turns negative, we find a strongly positive and highly significant effect for firms that are more bank dependent. This result is confirmed in model (3), which applies even more stringent country-year and firm fixed effects – a model similar to our reference case above. Taken together, these results provide strong indications that there is not only a quality effect that explains the impact of our catharsis indicator on firm growth but also a quantity effect that leads to an improved channeling of credit to firms that need it most.

5.5. Extension of analyses II – where the 'catharsis effect' does not work

We argued at the beginning of this paper that the direction of the 'catharsis effect' is far from obvious a priori. Although we may conclude that this positive 'catharsis effect' resulting from restored incentives is confirmed by our tests, it would be premature to not take the counterargument into consideration. This counterargument stipulates that the positive effect might be outweighed by the negative effects of individual bank failures. Not investigating what seems to be a valid argument may lead to myopic policy recommendations. Although in general we find an overall positive effect, there may be particular economic conditions in which this is not the case. In this situation, recommending a more rules-based insolvency resolution policy may have no or even detrimental effects. We investigate one such potentially influential condition, i.e., the openness of the banking system and the presence of foreign competitors and foreign credit supply.

The rationale for this characteristic of the banking system to moderate the 'catharsis effect' is straightforward. In an open banking system, banks that are resolved in insolvency can be more easily replaced by competitors, potentially from abroad, on the supply side. Likewise, on the demand side, domestic firms may be able to satisfy their credit demand by borrowing from non-domestic creditors, provided that they really exhibit profitable investment opportunities. Where this is not the case, i.e., in a banking system relatively closed to international entry and competition, resolved banks (or their share of the market) may not be assumed or replaced, and firms with profitable investment opportunities may not have access to alternative creditors. Thus, we propose that an open banking system plays a catalytic role for the 'catharsis effect': It provides the environment for resolution to work more seamlessly as it mitigates its potentially negative impact with regard to shortages in credit supply.

We test this hypothesis by defining access to international finance as a proxy for the openness of the banking system. Access to

[17] To take this further, we suggest that one could also look at bank level data for evidence of this effect, for example via a reshuffling between asset classes on bank balance sheets. We leave this for future research.

Table 6
Transmission channel: Firm finance and bank 'catharsis effect'.
This table reports the results from a regression model using Δdebt/assets, the change in firm debt ratios, as dependent variable and the catharsis indicator (column (1)) or the catharsis indicator, an indicator of firms' bank dependence (evaluated at the industry level), and the interaction between these two variables (columns (2) and (3)) as main explanatory variables. Firm-level and country-level control variables (the latter interacted with bank dependence when country-year fixed effects are included in the model) and firm, year, and country-year fixed effects are included as indicated. Robust standard errors are clustered at the firm-level and reported in parentheses, significance levels are indicated by $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Model Dependent variable	(1) Δdebt/assets	(2) Δdebt/assets	(3) Δdebt/assets
Catharsis indicator	0.00393	−0.126***	
	(0.00433)	(0.0138)	
Catharsis indicator × bank dependence		0.670***	0.709***
		(0.0709)	(0.0840)
Firm-level controls	YES	YES	YES
Country-level controls	YES	YES	NO
Country-level controls × bank dependence	NO	NO	YES
Firm FE	YES	YES	YES
Year FE	YES	YES	NO
Country-Year FE	NO	NO	YES
Observations	957,432	957,367	957,367
R-Squared	0.041	0.042	0.312

international finance is measured by the ratio of loans from non-resident banks and international debt issues (i.e., debt securities issued by residents in non-domestic capital markets) to GDP. As we did above, we split our sample at the terciles of this variable and run our main specification on the subsamples. The results are displayed in Table 7 alongside the reference model. Examining only the subsample with high access to international finance (model (2)), the coefficient on the main interaction more than doubles and is highly significant, which indicates a strong 'catharsis effect' in a relatively open system. However, in a closed system, i.e., the bottom tercile of access to international finance, the coefficient drops close to zero and becomes insignificant. The difference between the coefficients of interest in the two subsamples is highly statistically significant (*p*-value of 0.000). These results indicate that the 'catharsis effect' seems not to be found in the presumably adverse environment of relatively closed banking systems, which highlights an important corollary to be considered in any policy recommendation favoring strict and rules-based insolvency resolution.

6. Robustness

The robustness of the results shown above is tested using various alternative specifications of the variables and several restrictions on the dataset. This section summarizes the robustness test specifications and reports the main results. For brevity, Tables 8 and 9 display only the results of the robustness test for the full specification of the augmented model (interaction approach), including all fixed effects and control variables. Thus, the results of the robustness tests should be compared with the results of model (4) in Table 4, which are also reported as the reference model in Tables 8 and 9. If we expect to find any deviations, we will find them here, and other results are at least as robust as these.

As a first test, we address concerns related to our sample by applying or lifting restrictions on the dataset. There may be concerns that the results are driven by observations from particular countries. We employ two – admittedly arbitrary – sample cuts to

Table 7
Extensions: firm growth and bank sector 'catharsis effect' by access to international finance.
This table reports the results from a regression model using Δln(OpRev), the growth in firm operating revenues, as dependent variable and the catharsis indicator interacted with an indicator of firms' bank dependence (evaluated at the industry level) as main explanatory variable. All models include both firm-level and country-level control variables (the latter interacted with bank dependence), in addition to firm and country-year fixed effects. Column (1) displays the results from the reference model. Panel B displays the results from the model run on subsamples containing only firms located in countries in the top tercile of an indicator for access to international finance (column (2)) and firms located in countries in the bottom tercile of an indicator for access to international finance (column (3)). Access to international finance is defined as (loans from non-resident banks + international debt issues)/GDP. The growth rate differential evaluates a measure (in % growth) of the difference in the growth rate between a firm located half a standard deviation above the mean of bank dependence as compared to a firm with a bank dependence measure half a standard deviation below the mean, if located in a country half a standard deviation above the mean of the bank catharsis indicator rather than in a country half a standard deviation below the mean. Robust standard errors are clustered at the firm-level and reported in parentheses, significance levels are indicated by $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Model Dependent variable	(1) Δln(OpRev)	(2) Δln(OpRev)	(3) Δln(OpRev)
	Panel A Full sample (reference model)	**Panel B: Split sample** High access to international finance	 Low access to international finance
Catharsis indicator × bank dependence	0.549***	1.181***	0.0366
	(0.164)	(0.387)	(0.246)
Firm-level controls	YES	YES	YES
Country-level controls × bank dependence	YES	YES	YES
Firm FE	YES	YES	YES
Country-Year FE	YES	YES	YES
Test for equality of coefficients (*p*-value)		0.000	
Observations	1,252,126	337,343	503,041
R-Squared	0.432	0.530	0.530
Growth rate differential (% of firm growth)	0.6	1.4	N/A

Table 8

Firm growth and bank sector 'catharsis effect' (Robustness tests I: Restricted samples).

This table reports the results from a regression model using Δln(OpRev), the growth in firm operating revenues, as dependent variable and the catharsis indicator interacted with an indicator of firms' bank dependence (evaluated at the industry level) as main explanatory variable. All models include both firm-level and country-level control variables (the latter interacted with bank dependence), in addition to firm and country-year fixed effects. Column (1) displays the results from the reference model. The model in column (2) excludes the three largest countries (DE, FR, UK) from the dataset. The model in column (3) excludes all countries for which fewer than 10,000 observations are available from the dataset. The models in columns (4) and (5) use a sample in which the dependent variable is not trimmed or the explanatory variable is trimmed (at the 1st and 99th percentile), respectively. The growth rate differential evaluates a measure (in % growth) of the difference in the growth rate between a firm located half a standard deviation above the mean of bank dependence as compared to a firm with a bank dependence measure half a standard deviation below the mean, if located in a country half a standard deviation above the mean of the bank catharsis indicator rather than in a country half a standard deviation below the mean. Robust standard errors are clustered at the firm-level and reported in parentheses, significance levels are indicated by $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Model	(1)	(2)	(3)	(4)	(5)
Robustness test	Reference model	Excluding top-3 countries	Excluding countries with few observations	No trimming in dep. variable	Trimming in expl. variable
Dependent variable	Δln(OpRev)	Δln(OpRev)	Δln(OpRev)	Δln(OpRev)	Δln(OpRev)
Catharsis indicator × bank dependence	0.549***	0.573***	0.575***	0.799**	0.597***
	(0.164)	(0.175)	(0.164)	(0.358)	(0.220)
Firm-level controls	YES	YES	YES	YES	YES
Country-level controls × bank dependence	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
Country-Year FE	YES	YES	YES	YES	YES
Observations	1,252,126	890,227	1,221,023	1,272,329	854,737
R-Squared	0.432	0.433	0.429	0.348	0.477
Growth rate differential (% of firm growth)	0.6	0.7	0.7	0.9	0.7

test these concerns. On the upper end, we run our tests on samples that exclude the largest economies (Germany, the United Kingdom, and France). On the lower end, we employ a panel that excludes all countries for which fewer than 10,000 firms are available. In addition, we perform the tests using a sample that is not trimmed from outliers in the dependent variables at the 1st and 99th percentiles. Finally, we trim the main explanatory variable, the bank catharsis indicator, at the 1st and 99th percentiles. Although there cannot be any obviously unrealistic result (below 0% or above 100%) by definition because we are using a matched indicator, we use this trimmed sample as a further robustness check to ensure that the results are not driven by extreme values within this range. All the above samples yield highly significant and economically comparable results for the coefficient of interest. These results are reported in columns (2)–(5) of Table 8.

Second, to check that our results are not driven by the threshold chosen for computing the catharsis indicator, we use alternative thresholds. We compute the catharsis indicator based on a 7% and 9% simple capital ratio (instead of 8% in the reference case). The results are reported in columns (2) and (3) of Table 9 and are close to those of our reference case with respect to their economic and statistical significance.

Table 9

Firm growth and bank sector 'catharsis effect' (Robustness tests II: Variations in variables).

This table reports the results from a regression model using Δln(OpRev), the growth in firm operating revenues, as dependent variable and the catharsis indicator interacted with an indicator of firms' bank dependence (evaluated at the industry level) as main explanatory variable. All models include both firm-level and country-level control variables (the latter interacted with bank dependence), in addition to firm and country-year fixed effects. Column (1) displays the results from the reference model. The models in columns (2) and (3) include catharsis indicators that are computed using alternative capital ratio thresholds (7% and 9%). The model in column (4) excludes mergers and acquisitions of banks falling below the capital ratio threshold from the definition of resolved banks. The models in columns (5) and (6) include catharsis indicators that are computed using yearly averages of the capital ratio or using the reported tier 1 ratio instead. The model in column (7) includes a catharsis indicator that is computed using numbers of banks instead of bank assets. The model in column (8) includes an alternative bank dependence indicator evaluated at the industry classification levels according to U.S. SIC. The growth rate differential evaluates a measure (in % growth) of the difference in the growth rate between a firm located half a standard deviation above the mean of bank dependence as compared to a firm with a bank dependence measure half a standard deviation below the mean, if located in a country half a standard deviation above the mean of the bank catharsis indicator rather than in a country half a standard deviation below the mean. Robust standard errors are clustered at the firm-level and reported in parentheses, significance levels are indicated by $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Robustness test	Reference model	Alternative cutoff (7%)	Alternative cutoff (9%)	Resolution w/o M&A	Avg. capital ratio (8%)	Tier 1 ratio (8%)	Number of banks (8%)	SIC-level bank dep.
Dependent variable	Δln(OpRev)	Δln(OpRev)	Δln(OpRev)	Δln(OpRev)	Δln(OpRev)	Δln(OpRev)	Δln(OpRev)	Δln(OpRev)
Catharsis indicator × bank dependence	0.549***	0.350***	0.631***	0.607***	0.238*	0.301***	1.039***	0.395**
	(0.164)	(0.128)	(0.173)	(0.171)	(0.130)	(0.0619)	(0.0382)	(0.171)
Firm-level controls	YES	YES	YES	YES	YES	YES	YES	YES
Country-level controls × bank dependence	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Country-Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	1,252,126	1,252,126	1,252,126	1,252,126	812,358	1,087,004	1,252,126	1,251,744
R-Squared	0.432	0.432	0.432	0.432	0.476	0.452	0.042	0.432
Growth rate differential (% of firm growth)	0.6	0.5	0.7	0.7	0.4	0.8	1.1	0.4

Third, our results may also be driven by the manner in which the catharsis indicator is defined. To test the robustness of the effect, we use four alternative definitions, varying both the numerator and denominator of the catharsis indicator. Regarding the numerator, we exclude the M&As of banks that fall below the predefined capital ratio threshold from the definition of resolved banks. Alternating the computation of the denominator, we use average values of capital and assets in computing the capital ratio. Additionally, we compute the catharsis indicator based on an entirely different capital ratio definition, i.e., using reported tier 1 ratios instead of simple capital ratios. Finally, we use a catharsis indicator that is computed with numbers of banks instead of bank assets. The results are reported in columns (4)–(7) of Table 9 and all display coefficients that are positive and highly significant.

Fourth, we test an alternative bank dependence index that is computed as the sector average of industries classified according to the U.S. SIC. This provides a less detailed classification (distinguishing only 200 sectors) than NACE-4, which is our reference classification framework. Applying these alternative measures of bank dependence yields a result with comparable economic and statistical significance, which is reported in column (8) of Table 9.

Finally, various specifications are tested, including and excluding the control variables and fixed effects, for example, or with the lagged share of assets replaced by a natural logarithm of assets. The coefficient on the interaction of the bank catharsis indicator remains quantitatively similar and highly significant for all specifications (not reported).

Taken together, the robustness tests suggest that our results are not driven by sample selection or variable definition. Instead, the results prove robust to a range of restricted samples, alternative variables, and alternative specifications.

7. Concluding remarks

In this paper, we analyze the impact of a rules-based bank insolvency resolution policy on economic growth. In particular, we examine a specific insolvency resolution policy – the closure rule at positive capital – and test its effects on individual firm growth.

Economic theory and empirical research demonstrate that financial intermediation generally has a positive effect on the real economy. However, misguided incentives for banks, their creditors, and regulators in connection with bank insolvency and resolution may distort banks' credit allocation and monitoring decisions, which may lead to suboptimal real economic performance. Conversely, theory also postulates that a rules-based prompt resolution policy stipulating purchase and assumption or straightforward closure and liquidation of distressed banks will reestablish the incentive system and provide for economically superior outcomes. However, this result may come at a cost, e.g., when a negative credit supply effect accompanies bank closures. Thus, we test the postulated 'catharsis effect' of regulatory insolvency and closure rules at positive capital with respect to their impact on the real economy.

We assemble a panel dataset of more than 2 million firm-year observations and propose a catharsis indicator that measures how strictly a hypothetical closure rule at positive capital is implemented by essentially forming a ratio between insolvent banks that have been resolved and banks that should have been resolved under the closure rule. We use a three-step identification strategy to overcome potential endogeneity concerns and to establish causality. Beginning with a regression framework that exploits the panel characteristics of our dataset, we also utilize an instrumental variable approach and an interaction specification. In the latter model, we assume that the regulatory insolvency of banks should have a particularly strong effect on firms that are structurally more dependent on bank finance. Thus, any 'catharsis effect' should surface in an interaction with bank dependence, in particular. In all our specifications, we find an economically and statistically significant positive impact of 'catharsis' on firm growth – particularly for firms that depend more on bank financing.

We are convinced that these results show that rules-based insolvency resolutions have a causal effect on firm growth and are not spurious for several reasons. First, our identification strategy helps us overcome potential endogeneity concerns. If we use the interaction specification, we can control for various channels of endogeneity. Even if reverse causation or omitted variables drive a correlation between the growth rates of firms and the strength of bank insolvency resolution, it seems inconceivable that they do so systematically with the level of firms' bank dependence. Second, the robustness of the results is confirmed by testing various alternative specifications, variable definitions, and restrictions on the dataset. Finally, we find not only a significant 'catharsis effect' but also trace evidence for two potential transmission channels from bank insolvency resolution to firm growth. Through the quality channel, the 'catharsis effect' mainly impacts economic growth by exerting a disproportionately positive effect on higher quality (e.g., more profitable) firms because those firms are the beneficiaries of more efficient credit allocation decisions. The quantity channel, moreover, stipulates a (re)allocation of credit that results in an increase in bank debt – particularly for those firms that structurally depend more on bank credit. Thus, these two channels effectively provide a 'smoking gun' that reveals the mechanisms through which the 'catharsis effect' influences real growth.

We also demonstrate that the effectiveness (and potentially even the direction) of the 'catharsis effect' is determined by the regulatory and economic conditions in which it is implemented. One such determinant is the openness of the banking system, which can work as a catalyst to the 'catharsis effect'. The potentially negative consequences of bank closures – ranging from contagion to credit crunches – should be less severe in the mitigating environment of an open banking system in which foreign banks can take over the positions of insolvent competitors and supply credit to viable firms. Our results lend support to this rationale and show that there is a much stronger 'catharsis effect' when access to international finance is high and no such effect when it is low. This finding should guard against premature policy recommendations because there may be circumstances in which the negative effects of bank closures outweigh the generally positive 'catharsis effect'.

This last result underlines one of the weaknesses of our findings insofar as policy recommendations are concerned. First, there are circumstances in which we find that the generally positive 'catharsis effect' does not work. Second, our data indicate that the hypothetical closure rule at positive capital remains – at least thus far – rather hypothetical because we find only low levels of implementation for most countries and years. Although this allows inferences about the effects of the catharsis indicator in the range in which we find it here (roughly between 0% and 50%, skewed toward the lower end), care should be exercised in drawing conclusions about a fully implemented closure rule at positive capital. Although it may exhibit similar effects, it could also be that the documented implementation of the rule is sufficient to discipline banks and restore incentives and that a full implementation would exacerbate the negative effects of bank closures. Further research is required to shed light on the ‘catharsis effect’ under the full implementation of a closure rule at positive capital.

In general, several directions remain for future research concerning (a) the policies and rules of bank insolvency (such as testing the effect of different resolution policies), (b) its mechanisms and transmission channels, and (c) the conditions for the effectiveness of such rules. The ability of future researchers to include credit demand and supply effects in the analysis may also greatly improve our understanding of the ‘catharsis effect’. Notwithstanding this future research, our results strongly advocate for placing bank insolvency and resolution regimes center stage in discussions about reforming bank regulation. Setting up incentive-compatible bank resolution regimes that facilitate the ‘catharsis effect’ should be a focal point of policymakers’ efforts.

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Appendix A.

Table 10
Appendix A – Number of firms by country and year.
This table reports the number of firms in our sample by country and year. Only firms that meet one of the following criteria are included in the sample: (a) total assets of minimum USD 20 million, or (b) total operating revenue of at least USD 10 million, or (c) at least 150 employees. In addition, the sample only contains firms for which the required data is available.

Country	2003	2004	2005	2006	2007	2008	2009	2010
Austria	245	245	2016	3578	4077	4234	3793	3523
Belgium	9473	9473	9730	10,034	11,106	11,275	11,409	10,668
Bosnia and Herzegovina	296	296	333	373	440	654	648	655
Bulgaria	2171	2171	2397	2383	2599	2927	2935	2458
Croatia	1506	1506	1576	1652	1709	1707	1700	1666
Cyprus				54	62	102	103	51
Czech Republic	4917	4917	5537	6003	6661	6952	6797	4913
Denmark					5244	5681	5895	6104
Finland			2980	3168	3694	4351	4476	4077
France	32,299	32,299	33,619	34,832	36,450	36,701	35,056	28,239
Germany	9900	9900	13,699	32,223	45,910	46,972	47,299	17,097
Greece	2802	2802	2947	3070	3246	3336	3351	3220
Hungary	2022	2022	2962	2920	3061	3412	3568	3718
Iceland	193	193	223	257	327	337	349	341
Ireland	1816	1816	1975	2300	2660	2967	2834	1348
Italy	30,319	30,319	38,424	40,297	43,353	45,519	45,384	42,963
Latvia	716	716	788	917	1049	866	777	735
Liechtenstein	31	31	34	37	46	52	57	58
Lithuania			743	816	886	1396	1389	1371
Luxembourg	336	336	423	640	1063	1241	1356	794
Macedonia	33	33	27	24	75	131	262	371
Malta	102	102	114	142	166	185	185	50
Moldova	34	34	34	32	33	41	32	27
Montenegro				42	32	33	39	
Netherlands	10,045	10,045	11,616	14,215	17,446	18,452	19,252	10,932
Norway	6107	6107	6460	6951	11,071	11,658	12,155	12,320
Poland	7790	7790	8230	9013	10,588	11,672	12,319	8630
Portugal	4228	4228	4869	7505	7691	7737	7743	6649
Romania	3509	3509	3774	3508	3680	4566	4835	5028
Russian Federation	22,030	22,030	24,169	28,231	33,420	33,628	32,632	31,981
Serbia	1388	1388	1442	1538	1667	1703	1692	1625
Slovakia	895	895	1078	1416	1610	1385	1249	1116
Slovenia	913	913	958	1002	1082	1116	1135	1140
Spain	29,049	29,049	30,402	32,421	33,551	30,503	30,770	17,939
Sweden	8168	8168	8650	9275	10,111	10,483	10,903	11,075
Switzerland	2323	2323	6295	6630	7653	14,037	15,767	15,175
Turkey			99	285	590	777	769	516
Ukraine	7364	7364	8112	8785	9610	10,000	10,093	9767
United Kingdom	24,107	24,107	25,659	27,656	29,853	30,871	31,547	31,486

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