The Economics of Supranational Bank Supervision*

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Abstract

This paper examines the effectiveness of cooperation among bank supervisors using a novel dataset on supranational agreements among 4,278 country-pairs. Exploiting that globally operating banks are differently covered by these agreements, we show that supervisory cooperation generally improves bank stability. The magnitude of the effect is higher for smaller and less complex banks, and when supervisors are more stringent and have access to higher quality information. We also show that actual supervisory cooperation varies across country-pairs consistent with differences in economic costs and benefits to cooperation. This suggests that cooperation is not always desirable, despite being effective in reducing bank risk.

Keywords: Supranational supervisory cooperation; cross-border banking; externalities

JEL codes: G1, G2.

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1 Introduction

The failure of internationally active financial institutions, such as Lehman Brothers, and cross-border banks, such as Fortis, Dexia or the Icelandic banks, played a prominent role during the Global Financial Crisis. Following the crisis, countries have significantly increased their efforts to cooperate in the supervision of their banks. Perhaps most notably, the Eurozone has now a common supervisor for large banks in the form of the ECB. However, very little is known about whether such cooperation is effective, and overall desirable.

This paper studies supervisory cooperation using hand-collected information on agreements among 4,278 country pairs during the period 1995-2013. The bilateral (and sometimes multilateral) nature of cooperation creates bank-level variation as cross-border banks differ regarding the location of their subsidiaries. We use this setting to show that cooperation is generally effective in improving bank stability – but effectiveness depends critically on the supervisory environment as well characteristics of the supervised bank itself. We also show that supervisory cooperation varies across country pairs consistent with proxies for economic costs and benefits of cooperation. Costs may thus outweigh the benefits for specific country-pairs, implying that more cooperation is not necessarily uniformly desirable. These findings are important not only for policy makers interested in designing financial safety nets, including cross-border components, but also advance our understanding of costs and benefits of (supra-)national decision-making in banking policies.

An important contribution of our paper is the novel data on supervisory cooperation. Such cooperation can take many different forms. Besides a common supervisor, there are more limited types of cooperation, such as agreements on information sharing or joint exercises on crisis prevention and resolution. Figure 1 plots the distribution of cooperation agreements across countries, showing that there is significant variation in the propensity with which individual countries form cooperation agreements. About a third of countries have cooperation agreements with less than 5% of the other countries, while a quarter of countries have agreements with more than 20% of countries.

We first examine the effectiveness of supervisory cooperation. Cooperation, if effective, should improve banking stability.[1] However, supervisors in practice face many

[1]The theoretical impact of (effective) supervision on banking stability is not necessarily a positive

constraints;[2] many of them being compounded in an international setting. Cooperation agreements – even though well intended – may hence not result in higher stability. We investigate the question of cooperation effectiveness exploiting bank-level variation. We construct bank-specific supervisory cooperation indices that measure the degree to which a global bank's parent-subsidiary structure is covered by cross-border supervisory cooperation agreements. These bank-level (supervisory) cooperation indices vary among banks within a (parent) country, facilitating identification. Using panel analysis for a large sample of cross-border banks, we find that a higher incidence of supervisory cooperation is associated with higher bank stability, as measured by the Z-score or the bank's Marginal Expected Shortfall. The effect is economically large. For example, a standard deviation increase in the supervisory cooperation intensity at the bank level improves the bank's Z-score by 24%. Interestingly, we find the association to be concentrated at the smaller institutions in our sample of cross-border banks, and we provide evidence consistent with complexity reducing supervisory effectiveness at the very large banks.

Focusing on the sample of smaller banks, we show that the link between cooperation and bank stability runs through asset risk. This is consistent with the notion that asset risk is difficult to observe and control at arms-length; intensive cooperation and information exchange should hence have a pronounced effect.[3] Next, we employ an instrumental variable approach based on similarities in countries' voting patterns in the U.N. General Assembly. Following Signorino and Ritter (1999) we calculate a bilateral affinity variable that we use as an instrument in the calculation of the cooperation index. The results are robust to the instrumental variable approach, providing us with some confidence that the link between cooperation and bank risk is causal. We also analyze how the characteristics of a country's supervisory and financial system influence the effectiveness of supervision. Among others, we find that effectiveness of cooperation increases both with the stringency of home and host supervision, as well as the quality

one (see, for example, Dell'Ariccia and Marquez (2006), Beck, Todorov and Wagner (2012) and Calzolari, Colliard and Lóránth (2018)), however, most mechanisms suggest a positive effect. For example, cooperation should lead to higher supervisory stringency as supervisors then take into account the cost of bank-failure to other countries. In addition, cooperation also provides supervisors with new information that should result in better decision-making.

[2]Such as limited legal powers, regulatory capture, imperfect information and/or political pressure.

[3]By contrast, bank leverage (which also affects the Z-score) is already well covered by existing (international) regulations, such as capital adequacy standards, and may hence be less affected by cooperation.

of information that is available to supervisors.

The principal effectiveness of cooperation suggests that countries should cooperate in their banking supervision. This seems at odds with our data, which show that many countries have fairly low propensities to cooperate. However, absence of cooperation can be explained by the presence of (economic) costs to cooperation, which vary across countries, sometimes exceeding the gains to cooperation. Economic theory suggests that costs to cooperation (or, more generally, to a centralization of decision-making among independent jurisdictions) arise in the form of heterogeneity between countries, while externalities create the benefits to cooperation.[4] Heterogeneity – which may take the form of different preferences, or differences in economic and institutional structures – simply makes common policies less desirable. Externalities make cooperation more likely; when national decisions affect other countries, decentralized policies will be inefficient. In particular, individual countries may choose supervision levels that are insufficient from a global perspective as they will tend to ignore that the failure of their banks has international spillovers. By taking these spillovers into account, cooperation improves outcomes.

The empirical results suggest that the cooperation pattern observed in the data vary consistently with (net) cooperation gains arising from externalities and heterogeneities. We examine three dimensions of cooperation at the bilateral level: the existence and intensity of cooperation between two countries, as well as the propensity of a given country-pair to move to cooperation. In each case we find a composite proxy for bilateral externalities to be positively related to cooperation: higher externalities make it more likely that countries cooperate, that they cooperate in more intense forms (e.g., have a common supervisor instead of only exchanging information), and they also accelerate cooperation. To the contrary, we find that a composite proxy for bilateral heterogeneities is negatively related to all three dimensions of cooperation.

Our analysis offers several important lessons for policy. First, cooperation improves banking stability but the impact depends critically on institutional characteristics, such as supervisory powers and access to information. Second, the effectiveness of cooperation declines with bank size, possibly reflecting that supervision of more complex

[4]See the literature on optimal currency unions (McKinnon (1963)) or fiscal decentralization (Oates (1972)). For an application to banking, see Dell'Arricia and Marquez (2006) and Beck and Wagner (2016).

institutions is more difficult. Third, a uniform global push towards more coordination of banking supervision – even though it is expected to improve banking stability — may not necessarily be optimal as the (net) gains from cooperation differ across countries, and actual agreements may already reflect this. Policy makers, in their effort to improve the international financial architecture, should be aware of cross-country differences in cooperation gains.

This paper relates to a small but rapidly expanding literature on cross-border cooperation between bank regulators and supervisors– which up to now has been almost exclusively of theoretical nature. First, several papers have analyzed the design of the financial safety net in the presence of cross-border banks. Dell'Arricia and Marquez (2006) show that competition between national regulators can lower capital adequacy standards, since national regulators do not take into account the external benefits of higher capital adequacy standards in terms of higher stability in other countries. Dell'Arricia and Marquez (2006) also show that cooperation is more desirable when external benefits are higher, and when the preferences of regulators are homogenous. Our analysis of actual cooperation can be viewed as a test of their theory, as applied to supervision. Acharya (2003) argues that coordinating capital adequacy ratios across countries without coordinating on other dimensions of the regulatory framework, such as resolution policies, can have detrimental effects for stability. Loranth and Morrison (2007) discuss the implications of capital requirements and deposit insurance for cross-border banks and show that capital requirements set at a level to offset the safety net subsidy of deposit insurance result in too little risk-taking in the case of multinational banks. Freixas (2003) and Goodhart and Schoenmaker (2009) show that relying on ex-post arrangements for the recapitalization of failing cross-border banks leads to underprovision of resources; ex-ante burden sharing agreements are needed to overcome coordination problems between supervisors. Our paper generally relates to this literature by providing evidence that when distortions from uncoordinated domestic policies are high (because of externalities), countries are more likely to implement supranational solutions.

Second, several papers have discussed the incentives of national supervisors vis-a-vis cross-border banks and possible cross-border cooperation forms. Niepmann and Schmidt-Eisenlohr (2013) show that decisions of national governments on recapitaliz-

ing failing banks are inefficient if banking systems are linked through interbank markets. Calzolari and Loranth (2011) show that organization of foreign presence through branches leads to higher incentives to intervene as the home country regulator can draw on all assets. At the same time, it can reduce intervention incentives if the regulator is responsible for repaying all deposits, including in foreign branches. Beck, Todorov and Wagner (2013) analyze interventions into banks during the Global Financial Crisis, showing that cross-border linkages lead to distortions in national decisions, consistent with the presence of externalities. Carletti, Dell'Ariccia, and Marquez (2016) examine the interaction between centralized supervision, and information collection by local regulators. Calzolari, Colliard and Loranth (2018) show that there is a coordination problem among national supervisors, and that hence supranational supervisors can implement more efficient monitoring. Our paper contributes to this literature by showing that cross-border supervisory cooperation can be effective in increasing bank stability, but is not necessarily optimal for all country pairs.

Finally, this paper also relates to the literature examining the effects of the regulation of multinational banks. These papers have shown that higher capital requirements for multinational banks are associated with a reduction in both cross-border credit (e.g., Aiyar et al. (2014a), Forbes et al. (2017)) and domestic credit (Aiyar et al. (2014b)). Ongena et al. (2013) also show that tighter regulation in home countries lowers lending standards in subsidiaries, increasing lending to riskier firms. We contribute to this literature by examining whether cooperation between host and home countries affects bank stability. More broadly, our paper relates to debates in other areas of financial sector regulation, including international standards such as Basel and cooperation between securities market supervisors (Silvers, 2019). We regard both as complementary to our focus on supervisory cooperation in banking.

Before proceeding, we would like to state an important caveat: Whereas our hand-collected data provide novel and rich information about supervisory arrangements around the world, it surely comes with measurement errors, especially in terms of the intensity of cooperation. We nevertheless regard our analysis as an important first step to analyze cross-border supervisory cooperation.

The remainder of the paper is structured as follows. The next section describes our cooperation data. Section 3 uses bank-level analysis to examine the relationship

between supervisory cooperation and stability. Section 4 contains the analysis of the determinants of cooperation agreements. Section 5 concludes.

2 Cooperation data

We have hand-collected data on supervisory cooperation at the country-pair level. The information was gathered from the supervisory bodies' websites and official documents available online. Because of data availability, we focus our search on countries in Europe, the Americas, Africa, and the Trans-Tasman Union. Within these regions, we search the countries that are covered in the database of Claessens and Van Horen (2014). We look for agreements that have been signed up and until 2013. Our final sample comprises 4,278 country pairs (involving 93 countries), covering the years from 1995 until 2013.

Supervisory cooperation can take many different forms. Based on guidelines of the Basel committee, we distinguish four (and increasingly intensive) forms of cooperation: a Memorandum of Understanding for information sharing and on-site inspection, a College of Supervisors, a Memorandum of Understanding on crisis management and resolution and a supranational supervisor (more information on these agreements is provided in Appendix A). We first construct a dummy variable *Cooperation* indicating that any form of the four levels of cooperation is present. If we do not find any information about agreements for a given country pair, we assume that no cooperation exists (this is the case for 880 country pairs; in a robustness test we exclude such cases). Second, we construct an ordinal variable, *Cooperation intensity*, which ranges from zero to four (zero referring to no cooperation being present, while four referring to the existence of a supranational regulator). If a country pair has signed several agreements that correspond to different levels of cooperation intensity, we code this variable with the highest level.

By the last year of our sample period (2013), 522 country pairs have signed a cooperation agreement (about 12% of all possible pairs). Of the country pairs that have signed an agreement, 70% are part of a multilateral arrangement and 58% are part of a bilateral agreements (some country pairs have both types of agreements in place). Out of the 522 cooperation agreements signed, we have information about the type of the

agreement for 441 country pairs, 142 of which have a Memorandum of Understanding for information sharing and on-site inspection, 220 of which have a College of Supervisors, 51 of which have a Memorandum of Understanding on crisis management and resolution, and 28 of which have a supranational supervisor.[5] There is significant variation across countries in terms of the number of agreements signed, as shown in Figure 1. This figure shows the fraction of other countries a country cooperates with by the end of 2013 (see Appendix B for the underlying data). Many countries, most of them from Africa, have not signed any agreement, whereas some other countries, mostly in Europe, actively cooperate internationally with respect to joint supervision. For example, Germany and France have agreements with 40% and 38% of the other countries, respectively. Figure 2 depicts the evolution of the outstanding cooperation agreements in each region. Most of the agreements were signed after 2000. In addition, Europe has, for all the years considered, the largest number of outstanding agreements. As can be seen in the figure, there has been a steady increase in cross-border arrangements in both Latin America and the European Union, with a jump in 2007 and 2009, respectively. In Africa, on the other hand, the evidence points at cross-border cooperation only starting in 2009, but then rapidly increasing over the past years.

3 Effectiveness of cooperation

In this section we study whether supervisory cooperation is effective. Based on our country-pair cooperation data we construct bank-specific indices of supervisory cooperation. These indices measure the extent to which the parent-subsidiary structure of a cross-border bank is covered by supervisory cooperation. We then relate these indices of supervisory cooperation to different proxies of bank risk and stability.

3.1 Data and methodology

To construct bank-level cooperation indices, we require information on the (foreign) subsidiaries of cross-border banks. For this we match the subsidiaries in the Claessens

[5]This includes the West African Monetary Union, but not the Eurozone (the Single Supervisory Mechanism became only effective in 2014).

and Van Horen (2014) database with their parents.[6] As the database contains information on the country of the owner of a subsidiary (but not the actual parent bank), we hand-collect information on ownership (defined as majority ownership) from annual reports, banks' and regulators' websites, and newspaper articles. We restrict ourselves to subsidiaries of parent countries in our cooperation database. We match with Bankscope (using consolidated data for the parents and the unconsolidated for the subsidiaries) to obtain balance sheet variables. We also include macroeconomic data from the World Bank database to construct country-level controls. The final sample comprises 197 parent banks in 52 home countries and 116 host countries[7], between 1995 and 2013. The subsidiaries of these parent banks span 424 home-host country-pairs.

Our regressions take the following form

$$y_{b,j,t} = \beta_1 Cooperation_{b,t} + \beta_2 X_{b,t} + \beta_3 Z_{j,t} + \gamma_b + \delta_t + \epsilon_{b,j,t}, \tag{1}$$

where y is a measure of the stability of parent bank b in country j in year t. The variable of interest, *Cooperation*, is the share of host supervisors (i.e., supervisors of the parent bank's subsidiaries) with whom the home (parent-bank) supervisor has a cooperation agreement. To calculate the share we weigh by the importance of each subsidiary, measured as the subsidiary's share in the parent bank's total foreign assets. X is a set of bank-level control variables and Z a set of home country control variables. For the bank-level variables we include the *Log(assets)* as size indicator, the ratio of foreign to total assets to measure the importance of foreign operations for the parent bank *Foreign TA/TA*, *Liabilities/TA* as an (inverse) measure of bank capitalization, *Loan loss provisions over total loans* as indicator of lending quality, and *Non-interest income to total income* to proxy for the business model. This follows the literature that has explored the relationship between bank characteristics and bank stability (see, e.g., Anginer et al. (2014), Brunnermeier et al., (2012)). We also include the home country's *Log(GDP per capita)*, the volatility of GDP growth (measured over a five-year rolling window), *Vol(GDP growth)* and its trade openness, measured as exports plus imports, relative to GDP, *Trade/GDP*. Furthermore, we include bank and year fixed

[6]The Claessens and Van Horen (2014) data accounts for more than 90 percent of the assets of the banking systems in 139 countries.

[7]We also collected additional cooperation data for host-countries that were not in our original dataset, resulting in a higher number of such countries.

effects γ_b and δ_t, so that β_1 captures the relationship between supervisory cooperation and a bank's stability relative to the bank's average stability over the sample period. Year fixed effects control for global trends in bank stability that might co-vary with cooperation agreements. We report robust standard errors clustered at the bank level in all regressions.

In our main analysis, we use the natural logarithm of the Z-score (as in e.g. Houston et al. (2010), Demirguc-Kunt and Huizinga (2010), Laeven et al. (2009), and many others) as a measure of bank stability. The Z-score measures the distance from insolvency (Roy (1952)) and is calculated as

$$Z_{b,t} = \frac{ROA_{b,t} + E/A_{b,t}}{\sigma(ROA)_{b,t}}, \tag{2}$$

where ROA is return on assets, E/A denotes the equity to asset ratio and $\sigma(ROA)$ is the standard deviation of return on assets. We use a three-year rolling time window to compute the standard deviation of ROA (rather than the full sample period) to allow for time variation in the denominator of the Z-score. In separate regressions, we also split the Z-score into the numerator and denominator. In a further robustness test, we use the Marginal Expected Shortfall (MES) (Acharya et al. (2017)), which measures a bank's average return when the market experiences stress, thus capturing systemic risk exposure. We follow common practice and compute the MES for each bank-year observation by looking at the average daily stock return of the bank on days where the country's local banking sector index (MSCI banking sector index) experiences one of its 5% lowest returns. Doing so, the MES of bank b in year t corresponds to bank b's expected equity loss per dollar in year t conditional on the local banking sector experiencing severe stress. We take the negative value of this measure for ease of interpretation.

Table 1 presents the descriptive statistics for our sample of cross-border banks. The natural log of the Z-score varies between -7.44 and 12.3. The MES varies between -0.016 and 0.134. The weighted supervisory cooperation index varies between 0 and 1, with a mean of 0.6. This implies that in 60% of home-host relationships in our sample (weighted by subsidiaries' assets) there was a cooperation agreement in place. The standard deviation of the cooperation index is 0.445, indicating that there is substantial variation in the extent to which the foreign subsidiaries of different banks are covered

by supervisory cooperation. A full description of these variables and their sources are given in Appendix C.

3.2 Evidence

Table 2 shows that higher cooperation between a bank's home and host supervisors is associated with lower bank risk, as measured by a higher distance from default of the consolidated bank. We regress (annual) Z-scores for the 197 cross-border banks on their cooperation index and a series of bank- and country-level control variables. The cooperation index enters positively and significantly in both columns (1) and (2). The coefficient estimate of 0.54 in both columns suggests that a one standard deviation increase in cooperation (0.445) is associated with a 24% increase in distance from default of the consolidated bank, thus a meaningful economic effect. Among the control variables, we find that larger banks have higher Z-scores and that less capitalized banks have lower Z-scores. Banks with higher loan loss provisions as share of total loans have lower Z-scores, while banks with a higher fraction of non-interest income have higher Z-scores. In column (2), where we include several home country variables that might co-vary with cooperation, we find that banks in richer and more open (to trade) home countries have higher Z-scores.[8]

The results in columns (3) and (4) show that our findings are driven by the smaller banks in our sample. Higher complexity and their too-big-to-fail status may make supervisory cooperation less effective at large banks. We therefore split the sample at the 50th percentile according to total assets and find that cooperation only enters positively in the sample of small banks (column 4).[9] The coefficient estimate for small banks (1.19) is more than twice as high as the corresponding coefficient in the entire sample, suggesting fairly effective supervision at small banks (a standard deviation increase in cooperation now increases the Z-score by 53%). Given that there is only a positive and significant relationship for smaller banks, we focus in the following on the subset of these banks.

[8]One of our control variables, liabilities/total assets, captures also bank risk as reflected in the dependent variable (the Z-score). We thus re-estimate the model excluding liabilities/total assets. The results are unchanged.

[9]In (unreported) results we alternatively split the sample according to the (median) number of subsidiaries and find that cooperation is only effective for the banks with a low number of subsidiaries. This points at the ineffectiveness of cooperation at large banks being caused by complexity, rather than size.

The results in columns (5) and (6) show that our findings are driven by (small) banks with a high share of foreign assets. The importance of cross-border supervisory cooperation for bank stability should matter more for banks with a higher share of assets in foreign subsidiaries, and banks in fact vary considerably along this dimension (the share of foreign subsidiaries ranges from 0.005 to 0.942). We therefore split the sample according to the median of total foreign assets in total assets. In columns (5) and (6) the cooperation variables enter positively and significantly only in the sample of small banks with above-median ratio of foreign in total assets.

Finally, the results in columns (7) and (8) show that our findings are driven by higher cooperation resulting in lower profit volatility rather than higher capital or profitability. In principle, banks can decide to become riskier along two dimensions. First, they can engage in riskier activities, increasing the variance of returns and thus increasing the likelihood of default. Alternatively, they can increase leverage or take on less profitable activities, which reduces the buffer they have before they reach default. We would expect supervisory cooperation to be mainly operative along the first dimension. This is because asset risk is more difficult to observe and control at arms-length; intensive cooperation and information exchange should hence have a pronounced effect. The second dimension, by contrast, is already well covered by existing (international) regulations, such as capital adequacy standards; we would hence expect the (incremental) effect of supervisory cooperation to be more limited. We split the Z-score into the numerator (capital-equity ratio and ROA) and the denominator (standard deviation of ROA over a rolling three-year window). While cooperation does not enter significantly in the regression of capital-asset-ratio and ROA, it enters negatively and significantly in the regression of profit volatility.

3.2.1 Robustness tests

The results in Table 3 confirm our main (small bank) findings using four robustness tests. To start with, we employ an instrumental variable approach to address concerns about endogeneity of the bank-level cooperation index. First, supervisory cooperation itself may be endogenous, for example, because the benefits from cooperation increase with cross-border linkages. Second, the subsidiary structure may be dependent on cooperation, for example, cooperation may lead to retrenchment and a reduction in

assets in subsidiary countries with whom the home country cooperates (as suggested by the theory in Calzolari, Colliard, Loranth (2018)). We thus construct an instrumental variable based on two components.

First, we estimate cooperation propensities at the *country-pair* level. Specifically, we exploit the fact that higher political affinity is related to lower country pair heterogeneity. We make use of an affinity measure widely used in the political science literature (e.g., Signorino and Ritter (1999)), where affinity is defined as the similarity in voting patterns in the U.N. General Assembly. For this, we obtain data on countries' roll call votes in the U.N. General Assembly during our sample period from Voeten (2013). For country pair (i, j) in year t, affinity S is measured as follows

$$S_{i,j,t} = 1 - \frac{\sum_{r=1}^{R} \left| V_r^i - V_r^j \right|}{R}, \tag{3}$$

where R is the number of resolutions and V_r^i and V_r^j, are the votes of each country in each resolution in that year. Following the literature, we code $V = 1$ if the country voted "Yes", $V = 0$ if the country "Abstain", and $V = -1$ if the country voted "No". The measure varies between -1 and 1, where higher values indicate greater affinity.

This approach has been applied in previous literature to measure similarity in preferences among states (e.g. Andersen, Harr, and Tarp, (2006) and Garmaise and Natividad, (2013)). Similiarity in preferences (at the country-pair level in our context) is expected to increase the probability of supervisory cooperation.[10] As (individual) banks are unlikely to influence diplomatic decisions of countries, reverse causality should not be a concern in this context. Further, it is unlikely that bilateral political preferences are related to (unobserved) bank-level characteristics. Thus, bilateral variation in voting patterns are expected to be exogenous to bank soundness. We thus exploit variations in bilateral affinity to obtain (predicted) cooperation intensities. Specifically, we run a duration model of cooperation[11] on lagged political affinity for all country-pairs in our sample over the entire sample period, and obtain (time-varying) estimated probabilities from the model. The results (unreported) confirms that political affinity predicts

[10] Specifically, Dell'Ariccia and Marquez (2006) show gains to cooperation increase when regulators have more homogenous preferences. Outside banking, preference similarities have been identified as the main determinant of fiscal centralization (see Oates (1972)).

[11] As we explain in more detail in Section 4.2.2., duration analysis is appropriate in our setting (while a normal panel analysis is not) due to the specific time-structure of the dependent variable (in particular, countries never move from cooperation to no cooperation).

cooperation (the affinity coefficient is positive and significant at the 1% level).

In a second step, we calculate *bank-specific* instruments from the country-pair cooperation propensities using the subsidiary structure at the beginning of the sample period (in case a subsidiary was formed during the sample period, this implies that the subsidiary receives a weight of zero, thus effectively dropping it from the analysis). By using only subsidiary information at the beginning of the sample period, we exclude any variations in subsidiary structure that occur due to changes in cooperation during the sample period (and our bank-fixed effects absorb the time-invariant component of the subsidiary structure). The first stage regression of the IV is reported in column (1), showing a strong positive and significant relationship between the predicted cooperation and actual cooperation. The second-stage results reported in column (2) confirm our previous finding of a positive relationship between supervisory cross-border cooperation and bank stability: the estimated coefficient is positive and significant (p-value equals 5.2%). The higher coefficient compared to the corresponding OLS coefficient in Table 2 indicates the presence of reverse causation (as higher bank fragility may increases the likelihood of cooperation).

A second robustness test, reported in column (3), uses the Marginal Expected Shortfall (MES) as alternative stability measure. The MES offers two potential advantages over the Z-score. First, it is based on market prices, and thus captures different information than balance-sheet based measures. Second, as a measure of systemic risk it relates more closely to policy makers' objectives of maintaining financial stability.[12] A disadvantage is that this measure can only be calculated for listed banks, reducing our sample by two thirds. The results in column (3) confirm our previous findings, showing a negative and significant coefficient for the supervisory cooperation index. This suggests that systemic risk exposure of the parent bank is lowered as cross-border cooperation increases.

As a third test, we examine whether effectiveness is reduced (or even disappears) during crisis times. We add an interaction term between cooperation and a dummy for the GFC (column 4). While cooperation continues to enter positively and significantly, its interaction with the crisis dummy enters positively and insignificantly. This suggests that supervisory cooperation is not weakened during crisis periods.

[12]In the case of small banks, systemic risk arises due correlated failures (Acharya and Yorulmazer (2007) and Gong and Wagner (2019)).

As final robustness test, we examine the presence of non-linearities in the relationship between supervisory cooperation and bank stability by adding the square of the cooperation index (column 5). Cooperation may arguably only become effective once it covers a wide part of the bank's subsidiaries (as long as there are some subsidiaries not covered by cooperation, the bank can always shift risk there), suggesting that the effectiveness of cooperation increases with the level of cooperation. The squared term is positive and marginally significant (p-value 0.11), indicating that there may be increasing returns to supervisory cooperation.

3.2.2 Effectiveness and regulation

The results in Table 4 show that the effectiveness of supervisory cooperation is a function of the regulatory framework of home and host countries. Here we interact the cooperation index with a number of regulatory indicators. Regulatory data is obtained from Barth, Capri and Levine (1999, 2003, 2007, and 2011). Effective supervisory cooperation requires that supervisors can act swiftly if needed. We would expect both the home and host supervisor's stringency to matter, as interventions may require actions in either the parent or the subsidiary. In column (1) we find that both coefficients on the interaction terms of the cooperation index with supervisory stringency are positive and significant. The relationship is stronger for the home supervisor, which may reflect that effective supervision at the parent bank level is more important as it applies to a larger part of the bank's operation and also because it is more complex than supervising a single subsidiary.

The results in column (2) suggest that the positive relationship between supervisory cooperation and bank stability is more than twice as high if financial statements (at either parent or subsidiary level) have to be audited by a licensed or certified external auditor. Effective supervision relies on credible information that can be exchanged with other parties, thus we would expect the quality of information availability to improve supervision. The interaction term between cooperation and the external audit dummy for both home and host country enters positively and significantly. Their coefficients are of similar magnitude and are more than twice as large as the one for the cooperation variable.

The results in column (3) suggest that supervisory cooperation has a stronger rela-

tionship with bank stability if there are fewer limits on foreign bank entry in the host countries. When foreign bank entry is easier, we would expect there to be more foreign banks in the subsidiary country. Given a higher importance of foreign activities, the supervisor may thus focus more on such activities, increasing effectiveness. While a similar argument also applies to home country supervision, we may expect the relationship to be weaker as for the home country (with possibly many parent banks) the presence of subsidiaries from other countries may matter less for overall financial stability. The results in column (3) are consistent with this, suggesting that supervisory cooperation has a stronger relationship with bank stability if there are fewer limitations on foreign bank entry in the host countries, whereas there is no relationship for the home country.

In summary, the results in this section provide evidence that supervisory cooperation between home and host countries has a positive relationship with bank stability. While we cannot provide conclusive evidence that this is a causal relationship, our regression set-up (exploiting within-bank and -year variation), our sample splits, our instrumental variable approach, and the fact that cooperation effectiveness varies with measures of the regulatory framework in a manner consistent with expectations, provides us with some comfort about the validity of our findings.

4 Determinants of cooperation

The previous section has shown that cooperation is effective in improving bank stability. However, this does not necessarily imply that countries should cooperate as there are also costs to cooperation. Cooperation is only optimal for a country-pair when their gains from cooperation outweigh the costs. In this section we examine whether actual cooperation across country-pairs can be explained by differences in benefits and costs, as suggested by the externality-heterogeneity trade-off.[13]

[13]To be sure, even if this is the case, this does not imply that the cooperation is a direct consequence of the benefits and costs. For example, cooperation may also be the result of a wider process of financial integration, which in turn is linked to net benefits (the Eurozone is a point in case here). Our analysis does not speak to how cooperation is actually brought about; we only examine whether the ultimate outcome is consistent with net benefits to cooperation.

4.1 Data and methodology

We first describe our empirical measures of cooperation benefits and costs, arising from externalities and heterogeneities.[14] A full description of the variables and their sources is given in Appendix C.

Externalities (of cross-border nature) increase the benefits from supranational cooperation as individual country supervisors will fail to take effects outside their regulatory perimeter into account. Cross-border externalities most directly arise from international activities of financial institutions. For example, the failure of a bank that has foreign assets will incur costs abroad, among others by leading to lower credit availability to foreign firms and losses imposed on depositors (or taxpayers). Such costs will not be taken into account by a domestic supervisor, leading to inefficient decisions.[15] A case in point is Iceland (which from the perspective of the Icelandic supervisor had substantial foreign assets and deposits) where it can be argued that supervisors had insufficient incentives to control bank risk. As a first proxy we hence compute the share of the assets of banks from country j operating in country i and vice versa. We take the average of the two shares to construct a country-pair measure of cross border activity, *Avg. foreign share*. This measure directly captures the cross-border externalities arising from the failures of banks in one country on financial stability of the pair's other country. Contagion effects are arguably intensified in the presence of systemically important banks. We thus include as a second proxy a dummy variable *G-SIB* that indicates whether both countries share a common Global Systemically Important Bank, identified by the Financial Stability Board in their 2013 update.

In a financially integrated world, there are various other channels through which a shock arising from the failure of one bank can spill over to other countries. This includes fire-sale externalities (e.g., Stein (2009)), informational contagion or panics. For such effects to materialize, no direct cross-border links have to exist between two banking systems as these spillovers can arise through capital markets. We expect such

[14] Dell'Arricia and Marquez (2006) and Beck and Wagner (2016) provide the theoretical background for how cross-border externalities and country heterogeneity affect supervisory and regulatory cooperation. They show that the gains from delegating decisions to a supranational agency i) increase in cross-border externalities, and ii) decrease in preference heterogeneity across countries.

[15] Beck, Todorov and Wagner (2013) analyse interventions in cross-border banks during the crisis of 2007-2009 and show that they are distorted in the presence of foreign operations. In particular, regulators intervene at a later stage (that is, when bank health has already deteriorated significantly) when a bank has more foreign investments and debt funding.

spillovers to be more pronounced when countries have integrated capital markets. We thus employ as a proxy the average *Correlation* between country *i's* and *j's* stock market index when each country's index experiences the 5% lowest returns (we use the Datastream index to proxy a country's stock market; when this is not available we use the MSCI Market Index). By conditioning correlations on the left tail, we capture that fire-sale externalities materialize in bad states.

Externalities are also more pronounced in a monetary union. First, in a monetary union it is more difficult for governments to deal with spillovers from other countries. As the fiscal capacity of sovereigns is more limited (they cannot print their own money), it is more difficult to backstop troubled banks, resulting in more failures and higher costs. This mechanism was at play during the European Sovereign Debt Crisis. Second, the presence of a common lender of last resort in a monetary union might result in a tragedy of commons problem, as it is in the interest of every member government to share the burden arising from troubles at its own banks with the other members. We capture higher costs of cross-border spill-overs in the presence of a common currency (or fixed exchange rates) by including a dummy variable *Currency* that indicates whether country i and country j have the same currency or their currency is fixed with respect to the other. We expect higher benefits from supranational cooperation when this dummy takes the value of one. A point in case is the Eurozone, where it has been argued that the presence of a monetary union has increased the need for having a banking union as well.

In our empirical analysis, we use the four proxies separately but also construct an index. We calculate the index from the average of the four externality measures (in case of a missing input, this input is dropped from the calculation of the average), where each measure is normalized to lie between zero and one. Figure 3a shows the development of the (averaged) index during the sample period; we can see a clear increase in cross-border externalities over time.

We next discuss our measures for costs of integration arising due to *heterogeneity*. If countries were identical ex-ante, they would agree on the type of supranational supervision they want to implement (and the implementation would not be particularly burdensome). However, countries differ in practice along various dimensions. This increases the cost of cooperation, in particular as common policies may then not be

optimal for either country (or both of them).

First, we include the preference affinity measure introduced in the previous section. Since cooperation typically comes with uniform standards, it is less desirable for countries that disagree. Specifically, the costs to cooperation have been shown to be higher when regulators have different preferences (Dell'Ariccia and Marquez (2006)) and when countries perceive different costs to letting banks fail (Beck and Wagner (2016)). Similarly, gains from centralized decision-making are also lower when countries differ in their fiscal preferences (Oates (1972)), which in our context may take the form of differences in the willingness to use public founds to bail out banks. We construct a preference heterogeneity measure *Preferences*, which is defined as the affinity measure times -1 and normalized to the range $[0, 1]$.

Heterogeneity can also result from incentive asymmetries. Such asymmetries arise when the importance of the foreign country's subsidiaries in the host banking system is large compared to the importance of these subsidiaries in the home country's banking system. We hence also include a proxy for the asymmetry with respect to cross border activity. For this, we consider the difference between the banks' foreign assets of one country in the other over the total assets of the other country banking system and over the total assets of the country banking system, and vice versa and compute the absolute value of the average.

Similar to preferences, we conjecture that differences in geographic, institutional, and linguistic proximity makes cooperation more costly as they increase differences in failure and resolution costs. We capture this with several variables. First, we include the country's *Legal origin*, indicating whether legal tradition of a given country is English, French, German, Socialist or Scandinavian (LaPorta et al. (2008)). We also consider the *Language* spoken in the country. Finally, we include each country's *Latitude* and *Longitude*. We construct differences in these variables for each country-pair.

Furthermore, countries may also differ in their ability to address bank failures swiftly. The literature has shown that rapid and decisive political action during systemic banking distress relies on fiscal space. We therefore include the difference between countries' *Government Debt/GDP* ratio as an (inverse) measure of fiscal capacity. Finally, we expect countries with different levels of economic development to face differences in the cost of bank failure, given the different role of banks in these economies. We therefore

include the difference in gross domestic product divided by population, *GDP per capita*.

Similar to the externality index, we can construct a *heterogeneity index* from the average of the (non-missing) normalized individual heterogeneity measures. Figure 3b shows the average heterogeneity between country pairs over time. Unlike in the case of externalities, we do not see a clear time trend. A possible reason for the persistence of the heterogeneity index is that many of the variables are time-invariant. Figure 3c depicts next the heterogeneity index including only time-varying variables. There is now significant variation over the 20 years of our sample – but still no clear time trend.

4.2 Evidence

In this section we examine whether actual cooperation agreements are consistent with our measures of economic benefits and costs. We present first a cross-sectional analysis of the existence of cooperation agreements. Following this, we explore the time dimension employing duration analysis. Finally, we use a sub-sample to study the intensity of supervisory cooperation.

4.2.1 Cross-sectional analysis

We examine whether higher externalities between two countries increase the probability that there is a supervisory cooperation agreement among them, and whether higher heterogeneity reduces this probability. We carry out a logit analysis at the country-pair level. We estimate this model with two-way clustering at each country of the pair.[16] We do not include country fixed effects in the main model to avoid biases arising from the incidental parameters problem in non-linear panel data models with fixed effects (Neyman and Scott (1948)). Table 5 shows the descriptive statistics for our externality and heterogeneity variables for the cross-sectional sample in 2013. We see considerable variation across country pairs in externality and heterogeneity that we will exploit in the following regression analysis. Table 6 contains the results for logit analysis for the last year of our sample (2013), showing the marginal effects.

The results in Table 6 provide evidence for the importance of externalities and heterogeneity in explaining the likelihood of countries cooperating in bank supervision.

[16]This controls for the possibility that a country's propensity to cooperate is correlated across potential cooperation target countries (e.g., a high propensity of country A to cooperate may show up in both cooperation with B and cooperation with C).

Column (1) shows that the externality index enters positively and significantly while the index of heterogeneity between two countries enters negatively and significantly. This is consistent with theory in that externalities increase the benefits from cooperation, while heterogeneity reduces it. The effects are economically significant. One standard deviation increase in the externality index increases the probability of cooperation by 9 percentage points, whereas one standard deviation increase in the heterogeneity index decreases the probability of cooperation by 6 percentage points (recall that the average propensity to cooperate is 12% in the sample). It is often implied that supranational cooperation is largely an outcome of political considerations and other non-economic constraints, such as legal factors. Our analysis, in contrast, suggests that economic factors are highly relevant for determining cooperation. The higher importance of externalities relative to heterogeneities (in terms of economic significance) is also noteworthy. It suggests that the economic gains from cooperation are a more important factor for countries when determine whether or not to cooperate, rather than frictions stemming from country differences.

Column (2) shows that all four dimensions of externalities matter individually; each of them is significantly and positively related with the probability of having a supervisory agreement; i.e., country pairs with higher cross-border activities, country pairs that share a G-SIB and either a common currency or a fixed exchange rate, and country pairs with a higher stock market correlation are more likely to have a supervisory cooperation agreement. The results in this column also show that some but not all dimensions of our heterogeneity measure are significantly correlated with the probability of a supervisory cooperation agreement. Specifically, country pairs that have different preferences, have assymmetric bank linkages, and are more distant from each other are less likely to have a supervisory cooperation agreement as do country pairs that do not share the same language. Informed by the results of column (2), we re-estimate the model in column (1) using for the construction of the heterogeneity index only those subcomponents that enter significantly. The results remain unchanged, both measures display the correct sign and are significant at 1% (results available on request).[17]

[17]It should be noted that the indices are generally not very sensitive to their construction. We have calculated correlations between the full index and indices that exclude a (random permutation) of variables. For the externality measure, the (mean) correlations when excluding one and two variables are 0.9 and 0.76. The correlations for the heterogeneity index are 0.97 and 0.80 when excluding one and five variables. This suggests that there is a strong common component in each index.

We consider several variations of the baseline model to examine robustness. First, we include fixed effects for each country in the pair to account for potential time invariant unobserved heterogeneity at each country level. The results of this model in column (3) show that both variables remain significant and with the expected sign (we estimate a linear model to avoid the incidental parameter problem in this regression). Second, we estimate our model using principal component indicators for externality and heterogeneity (column 4). While we lose two thirds of our sample (given that we now need all externality and heterogeneity variables to be available), both variables remain significant and with the expected sign.

Third, we restrict our sample to only include those countries that have published an exhaustive list of international cooperation agreements or on country-pairs for which there is explicit information whether or not an agreement is present. In other words, we do not assume that country-pairs did not engage in an agreement when we do not find any information on an agreement, but rather treat these country-pair observations as missing. In this model, reported in column (5), both coefficients remain significant at the 1% level. We also note that in each case the (absolute) value of the estimated coefficients increases, confirming the idea that there is some measurement error in the baseline sample.

Fourth, we limit our sample to bilateral agreements. It can be argued that for multilateral arrangements, also the characteristics of the other countries that join the agreement will determine the cooperation. The results in column (6) show that both indices remain highly significant and with the expected sign.

Fifth, we control for trade links. One possible bias arises from omitted variables that are correlated both with our externality and heterogeneity measures, and the propensity to cooperate. Two such variables may be bilateral trade and trade agreements between the two countries. We control for these variables in column (7) of Table 6, using the sum of imports and exports between the two countries relative to their combined GDP and a dummy variable that indicates whether a preferential trade agreement exists between the two countries. Bilateral trade data is taken from Barbieri and Omar (2012) and trade agreements data is from the World Bank. The externality and heterogeneity variables remain significant and with the expected sign. Both bilateral trade and trade agreements enters with a positive and significant coefficient.

Sixth, we mitigate issues arising from reverse causation. Supervisory cooperation may lead to more monitoring of banks and cause retrenchment (Calzolari, Colliard and Loranth (2018)), affecting market integration (Colliard (2017)) and result in lower externalities. We address this issue in column (8), where we include our two indices (heterogeneity and externality) calculated for the year 2000. Most of the agreements were signed after this date. The results remain unchanged.

Finally, the availability of the data on cooperation agreements might be endogenous. For example, less developed countries are less likely to publish cooperation data online and do so in accessible form. To account for potential sample selection bias, we employ a Heckman estimation. Column (9) shows the first stage of this estimation. We take the internet use in both countries as selection variable. We argue that when internet usage is widespread, it is more likely that countries will report information on cooperation agreements. The first stage of this model suggests that this is indeed the case. Higher internet usage increases the probability of observing data on cooperation agreements for a country-pair. The second stage results in column (10) confirm our previous results; the externality measure remains positive and highly significant, while the heterogeneity measure becomes more negative (taking a value of -0.75) and stays significant at 1%.

We provide two goodness-of-fit measures alongside the pseudo-R2 (the latter may not be the most appropriate measure as the dependent variable is binary). Both measures provide information on the fraction of correctly predicted outcomes. First, overall we predict 61% to 86% of all outcomes correctly across the specifications in Table 6. Second, according to McIntosh and Dorfman (1992) the sum of the fraction of zeroes correctly predicted plus the fraction of ones correctly predicted should exceed 100% if the prediction method is of value. In our case the sum of these fractions vary between 148% and 165%.

4.2.2 Duration analysis

While so far we have studied variation across country pairs, we now also exploit variation across time. Because of the specific time structure in the dependent variable, a (logit) panel approach is not appropriate in our context. In particular, since in our data countries never move from cooperation to no cooperation, the process for the dependent variable can be characterized by a single jump (or absence of a jump) over the sample

period. This is precisely the setting used in duration (and survival) analysis.

Unlike commonly used logit or probit models, which measure the unconditional probability of the occurrence of an event, duration models estimate the conditional probability of an event at time t, given that no event has occurred until this time. If T is a non-negative random variable denoting time to cooperation, then duration models define a survival function $S(t)$ which is the reverse cumulative distribution of T: $S(t) = 1 - F(t) = P(T > t)$, where $F(t)$ is the cumulative distribution function of the probability density function $f(t)$. Thus, the survival function reports the probability of surviving beyond time t. The average probability that the event occurs in a given interval, conditional on the subject having survived to the beginning of that interval is defined as,

$$h(t) = \lim_{\Delta t \to 0} \frac{P(t + \Delta t > T > t | T > t)}{\Delta t} = \frac{f(t)}{S(t)}. \tag{4}$$

This average probability is called the hazard function. Following the literature (e.g. Ongena and Smith (2001)), we assume the following proportional hazard specification

$$h(t, X(t), \beta) = \lim_{\Delta t \to 0} \frac{P(t + \Delta t > T > t | T > t, X(t), \beta)}{\Delta t} = h_0(t) exp(\beta' X_t). \tag{5}$$

where X_t are time varying controls (the externality and heterogeneity indices in our context). The term $h_0(t)$ is the baseline hazard function, which determines the shape of the hazard function with respect to time. We estimate this model assuming an exponential distribution, fitting a baseline hazard which is constant over time. We report our coefficients in the proportional hazard time metric. The latter represents the likelihood of two countries cooperating, given that up to now they have not cooperated. We do not include country or country-pair fixed effects, as this would bias our coefficient results upwards (Greene (2004)), though our findings are robust to the inclusion of country fixed effects.

The sample covers 4,138 country-pairs over the years 1995-2013 (in 140 cases there was already cooperation prior to 1995; these observations are dropped). The duration variable varies from $t = 1$ if cooperation occurred in the first year of our sample, to $t = 18$ if no cooperation occurred up to 2013 (in the latter case, the data is said to be right censored). Consistent with the assumption of the duration analysis there are no cases where countries ceased cooperation, that is, move from cooperation to no

cooperation.

The results in column (1) of Table 7 show that higher cross-border externalities increase the hazard rate of a cooperation arrangement, while higher heterogeneity between countries is associated with a decrease of the probability of cooperation. In economic terms, one standard deviation in cross-border externalities increases the probability of moving towards cooperation in a given year by 60%, while one standard deviation in heterogeneity decreases this probability by 49%. In column (2) we control for a post-crisis effect; specifically, we include a dummy *Crisis* that takes on the value one starting in 2008. Our results continue to hold. We can see that the crisis increases the likelihood that a cooperation arrangement will be adopted – as to be expected. Finally, we control for the share of joint cooperation partners (that is, the share of third countries that have cooperation agreements with both countries). This captures the idea that when two countries have cooperation agreements outstanding with the same (other) countries, there most likely has already been some form of standardization that will make cooperation between the specific country-pair less costly. In column (3) we find indeed that a higher share of common cooperation partners increases the probability of the adoption of cooperation arrangement. Finally, in column (4) we estimate a panel Logit-model; this allows for two-way clustering and the inclusion of country-fixed effects. We confirm that higher externalities (heterogeneity) reduce (increases) the likelihood of cooperation, with both coefficients significant at the 1%-level.

4.2.3 Intensity of cooperation

While so far we have focused on whether there is any form of cooperation present, we study next whether the externality-heterogeneity trade-off can also explain the intensity of cooperation.

Table 8 presents the results using an ordered probit model with data from 2013. The sample size drops from 3,828 to 3,762 because for 66 country pairs we do not have information on the form of cooperation. The first column in Table 8 shows the estimates of the main model, while columns (2)-(6) break down the (marginal) effect on the likelihood of each of the five cooperation levels.

The results show that higher externalities and lower heterogeneity increase the expected intensity of cooperation, as they increase the likelihood of each (positive) co-

operation level. The coefficient estimates for the main model in column (1) have the same sign and are highly significant as in the previous analyses. Column (2) contains the results for a cooperation intensity of zero (no cooperation); the marginal effect on the externality measure takes the value of -0.44, significant at the 1% level, whereas the coefficient on the heterogeneity measure takes the value of 0.39, also significant at the 1% level. Thus lower externalities and higher heterogeneity increase the likelihood of no cooperation. This is consistent with the results in Table 6 where we have effectively examined the opposite question. In column (3) (Memorandum of Understanding on information sharing) the coefficients take the opposite sign (significant at the 1% level). This tells us that higher externalities and lower heterogeneity make it more likely that a pair of countries chooses a Memorandum of Understanding on information sharing as the form of cooperation. Similarly, in all other columns (column (4)-(6)), the externality variable takes a positive sign while the heterogeneity variables takes a negative sign. Thus higher net (economic) benefits increase the likelihood of all levels of cooperation.

It is informative to compare the size of the coefficients in the various regressions for (non-zero) cooperation. From columns (3)-(5) we can see that the externality coefficients decrease in magnitude, from 0.104 for MoU to 0.039 for a supranational supervisor, with the exception of a College of Supervisors, which has a marginal effect of 0.221. We see the same ordering for the heterogeneity index, but with a negative sign. An increase in the net benefits has thus has a higher impact on lower cooperation stages than higher ones, with the exception of the College of Supervisors. An interpretation of this is that subsequent cooperation stages are more difficult to implement, and hence require a higher increase in net benefits to make them worthwhile. The higher sensitivity for the College of Supervisors may reflect that such colleges can be implemented for a specific bank only, and are hence less burdensome than country-wide agreements.

In unreported robustness tests, we rerun the regression with a linear model, as such a model allows for two-way clustering and the inclusion of country-fixed effects, unlike the ordered probit model. We confirm that higher externalities (heterogeneity) increase (reduces) the intensity of cooperation, with both coefficients significant at the 1%-level. To further gauge the sensitivity of our findings, we undertake three additional (unreported) robustness tests. First, we exclude the Eurozone countries from the sample. Second, we calculate the intensity variable weighing each intermediate

cooperation degree equally (specifically, a common supervisor gets a "2" and all other degrees of cooperation are coded with "1"). Finally, we also test our results excluding intermediate cooperation degrees (thus we only include country-pairs that have either zero of full cooperation (common supervisor). Our two variables remain significant in all specifications, and with the expected signs.

5 Conclusion

The question of how to design the supranational financial architecture is an important one. Following the Global Financial Crisis, which saw significant international spillovers, several countries intensified cooperation in the supervision of their banks. This raises the question whether cooperation is effective in improving the stability of cross-border banks. There is also large variation in countries' propensity to cooperate, raising in addition the question of why some countries cooperate while others not. Economic theory suggests that cooperation should be driven by two, opposing, factors. On the one hand, cross-border externalities imply that uncoordinated domestic policies will result in inefficient supranational outcomes. Their presence suggests benefits to cooperation, as the latter allows internalizing international spillovers. On the other hand, heterogeneity across countries posits a cost to cooperation as it limits the set of policies that are mutually beneficial, as well as making the implementation of common policies costly.

Using bank-level analysis we have shown that higher cooperation is associated with improved bank stability. We have also shown that actual cooperation arrangements among countries are consistent with benefits and costs predicted by externalities and heterogeneity across countries. This suggests that the varied and rich cooperation patterns found in the data may reflect differences in cooperation gains. Taken together, our results provide both a cautionary background for a global move towards uniformly more supervisory cooperation. Even though such cooperation can be expected to improve banking stability, it may not be necessarily be beneficial as cooperation gains vary across countries.

References

[1] Acharya, V. (2003), Is the international convergence of capital adequacy regulation desirable?, *Journal of Finance 58, 2745–2781.*

[2] Acharya, V. and Yorulmazer, T. (2007), Too many to fail–An analysis of time-inconsistency in bank closure policies, *Journal of Financial Intermediation 16, 1–31.*

[3] Acharya, V., Pedersen, L., Philippon, Th. and Richardson, M. (2017), Measuring Systemic Risk, *Review of Financial Studies 30, 2–47.*

[4] Aiyar, S., Calomiris, C., Hooley, J., Korniyenko, Y., and Wieladek, T. (2014a), The international transmission of bank capital requirements: Evidence from the UK, *Journal of Financial Economics 113, 368–382.*

[5] Aiyar, S., Calomiris, C., and Wieladek, T., (2014b), Does Marco-Prudential Regulation leak? Evidence from a UK Policy Experiment, *Journal of Money, Credit and Banking 46, 181–214.*

[6] Andersen, T., Harr, T., and Tarp, F. (2006), On U.S. politics and IMF lending, *European Economic Review 50, 1843â€“1862.*

[7] Anginer, D., Demirguc-Kunt, A., and Zhu, M. (2014). How does Competition Affect Bank Systemic Risk? *Journal of Financial Intermediation 23(1), 1–26*

[8] Barbieri, K. and Omar, K. (2012), Correlates of War Project Trade Data Set Codebook, Version 3.0. Online: http://correlatesofwar.org.

[9] Beck, T., Todorov, R. and Wagner, W. (2013), Bank Supervision Going Global? A Cost-Benefit Analysis, *Economic Policy 28, 285–44.*

[10] Beck, T. and Wagner, W. (2016), Supranational Supervision: How Much and for Whom?, *International Journal of Central Banking 12, 221–68.*

[11] BIS (1975), Report on the supervision of banks' foreign establishments - Concordat, *BIS.*

[12] BIS (1983), Principles for the supervision of banks' foreign establishments, *BIS.*

[13] Brunnermeier, M., Dong, G., and Palia, D. (2012). Banks' Non-Interest Income and Systemic Risk. *AFA 2012 Chicago Meetings Paper.*

[14] Calzolari, Colliard and Loranth (2018), Multinational Banks and Supranational Supervision, forthcoming, *Review of Financial Studies.*

[15] Calzolari, G. and Loranth, G. (2011), Regulation of Multinational Banks: A Theoretical Inquiry, *Journal of Financial Intermediation 20, 178–98.*

[16] Cameron, A. C., Gelbach, J., and Miller, D. (2011) Robust Inference with Multiway Clustering, *Journal of Business & Economic Statistics 29, 238–249.*

[17] Carletti, Dell'Ariccia, and Marquez (2016), Supervisory Incentives in a Banking Union, *IMF Working paper 16/186.*

[18] Colliard, J.-E. (2017), Optimal Supervisory Architecture and Financial Integration in a Banking Union, forthcoming, *Review of Finance.*

[19] Claessens, S. and Van Horen, N. (2014), Foreign banks: Trends and impact, *Journal of Money, Credit and Banking 46, 295–326.*

[20] Dell'Ariccia, G. and Marquez, R. (2006), Competition Among Regulators and Credit Market Integration, *Journal of Financial Economics 79, 401–30.*

[21] Demirguc-Kunt, A., and Huizinga, H. (2004), Bank activities and funding strategies: The impact on risk and returns, *Journal of Financial Economics 98(3), 626–659.*

[22] Forbes, K., Reinhardt, D., and Wieladek, T. (2017), The Spillovers, interactions, and (un)intended consequences of monetary and regulatory policies, *Journal of Monetary Economics 85, 1–22.*

[23] Freixas, X. (2003), Crisis Management in Europe. In *Financial Supervision in Europe, ed. J. Gremers, D. Schoenmaker, and P. Wierts, 102–19. Cheltenham: Edward Elgar.*

[24] Garmaise, M. and Natividad, G. (2013), Cheap Credit, Lending Operations, and International Politics: The case of Global Microfinance, *Journal of Finance 68, 1551–1576.*

[25] Gong, D. and Wagner, W. (2019), Too-many-to-fail and the pricing of risks, mimeo Erasmus University.

[26] Goodhart, C. and Schoenmaker, D. (2009), Fiscal Burden Sharing in Cross-Boarder Banking Crisis, *International Journal of Central Banking 5, 141–65.*

[27] Greene, W. (2004), The Behaviour of the Maximum Likelihood Estimator of Limited Dependent Variable Models in Presence of Fixed Effects, *Econometrics Journal 7, 98–119.*

[28] Houston, J. F., Lin, C., Lin, P., and Ma, Y., (2010), Creditor rights, information sharing, and bank risk taking, *Journal of Financial Economics 96(3), 485–512.*

[29] Kalemli-Ozcan, S., Papaioannou, E. and Peydro, J. L. (2010), What Lies Beneath the Euro's Effect on Financial Integration?Currency Risk, Legal Harmonization or Trade, *Journal of International Economics 81, 75–88.*

[30] Klerman, D., Mahoney, P., Spamann, H. and Weinstein, M. (2011), Legal Origin or Colonial History?, *Journal of Legal Analysis 3, 379–409.*

[31] Laeven, L., and Levine, R. (2009), Bank governance, regulation and risk taking, *Journal of Financial Economics, 93(2), 259–275.*

[32] La Porta, R., Lopez-de-Silanes, F. and Shleifer, A. (2008) The Economic Consequences of Legal Origins, *Journal of Economic Literature 46, 285–332.*

[33] Loranth, G. and Morrison, A. (2007), Deposit Insurance, Capital Regulations and Financial Contagion in Multinational Banks, *Journal of Business Finance & Accounting 34, 917–49.*

[34] McIntosh, C. S. and Dorfman, J. H. (1992), Qualitative Forecast Evaluation: A Comparison of Two Performance Measures, *American Journal of Agricultural Economics 74, 209–214.*

[35] McKinnon, R. (1963), Optimum Currency Area, *American Economic Review 53, 717–725*

[36] Neyman, J., Scott, E.L., (1948). Consistent estimation from partially consistent observations. *Econometrica 16, 1–32.*

[37] Niepmann, F. and Schmidt-Eisenlohr, T. (2013), Bank Bailouts, International Linkages, and Cooperation, *American Economic Journal: Economic Policy 5, 270–305.*

[38] Roy, A. D., (1952), Safety First and the Holding of Assets, *Econometrica 20(3), 431–449.*

[39] Oates, W. (1972), Fiscal Federalism, *Harcourt-Brace, New York.*

[40] Ongena, S. and Smith, D. C. (2001), The Duration of Bank Relationships, *Journal of Financial Economics 61, 449–475.*

[41] Ongena, S., Popov, A., and Udell, G. (2013), "When the cat is away the mice will play": Does regulation at home affect bank risk-taking abroad?, *Journal of Financial Economics 108, 727–750.*

[42] Signorino, C., and Jeffrey, R., (1999), Tau-b or not Tau-b: Measuring the similarity of foreign policy positions, *International Studies Quarterly 43, 115–144.*

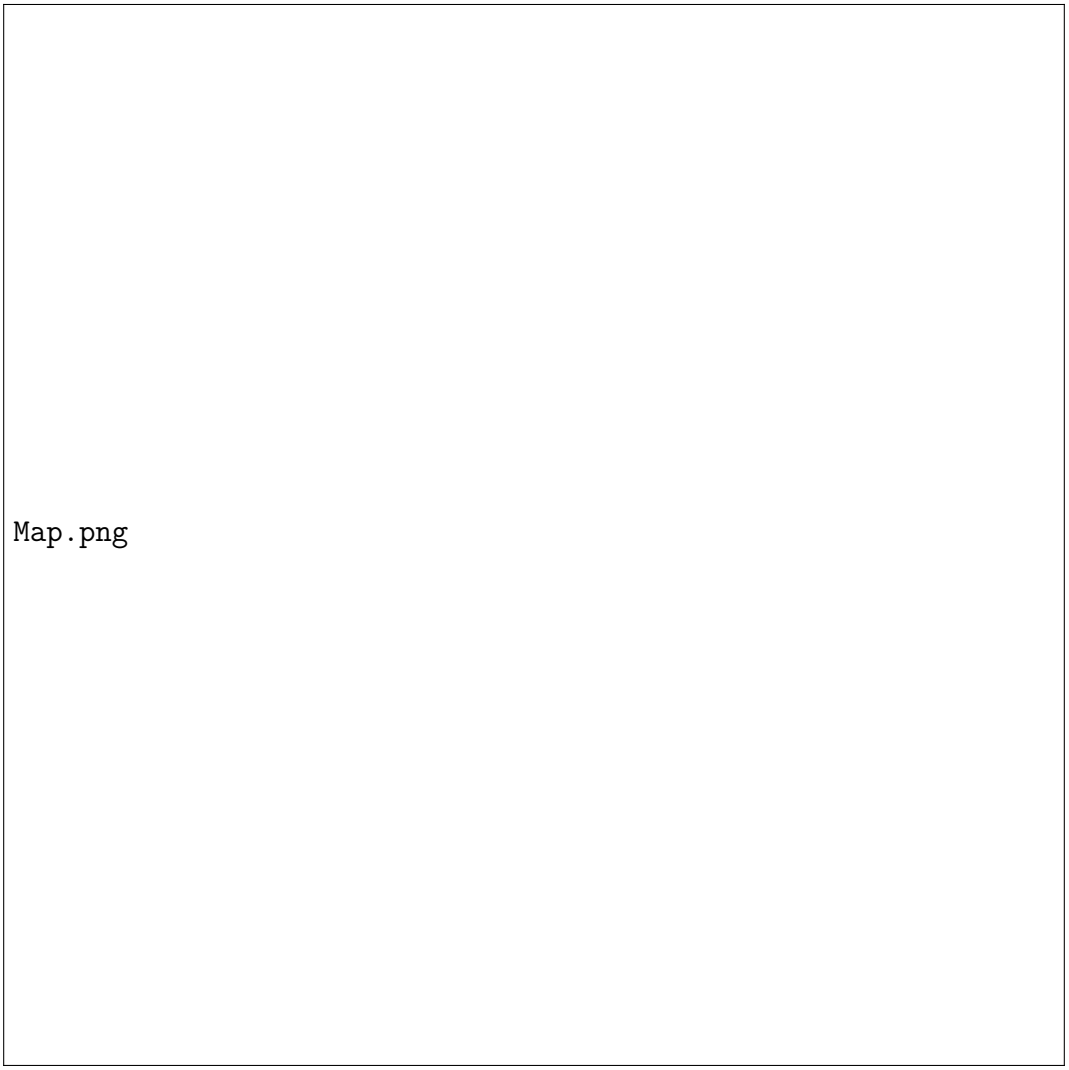
[43] Silvers, R. (2019), Cross-Border Cooperation Between Securities Regulators, *Available at SSRN: https://ssrn.com/abstract=3381887 or http://dx.doi.org/10.2139/ssrn.3381887*

[44] Stein, J. (2009), Presidential Address: Sophisticated Investors and Market Efficiency, *Journal of Finance 64, 1517–1548.*

[45] Voeten, E. (2013), Data and Analyses of Voting in the UN General Assembly, *Routledge Handbook of International Organization, edited by Bob Reinalda.*

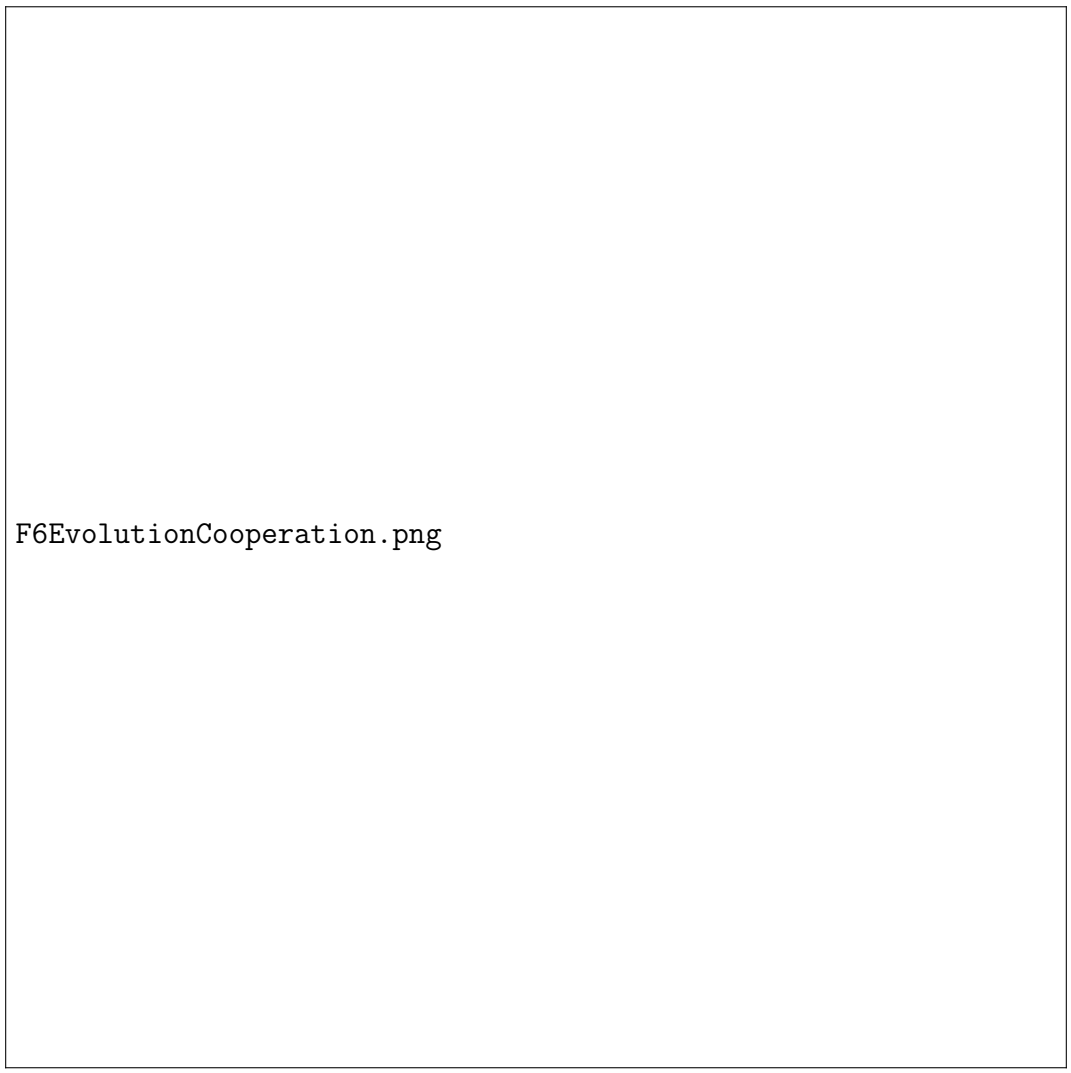
Figures

Figure 1. Geographic distribution of cooperation agreements



The figure shows the cooperation intensities of individual countries at the end of 2013. Darker red areas represent higher cooperation intensities, measured as the percentage of other countries a country cooperates with.

Figure 2. Evolution of cooperation agreements

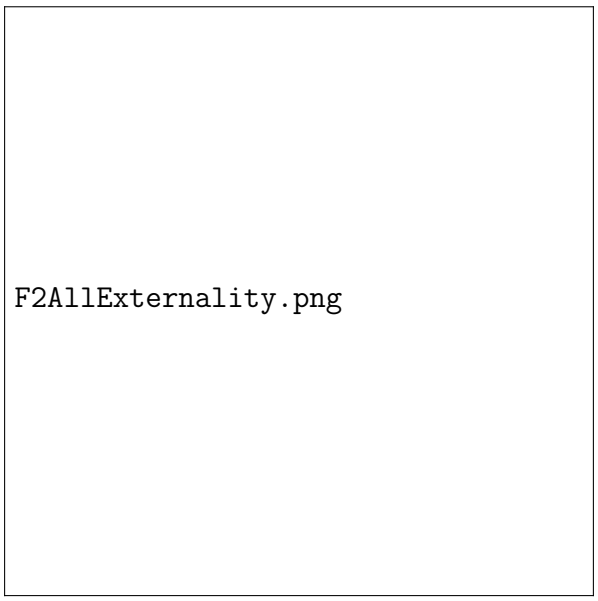


The figure shows the share of country-pairs cooperating, relative to the total possible number of cooperation-pairs within the region for each year.

Figure 3a. Evolution of externalities

Figure 3b. Evolution of heterogeneity

Figure 3c. Evolution of heterogeneity (time variant)



The figure shows the average externality index across all country-pairs.

The figure shows the average heterogeneity across all country-pairs for each year.

Tables

The figure shows the average heterogeneity across all country-pairs for each year including only the time-variant components.

Table 1: Descriptive statistics bank-level analysis

Variable	Mean	Std. Dev.	Min.	Max.	N
Log(Z-Score)	3.752	1.647	-7.44	12.298	1105
Log(ROA+Equity/TA)	-2.595	0.741	-11.139	0.134	1618
Log(SD(ROA))	-6.311	1.703	-14.388	-1.755	1128
MES	0.038	0.026	-0.016	0.134	508
Cooperation	0.6	0.445	0	1	1661
Foreign TA/TA	0.16	0.237	0.005	0.942	1661
Log(assets)	10.364	1.975	2.333	12.358	1661
Liabilities/TA	0.906	0.12	0.069	0.992	1661
Loss prov./TL	0.014	0.021	-0.017	0.142	1540
Non-interest income/Income	0.299	0.208	-0.147	1	1177
Log(GDP per cap.)	9.822	1.167	5.48	11.322	1650
Vol(GDP growth)	0.093	0.061	0.004	0.566	1661
Trade/GDP	69.117	34.937	15.636	341.862	1657

This table reports summary statistics of the main regression variables in risk models. The statistics are based on annual data for the years 1995-2013. Definition and sources of variables are listed in Appendix C.

Table 2: Effectiveness of cooperation

					Small banks			
	Log(Z-Score)	Log(Z-Score)	Log(Z-Score) Large	Log(Z-Score) Small	Log(Z-Score) High FTA	Log(Z-Score) Low FTA	Log(ROA+Equity/TA)	Log(SD(ROA))
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cooperation	0.540**	0.541**	0.184	1.187***	2.079***	0.695	0.028	-1.159***
	(0.258)	(0.234)	(0.196)	(0.369)	(0.627)	(0.595)	(0.084)	(0.341)
Foreign TA/TA	-0.708	-1.003	0.251	-1.000	-0.817	0.361	0.025	1.025
	(1.117)	(1.092)	(1.716)	(1.190)	(1.232)	(13.57)	(0.172)	(1.103)
Log(assets)	0.704***	0.527**	1.753**	0.431	0.516	0.960	0.075	-0.356
	(0.268)	(0.253)	(0.688)	(0.350)	(0.543)	(0.690)	(0.147)	(0.330)
Liabilities/TA	-4.319*	-4.631**	-30.44***	-3.075	3.424	-1.106	-6.946***	-3.872
	(2.238)	(1.980)	(7.189)	(2.733)	(4.619)	(7.940)	(1.114)	(2.669)
Loss prov./TL	-14.83**	-11.36**	-22.07***	-5.546	-11.61	-3.292	-6.094**	-0.548
	(6.329)	(5.465)	(4.565)	(6.331)	(9.104)	(7.042)	(2.419)	(5.434)
Non-interest income/Income	2.298***	2.127***	1.960***	1.044	1.362	1.264	0.491	-0.554
	(0.521)	(0.448)	(0.421)	(0.784)	(1.083)	(1.604)	(0.413)	(0.696)
Log(GDP per cap.)		8.811***	8.094***	9.179*	2.890	10.72	4.859	-4.319*
		(1.524)	(1.448)	(4.956)	(3.705)	(8.120)	(3.779)	(2.258)
Vol(GDP growth)		0.398	3.541	0.333	0.125	0.777	1.431	1.098
		(1.248)	(2.945)	(1.642)	(2.757)	(2.263)	(1.182)	(0.875)
Trade/GDP		0.022**	-0.006	0.031**	0.024	0.036**	0.0059	-0.025**
		(0.0097)	(0.014)	(0.013)	(0.016)	(0.016)	(0.0051)	(0.012)
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	804	804	402	402	201	201	402	402
R-squared	0.21	0.28	0.47	0.21	0.34	0.21	0.35	0.26

This table presents the results of regressions of bank risk and its components on cooperation. The dependent variables are bank's *Log(Z-Score)* in columns (1) - (6), *Log(ROA+Equity/TA)* in column (7), and *Log(SD(ROA))* in column (8). *Cooperation* equals the asset-weighted cooperation dummy between the parent bank country and its subsidiaries' countries. The sample is split at the 50th percentile according to total assets (columns (3) and (4)), and according to total foreign assets over total assets (columns (5) and (6)). Regressions in columns (4) - (8) contain the sample of small banks only. The sample period spans from 1995-2013. Definitions and sources of control variables are listed in Appendix C. All regressions are estimated including bank and year fixed effects, and robust standard errors clustered at the bank level (in parentheses). ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 3: Robustness

	Cooperation IV 1st stage	IV 2nd stage	MES	Crisis	Cooperation intensity
	(1)	(2)	(3)	(4)	(5)
Cooperation IV	0.956**				
	(0.456)				
Cooperation		3.883*	-0.023***	0.894***	1.721***
		(1.998)	(0.007)	(0.330)	(0.586)
Cooperation*Crisis				0.625	
				(0.495)	
Cooperation^2					2.493
					(1.535)
Foreign TA/TA	-0.209	1.069	-0.024	-1.005	-0.945
	(0.146)	(0.815)	(0.029)	(1.143)	(1.145)
Log(assets)	-0.024	0.392	-0.005	0.431	0.478
	(0.063)	(0.429)	(0.017)	(0.350)	(0.350)
Liabilities/TA	0.279	-1.933	-0.026	-3.169	-3.228
	(0.422)	(3.493)	(0.131)	(2.722)	(2.688)
Loss prov./TL	1.468	13.132**	0.013	-6.209	-4.746
	(1.216)	(5.670)	(0.123)	(6.097)	(6.403)
Non-interest income/Income	0.193	-1.363	0.035	1.056	1.129
	(0.157)	(0.966)	(0.021)	(0.786)	(0.794)
Log(GDP per cap.)	0.079	0.941	0.0076	9.433*	9.271*
	(0.598)	(3.203)	(0.086)	(4.923)	(4.977)
Vol(GDP growth)	0.186	-2.592**	-0.025	0.487	0.350
	(0.213)	(1.040)	(0.063)	(1.640)	(1.629)
Trade/GDP	-0.001	0.014	0.0005	0.031**	0.030**
	(0.003)	(0.020)	(0.0003)	(0.012)	(0.012)
Bank FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Observations	193	193	137	402	402
R-squared	0.35		0.62	0.22	0.22

This table presents the results of regressions of bank risk on cooperation. The dependent variables are the asset-weighted cooperation indicator and a bank's *Log(Z-Score)* in the instrumental variable model in columns (1) and (2), respectively, and a bank's MES in column (3). *Cooperation* equals the asset-weighted cooperation dummy between the parent bank country and its subsidiaries' countries. *Cooperation IV* equals the asset-weighted predicted cooperation dummy between the parent bank country and the countries of its subsidiaries in the bank's first period in our sample. *Cooperation* is mean centered in column (5). The regressions contain the sample of small banks only. *Crisis* is a dummy variable equal to one starting in 2008. The sample period spans from 1995-2013. Definitions and sources of control variables are listed in Appendix C. All regressions are estimated including bank and year fixed effects and robust standard errors clustered at the bank level (in parentheses). ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 4: Regulation and effectiveness

	Log(Z-Score)	Log(Z-Score)	Log(Z-Score)
	(1)	(2)	(3)
Cooperation	2.436***	1.113**	0.876
	(0.714)	(0.457)	(0.567)
Supervisory stringency$_S$	-0.251***		
	(0.0829)		
Cooperation*Supervisory stringency$_S$	0.274***		
	(0.0812)		
Supervisory stringency$_P$	-0.0668		
	(0.129)		
Cooperation*Supervisory stringency$_P$	0.775***		
	(0.237)		
External audit$_S$		-0.120	
		(0.695)	
Cooperation*External audit$_S$		1.086	
		(1.051)	
External audit$_P$		-0.720	
		(0.649)	
Cooperation*External audit$_P$		2.431**	
		(1.155)	
Foreign entry$_S$			0.824***
			(0.178)
Cooperation*Foreign entry$_S$			0.783***
			(0.260)
Foreign entry$_P$			-0.0397
			(0.353)
Cooperation*Foreign entry$_P$			0.222
			(0.615)
All controls	Y	Y	Y
Bank FE	Y	Y	Y
Year FE	Y	Y	Y
Observations	196	338	290
R-squared	0.404	0.258	0.35

This table presents the results of regressions of bank risk on cooperation. The dependent variable is bank's *Log(Z-Score)*. *Cooperation* equals the asset-weighted cooperation dummy between the parent bank country and its subsidiaries' countries. *Supervisory stringency* corresponds to an index that indicates capital stringency. *External audit* is a dummy equal to one if there is a compulsory licensed or certified external audit. *Foreign entry* is an index that indicates whether there are limits to foreign entities from entering the country. S and P stands for subsidiaries and parent, respectively. Subsidiaries' country data is aggregated at the parent-bank level using the subsidiaries' assets as weights. All variables included in the interaction terms are mean centered. All regressions contain the sample of small banks only. The sample period spans from 1995-2013. Definitions and sources of control variables are listed in Appendix C. All regressions are estimated including bank and year fixed effects, and robust standard errors clustered at the bank level (in parentheses). ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 5: Descriptive statistics country-pair analysis (Logit)

Variable	Mean	Std. Dev.	Min.	Max.	N
Cooperation	0.122	0.327	0	1	4278
Intensity	0.201	0.646	0	4	4206
Externality	0.151	0.188	0	0.832	3828
Heterogeneity	0.366	0.140	0.006	0.669	4278
Avg. foreign share	0.003	0.024	0	0.5	3828
Correlation	0.276	0.328	-0.695	0.956	1219
Currency	0.173	0.378	0	1	4278
G-SIB	0.168	0.374	0	1	3828
ΔPreferences	0.238	0.197	0	1	4278
ΔForeign share	0.002	0.022	0	1	3828
ΔLegal origin	0.625	0.484	0	1	4278
ΔLatitude	0.189	0.169	0	1	4278
ΔLongitude	0.308	0.222	0	1	4278
ΔLanguage	0.833	0.373	0	1	4278
ΔDebt/GDP	0.204	0.175	0	1	4186
ΔGDP per cap.	0.219	0.226	0	1	4186

This table reports summary statistics of the main regression variables in logit models. Definitions and sources of variables are listed in Appendix C. The sample consists of 4278 country-pairs in 2013.

Table 6: Cross-sectional analysis

	Indices	Components	Fixed effects	Principal components	Conservative sample	Bilateral agreements	Trade	Lagged indices	Heckman 1st stage	Heckman 2nd stage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Externality	0.485***		0.433***		0.568***	0.328***	0.266***			0.566***
	(0.0617)		(0.0458)		(0.0621)	(0.0498)	(0.0409)			(0.0332)
Heterogeneity	-0.427***		-0.990***		-0.550***	-0.339***	-0.282***			-0.746***
	(0.0624)		(0.104)		(0.0723)	(0.0618)	(0.0547)			(0.0405)
Externality_{PCA}				0.0831***						
				(0.0185)						
$\text{Heterogeneity}_{PCA}$				-0.112***						
				(0.0111)						
$\text{Externality}_{2000}$								0.488***		
								(0.0575)		
$\text{Heterogeneity}_{2000}$								-0.443***		
								(0.0583)		
Avg. foreign share		2.132*								
		(1.116)								
Correlation		0.251***								
		(0.0590)								
Currency		0.0812**								
		(0.0356)								
G-SIB		0.114***								
		(0.0303)								
ΔPreferences		-0.249**								
		(0.119)								
ΔForeign share		-0.438***								
		(0.156)								
ΔLegal origin		-0.00951								
		(0.0222)								
ΔLatitude		-0.298***								
		(0.109)								
ΔLongitude		-0.415***								
		(0.106)								
ΔLanguage		-0.0841**								
		(0.0422)								
ΔDebt/GDP		0.0393								
		(0.0759)								
ΔGDP per cap.		0.0926								
		(0.0639)								
Trade							26.29***			
							(4.925)			
PTA							0.0988***			
							(0.0159)			
Internet use									0.004***	
									(0.0004)	
Observations	3,828	1,177	3,826	1,177	2,948	3,625	3,620	3,733	3,828	3,828
Pseudo-R^2	0.26	0.40	0.40	0.35	0.28	0.27	0.41	0.24		
%-Predicted	74.8	72.4	61.1	70.4	72.5	85.5	84.1	74.5		
M-D test	152.3	157.8	143.5	154.4	153.2	152.6	164.9	148.4		

This table presents the results of logit regressions of a cooperation indicator on the externality and heterogeneity indexes. The dependent variable is a country-pair dummy equal to one if any form of cooperation is present between the two countries. $Externality_{PCA}$ is an index constructed using the first component of a principal component analysis of the variables included in the baseline externality index. $Heterogeneity_{PCA,ij}$ is an index constructed using the first component of a principal component analysis of the variables included in the baseline heterogeneity index. $Trade$ is the sum of exports and imports between the two countries over the sum of both countries' GDP. PTA is a dummy equal to one if a preferential trade agreement exists between the two countries. $\text{Externality}_{2000}$ is the externality index constructed using data from year 2000. $\text{Heterogeneity}_{2000}$ is the heterogeneity index constructed using data from year 2000. *Internet use* is the sum of both countries' individuals use of the internet as a percentage of each country's population. Definitions and sources of variables are listed in Appendix C. The sample consists of 4278 country-pairs in 2013. All regressions report marginal effects. Model (3) includes fixed effects for each country in the pair and is estimated as a linear model. Models (1)-(8) are estimated with two-way clustered standard errors at each country of the pair and model (9) and (10) are estimated with robust standard errors (in parentheses). ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 7: Hazard rate cooperation

	(1)	(2)	(3)	(4)
Externality$_{t-1}$	3.622***	3.452***	2.746***	0.027***
	(0.179)	(0.185)	(0.212)	(0.0051)
Heterogeneity$_{t-1}$	-4.096***	-4.284***	-4.214***	-0.062***
	(0.348)	(0.357)	(0.363)	(0.0080)
Crisis$_t$		0.832***		
		(0.104)		
Common share$_{t-1}$			21.95***	
			(1.286)	
Observations	63,257	63,257	63,257	63,257

Models in column (1)-(3) in this table present the results of duration model regressions of the hazard rate on the externality and heterogeneity indexes. The dependent variable in these models is the hazard rate of cooperation between a given country pair. $Crisis_t$ is a dummy variable equal to one starting in 2008. $Common\ share_{t-1}$ is the number of third countries with which both countries have a cooperation arrangement over the total possible number of joint countries that the two can cooperate with. Column (4) presents the results of a linear model of the probability of cooperation on the externality and heterogeneity indices. The sample consists of 4138 country pairs during the period 1995-2013 (country pairs with agreements before 1995 are dropped). Regressions (1)-(3) report coefficients from the proportional hazard metric of duration models and are estimated with robust standard errors (in parentheses). Regression (4) is estimated including fixed effects and two-way clustering at each country of the pair. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 8: Cooperation intensity

	Model estimates	Average marginal effects				
		No cooperation	MoU info. sharing	CoS	MoU crisis management	Supranational supervisor
	(1)	(2)	(3)	(4)	(5)	(6)
Externality	3.17***	-0.438***	0.104***	0.221***	0.073***	0.039***
	(0.145)	(0.019)	(0.009)	(0.015)	(0.009)	(0.006)
Heterogeneity	-2.822***	0.389***	-0.093***	-0.196***	-0.065***	-0.035***
	(0.205)	(0.029)	(0.010)	(0.014)	(0.009)	(0.007)
Observations	3,762	3,762	3,762	3,762	3,762	3,762
Pseudo-R^2	0.21	0.21	0.21	0.21	0.21	0.21

This table presents the results of ordered probit regressions of the cooperation intensity on the externality and heterogeneity indexes. The dependent variable in these models is the intensity of cooperation between a given country pair. Intensity of cooperation ranges from zero to four if (i) the countries do not cooperate, (ii) have a Memorandum of Understanding for information sharing and on-site inspection, (iii) have a College of Supervisors, (iv) have a Memorandum of Understand on crisis management and resolution and (v) have a supranational supervisor. The sample consists of 4206 country-pairs in 2013. Column (1) reports the ordered probit coefficients. Columns (2)-(6) report marginal effects. All models are estimated with robust standard errors (in parentheses). ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Appendix A: Background on cooperation agreements

Supervisory authorities recognized in the Basel Concordat (BIS, 1975, 1983) the importance of good work relationships with their counterparts where a cross-country institution exists. Over the years, the Basel Committee has produced several documents that define good practice principles and essential elements of successful cooperation between banking supervisors. At the core of these principles is the establishment of regular flows of information and mechanisms for establishing trust between regulators regarding the confidentiality of the information shared. In this context, supervisors have entered into various types of arrangements to comply with these recommendations, including the exchange of letters, Memorandum of Understandings (MoU), and College of Supervisors (CoS). These arrangements have been signed bilaterally by a country-pair or multilaterally by a group of countries. Furthermore, while the Basel Committee guidelines are not mandatory, countries have largely followed the essential elements defined in these documents when designing the arrangements for the various forms of cooperation.

A Memorandum of Understanding in this context is a declaration of intent of cross-border cooperation between the parties regarding the supervision of international banks. They introduce the appropriate procedures and principles that facilitate such cooperation. These agreements are not legally binding and usually define supervision guidelines during normal times. The Committee has defined the essential elements of these agreements (BIS (2001)): (1) the establishment of information sharing between supervisors to facilitate effective consolidated supervision of multinational financial institutions, (2) mutual assistance in carrying out on-site inspection of these establishments, (3) the recognition of the importance of mutual trust and protection of the information shared, and (4) the ongoing coordination between the parties.

One step further in cooperation are the Colleges of Supervisors. These colleges are multilateral working groups of supervisors that collaborate with the purpose of enhancing effective consolidated supervision of a given multinational banking group. The principles included in a CoS are the same ones included in an MoU. However, the CoS should establish an additional step towards cooperation in crisis management (see, e.g., BIS (2010a)). Even though they are not decision-making bodies, they should operate as conduits of information for contingency planning in crisis management meetings.

Cross-border supervision in crisis periods is further addressed in MoUs on crisis management. These MoUs are intended to provide authorities with additional guidelines during these periods. For instance, the establishment of the exchange of additional information, not shared during normal times, which is necessary during crisis periods. This information could involve, for instance, cross-sectoral flows of information, between the central bank and the supervisor. These agreements also provide effective sets of bank resolution tools, such as the promotion of ex-ante burden sharing (BIS, 2010b).

Countries reach the highest level of cooperation when forming a banking union. This form of cooperation transfers banks' supervision from the national level to a single supranational level authority.

Appendix B: Distribution of cooperation agreements

Country	Cooperation	Country	Cooperation
Algeria	0	Latvia	0.16
Angola	0.04	Liberia	0.04
Argentina	0.1	Lithuania	0.13
Australia	0.09	Luxembourg	0.33
Austria	0.23	Malawi	0.02
Barbados	0.02	Mali	0.12
Belgium	0.29	Malta	0.14
Benin	0.12	Mauritania	0
Bolivia	0.02	Mauritius	0.11
Botswana	0.01	Mexico	0.16
Brazil	0.05	Mozambique	0.02
Bulgaria	0.2	Namibia	0.04
Burkina Faso	0.12	Netherlands	0.3
Burundi	0.04	New Zealand	0.02
Cambodia	0.01	Nicaragua	0.1
Cameroon	0.13	Niger	0.12
Canada	0.11	Nigeria	0.17
Chile	0.04	Norway	0.24
Colombia	0.12	Panama	0.21
Congo, Dem. Rep.	0.05	Paraguay	0.02
Costa Rica	0.08	Peru	0.09
Cote D'Ivoire	0.11	Poland	0.25
Croatia	0.05	Portugal	0.07
Cyprus	0.21	Romania	0.2
Czech Republic	0.21	Rwanda	0.05
Denmark	0.22	Senegal	0.12
Dominican Republic	0.1	Sierra Leone	0.04
Ecuador	0.02	Slovak Republic	0.25
Egypt	0	Slovenia	0.18
El Salvador	0.12	South Africa	0.2
Estonia	0.16	Spain	0.26
Ethiopia	0	Sudan	0.02
Finland	0.16	Swaziland	0.01
France	0.38	Sweden	0.17
Gambia	0.04	Switzerland	0.18
Germany	0.4	Tanzania	0.09
Ghana	0.05	Togo	0.12
Greece	0.17	Trinidad and Tobago	0.02
Guatemala	0.11	Tunisia	0
Guinea-Bissau	0.12	Uganda	0.05
Honduras	0.08	United Kingdom	0.37
Hungary	0.18	United States	0.24
Iceland	0.1	Uruguay	0.09
Ireland	0.28	Venezuela	0.04
Italy	0.29	Zambia	0.05
Jamaica	0.02	Zimbabwe	0.11
Kenya	0.12		

This table shows for each country the fraction of agreements signed by 2013 relative to the number of all possible agreements.

Appendix C: Variable definitions

Variable	Definitions	Source
Panel A: Effectiveness of regulation		
Bank risk		
Log(Z-Score)$_b$	Is a bank's natural logarithm of Z-score calculated as the ROA plus equity (over assets) divided by the three-year standard deviation of ROA.	Authors' calculation using Bankscope data.
MES$_b$	Corresponds to the average daily stock return of the bank on days where the country's local banking sector index (MSCI banking sector index) experiences one of its 5% lowest returns.	Authors' calculations based on Datastream share price data.
Bank-specific cooperation		
Cooperation$_b$	Is the share of host supervisors (i.e., supervisors of the parent bank's subsidiaries) with whom the home (parent-bank) supervisor has a cooperation agreement. To calculate the share we weigh by the importance of each subsidiary, measured as the subsidiary's share in the parent bank's total foreign assets.	Authors' calculations based on Bankscope data and cooperation data from Central Banks' and Supervisory authorities' websites and other sources.
Bank controls		
Foreign TA/TA$_b$	Is the ratio of the bank's foreign to total assets.	Authors' calculation using Bankscope data.
Log(assets)$_b$	Logarithm of total assets in US dollars.	Authors' calculation using Bankscope data.
Liabilities/TA$_b$	Total liabilities over total assets.	Authors' calculation using Bankscope data.
Loss prov./TL$_b$	Loan-loss provisions divided by total loans.	Authors' calculation using Bankscope data.
Non-interest income/Income$_b$	Total non-interest income over total income.	Authors' calculation using Bankscope data.
Country controls		
Log(GDP per cap)$_j$	Logarithm of GDP per capita.	World Bank data.
Vol(GDPgrowth)$_j$	Standard deviation of GDP growth measured over a five-year rolling window.	World Bank data.
Trade/GDP$_j$	Imports plus exports over GDP.	World Bank data.
Regulatory variables		
Supervisory stringency$_j$	Index that ranges between 0 and 7 that indicates overall capital stringency. Higher values indicate greater stringency.	Wold Bank survey on bank regulation (Barth, Caprio and Levine, 1999, 2003, 2007 and 2011).
External audit$_j$	Dummy equal to one if there is a compulsory licensed or certified external audit.	Wold Bank survey on bank regulation (Barth, Caprio and Levine, 1999, 2003, 2007 and 2011).
Foreign entry$_j$	Index that ranges between 0 and 4 that indicates whether there are limits to foreign entities from entering. Higher values indicate more freedom.	Wold Bank survey on bank regulation (Barth, Caprio and Levine, 1999, 2003, 2007 and 2011).
Instrument		
Affinity$_i j$	Signorino and Ritter (1999) measure of political affinity defined as the similarity of voting patterns in the U.N. General Assembly.	Voeten (2013)

Appendix C: Variable definitions (cont.)

Variable	Definitions	Source
Panel B: Cooperation determinants		
Cooperation		
Cooperation$_{ij}$	Dummy variable equal to one if country i and country j have signed a Memorandum of Understanding or College of Supervisors agreement for cooperation in cross-border supervision or if they have a supranational supervisor.	Central Banks' and Supervisory authorities' websites and other sources.
Cooperation intensity$_{ij}$	Ordinal variable that ranges from zero to four if (i) the countries do not cooperate, (ii) have a Memorandum of Understanding for information sharing and on-site inspection, (iii) have a College of Supervisors, (iv) have a Memorandum of Understanding on crisis management and resolution and (v) have a supranational supervisor.	Central Banks' and Supervisory authorities' websites and other sources.
Externality		
Externality$_{ij}$	Corresponds to the average of a set of variables' differences between each country-pair observation and the minimum of that variable normalized by the difference between the maximum and the minimum of the variable.	Authors' calculations.
Avg. foreign share$_{ij}$	Corresponds to the average of the share of assets from country j operating in country i and vice versa.	Authors' calculation using Bankscope data and Claessens and Van Horen (2014).
Correlation$_{ij}$	Corresponds to average correlation between country i and j stock market index when each country's index experiences the 5% lowest returns. We use the Datastream index whenever available, other the MSCI index.	Datastream and MSCI market index.
Currency$_{ij}$	Dummy variable equal to one if country i and country j have the same currency, their currencies are fixed with respect to the other or their currencies are fixed with respect to a third common currency.	IMF.
G-SIB$_{ij}$	Dummy variable that equals one if there exists at least one Global Systemically Important Bank that has operations in both countries i and j.	Financial Stability Board (2013).
Heterogeneity		
Heterogeneity$_{ij}$	Corresponds to the average of a set of variables' absolute values of the differences between both countries' observations normalized by the difference between the maximum and the minimum of the variable.	Authors' calculations.
ΔPreferences$_{ij}$	Negative of Signorino and Ritter (1999) measure of political affinity defined as the similarity of voting patterns in the U.N. General Assembly, normalized to be between zero and one.	Voeten (2013)
ΔForeign share$_{ij}$	Absolute value of the average of the difference between the banks' foreign assets of one country in the other over the total assets of the other country banking system and over the total assets of the country banking system, and vice versa; normalized by the difference between the maximum and the minimum of this variable.	Authors' calculation using Bankscope data and Claessens and Van Horen (2014).
ΔLegal Origin$_{ij}$	Dummy variable equal to zero if both countries have the same legal origin (English, French, German, Socialist or Scandinavian), and equal to one otherwise.	LaPorta, et al. (2008).
ΔLatitude$_{ij}$	Absolute value of the difference between both countries' latitude coordinates of the capital, normalized by the difference between the maximum and the minimum of this variable.	Nationmaster.
ΔLongitude$_{ij}$	Absolute value of the difference between both countries' longitude coordinates of the capital, normalized by the difference between the maximum and the minimum of this variable.	Nationmaster.
ΔLanguage$_{ij}$	Dummy variable equal to zero if both countries speak the same language, and equal to one otherwise.	CIA World Factbook.
ΔDebt/GDP$_{ij}$	Absolute value of the difference between both countries' government debt as a share of GDP, normalized by the difference between the maximum and the minimum of this variable.	IMF.
ΔGDP per capita$_{ij}$	Absolute value of the difference between both countries' gross domestic product divided by midyear population, normalized by the difference between the maximum and the minimum of this variable.	World Bank.
Other control variables		
Trade$_{ij}$	Corresponds to the sum of exports and imports between the two countries over the sum of both countries' GDP.	Barbieri and Omar (2012).
PTA$_{ij}$	Dummy variable equal to one if a preferential trade agreement exists between the two countries.	World Bank.
Internet use$_{ij}$	Corresponds to the sum of both countries' individual use of the internet as a percentage of each country's population.	World Bank.
Crisis	Dummy variable equal to one starting in 2008.	
Common share$_{ij}$	Corresponds to the number of third countries with which country i and country j have a cooperation arrangement over the total possible number of joint countries that the two can cooperate with.	Authors' calculations based on collected data on cooperation.