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The Corporate Complexity of Global Systemically Important Banks

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Abstract The financial crisis of 2007-2009 revealed that the corporate complexity of most of the Global Systemically Important Banks (G-SIBs) presented a formidable obstacle to any plausible orderly resolution of these institutions. This paper documents the extent of this complexity making use of an historical time series, developed by the authors, that shows the evolution of the number of majority-owned subsidiaries of G-SIBs over time. After a very significant increase in complexity before the crisis and until 2011, this trend may be reversing, possibly in response to regulatory and market pressures on banks since then. Nonetheless the reduction in complexity has been uneven across institutions and may not persist. The econometric analysis of this new set of panel data produces two key results with relevant policy implications: first, the relationship found in previous studies between the number of subsidiaries and bank size loses significance when time effects are introduced; second, large mergers and acquisitions are a key driver of complexity and their effect remains significant even when time effects are considered.

Keywords Basel Committee · Corporate complexity · Corporate structure · G-SIBs · Cross-border resolution · Resolution policy · Financial Stability Board · Systemic risk

1 Introduction

While excessive risk-taking and leverage may have caused the 2008 global financial crisis (Calomiris et al. 2011), the complexity of the structure of financial institutions and opaque interconnections among them impeded effective oversight by the authorities ex ante and greatly complicated crisis management and the resolution of institutions ex post. The failure

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of Lehman Brothers provided clear evidence of the difficulties inherent in complex, opaque legal structures that span multiple national borders and bear little relationship to the way business is managed. The challenges of coordinating, much less harmonizing, scores of legal proceedings across multiple jurisdictions proved to be daunting (FDIC 2011, Herring 2014; Kapur 2015). Once the financial group entered multiple resolution processes for the various separate legal entities, information became so fragmented that it was virtually impossible to preserve any going concern value the group may have had.

More generally, in the event of the insolvency of a global, systemically important bank, hundreds or even thousands of legal entities would need to be resolved. Since most of these firms are managed in an integrated fashion along lines of business with only minimal regard for legal entities, national borders, or functional regulatory domains, simply mapping an institution's business activities into the legal entities that must be resolved presents a formidable challenge. Moreover, these legal entities would be subject to numerous different national regulatory and bankruptcy procedures, many of which conflict (Herring 2003).

Despite the relevance of the complexity of bank corporate structures for supervision and resolution policy, it has received relatively little attention in the literature, most of it after the 2008 financial crisis (Herring and Santomero 1990; Herring and Carmassi 2010, 2015; Avraham et al. 2012; Cetorelli and Goldberg 2014; Lumsdaine et al. 2015). This paper builds on and extends Herring and Carmassi (2010, 2015), chapters in the Oxford Handbook of Banking, which present a broad analysis of the corporate structure of Global Systemically Important Banks (G-SIBs) with emphasis on the implications for systemic risk, and a monograph written for the Systemic Risk Council (Carmassi and Herring 2015) that surveys a broad range of issues regarding the corporate structure of G-SIBs including the evolution of corporate complexity, disclosure, and challenges posed to resolution policy. In this paper our focus is on the number of legal entities controlled by the top-level corporation in each of the twenty-nine banking groups designated by the FSB (2013) as G-SIBs. We present a time-series overview of the size and complexity of the G-SIBs based on new data that we have compiled for both US and non-US G-SIBs. After discussing various possible factors that may lead G-SIBs to adopt more complex structures such as regulation, tax incentives and merger activity, we subject our panel data to econometric analysis to investigate the drivers of complexity.

In contrast to the earlier empirical literature, which relates complexity primarily to asset size based on cross-sectional data, we find that a bank's history of mergers and acquisitions has a more significant impact on complexity. Indeed, once account is taken of regulatory and tax incentives and other factors that tend to evolve over time, asset size appears to have no significant additional impact on the complexity of G-SIBs. From an analytical perspective, this should not be surprising. If a bank were to grow organically, without making acquisitions or offering new products or expanding internationally, its assets could grow as rapidly as market conditions permitted without creating any new legal entities. Of course, this hypothetical is unrealistic, but it does highlight the inadequacy of a focus on the relationship between size and complexity for policy analysis. If complexity is not necessarily related to size, then policies aimed at reducing the size of banks should not necessarily be expected to reduce their complexity.

The paper is organized as follows. The next section presents an overview of the evolving size and complexity of the G-SIBs, which draws on our new data showing how the G-SIBs have grown from 2002 to 2013. The following (third) section reviews the empirical literature on the corporate structure of G-SIBs and considers incentives that may have encouraged G-SIBs to adopt the complicated legal structures described in the preceding section. The fourth

section describes our attempt to reflect these incentives in the specification of a regression equation describing the evolution of complexity of the 29 G-SIBs over time. We then discuss the implications of our results for understanding the complexity of G-SIBs. We conclude with a discussion of issues for future research with emphasis on the need for more precise, consistent and comprehensive data to enhance our understanding of the factors that drive the corporate complexity of G-SIBs. The issue of complexity remains a key policy concern that was highlighted by the Fed and FDIC in their rejection in August 2014 of the living wills submitted by 11 banks (FDIC and FRB, 2014). An appendix explains the construction of our database tracking the number of separate legal entities controlled by each G-SIB, and provides an overview of available data sources on bank corporate structures.

2 Complexity of bank corporate structures: an overview

While the complexity of international banks has multiple dimensions including interconnectedness with other institutions and links with crucial financial infrastructures, our analysis of complexity focuses on the number of separately incorporated entities in the banking group. Although this is only one dimension of corporate complexity, it provides a basic starting point for any more comprehensive analysis. From the perspective of resolution policy, the authorities must deal with the number (and complexity) of the legal entities that would need to be taken through some sort of bankruptcy or resolution process in the event of insolvency.

Our measure undoubtedly overstates corporate complexity to some extent because it unavoidably includes transactional or shell subsidiaries that would be subject to automatic unwind provisions and thus would pose no systemic threat in the event of the collapse of the group. But this overstatement is offset to some extent because the measure does not include the number of significant foreign branches, which are not disclosed systematically and comprehensively in any public database. In the event a group appears on the verge of insolvency, some of these branches might be ring-fenced and treated as if they were subsidiaries.

Surprisingly, the Basel Committee on Banking Supervision (BCBS, 2013, 2014) and, subsequently, the Federal Reserve Board (2015) have adopted measures of the systemic importance of banks that omit the number of subsidiaries. Their approach is based on indices for the size of banks, interconnectedness, the lack of readily available substitutes for a bank's services, cross-jurisdictional activity and complexity. The BCBS weights each of these individual indicators by 20 % to determine a weighted average score intended to reflect the systemic importance of the bank. The Fed has added a measure of dependence on wholesale funding and has increased the capital surcharge associated with each bank's score. While these other indicators are certainly relevant, it is by no means clear that they are more relevant for policy purposes than the number of legal entities that would need to be dealt with in insolvency. The Fed does address the omission of organizational complexity in passing (FRB 2015, p. 49096). It defends the absence of this factor by saying that organizational complexity is indirectly reflected in the quantity of Level 3 assets and cross-jurisdictional activity. While these indirect measures shed light on some aspects of complexity, they do not supplant the information provided by the number of legal entities, which can be directly measured.

We have examined the correlations between the "official" indicators of systemic importance (as reported by Glasserman and Loudis 2015) and our measure of complexity, the number of majority-owned legal entities, for 2013. The Basel Committee has designated three different sub-indicators as proxy measures for complexity: (1) the amount of over-the-counter

Table 1 Majority-owned subsidiaries of Global Systemically Important Banks (ranked by number of subsidiaries in 2013). The table displays the number of majority-owned subsidiaries from 2002 to 2013 of the 29 banking groups designated as G-SIBs by the FSB in November 2013. Data refer to a specific month for each year. Majority-owned subsidiaries are defined as those for which the G-SIB is the ultimate owner with a minimum control path of 50.01 % in each piece of the control chain

	G-SIBs	December 2013	December 2012	December 2011	December 2010	December 2009	December 2008	November 2007	December 2006	October 2005	December 2004	December 2003	November 2002
1	BNP Paribas	2,460	2,813	2,936	2,766	1,993	1,316	1,163	1,248	1,043	1,054	903	931
2	HSBC	2,348	1,902	1,799	2,010	1,807	1,111	1,182	1,248	686	989	651	650
3	Unicredit	2,189	2,044	2,409	2,222	1,562	1,560	932	1,444	185	183	170	102
4	Deutsche Bank	2,101	2,156	2,176	2,040	2,052	1,988	1,918	1,746	632	989	1,008	1,879
5	Citigroup	1,997	2,325	3,490	2,626	2,733	3,030	2,374	2,696	497	1,382	1,552	–
6	Bank of America	1,891	2,103	2,191	2,210	2,745	1,457	1,410	1,840	1,146	790	–	–
7	Royal Bank of Scotland	1,818	1,516	1,796	1,237	949	1,110	1,155	1,277	1,218	860	777	675
8	Barclays	1,597	1,242	1,398	1,380	1,038	1,090	1,017	1,006	796	476	483	468
9	Wells Fargo	1,570	1,557	1,890	2,120	2,646	838	910	1,316	621	590	–	–
10	BPCE SA	1,435	1,442	938	–	763	–	–	–	–	–	–	–
11	Crédit Agricole SA	1,272	1,187	1,570	812	–	768	762	591	126	119	122	183
12	JPMorgan Chase	1,246	1,190	972	923	831	1,000	829	946	532	678	393	364
13	Morgan Stanley	1,194	1,344	1,481	1,650	1,691	1,299	1,008	1,194	788	–	–	–
14	ING Groep	1,107	1,427	1,749	1,762	1,739	1,720	1,383	1,566	1,409	1,925	1,401	1,392
15	Société Générale	860	927	941	1,016	1,037	963	846	743	672	630	554	382
16	Santander	745	596	651	670	999	687	539	584	535	396	310	308
17	UBS	458	474	382	364	320	334	412	568	385	301	–	–
18	BBVA	422	417	380	484	507	402	352	399	344	422	345	344
19	Standard Chartered	366	249	238	281	161	122	102	70	49	48	55	65
20	Goldman Sachs	356	440	402	298	307	424	446	191	136	70	56	47
21	Credit Suisse	340	265	273	262	303	330	286	470	361	440	427	436
22	Bank of New York Mellon	238	301	356	270	428	258	–	–	–	–	–	–
23	Nordea	227	182	218	193	224	181	206	180	206	228	154	192
24	Sumitomo Mitsui	182	165	135	147	148	241	76	10	67	61	73	–

Table 1 (continued)

	G-SIBs	December 2013	December 2012	December 2011	December 2010	December 2009	December 2008	November 2007	December 2006	October 2005	December 2004	December 2003	November 2002
25	Mizuho	175	104	97	129	137	109	77	37	18	12	5	–
26	State Street Corporation	167	147	142	95	85	83	72	70	51	47	–	–
27	Mitsubishi UFJ	129	110	103	139	147	145	104	198	104	92	87	82
28	Bank of China	106	108	113	108	106	108	103	104	–	–	–	–
29	ICBC	56	30	23	21	35	31	18	11	–	–	–	–
	Average	1,002	992	1,078	1,008	982	811	729	806	504	533	476	500
	Median	860	927	938	741	797	728	762	591	497	431	369	364
	Range	2,404	2,783	3,467	2,745	2,710	2,999	2,356	2,686	1,391	1,913	1,547	1,832

Source: Bankscope. Missing values are not available either because the current G-SIB did not exist in a specific year or because Bankscope does not report the data

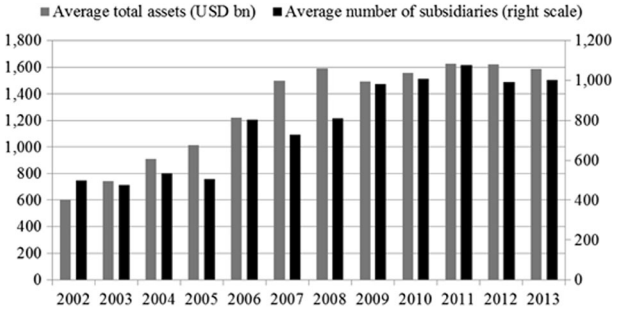

Fig. 1 Evolution of the average number of majority-owned subsidiaries and the average of total assets for the sample of 29 G-SIBs, 2002–2013

Source: analysis of Bankscope data

derivatives; (2) the quantity of trading and available for sale securities; (3) the amount of Level 3 assets. Our measure of complexity has a positive 0.5 correlation (significant at the 1 % level) with the index that combines these three sub-indicators. The correlations are also positive and significant between the number of subsidiaries and each of the three sub-indicators (see Appendix B). Our measure is thus consistent with the Basel Committee indicators, but since the correlations are not perfect and our measure is of direct, practical importance in resolving a G-SIB, we believe that it would add useful information to the Basel Committee's measures of complexity.

Our measure of complexity is assembled from data spanning a 12-year period from 2002 to 2013. These data, which are summarized in Table 1, show the evolution of the number of majority-owned subsidiaries of the G-SIBs based on consistent criteria and thresholds for identification of majority-owned subsidiaries. Although the number of subsidiaries should be easily verifiable, we lack a definitive official source that reports the number of subsidiaries for all G-SIBs on a consistent basis (see Appendix A for a detailed discussion of alternative sources of data and the rationale for our reliance on Bankscope data).

Our average measure of complexity has approximately doubled over this 12-year period, albeit with significant differences across G-SIBs. The average number of subsidiaries rose from 500 in 2002 to about 1,000 in 2013. This average, however, masks substantial differences among the most and least complicated G-SIBs that appear to be stable over time. After 2005, the difference has always exceeded 2,000 subsidiaries. Moreover, these differences persist even if the Asian G-SIBs, which have much simpler corporate structures, are excluded.

Figure 1 depicts the average of majority-owned subsidiaries graphed alongside the average of total assets for the 29 G-SIBs each year from 2002 to 2013. Clearly, both size and complexity grew substantially until 2011, but these trends have reversed to some extent since then in response to both regulatory pressures and market forces.

Table 2 contrasts the classification of subsidiaries by industry just before, and 4 years after the crisis (December 2007 versus May 2013). This table is based on data for the 13 G-SIBs that had also been identified by the Bank of England and the International Monetary Fund as Large and Complex Financial Institutions (LCFIs) before the crisis and managed to survive the crisis.

These data show that banks comprise a small proportion of the number of legal entities (4 % in 2013), insurance companies a still smaller proportion (1 % in 2013), while larger proportions include trusts and financing vehicles (22 %), other financial companies (25 %) and non-financial companies (47 %). These percentages appear to be quite stable between 2007 and 2013, as reported in Table 2.

Trusts and financing vehicles represent a substantial number of subsidiaries for each of the 13 G-SIBs. Undoubtedly, some of these trusts are Special Purpose Vehicles (SPVs), but many

Table 2 Breakdown by industry of subsidiaries of G-SIBs. This table shows the breakdown by industry of majority-owned subsidiaries of G-SIBs as of May 2013 and December 2007 (in parentheses)

	Banks	Insurance companies	Mutual & pension funds/nominees /trusts /trustees	Other financial subsidiaries[1]	Non-financial subsidiaries[2]	Total subsidiaries
Bank of America	72	17	584	322	915	1,910
	(32)	(24)	(396)	(282)	(673)	(1,407)
Barclays	54	16	465	380	824	1,739
	(49)	(21)	(309)	(239)	(385)	(1,003)
BNP Paribas	103	68	323	760	1,338	2,592
	(88)	(74)	(102)	(433)	(473)	(1,170)
Citigroup	111	41	456	650	1,039	2,297
	(101)	(35)	(706)	(584)	(1,009)	(2,435)
Credit Suisse	30	4	89	52	67	242
	(31)	(4)	(91)	(63)	(101)	(290)
Deutsche Bank	68	8	541	618	889	2,124
	(54)	(9)	(458)	(526)	(907)	(1,954)
Goldman Sachs	15	10	74	121	200	420
	(7)	(4)	(48)	(151)	(161)	(371)
HSBC	89	37	309	298	832	1,565
	(85)	(37)	(246)	(381)	(485)	(1,234)
JPMorgan Chase	54	13	305	205	518	1,095
	(38)	(17)	(229)	(145)	(375)	804
Morgan Stanley	19	12	245	236	799	1,311
	(19)	(22)	(225)	(170)	(616)	(1,052)
Royal Bank of Scotland	33	5	162	206	393	799
	(31)	(29)	168	450	483	(1,161)
Société Générale	95	20	97	405	296	913

Table 2 (continued)

	Banks	Insurance companies	Mutual & pension funds/nominees /trusts /trustees	Other financial subsidiaries[1]	Non-financial subsidiaries[2]	Total subsidiaries
	(81)	(13)	(93)	(270)	(387)	(844)
UBS	28	4	108	152	166	458
	(29)	(2)	(121)	(66)	(199)	(417)
Total by industry	771	255	3,758	4,405	8,276	17,465
	(720)	(310)	(3,490)	(4,263)	(6,729)	(15,512)
% by industry	4 %	1 %	22 %	25 %	47 %	100 %
	(5 %)	(2 %)	(22 %)	(27 %)	(43 %)	(100 %)

Source: Bankscope

[1] 'Other financial subsidiaries' include, among others, hedge funds, private equity and venture capital subsidiaries

[2] 'Non-financial subsidiaries' include all companies that are neither banks nor insurance companies nor financial companies. They can be involved in manufacturing activities but also in trading activities (wholesalers, retailers, brokers, etc.). We have allocated foundations and research institutes to this category as well

securitization vehicles are unlikely to be included in our count of majority-owned subsidiaries because sponsors have often attempted to avoid the obligation to consolidate these entities by structuring them to ensure that the sponsor's voting rights (if any) fall below the reporting threshold for consolidation. Finally, we note that assets are typically concentrated in very few subsidiaries, generally the depository entities and the broker-dealer entities. Most subsidiaries have negligible assets and income, as shown in Table 3. If such subsidiaries provide critical services to the rest of the group or serve essential functions, they may require special attention in the resolution process. Institutions subject to the living wills requirement in the US must now identify these subsidiaries in the public sections of their resolution plans.

The cost of establishing and maintaining a separate legal entity varies with its purpose, regulatory status and chartering jurisdiction. At one extreme, the cost of establishing and maintaining a subsidiary in a booking center may be trivial because such jurisdictions typically impose minimal chartering, regulatory or reporting requirements. Generally such subsidiaries do not require external directors, independent audits or any of the other costs of corporate governance and so the burden of maintaining such subsidiaries is also de minimis.

Other kinds of subsidiaries are much more costly to establish and maintain, particularly if they conduct a regulated activity in the local jurisdiction. These may require heavy expenditures to obtain a license and the jurisdiction is likely to impose heavier continuing costs of corporate governance and regulatory compliance costs. Nonetheless, it seems unlikely that the cost of establishing separate legal entities has been a decisive factor in shaping the corporate structure of G-SIBs. Instead their complex corporate structures are likely to have been largely demand determined.

Of course, the demand for legal entities is a derived demand. Legal entities have no intrinsic value except for the activities they facilitate. The creation of separate legal entities is a response to a complex array of regulatory, tax and reporting incentives as well as profit opportunities

Table 3 Selected data on the corporate structures of four G-SIBs. The table categorizes data for the majority-owned subsidiaries of four G-SIBs (as of June 2014) showing the number of subsidiaries in each industry classification and the number of subsidiaries relative to certain thresholds for total assets, operating income and number of employees

	Citigroup	Deutsche Bank	HSBC	Santander
Number of majority-owned subsidiaries	1,945	1,985	2,076	710
Bank	5 %	3 %	4 %	9 %
Insurance	2 %	0.5 %	2 %	2 %
Vehicles/trusts	23 %	23 %	19 %	29 %
Other financial subsidiaries	31 %	28 %	20 %	26 %
Non-financial subsidiaries	39 %	45 %	55 %	33 %
No. of subs with asset data available (>= $ 0.5 mln)	165	644	330	272
No. of subs with assets > $ 10 bn	31	24	42	28
No. of subs with operating income available (>= $ 0.5 mln)	214	423	294	206
No, of subs with operating income >= $ 1 bn	21	18	34	21
No. of subs with no. of employees available	194	406	358	165
No. of subs with employees >= 100	74	81	135	62
No. of subs with employees < 10	62	243	71	46

Source: computations on Bankscope data

and the mitigation of agency costs. In the next section we examine some of the key factors that influence the derived demand for separate legal entities.

3 Why do G-SIBs adopt such complex legal structures?

3.1 The literature on bank corporate structure and complexity

Herring and Carmassi (2010) documented hundreds of majority-owned subsidiaries of the 16 Large, Complex Financial Institutions just before the 2008 crisis. Using Bankscope data on majority-owned subsidiaries (subsidiaries that are controlled with a minimum ownership path of 50.01 % along the entire control chain), they showed that, at year-end 2007, LCFIs were operating with a vast and complex network of legal entities, ranging from 267 (Merrill Lynch) to 2,435 (Citigroup), with a median value of 923.5 and a mean of 969.5. On average only a small share of subsidiaries for each LCFI was engaged in the banking (5 %) or insurance (2 %), while most subsidiaries were trusts and vehicles (22 %), other financial companies (27 %) and non- financial/industrial companies (43 %) (see Table 2).

While most of the identified possible causes of complexity are not specific to the financial services sector, regulation is and deserves special consideration. As illustrated by Herring and Santomero (1990), regulatory constraints include the requirement to operate with a bank parent controlling non-bank operating subsidiaries or to establish a bank holding company controlling bank and non-bank subsidiaries (the dominant model in the United States). More broadly, regulators may impose some form of corporate separateness on bank activities in securities, insurance and real estate business. For banking firms operating worldwide such requirements may be imposed not just by the home country, but also by a significant number of host jurisdictions, further increasing complexity.

Avraham et al. (2012) focused on the corporate structure of US bank holding companies, showing their increase in size, complexity and geographical scope over the last two and a half decades. They report that the four most complex firms in terms of number of legal entities had over 2,000 subsidiaries as of February 2012 (with two of them above 3,000); in contrast, based on Federal Reserve filings, only one firm was operating with more than 500 subsidiaries in 1990. After discussing the various factors that have driven the increase in size, complexity, scope and consolidation of BHCs over time, their statistical analysis focuses on cross-sectional data as of February 2012. They find that size is significantly correlated with complexity, although the relationship is not proportional: a one percent increase in size is likely to be correlated with a less than one percent increase in the number of subsidiaries. Other factors, such as industry or geographical diversification or the share of non-commercial bank assets, are positively correlated with complexity, but the relationships are not statistically significant.

Cetorelli and Goldberg (2014) refer to three different concepts of complexity: (1) organizational complexity (the number of affiliates); (2) business complexity (the types and variety of activities conducted) and (3) geographical complexity (the global diversity of operations). Unlike Avraham et al. (2012), Cetorelli and Goldberg use the Bankscope database and data definitions consistent with those adopted by Herring and Carmassi (2010) and Carmassi and Herring (2015). Their empirical study focuses on banking groups headquartered in the US and on non-US banking groups with significant operations in the United States. Consistent with Avraham et al. (2012), they also find a significant, positive and less than proportional relationship between the number of subsidiaries and the size of the banking group. In addition, they find

that geographical diversification and the weight of nonbanking affiliates relative to banking subsidiaries have a positive and significant correlation with the number of subsidiaries.

Cetorelli and Goldberg (2014) also show that a very large proportion of subsidiaries are not controlled directly by the parent (at Level 1). Rather they are controlled indirectly through other subsidiaries with increasing distance from the parent, and so they conclude that most of the organizational complexity arises through indirectly controlled subsidiaries. Although Cetorelli and Goldberg (2014) confirm the correlation between size and organizational complexity, they refrain from drawing conclusions about the drivers of complexity. The analyses of Avraham et al. (2012) and of Cetorelli and Goldberg (2014) are mostly based on a cross-sectional of data.

Laeven et al. (2014) also found a positive and significant (at 1 %) correlation between the log of the number of subsidiaries and the log of total assets, based on cross-section data as of year-end 2011 for a global sample of 370 publicly traded banks from 52 countries with assets of at least US$ 10 billion. They also found a positive correlation between the log of the number of subsidiaries and non-interest income, leverage and funding fragility, and a negative correlation between the log of the number of subsidiaries and Tier 1 ratio, deposits/assets and loans/assets. These results suggest that banks with more subsidiaries are more likely to be more involved in market-based activities, to be more leveraged and to be more reliant on wholesale funding.

Lumsdaine et al. (2015) focused on the organizational structure of 29 large financial institutions including 19 G-SIBs, 5 non-G-SIB banks and 5 insurance companies. Using a non-public dataset, they show measures of organizational complexity at two different times – May 2011 and February 2013. They conclude that geographical and business complexity seems to have decreased over this interval, but their data show that complexity measured by the average number of subsidiaries has increased. They report a positive correlation between size and the number of subsidiaries, but question the strength of this relationship and also suggest that geographical and business complexity might be negatively correlated with size.

Much remains to be understood about the complexity of the legal structures of G-SIBs and why it has grown. However, the empirical literature has provided evidence that: (1) complexity (as measured by the number of subsidiaries) has increased over time; (2) size and complexity appear to be positively correlated; and (3) non-bank, indeed, non-financial entities comprise the largest number of subsidiaries in most G-SIBs.

In the following section (3.2) we examine external incentives and restrictions that encourage banks to conduct activities through separate legal entities. Although we believe these incentives are of fundamental importance, banks would have strong reasons to introduce a certain amount of legal separateness in their corporate structures even in the absence of regulatory requirements and tax and regulatory incentives. We consider these internal objectives in Section 3.3.

3.2 External restrictions and incentives: the role of regulations, taxation and accounting policies

Often a G-SIB is obliged to create a separate entity if it wants to undertake a particular kind of activity or operate in another jurisdiction. The history of US bank regulation illustrates this phenomenon. From the adoption of the Edge Act in 1919 through the Glass-Steagall Act in 1933 to the Gramm-Leach-Bliley Act of 1999 and the Intermediate Holding Company Rule of 2014 banks have been required to establish separate entities to undertake particular activities.

The US authorities have long relied on corporate separateness as a way of permitting banks to extend their activities geographically or undertaking new activities, while insulating the depository institutions from problems that may arise in an affiliate. Indeed, one of the reasons that virtually every major US bank resides in a bank holding company springs from the Bank Holding Company Act of 1956, which provided banks with means of expanding their geographic domains without violating state laws that limited intra-state branching or the ban on interstate branching that existed until the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994. The Bank Holding Company Act also provided a way for banks to conduct activities "related to banking" but prohibited under the bank charter. In addition, the authorities have imposed corporate separateness on G-SIBs for the convenience of specialized regulators. Broker-dealer operations are housed in separate subsidiaries at least in part to facilitate supervision by the SEC and insurance activities must be chartered in individual states to facilitate oversight by state insurance commissioners.[1]

Although host countries share the objective of safeguarding local financial stability, they differ markedly in their regulatory strategies for achieving this objective. Some countries believe this is best accomplished by requiring foreign G-SIBs to operate through branches of the parent bank. They contend that if local activities are backed by the full capital and liquidity of the parent and overseen by the parent bank's supervisor, they are less likely to cause instability in the local market. Other countries believe that local financial stability can be best preserved by requiring that these activities be conducted in locally chartered, separate legal entities subject to local capital and liquidity regulations, overseen by host country authorities. New Zealand is perhaps the most outspoken advocate of this approach, requiring not only that foreign-owned institutions establish a local subsidiary, but also that the subsidiary be insulated from the parent by a number of operational and financial firewalls.[2]

These are but a few examples of corporate separateness required (or at least incentivized) by the regulatory authorities. This web of regulatory restrictions and incentives in both home and host countries is so complex and pervasive that it is difficult to estimate the extent to which it has had an influence on the complexity of the legal structure of G-SIBs. The importance of regulation may help explain why, on average, the number of majority-owned subsidiaries (Bankscope, May 2013) of the 28 G-SIBs identified by the Financial Stability Board as of November 2012 was 2.6 times the number of majority-owned subsidiaries (Osiris, August 2013) of the biggest 28 non-financial firms by market capitalization (as of yearend 2012). Since financial and non-financial firms face broadly similar tax rates and tax incentives, the main reason for the difference in the total number of subsidiaries is likely to be attributable to regulation.

Tax policy is not generally considered to be part of the regulatory framework, but its impact on corporate structure is profound and ubiquitous. The deductibility of interest payments, but not dividends has led to a preference for debt finance relative to equity, as with most corporations, and has created an incentive to use affiliates to raise debt. These institutional

[1] Undoubtedly, many banks also adopted the holding company structure because of the opportunities that it provided for double-leverage. By borrowing at the holding company level and down-streaming the proceeds as equity in affiliated banks, the holding company could satisfy capital adequacy guidelines at affiliated banks while simultaneously achieving its desired degree of leverage in the consolidated financial structure. Subsequent regulatory constraints on bank holding companies and increasing emphasis on consolidated regulation and supervision have reduced this flexibility.

[2] The BCBS (2010, p. 29) cautions that the line between a branch and a subsidiary is often quite blurred in practice noting that "in some jurisdictions branches…may have to meet many of the requirements normally imposed on locally-incorporated subsidiaries, while in other jurisdictions subsidiaries may function much more like branches integrated into the parent". Luciano and Wihlborg (2013) make a similar point.

innovations are designed to capture the tax benefits of debt while satisfying regulatory capital requirements for equity. One example is the proliferation of vehicles for issuing Trust Preferred Securities (TruPS) (Goodman et al. 2007).

Because the authorities often use the tax code to encourage particular kinds of activities, this may also provide incentives for G-SIBs to establish separate entities to obtain tax benefits. Banks frequently establish separate entities to qualify for tax subsidies targeted at special activities such as real estate investment, leasing, or energy conservation.

The ability to establish subsidiaries in foreign tax havens may facilitate the use of excess foreign tax credits and defer taxes on certain kinds of income more or less indefinitely. In addition, particular locations may be preferred so that a G-SIB can take advantage of special tax-sparing treaties with specific countries in which it conducts business. Moreover, the establishment of an intermediate-level holding company in such jurisdictions may reduce the cost of transferring funds from one foreign entity to another by avoiding withholding and transfer taxes. G-SIBs may also establish subsidiaries in tax havens for the benefit of foreign customers who would otherwise be subject to withholding taxes (these customers may also value the secrecy that tax havens also tend to provide).

This web of tax incentives is even more complex than the morass of regulatory constraints, and so it is virtually impossible to measure the extent of their impact on the complexity of G-SIBs. It certainly extends well beyond the count of the number of subsidiaries in tax havens. Nonetheless, this count provides a minimal indication of the impact of tax incentives. In May 2013 nine of the G-SIBs each had more than 100 subsidiaries located in offshore booking centers and six of them had 20 % or more of their subsidiaries in off-shore tax havens.

Despite years of effort to harmonize accounting principles and practices across countries, substantial differences remain. A G-SIB may sometimes be able to exploit those differences by establishing a subsidiary in a strategic location or by creating a separate entity to escape accounting consolidation requirements or disclosure laws. Regulators rely on accounting measures to set capital and liquidity requirements and so often the underlying motive for the creation of a more elaborate legal structure is not only to achieve a more favorable accounting treatment for a particular activity or portfolio of assets, but also to lighten the burden of complying with the costs of regulation.

The growth in special purpose vehicles (SPVs) before the crisis illustrates the distortions that can occur and the implications for corporate complexity. In addition to TruPS (mentioned above), another example of the use of a separate entity to reduce taxes is provided by Hume (2011). He reported that one G-SIB had established a separate legal entity in the Cayman Islands to off-load billions of troubled mortgage-backed securities. This new entity qualified as a separate company because the equity, equal to 3.5 % of the assets (which qualified the new entity for off-balance sheet treatment under accounting regulations), was placed with external investors. Nonetheless, the G-SIB guaranteed the external shareholders against loss and provided a loan to finance the remaining 96.5 % of the assets. The creation of this separate legal entity (which, by design, would not be counted as a controlled subsidiary of the parent) allowed the parent to avoid establishing a loan loss reserve against the portfolio of assets – which would have been required if they had remained on the balance sheet – and an increase in regulatory capital requirements. Moreover, it enabled the parent to crystalize a substantial tax loss, which could be used to offset profits in the rest of the group. This example illustrates the difficulty in understanding a G-SIB's span of control solely from data about ownership shares. Although accountants and regulators have revised their rules to close such loopholes after the crisis, similar opportunities and incentives undoubtedly remain.

3.3 Why do G-SIBs adopt such complex legal structures? Internal objectives

Even if regulatory restrictions and incentives, tax distortions and accounting loopholes were eliminated, G-SIBs are likely to prefer to establish a number of subsidiaries rather than conduct all of their business through a single legal entity. The corporate finance literature creates a presumption that many of these subsidiaries are established to reduce frictions in markets (both external and internal). Herring and Carmassi (2015) identify a number of such frictions. They include: reducing asymmetric information costs between shareholders and creditors; reducing asymmetric information costs and agency problems between external shareholders and managers; mitigating customer concerns regarding potential conflicts of interest; reducing the costs of financial distress by protecting the group from a risky subsidiary and/or protecting a subsidiary from risks in the rest of the group; and the legacy of mergers and acquisitions.

The impact of mergers and acquisitions deserves special consideration because many G-SIBs have grown through a series of substantial mergers and acquisitions (Herring and Carmassi 2010; Carmassi and Herring 2015). The restructuring of corporate legal structures is likely to involve substantial transactions costs and requires considerable attention from top-level management, and so the corporate structure of the acquired institution is often left largely intact. Thus mergers and acquisitions are likely to have a significant impact on the complexity of the corporate structure of G-SIBs. Relative to a firm of equal size that has grown organically, an acquisitive G-SIB is likely to have many more subsidiaries, if only because of the transactions costs in closing or consolidating the acquired subsidiaries. Many G-SIBs have engaged in a substantial number of mergers, some of them exceptionally large. For example, since 1990, Bank of America, Deutsche Bank, JPMorgan Chase, and UBS have implemented mergers in which the target institution was larger than 10% of the acquiring firm's total assets (source: Thomson Securities Data Company).

JPMorgan Chase provides a good example of how mergers may increase corporate complexity. The current organization is the result of a series of mergers of very large banks that began in 1991 with the merger of Chemical Bank Corporation and Manufacturers Hanover Corporation. This merger resulted in a near doubling of the size of the surviving institution, Chemical Bank, and, in 1996, was followed by the merger of Chemical Bank with The Chase Manhattan Corporation. The resulting institution merged with JPMorgan & Co., forming JPMorgan Chase & Co. (JPMC) in 2000. This series of mergers culminated in July 2004 with the merger of JPMC and Bank One Corporation (BOC) before the crisis and during the crisis included the merger with Bear Stearns and the acquisition of the assets of Washington Mutual. According to Federal Reserve/National Information Center (FED/NIC) data, at year-end 2003 JPMC had 1,569 subsidiaries; after acquiring BOC, it had 3,406 subsidiaries at year-end 2004, an increase of 117 %. At year-end 2007 JPMC had 3,683 subsidiaries. After the acquisitions of Bear Stearns and of the assets of Washington Mutual in 2008, the figure rose to 5,384, a 46 % increase. Subsequently, JPMC has undergone a process of simplification of its structure. By June 2013, it had succeeded in reducing its number of subsidiaries to 4,059, a 25 % reduction.[3] A similar pattern can be observed for Bank of America, with a doubling of

[3] The total number of controlled subsidiaries reported in FED/NIC database is often larger than the number we have reported in Table 1 based on the Bankscope database. One reason may be that the FED/NIC uses a lower ownership threshold (25 %) to define "control" than we do (50 %). In addition, the FED/NIC data include two other categories of subsidiaries: (1) entities that meet additional "reportability" criteria and (2) entities that are "of interest" to the Fed (but these do not necessarily meet the definition of control). For an analysis of corporate structures of US bank holding companies based on NIC/FED data see Avraham et al. (2012).

the number of subsidiaries after the 2008 acquisitions, followed by a significant reduction (of about 25 % from year-end 2009 to June 2013).

In addition to the avoidance of transactions costs in consolidating the subsidiaries of the acquired firm, the surviving G-SIB may choose to retain a considerable amount of corporate separateness in the target firm for two reasons. First, the acquirer may perceive value in the brand and hope to retain the reputational capital of the target firm. Second, the willingness to retain the existing corporate structure may facilitate acceptance of the merger. As Dermine (2006) notes, by committing to keep a local structure and staff in place, local shareholders and the board of directors of the target may be reassured about the future of the target firm. Also, the host country regulatory authorities sometimes require that the acquiring bank maintain the target bank as a separate, locally chartered corporation.

Nonetheless, even when a G-SIB wants to reduce its corporate complexity, it may take a significant amount of time to do so because of a wide range of frictions such as outstanding litigation involving particular subsidiaries. Moreover, rationalization of corporate structure requires resources and management attention at a time when the main goal may be simply continuing operations and trying to meet profitability objectives.

Given the low costs of creating some kinds of additional legal entities it may sometimes be easier to create a new legal entity than to identify and make use of an existing one. As a result, some of the proliferation of subsidiaries may simply be attributable to lackadaisical house-keeping of corporate structures. To the extent that increased complexity may have been the result of inadequate attention to the growing complexity of corporate structures, the living will process should be effective in encouraging banking groups to simplify and rationalize their corporate structures.

Finally, given the challenges that a complex corporate structure poses for timely resolution, it is certainly possible that some banks find it useful to develop complex corporate structures to ensure that they are considered too complex to fail. The perception of this status might be expected to give them an advantage in funding costs.

Our review of mergers and the impediments to consolidating subsidiaries once the merger has been completed leads us to expect that mergers will have a lasting impact on the degree of complexity of financial institutions. In addition, given changes in regulations and tax policies – and the tendency to grandfather particular institutions when taxes or regulations are changed – the current structures of G-SIBs must be regarded as path dependent. These structures reflect a broad range of external and internal incentives that may have changed over time (and across countries). They tend to accrue over time and a number of frictions may impede corporate simplification – especially in the absence of regulatory pressures to do so.

4 Econometric analysis

4.1 Methodology

Our count of subsidiaries is based on the Bankscope database and includes majority-owned subsidiaries, defined as those legal entities controlled by the ultimate parent with a minimum ownership path of 50.01 % through each level of the chain of control (see Appendix A for additional details).

Our objective is to enhance our understanding of the factors that influence the corporate complexity of G-SIBs. The most robust result from the preceding literature is that an institution's complexity (as measured by the number of its subsidiaries) is positively, but less than proportionately, related to its size (as measured by its total assets). Our first step is to determine whether this relationship, which has usually been estimated from cross-sectional data, holds for the full sample of G-SIBs over time. Following Avraham et al. (2012) and Cetorelli and Goldberg (2014) we examine the relationship between the log of the number of subsidiaries and the log of total assets.

Although the preceding literature does not examine the impact of mergers and acquisitions on corporate complexity, the interviews that we conducted for this study and our analysis of the transactions costs involved in consolidating or closing subsidiaries have led us to focus on this factor. We have scanned the merger and acquisition (M&A) activity of all G-SIBs from 2002 and 2013 and identified all mergers or acquisitions in which the size of the acquired firm was at least $50 billion in the year before the transaction (based on the Zephyr database). From these data, we constructed a proxy for significant M&A activity by dividing the number of subsidiaries of the acquired firm (the year before the M&A transaction) by the number of subsidiaries of the acquirer in the year before the deal is completed. This ratio was recomputed for each subsequent, significant acquisition. The resulting M&A ratio reflects the cumulative impact of mergers.[4] Based on our observation that consolidation of subsidiaries is costly, we expect the impact of M&A activity to be cumulative and that an increase in the M&A ratio will have a positive and significant impact on the log of the number of majority-subsidiaries.

Our analysis in Section 3 identified a number of additional factors that are likely to affect corporate complexity including regulations, taxes, accounting rules, growth strategies, choices of business models, attempts to minimize transaction costs and other agency issues such as protection against the cost of financial distress. Unfortunately, our efforts to develop suitable proxies for these factors have not been successful. Tax and regulatory incentives are too pervasive and complex to represent by a proxy variable. These factors are likely to vary across countries and over time. Moreover, they may even vary across institutions within the same country because changes in tax laws and regulations are usually implemented in such a way that incumbent institutions and preexisting activities are grandfathered. Thus the particular tax and regulatory constraints and incentives that an institution faces may depend on its status when regulations or taxes changed. The same may be true of agency costs and transactions costs.

Differences in corporate strategy may also have an important impact on corporate complexity. For example, a heavy emphasis on leasing or commercial real estate lending may lead to a much more extensive use of subsidiaries than specialization in other lines of business. Unfortunately, the income and balance sheet data available for the G-SIBs are not sufficiently granular to enable us to develop plausible proxies for these differences. Because we have not been able to devise credible proxies for the strategic choices and the impacts of regulation and taxes on each institution, we have attempted to capture the effects of these unobserved bank-specific factors through fixed effects dummy variables.

The time series data that we have compiled enable us to consider time effects in our analysis. Innovations in financial markets and technology, for example, should be expected to

[4] For G-SIBs that completed more than one significant acquisition, we have adjusted the ratio to reflect the additional large acquisitions. Each new transaction is represented by dividing the cumulative sum of the subsidiaries of all acquired firms in the year before the transaction by the number of subsidiaries of the acquirer in the year preceding the very first significant deal. In some cases where data on subsidiaries of acquired firms were not available in Bankscope, we have used FED/NIC or SEC data.

affect the number of subsidiaries by influencing the costs and expected benefits for G-SIBs of establishing subsidiaries.

4.2 Results

Table 4 displays the results of our analysis of panel data. We ran random effects GLS regressions and fixed effects regressions, including bank-specific fixed effects and time effects. We began by trying to affirm the relationship between size and complexity that has been reported in the literature. Column 1 shows that total assets appear to have a highly significant and positive, but less than proportionate relationship to corporate complexity. This result is consistent with the earlier literature, but omits a number of other variables that may be relevant.

As we have noted, we believe that a history of substantial M&A activity may lead to an increase in the number of subsidiaries that persists over time. Column (2) of Table 4 displays the results when we include our M&A proxy in the specification. The coefficient of the M&A proxy is highly significant, but the coefficient of the size variable remains highly significant although lower in magnitude. The introduction of the M&A proxy does increase the explanatory power of the equation.

In Section 3 we noted that a number of different factors from regulation to taxation to strategic choices may vary from bank to bank and so in the third specification, Column (3), we introduce fixed effects. The inclusion of fixed effects does not have a significant influence on the coefficients of the size variable or the M&A proxy, which also remain significant at 1 %, but it

Table 4 Factors affecting the complexity of G-SIBs, 2002–2013. This table shows the results of panel data regressions for the period 2002–2013. The dependent variable is the log of the number of majority-owned subsidiaries and independent variables include the log of total assets, the M&A ratio[1] as well as time effects and fixed effects

Dependent variable: log of number of majority-owned subsidiaries				
Independent variables	(1)	(2)	(3)	(4)
Log total assets	0.877***	0.706***	0.711***	0.338
	(0.123)	(0.128)	(0.134)	(0.219)
M&A ratio		0.405***	0.401***	0.367***
		(0.106)	(0.111)	(0.126)
Fixed effects	No	No	Yes	Yes
Time effects	No	No	No	Yes
Observations	311	311	311	311
Adjusted R^2	0.187	0.222	0.470	0.527
Number of G-SIBs	29	29	29	29

Robust standard errors in parentheses

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

Random effects GLS regression for Columns 1 and 2; fixed effects regression for Columns 3 and 4

[1] The M&A ratio is constructed by selecting the M&A deals between 2002 and 2013 in which G-SIBs were involved and in which the size of the acquired firm was at least $50 billion in the year before the transaction; to obtain the M&A ratio, the number of subsidiaries of the acquired firm (the year before the M&A transaction) is divided by the number of subsidiaries of the acquirer in the year before the deal is completed. In case of multiple large M&A deals in 2002–2013, the M&A ratio is recalculated by dividing the cumulative sum of the subsidiaries of all acquired firms in the year before the transaction by the number of subsidiaries of the acquirer in the year preceding the very first large deal in the period 2002–2013

Source: Bankscope for majority-owned subsidiaries and total assets of G-SIBs, as well as for the data on majority-owned subsidiaries used to build the M&A ratio; Zephyr dataset for the identification of large M&A deals

does improve the adjusted R^2. This seems entirely plausible because many of the omitted factors – regulatory incentives, tax incentives, strategies – are likely to be bank-specific in their impacts.

We are skeptical that the growth in assets has a causal link to the number of subsidiaries and suspect that the growth in assets may reflect a spurious correlation because other omitted variables may also tend to increase over time. We attempt to test this hypothesis by introducing time effects in the fourth specification, Column (4). Although the coefficient of the M&A proxy remains highly significant and close in magnitude to the estimates in (2) and (3), the coefficient of the size variable decreases by more than 50 % and, more importantly, loses all statistical significance. Thus asset size appears to have no significant influence on complexity apart from the passage of time. Unfortunately, we have been unable to identify which of the many factors that change over time drive this result.

We have examined the data for multicollinearity by calculating correlation coefficients. The correlation coefficient between the log of total assets and the M&A ratio is 0.22 (see Appendix B), well below the levels (0.8–0.9) that are likely to signal the presence of multicollinearity problems. We have not conducted formal tests for endogeneity between our measure of complexity and the regressors, but reverse causation seems highly unlikely. Since most of the assets of G-SIBs are held in the depository and broker-dealer subsidiaries, which are few in number, and most of the other subsidiaries, which are much more numerous, hold relatively few assets, it is highly implausible that the number of subsidiaries would determine asset size.

Table 5 Factors affecting the complexity of G-SIBs, 2002-2007 and 2008-2013. This table reports two panel data regressions in which the dependent variable is the log of the number of majority-owned subsidiaries and the independent variables include the log of total assets and the M&A ratio[1] as well as time effects and fixed effects. As a robustness check, the period is divided into two sub-periods, 2002–2007 (before the crisis) and 2008–2013 (the crisis and after)

Dependent variable: log of number of majority-owned subsidiaries

Independent variables	(1)		(2)		(3)		(4)	
	02-07	08-13	02-07	08-13	02-07	08-13	02-07	08-13
Log total assets	0.715***	0.128	0.561***	0.092	0.545***	0.030	0.345	-0.067
	(0.118)	(0.196)	(0.117)	(0.191)	(0.125)	(0.205)	(0.303)	(0.191)
M&A ratio			0.439***	0.742***	0.450***	0.829***	0.432***	0.696***
			(0.105)	(0.101)	(0.106)	(0.143)	(0.100)	(0.117)
Fixed effects	No	No	No	No	Yes	Yes	Yes	Yes
Time effects	No	No	No	No	No	No	Yes	Yes
Observations	140	171	140	171	140	171	140	171
Adjusted R^2	0.198	0.115	0.182	0.118	0.370	0.123	0.409	0.167
Number of G-SIBs	27	29	27	29	27	29	27	29

Robust standard errors in parentheses

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

Random effects GLS regression for Columns 1 and 2; fixed effects regression for Columns 3 and 4.

[1] The M&A ratio is constructed by selecting the M&A deals between 2002 and 2013 in which G-SIBs were involved and in which the size of the acquired firm was at least $50 billion in the year before the transaction; to obtain the M&A ratio, the number of subsidiaries of the acquired firm (the year before the M&A transaction) is divided by the number of subsidiaries of the acquirer in the year before the deal is completed. In case of multiple large M&A deals in 2002–2013, the M&A ratio is recalculated by dividing the cumulative sum of the subsidiaries of all acquired firms in the year before the transaction by the number of subsidiaries of the acquirer in the year preceding the very first large deal in the period 2002–2013

Source: Bankscope for majority-owned subsidiaries and total assets of G-SIBs, as well as for data on majority-owned subsidiaries used to build the M&A ratio; Zephyr dataset for the identification of large M&A deals

We have checked for robustness by dividing our sample in two sub-periods – 2002–2007 and 2008–2013 – and re-estimated the equations. As shown in Table 5, in both sub-periods the coefficient for the M&A ratio is significant at 1 % and its value is higher than in the full period 2002–2013. The asset size variable, on the other hand, loses significance in the period 2002–2007 when time effects are taken into account; in the period 2008–2013 it loses significance even before time or fixed effects are introduced.

5 Concluding comments

We have developed a data series that shows the evolution of complexity of the corporate structure of G-SIBs. These panel data allow us to investigate the relationship between corporate complexity and asset size, M&A activity, bank-specific fixed effects and time effects.

Unfortunately, we have not been able to devise satisfactory proxies for several of the factors identified in Section 3 that may affect organizational complexity. The bank-specific effects we introduce in the econometric analysis are intended to capture some of these factors, but we would have preferred to have much more direct measures of the influence of variables such as tax incentives, regulatory incentives and requirements, and differences in business strategies as well as broader environmental forces such as improvements in information and telecommunications technology that facilitate control over more complex, far flung enterprises. A better understanding of the quantitative impact of these factors remains a challenge for future research. In addition, it is important to provide a rigorous theoretical framework for understanding the determinants of decisions regarding corporate structure.

But the most urgent issue on the research agenda should be the collection and disclosure of better data regarding the corporate structure of G-SIBs. Given the substantial expenditures of resources by the US and other members of the Group of 20 in efforts to identify, supervise, regulate and resolve G-SIBs, it is astonishing that doubt remains about something as fundamental as the number of subsidiaries controlled by each G-SIB. For example, even though two US regulatory agencies collect and report the number of subsidiaries controlled by each US based G-SIB, the two reported totals sometimes vary by startling amounts (see Appendix A).

To facilitate more insightful analysis of the issues associated with corporate complexity, comprehensive data on the number of subsidiaries should be disaggregated in meaningful analytical categories. For example, material entities should be identified on the basis of consolidating statements with specified reporting thresholds relative to consolidated assets or revenues. These should include not only operating entities but also any holding companies that issue debt to non-affiliated entities. Entities providing critical services and performing critical functions should also be classified as material, regardless of their size. Information relevant to creditors and counterparties should be publicly disclosed. Although material entities would likely be the focus of most analyses, other entities, not considered material, should be classified in well-defined groups. Each standardized category should include an explanation about why entities listed in the group would not present an obstacle to an orderly resolution. In addition, foreign branches located outside the jurisdiction in which the top-level entity is chartered should be disclosed because in a non-cooperative resolution the host country might treat such branches as if they were subsidiaries. Improved data would have enabled us to undertake a much better focused analysis than has been possible with the publicly available data.

Despite the inadequacy of the available data, we believe that our analysis has produced two implications of policy significance. First, although Avraham et al. (2012), Cetorelli and Goldberg

(2014), Laeven et al. (2014) and Lumsdaine et al. (2015) all reported a positive and less than proportional relationship between the number of subsidiaries and asset size based on cross-sectional data, our estimates, based on panel data, imply that the relationship disappears into insignificance once time effects are introduced. The economic logic for a causal relationship between asset size and corporate complexity has never been clear. And, as we noted in section 2, most subsidiaries of G-SIBs have negligible assets, with virtually all assets concentrated in very few subsidiaries (typically depository institutions and broker-dealers). Balance sheets of depository institutions and broker/dealers can grow substantially without necessarily adding to corporate complexity and, since most G-SIBs include relatively few such institutions, it seems likely that the size variable may be serving as a proxy for other omitted variables. Such variables might include improvements in information and communications technology that facilitate the ability of G-SIBs to expand globally and control a broad range of activities, the secular decline in capital controls and the gradual reduction in barriers to cross-border direct investments in the financial services industry.

If the correlation between asset size and corporate complexity does not reflect a causal link, then policies intended to reduce the complexity of G-SIBs by reducing their asset size are unlikely to succeed. While policy-makers may have other reasons to want to cap or reduce the asset size of G-SIBs, our analysis implies that such measures should not be necessarily expected to reduce complexity. The issues of asset size and corporate complexity differ and may require different policy approaches.

Our second key result is that growth through mergers and acquisitions appears to have a significant and enduring impact on corporate complexity. The M&A ratio remains highly significant even when fixed effects and time effects are introduced in the regression and this relationship is robust across time periods. Thus, if policy-makers wish to curb the growth of corporate complexity, they may wish to scrutinize post-merger integration plans before approving a merger or acquisition. This may be one effective way to discourage growth in the complexity of legal structures of G-SIBs. A more fundamental approach should include a reexamination and reform of the many laws, rules and regulations that have encouraged and often required the creation of such complex structures. Unfortunately, we see no evidence of the authorities undertaking these efforts.

More broadly, the regulatory authorities have recognized the challenges that a complex legal structure can pose for an orderly resolution. They realize that if they do not develop credible resolution tools for G-SIBs, they may once again find themselves in a situation with no good alternative options and be obliged to improvise bailouts. The FSB has highlighted this issue and agreed on standards to evaluate the resolvability of G-SIBs.

That regulatory pressure will be necessary to achieve simplification of the corporate structure of G-SIBs should not be surprising. G-SIBs have designed their corporate structures in response to powerful regulatory, tax and accounting incentives as well as compelling internal objectives. Because transactions costs of reorganization can be substantial, the current corporate structures of G-SIBs should be viewed as heavily path dependent. Since G-SIBs perceived benefits from the decisions that have led to the development of complex corporate structures, it would be naïve to expect they would undertake substantial simplification efforts without prodding from the regulators.[5]

[5] Of course, market pressures may also cause G-SIBs to simplify their corporate structures. Klein and Saidenberg (2005) found that bank holding companies face market pressures to simplify their structures. Laeven and Levine (2007) adopt a different approach, but also find a conglomerate discount in large complex financial institutions. They identify agency problems and diseconomies of scope that outweigh economies of scope as probable causes. These findings indicate that market pressures may reinforce regulatory pressures for banks to simplify their corporate structures, but it remains a puzzle why banks chose to form conglomerates just as non-financial firms were abandoning the model and emphasizing focus.

After the crisis, regulators have introduced a number of policies that may encourage banks to simplify their corporate structures. First, regulatory capital requirements are now calibrated to increase in line with the regulatory view of the degree of systemic risk posed by the G-SIBs. The degree of systemic risk posed by each institution is determined in part by indicators of its complexity, which oddly do not include information about organizational complexity such as the number of separate legal entities.

Second, enhanced supervision, particularly the Comprehensive Capital Analysis and Review process implemented in the US, has proven especially burdensome for banks with complex corporate structures. G-SIBs are obliged to show how the capital and liquidity of each of their major subsidiaries would be affected under three different scenarios specified by the regulators. Compliance costs rise with the number of a G-SIB's significant subsidiaries and provide some incentive for G-SIBs to reduce their corporate complexity – or, at least, hesitate to increase it.

Third, proposals in the European Union (Liikanen Report), the UK (Vickers Commission Report) and the US (Dodd-Frank legislation) have been made to insulate depository institutions within G-SIBs from possible damage from "speculative trading" and other activities deemed especially risky. Although a reduction in organizational complexity was not the objective of these proposals, they might lead to a simplification of corporate structures, at least that has been the outcome in the US. The Volcker rule prohibits banks from conducting certain kinds of activities within the group and so the entities that currently conduct these activities will need to be either sold to other less-regulated entities or closed.

Fourth, living wills are the primary tool for structuring the dialogue between G-SIBs and the regulatory authorities. These documents are required to emphasize the potential obstacles to an orderly resolution identified by the FSB. Living wills are costly to prepare and, to some extent, the cost varies directly with the complexity of the underlying organizational structure. The main pressure for organizational simplification, however, comes from the regulatory review process. For example, the FED and the FDIC (2014) rejected the living wills submitted by the eleven "first wave filers," the largest and most complex of the G-SIBs that conduct significant operations in the US. They noted that the G-SIBs failed "to make, or even identify, the kinds of changes in firm structure and practices that would be necessary to enhance the prospects for an orderly resolution." In addition, they demanded that the next round of submissions of living wills (which occurred in July 2015) establish "a rational and less complex legal structure that would take into account the best alignment of legal entities and business lines to improve the firm's resolvability." If the Fed and FDIC are not satisfied with the responses to their admonitions, they have the authority to impose an array of sanctions including, after due process, forced divestitures, and so it seems likely that some degree of simplification will be achieved and may already be apparent in the average data summarized in Fig. 1. Unfortunately, under the current disclosure regime, external observers will have difficulty affirming the progress made. Both G-SIBs and bank regulators would benefit from more transparent reporting of corporate structures. A skeptical public would have greater confidence that the regulators are making tangible progress with regard to ending this important aspect of too-big-to-fail and that the G-SIBs are making substantive efforts to comply.

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Appendix A

Data on subsidiaries: methodology issues and alternative sources

The aspect of the complexity of G-SIBs that should be easiest to measure is the number of subsidiaries. Unfortunately, it is not. Inconsistent and opaque definitions and gaps in disclosures present formidable hurdles. We lack an official data source with comprehensive and consistent data for all G-SIBs. Data provided by regulators often differ because they have differing objectives and statutory obligations. Sometimes the differences can be quite significant and raise troubling questions about consistency. Figures 2 and 3 illustrate this problem using data from two different US regulatory agencies, the Securities and Exchange Commission and the Federal Reserve Board, and the private vendor we use for this article. As shown by Fig. 2, in some cases two different sources may provide quite similar figures, with a third source giving very different results. In other cases, there may be significant differences among multiple sources (see Fig. 3). Although we have cross-checked the data with every available source, in the end we have relied on Bankscope because of the comprehensiveness of its international coverage, the consistency of its methodology, and the granularity of the detail.

Inconsistencies across sources are likely to be produced by differences in regulatory objectives and criteria used to identify subsidiaries. Nonetheless, despite the inconsistencies across sources of data and uncertainties that may remain about the precise number of subsidiaries for each G-SIB, the totals are high – with hundreds or even thousands of legal entities for each institution. Of course, a simple count of subsidiaries is not a complete indicator of the complexity of G-SIBs, but the number of subsidiaries does indicate a key challenge to an orderly resolution.

Our analysis of bank corporate structures largely relies on the Bankscope database, which provides a clear and quite simple criterion to identify majority-owned subsidiaries. Bankscope reports the parent's extent of ownership in each legal entity tracing the ownership share along the entire chain of control. We identify a subsidiary as controlled ("ultimately owned", in Bankscope terminology), if the parent owns at least 50.01 % of the voting shares through each level of the chain of control. This is a very conservative standard that includes both directly and indirectly controlled subsidiaries. While other sources are available for institutions headquartered in the United

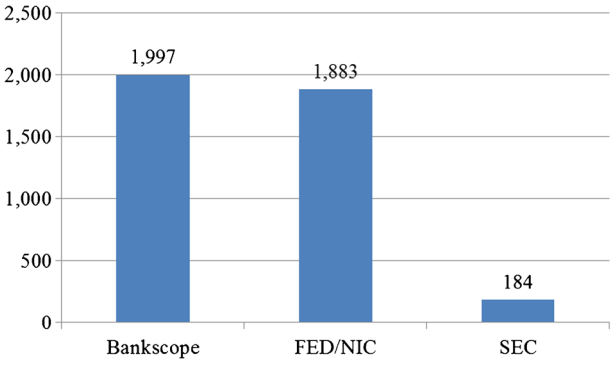

Fig. 2 Number of subsidiaries of Citigroup. This figure shows the number of subsidiaries of Citigroup (as of year-end 2013) reported in the FED/NIC database, SEC filings and Bankscope

Sources: Bankscope (majority-owned subsidiaries), National Information Center/Federal Reserve,Citigroup 10-K SEC filing for 2013 (Exhibit 21.01)

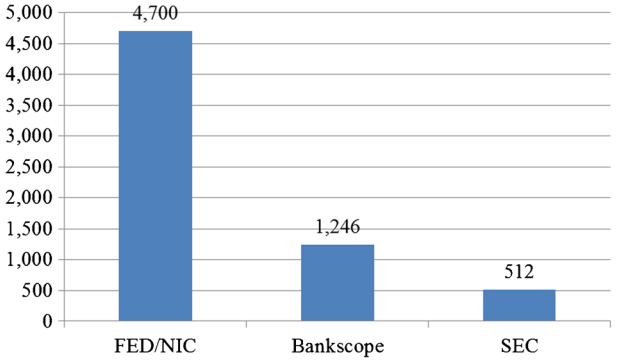

Fig. 3 Number of subsidiaries of JPMorgan Chase & Co. This figure shows the number of subsidiaries of JPMorgan Chase & Co. (as of year-end 2013) reported in the FED/NIC database, SEC filings and Bankscope

Sources: Bankscope (majority-owned subsidiaries), National Information Center/Federal Reserve, JPMorgan Chase & Co. 10-K SEC filing for 2013 (Exhibit 21)

States, most G-SIBs are headquartered elsewhere and Bankscope is the only source that provides consistent and detailed coverage of all banking groups worldwide. In addition to information on the number of subsidiaries, Bankscope includes data on location, assets, operating income and number of employees of subsidiaries and a classification of subsidiaries by industry codes. Moreover, Bankscope also offers comprehensive data for all G-SIBs over time. Our data cover the period 2002–2013.[6]

Alternative sources, such as the Federal Reserve/National Information Center data and SEC filings, do not provide all these details. For example, FED/NIC data on organizational structures, based on confidential forms submitted by banks (e.g. form FR Y-10), are focused on US banks and on US operations of non-US banks. This omits a considerable amount of useful information on the non-US corporate structures of European and Asian G-SIBs. Moreover, publicly available FED/NIC data do not report the financials of subsidiaries, and the categorization of the business/industry is much less specific than the Bankscope classifications. Finally, the FED/NIC data are only available in pdf files, which are less amenable to statistical analysis with standard software.

The main criterion for the inclusion of legal entities in the FED/NIC organizational hierarchy is a definition of control under Regulation, which is essentially a 25 % control (Bank Holding Companies and Change in Bank Control, 12 CFR 225.2 (e)). However, additional entities that meet FR Y-10/10F "reportability criteria" are included, as well as entities for which the relationship is "of interest to the Federal Reserve". The inclusion of the latter two categories makes it very difficult for an

[6] Since at any point Bankscope makes current data on bank corporate structures available, but not the historical data, we have also used Bankscope historical discs to get the information and data on majority-owned subsidiaries for past years, going back to 2002. The latter is the earliest year for which data on subsidiaries reported by Bankscope appear to have the same coverage as current and most recent data and for which numbers on subsidiaries can be consistently analyzed and enables us to use the 50.01 % filter for majority-owned subsidiaries for all G-SIBs and for all years from 2002 to 2013.

external analyst to compare these data with data available from other sources.[7] But the FED/NIC data also have strong points: first, they provide information on the level of ownership and hierarchy of control for each subsidiary (which, however, is available also in Bankscope); second, it appears to be the only database that provides corporate structure trees at a given time (Bankscope only reports current data in the version available to subscribers, and the historical discs refer to an unspecified day during each month).

The exhibits of SEC filings reporting the list of subsidiaries (in 10-K for US firms, in 20-F for non-US firms) only indicate the name and jurisdiction of subsidiaries, as of year-end. The minimum percentage of control for each may be indicated in an explanatory note preceding the list. Unfortunately, the SEC lists provide no information on the financial profile of the subsidiary or its principal line of business. Moreover, unlike Bankscope and FED/NIC data, the SEC filings do not provide an indication of the ownership/hierarchical structure (i.e. the chain of control from the top of the group to each of the subsidiaries). Most troubling, the SEC permits reporting firms to omit "non-significant" subsidiaries (Regulation S-K, 17 CFR 229.601 (b) (21) (ii) and Regulation S-X 17 CFR 210.1-02 (w)). This ill-defined category might include a large number of subsidiaries that could pose an obstacle to an orderly resolution. Finally, the SEC does not provide lists of subsidiaries in a format that may be easily analyzed with standard statistical software.

Annual reports of banks and other official documents published by banks on their websites often include a list of subsidiaries. However, the criteria used to build these lists may vary significantly across institutions and across countries, which will inevitably give rise to inconsistencies. Moreover, relevant information related to each of the subsidiaries such as the financial profile, sector of activity, and ownership level, are seldom included. Even the public sections of living wills submitted to the US regulators by US and non-US banking groups do not include a full list of subsidiaries, but focus only on material entities.

Other sources (e.g. the SNL database, or the new website www.opencorporates.com) do report bank corporate structures information, albeit with differing degrees of detail, but they generally provide less comprehensive information, and they do not seem as helpful as other sources for our statistical analysis.

For all of these reasons, we have chosen to rely on Bankscope as the primary source of information on the corporate structures of G-SIBs. Nonetheless, we used other sources as well to evaluate the consistency of information across sources. Some internal experts in various G-SIBs emphasize that Bankscope data may often be flawed; however, in the absence of stronger, more consistent disclosure regulations these are the best publicly available data for our purposes.

[7] These broader criteria for inclusion of legal entities in the NIC/FED organizational hierarchy are likely to produce a significant impact. Specifically, we have noticed that the NIC/FED list of subsidiaries is particularly long for two of the largest firms, Goldman Sachs and Morgan Stanley, respectively with 14,814 and 8,998 entities as of 31 December 2013. The entities for which the relationship is "of interest to the Federal Reserve" are outside of the scope of Regulation Y definition of control and do not need to fall under such definition: Large Merchant Banking Investments are included in this category, and this might explain the very high number of entities for Goldman Sachs and Morgan Stanley.

Appendix B

Table 6 Matrix of Pearson correlations between the number of majority-owned subsidiaries and the BCBS indicators of complexity for G-SIBs (2013). The table displays the correlations between the indicator of organizational complexity used in this paper – the number of majority-owned subsidiaries – and the indicators of business complexity used by the BCBS (both the overall indicator and the three sub-components)

	subs	Complex	OTC	TradAFS	Level3
subs	1.0000				
Complex	0.5041*	1.0000			
	0.0053				
OTC	0.5519*	0.9241*	1.0000		
	0.0019	0.0000			
TradAFS	0.4003*	0.8645*	0.6766*	1.0000	
	0.0314	0.0000	0.0001		
Level3	0.3761*	0.8991*	0.7641*	0.6774*	1.0000
	0.0444	0.0000	0.0000	0.0001	

* indicates significance at least at the 10 % level. Subs is the number of majority-owned subsidiaries based on our dataset. Complex is the BCBS aggregate indicator of complexity; OTC is the amount of over-the-counter derivatives; TradAFS is the quantity of trading and available for sale securities; Level3 is the amount of Level 3 assets. Source: own computations for the number of subsidiaries, Glasserman and Loudis (2015) for the BCBS indicators of complexity

Table 7 Pearson correlations matrix for G-SIBs variables used in the econometric estimates. The table shows the correlations among the three variables used in the econometric analysis in this paper: the log of the number of majority-owned subsidiaries (dependent variable), the log of total assets and the M&A ratio (independent variables)

	Lnsubs	Lnassets	MAratio
Lnsubs	1.0000		
Lnassets	0.4350*	1.0000	
	0.0000		
MAratio	0.2810*	0.2264*	1.0000
	0.0000	0.0000	

* indicates 1 % significance. Lnsubs is the logarithm of the number of majority-owned subsidiaries; lnassets is the logarithm of total assets; MAratio is our measure of the cumulative impact of large M&A deals. Source: own computations on Bankscope, NIC/FED, SEC and Zephyr data

Appendix C

Table 8 Bankscope codes for total assets of G-SIBs and information related to subsidiaries

Total assets of G-SIBs	11350*
Name of subsidiaries	−9300
Country code of subsidiaries	−9302
City of subsidiaries	−9306
Type (industry) of subsidiaries	−9314
Status (UO)** of subsidiaries	−9345
Operating revenue of subsidiaries	−9303
Total assets of subsidiaries	−9337
Number of employees of subsidiaries	−9365

*Universal bank model

**This item is used to select ultimately-owned subsidiaries only, on the basis of the minimum percentage set by the user to define ultimate ownership (this percentage is 50.01 % for the lists of subsidiaries used for this paper). The status for subsidiaries which are ultimately owned is indicated by UO, while the cell is blank for entities which are not ultimately owned. There is no code for the entire list of UO subsidiaries

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