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Do Syndicated Loans Influence Systemic Risk? An Empirical Analysis of the Canadian Syndicated Loan Market

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Abstract: This study examines the impact of syndicated loans on individual and national diversity of loan portfolios of the six largest Canadian banks, as well as their marginal contribution to Canadian systemic risk. To test the marginal impact of Canadian syndicated loans on risk, we use a simulation of fictitious loan portfolios to create benchmarks based on syndicated loans along with Hirschman-Herfindahl index and Euclidian distance measures. Our results show that syndicated loans have a positive impact on industrial diversity for each bank's loan portfolio. Empirical results also suggest that lenders' involvement in industries in which they lack expertise tends to develop a more homogeneous and concentrated national loan portfolio. Finally, we conclude that the homogenization of loan portfolios and the concentration of the national loan portfolio have an ambiguous impact on Canadian systemic risk. Specifically, the impact depends on the systemic risk measure and an industry effect is present.

Keywords: Diversity of loan portfolios; Homogenization; Concentration; Interconnectedness; Network theory

JEL Classifications: G20, G21, N20

1. Introduction

Since the 2008 financial crisis, contagion and systemic risk has been a particular concern for financial sector stakeholders.[1] The general objective of this study is to examine the impact of syndicated loans on Canadian systemic risk through their impact on the homogenization of individual banks' loan portfolios and the concentration of the national loan portfolio.[2] Specifically, we examine whether syndicated loans influence the individual diversity of banks' loan portfolios. We also examine whether syndicated loans impact the homogeneity of loan portfolios and the concentration of the Canadian national loan portfolio. Further, we verify whether Canadian lenders generally participate more in national (i.e. more homogenization) or international (i.e. less homogenization) loan syndicates. Finally, we examine whether the homogenization of loan portfolios and the concentration of the national loan portfolio have a positive impact on systemic risk.

[1] Hereafter, the term systemic risk refers to both systemic and contagion risk.

[2] The national portfolio is the aggregated portfolio of the different national banks' loan portfolios.

Overall, this study makes both scientific and practical contributions. It contributes to the literature on financial institutions by analyzing a possible adverse effect of the syndicated loan market, which has been underexplored to date. Further, this study examines the Canadian syndicated loan market and provides empirical results, which is a significant contribution in itself given the scant studies on this specific market. The Canadian syndicated loan market is very interesting because it comprises a small number of active players. As a result, connections at the national scale are more easily observable. Our research also innovates in terms of methodology because we combine the relatively new approach of financial network analysis with more common statistical and econometric approaches. Lastly, our results shed light on the impact of the syndicated loan market on systemic risk and help identify potentially systemically important financial institutions (SIFIs).

The remainder of the paper is organized as follows. Section 2 presents our literature review with a theoretical framework. Section 3 describes the data, the simulation of fictitious loan portfolios and the methodological framework. Section 4 examines empirical results on the impact of Canadian syndicated loans on the diversity and homogenization of loan portfolios and on the concentration of the national portfolio as well as on the Canadian systemic risk. Section 5 concludes.

2. Literature Review and Theoretical Framework

In the financial literature, several authors have observed factors of importance in the decisions made by a bank to diversify or focus its portfolio. These factors are mainly the risk level of a bank (Acharya et al., 2006; Hayden et al., 2007), its monitoring expertise in lending (Böve et al., 2010), its size (Cole et al., 2004) and its classifications, namely its bank group (Kamp et al., 2004; Pfingsten and Rudolph, 2002) or ownership control (Tabak et al., 2011). As syndicated loans have their own characteristics (vs. bilateral loans), we believe that their impact on the diversity of each banks' loan portfolio may be different. Syndicated loans are distinguished from bilateral loans mainly by their structure, made up of lead(s) and participants (Sufi, 2007), along with their internal functioning (François and Massonier-Piera, 2007). Our premise is thus the following (see H_1 in section 3.4). If the bank is able to grant a loan by itself to a specific borrower, syndication should not contribute to the bank's portfolio diversity since the portfolio would be composed of the same borrowers (assuming no capital constraints).[3] However, because syndication allows for different geographical or industrial exposures to risk (Dennis and Mullineaux, 2000), and because it gives smaller banks access to large borrowers they wouldn't have access to otherwise (Altunbas et al., 2005), we expect syndication to influence the individual diversity of bank portfolios.

Paradoxically, loan syndication decreases the risk in individual banks' loan portfolios through diversification, but it can also increase systemic risk by homogenizing the national loan portfolio. With this in mind, we examine whether syndicated loans impact the homogeneity of loan portfolios and the concentration of the Canadian national loan portfolio (see H_2 in section 3.4). In the relationship banking literature, Bharath et al. (2011) provide evidence for the importance of past borrower-lender relationships in granting new loans. Syndicated loans imply that many lenders are exposed to specific borrowers, which makes those lenders more vulnerable to systematic shocks as a possible consequence of their participation in several syndicates (i.e. a more concentrated national loan portfolio). Further, Champagne and Kryzanowski (2007) conclude that banks on the international syndicated loan market tend to ally with the same lenders, either as a lead or a participant, and such behavior can increase the homogenization of loan portfolios. We verify

[3] The bank can finance the entire syndicated loan by itself, which makes it a bilateral loan.

whether Canadian lenders generally participate more in national (i.e. more homogenization) or international (i.e. less homogenization) loan syndicates.

As a final observation and as noted in Acharya and Yorulmazer (2008), banks' behavior on the investment choice is procyclical and that behavior is also linked to a herding phenomenon. The authors observe that banks choose to lend to similar industries *ex ante* as this behavior is profit-maximizing in terms of *ex post* borrowing costs. This *ex ante* behavior greatly accentuates the diversity of the national loan portfolio, which in turn positively influences the threat of systemic risk. As mentioned above, we examine whether the homogenization of loan portfolios and the concentration of the national loan portfolio have a positive impact on systemic risk (see H_3 in section 3.4). Duport et al. (2012) observe that the greater the diversification of an individual bank, the higher the probability of the financial system failing. We believe that the syndicated loan market provides greater individual diversity to several lenders. This simultaneous diversity can theoretically increase the probability of the financial system collapse from the greater homogenization of individual loan portfolios and the concentration of the national loan portfolio.

3. Method

3.1 Data

The Loan Pricing Corporation (Reuters Thomson) database Dealscan contains the main information on syndicated loans issued around the world since 1982.[4] We apply two sorting criteria to obtain our sample: i) selection of syndicated loans from 1995 to 2012 because of the greater reliability in terms of data recording and ii) exclusion of lenders involved in fewer than ten syndicated loans because the noise they create outweighs the informational advantage of including them in our sample. In total, 123,817 syndicated loans are retained, including 22,829 loans that have at least one Canadian member in the syndicate (hereafter called “Canadian syndicated loans”). We also exclude Canadian institutions who are not active at least once each year from 1995 to 2012. Overall, 22,464 out of 123,817 syndicated loans include at least one Canadian member who is one of the six largest Canadian banks.[5]

We collect monthly systemic risk measures (SRISK%, MES) from July 2000 to January 2013 as well as betas from V-lab, the financial laboratory on systemic risk at NYU.[6] Finally, we collect annual corporate data on total assets, ROE ratios, Tier 1 capital ratios and economic indicators such as the annual growth of Canadian GDP (%) from 1997 to 2013 as well as the annual S&P/TSX index return from 1994 to 2012 from the Bloomberg database.

3.2 Analysis of financial networks

We explore the Canadian syndicated loan market through the lens of financial network analysis in order to better understand connections between lenders underlying the corporate loan market. In this study, a financial network is made up of Canadian financial institutions belonging to the same loan syndicate. We estimate network measures such as size, diameter and density, which

[4] We categorize syndicated loans into 10 industries, namely agriculture, mines, construction, transport and communications, wholesale trade, retail trade, finance, services, public sector and "other". We also categorize them into nine geographical regions in terms of borrower, namely Canada, United States, Europe, Asia, Latin America, Middle East, Africa, Oceania and "other".

[5] The big six are: National Bank of Canada (NBC), Bank of Montreal (BMO), Toronto-Dominion Bank (TD), Scotia Bank (BNS), Canadian Imperial Bank of Commerce (CIBC), and Royal Bank of Canada (RBC).

[6] The website can be found at http://vlab.stern.nyu.edu/welcome/risk

are largely used in the financial literature on networks, together with the Clustering Coefficient (CC) and Characteristic Path Length (CPL) of Watts and Strogatz (1998). We perform tests to characterize the structure of networks, namely a small-world network as studied by Watts and Strogatz (1998), a scale-free network established by Barabàsi and Albert (1999) or a combination of the two, to verify the fragility/stability of the network and its systemic vulnerability. We also estimate aggregated measures of centrality among the six largest Canadian banks, namely degree, betweenness centrality and closeness centrality (Freeman, 1979), to observe the variation over time.

3.3 Simulation of fictitious loan portfolios

To test the marginal impact of syndicated loans on risk, we need base cases in which there are no syndicated loans available. We create such benchmarks by converting syndicated loans into bilateral loans based on different hypotheses. Because the existing data on the actual percentage of syndicated loans held by Canadian financial institutions are scant, we use a series of simulated scenarios.[7] We want to determine what the loan portfolio of Canadian banks would contain in a world without syndicated loans, which is not the same as comparing syndicated loans and non-syndicated loans reported on banks' balance sheets as banks can invest strategically in both types.

In total, three Canadian markets are simulated, and each includes five scenarios. Each Canadian simulated market (CSM) has a different perspective on how to convert syndicated loans into bilateral loans: i) CSM1 sets constraints on loan allocation by the nationality of lenders and borrowers, ii) CSM2 sets constraints on loan allocation by the borrower's industry and the weight of this industry in the portfolio of each lender, and iii) CSM3 sets the loan allocation constraints of both CSM1 and CSM2 simultaneously.[8]

To construct our scenarios and allocate syndicate loans, we create two groups *by lender* (i.e. lender-loan observations): 1) syndicated lender-loans in which the lender's nationality is the same as that of the borrower (hereafter "group 1") and 2) syndicated lender-loans in which the lender's nationality is different from the borrower's (hereafter "group 2"). In our simulated market, lenders then receive a portion of the loan which varies (between 0% and 100%) according to the scenario.[9] Scenarios A1 to A5 of CSM1 and C1 to C5 of CSM3 are defined as follows:

A1 and C1: The syndicated loan is distributed equally among all the syndicate leads whose nationality is the same as that of the borrower;

A2 and C2: The syndicated loan is distributed equally among all syndicate members whose nationality is the same as that of the borrower;

[7] In Dealscan, the BankAllocation variable represents the percentage of the syndicated loan held by each syndicate member. The lack of data for many loans involving Canadian banks would lead to the exclusion of BNS and the limited presence of BMO. This would significantly bias our results because those banks are the two largest players in the Canadian syndicated loan market in terms of number of syndicated loans.

[8] For the loan allocation by borrower industry and the weight of this industry in the portfolio of each lender, we use the full amount of the loans to establish the annual proportions of each of the 10 industries in the loan portfolio for each lender. We thus choose, respectively, the five, four, three and two industries with the largest weight in the decision to allocate syndicated loans. We assume that the most heavily weighted industries in the syndicated loan portfolios of banks are those for which the lenders know most about their functioning and borrower supervision and have thus developed an expertise for the industry.

[9] As a robustness test, we tried a different random selection technique based on loan observations (vs. lender-loan observations) to simulate our markets. Results are very similar and are available upon request.

A3 and C3: The syndicated loan is distributed equally among 75% of (randomly selected) syndicate members in group 1 and 25% of (randomly selected) syndicate members in group 2;
A4 and C4: The syndicated loan is distributed equally among 50% of (randomly selected) syndicate members in group 1 and 50% of (randomly selected) syndicate members in group 2;
A5 and C5: The syndicated loan is distributed equally among 25% of (randomly selected) syndicate members in group 1 and 75% of (randomly selected) syndicate members in group 2.

As an example, let syndicated loan S be shared by 5 lenders: A, B, C, D and E. Suppose that lender A is the lead lender, lenders A, B and C have the same nationality as the borrower (group 1) and lenders D and E have a different nationality (group 2). Under scenario A1, loan S would be allocated entirely to lender A, the lead (i.e. 100%). Under scenario A2, loan S would be distributed equally between lenders A, B and C (i.e. 33.3% each), all in group 1.[10]

Under scenario A3, the allocation of loan S depends upon the random selection of lender-loan observations from the two groups. Suppose lender A belongs to 490 syndicates in group 1 (i.e. syndicates in which lender A is from the same nationality as the borrower) and 2,003 syndicates in group 2 (i.e. syndicates in which lender A is from a different nationality than the borrower). Under scenario A3, we randomly select 867 lender-loan observations for lender A, of which 367 are from group 1 (75% of 490) and 500 are from group 2 (25% of 2,003). Assuming loan S is one of the 367 randomly selected lender-loan observations for lender A, then lender A would receive a portion of loan S. If loan S is also randomly selected as one of N lender-loan observations for lender B but is not randomly selected for lenders C, D and E, then loan S would be equally distributed between lenders A and B (i.e. 50% each). The allocation of loan S under scenarios A4 and A5 would follow a similar procedure as under A3 but with different probabilities of random selection according to which group the lender belongs to.

Scenarios B1 to B5 of CSM2 are as follows:

B1: The syndicated loan is distributed equally among all syndicate leads;
B2: The syndicated loan is distributed equally among 25% of randomly selected syndicate members;
B3: The syndicated loan is distributed equally among 50% of randomly selected syndicate members;
B4: The syndicated loan is distributed equally among 75% of randomly selected syndicate members;
B5: The syndicated loan is distributed equally among all syndicate members.

In CSM1 and CSM3, scenarios A1 to A3 and C1 to C3 reflect the reality of bilateral loans, whereas scenarios A4, A5, C4 and C5 reflect the reality of syndicated loans. Because syndicated loans allow for different exposures to geographical risk, scenarios A4, A5, C4 and C5, which allow more syndicate members to be exposed to a variety of foreign borrowers, are more closely linked to syndicated loans. On the other hand, scenarios A1 to A3 and C1 to C3 keep local/national proximity between lenders and borrowers. Scenarios A3 and C3 consider that bilateral loans can improve the accessibility of foreign borrowers.

In CSM2, scenarios B1 and B2 reflect the reality of bilateral loans whereas scenarios B3 to B5 better represent the reality of syndicated loans. Syndicated loans in scenario B1 are converted into bilateral loans for the leads only because these lenders typically have contact with the borrower. In the absence of a syndicated loan market, borrowers would need to negotiate with more lenders in order to obtain sufficient financing for their projects. Because the search for lenders incurs costs for

[10] Scenarios A1 and A2 don't involve any random selection of lender-loan observations.

the borrower, scenario B2 realistically represents the number of lenders that the borrower would need to approach for financing. Lastly, scenarios B3 to B5 leave more lenders with a share of the loan, which mirrors the reality of syndicated loans in terms of exposures to borrowers.

3.4 Research hypotheses and tests

Following our discussion in section 2, we develop three research hypotheses that we test herein:

H_1: *Syndicated loans influence the individual diversity of banks' loan portfolios.*

H_2: *Syndicated loans impact the homogeneity of loan portfolios and the concentration of the Canadian national loan portfolio.*

H_3: *The homogenization of loan portfolios and the concentration of the national loan portfolio have a positive impact on systemic risk.*

We use the Hirschman-Herfindahl Index (HHI) of Acharya et al. (2006), $HHI_{i,t}$, and the Euclidian distance measure of Cai et al. (2014), $DISTANCE_{i,t}$, to test H_1 and H_2. Both variables are defined in Table 1 below. By comparing aggregated annual HHI_t and $DISTANCE_t$ obtained from the scenarios that reflect the reality of bilateral loans and syndicated loans for the six largest Canadian banks, we can observe whether statistically significant differences exist.

Table 1 Definition of variables

Independent variable	Definition	Expected sign
$HHI_{i,\,t}$	Concentration of bank i's loan portfolio measured by its Herfindhal-Hirshman Index. Two HHI measures are estimated: industrial (HHI-IND) and geographical (HHI-GEO).	NA
$DISTANCE_{i,\,t-1}$	Euclidean distance between bank i's loan portfolio and those of other banks at year t-1. Varies between 0 and √2. We distinguish two types of distance: industrial (DIST-IND) and geographical (DIST-GEO).	-
$CENTRALITY_{i,\,t-1}$	Network centrality of bank i's at year t-1. Three centrality measures are considered: DEGREE i, t-1, BETWEENNESS i, t-1 or CLOSENESS i, t-1 (see definitions below).	
$DEGREE_{i,\,t-1}$	Number of direct connections of bank i in the Canadian syndicated loan market at year t-1.	+
$BETWEENNESS_{i,\,t-1}$	Quantifies the number of times that bank i is found on geodesic distances that connect any pair of banks in the Canadian loan market at year t-1.	+
$CLOSENESS_{i,\,t-1}$	Inverse of the sum of geodesic distances of bank i with other banks taken individually in the Canadian syndicated market at year t-1.	-
$ASSETS_{i,\,t-1}$	Logarithm of bank i's assets in year t-1.	+
$BETA_{i,\,t-1}$	Systematic risk of bank i's stock at year t-1.	+
$ROE_{i,\,t-1}$	Profitability ratio measured by the net income on book value of equity for bank i at year t-1.	+
$RTIER1_{i,\,t-1}$	Tier 1 capital ratio for bank i at year t-1.	-

Note: This table presents the definition of variables that are used in our study. The third column presents the expected signs for the independent variables in models (4) to (9).

The HHI is used in a number of the studies cited in section 2 (Acharya et al., 2006; Böve et al., 2010; Hayden et al., 2007; Kamp et al., 2004; Pfingsten and Rudolph, 2002). For instance, Acharya et al. (2006) find that the diversification of loan portfolios is not necessarily linked to superior performance and smaller risk for financial institutions. Hayden et al. (2007) corroborate those results by investigating whether they depend on the data set and the risk measure and conclude that the diversification strategy is associated on average to an inferior performance when risk is controlled for. Although the HHI is a naive measure of diversification, it is still commonly used in the financial literature and is an adequate measure of diversity (or focus) in the context of our study. Our methodology also relies on a distance measure which is appealing from a theoretical point of view because it evaluates banks' portfolios deviations from one another, which is an indication of whether these loan portfolios have exposure to common shocks or not. Moreover, in previous studies (Böve et al., 2010; Kamp et al., 2004; Tabak et al., 2011), HHIs and distances are often jointly analyzed since HHIs alone may be misleading as these measures mostly support a Markowitz perspective of diversity. In fact, the distance measure is better at capturing a financial intermediation theory perspective in which financial institutions benefit from diversification by reducing their risk while focusing in some industries in which they have greater monitoring skills. In the financial literature, there are many definitions of distance measures. For instance, Pfingsten and Rudolph (2002) use six distance measures to quantify the distances between many portfolio compositions and find that almost all bank groups tend to mimic the industrial weights of the market portfolio. In the syndicated loan literature, Cai et al. (2014) also use measures of distance and observe that the greater the loan portfolio similarity between two syndicate members, the greater the likelihood that one lender is chosen as a syndicate member if the other plays a lead role.

To test H_3, we use an econometric approach which tests whether our measures of distance (industrial or geographical) or centrality (degree, betweenness or closeness centrality), that are estimated previously, can have an impact on systemic risk, as measured by the marginal expected shortfall (MES) or the *SRISK%* of Acharya et al. (2010) and Brownless and Engle (2015). The *MES* provided by NYU is defined as the equity loss for a 2% daily market decline. The following equation allows for the estimation of *SRISK*:

$$\begin{aligned} CS_{i,t+h|t} &= -kD_{i,t} + (1-k)W_{i,t}E_t(R_{i,t+h|t} \mid R_{m,t+h|t} < C) \\ &= -kD_{i,t} + (1-k)W_{i,t}MES_{i,t+h|t}(C) \end{aligned} \tag{1}$$

where $CS_{i\,t+h|t}$ is bank *i*'s capital shortfall between time *t* and *t+h*, which measures the distress of a financial firm, D is bank *i*'s book value of debt at time *t* (assumed steady over the crisis period), W is bank *i*'s market value of equity at time *t*, k is the prudential capital ratio (assumed to be 8% for Canadian banks), $R_{i,t+h|t}$ is the bank *i*'s return between time *t* and *t+h*, $R_{m,t+h|t}$ is the market return between time *t* and *t+h* and C is a threshold over a time horizon *g* (assumed to be steady when the overall market returns fall by 40% over the crisis period). *SRISK* is then defined as:

$$SRISK_{i,t} = \max(0, CS_{i,t}) \tag{2}$$

$$SRISK\%_{i,t} = SRISK_{i,t}/(\textstyle\sum_{i=1}^{I} SRISK_{i,t}), \text{ if } SRISK_{i,t} > 0 \tag{3}$$

where $SRISK_{i,t}$ is defined as the systemic risk index of bank *i* at time *t*, and $SRISK\%_{i,t}$ is defined as its percentage version. The latter is constructed by dividing *SRISK* for one bank by the sum of *SRISK* across all banks at each point in time. Our models, which are shown below, therefore measure the collective marginal contribution of the six largest Canadian banks to Canadian systemic risk:

$$MES_{i,t} = \beta_0 + \beta_1 \times \text{DISTANCE}_{i,\,t-1} + \textstyle\sum_{k=1}^{K} \beta_k \times X_{k,i,t-1} \tag{4}$$

$$MES_{i,t} = \beta_0 + \beta_1 \times \text{CENTRALITY}_{i,\,t-1} + \textstyle\sum_{k=1}^{K} \beta_k \times X_{k,i,t-1} \tag{5}$$

$$SRISK\%_{i,t} = \beta_0 + \beta_1 \times \text{DISTANCE}_{i,\,t-1} + \sum_{k=1}^{K} \beta_k \times X_{k,i,t-1} \quad (6)$$

$$SRISK\%_{i,t} = \beta_0 + \beta_1 \times \text{CENTRALITY}_{i,\,t-1} + \sum_{k=1}^{K} \beta_k \times X_{k,i,t-1} \quad (7)$$

$$\log(SRISK\%)_{i,t} = \beta_0 + \beta_1 \times \text{DISTANCE}_{i,\,t-1} + \sum_{k=1}^{K} \beta_k \times X_{k,i,t-1} \quad (8)$$

$$\log(SRISK\%)_{i,t} = \beta_0 + \beta_1 \times \text{CENTRALITY}_{i,\,t-1} + \sum_{k=1}^{K} \beta_k \times X_{k,i,t-1} \quad (9)$$

where $DISTANCE_{i,t-1}$ is our estimated industrial or geographical proximity measure, $CENTRALITY_{i,t-1}$ is one of three measures of network centrality, namely degree, betweenness or closeness centrality, and $X_{k,i,t-1}$ are control variables that include $ASSETS_{i,t-1}$, $BETA_{i,t-1}$, $ROE_{i,t-1}$ and $RTIER1_{i,t-1}$. All variables are defined in Table 1. Equations (8) and (9) include the logarithm of *SRISK%* to account for the possible skewness of the variable.

With our measures of distances, we examine whether syndicated loans have a positive impact on Canadian systemic risk through their impact on the homogenization of individual loan portfolios (for the six largest Canadian banks) and on the concentration of the national loan portfolio. With centrality measures, we examine whether banks characterized as more central in the financial system can provide a marginal contribution to systemic risk. Our methodology is linked to a new emerging literature associating network structure and centrality to systemic risk in financial markets (Boss et al., 2004; Iori et al., 2008; Leitner, 2005).

4. Results

4.1 Univariate tests

Table 2 compares syndicated loans when Canadian lenders are present with loans in which Canadian lenders are absent. From Panel 1 of Table 2, there is a statistically significant difference between the total number of members (μ=10.43 vs. 4.75), the total number of leads (μ=3.12 vs. 2.44), the total number of participants (μ=7.31 vs. 2.30) and the average loan amount (μ=$506 vs. $196 million) in a syndicated loan in which there is at least one Canadian member.[11] Syndicated loans that include at least one Canadian syndicate member therefore have more members, both leads and participants, and a larger loan amount.

From Panel 2 of Table 2, we observe a statistically significant difference between the total number of members (μ=9.02 vs. 11.48), the total number of leads (μ=4.84 vs. 1.84), the total number of participants (μ=4.17 vs. 9.64), the total number of Canadian members (μ=2.10 vs. 1.38) and the average loan amount (μ= $458 vs. $542 million) in a Canadian syndicated loan. Therefore, Canadian syndicated loans that include at least one Canadian lead have fewer members, corresponding to more leads and fewer participants, a lower loan amount and more Canadian lenders.

Overall, we observe that when a Canadian bank is a lead, the average loan amount is lower than when there is a Canadian member in the syndicate (regardless of that member's role), which implies that a Canadian lender that wants to act as lead has access to "smaller" syndicated loans. When syndicated loans are "larger", Canadian members tend to act as participants, letting other lenders manage the syndicated loan.

4.2 Analysis of financial networks

Table 3 presents the non-directed and non-weighted annual networks of Canadian lenders in the Canadian syndicated loan market. Overall, 19 Canadian lenders are compiled from 1995 to

[11] Confidence level of 1%, unless otherwise noted.

2012, and network size varies between 10 and 16 active lenders per year. We observe that the network diameter is always between two and four inclusively. This result signifies that every pair of Canadian lenders has at most one lender in-between for 13 of the 18 years and two lenders in-between for 4 of the 18 years, which indicates great proximity among Canadian lenders. Additionally, the density increases from 64.4% in 1995 to 75.6% in 2012, which demonstrates that connections between lenders are numerous and tend to increase, with the exception of 1998, 2007 and 2011 which were difficult years for the global economy. These years show a decrease in density compared with the previous year, which signifies that networks had fewer direct connections between lenders during those years.[12] The CPL also indicates that every lender is on average at a geodesic distance of 1.31 lenders from any other lender in the network, which signifies that financial difficulties from one bank can quickly spread to another bank. We note that betweenness centrality increases while closeness centrality decreases considerably for the years 1998, 2007 and 2011, which implies that the network becomes more centralized as the economy declines.

Table 2 Univariate tests between different groups of syndicated loans

Panel 1	**International non-Canadian syndicated loans vs. Canadian syndicated loans**							
Variables	International syndicated loans - no Canadian members -			Canadian syndicated loans			Equality of Means	Equality of Variances
	N	Mean	Std.Dev	N	Mean	Std.Dev	t-value	F-value
No. of members	100,988	4.748	4.606	22,829	10.427	8.871	-93.90***	3.71***
No. of leads	100,988	2.444	3.270	22,829	3.120	4.915	-19.81***	2.26***
No. of participants	100,988	2.304	3.339	22,829	7.307	7.827	-94.64***	5.50***
Loan amount ($)	100,988	196.25M	700.89M	22,829	505.76M	1,064.2M	-44.94***	2.31***

Panel 2	**Canadian syndicated loans with at least one Canadian lead vs. Canadian syndicated loans without Canadian lead**							
Variables	Canadian syndicated loans - no Canadian lead -			Canadian syndicated loans - ≥ 1 Canadian lead -			Equality of Means	Equality of Variances
	N	Mean	Std.Dev	N	Mean	Std.Dev	t-value	F-value
No. of members	13,088	11.477	8.859	9,741	9.015	8.689	21.00***	1.04**
No. of leads	13,088	1.838	2.124	9,741	4.843	6.737	-42.49***	10.06***
No. of participants	13,088	9.639	8.433	9,741	4.172	5.557	58.95***	2.30***
No. of Canadian members	13,088	1.380	1.367	9,741	2.097	1.574	-41.46***	4.27***
Loan amount ($)	13,088	541.68M	984.97M	9,741	457.5M	1,160.4M	5.78***	1.39***

Note: This table presents univariate comparisons of groups of loans. Panel 1 compares syndicated loans that include at least one Canadian member to international syndicated loans in which no Canadian member is present. Panel 2 compares Canadian syndicated loans in which there is at least one Canadian lead to Canadian syndicated loans in which there is no Canadian lead. We present the pooled *t* statistic or the satterthwaite *t* statistic for the equality of means, depending on the rejection or not of the null hypothesis for the F-statistic testing the equality of variances. ** and *** indicate statistical significance at the 5% and 1% level, respectively.

[12] A decreasing density signifies that direct connections have disappeared (i.e. financial relations no longer exist) if the size of the network remains the same.

Table 3 Network and centrality measures for the Canadian syndicated loan market

Year	Panel 1 - Network measures							Panel 2 - Centrality measures		
	Size	Diameter	Density (%)	CPL	CC	Small-world statistic	Scale-free p-value	Degree	Between-ness	Close-ness
1995	10	2	64.4	1.36	0.79	1.10	.411	7.3	2.7	.094
1996	11	2	69.1	1.31	0.81	1.26	.177	8.7	2.8	.088
1997	12	3	63.6	1.38	0.81	1.31	.274	9.2	4.1	.079
1998	14	3	40.7	1.68	0.69	1.76	.783	8.7	10.3	.058
1999	13	2	62.8	1.37	0.76	1.26	.173	10.2	4.7	.074
2000	14	2	67.0	1.33	0.80	1.24	.460	11.3	4.6	.068
2001	14	3	63.7	1.38	0.82	1.26	.028	11.0	5.6	.067
2002	12	2	77.3	1.23	0.90	1.20	.037	10.2	2.5	.085
2003	12	2	77.3	1.23	0.90	1.16	.008	10.2	2.4	.085
2004	14	2	76.9	1.23	0.86	1.12	.044	12.2	3.2	.074
2005	14	2	70.3	1.30	0.84	1.13	.470	11.8	4.2	.072
2006	14	2	83.5	1.16	0.88	1.08	.058	12.3	1.5	.074
2007	16	4	65.8	1.44	0.84	1.14	.002	13.0	4.0	.059
2008	15	2	76.2	1.24	0.88	1.18	.000	13.2	3.8	.068
2009	15	2	74.3	1.26	0.82	1.10	.063	12.7	3.2	.067
2010	14	2	89.0	1.11	0.91	1.03	.003	12.8	1.2	.076
2011	16	3	66.7	1.37	0.89	1.34	.004	12.7	4.2	.058
2012	13	2	75.6	1.24	0.91	1.23	.634	10.7	2.8	.076

Note: Table 3 presents a summary of network measures for annual networks of lenders from the Canadian syndicated loan market. Panel 1 provides the estimated measures for the network in which all 19 Canadian players are. Panel 2 provides the estimated centrality measures aggregated for the six largest Canadian banks exclusively.

We verify whether yearly networks are characterized as small-world, scale-free or a combination of the two (hybrid). A small-world network is a network in which the CC is similar to that of a regular lattice and in which the CPL is similar to that of a random network.[13,14] This network structure tends to contain cliques, which represent embedded structurally well-defined groups of nodes. By contrast, a scale-free network is a network in which degree distribution follows a power law. This network structure includes a few nodes that are highly connected to many others (i.e. “hubs”), while most nodes have only a few connections. The two network structures are both robust and fragile, meaning that a local problem can quickly become global. We use the statistic of Kogut and Walker (2001) to test whether a network has small-world characteristics. This “small-world statistic” is defined as the ratio of the CC of the network under observation to the CC of a

[13] A regular lattice is a network in which each vertex is connected to the closest vertex, to the second closest vertex, to the k^e closest vertex. Each vertex has the same number of degrees.

[14] Barabàsi and Bonabeau (2003) define a random network as a network in which most vertices have approximately the same number of edges. Its degree distribution follows a Poisson distribution and it is extremely rare that some vertices have significantly more or fewer edges than the other vertices.

random network for the numerator to the CPL of the network under observation to the CPL of a random network for the denominator, considering the same number of edges and vertices for the random network.[15] It characterizes a small-world network when it is higher than 1. We use the p-value of Clauset et al. (2009) to test whether the network has scale-free characteristics. This p-value characterizes a scale-free network when it is greater than 0.05.[16]

In Table 3, results show that networks are hybrid from 1995 to 2000, from 2005 to 2006, in 2009 and in 2012. Hybrid networks are characterized by proximity, the formation of cliques and preferential attachment ("rich get richer"). Networks from 2001 to 2004, 2007 to 2008 and 2010 to 2011 present only small-world characteristics, particularly high proximity between lenders. These findings corroborate those of Champagne (2014) who observes similar structural characteristics for different networks on the international syndicated loan market.

4.3 Test of H_1

Table 4 presents the aggregated HHIs for the three CSMs.[17] Analysis of the last column shows that for all simulated markets of the industrial segment, the differences are positive and statistically significant, implying that industrial $HHIs_t$ are larger for scenarios that reflect the reality of bilateral loans. In other words, scenarios that are closer to the reality of syndicated loans exhibit greater individual industrial diversity of loan portfolios because of their smaller aggregated industrial HHIs. In the geographical segment, we observe that, although differences are positive, none is statistically significant. This suggests that aggregated geographical HHIs are similar for scenarios that reflect the reality of bilateral loans and syndicated loans, and that the two groups of scenarios provide similar individual geographical diversity. Overall, we can't conclude that syndicated loans allow different exposures to geographical risk than bilateral loans, at least for Canadian lenders.

Table 4 Aggregated industrial and geographical HHIs for the three CSMs

Panel 1	**Aggregated HHIs for CSM1**					
Scenarios	A1	A2	A3	A4	A5	Difference
HHI-IND	.282	.234	.222	.214	.213	$.033^{***}$
Panel 2	**Aggregated HHIs for CSM2**					
Scenarios	B1	B2	B3	B4	B5	Difference
HHI-IND - Top 5	.313	.268	.256	.249	.247	$.040^{***}$
HHI-IND - Top 4	.357	.311	.297	.296	.292	$.039^{***}$
HHI-IND - Top 3	.439	.405	.390	.381	.379	$.039^{***}$
HHI-IND - Top 2	.585	.564	.548	.548	.539	$.030^{***}$
HHI-GEO - Top 5	.552	.557	.550	.541	.539	.011

[15] The CCs and CPLs of random networks are available upon request.

[16] A p-value greater than 0.05 does not give evidence to reject the null hypothesis that degrees are distributed according to a power law.

[17] In the geographical segment of CSM1 and CSM3, the difference is not tested because scenarios built under these two CSMs create a geographical bias. Specifically, regardless of the random sampling assumption, we invariably force a greater sampling of lenders with different nationalities than the borrowers, which increases the geographical diversity and thus creates smaller geographical HHI_t (i.e. normal expected behavior). As the bias is still present in the data when we test H2, the geographical segment for the latter two CSMs is also not present in Table 5.

HHI-GEO - Top 4	.551	.557	.549	.540	.539	.012
HHI-GEO - Top 3	.545	.557	.549	.546	.543	.005
HHI-GEO - Top 2	.535	.569	.548	.538	.533	.012
Panel 3	**Aggregated HHIs for CSM3**					
Scenarios	C1	C2	C3	C4	C5	Difference
HHI-IND - Top 5	.371	.303	.272	.262	.258	.055***
HHI-IND - Top 4	.417	.356	.312	.300	.293	.065***
HHI-IND - Top 3	.492	.415	.389	.393	.385	.043***
HHI-IND - Top 2	.646	.565	.547	.551	.545	.038***

Note: This table presents the aggregated industrial and geographical HHIs for the three CSMs. Panel 1 shows aggregated industrial HHIs for CSM1, Panel 2 shows aggregated industrial and geographical HHIs for CSM2, and Panel 3 shows aggregated industrial HHIs for CSM3. For Panels 2 and 3, HHIs are estimated with, respectively, the top 5, 4, 3 or 2 industries to allocate the loans. The last column shows the difference between the average scenarios that reflect the reality of bilateral loans (i.e. scenarios A1 to A3 in Panel 1, scenarios B1 and B2 in Panel 2 and scenarios C1 to C3 in Panel 3) and scenarios that reflect the reality of syndicated loans (i.e. scenarios A4 and A5 in Panel 1, scenarios B3 to B5 in Panel 2 and scenarios C4 and C5 in Panel 3). The difference is calculated from the average HHIs in the two groups. *** indicates statistical significance at the 1% level.

Overall, our first research hypothesis is partly confirmed; syndicated loans affect individual industrial diversity of banks' loan portfolios, but they have no impact on the individual geographical diversity of these portfolios.

4.4 Test of H_2

Table 5 presents the aggregated distance measures for the three CSMs. In the industrial segment, we note that the results for CSM1, CSM2 based on Top 5 and 4 industries and CSM3 based on Top 5 industries demonstrate statistically significant positive differences (at confidence levels ranging from 1% to 10%). This signifies that scenarios that portray the reality of syndicated loans have smaller measures of aggregated industrial distances and, therefore, that the national loan portfolio is more homogeneous when compared to the scenarios that reflect the reality of bilateral loans. However, the differences between the two groups of scenarios are not statistically significant for CSM2 based on Top 3 and 2 industries and CSM3 based on Top 4, 3 and 2 industries, which implies that syndicated loans do not increase or decrease homogenization when we mainly restrict the industries to the two or three largest in the loan portfolio of each bank. Although the five largest industries for the six largest Canadian banks are fairly similar, the proportions of the Top 4, 3 and 2 industries could differ yearly for each bank, hence affecting the presence or absence of an impact on the homogenization of the national portfolio as we compare the two groups of scenarios.[18]

In the geographical segment, positive differences observed between the two groups of scenarios are not statistically significant. Given the results obtained for H_1, we argue that syndicated loans, because they have no impact on individual geographical diversity of loan portfolios, also do not affect the geographical homogenization of loan portfolios and the concentration of the national loan portfolio. The second research hypothesis is therefore rejected: syndicated loans have a mitigated impact on the industrial homogenization of loan portfolios and they don't affect the geographical homogenization. Interestingly, some industries, namely those absent from the Top 3 industries for each lender, seem to create more industrial homogenization and concentration of the

[18] Four of the Top 5 industries for the six largest Canadian banks are typically: transport and communications, finance, services, and "other".

national loan portfolio. These are typically the industries for which lenders have the least experience and expertise.

Table 5 Aggregated industrial and geographical distances for the three CSMs

Panel 1	**Aggregated distances for CSM1 from scenario A1 to A5**					
Scenarios	A1	A2	A3	A4	A5	Difference
DIST-IND	0.377	0.209	0.238	0.224	0.241	0.042**
Panel 2	**Aggregated distances for CSM2 from scenario B1 to B5**					
Scenarios	B1	B2	B3	B4	B5	Difference
DIST-IND - Top 5	0.384	0.336	0.306	0.293	0.281	0.066***
DIST-IND - Top 4	0.408	0.358	0.336	0.330	0.320	0.054*
DIST-IND - Top 3	0.434	0.440	0.403	0.392	0.382	0.045
DIST-IND - Top 2	0.566	0.573	0.546	0.537	0.524	0.033
DIST-GEO - Top 5	0.412	0.411	0.403	0.389	0.387	0.018
DIST-GEO - Top 4	0.401	0.424	0.383	0.379	0.378	0.033
DIST-GEO - Top 3	0.406	0.414	0.394	0.388	0.387	0.020
DIST-GEO - Top 2	0.447	0.432	0.402	0.400	0.382	0.045
Panel 3	**Aggregated distances for CSM3 from scenario C1 to C5**					
Scenarios	C1	C2	C3	C4	C5	Difference
DIST-IND - Top 5	0.422	0.290	0.296	0.280	0.311	0.041*
DIST-IND - Top 4	0.446	0.334	0.315	0.317	0.325	0.044
DIST-IND - Top 3	0.477	0.355	0.401	0.412	0.407	0.002
DIST-IND - Top 2	0.587	0.507	0.527	0.550	0.546	-0.007

Note: This table presents the aggregated industrial and geographical distances for the three CSMs. Panel 1 shows aggregated industrial distances for CSM1, Panel 2 shows aggregated industrial and geographical distances for CSM2 and Panel 3 shows aggregated industrial distances for CSM3. For Panels 2 and 3, distances are estimated with, respectively, the top 5, 4, 3 or 2 industries to allocate the loans. The last column shows the difference between the average scenarios that reflect the reality of bilateral loans (i.e. scenarios A1 to A3 in Panel 1, scenarios B1 and B2 in Panel 2 and scenarios C1 to C3 in Panel 3) and scenarios that reflect the reality of syndicated loans (i.e. scenarios A4 and A5 in Panel 1, scenarios B3 to B5 in Panel 2 and scenarios C4 and C5 in Panel 3). The difference is calculated from the average distances in the two groups. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

4.5 Test of H_3

4.5.1 National homogenization and systemic risk

Tables 6 to 10 present the results for the regression of model (4) with industrial and geographical $DISTANCE_{i,t-1}$ for CSM1 and CSM2.[19, 20] For the industrial segments in tables 6 to 10,

[19] As we find similar results for CSM2 and CSM3, we only present the results for the former. All our results are available upon request.

we find that 21 out of 25 regression coefficients for *DISTANCE* show the expected negative sign, from which 16 are statistically significant (28 out of 45 when we include untabulated results for CSM3). A possible explanation lies in the relative small size of NBC compared with the Big Five banks. The bank's participation to the Canadian syndicated loan market is also different in terms of syndicate structure and composition.

Table 6 Multivariate regression for the MES under the CSM1(Sample size: N=66)

Panel 1	**Regression of model (4) with industrial distances estimated with CSM1**				
	(1)	(2)	(3)	(4)	(5)
Constant	-40.05***	-38.13***	-38.21***	-32.63***	-42.41***
DIST-IND-A1	0.02				
DIST-IND-A2		1.78***			
DIST-IND-A3			-0.35		
DIST-IND-A4				-1.35*	
DIST-IND-A5					0.78
ASSETS	3.67***	3.44***	3.52***	3.03***	3.87***
ROE	0.58	0.269	0.63	0.91	0.40
BETA	1.72***	1.74***	1.84***	2.30***	1.53**
RTIER1	-14.29***	-10.39***	-15.12***	-15.83***	-13.75***
Adjusted R^2	.533	.593	.571	.606	.533
Panel 2	**Regression of model (4) with geographical distances estimated with CSM1**				
	(1)	(2)	(3)		
Constant	-33.66***	-37.25***	-39.75***		
DIST-GEO-A3	-0.70				
DIST-GEO-A4		-0.98***			
DIST-GEO-A5			0.05		
ASSETS	3.11***	3.43***	3.64***		
ROE	0.56	0.76	0.58		
BETA	2.02***	1.93***	1.71***		
RTIER1	-13.74***	-12.80***	-14.37***		
Adjusted R^2	.577	.533	.594		

Note: This table summarizes the results for regression model (4) in which MES is regressed against industrial and geographical distance measures. Distance measures are estimated under the CSM1. The suffixes A1, A2, A3, A4 and A5 indicate scenarios 1 to 5, respectively for CSM1. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively

These characteristics can bring more volatility in the data. As a matter of fact, we observe that industrial distances between NBC and any other big-five bank are always larger than industrial distances between any two big-five banks, with a few exceptions. There also appears to have an industry effect, evident from the results in tables 7 to 10 that depend on the industries selected for the CSM. For the geographical segments in tables 6 to 10, 10 out of 23 regression coefficients for

[20] Scenarios A1 and A2 of CSM1 (and scenarios C1 and C2 of CSM3) are not estimated for the geographical segment linked to model (4). As the six largest Canadian banks only obtain shares of Canadian borrowers' syndicated loans in these scenarios, geographical distances are null.

DISTANCE show the expected negative results (11 out of 35 when we include untabulated results for CSM3). Untabulated results for the estimation of equations 6 and 8 show few significant coefficients for *DISTANCE*.[21] Overall, results show that the homogenization of loan portfolios and concentration of the national loan portfolio have an ambiguous positive impact on systemic risk. Specifically, the effect depends on the measure of systemic risk. Further, there seems to be an industry effect as the choice of industries selected to allocate loans has an impact on the size and significance of the effect.

Table 7 Multivariate regression for the MES under the CSM2 with top 5 industries (N=66)

Panel 1	**Regression of model (4) with industrial distances estimated with CSM2**				
	(1)	(2)	(3)	(4)	(5)
Constant	-37.50***	-40.51***	-39.81***	-36.55***	-36.37***
DIST-IND-B1	-0.70*				
DIST-IND-B2		0.40			
DIST-IND-B3			-0.37		
DIST-IND-B4				-1.34*	
DIST-IND-B5					-1.32*
ASSETS	3.46***	3.71***	3.65***	3.37***	3.35***
ROE	0.69	0.55	0.68	0.98	1.01
BETA	1.88***	1.56***	1.83***	2.23***	2.18***
RTIER1	-14.83***	-13.87***	-14.54***	-14.59***	-14.06***
Adjusted R^2	.548	.545	.537	.543	.547
Panel 2	**Regression of model (4) with geographical distances estimated with CSM2**				
	(1)	(2)	(3)	(4)	(5)
Constant	-34.93***	-39.16***	-36.57***	-38.77***	-38.60***
DIST-GEO-B1	-0.68				
DIST-GEO-B2		-0.74**			
DIST-GEO-B3			-0.95***		
DIST-GEO-B4				-0.51	
DIST-GEO-B5					-0.64*
ASSETS	3.23***	3.61***	3.37***	3.56***	3.55***
ROE	0.32	0.75	0.91	0.67	0.67
BETA	1.89***	2.04***	2.18***	1.92***	1.94***
RTIER1	-13.45***	-14.98***	-14.27***	-14.14***	-13.82***
Adjusted R^2	.562	.488	.534	.539	.538

Note: This table summarizes the results for regression model (4) in which MES is regressed against industrial and geographical distance measures. Distance measures are estimated under the CSM2 with the top 5 industries. The suffixes B1, B2, B3, B4 and B5 indicate scenarios 1 to 5, respectively for CSM2. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

[21] Results are available upon request for equation (6) for CSM1, CSM2 and CSM3 and for equation (8) for CSM1, CSM2 and CSM3.

4.5.2 Centrality and systemic risk

Table 11 shows the results for the estimation of model (5). We observe that, as expected, an increase in degree and a decrease in closeness centrality are related to a marginal contribution to systemic risk. The centrality of the six largest Canadian banks therefore has a positive impact on the Canadian systemic risk. Untabulated results for the estimation of equations 7 and 9 show few significant coefficients for *CENTRALITY*.[22] Overall, we conclude that centrality has an impact on Canadian systemic risk but this impact depends on the systemic risk measure used.

Table 8 Multivariate regression for the MES under the CSM2 with top 4 industries (N=66)

Panel 1	**Regression of model (4) with industrial distances estimated with CSM2**				
	(1)	(2)	(3)	(4)	(5)
Constant	-34.36***	-34.09***	-31.02***	-22.58***	-23.22***
DIST-IND-B1	-0.59*				
DIST-IND-B2		-0.85*			
DIST-IND-B3			-0.78*		
DIST-IND-B4				-1.42***	
DIST-IND-B5					-1.37***
ASSETS	3.19***	3.17***	2.89***	2.14***	2.20***
ROE	0.75	0.79	0.74	1.03	0.97
BETA	1.98***	1.90***	1.98***	2.32***	2.23***
RTIER1	-15.42***	-14.66***	-14.00***	-13.50***	-13.60***
Adjusted R^2	.600	.592	.628	.691	.689
Panel 2	**Regression of model (4) with geographical distances estimated with CSM2**				
	(1)	(2)	(3)	(4)	(5)
Constant	-34.15***	-38.85***	-37.95***	-36.28***	-37.89***
DIST-GEO-B1	-0.66*				
DIST-GEO-B2		-0.48**			
DIST-GEO-B3			-0.52*		
DIST-GEO-B4				-0.85***	
DIST-GEO-B5					-0.59*
ASSETS	3.16***	3.58***	3.49***	3.35***	3.49***
ROE	0.39	0.58	0.56	0.57	0.57
BETA	1.97***	1.90***	1.88***	2.00***	1.92***
RTIER1	-13.64***	-14.59***	-13.78***	-13.60***	-14.07***
Adjusted R^2	.575	.534	.533	.534	.534

Note: This table summarizes the results for regression model (4) in which MES is regressed against industrial and geographical distance measures. Distance measures are estimated under the CSM2 with the top 4 industries. The suffixes B1, B2, B3, B4 and B5 indicate scenarios 1 to 5, respectively for CSM2. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

[22] Results are available upon request.

Table 9 Multivariate regression for the MES under the CSM2 with top 3 industries (N=66)

Panel 1	**Regression of model (4) with industrial distances estimated with CSM2**				
	(1)	(2)	(3)	(4)	(5)
Constant	-40.69***	-39.47***	-39.50***	-38.81***	-38.60***
DIST-IND-B1	-0.20				
DIST-IND-B2		-0.21			
DIST-IND-B3			-0.50		
DIST-IND-B4				-0.67*	
DIST-IND-B5					-0.65*
ASSETS	3.74***	3.63***	3.64***	3.59***	3.57***
ROE	0.59	0.63	0.56	0.35	0.45
BETA	1.71***	1.76***	1.78***	1.69***	1.73***
RTIER1	-14.80***	-14.69***	-14.96***	-13.66***	-14.08***
Adjusted R^2	.536	.534	.536	.548	.549
Panel 2	**Regression of model (4) with geographical distances estimated with CSM2**				
	(1)	(2)	(3)	(4)	(5)
Constant	-36.37***	-40.00***	-39.20***	-39.74***	-39.68***
DIST-GEO-B1	-0.55				
DIST-GEO-B2		0.00			
DIST-GEO-B3			-0.83**		
DIST-GEO-B4				-0.27	
DIST-GEO-B5					-0.45
ASSETS	3.37***	3.67***	3.62***	3.65***	3.65***
ROE	0.30	0.59	0.69	0.58	0.53
BETA	1.70***	1.72***	1.72***	1.77***	1.75***
RTIER1	-13.54***	-14.36***	-13.72***	-14.37***	-14.18***
Adjusted R^2	.550	.561	.533	.547	.544

Note: This table summarizes the results for regression model (4) in which MES is regressed against industrial and geographical distance measures. Distance measures are estimated under the CSM2 with the top 3 industries. The suffixes B1, B2, B3, B4 and B5 indicate scenarios 1 to 5, respectively for CSM2. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

4.6 Discussion

While policymakers recently developed a macro-prudential approach to the supervision and regulation of financial institutions to identify SIFIs, the underlying networks and their impact on systemic risk are still not fully understood, especially for growing markets such as syndicated loan market. While the indicator-based measurement approach of Basel III (Basel Committee on Banking Supervision, 2013) offers a global systemic evaluation of a financial institution in terms of size, interconnectedness, infrastructure, cross-jurisdictional activity, and complexity, we believe that institutional participation in specific financial markets should be more properly evaluated. This study provides some answers for policymakers and legislators regarding the impact on systemic risk from the Canadian syndicated loan market that can easily be extended to other markets or countries. This paper incorporates both a micro- and macro-prudential approach with our combined analyses of the diversity of loan portfolios and the homogenization of loan portfolios and the concentration of the national loan portfolio, while retaining the same point of view as policymakers and legislators. The latter should also be interested in whether financial institutions benefit from industrial and geographical loan diversity. Our methodology innovates from earlier studies by establishing a new way of simulating fictitious loan portfolios. One limitation is that the categorizations of scenarios that reflect the reality of syndicated and bilateral loans, while carefully evaluated individually with regards to their intrinsic characteristics, are still arbitrary.

Table 10 Multivariate regression for the MES under the CSM2 with top 2 industries (N=66)

Panel 1	**Regression of model (4) with industrial distances estimated with CSM2**				
	(1)	(2)	(3)	(4)	(5)
Constant	-39.24***	-36.74***	-36.22***	-34.06***	-34.71***
DIST-IND-B1	-0.49*				
DIST-IND-B2		-0.73*			
DIST-IND-B3			-0.78***		
DIST-IND-B4				-0.83***	
DIST-IND-B5					-0.81***
ASSETS	3.63***	3.41***	3.36***	3.17***	3.22***
ROE	0.91	0.74	0.90	0.85	0.94
BETA	1.87***	1.95***	1.96***	2.01***	2.05***
RTIER1	-15.62***	-13.86***	-13.88***	-13.89***	-13.87***
Adjusted R^2	.555	.583	.606	.631	.622
Panel 2	**Regression of model (4) with geographical distances estimated with CSM2**				
	(1)	(2)	(3)	(4)	(5)
Constant	-38.08***	-39.73***	-40.06***	-40.22***	-39.94***
DIST-GEO-B1	-0.40				
DIST-GEO-B2		-0.21			
DIST-GEO-B3			-0.20		
DIST-GEO-B4				-0.37	
DIST-GEO-B5					-0.48
ASSETS	3.52***	3.65***	3.68***	3.70***	3.67***
ROE	0.38	0.66	0.65	0.67	0.72
BETA	1.70***	1.70***	1.77***	1.79***	1.82***
RTIER1	-14.38***	-13.92***	-14.44***	-14.52***	-14.50***
Adjusted R^2	.537	.538	.556	.558	.551

Note: This table summarizes the results for regression model (4). Distance measures are estimated under the CSM2 with the top 2 industries. The suffixes B1 to B5 indicate scenarios 1 to 5, respectively for CSM2. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Table 11 Multivariate regression for the MES with centrality measures (N=66)

Panel 1	Regression of model (5) with one of the three centrality measures		
	(1)	(2)	(3)
Constant	-30.60***	-40.31***	-31.22***
DEGREE	0.14***		
BETWEENNESS		0.01	
CLOSENESS			-12.86**
ASSETS	2.72***	3.69***	2.97***
ROE	0.15	0.50	0.35
BETA	1.64***	1.70***	1.73***
RTIER1	-14.27***	-14.22***	-12.85***
Adjusted R^2	.666	.533	.646

Note: This table summarizes the results for regression model (5) in which MES is regressed against one of the three centrality measures. Asterisks ** and *** indicate statistical significance at the 5% and 1% level, respectively.

5. Conclusion

This paper examines the impact of syndicated loans on the Canadian systemic risk, particularly via their effect on the homogenization and the concentration of the national loan portfolio caused by individual diversity of loan portfolios. We find that syndicated loans have an impact on individual industrial diversity of loan portfolios, but they do not affect individual geographical diversity of loan portfolios. Our results also suggest that industries for which lenders are less able to supervise borrowers appropriately may lead to more homogenization of the national loan portfolio. Further, the homogenization of loan portfolios and the concentration of the national loan portfolio have an impact on the Canadian systemic risk. However, this impact depends on the systemic risk measure and by the industries selected to allocate the loans. Similarly, we find a significant relationship between centrality and systemic risk but it depends on the systemic risk measure used.

The choices made by banks to diversify or to specialize in the syndicated loan market and its impact on the homogenization of the national portfolio is an interesting avenue for future research. Additional research should provide more answers in this area.

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