Finance and the Earth system – exploring the links between financial actors and non-linear changes in the climate system

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Abstract

Financial actors and capital play a key role in extractive economic activities around the world, as well as in current efforts to avoid dangerous climate change. Here, in contrast to standard approaches in finance, sustainability and climate change, we elaborate in what ways financial actors affect key biomes around the world, and through this known "tipping elements" in the Earth system. We combine Earth system and sustainability sciences with corporate finance to develop a methodology that allows us to link financial actors to economic activities modifying biomes of key importance for stabilizing Earth's climate system. Our analysis of key owners of companies operating in the Amazon rainforest (Brazil) and boreal forests (Russia and Canada) identifies a small set of international financial actors with considerable, but as of yet unrealized, globally spanning influence. We denote these "Financial Giants", and elaborate how incentives and disincentives currently influence their potential to bolster or undermine the stability of the Earth's climate system.

Keywords: climate change; tipping elements; financial systems; telecoupling; sustainable finance; deforestation.

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References: 52.

Supporting Information: 18 pages.

1. Introduction

Humans have become the main driving force behind global environmental change at unprecedented scales (Rockström *et al.* 2009; Steffen *et al.* 2015; Worm and Paine 2016). However, not all of the world's regions are affected by, nor affect, the climate system in the same way. A number of specific biomes and biogeophysical processes have been highlighted as exceptionally important for global climate stability due to their ability to affect feedback dynamics in the Earth system (Steffen *et al.* 2015). These different biomes and Earth system processes have variously been conceptualized as "sleeping giants" in the carbon cycle (Steffen 2006), "tipping elements" in the Earth system (Lenton *et al.* 2008), and "planetary-scale tipping points" (Barnosky *et al.* 2012; Lenton and Williams 2013). Changes in the stability of tipping elements are increasingly being accounted for in climate models (Cornell *et al.* 2012), and include, among other things, deforestation (Steffen *et al.* 2004). Forest biomes are of particular importance as tipping elements because of the nature of their biogeophysical climate feedbacks. Of all the major forests on the planet, the Amazon and the boreal forests are of particular importance; more so than temperate forests and Asian rainforests (Snyder *et al.* 2004; West *et al.* 2011; Steffen *et al.* 2015, see also Supporting Information 1). Their disproportionate influence on climate stability suggest that in order to safeguard a prosperous future for humanity, society needs to consider approaches that, in addition to emission reductions, maintain and enhance resilience of these forested biomes (and other tipping elements) (Schellnhuber *et al.* 2016; Rockström *et al.* 2017).

Financial actors, such as international development banks, institutional investors, credit rating agencies and international commercial banks, are increasingly interested in the financial risks of climate change and associated changes in ecosystems. In parallel, scholarly interest in the climate-finance nexus has also increased. This includes work on e.g. "green bonds" and other impact investments, assessment of climate-related financial risk and insurance mechanisms, ESG measures and differential performance of socially responsible investment portfolios, as well as drivers of responsible investment (Collier *et al.* 2009; Sievänen *et al.* 2013; Revelli and Viviani 2015; Müller and Kreuer 2016; Battiston *et al.* 2017; OECD 2017; Scholtens 2017).

Two gaps emerge in relation to this development, particularly in the finance industry. First, while the growth in the "green bonds" market is impressive, it represents only a fraction of global capital flows: less than 0.2% of debt securities issued globally (OECD 2017 p. 23). Second, avoiding dangerous climate change requires taking account of the non-linear, threshold dynamics encompassed by the tipping elements outlined above (Steffen *et al.* 2018). However, most current "green" financial initiatives focus primarily on various ways to reduce emissions through e.g. divestment, or renewable energy, energy efficiency and low-carbon transport investments — the latter three together representing 79% of the green bond market (OECD 2017 p. 25).

Thus, while reduction of greenhouse gas (GHG) emission is crucially important to avoid dangerous climate change, it is not enough (Steffen *et al.* 2018). Bolstering the capacity of key tipping elements to prevent them from "tipping" is equally essential.

73 Ignoring the non-linear dynamics encompassed by tipping elements could have
74 detrimental effects on the ambitions set by the Paris Agreement, and threaten the
75 achievement of the Sustainable Development Goals (Schellnhuber *et al.* 2016;
76 Rockström *et al.* 2017). It also has repercussions for economic stability and financial
77 risk (Lawrence and Vandecar 2015; Chatterjee *et al.* 2016; UNEP Inquiry 2016;
78 Battiston *et al.* 2017; Scholtens 2017).
79
80 This paper combines Earth system and sustainability science with corporate finance,
81 to explore how the links between financial investment and non-linear climate
82 dynamics can be analyzed. This is not only of interest to policy and financial actors,
83 but also for scholars interested in understanding how key global actors affect the
84 climate system either through their position in global markets (*cf.* Österblom *et al.*
85 2015), or through processes of "telecoupling" (Liu *et al.* 2015). Telecoupling refers to
86 the connections between geographically separate biomes and economic activities.
87 These global connections between human and natural systems have both
88 socioeconomic and environmental effects (Liu *et al.* 2015). In the context of finance
89 and the biosphere, such telecoupling emerges from the fact that financial investments
90 and investment policy decisions may have cross-continental social and ecological
91 effects. Documented examples include international investments in companies
92 associated with land use change through e.g. palm oil production in Borneo (WWF
93 and EnviroMarket 2012), or sustainable investment policies by major pension funds
94 which increase the pressure on corporations to improve their environmental, social
95 and governance performance (Galaz *et al.* 2015).
96

We propose a novel methodology to identify the ways in which financial actors and flows of capital are linked to biomes associated with key tipping elements in Earth's climate system and ask:

a) Is it possible to identify a limited set of financial actors mediating flows of capital to known tipping elements in the Earth's climate system?
b) What incentives and mechanisms of influence exists for these actors to alter investments in support of global climate stability?

2. Methods and data

2.1. Selection of cases

A number of regional biomes and associated Earth system processes have been proposed as tipping elements, whose dynamics, if disrupted through multiple feedbacks in the Earth system, could contribute to the destabilization of the global climate system (Lenton *et al.* 2008 and references therein; Steffen *et al.* 2018). Here we select two of these known biomes – the Amazon tropical forest in Brazil and the boreal forests in Canada and Russia (Figure 1). The resilience of these biomes is linked to both climatic and non-climatic anthropogenic drivers, such as deforestation driven by economic activities and their associated financial inputs (see Supporting Information 1 for details and known threshold uncertainties).

[Figure 1 placeholder]

120 It should be noted that market structure, financing of corporate operations, and a
121 firm's influence on key drivers of change of tipping elements, can differ considerably
122 depending on the sector and the country of interest. Table 1 summarizes the corporate
123 structure in the selected biomes, and shows the level of concentration in each sector,
124 across both publicly listed companies and in private and other companies (see
125 Supporting Information 2 and 3, as well as tables S1 and S2 for limitations, detailed
126 data and information about available data depending on company type). Table 1
127 shows that concentration is high in all four sectors and motivates our focus on the
128 major owners of the dominant companies operating in the biomes.
129
130 **[Table 1 placeholder]**
131
132 As noted earlier, our selection of biomes is based on the strength of biogeophysical
133 feedbacks of these forests to the climate system. As such, the sample provides a
134 strategic first selection to illustrate the strength of the methodology as well as the kind
135 of insights provided. The methodology could also be applied to assess links between
136 financial actors and other critical ecosystem services or "planetary boundaries", such
137 as biodiversity. We leave this for future research.
138

139 2.2. Different finance modes of importance for
140 mapping links between the biosphere and financial
141 sectors

142 Financial actors contribute to biome modifications by financing the extractive
143 activities of companies. Financing generally occurs through a combination of loans

144 and bonds, and through stock (also known as equity), where stocks are issued either
145 through an initial public offering or so-called seasoned offerings (Mayer 1990; Rajan
146 and Zingales 1995; Booth *et al.* 2001). Hence both equity and debt are important for
147 understanding the links between financial actors and our focal biomes.
148
149 However, from a finance perspective, there is a fundamental difference between
150 stocks, and bonds and loans. Bonds and loans relate to a usually fixed claim on part of
151 the revenues of a project or firm. With debt, financiers can reveal their preference
152 with origination: they may withhold capital from environmental laggards, thus
153 signaling discontent and pushing down prices. Financiers may also include covenants
154 in the debt contract relating to environmental performance. Violation of a covenant
155 may trigger default. Stock on the other hand, holds a residual claim on the firms'
156 profits and has ownership rights allowing stockholders to vote about strategic
157 decisions of the firm and the appointment of top executives. As such, the role of stock
158 is more prominent than that of other types of finance in the governance of the firm
159 (Edmans 2014). In addition, stock ownership also determines the potential degree to
160 which any one investor has influence over corporate decisions, operations, and thus
161 strategic development (Apple *et al.*, 2016).
162
163 There are three main mechanisms by which influence can be achieved by
164 shareholders: *voting* (or proxy voting in the case of investment managers, Dam and
165 Scholtens 2013); *direct engagement* with management, either informally or through
166 systematic engagement (Dimson *et al.* 2015); and *divestment* (or the threat of it),
167 which may push stock prices down and signal discontent by investors with the
168 corporate governance of the firm (Edmans 2014).

Mapping the ownership of financial assets in firms, the capital flows from financial actors to companies, and the specific economic activities of firms on the ground is not straightforward due to severe limits in the availability of financial data. While data on shareholders is freely available for publicly listed companies, data on loans is not generally easily accessible due to the opacity of banks' balance sheets, especially their loans section. Ownership of private firms is in addition highly opaque (Morgan 2002; Flannery *et al.* 2004; Stiroh 2006). Limited access to financial data is not a problem exclusively for our analysis, but an issue for studies in this domain in general (Galaz *et al.* 2018).

Given the limited accessibility of detailed debt data, and the influence associated with stock ownership, our main analysis uses equity data and maps the ownership of financial actors in key corporations that currently affect the ecological dynamics of our focal biomes. We also assess the sensitivity of the firms to financiers by calculating the debt to capital ratio for all companies in our sample, and compare them to industry-wide averages (Damodaran 2017).

2.3. Data analysis

To assess linkages between financial systems and tipping elements in a systematic way, we develop an interdisciplinary and exploratory methodology that combines insights from the Earth system and sustainability sciences with corporate finance. The details, as well as limitations, can be found in Supporting Information (2), and include five steps: a) identification of the main proximate drivers of land-use change in each biome (*sensu* Geist and Lambin 2002); b) identification of the most important

194 industrial sectors associated with these drivers in the selected biomes; c) identification
195 of the largest companies in each sector in terms of market share; d) data analysis of
196 the ownership in selected strategic companies; and e) identification of the prevalent
197 stockholders, that is, financial actors with ownership in at least one company
198 operating in each of the selected biomes and sectors linked to tipping elements.
199
200 The selection of companies in c) is based on their market share in the sector of interest
201 only, without incorporating any company-specific environmental assessment. Several
202 of the companies in our analysis have deforestation policies in place, but are included
203 by virtue of their size and market dominance. By being vertically integrated and by
204 providing enhanced market access to a vast amount of producers (particularly in
205 Brazil), we argue that selected companies can influence the rest of the supply chain,
206 as well as have spill-over effects on market competitors. The chosen forestry
207 companies in Canada and Russia control a large landbank and represent a substantial
208 revenue share in the sector, therefore making their forest management policies crucial
209 to forest degradation and forest cover loss.
210
211 As we elaborate below, the stockholders identified in e) can influence drivers of
212 environmental change in multiple regions at the same time. Through their investments
213 policies or engagement strategies they could therefore *in principle* affect multiple
214 known tipping elements simultaneously.
215
216 Analysis of ownership is based on data from the *Orbis* database which contains
217 information on over 200 million companies worldwide (Bureau van Dijk 2017). Note
218 that identification of prevalent stockholders is only possible for listed companies and

219 private companies with known owners. For several private companies in our selection
220 (7 out of 29 companies), no information about shareholders is available through
221 databases like *Orbis*. We calculate the debt ratio as the book value of debt (both long-
222 term and short-term), divided by total book value of debt and shareholders' equity
223 (based on Damodaran 2017). For detailed information on calculations and full list of
224 company ratios, see Supporting Information (5).
225

226 3. Results and Discussion

227 3.1. "Prevalent stockholders": who are they and why
228 are they important?

229 Large financial actors have been shown to possess significant corporate control
230 globally (Vitali *et al.* 2011; Fichtner *et al.* 2017). Until now, however, such control
231 has not been linked to changes in biomes associated with tipping dynamics in the
232 Earth's climate system. Table 2 lists what we denote as prevalent stockholders, and
233 estimates of their "blockholding" power in key companies operating in each selected
234 biome associated with a tipping element (see Supporting Information 4 for more
235 details). We label these owners as "Financial Giants" because of their size and
236 potential to influence companies. They are ranked according to the number of
237 companies in which they own shares, here denoted "ownership breadth" (see Fichtner
238 *et al.* 2017). Blockholding generally refers to shareholding of at least 5% (Edmans
239 2014), and is in the finance literature generally assumed to entail considerable
240 influence over corporate governance.
241

[Table 2 placeholder]

As our data show, these prevalent stockholders include a variety of financial actors ranging from international banks to institutional investors such as insurance companies, asset managers, and pension funds. All prevalent stockholders in Table 2 have shares in five or more of the selected companies. Six have individual blockholdings (≥ 5% of the shares) in at least one company. Two thirds are based in the US, including five of the top seven actors (in terms of ownership breadth).

Stockholders can coordinate their voting on issues related to corporate control (elaborated below). Therefore, it is also interesting to assess these actors' aggregated influence in each of the selected biomes. In Figure 2, we choose a 10% ownership level to indicate considerable voice in corporate governance that could be mobilized by these actors. This is the level usually applied to identify so-called "insiders" in the US corporate context. We also calculate the aggregated ownership of different coalitions based on possible patterns of potential collaboration between stockholders (elaborated below).

[Figure 2 placeholder]

Our analysis shows that the largest passive asset managers in the world, the "Big Three" (*Blackrock*, *Vanguard* and *State Street*) together hold stocks above the 10%-threshold in 2 of 8 companies in the Amazon biome, 2 out of 16 in Canada's boreal forests, and 3 of 5 in Russia's boreal forests. The "Big Three" are known to collectively represent the largest corporate stockholders in the US (Fichtner *et al.*

2017), but their ownership has never before been linked to their influence on climate stability.

The 16 identified prevalent stockholders have an even larger aggregate potential influence. Findings indicate that these reach above the 10%-threshold in 3 of 8 companies in the Amazon, 5 of 16 in Canadian boreal forests, and 3 of 5 in Russian boreal forests. In seven of the 29 companies, the prevalent stockholders collectively represent the largest single stockholder.

A complementary measure of their influence relates to the concentration of equity ownership in each of the selected companies. High concentrations of equity ownership (in this case a high value on the Herfindahl-Hirschman index) also indicates the latent influence of equity owners. As Table 3 shows, such concentration is substantial for companies in the beef sector in Brazil, for economic activities in boreal forests in Canada and partly also in Russia (see also Supporting Information 4).

[Table 3 placeholder]

Figure 2 and Table 3 thus show that as a collective, the "Financial Giants", through their common blockholding power, have a previously ignored, yet considerable potential influence in companies shaping biomes critical for the stability of the climate system.

3.2 Complementary mechanisms for influence

The previous section focused on equity as a means for the financial sector to exert influence over the fate of known tipping elements. Influence associated with ownership is, however, only attainable in listed companies. To what extent ownership influence alone is able to also translate into impacts on the sector as a whole, depends to a large extent on the composition of listed and non-listed companies, with the latter being more dependent on alternative funding. As mentioned above, debt is an important alternative financing mechanism for companies. However, debtholders lack control rights and have fewer means to influence corporate strategy (apart from including covenants in the contracts).

Table 4 shows the total book debt to capital of the selected companies, presented per sector and compared to industry averages. All our focal companies in the beef sector rely heavily on debt. In the Canadian forestry sector a few companies (4) rely heavily on debt (see Supporting Information 5 and Table S3 for details). The debt ratio in the four sectors studied does not differ that much from global industry averages, as there is much variation in these figures (Damodaran 2017; Appel *et al.*, 2016).

[Table 4 placeholder]

In summary, the influence of "Financial Giants" on companies is considerable, but the extent differs depending on sector, and where companies operate. The investors' latent influence is largest in the beef and soy sectors associated with activities modifying the Amazon tipping element, but the influence of the "Financial Giants" is still substantive in the other industries and regions. All four sectors show relatively high concentration and dominant power in their respective market, and are sensitive to

316 external financing. Further, there is concentrated ownership of equity in the firms
317 operating in each sector. As such, we conclude that the "Financial Giants" have the
318 potential to influence corporate strategy in the Amazon and boreal forests.
319

320 3.3 Financial Giants – influence over climate stability
321 and transformation

322 Despite limitations in available financial data, our methodology allows us to identify
323 key financial actors with influence over economic activities modifying biomes
324 associated with tipping elements in the Earth's climate system. The specific
325 stockholders listed are naturally related to the selection criteria imposed here, but the
326 interesting issue is the concept (and existence) of prevalent stockholders with the
327 hitherto unrealized influence on such tipping elements. While several of the prevalent
328 stockholders identified have indeed publicly acknowledged climate-related risks, we
329 argue that their continued substantial ownership in industries that impact on key
330 biomes and Earth system tipping elements suggests they "punch below their weight"
331 with regards to the promotion of corporate governance that bolsters the resilience of
332 these biomes.
333
334 The degree to which the influence of the "Financial Giants" can be used in favor of
335 climate stability is an issue deserving more attention by scholars interested in
336 exploring the role of financial flows for sustainability. For the financial institutions to
337 become change agents would require concerted action by a coalition of the financial
338 actors identified here. However, a number of possible factors could be seen as barriers
339 to an influence of this sort.

340

341 The first is the comparatively marginal economic role the ownership in these
342 companies play for the portfolios of the identified prevalent stockholders. As an
343 example, while investments of one of the largest asset managers (#1 in Table 2) in the
344 selected biomes and economic sectors are considerable (we estimate them to be USD
345 8 billion), they represent only a fraction (<0,01%) of the total assets under
346 management by this investor, estimated to be of a total value of USD 5.1 trillion
347 (BlackRock 2017). Furthermore, several actors in Table 2 (#1, #2, #4, and #7) are
348 commonly referred to as *passive investors*. These are investors who provide
349 investment vehicles that track a market index or a specific market segment, activities
350 which do not rely on active investment, such as voting and engaging. These investors
351 not only invest on behalf of their clients (such as pension funds), but are also often
352 assumed to lack incentives for exercising influence over individual companies, due to
353 associated costs. In addition, coordination problems and free-rider dynamics can arise
354 when the number of blockholders in any one company increases, decreasing
355 individual incentives to act (Dam and Scholtens 2013; Edmans 2014). Together, this
356 would imply that the identified financial actors might lack incentives to engage
357 actively.

358

359 However, there are two reasons to believe the influence of identified prevalent
360 stockholders is both considerable and possible. First, blockholders are, as already
361 noted, generally considered influential. Despite the fact that most passive investors
362 are characterized by investing small amounts in a multitude of companies to diversify
363 risk, Fichtner *et al.* (2017) show that several of the largest investment firms in the US
364 (including the "Big Three") are taking active steps toward more centralized

365 stewardship and governance processes among their funds, which will allow them to
366 maximize their voting power across all discretionary holdings. By pooling their funds'
367 votes, the "Big Three" have been shown to vote against, and win over, short- and
368 medium-term oriented investors at critical moments of decision-making (Appel *et al.*
369 2016; McCahery *et al.* 2016; Fichtner *et al.* 2017). Interestingly, recent analysis of the
370 voting behavior of the "Big Three" show that these global investors tend to vote
371 against proposals related to Environmental, Social and Governance (ESG) issues
372 proposed by activist shareholders (Fichtner *et al.* 2017, pp. 21).
373
374 Second, institutional investors are expected to vote as part of their fiduciary duty to
375 counterbalance the power of company management. While fiduciary duty has most
376 often been interpreted by investors as seeking maximum financial returns on
377 investments for their beneficiaries, there is a growing perception that the fiduciary
378 duties of institutional investors should include sustainability considerations, even
379 though it remains a contested position (EU High-Level Expert Group on Sustainable
380 Finance 2018). Actors such as pension funds and asset managers also invest for the
381 long term, and at least some of the large investors are recognizing both their influence
382 and their responsibility (Fichtner *et al.* 2017). As several scholars have noted, such
383 investments in improved Environmental, Social and Governance criteria (ESG) may
384 also have financial benefits, thereby providing further incentives for engagement from
385 the side of stockholders (Margolis and Walsh 2003; Orlitzky *et al.* 2003; Dimson *et*
386 *al.* 2015; van Duuren *et al.* 2016).
387

4 Next steps

Financial actors and flows play a key role in the global economy. Through their influence over economic activities that modify biomes associated with tipping elements, financial actors can also affect climate stability. Our analysis shows that a subset of the global financial community plays a particularly important role in this regard.

These insights are of relevance to scholars, financial actors and policy makers. First, we bring to light the key role of large international institutional investors. Their behavior and influence, as major blockholders in companies directly linked to economic activities shaping ecosystems all over the world, have yet to be studied in depth. Second, the approach and results presented here can provide further impetus for research on how global actors, distant drivers and "telecouplings" affect the climate system and the biosphere (Liu *et al.* 2015; Österblom *et al.* 2015; Scholtens 2017).

The methodology presented here could be applied to other economic sectors to link companies and investors to other important biosphere functions. Such analyses could, and should, be complemented with other financial data. Mapping the links between financial actors and critical tipping elements in the climate and the broader Earth system opens up a range of new and important questions. Can fiduciary duty include damages to global environmental commons, affecting millions of people for generations to come? How large are the material risks associated with non-linear changes in these critical biomes, including their climate repercussions? What

412 economic, political and social pressures shape the investment and corporate
413 engagement behavior of “Financial Giants”? And does their voting behavior and
414 ownership engagement differ across sectors, including those associated with biomes
415 critical for alternative trajectories of the Earth system (Steffen *et al.* 2018)?
416
417 Questions such as these require increased attention as scholars, financial institutions,
418 policy-makers and civil society move forward to address the risks entailed with rapid
419 global environmental change.

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Figure and figure captions

Figure 1. Threshold dynamics in selected tipping elements.

See separate JPG files.

Figure 1a. Amazon region. Deforestation in the Amazon region has been a well-known challenge for climate policy for decades. The Amazon biome has been proposed to contain a tipping point beyond which increasing deforestation could lead to an abrupt shift from rainforests to savannas and possibly to the emergence of a semi-desert area (in the driest portion of Northeast Brazil) with detrimental implications for both the regional and global climate. Symbols display main environmental and socio-economic drivers.

Figure 1b. Boreal forests. The world's forests both dampen or amplify anthropogenic climate change through forest-climate interactions and exchanges of energy, water, and CO_2. Boreal forests play a critical role in the climate system by affecting the surface albedo. It has been proposed that these forests have a significant biogeophysical effect on annual mean global temperature. Symbols display main environmental and socio-economic drivers. See Supporting Information (1) for details including references.

Figure 2. Total ownership by the 16 prevalent stockholders in selected companies

(a) Brazil, soy and beef sectors **(b) Russia, wood, pulp and paper sector**

(c) Canada, wood, pulp and paper sector

Legend

548 **See separate PDF files.**

549

550 **Figure 2** shows the percentage of stock ownership of prevalent stockholders, the "Big
551 Three" and the largest stockholder in each company (bar charts). For each sector, it
552 also shows the total market share controlled by selected companies (pie charts). See
553 Supporting Information (2) for methodological details.

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Tables

Table 1. Market share held by the top 4 publicly listed and the top 4 private and other companies in each sector (%).

Sector	Top 4 publicly listed companies	Top 4 private and other companies	Sum of the top 4 public and top 4 non-public companies
Brazil, Beef	70.4%	10.7%	81.0%
Brazil, Soy	29.0%	32.0%	60.9%
Canada, Wood, pulp and paper	23.4%	12.1%	35.5%
Russia, Wood, pulp and paper	21.3%	45.6%	66.9%

Note: The table is based on data from the top 100 companies in each sector (top 50 in Russia). 'Private and other' include private companies, state-owned companies, cooperatives, First Nations, and similar. See Supporting Information (3) for details.

568 **Table 2. List of financial institutions with ownership in the selected companies in**

569 **all selected regions and sectors**

Nr	Stockholder	Location of headquarters	Category of stockholder	Ownership breadth[a]	Number of holdings ≥5%	Size of ownership[b] (million USD)
1	Blackrock	United States of America	Investment management firm	18	7	8,076
2	Vanguard	United States of America	Investment management firm/Mutual funds	18	6	6,853
3	Norway (via Norges bank and other funds)	Norway	State/Bank/Pension fund/Sovereign wealth fund	18	0	2,193
4	Dimensional Fund Advisors	United States of America	Investment management firm/Mutual funds	17	0	1,151
5	Credit Suisse	Switzerland	Bank/Investment management firm	12	1	422
6	Bank of New York Mellon	United States of America	Investment management firm/Bank	12	0	1,188
7	State Street	United States of America	Investment management firm/Bank	11	2	4,804
8	AXA	France	Insurance/Investment management firm	10	1	890
9	JPMorgan Chase & Co	United States of America	Bank/Investment management firm	10	0	1,123
10	Principal Financial	United States of America	Investment management firm	10	0	402
11	Deutsche Bank	Germany	Bank/Investment management firm	10	0	356
12	Fidelity Management & Research	United States of America	Investment management firm/Mutual funds	9	3	3,200
13	Stichting Pensioenfonds ABP (National Civil Pension Fund)	The Netherlands	Pension fund	9	0	646
14	Franklin Templeton Investments	United States of America	Investment management firm	5	0	1,641
15	Van Eck	United States of America	Investment management firm	5	0	337
16	Russell Investments	United States of America	Investment management firm	5	0	93

570

571 Note: [a)] Ownership breadth is defined as the number of companies in which a
572 stockholder is invested (Fichtner *et al.* 2017), out of the 29 companies studied.
573 [b)] Size of ownership is calculated as the product between the market capitalization of
574 the listed company and the percentage of shares directly or indirectly owned by the
575 stockholder.

Table 3. Concentration of equity ownership in each publicly listed company, measured by the Herfindahl-Hirschman index (HHI)

Sector	Company	HHI	Average HHI per sector
Brazil, Beef	JBS	4938	2546
	Marfrig	1221	
	Minerva	1478	
Brazil, Soy	Archer Daniels Midland	292	345
	Bunge	398	
Canada, Wood pulp and paper	Canfor	2904	1021
	Hokuetsu Kishu Paper	542	
	Louisiana-Pacific	384	
	Marubeni	308	
	Nippon Paper Industries	204	
	Norbord	2640	
	Resolute Forest Products	1415	
	Tembec	1428	
	West Fraser	192	
	Weyerhaeuser	195	
Russia, Wood pulp and paper	International Paper	306	2133
	Mondi Ltd.	1308	
	Mondi plc	1652	
	Sistema	5265	

Note: The HHI index is computed as the sum of squared ownership (in %). Its theoretical maximum is 10,000 (monopoly), and its theoretical minimum is approaching zero (pure competition) (Rhoades, 1993). Note that only shareholders with shares of at least 0.01% appear in our data.

583 **Table 4. Total book debt to capital of all selected companies, presented per sector**

584 **and compared to industry averages (2016)**

Sector	Book debt to capital	Industry total book debt to capital (Damodaran 2017)	
Beef Brazil	73.7%	Food processing, Emerging markets	40.1%
Soy Brazil	25.4%	Farming/Agriculture, Global	49.1%
Wood, pulp and paper Canada	56.5%	Paper/Forest Products, Global	45.6%
Wood, pulp and paper Russia	53.9%	Paper/Forest Products, Global	45.6%

585

586 Note: The total book debt to capital ratio is calculated as the ratio between the book
587 value of long-term and short-term debt and the sum between book value of long-term
588 and short-term debt and the book value of shareholders' equity, following the
589 methodology adopted by Damodaran (2017). See Supporting Information (5) for
590 details.