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Title: The Network around Revolut: How Interconnected are the Leading Digital Banks?

1 Introduction.

If the 2008 crisis generated a demand for independence from traditional financial institutions, the demand has thus far not been matched. Nevertheless, technological innovations in the following years prompted a transformation of financial activities, and the economic conditions under the 2020 global pandemic reinforced this trend. Startups offering services such as cryptocurrencies, mobile payments, AI-based insurance, or online personal loans so far have played the role of complements to traditional banking. However, this may change in the upcoming decades with the potential rise of financial super apps, which will likely target all the existing specialized markets for alternative banking services with a single ecosystem (Curry 2022). As of November 2021, there were 9,323 fintech startups in the EMEA region (Europe, the Middle East, and Africa), making it the second region with the highest number of fintech startups globally after Americas (Norrestad 2022). Among this astonishing number is Revolut, the current leader among business-to-consumer fintechs in Europe, which has the ambition to become a global super app revolutionizing the banking industry (Curry 2022).

The goal of this paper is to analyze the network around Revolut, a London company that has emerged from a startup offering an inter-bank rate currency exchange to a challenger bank that is the second largest in the world and the largest in Europe by market valuation. To that end, I consider the network structures of financial, human, and social capital flows among Revolut

and its four direct competitors: London-based Monzo and Starling Bank, Berlin-based N26, and San Francisco-based Chime.

I focus on understanding the network characteristics of the flows of financial capital from investors and owners, of the flows of human capital carried by digital banks' board and team members, as well as the mutual dynamics in the banks' use of social media capital on Twitter. Furthermore, I am investigating human capital flows between regions of the globe that the employment and investment patterns generate.

The rest of the paper is organized as follows. Section 2 discusses the importance of digital banks and describes Revolut and its competitors. Section 3 presents the literature and concepts applied in my analysis. Section 4 formulates the research questions. Section 5 elaborates on data sources, data limitations, and graphs. Section 6 offers a qualitative analysis of the data by telling the stories behind the graphs of investors, owners, interlocks, employment flows, and social media interactions. It then discusses how these stories can partly explain differences in market sizes and profitability of the digital banks. Section 7 provides quantitative analysis by reporting graph metrics. Section 8 concludes with a perspective on the results and suggestions for future research.

2 Background.

2.1 Importance of Digital Banks.

The technological revolution, which happened over the last decade, has enabled the rapid emergence of startups offering digital financial services. While traditional banks are subjects to excessive regulations, fintechs, especially those dealing with cryptocurrencies, have so far managed to escape the regulatory-related problems. Few regulatory constraints as well as lack of physical branches cause low operational costs and as a result, low transaction costs and high

flexibility for customers. Those aspects, combined with usage of innovative technologies enable convenient and quick services, which are an attractive alternative to traditional banking. Given the utmost importance of banking in the global economy, a change in what we understand by "a bank" may have a profound impact on financial outcomes, independence, security, inclusion as well as on daily habits.

2.2 Leading Companies.

2.2.1 Revolut.

Revolut started as an app enabling currency exchange at interbank rates without fees. This gained popularity first among European travelers who no longer had to rely on expensive currency conversions through their bank accounts or exchange offices when traveling or sending payments abroad. The app expanded its functionalities related to traveling, such as insurance or concierge services, and related to domestic use, such as splitting bills, budgeting analytics, or savings vaults. In addition to the smartphone-oriented app itself, Revolut offered physical and virtual debit cards integrated with Google Pay and Apple Pay. During the pandemic, when travel went down, the company implemented in-app cryptocurrency and stock trading. In 2020, Revolut obtained the European Central Bank banking license through its operations in Lithuania and applied for banking licenses in other countries, including the US and the UK. The license allowed Revolut to start offering loans in early 2022 (Vaznouka, 2022).

Revolut presented a highly impressive record of expanding its services, broadening the customer base, and accessing new international markets while complying with legal regulations. As a result of its explosive growth, the startup has become one of the most valuable fintech companies in the world, valuated at 33 billion U.S. dollars as of summer 2021 (Browne, 2021).

However, the large size carries a lot of responsibility. Although Revolut secured banking licenses entailing deposit guarantee protection, the giant startup cannot simply guarantee its long-term profitability. While Revolut grew continuously before and through the pandemic, the company prioritized growth over profitability and, unlike its smaller direct competitors, was generating losses (Woodford, 2020). Thus, some commentators have asked whether Revolut was just a bubble that might still collapse, especially given its high-volume and low-margin model and given that it gained trust of mostly tech investors, who historically had been tolerant of high risk (Woodford, 2020; Irwin-Hunt, 2019). Looking at Revolut's increase in valuation and decrease in profit, it seems as if these two were inverse functions of one another (see Figures 1 and 2). Since even banks sometimes go bankrupt, so could Revolut if it fails to turn towards profitability at some point. A possible collapse of such a large startup would undermine or even shatter the credibility of the entire fintech sector, which could lose the opportunity match up the trust level the traditional financial institutions enjoy.

On the other hand, the combination of Revolut's ambition to become the first global super app with its record of aggressive growth gives it a chance to upend the banking industry, taking over the role of the primary financial institution in at least some countries. As a digital bank, the company offered major banking services delivered often faster, at a lower cost, with more transparency, and with a better user experience, which seems to seriously challenge the competitiveness of traditional banks in the long term. As a company successful in multiple countries, it seems to have an edge over the existing super apps such as WeChat or AliPay, which have not yet succeeded in the international market (Pimentel and Geron, 2021).

2.2.2 Revolut's Competitors.

I narrow the choice of Revolut's competitors to the four mentioned in press together most often: London's Monzo and Starling Bank, Berlin's N26, and San Francisco's Chime. Appendix Figure 1 shows the logos of the digital banks.

Starling Bank launched in 2014 in London and has the least number of users (2.1 million) of the digital banks considered. It focuses on money management, including savings, repayments, overdraft, and loans for individuals and businesses (Curry, 2022). Monzo was founded in 2015 in London and has about five million users in 2022. It gained its popularity with peer-to-peer payment features and real-time balance updates (Curry, 2022). Monzo offers debit, credit, and savings and makes profit on every debit card transaction (Curry, 2022). N26 started in 2013 in Munich. It reaches seven million uses in 24 countries (mostly Germany, France, and Italy). It has a banking license in the EU and offers fee-free current account, savings account, and insurance. Chime was founded in 2013 in San Francisco. It is the largest digital bank in the United States and is currently only available there. It offers a debit, credit, and savings accounts and peer to peer payments, which are insured up to 250 thousand dollars. Chime collects no fees for its mobile banking services, and its revenue is generated to the most part by interchange fees (Curry, 2022).

Monzo is valuated at 4.5 billion dollars, Starling Bank at 1.5 billion dollars, N26 at 3.5 billion dollars, and Chime at 14.5 billion dollars (Figure 14). Figure 1 illustrates how Revolut's valuation skyrocketed over 2020 and 2021, leaving its European competitors far behind relatively recently. This disproportion raises the question about the story behind Revolut's success against the background of its competitors. My research is an attempt to examine the structural side of the story.

3 Literature and Concepts.

A social network analysis of fintech companies hard to find. A publication closest to the interests of my project is as a network analysis of fintech influencers, which analyzes Twitter data to determine which professionals and companies are central to the online discourse on financial technology (Fields, 2015).

There is, however, a strong tradition of sociological literature on networks inside and among businesses. Inspired by Stark et al., (2012) who analyzes ownership ties among Hungarian firms, I analyze ownership structures among digital banks. Similarly to Powell et al. (2021), I investigate clusters of various types of firms and consider their geographical locations. Like Powell et al. (2012, p. 444-5), computer software (although Gephi rather than Pajek) with which I represent the relationships and calculate my metrics is an important element of my analysis. Following Baker, (1990) I examine the intensity of interactions while investigating the use of social capital by business organizations; however, rather than looking at market relations, I utilize social media data to understand the relations of among organizations.

The concept of an egocentric network understood as a network "defined from the standpoint of focal individuals" (Wellman, 1988, p. 27) most accurately describes the overall analytical approach of this project: my goal is to analyze the network around Revolut, and, to that end, I collect data on organizations surrounding Revolut and its competitors. Another important feature of digital bank networks I analyze are structural holes as gaps separating clusters in a network. More generally, all fintechs take their "good ideas" (Burt, 2004) from the traditional finance institutions and technological companies, and their success relies on building bridges, or crossing structural holes, between these two sectors of the economy. McPhearson (1983, p. 341), tracks the notion of network density to Barnes (1969), and Krackhardt (1988, p. 223) follows Freeman (1979) on the concepts of in-degrees, out-degrees, centrality, and

betweenness centrality. I use these concepts, but rather than on my own calculations, I rely on the algorithm built in Gephi to calculate the values of these metrics.

(Breiger, 1983, p. 358) draws a distinction between cliques and blocks of structural similarity. In my analysis, I construct networks starting from a digital bank and its first-degree ties; taking several such equivalent structures (by design) forms a block. By a clique, therefore, I mean when these blocks are entirely separated from the rest of the network. McPherson stresses the understanding of an organization as a point in the network and argues for the importance of multiple memberships for comparisons across systems (1983, p. 327, 331). My analysis of interlocks relies on this idea.

4 Research questions.

In my analysis, I will try to understand the network side of the story about digital banks' financial, human, and social capital. While doing that, I am asking the following questions: How are the top digital banks linked to each other? How strongly are they interconnected? How do the top digital banks interact with each other? What underlying patterns do these ties reveal? These questions will guide my analysis of each form of capital. Finally, I answer what the structural differences tell us about profitability or valuation of the digital banks.

5 Data and Graphs.

5.1 Data Sources.

The main data source in my study is the PitchBook Data, one of the most recognized public and private market financial databases. I use the data on digital banks' investment deals and names of investors and owners. I also collect data on the current board members and current team members whose experience I obtain searching further in PitchBook's records and on LinkedIn.

In order to track employees' past and current experience, I will use LinkedIn, which is a popular platform among professionals frequently used for job search and applications as well as for "networking," or maintaining or forming weak ties with the hope of getting a job or finding an employee. I retrieve data on the current employers of Revolut, Monzo, Starling Bank, N26, and Chime. Appendix Figure 2 uses a graphic about Revolut's 15 most senior people to give an illustration of the kind of employees my analysis of human capital investigates. Using LinkedIn, I found Revolut's 22 employees out of 26 listed in Pitchbook, 11 out of 18 for Monzo, 10 out of 12 for N26, and all 9 for Chime.

Twitter is a micro-blogging news and networking social medium that has been increasingly used for official communication from and between important figures and entities. I use Twitter data to understand the interactions of the digital banks at a platform where they can maintain both ties among themselves and with their users in a publicly available way. Twitter followers are not necessarily the same people who use the digital bank apps, but most interactions the banks have on Twitter are with people having issues with the app or those interested in becoming users. Thus, the quality and quantity of interactions of digital banks with Twitter users seem legitimate measures of social capital for the purpose of my study.

5.2 Data Limitations.

My networks are egocentric, meaning that digital banks focal points from which I started as I was collecting data. This approach narrows the focus of analysis by limiting the size of these networks.

My data on people only include employers if a person still worked for a company in 2012. The account of professional paths of the digital banks' board and team members is not entirely complete due to not every member being present on LinkedIn or not adding every piece

of information to the experience section on their profile. For example, employer's location was frequently not mentioned. Some people worked for two or more employers at the same time, so some transitions between companies did not happen exactly as shown. Some location information is not precise. In case multiple locations were mentioned, only the latest one was chosen.

5.3 Graphs.

In social network analysis, nodes typically represent people. However, in the case of my analysis, nodes stand for organizations. These nodes are heterogenous. Digital banks are always represented as nodes, taking central positions in the network. The remaining nodes are investors, owners (both individuals and companies), or various kinds of companies where the banks' employees worked before joining the digital banks, or geographical regions. Node sizes are uniform, but the intensity of their color reflects their in-degree or out-degree.

Edges usually represent ties between actors, such as friendships. In my analysis, edges represent different relationships: an investment in a digital bank, partial ownership of a digital bank, a movement between two companies or two countries, a common membership in two companies (an interlock), and a mention in a tweet. Edge thickness and arrow size reflect weight, which is the count of ties with the same source and target, for example the number of employees who came from company A to company B. However, in the case of investments, edge thickness and arrow size reflect the size of the deal in which an investor participated, and in the case of ownership, it reflects ownership share. In Twitter interactions, thickness is constant. In my graphs, arrows point either directly to digital banks or to the direction of paths toward digital banks.

6 Qualitative Analysis: Stories Behind Graphs.

6.1 Financial Capital: Investors and Owners. (Figures 3 to 7.)

Figure 3 reveals that the investment ties linking the network of Revolut and its four competitors are surprisingly scarce. There are two funds that invested in three digital banks: TriplePoint (nomen omen) and Coatue Management. There are about 16 funds (which is less than 10% of the total of 169) that invested in two of the digital banks. It is not clear why about 90% of investors are disconnected from each other, meaning that they have invested in only one of the five competitors.

While this would be an intuitive assumption that German N26 and American Chime were disconnected from a potential tight London cluster of Revolut, Monzo, and Starling Bank, geography does not seem to play any role in the digital bank reality when it comes to financial capital. In fact, Starling Bank is disconnected from the connected component of the remaining banks, which may be related to having just ten investors. Meanwhile, Chime has six ties across the Atlantic Ocean: four common investors with Revolut and two with N26. Revolut, the most valued bank, also has the most connections to other banks through an investor: three or four with each (except for Starling Bank) for a total of 11 out of 59 all ties. Monzo has seven such connections out of 36, and N26 and Chime both have six out of 38 and 41, respectively. Thus, each digital bank shares from 14 to 19 percent of the investors with at least one of its competitors. Adding shareholders in Figure 4 to the picture does not really change the structure, and Figure 5 restricting the graph to owners shows why: the digital banks do not have any common owners.

The British startups, Revolut, Monzo, and Starling Bank, have 17, 25, 11 owners with at least 1% of shares, respectively. In turn, N26 and Chime do not have any external owners, as they are not public. Figure 6 represents the counts of owners of each of the three London-based

startups by investment fund type, and Figure 7 shows how many owners of each startup are located in each country. Venture capital funds dominate as the primary ownership type for both Revolut and Monzo. In contrast to Revolut, Monzo and Starling have corporations as their owners. Overall, these two startups belong to more diverse groups of owners than Revolut. All three British banks are most closely connected to their country of origin, although Monzo has almost twice as many British investors as Starling. Surprisingly, the startups do not have many ties to continental Europe—only one to two of their owners come from Germany, Switzerland, or Luxembourg. Almost half of Monzo's owners come from the United States, mostly from California. Individual owners from Asia are present in the case of Revolut and Starling.

6.2 Human Capital: Interlocks and Flows. (Figures 8 to 11.)

Figure 8 reveals that digital banks do not share any companies with which their board and team members have ties. In other words, there is not a single company that any pair employees from two of the five banks share. At the company-level, the top employees of Revolut, Monzo, Starling Bank, N26, and Chime from five separate cliques, which is an important insight. Chime clearly has the most interlocks with other companies, while Revolut—the least. The companies sharing membership with the digital banks are diverse, ranging from fintechs to consulting companies and research institutions.

Figure 9 presents all the companies where the digital banks' current board and team members gained their professional experience within ten years prior to joining the bank or concurrently with in the bank. The companies are arranged in parallel, neglecting how far in the past the experience took place. The result is very surprising: There are only five common employers in a picture of 303 nodes. One of these cases is special: a member of Monzo previously worked in Starling Bank. This is the only direct employment link between any of the

digital banks I have found. It turns out to be Tom Blomfield, the founder of Monzo, who left the Starling in 2015 after tensions with Anne Boden, its current CEO (Curry, 2022).

Thus, other than the individuals sharing experience from Uber, Google, Tide, and Nationwide Building Society, all current board and team members of the digital banks came from entirely different firms. This graph, therefore, reveals that the competing startups are led by professionals who are unlikely to know each other. Each digital bank's leadership draws from experience from a different workplace. Another interesting observation is that Revolut has the highest number of companies where its members gained experience (70), and Monzo the least (51).

Figure 10 expands the structure of the network to reflect the sequence of companies that human capital in the form of professional experience flowed before entering the digital banks. It shows that each board and team member can have a different number of prior experiences. While most members joined a digital bank after working in one or two companies in recent years, some jumped between five or six employers before settling in a digital bank. Revolut's members seem to have originally come from more established banks, both large, such as Capital One, Deutsche Bank, or Barclays and smaller, such as Barclaycard or Heritage Oaks Bank. The picture looks similar for Starling Bank. Monzo and N26, in turn, seem to have a greater balance between traditional banking and tech background. The limited data on Chime indicates mostly tech background of its members. All digital banks have members who previously worked for some other kind of fintech. Big consulting names are present throughout the network as well.

Figure 11, using a subset of data from Figure 10, shows that geography matters for the human capital flow in the digital bank network. London and the San Francisco Bay Area are the two key centers of human capital. The Bay Area, New York, and London are the most important

sources of human capital, while London, Berlin, and the Bay Area are the most important targets of human capital. The Bay Area connects different parts of the US as well as India, China, and continental Europe to Berlin and London, with flows in both directions. London extensively draws from other parts of the United Kingdom.

6.3 Social Capital: Interactions on Social Media. (Figures 12 and 13.)

Figure 12 presents summary statistics on Twitter use by the digital banks. N26 has the most effective strategy in terms of likes and engagement with its tweets. It seems that the most important part of this strategy is tweeting the least—45 tweets in the previous 30 days is almost 20 times less than Revolut, the most frequent Tweeter user, and over 13 times less than Starling, which comes second to last. The most active Revolut is also the least liked, with just 1.4 likes per tweet, which contrasts the most with N26's 103.4, Chime's 47.8. The followers of N26 engage with 62% of its tweets, which is three times more than in the case of Revolut, the least engaged Twitter user. However, Revolut has a decisive edge in the number of followers, which has hit over 283 thousand, twice as much as Chime's and Monzo's (167 and 63 thousand, respectively) and about four times more than N26 and Starling Bank (76 and 63, thousand respectively).

To understand how Revolut and its competitors use their Twitter social capital to interact with each other, I counted the number of mutual mentions on Twitter (Figure 13). These were mostly responses to individual users who ask questions or reach out with issues rather than direct messages to the competitor. It is not clear what these mentions serve, although a rational economic explanation is that company A wants to attract the users who search company B on Twitter by showing that company A actively responds to questions and problems. It seems more beneficial then for a smaller startup to mention a larger startup than the other way round.

Starling Bank follows this logic; it is very proactive and mentions each competitor more often than the competitors mention Starling. However, the opposite logic governs Revolut's interaction with N26 and Monzo, as the larger Revolut mentions these competitors about six to seven times more often. Monzo and N26 do not interact frequently with each other—much less frequently than with Revolut or Starling Bank. Thus, the startups employ different strategies and place quite diverse emphases mutual mentions. This is the simplest network analyzed in this project, yet the most clearly following the idea that ties represent frequent and measurable interactions between actors. In the sphere of social media, the digital banks are quite well connected.

6.4 Networks of Capital and Profit. (Figure 14.)

Finally, is there any evidence of correlation between the patterns observed so far and the market valuation or profitability of the startups? This part of the analysis compares the data from Figures 14 on financial outcomes and Figure 15 summarizing results from the preceding sections.

It is worth starting with the features that distinguish Revolut, the highest valuated startup from Starling Bank, the least valuated startup in my analysis. It is not entirely surprising that Revolut is the best-connected node, and Starling Bank is the most isolated point in the investment network, since the higher the value of a startup, more investor it attracts, and the investors are more likely to be key players in the industry. However, Starling gained the recognition of Goldman Sachs, the largest investment bank in the world. Considering the startup owners, the fact that Revolut is backed by a lot of venture capitalists may partly explain its lead over Starling Bank, which had to rely on presumably more reserved types of investors.

Revolut's activity on Twitter corresponds to its mass scale character: it has the most followers, it is capable of producing the most tweets, but it does not need to care about engaging its followers to like the tweets. Starling, the smallest company with the smallest follower base optimizes its Twitter presence with frequent mentions of the competitors in the hopes of making their (dissatisfied) users discover Starling as the alternative. The human capital is the only area which is not immediately explained by market or revenue size and measurable capital: while the employees of both banks have a portfolios of extensive and high quality professional experiences, Revolut has the least interlocks, and Starling Bank has the most of all digital banks. Perhaps Revolut's members are more focused on the company, since it has prospects for a great success that requires a great commitment, while Starling Bank's members devote more attention to alternative opportunities for growth.

While Starling Bank is valuated at a lower amount than Monzo and N26, it is also more profitable than the latter two. While its lower valuation may be related to its significantly sparser connection with investors, it may be the case that Starling Bank owes its success in generating profit to the diversity of its human capital, which comes from different industries and locations and to stronger ties with its fewer investors, who may pressure the leadership to direct strategic decisions toward profitability.

7 Quantitative Results: Reports of Metrics. (Figures 3 to 5 and 8 to 11.)

Quantitative analysis of Figure 3 (Investors). Network Interpretation: directed. There are 173 nodes and 184 edges in the graph. There are two weakly connected components. Graph density is 0.006, and the average degree is 1.06. The the average path length is 1, and betweenness centrality is 0 for all nodes. Revolut has the largest degree of 59 and the largest

eigenvector centrality of 1, followed by Chime—41 and 0.69, N26—38 and 0.64, Monzo—36 and 0.61, and Starling 10 and 0.17.

Quantitative analysis of Figure 4 (Investors and Owners). Network Interpretation: directed. There are 216 nodes and 227 edges in the graph. There are 2 weakly connected components. Graph density is 0.005, and the average degree is 1.05. The average path length is 1, and betweenness centrality is 0 for all nodes. Revolut has the largest degree of 75 and the largest eigenvector centrality of 1, followed by Monzo—53 and 0.71, Chime—41 and 0.55, N26—38 and 0.51, and Starling 20 and 0.27.

Quantitative analysis of Figure 5 (Owners). Network Interpretation: directed. There are 46 nodes and 43 edges in the graph. There are three clearly visible connected components. Graph density is 0.021, and the average degree is 0.935. The average path length is 1, and betweenness centrality is 0 for all 46 nodes. Revolut has the largest degree of 59 and the largest eigenvector centrality of 1, followed by Chime—41 and 0.69, N26—38 and 0.64, Monzo—36 and 0.61, and Starling Bank 10 and 0.17.

Quantitative analysis of Figure 8 (Interlocks). Network Interpretation: directed. There are 129 nodes and 124 edges in the graph. There are 5 connected components. Graph density is 0.008, and the average degree is 0.961. The average path length is 1, and betweenness centrality is 0 for all nodes. Chime has the largest degree of 46 and the largest eigenvector centrality of 1, followed by N26—27 and 0.59, Monzo—19 and 0.41, Starling Bank—19 and 0.41, and Revolut 13 and 0.28.

Quantitative analysis of Figure 9 (Human Capital Flow, Parallelly). Network Interpretation: directed. The average path length is 1.16. Revolut has the highest number of

companies where its members gained experience (70), and, as such, has the achieves the highest eigenvector centrality of 1. Thus, its senior staff bring experiences from more companies than Monzo, the second key node in the network with in-degree of 51 and eigenvector centrality of 0.62. The remaining digital banks have similar positions to each other in the network, with in-degrees ranging from 57 (N26) to 66 (Chime) and eigenvector centrality from 0.34 (N26) to 0.39 (Chime). Interestingly, Starling Bank is the only one with a non-zero betweenness centrality of 59.

Quantitative analysis of Figure 10 (Human Capital Flow, Sequentially). Network Interpretation: directed. There are 187 nodes and 193 edges. The network consists of four connected components. The average degree is 1.03, and the average weighted degree is 1.04. The average path length is 2.35. Starling Bank, HipDial, and Lloyds Banking Group have the largest betweenness centrality (86, 43, and 40, respectively), and Monzo, Revolut, and HipDial have the largest eigenvector centrality (1.0, 0.74, and 0.73, respectively). Revolut has the in-degree of 20 and out-degree of 0, Starling Bank—19 and 1, and Monzo—13 and 0. PwC Mongolia, PricewaterCoopers, and Insight Finance GmbH are the three most eccentric nodes.

Quantitative analysis of Figure 11 (Human Capital Flow, Sequentially and Geographically). Network Interpretation: directed. The network consists of just one connected component. The average degree is 1.73, and the average weighted degree is 4.07 The average path length is 2.40. London and the San Francisco Bay Area are the two key centers of human capital with betweenness centrality of 100 and 102, respectively. Berlin and New York are far behind with the values of 27 and 12, respectively. However, London is the leader of eigenvector centrality, followed by Berlin, the Bay Area, and other parts of the UK with values of 1, 0.66, 0.57, 0.50, respectively. London has 14 in-degrees and 3 out-degrees, Berlin—8 and 2, the Bay

Area—6 and 6, and all other locations—less than 4 in either. Berlin, Hamburg, and the Bay Area lead closeness centrality. The three most eccentric locations are Guaron, India; Sydney, Australia; and Guatemala.

8 Concluding Discussion.

8.1 A Perspective on the Results.

Revolut, Monzo, Starling Bank, N26, and Chime do not form dense networks in terms of investors, owners, or companies where their board and team members work concurrently or gained professional experience. It is very surprising that there are few connections among these digital banks. By construction of my analysis, digital banks are central members of the networks and hold structurally equivalent role relationships. Within these narrowly defined networks, the digital banks formed only indirect linkages through investors, and very few shared former employers of their board and team members. This situation generates a lot of structural holes in the network of digital bank startups; investors and owners form cliques, and expertise and experience do not flow between the banks in a way observable in my data. In fact, in the case of interlocks, the board and team members form cliques around their digital banks. Are there, then, any opportunities for arbitrage or bridging some of the companies? Considering that these startups differ in the characteristics of their capital structures, a merger between the ones with complimentary features of human capital seems a viable option to consider.

8.2 Future Research

One obvious improvement to the analysis in this paper is adding more digital banks to the dataset. This could greatly change the picture and reveal a denser network or at least some clustering patterns that would not merely reflect the nature of data collection. An important omission due to constraining my analysis to Europe and North America is NUbank, which is

larger than any of the banks considered, with a valuation of $41.5 billion. In a revised version of this project, it would be valuable to create and analyze a network where nodes stood for industries such as tech, fintech, traditional banking, or lower-level branches of these industries—extracting the industry plane underlying the main graph in a way analogous to the representation of the human capital flows in Figure 11. This would give answers as to what industries digital banks link and from which industries they draw their know-how.

There are also potential alternative approaches to the focus of this project. For example, an analysis of financial capital flows could use a network of companies connected by digital banks' lead partners on deals. Similarly, an analysis of human capital flows could further investigate egocentric networks around individuals forming boards and teams of digital banks and form networks of companies where the co-members from previous companies work. If data were available, it would also be interesting to track human capital flows of all the employees of the digital banks rather than only their board and team members.

Future research could replace the egocentric network approach with starting with datasets of a larger scope and then finding the digital banks within them. For example, the addition of the fintech ecosystem or even broader parts of the tech world would enable tracking the sources of capital of the digital banks in a broader scale. This method would potentially make quantitative analyses more involved and more interesting. Moreover, future research could put the digital bank network it in a comparative perspective with the world of traditional financial institutions as well as the fintech and tech world. It would be valuable to see network structural comparison across these segments of the economy, in particular in relation to financial outcomes.

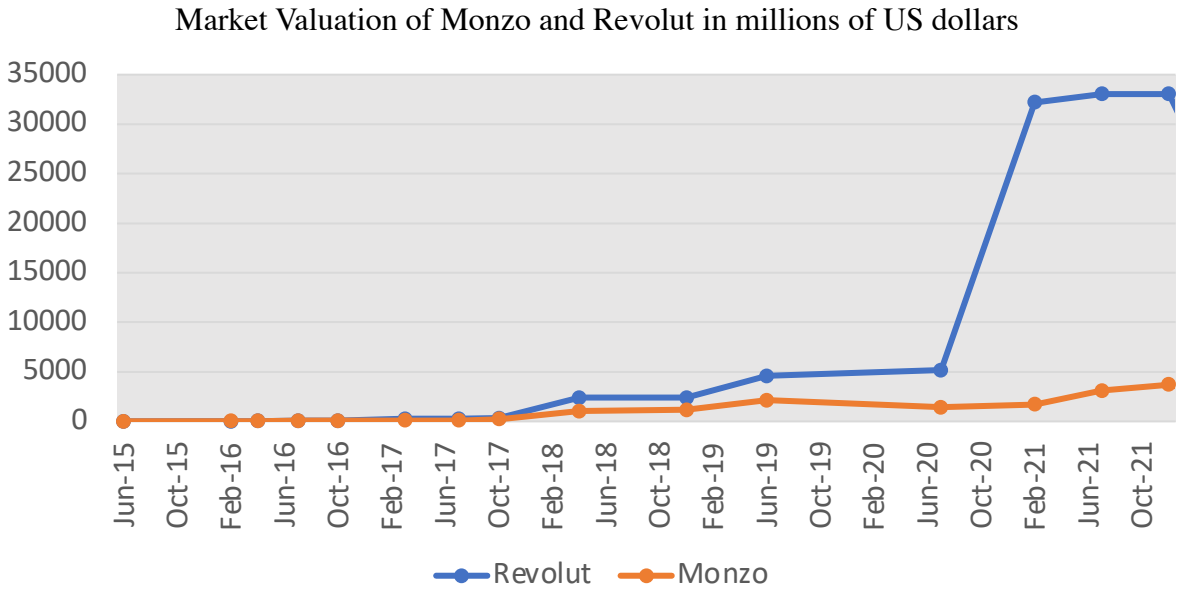

Figure 1: Market valuations of Revolut and Monzo as reported in funding rounds. Source of data: PitchBook

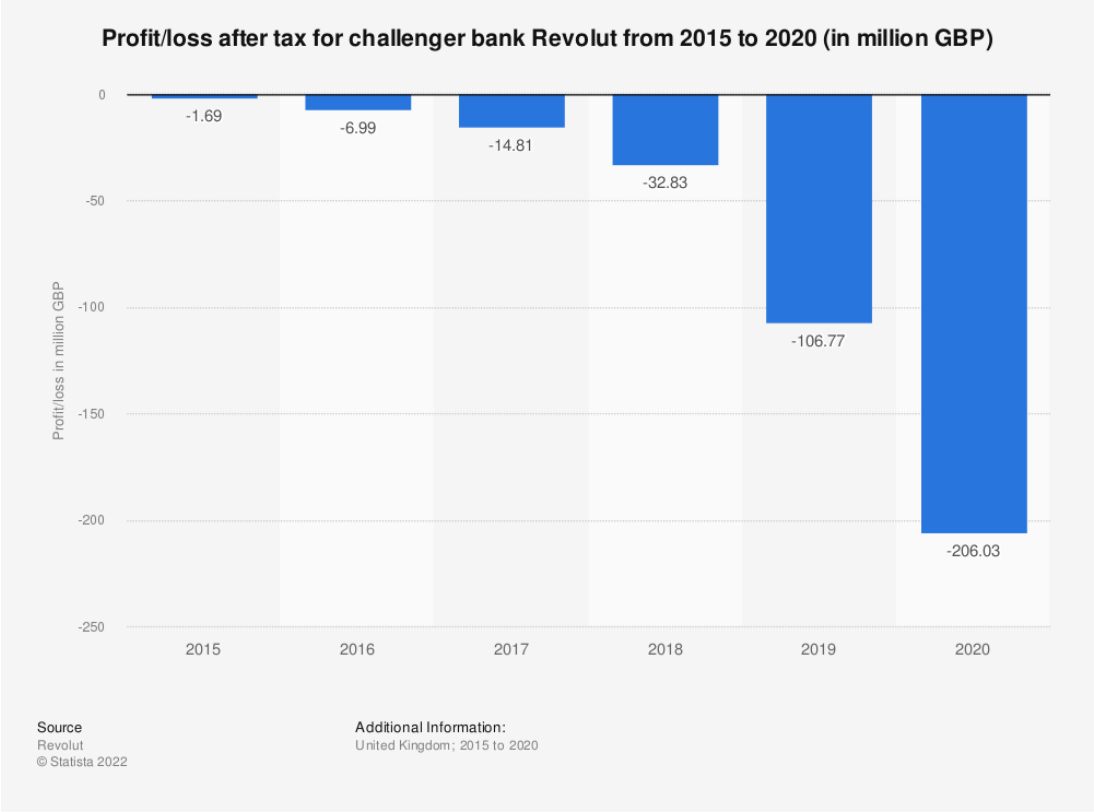

Figure 2: Revolut's profit. (June 4, 2021). Profit/loss after tax for challenger bank Revolut from 2015 to 2020 (in million GBP) [Graph]. In Statista. Retrieved March 14, 2022, from https://www.statista.com/statistics/1244990/profit-and-loss-for-revolut-bank-united-kingdom/

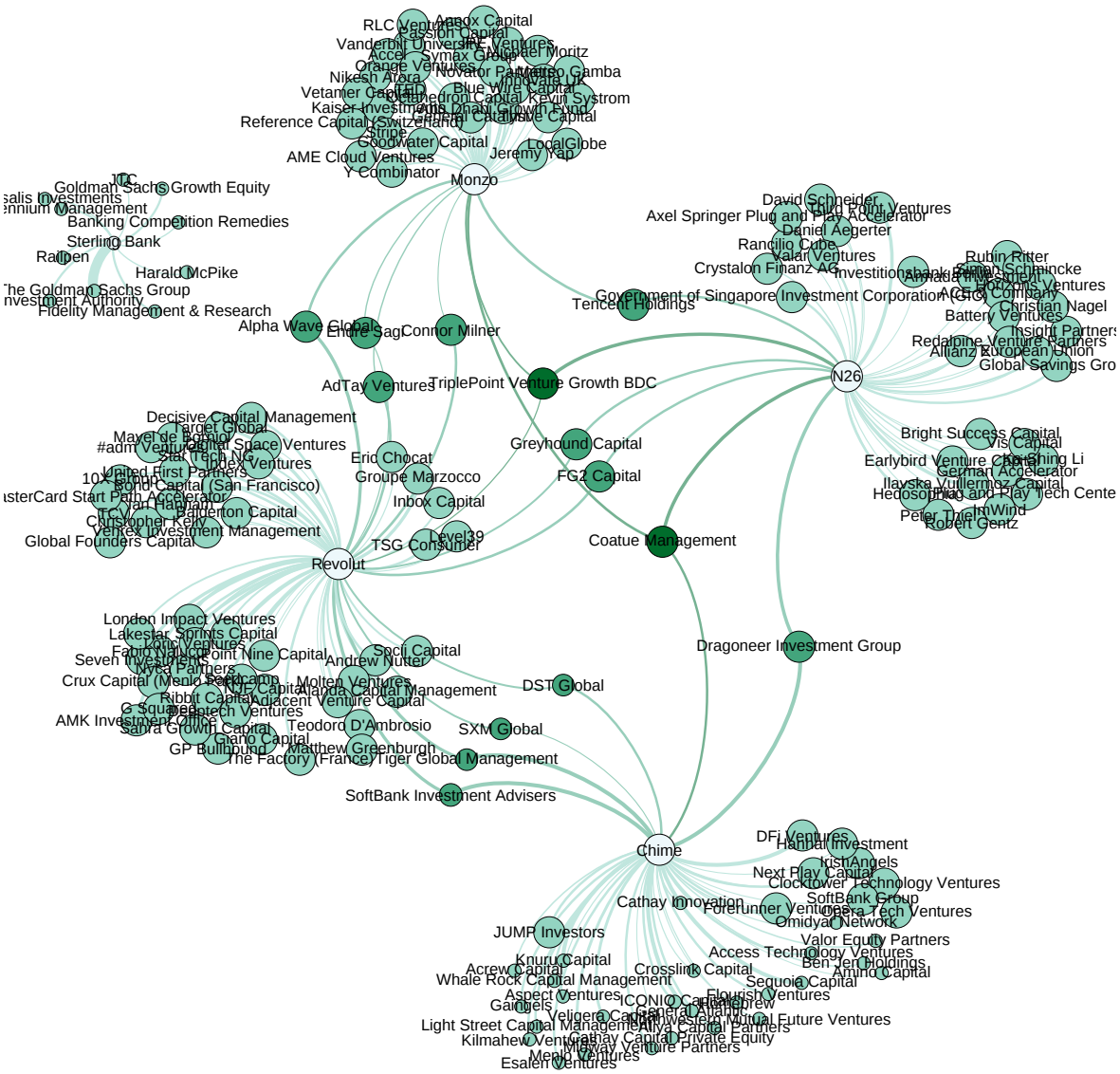

Figure 3: Investor networks of Revolut, Chime, Starling Bank, Monzo, and N26. Edge thickness reflects the size of the deal in which the owner participated. Node colors reflect out-degrees (or number of startups invested in). Data source: Pitchbook (retrieved on March 12th, 2022

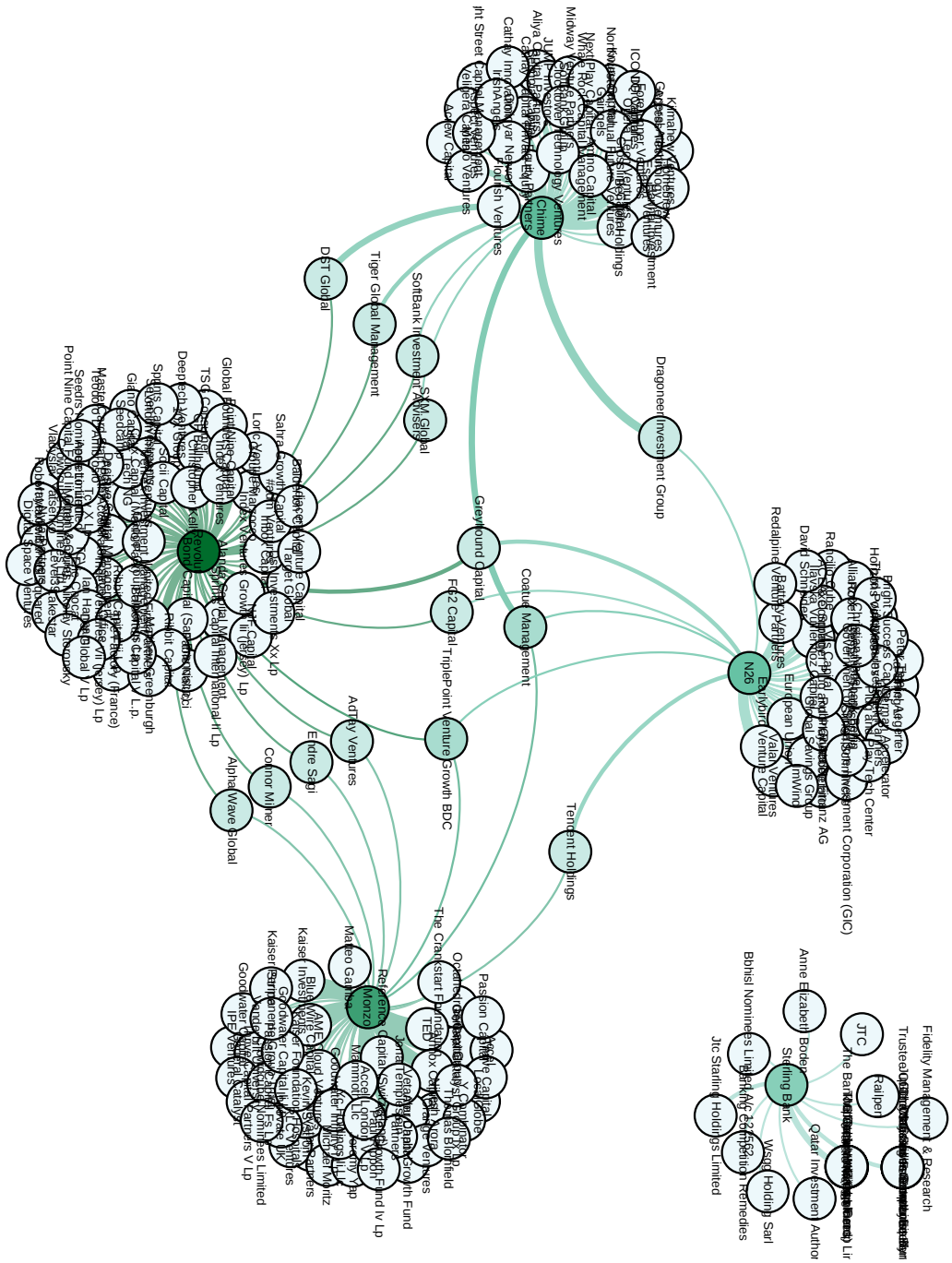

Figure 4: Investor and owner networks of Revolut, Chime, Starling Bank, Monzo, and N26. Edge thickness reflects the number of deals in which an investor participated. (It takes the value of 1 for owners who did not participate in fundraising deals). Data source: Pitchbook (retrieved on March 12th, 2022

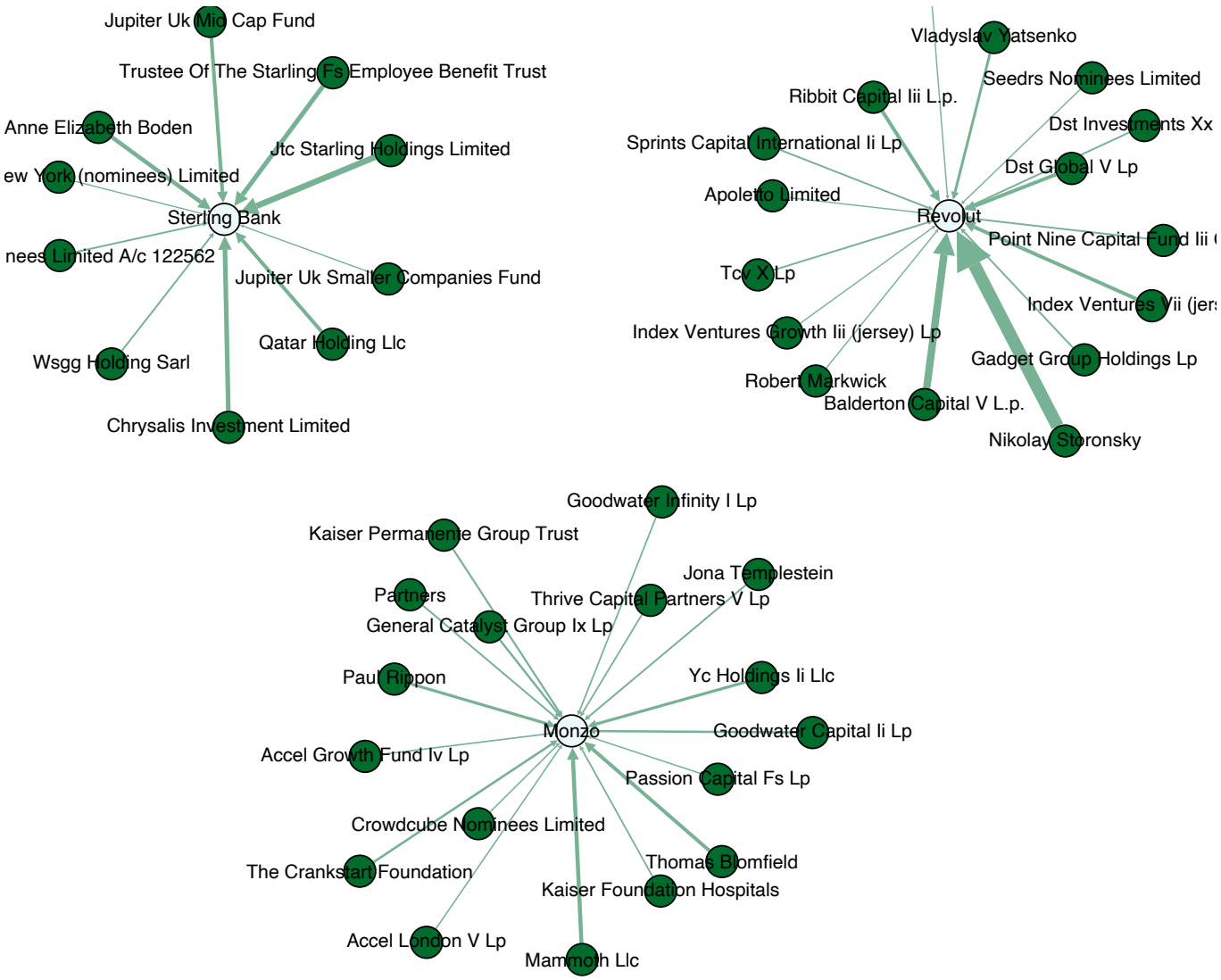

Figure 5: Ownership networks of Revolut, Chime, Starling Bank, Monzo, and N26. Edge thickness and arrow size reflect the size of ownership share. Node colors reflect out-degrees (or number of companies owned). Data source: Pitchbook (retrieved on March 12th, 2022).

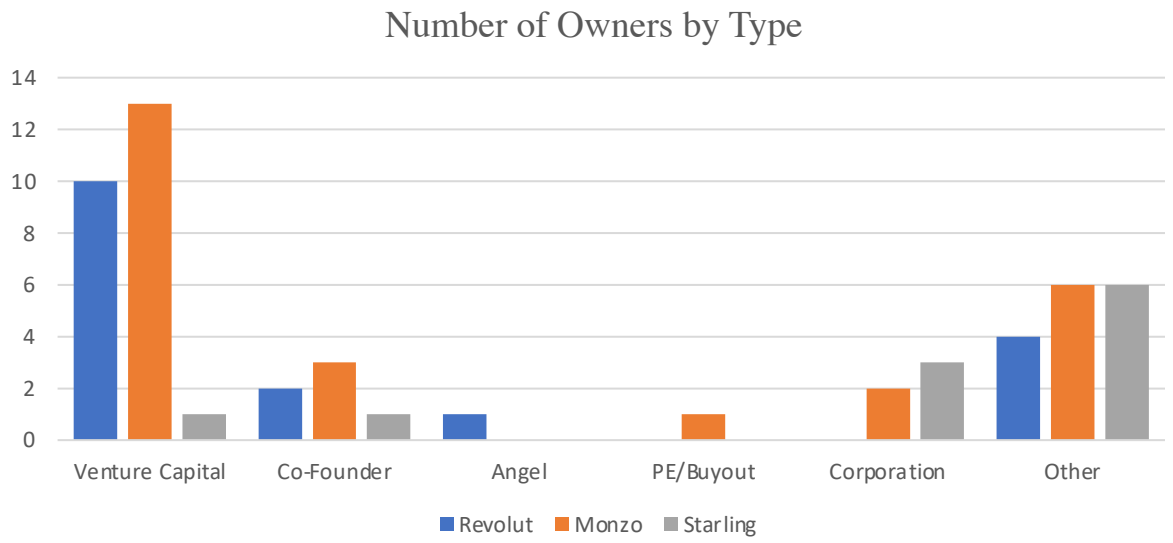

Figure 6: Owners of Revolut, Monzo, and Starling Bank by type. The category "other" includes companies described as Independent Non-Profit Foundation, Corporate Pension, Employee Trust, Sovereign Wealth Fund, Open Ended Investment Company, Limited, and Limited Partnership. Data source: Pitchbook (retrieved on March 17th, 2022).

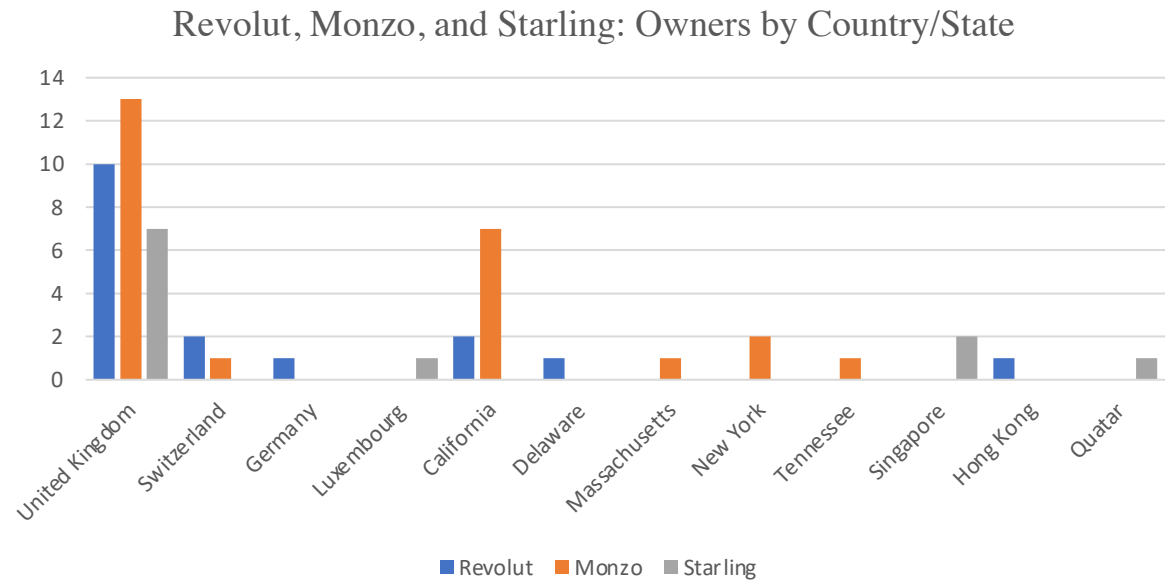

Figure 7: Owners of Revolut, Monzo, and Starling Bank by country or state. Data source: Pitchbook (retrieved on March 17th, 2022).

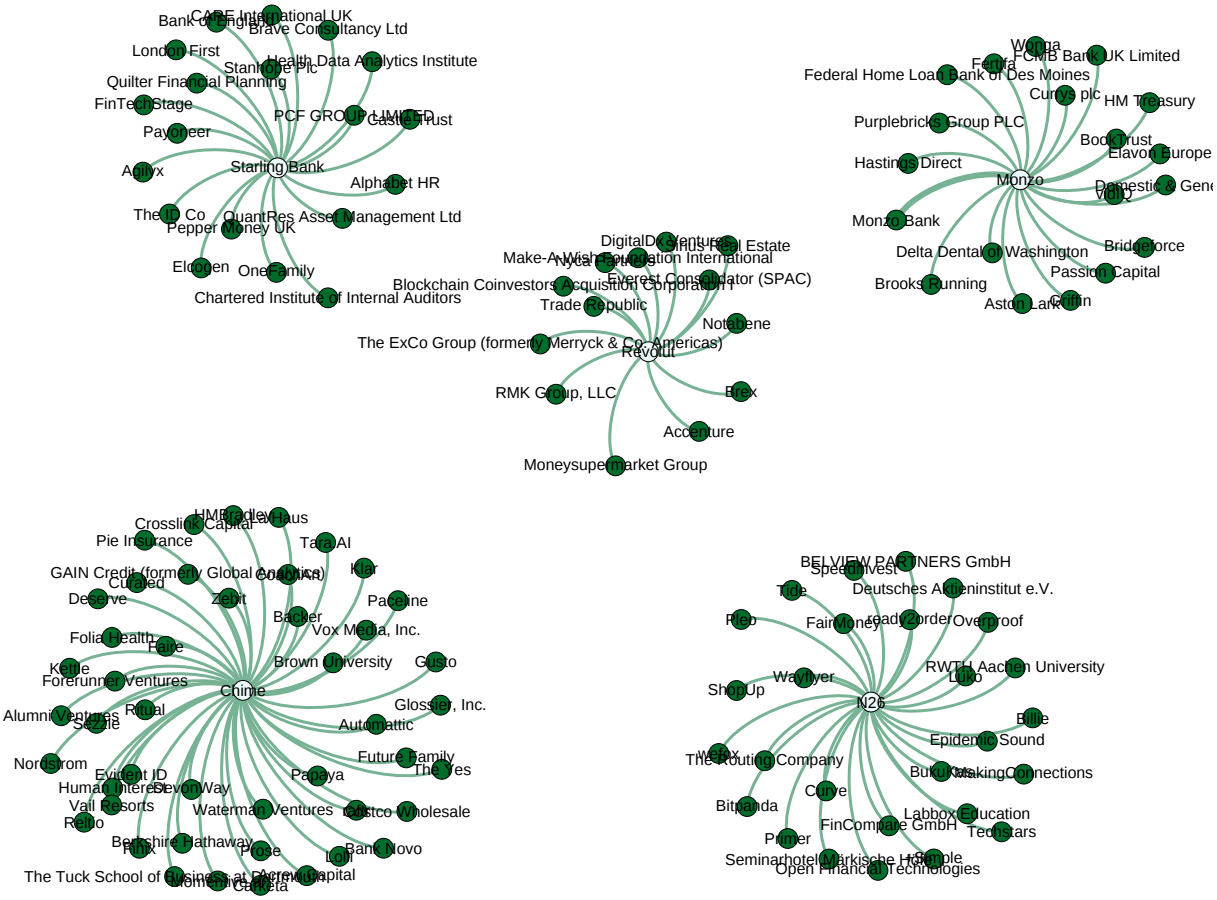

Figure 8: Interlocks. Edge thickness reflects the number of board or team members common to both companies. Node color indicates whether the entity is a digital bank or a different organization. Data source: Pitchbook (retrieved on March 12th, 2022) and LinkedIn.

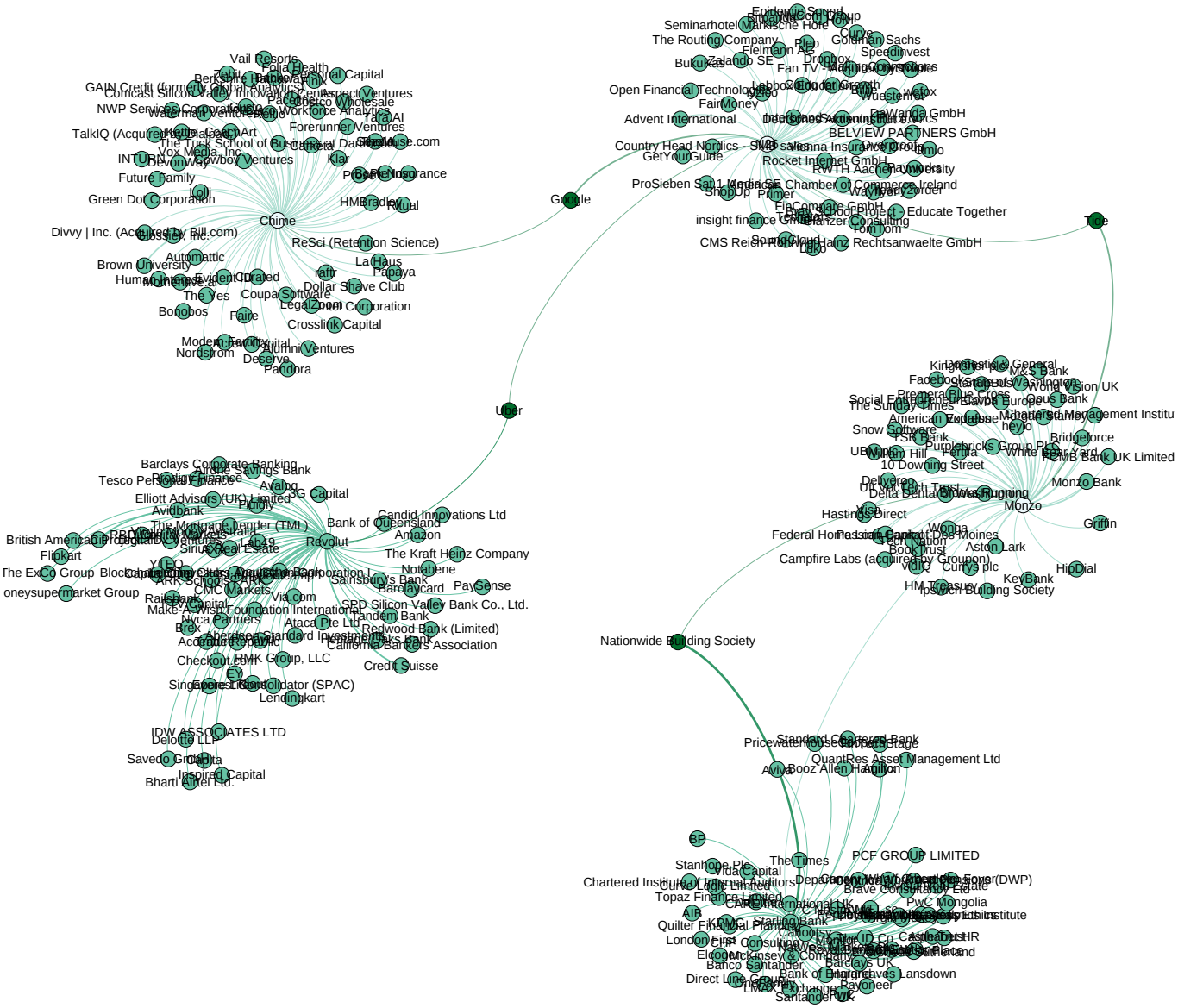

Figure 9: Human Capital Flows: Parallel. Edge thickness reflects the number of board or team members. Node color reflects the number of out-degrees. Data source: Pitchbook (retrieved on March 12th, 2022) and LinkedIn.

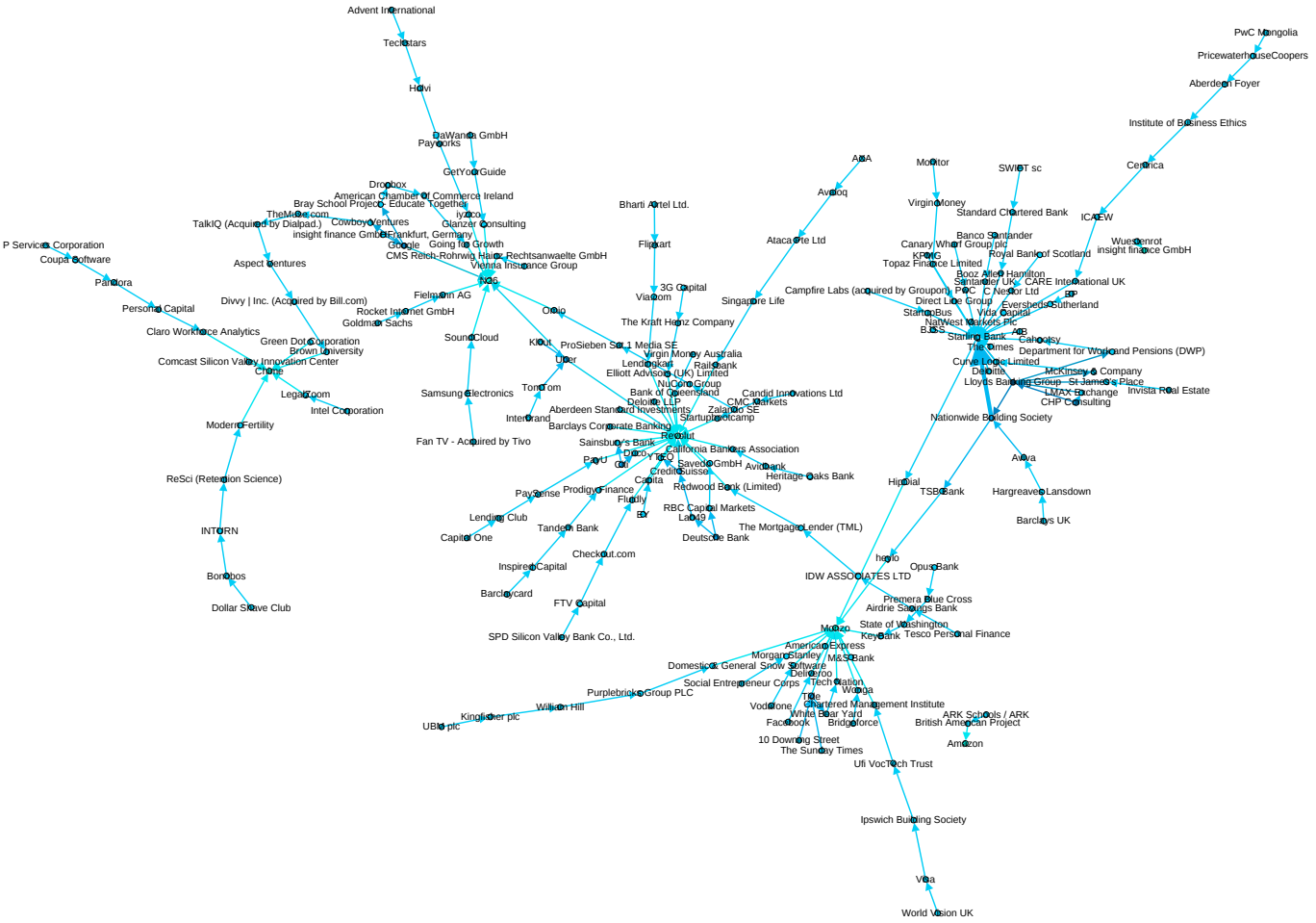

Figure 10: Human Capital Flows: Sequential. Edge thickness reflects the number of board or team members. Arrow point to the next company joined by an employee. Node color intensity corresponds to the out-degree. Data source: Pitchbook (retrieved on March 12th, 2022) and LinkedIn (retrieved between March 13th and 16th, 2022).

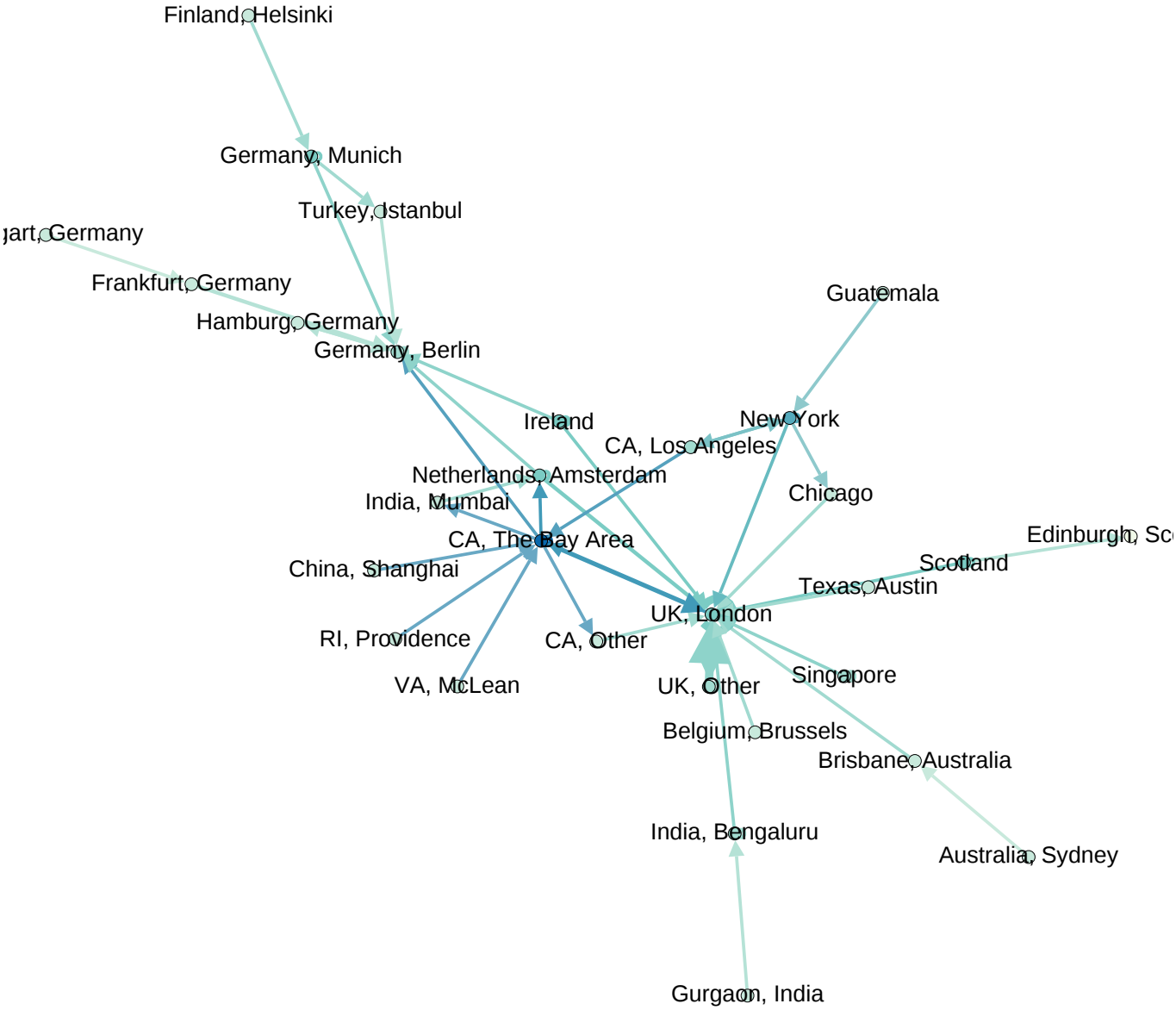

Figure 11: Human Capital Flows: Sequential, Geographic. Edge thickness reflects the number of board or team members. Arrow point to the next company joined by an employee. Node color intensity corresponds to the out-degree. Data source: Pitchbook (retrieved on March 12th, 2022) and LinkedIn (retrieved between March 13th and 16th, 2022). Note: Due to location data unavailability, the number of nodes is significantly smaller than in Figure 10.

	Revolut	Chime	Starling	Monzo	N26
Twitter followers	283.7 k	167.3 k	62.7 k	134.8 k	75.7 k
Number of tweets (last 30 days)	879	582	592	832	45
Average likes per tweet (last 30 days)	1.4	47.8	2.3	3.6	103.4
Percentage of tweets with engagement (last 30 days)	19%	36%	30%	35%	62%

Figure 12: Statistics on Twitter use and outcomes by Revolut, Chime, Starling Bank, Monzo, and N26. Data source: https://craft.co/revolut/competitors

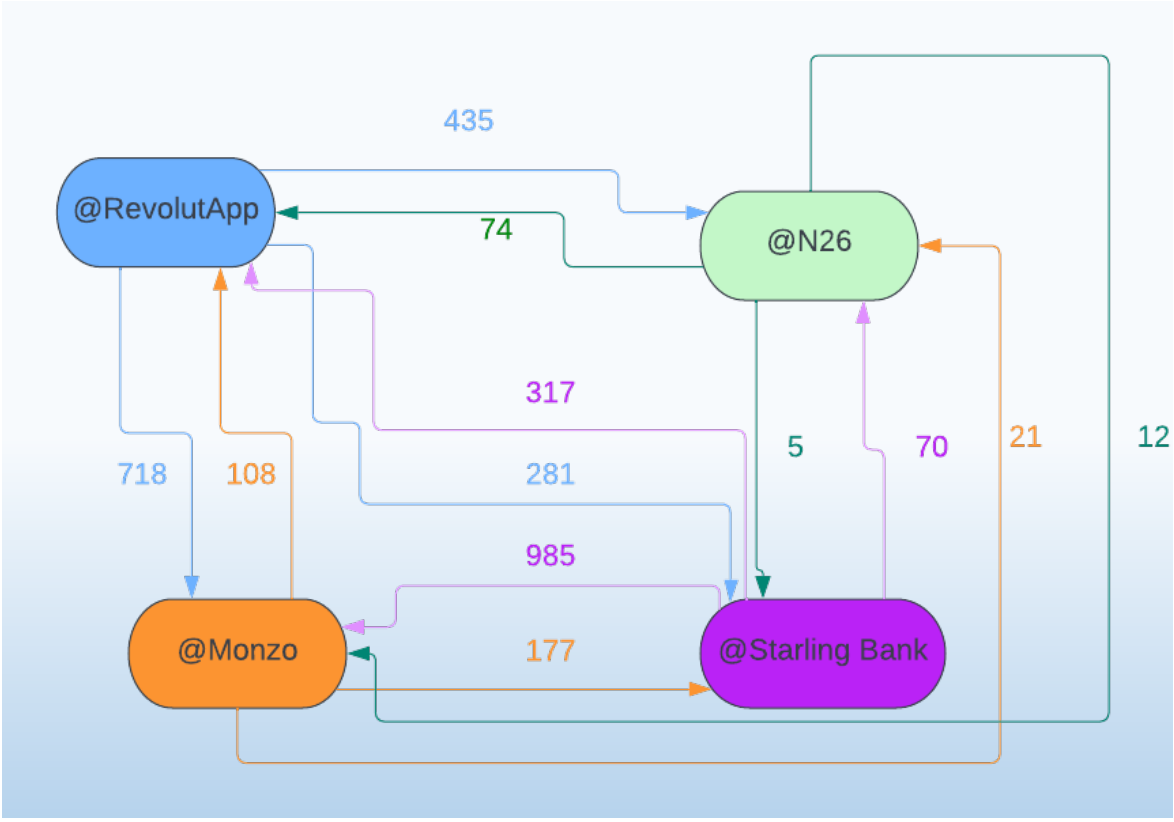

Figure 13: Interactions on Twitter. The arrow points from the company that tweets to the company that is mentioned in a tweet. The labels on edges represent the number tweets by the source company in which the target company is mentioned. Data source: Twitter (retrieved on March 13, 2022).

	Revolut	Chime	Starling Bank	Monzo Bank	N26
Valuation ($)	33 b	14.5 b	1.5 b	4.5 b	3.5 b
Revenue (est.)	£222.1m (FY, 2020)	N/A	£108.8m (FY, 2020)	£79.4m (FY, 2021)	€43.6m (FY, 2018)
Cost of goods	£152.4m (FY, 2020)	N/A	£11.2m (FY, 2020)	£17.2m (FY, 2021)	€14.5m (FY, 2018)
Gross profit	£69.7m (FY, 2020)	N/A	£97.6m (FY, 2020)	£62.2m (FY, 2021)	€29.6m (FY, 2018)
Net income	(£206m) (FY, 2020)	N/A	(£23.3m) (FY, 2020)	(£129.7m) (FY, 2021)	(€39.9m) (FY, 2018)
Users	15.5 m	12 m	2.1 m	5 m	7 m

Figure 14: Statistics on financial outcomes of Revolut, Chime, Starling Bank, Monzo, and N26. Data sources:
https://craft.co/revolut/competitors; https://www.businessofapps.com/data/revolut-statistics/
https://www.businessofapps.com/data/chime-statistics/
https://www.businessofapps.com/data/starling-bank-statistics/
https://www.businessofapps.com/data/monzo-statistics/
https://www.businessofapps.com/data/n26-statistics/

	Revolut	Chime	Starling Bank	Monzo Bank	N26
investors	highest centrality shares 3-4 investors with each competitor	high centrality large number of connections despite the most remote location	disconnected from the rest fewest investors very strong tie with Goldman Sachs	high centrality large number of investors	high centrality large number of investors
owners	intermediate number of owners mostly owned by VC very strong ties with some owners	private	smallst number of owners most diverse set of owners in terms of type and geography	highest number of owners mostly owned by VC half from the USA	private
employee experience	highest number of firms where members gained experience fewest interlocks members's background: large and established banks	large number of firms where members gained experience most interlocks members' background: mostly tech	large number of firms where members gained experience large number of interlocks members' background: diverse	least number of firms where members gained experience moderate number of interlocks members' background: mostly tech	large number of firms where members gained experience large number of interlocks members' background: diverse
Twitter	most active user least liked and engaged most followers	(not considered)	fewest followers mentions competitors most frequently	most tweets per follower moderately liked and engaged second highest no. of followers	least active user most liked and engaged second lowest no. of followers

Figure 15: A summary of features of Revolut, Chime, Starling Bank, Monzo, and N26 found in this paper's analysis.

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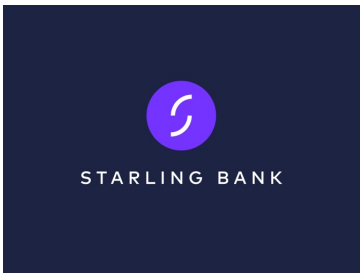
London, UK



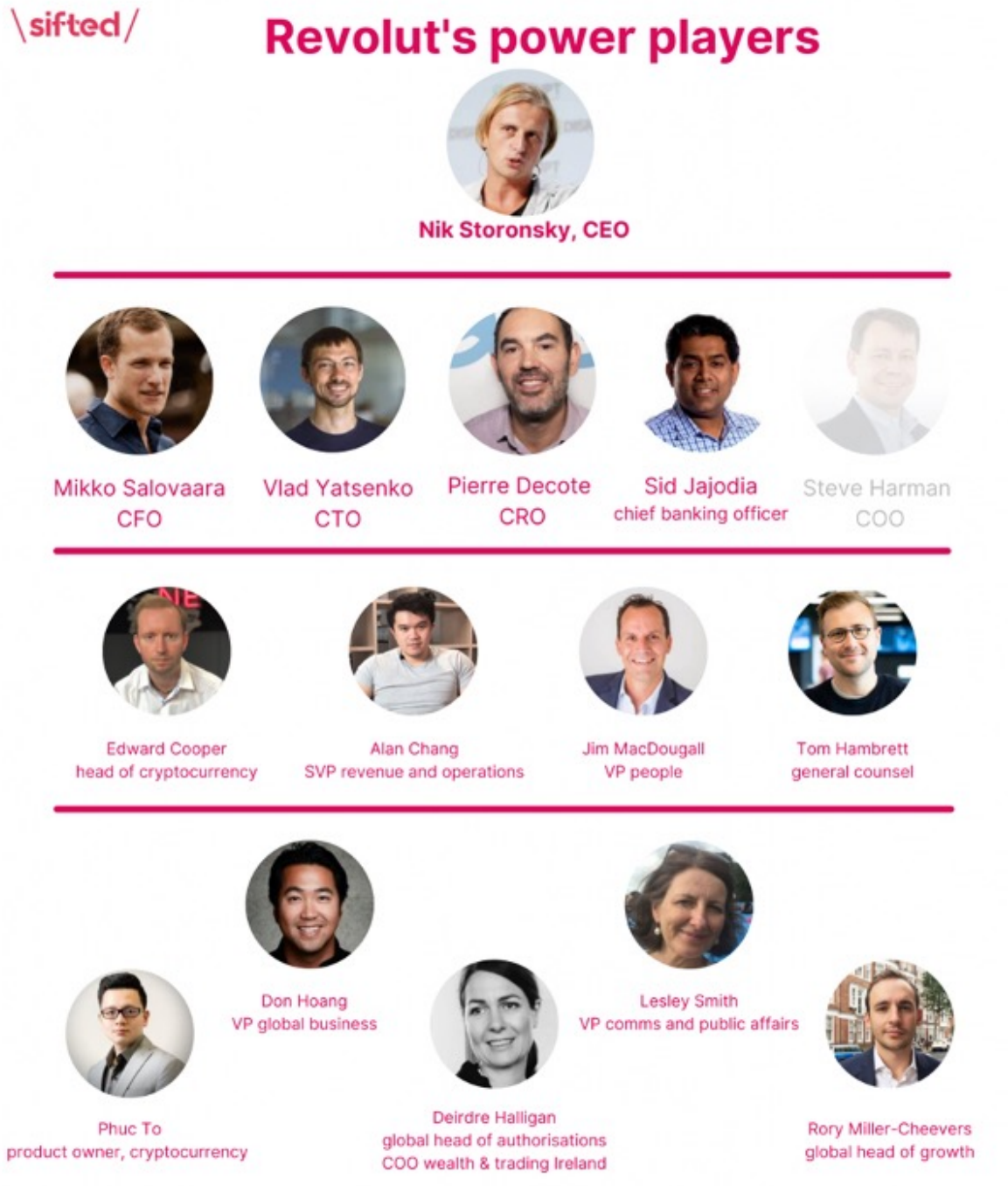
London, UK

Berlin, Germany

London, UK

San Francisco, CA

Appendix Figure 1: Logos and locations of the digital banks examined.



Appendix Figure 2: 15 most senior people of Revolut.
Source: (Isabel Woodford, 2021. "The people with power at Revolut: a map of Nik Storonsky's top team." *Stifted*): https://sifted.eu/articles/revolut-power-players/