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RESEARCH-ARTICLE

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Disconnected Platforms, Networked Lives: Social Bridging across Fragmented Payment Systems in China

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Money is increasingly accessed through multifunctional digital platforms via mobile payment and banking apps that offer various financial services, several of which integrate social media connectivity. In China, Alipay and WeChat Pay handle billions of transactions annually to the extent that physical cards and cash are rarely carried or used. These platforms have been described as 'walled gardens' because financial transfers cannot be made directly between them. While Alipay and WeChat Pay share similar transactional components, they differ in their financial products, constraints, interdependencies and social media integrations, and each offers different interactional possibilities for users to meet their everyday financial needs. We examine how users navigate infrastructural payment problems, perform financial management across different platforms and accounts, deal with 'trouble' in making payments, and weave their social and financial lives across platforms to create interoperability between these otherwise disconnected services. Our analysis suggests these apps do not just initiate, record and track payments, but are actively configured by users through interconnected social, transactional and money-management practices, and that user interactions and digital payment practices are shaped by complex socio-financial arrangements. We discuss the findings, drawing implications for designing social-financial interactions in bridging disconnected services.

CCS Concepts: • **Human-centered computing → Empirical studies in collaborative and social computing**; *User studies*; *Computer supported cooperative work*;

Additional Key Words and Phrases: CSCW, digital money, digital payment, financial platforms, financial services, social media, financial interaction, money management

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1 Introduction

The availability of pervasive connectivity and powerful, secure mobile devices has contributed to a profusion of innovations in mobile payments, digital money and financial services. The provision of these services over digital media has meant that they are not bound by the existing constraints of legacy banking systems and these app-based services are free to operate in new ways, with novel opportunities for interaction and user experience design, as well as building in opportunities for rich forms of social engagement around users' financial activities. At the same time, in the absence of regulatory demands, commercial pressures to restrict their users' financial access to competitors' services have led to many of these financial platforms limiting inter- or cross-platform connectivity. Direct payments and sharing information access between platforms is frequently made deliberately difficult with the intention that their users' financial data and money is 'locked' into a platform once it enters it because of the costs and other frictions associated with making cross-platform financial transfers. In many ways, these commercial pressures are little different to the ways that competing networked digital content platforms (e.g., Google/Alphabet, Meta/Facebook, Amazon, Apple's App Store) limit flexible sharing of user data between themselves, resulting in proprietary and closed ecosystems commonly known as 'walled gardens' [1]. The result of these closed financial platforms is a lack of choice and freedom for users who, while they gain the benefits of access to the financial services of one platform, also lose the potential to flexibly use their money on competitors' platforms to benefit from different services and opportunities. Nevertheless, in many cases, end-users of closed financial systems may be able to call on workarounds to enable connectivity between these otherwise disconnected ecosystems. This sets the scene for the topic of this article, in how people solve interactional problems when dealing with digital money, achieve financial flexibility across platforms and apps, and pull on the different resources of these services to meet their needs as they go about their everyday lives. To do this, we examine a setting with two of the most advanced and prevalent digital money platforms: The People's Republic of China.

China has been at the forefront of innovations in digital financial platforms, and our interest in the Chinese experience of these has been to pull out the ways in which people make use of their apps within this complex financial ecology to inform the design of future financial technologies. Two main incumbents, Alipay and WeChat Pay, are the predominant forces driving digital consumer payments in China, and together, they have instigated radical changes in the Chinese financial industry and moves towards a 'cashless' economy in many cities [11, 17]. To illustrate their reach within China at around the time our data was collected, Alipay was used by 63.6% and WeChat Pay by 84.3% of the population; WeChat Pay had 900 million monthly users while Alipay had 500 million monthly active users in 2019 [33]. In 2018, mobile payments totalled 277.4 trillion yuan (US$41.5tn) across 60.5 billion individual transactions [58]. By 2022, this had risen to 500 trillion yuan across 158 billion transactions [70]. The transformation of payments in China led by Alipay and WeChat is happening against a broader international backdrop of financial organisations increasingly moving into technology development (e.g., Barclays, Goldman Sachs) and of technology companies developing financial services (e.g., Apple, Meta, Alphabet), alongside hybrid 'fintech' entrants into the financial marketplace (e.g., Monzo, Revolut, Robinhood). Meta's Libra/Diem token (libra.org) was an extreme example of this change, presented as a financial technology that offered users new ways of transacting, but which threatened incumbent players and entire financial systems. Like WeChat Pay in China, as a payment platform integrated into social media, Libra promised a form of payment that would offer opportunities for use through this infrastructure, with its users' social media contacts giving it an enormous reach in a way that would not be possible with non-digital currencies. Libra was unsuccessful, in large part following pressure from national regulators concerned about its destabilising impact on the global financial system [80], but that it

failed as a result of its projected impact is instructive. The transformational effects from these new payment platform technologies and their reshaping of the financial landscape are anticipated to cause disruption to the industry, ways of working, and, for the purposes of this article, present new challenges to interaction and experience design.

To explore this topic, we undertook a series of interviews with digital money users in China, looking at their everyday use of payment apps. Participants were asked about their lives, recent transactions, payment decisions, transactional problems and their in-app transaction records to elicit information about specific instances of use. The analysis reported in this article therefore builds a rich picture of socio-digital payment practices in China, focusing on consumer interactions, rather than examining this from the perspective of the retailers or sellers of products or services. This research is situated within a growing body of work within **human–computer interaction (HCI)** and a recognition that financial interactions are complex and highly important to our everyday lives, from dealing with money management to showing how debt and lending, budgeting, planning and making financial choices are done [36, 41], exploring social interactions with money [3, 18] and its potential for harm [4, 34] and demonstrating how purchases are integrated into everyday interactions [38, 60]. To help frame the interactional work that is performed around money in making financial transactions, Perry and Ferreira [60] extended Colavecchia's [8] concept of 'moneywork', which they describe as '*including the physical and social interactions that users make individually and collectively in order to enable transactions*' [41, p. 2]. We use this conceptual framing to address the topic of digital money in China, showing *how* users act to make particular forms of digital money work for them. From a user's point of view, the proliferation of financial platforms and their associated apps means that they will have to do work to bridge their money across multiple infrastructures and enable financial interoperability between them. As yet, it is not clear how this future landscape will develop, but what is happening in China offers insight into this, given that Alipay and WeChat Pay are already operating on a massive scale with real transactions and widespread adoption across the population. We want to emphasise that our analysis in this article is not intended to provide a usability evaluation of the interface design of the apps at the time of this study; this would date quickly, as these apps, the platform infrastructures supporting them, and the regulatory policies governing allowable financial activities regularly change and adapt. Rather, our intention is to show how emerging social practices—often shaped by the very systems that our users paid through—are used to overcome the technical constraints of these apps on users' ability to pay for things, and enable money that is held across tightly restrictive digital platforms to be made liquid and useful.

2 Related Work

Recent developments in digital technologies have shifted the use of money from analogue forms of payment media (such as paper notes and metal coins) to payments being made online and on mobile devices. This has resulted in a growing movement within HCI and **Computer-Supported Cooperative Work (CSCW)** to consider users' experiences of these systems, and how best to support the use of digital money through its transformation into novel interactional forms. While the economic function of money has not changed greatly as a result of this shift (money still acts as a medium of exchange, measure and store of value, means of payment and unit of account (e.g., [13]), it has had a more significant impact on the ways that money can be *used* to buy, sell, borrow or loan, and the forms of financial services that can be built around it. In this respect, the emergence of various forms of digital money and innovative digital financial services allows stores of value to be created, held, moved, measured and exchanged in novel ways. 'Mobile money' in particular, has received considerable recent interest in the developing world (e.g., M-Pesa, MobiCash, Paytm), by enabling value transfer and storage, and is heralded as being transformational in broadening

financial inclusion and opening up financial services to the 'unbanked' [38, 48, 49], as well as presenting new challenges to its users in making payments [19, 27, 34, 66], including issues of trust between users, and their financial and digital literacy. This is not to say that mobile money has not had an impact in more affluent countries, with payments increasingly moving away from physical money. Sweden, for example, has reportedly almost become a 'cashless' society [32]. However, there are wide differences in the take-up of digital and mobile money across the globe, and these have been attributed to reasons ranging from economic, political, legal, geographical, educational, cultural, social and their technical and financial infrastructures, amongst others. These reasons have also meant that a wide array of technologies for transacting with mobile money have been deployed across many countries with quite different functionalities and means of interaction [49].

The success of new forms of transactional media has largely depended on the ways that they are understood as useful and credible as viable forms of exchange, and on how they support the ways that their users interact around them [60]. It would be wrong though, to think about these technologies as just being determined by their use in the action of making a payment, because they are shaped by, and through, social interaction: 'Money is not something that happens to us but something that we continuously produce and reproduce in specific social settings', as we are 'doing money' [22]. In recognition of this, there has been a growing body of literature studying the social dimensions of digital money, as researchers begin to explore a 'new sociability of money' [25], and with Swartz persuasively arguing that it should be understood as a form of social media [73]. For example, Pritchard et al. [64] describe how the movement from cash to digital only payment on London buses impacted both on the ways that drivers and passengers plan, pay and interact with one another, while O'Neill et al. [56] examine how different forms of money, specifically, digital money versus cash, impacts on the work of an organisation and its customers. Ferreira and Subramanian [18] draw on empirical data of mobile payments using the Bristol Pound, and show how the medium of payment can impact on users' pleasure, playfulness, trust, expression of sociality and consideration of their purchasing practices. There are also increasing numbers of studies focusing on the 'pragmatics of money' showing how language and context, including deixis, conversational turn taking, bodily organisation and gesture are deployed within settings to enable particular forms of action [24, 26, 42, 54, 75]. For example, in his detailed video analysis of till payments, Llewellyn [42] shows how the act of paying cash can be used to project its users' forthcoming actions allowing people to refuse or negotiate transactions, or to assemble the right change or payment media. A similar approach was taken by Vom Lehn [75] who shows how street market traders negotiate to determine a price through their physical actions and transactional practices. Social interactions around money and payment are therefore critical to understanding the impact of these new payment technologies.

As a topic, money itself has been accorded serious attention in the social sciences since Simmel's *The Philosophy of Money* [69] at the turn of the 20th century. However, as argued by Zelizer [79], classical sociological studies of money (e.g., [45, 76]) have largely focused on the field of 'market money', which treats money as a 'technically perfect' medium of economic exchange in which it mainly plays a 'calculation function'. In counterpoint to this perspective, Zelizer [77] has challenged this traditional utilitarian model, emphasising people's will to consciously and socially separate, personalize and earmark different sources of money. The logic underpinning this work is that social relationships and economic transactions are closely, regularly and routinely intertwined [31], so for example, immigrants support their families at home with regular transmission of remittances, and friends and relatives send money as wedding presents or loan each other money without charging interest. Here, people engage routinely in the process of differentiating meaningful social relations through their use of money to undertake 'relational work' [78]. Others have developed this perspective to explore the role of money in society and connections with community [13], or

to emphasize money's social roles in different modalities of exchange and circulation [47]. Given the role of social relationships around money in the rest of the world, this are also likely to hold true for China, the locale of our own investigation.

With its huge population, growing wealth, critical geo-political role and mass-scale adoption of mobile technology in making payments, China poses a fascinating case study of the operation, development and use of digital money in social interactions. There is a small but growing literature studying these Chinese mobile money and payment systems [21, 24, 37, 43, 51–53, 68], suggesting that payment apps in China have changed practices around payment and that this is a novel and unique function of the platforms themselves. Using video-based methods, Greiffenhagen and Llewellyn [24] explore issues in Chinese payment apps around how the (in)visibility of digital money changes peer-to-peer payment practices and how users have developed improvised methods for mutual trust around payment completion. In this, determining whether money has 'changed hands' is a serious concern for users because payment validation may be hidden within the app or infrastructure, so that users often need to deploy socially-mediated forms of resolution shaped around the specific features of the payment platforms involved. Shen et al. [68] also provides an excellent lens into user experiences and challenges with digital payments in China from the perspective of financial infrastructures. In this, they touch on the use of money in communication, its interoperability across different payment media and how people deal—technically *and* socially—with payment failures, suggesting that these are areas that merit closer examination for HCI research and how future interaction with payment systems will shape users' experiences. Nevertheless, given its pervasive reach, transformational effects and prevalence in everyday life for hundreds of millions of Chinese people [51, 68] this area seems to have received surprisingly little attention so far within HCI.

The two Chinese mobile payments systems, Alipay and WeChat Pay originated from very different routes. Alipay (owned by Ant Financial, a subsidiary of the Alibaba group) emerged first as a means of facilitating transactions on the Alibaba (阿里巴巴) and Taobao (淘宝) ecommerce platforms, functioning in a somewhat similar way to PayPal on eBay. The more recent entrant, WeChat Pay (owned by Tencent) grew out of the almost ubiquitous mobile messaging and lifestyle app WeChat (*Weixin*/微信), the closest comparison to which outside of China would be WhatsApp, but which encompasses a deep ecology of mini-app services [10]. The functionality, operation and adoption of these two payment systems stems, in large part, from this historical development [52]. McDonald [52] illustrates these differences, showing how migrant workers use WeChat for everyday payments to friends and family and for making small payments to vendors owing to its 'convenient' (*fangbian*/方便) close integration with the WeChat platform, but consider it too risky for substantial savings or transfers. In contrast, they consider Alipay as the more 'professional' (*zhuanye*/专业) platform for managing money, preferred for storing and transferring large sums of money and used in commercial transactions given its wide acceptance in large supermarkets, department stores and online retailers. As well as being tied to participants' consumer practices, McDonald shows how mobile payments could be tied in with highly social practices. He provides a revealing example of this in describing how an informant regularly visited a side street food stall for his early-morning meal and deliberately chose to intentionally delay payment until *after* he had left, allowing both himself and the vendor to reaffirm their mutual trust on a daily basis. He notes that this runs counter to popular discourses which generally assume that these technologies deliver greater speed and efficiency (see also [18, 49]). In this respect, the degree of trust and comfort in financial interactions (e.g., social lending) is considered to be extremely high in China, in large part due to Guanxi (关系), a web of interpersonal ties built on trust, familiarity and mutual benefit, where favours and assistance are exchanged over time [39], and underpinned with considerable 'moral force' (p. 127), for example, in repaying debts. Both Kow et al. [37] and Shen et al. [68]

also compare the interaction design of WeChat Pay and Alipay, showing how they have become incorporated into a variety of already culturally significant social activities, including payment, ceremonial gifting, gameplaying and bill-splitting, and how specific functional and interaction design features flexibly shape their use in payment. While both applications support social activities, they do so in different ways, impacting on their users' selection of a payment platform. While these papers sit closely to our own topics of investigation, they differ in their research interests and orientations. As we will describe below, our work orients how socio-digital resources are chosen, managed and deployed under conditions of highly fragmented financial interoperability across platforms.

Scholarship on infrastructures and infrastructuring offers a useful perspective into how digital payment platforms are entangled with everyday social and technical practices. Drawing from Science and Technology Studies, infrastructures are conceived as more than simply technical engineering objects, but encompass sets of networked enabling resources that are embedded within other structures and social arrangements [6]. A key insight from studies of infrastructure is that these systems—like digital payments—typically exist invisibly in the background and are frequently taken for granted by their users [71, 72]. When functioning seamlessly, they are largely invisible to users but can become seen when they break down. Infrastructure can also become visible with the emergence of infrastructural alternatives that require their users to assess the differences between them and decide which to use (see, e.g., [53] in the context of choosing apps to manage digital money). Infrastructures may therefore be seam*less* for those who are well aligned with them, but be seam*ful* (showing frictions, often presented as problems) for those who are not; Bowker and Star [5] argue that attending to these seams is crucial to understanding how infrastructures work. Although it draws from a somewhat different tradition, an orientation to gaps, edges and breakdowns in computational infrastructure has also been developed within HCI into 'seamful' design [9] by making the seams in systems visible and intelligible so that users can interpret, adapt to, or exploit these in practical ways. The concept of 'infrastructuring', or the ongoing work of producing and maintaining infrastructures, has been developed to highlight how infrastructures are transformed and managed, often by the communities using them [35] so that solutions to infrastructural problems are rarely social *or* technical but are usually distributed across both dimensions. As this article demonstrates, the collaborative 'moneywork' of Chinese digital money users shows how they do this work of infrastructuring, to navigate the complexities of their financial lives in concert with the disconnections that they encounter between fragmented platforms in making payments. This conceptual approach to looking at infrastructure has recently been applied to digital platforms [62] showing a dual process at work: platforms both *become* infrastructure as they embed into a wide range of activities, and at the same time, traditional infrastructures themselves *adapt* to the logic of those platforms. This perspective re-orients studies of infrastructure beyond social practices towards the importance of political and economic forces in shaping digital platforms *as* critical infrastructures in contemporary life, and in providing insights into how platforms come to reorder—disrupt—the order of everyday life. This platform effect can be seen in the distinctive ways that WeChat Pay and Alipay have displaced and reshaped traditional forms of money and payment infrastructures in China, and as we show in this article, transforming the ways that people make use of and adapt to them in going about their everyday lives.

3 Participants, Data Collection and Analysis

This article is based on in-depth interviews undertaken prior to the COVID-19 pandemic, between October 2018 and March 2019 with 22 adult participants who regularly used digital money in daily life. We focused our participant selection criteria on Chinese urban, professional 'middle class' users with a sufficient and regular enough income to use a variety of transactional services,

allowing us to examine a broad spread of use practices around digital money. We chose not to look at rural or migrant labour, or the very wealthy, as an 'edge case' study, but to look at urban, educated participants who held bank accounts. The economic middle class in China is a large and rapidly growing group: according to the National Bureau of Statistics of China [58], around 30%, or 400 million citizens fall into middle-income groups, with 140 million households earning 100K–500K yuan (USD$14.5K–$75K) annually. Pew Research, using World Bank income criteria, has estimated the number of middle- and upper-income citizens at 742 million [61]. However, our rationale for focusing on this cohort was not to undertake a segmentation study based around issues of class or income, but to understand patterns of technology use by participants who are not subjected to conditions of poverty, migrants living away from their families, lacking in access to technical or financial knowledge, or as using digital tools primarily as a means of managing debt or accessing work in the gig economy (cf. [51, 52]), and this set of choices is reflected in our participant cohort. Our study is therefore not about Chinese users who live on the margins of debt [52] or the mechanisms driving them into taking out microloans [65], but on financially and technically literate users who have sufficient income or savings for discretionary spending, operating in socially and infrastructurally dense settings. This group gives us an insight into how a wide span of financial tools that can be accessed from inside these payments apps is used, something that the limited opportunities available to more marginalised and financially excluded groups cannot; the financial activities of this cohort also maps more closely to the availability of financial services and the activities of users in more economically developed countries, allowing targeted generalisations to be made from the analysis that extend beyond China. Given the pandemic-related conditions in China and its extended 'Zero-Covid' strategy, the data collected was not as impacted by the travel and movement restrictions, lockdowns, public testing requirements and other extraordinary changes to the pattern of everyday life and social interactions that occurred over this period. As Mondada et al. [54] show, the risks of contagion have imposed changes on the practices of payment, money transfers and other forms of social interaction around money resulting in a considerable behavioural shift in personal payments to avoid infection [67], with the result that implications drawn from this study are also more easily generalizable outside of the particular circumstances experienced in China at this time.

For practical reasons of access, the majority of participants (n = 16) came from or worked in Shenzhen (Guangdong, China), a city that is relatively wealthy, youthful and educated compared to other Chinese cities. Although not all participants fell into a traditional middle-class income bracket, part of the reason for this was their student or part-time working status allowing them to draw from parental or spousal resources. More crucially for the purposes of this study, and as described in the interviews, these participants were both relatively technically and financially sophisticated, and had sufficient discretionary income to spend, for example, on leisure and cultural activities, private tuition, branded goods and financial investments—all markers of middle-class lifestyles. Our orientation to this aligns closely with Elfick's [15] ethnographic work around the contested definitions of what it means to be middle class in China, in which this is not just distinguished by income bracket, but also by consumption practices, active self-identification, education and self-development, lifestyle choices and modes of consumption (including leisure and cultural activities). These differentiators sit alongside our participants' (mostly) urban professional occupations and/or university education, and their international outlook, which are also identified as markers of being middle class in China [81]. Five participants (P2, 3, 7, 8 and 12) were from other cities (Zibo, Guangzhou and Xiamen), giving a wider geographical spread to our dataset. Participants were recruited via personal networks and advertisements on social network sites, as well as snowball sampling to obtain additional participants. As noted by our reviewers, we did not consistently collect information on specific aspects of participants' digital-financial literacy or competence,

or on their length of WeChat Pay or Alipay use, and recognize that this may present a limitation to the extent of the interpretations that we can draw from our data. Nevertheless, it was clear from our qualitative work that all of our participants were skillful and adept users of both their social and financial media. Given the depth of social media integration into the infrastructure of contemporary Chinese life (see, e.g., [68]) it is not surprising that all of our participants showed a highly developed understanding of digital communication on their mobile devices. Similarly, the frequent updating and changing set of services, media and apps used for social and financial operation means that 'years of experience' may be less important than the hours of use and effort invested in using specific features and services.

Although we did not recruit based on this, all participants had both Alipay and WeChat Pay accounts. Following participant requests, we either conducted face-to-face interviews (n = 15) or via WeChat videocalls (P3, 4, 7 and 8). In three cases, participants were accompanied by their partners to the interview. As their partners contributed to the interviews, we have included them in the analysis, identifying them by gender as PnF and as PnM to distinguish their contributions, but we did not collect demographic information on them. Following institutional ethical approval and prior to the interview, participants were provided with an information sheet and informed about ethical considerations, which included a permissions sheet allowing us to audio record and publish the interview data anonymously. Interviews were carried using a semi-structured format so that relevant deviations could be flexibly accommodated and interesting topics explored in more depth, as well as supporting triangulation by allowing interviewers to adjust and progressively focus on areas identified by previous participants. Participants were asked questions about themselves and their circumstances, before being asked about their life circumstances and interests to get an insight into their everyday activities, personal and financial relationships and their use of digital payment apps. They were then questioned about their recent transactions, covering the topics of to or from whom these were made (and why), which media or apps/wallets they selected for these, and the decision choices that were involved in making and choosing a mode of payment. This was followed with questions on problems they had faced in making digital transactions, including technical, social, trust/security and banking transfer issues. Finally, participants were asked to work through their in-app transaction histories to help elicit information about a range of payments and receipts of money that were grounded in real, rather than general and recalled instances over the previous month, during which they were encouraged to compare and contrast their use and understanding of the different payment apps that they had used. Interviews were recorded, ranging between 50 and 95 minutes (averaging 75 minutes). Demographic information on participants is reported in Table 1 (monthly income in Yuan; ¥1 = US$0.14). All audio recordings were transcribed in Chinese and translated into English. Analysis was carried out through a process of inductively coding and indexing the dataset, rather than being driven by *a priori* themes, loosely following a pattern-driven thematic approach [7]. Key issues, concepts and overarching themes were iteratively identified in multiple passes through the data by all of the authors (in multiple co-present and remote group data sessions over many months), from issues raised by the respondents themselves, and from views and experiences that recurred in the data, continuing until saturation had occurred.

4 Setting: Payments Infrastructure in China

The findings reported in this article need to be understood within the context of the systemic pervasiveness of digital payment media in everyday Chinese life [12, 68] in which China has been a largely cashless society for many years (e.g., [11]). Credit and debit cards are infrequently accepted, and cash is only rarely used, to the extent that the Chinese government has had to enforce its use as a legally acceptable form of tender with criminal prosecutions [40]. While cash is still prevalent in rural areas and among older populations who are less familiar with payment apps, this is a

Table 1. Participant Demographics

Participant ID	Age Range	Gender	Employment Status	Personal Income (¥/m)
P1	20–30	F	Student	15K–20K
P2	20–30	F	Office worker	5K–10K
P3	50–60	F	Retired accountant	4K–5K
P4	30–40	F	Teacher	5K–10K
P5	20–30	F	E-commerce worker	10K–15K
P6	20–30	M	Architect	5K–10K
P7	20–30	F	Company staff	5K–10K
P8	40–50	M	Office Manager	15K–20K
P9	20–30	F	Financial manager	30K–40K
P10	30–40	F	Medical researcher	20K–30K
P11	20–30	F	Masters student	1K–2K
P12	20–30	F	PhD Student	15K–20K
P13F, P13M	40–50	F (& M)	Primary teacher	5K–10K
P14	20–30	M	High school teacher	5K–10K
P15F, P15M	30–40	F (& M)	Office worker	10K–15K
P16	30–40	M	University professor	15K–20K
P17	30–40	M	Engineer	30K–40K
P18	30–40	F	University teacher	10K–15K
P19F, P19M	30–40	M (& F)	Civil Servant	10K–15K

small and shrinking population [33], and many people in China do not interact with physical money at all. Recognition of this massive integration and invasiveness of digital money was a frequent topic of discussion raised by our participants, from their use in services from healthcare to DiDi Chuxing (a ride-hailing service), in purchasing fast food and restaurant meals and in the growing financialisation of Chinese life in savings and investments—all of which, and more—was facilitated through digital payment apps. Indeed, the move to adopting digital payments has been almost total for our interviewees with digital payments platforms becoming ubiquitous, as seen in a typical comment from P9: '*I basically do not have cash in daily life*'. Given their market dominance, WeChat Pay and Alipay were primary hubs for our participants largely because of their deep embeddedness within a whole range of personal, social, consumer and financial activities: '*WeChat is all your everyday communication, daily life arrangements, interaction with others, then your kind of self-presentation, all is on that app*' (P1), while Alipay is '*basically what you eat, drink and live*' (P2). While some participants expressed some worries with its invasiveness into their lives, almost all mentioned how convenient (*fangbian*) it was, commenting on its ease of use and speed. Although the technology had been transformational across multiple levels for our Chinese participants since its introduction, many of our participants regarded using it as such a '*mundane*', '*everyday*' (P6) or '*routine*' and '*ordinary*' (P5) activity that had become almost invisibly interwoven into their lives, and only becoming conspicuous when it failed (see also [72] as a feature of infrastructure). Unlike cash payments or card transactions based on wired systems, failures in the mobile payment infrastructure, such as network disconnection or when the mobile devices' battery ran down could cause our participants serious difficulties because of the pervasiveness of mobile payments for goods and services, problems also noted by Shen et al. [68]. While network failures are a perennial concern for all kinds of mobile services, power issues seemed to be more of a concern reported by our participants and required regular attention because of the structural embeddedness of digital payments in so many aspects of everyday life. As P15M stated humorously, '*If it dies, you die*', so that when power issues occurred, these could throw the flow of people's lives into flux, turning the aphorism 'money is power' on its head.

In the majority of cases when making commercial transactions, users in China are most likely to be offered WeChat Pay or Alipay. Because of their development histories in supporting payment on different kinds of platforms, these two payment systems have been configured to work around different activities, although they can both be used to make ecommerce payments, payments in shops and peer-to-peer transfers. Alipay offers more complex transactional sources of funding to pay for goods, for example, using credit and delayed payment, while WeChat Pay is tightly integrated with social media contacts, allowing payments between friends to be made easily. WeChat Pay originated the extremely successful and commonly used 'red envelope' (*hong bao*) system for gifting small amounts of money (up to ~USD$25) to friends, colleagues and family drawn from the Chinese tradition of giving money in red envelopes on special occasions (see [37]), and which was subsequently copied by Alipay. However, hong bao can also be used to make and receive more routine small payments and money transfers. Importantly, payments or transfers are not directly possible between Alipay and WeChat Pay. The only way to make transfers between these platforms is via withdrawal to a bank account. These incur a small fee (0.1%), something that analysts have recognised as being designed to 'incentivise' users to keep money with their respective financial ecosystems [20].

Functionally, Alipay has various methods, or 'sources' of financing immediate payment from its 'wallet'. These include selecting to pay via the user's: (a) balance (zhanghuyué/账户余额), (b) direct 'bank accounts' (yinghang ka/银行卡) of which there may be several, (c) virtual credit card (huabei/花呗) allowing regular monthly payment or in instalments (similar to buy now, pay later), (d) a mutual fund (yu'e bao/余额宝) allowing user to choose between different investment services and offering different interest rates and (e) credit cards (e.g., VISA). The WeChat wallet offers a smaller set of services options but allows users to pay with: (a) 'balance' (lingqian/零钱), (b) 'bank account' (debit) (yinghang ka), (c) mutual fund (lingqiantong/零钱通) [like yu'e bao] and (d) credit card. Figure 1 demonstrates the respective 'top level' user interfaces (English version) for accessing these features and functionalities within the apps at the time of data collection. Note that many of the functions in WeChat Pay are integrated within its social media functionality and are not visible on this top-level payment screen.

5 Findings

For Chinese users, there is a complex ecology of financial services within and across Alipay and WeChat Pay, and between these platforms and the rest of the banking and credit infrastructure that underpin contemporary consumer life. In this section, we explore how the lack of *formal* financial interconnectivity between these financial platforms and infrastructures shaped users' interactional choices, and how the interactional embeddedness of payment media within their social media impacted on platform and account selection in payment. Here, we explore how our participants made sense of the constraints of this highly fragmented and disconnected financial infrastructure through the information visible in the app interfaces and tried to use it for their own particular needs and concerns. Our findings therefore primarily focus on how the different digital payment platforms (Alipay and WeChat Pay) and financial circumstances shape the payment choices made by our participants, and how emerging social practices are used to resolve practical, financial and technical problems arising from the use of these platforms.

5.1 Managing Fragmented Interoperability: payment Platform Selection

Weak interconnectedness across digital financial infrastructures—primarily through poor interoperability across bank accounts and payment platforms—required users to do work to make these systems function to make payments. This is evident in participants' frequent references to the question of which payment platform to use—Alipay or WeChat Pay—when they had a choice.

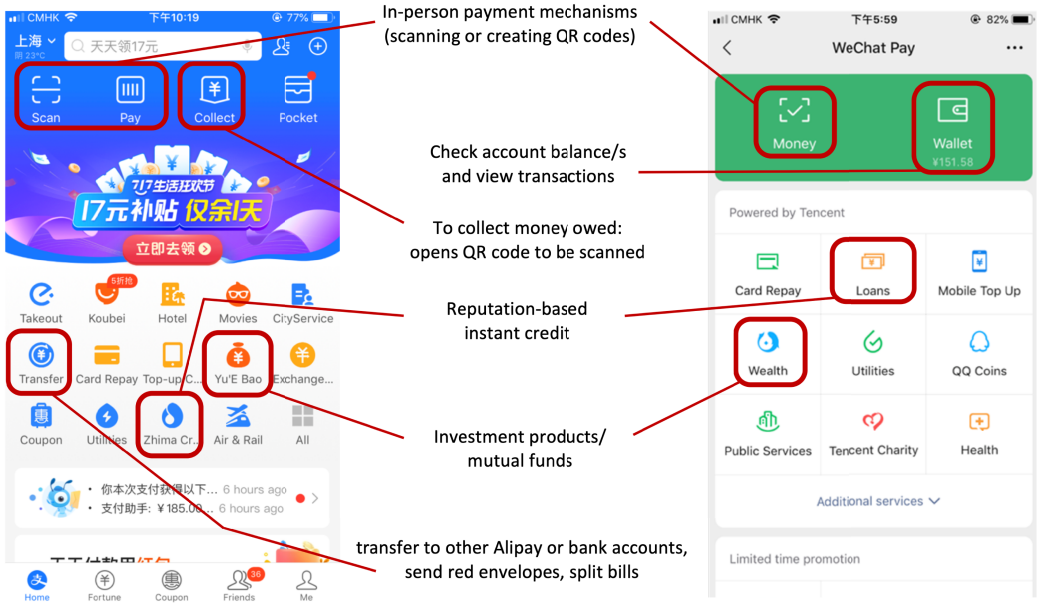

Fig. 1. Alipay app interface (left); WeChat Pay app interface (right).

Key determinants in selecting a payment method lay in the complexity of moving money across accounts and the financial cost of transferring money between Alipay and WeChat Pay in fees, so that most participants treated the money in their wallets within each of these platforms as if they were largely non-compatible currencies. One participant explained why they thought this was the case: '*I hate that Alipay and WeChat can't transfer money to each other because they are competitors*' (P12). While both payment methods transacted in Chinese Yuan and could be used almost interchangeably in making or taking payment for *purchases* (provided that points of sale were suitably equipped), in other forms of use, their inhibited exchangeability led to distinct and unique use practices to enable practical payment arrangements that worked for their users. In effect, these different platforms separated the funds within them into different kinds of money (cf. [77]), and required our participants to actively manage funding across their accounts to make them operationally useful for a wide variety of payments. Participant choices to pay with Alipay or WeChat were often determined by this separation of funds across platforms, given the likelihood that they would need to pay for something else later on that might require an account on a specific platform with money in it. Holding too much money in one platform that was left unused, while needing to pay for something using the other platform and not having sufficient funds in it was a common problem for our participants that they worked hard to resolve. Thus, when discussing the effects of cross-platform withdrawal fees on her payment choices, P11 described them as:

> '... very expensive, so in order to avoid the need to withdraw the money, I will try to use the money in the WeChat wallet when there is a lot of money in the WeChat wallet.... as long as (there is) a lot of money in WeChat, for example, when there are more than one thousand, I will choose to use WeChat when I pay'. (P11)

Here, our participant attempted to ensure that she did not accumulate WeChat funds that could not be used later if she was needed to pay for something from her Alipay wallet. Indeed, WeChat was commonly chosen for payment because of its *lack* of usefulness for more sophisticated purposes

(such as earning interest) as illustrated in a quote that was typical of many participants' payment practices:

> 'if I pay, I use WeChat… I have to quickly spend the money in WeChat. It is useless to put the money in WeChat. I will definitely not use Alipay, because Alipay has that [Yu'e Bao] interest, so I will not consider using Alipay first. When I used up the WeChat money, I then considered using Alipay, … but there are still 100[yuan] in WeChat. I just want to use it up quickly, because it is completely useless in it'. (P6)

P6's 'completely useless' money is held in the account he prefers not to use because, unlike Alipay's Yu'e Bao, it does not pay interest. He therefore tries to use up the money in his WeChat account because it is less valuable to him. This is a somewhat unexpected and counterintuitive effect of difficulty in transferring money between systems: it drives users to use money from the *least useful* account (here, P6's WeChat) up first, and in doing so, increases the need for, and therefore the prevalence of, this payment system in transactions. While our participants typically kept more funds in Alipay and only small change in WeChat, this behaviour was not universal, demonstrated by P7 who preferred using WeChat Pay, and therefore tried to get rid of her Alipay funds first: '*I will use Alipay mainly because it has dozens of yuan that are useless*' so that again, the money considered less useful was prioritised for payment. Here, P7's 'useless' yuan refers to money held in the account she prefers not to use because it holds too small an amount to pay for 'useful' things. However, in most cases, participants tried to keep larger funds in Alipay, not least because of the interest-bearing opportunities of its Yu'e Bao mutual fund:

> 'I rarely put money in WeChat Pay, I will put the money in Alipay. Just put there is a so-called Yu'e Bao, it seems to have a little profit…. Because the Yu'e Bao has benefits on the one hand, you can also spend it directly when you pay things. There is also Huabei, sometimes. It will be very convenient. In the case of WeChat, I basically only receive a red envelope, and if there is some money in it, I will use it a little'. (P9)

In this instance, participant P9 was not just making a choice to use money from one wallet source but was also choosing where to hold her savings because of its interest-bearing advantages. Typically, the payment and financial services offered through Alipay were considered more varied and tempting than those from WeChat. P6, for example, often chose to pay via Huabei (similar to a credit card, i.e. delaying payment), investing the money that he would otherwise have spent in his Yu'e Bao savings pot, and only paying off the Huabei from his savings when the repayment became due (essentially, using this service as a free 'loan'). So, in this case, the choice of payment modality allowed users to make, and not just save, money.

5.2 Balancing Infrastructural Disconnection with Social Connectivity

When developing new digital financial services, operators usually need to provide a means for their customers to move money through or onto their platforms ('on-ramp') so that it can be used. Without this connection into the financial infrastructure, there can be no way for users to access money on these systems and pay for the things that they want or need. This financial connectivity is provided by infrastructure known as 'payment rails' [73], typically utilised by connecting systems via bank accounts as a source of funding. In situations where users do not have bank accounts or credit cards, or do no not wish to connect them, they will be unable to add money onto an account on the new platform—these services will be effectively disconnected from the infrastructure of the wider financial system. However, one of the important drivers for users transitioning to digital money using WeChat Pay was that users *did not need* to link their payment apps to their bank account to access money, and set within the context of low bank penetration in

rural China, they did not even need to hold a bank account. This was possible due to functionality in the apps that allowed money to be sent directly between users. Thus, when discussing her use of WeChat Pay, P1 described how she initially '*didn't have to link it with the bank card. I used the red envelope money to make a small purchase*' (P1). So, because she already had a WeChat app and account on her device, and therefore, by default, a wallet that can receive funds from others via red envelope gifts, P1 could access and use any incoming money that had previously been *gifted* to her without requiring other institutional infrastructure (such as bank accounts, passwords and proof of identity). Much has already been made about the role of gifting, from Malinowski [44] and Mauss' [50] treatment of exchange obligations and reciprocity, and on its use in Chinese payment apps [37, 68]. However, beyond the sociological and anthropological importance for our participants', these gifts also enabled direct access to the payment infrastructure of these platforms without requiring access to any other forms of financial interconnectivity. The common practice in China of sending money via a 'red envelope' (*hong bao)* (see [37]) allowed both Tencent and Ant Financial to leverage their existing app deployments and the encultured social practices of their user base to drive adoption of their payment platforms, and a critical mass of users to be built up quickly, offering new users the benefits of financial inclusion within this critical payment infrastructure. It also benefitted these platforms to recruit customers and expand a userbase that could now make or take payments on their mobile apps.

Although it was possible to link a bank or credit card and pay via Alipay and WeChat Pay, most participants did not initially do this, and several chose not to do this at all. One of the frequently discussed reasons driving this grew from a very prosaic concern about the financial dangers of dealing with money through non-bank digital media, with some participants making a strategic choice to fully or partially disconnect their apps from the wider financial infrastructure potentially available to them as a means of *managing risk*. This was something that our participants were understandably worried about because of the potential of extremely adverse effects on their personal finances if something went wrong and drained their other accounts and to reduce their risk exposure to theft, leading to them deliberately disconnecting their payment apps from other sources of funding. Commonly, and especially when they first started using them, our participants tended to only link bank cards that held nil or small balances on them (most participants held multiple bank accounts), so that if compromised, these would not cause large losses: '*the card linked with Alipay had no money*' (P5) and '*If it's all lost, I can afford it*' (P18). Alternatively, they might choose to only link a bank account temporarily: '*After I finish transferring, I will delete it*' (P13F). Indeed, a consequence of a disconnection between users' payment apps and their bank accounts meant that for many of our participants, the funds in their digital wallets were the *only* form of money that they could practically access when they needed to make a quick mobile payment. This deliberate disconnection between the bank account, as a source of money, and the means of payment, via an app, had important ramifications for our participants' selection of payment methods (e.g., paying from apps that they had received hong bao to), and frequently required our participants to pull on their social relationships to request money as a means of fulfilling payments from an empty wallet on their app.

5.3 Social Media Integration into Financial Platforms

The ways that payments and social media platforms were integrated had a dramatic effect on how our participants made payment choices between the apps because of their different approaches in connecting these functionalities. The historical development of functionality within WeChat Pay and Alipay, and their role in the larger platform ecologies that they grew out of, has embedded different interactional opportunities into mobile transactions, and this has shaped different patterns of use around them. These different operational orientations are apparent in their titles and reflect

the interactional priorities of their design: We 'chat' ('*WeChat is chat*', P9) and Ali 'pay'[1]. The interactional impact of these histories on their use was clearly evident to our participants, as P6 explained about Alipay:

> 'Its main function is to pay. It is not like WeChat. WeChat is more from chat software, it is communication first, followed by payment software. So, if I talk about purely paying, I think the advantage of Alipay will still be a little bigger. WeChat payment is just an add-on function… the main function of WeChat is for communication… you can see that Alipay is first a payment software'. (P6)

Although it was a later entrant into mobile payments than Alipay, WeChat Pay had gained an advantage from its preeminent dominance as a social media platform, and this interactional 'stickiness' [30] was a major factor in it being selected for payments by users when given a choice of payment apps. P18 described this in her payment preference for WeChat, as it was used '*in the background anytime, anywhere, so you don't need to initialize it when you open it… The most used in daily life is WeChat*'. The differing ways that these apps were integrated into participants' everyday practices of use and interaction was stark and impacted on how they chose to use them, as seen when it was compared to Alipay:

> 'I basically spend all the time on WeChat, right, then Alipay is just using money. When you have to pay, open Alipay again… I will definitely not use Alipay for chat, except that others will send me a red envelope, and will rarely chat in it except a thank you'. (P9)

In this respect, WeChat Pay has much lower levels of 'friction' (see [67]) than Alipay because of its huge market penetration, high personal frequency of use and interactional stickiness:

> 'you often chat with WeChat, and then you can open the QR code directly, you can scan the QR code, but when you pay with Alipay, you have to re-open a software and then scan again, I think it seems like this is another step'. (P7)

In the case of P18, her WeChat Pay and Alipay accounts were connected to the same bank cards (i.e. both apps could draw payment directly from the same bank account), so her choice of payment app made no difference to where the money came from. Her choice of app was therefore not determined by access to funds, but by minimising her interactional time and effort to complete the transaction:

> 'When you want to pay, you need to open Alipay and it takes a certain amount of time to respond, so I rarely use Alipay to pay'. (P18)

The integration of WeChat into everyday Chinese life for most of our participants made their preferred payment choice a simple one that was frequently linked to their social media preferences and prevalence of use. In most cases, exiting an application to make payment in another application would have been an additional, unnecessary and effortful step where they had a choice of payment forms. This illustrates a classic HCI issue, setting the effort cost (see, e.g., [55]) in shifting between an application already in use, against any potential usability or transactional service advantages of another app. In this case, these costs appeared to prove too great for our participants to merit opening Alipay. Indeed, data from all participants suggests that patterns of use and selection of payment media were heavily shaped by the social interactions that people were engaged in, either from their ongoing online activities in which social media integration of payment increased the likelihood of payment within that media, or in their physical interactions, in which physically shifting between apps would add time and effort to the payment, and so was also avoided.

[1]See also [21] for a discussion on messaging in Alipay being unusual, *except* for conversations relating to transactions that were made using it.

5.4 Leveraging Social Relationships to Bridge Money across Platforms

As we have seen, it was common for participants to have digital money in both their Alipay and WeChat wallets, but also for them to try to pool most of their savings into one of these, rather than splitting their money across smaller pools. This allowed them to make larger purchases using the wallet holding the pooled funds than if it was split across both platforms. As a result, most participants recounted instances in which they had needed to make a payment through an app in which they had inadequate funds because their money was held on the wrong platform for the required payment method. While many stores and services took multiple forms of payment, some were less flexible, accepting only one of Alipay, WeChat Pay or cash. Because of the transfer fees and the complexity involved in moving money between these different platforms, most of our participants resorted to using their social networks to enable trans-platform payments. Asking friends and family to help act as informal intermediaries by what were effectively free short-term loans offered a form of financial 'bridge' between a user's otherwise disconnected accounts. To illustrate this, when asked why she had no funds in WeChat, P5 replied that as she did not use WeChat often, she rarely moved money into this wallet, but that this could cause problems with using public transport:

> 'if there is no money, I will let others give me a little, then I will give them back by Alipay.... because you have to use WeChat for bus or subway, and then you cannot use Alipay, but normally there will be money in Alipay. Then I have to borrow money from WeChat and pay back by Alipay. I often let my roommate transfer money to me'. (P5)

So here we see the participant avoiding having to make a transfer between her own digital wallets by making a personal request from a friend for a WeChat transfer and making a repayment via Alipay. This example illustrates how the forms of digital money on these two platforms are not fully exchangeable or liquid (i.e. *rapidly* exchangeable) and may require trusted third parties (usually friends or family) to socially intermediate and facilitate exchanges of value. It was also often necessary that this take place in near-real time, something that was effectively enabled with the integration of payment transfers into WeChat's always-on, omnipresent social media messaging system. As we will show below, these socially-mediated bridging activities around money were heavily shaped by the integration of social media into these platforms.

An interesting result of the disconnect between WeChat and Alipay, and the need to utilise social networks in bridging money between them led to what we have described as 'app-shaped relationships' in which participants reported distinctly different forms of socio-financial relationships based on their preferred financial platform. While cross-platform wallet transfers of the kind recorded above were relatively common, P12's account of asking friends to make an e-commerce payment on her behalf illustrates how the limitations of the payment mechanism forced her to differentiate between two technically-differentiated friendship groups:

> '... but my Alipay had no money, then I wanted to send the payment connection to my friends, but only to the Alipay friends, they can help you pay. But... because my friends are on WeChat, and then I send the bill to WeChat friends, they can't help me pay'. (P12)

The excerpt illustrates a distinction that derives from the socio-technical configuration of the two payment platforms: people can have distinct groups of WeChat [Pay] 'friends' and Alipay 'friends'. So, while social transfers of money might be used to solve issues of bridging money across platforms and wallets, this was not always possible because of our participants' reliance on trusted friends and family members who might not hold friendship status across both apps. While it might not be surprising that people can have different friendships groups across different forms of social media, what we see here is rather different because of the way that the method of payment is directly

connected into its users' social networks. Thus, even though a friend on WeChat was available and willing to offer a financial transfer, this might not be useful if they do not have an Alipay account. If they are primarily a 'WeChat Pay friend', they may also be anticipated to have insufficient funds on Alipay since they do not use it as the main account for pooling their money into.

5.5 Sharing Financial Knowledge to Reconnect Fragmented Infrastructures

As we have shown, our participants regularly called on other people to help them make payments and to bridge money across platforms. This often required participants to ask about and hold an intimate knowledge of their families', friends' or colleagues' financial arrangements so that they could make requests that were reasonably possible to grant, as P5 explained when discussing her plan to buy a computer through an online account that required WeChat payment:

> 'there is not so much money inside [my WeChat wallet], you ask for someone else, others don't have that much money, then I think of a way to talk to my roommate, because her WeChat is linked to her salary card, that is, there is money in it, then I ask her to transfer a little money to me, I will transfer back to her via Alipay'. (P5)

As this quote illustrates, the limitations that these payments platforms imposed on their users resulted in our participants occasionally needing to share and talk about their financial arrangements with others to accomplish relatively straightforward activities. In this instance, P5 was aware, not only of how much money other people she knew had in their accounts that she could reasonably ask for, but also how one of them, her roommate, had configured her payment app to directly access an account with income from her salary (which P5 assesses here to be a likely source of enough money to pay for a computer). This information was incredibly useful in making targeted requests for help in bridging money across the two platforms. However, sometimes the extra work and troubles with mobilising their social connections proved too great and acted as a driver for participants changing their financial arrangements to avoid this; while she had not originally wanted to do so, P7 described why she had eventually decided to directly connect her bank account to her WeChat wallet:

> 'I feel that I don't want to link my bank card, so sometimes I will ask my classmates, could you send me a 50 yuan red envelope, and I will transfer 50 yuan to you. Later, I thought if I did it every time, it was very troublesome'. (P7)

It seems that social relationships may only be leveraged so far before they start to creak, but for occasional purposes, short-term borrowing and lending through personal networks offers a useful financial bridge to make payment and create interoperable systems. Because of their integrated social network connectivity, WeChat Pay and, to a slightly lesser extent, Alipay, both offered online mechanisms to communicate their needs to others and to see their current availability online for near real-time transfers, necessary for when unexpectedly waiting in a queue, for example, to pay on the bus or subway.

Such knowledge sharing went beyond knowledge of other people's immediate financial circumstances, and included their intertwined financial circumstances over time, enabled by the embedding of their users' social obligations and financial accountability for their actions within the social media that payments occurred through. As illustrated above, people's use of their social contacts to smooth out funding across platforms, and communication around their financial arrangements with others often depended on delicate and mutually agreed 'practices of trust' [74]. Sharing money and financial information that is both socially and economically sensitive requires users to trust each other and people therefore need to continually maintain and assess their relationships with one another. While these practices of assessing how much and what to trust between people did

not arise directly out of the technologies used, the platform affordances of Alipay and WeChat contributed to how the transfer, lending, or borrowing of money with other people was made visible in their online social networks. So, for example, when asked how P5 had borrowed money, she recalled how WeChat had left an audit trail that she used to keep track of her credits and debts over time with a friend:

> 'Because we are friends, we trust each other. If they want to borrow some money, I will transfer it directly to him. There is a good thing about digital money, when you borrow money for a long time, you will find out how much he borrowed from me, and then go to check the record, because it will have a record there, how much you transferred, and you can see it…. not the bill, it is the page you talk to with him, the page of the transfer, it has a transfer record… the chat page can see the amount and information of the transfer'. (P5)

As this excerpt illustrates, WeChat formally records financial transfers within the flow of everyday conversation between social media contacts on a 'chat page'. These chat records make the context of each payment visible, helping their users interpret when and why transfers took place, what they were for, and who the other transacting parties were. This directly embeds what Maurer describes as a key role of money, through its use as 'a system of relationships, a chain of promises, and a record of people's transactions with one another' [49, p. 46], into their shared social media communications. As a consequence of this socially visible, and accountable, set of transfer records, money transfers using WeChat are considered less likely to breach social obligations. This social visibility results in a form of *accountability*, as debtors cannot reasonably forget about, or fail to repay their debts (which would result in a breakdown of mutual trust), or as lenders, in failing to acknowledge credit, offering them some social leverage while the loan remains unpaid. As P5 suggests above, this auditable record means that the awkwardness and embarrassment around debt is likely to become less of a problem in sustaining good social relationships because its status is readily available and checkable, and cannot be misremembered or forgotten. While similar issues to the participants in this study have been raised by users of financial apps in the UK [41], the ubiquitous nature of transactions being reified into these permanent, visible interactional records between people makes balancing people's debts an accessible and accountable phenomenon because they can be objectively referenced by both parties.

Although embedded payment information within 'chat' interactions was considered a valuable resource for 'following the money' cf. [41] and tracking expenditure (P1, P12), few of our participants reported actively accessing the account 'statement' functionality on their Alipay or WeChat apps that listed payment history, suggesting that this was less used or useful than previously supposed (also reported in [41]). Indeed, when asked to review their personal spending via payment account statements, most participants found navigating the app interfaces to locate this function was too challenging to demonstrate in the interview. This stands in clear contrast to the use of payment information within everyday social media or 'chat' interactions, which appeared to be more immediately accessible and socially meaningful. Users' everyday engagement with social media, and the simplicity with which payments can be referenced within an online conversation, appear to make financial obligations more shareable in that context. The availability of an accountable explanation for how and why a lender might have 'come across' an outstanding loan in the course of using the chat app may also make such financial obligations more socially acceptable to discuss than referring to a formal, externally sourced record of a debt.

5.6 Connection and Disconnection in Social Payment Relationships

The distinctive interactional and social affordances of Alipay and WeChat Pay gave their users different opportunities to manage their relationships with the people that they were paying. In some

of these instances, participants reported deliberately choosing to use Alipay, rather than WeChat Pay, because of its more *a*social design features. This was because making Alipay payments to a stranger would not necessitate them adding the payee as a 'friend' (required by WeChat at the time of data collection), and thereby connecting them into their private feeds, social network 'moments' and their real name that would have come as a parcel with such a WeChat friendship invitation (P15F). P15F and P15M described an example of how they deliberately choose to use Alipay to ensure that the transaction relationship remained as asocial as possible under the circumstances by deploying the communicative affordances of this platform to exclude any kind of intimacy:

> 'the only reason I can think of to use Alipay will be I don't know this person, but I need to pay him, I don't have his QR code, and he just needs to give me the phone number or the Alipay account, I don't need to add him as my friend. I can just enter his account and pay him on Alipay. (P15F) […] it turns out it is kind of strategy to keep distance from anyone, stranger or business person, you can just keep in touch with each other in Alipay, only in Alipay. Because you don't have to build up any connection with them in WeChat, that means if you want to pay with WeChat, you have to add them as friends, if you add them as friend, there will be another cost'. (P15M)

In this, P15M's reference to 'another cost' is one of a social price that must be paid for this intrusion and his loss of privacy, not a financial one. The choice of payment media here is important in keeping this other person as a distant, impersonal connection, rather than inadvertently bringing a stranger more closely entwined into their social life. As a counterpoint to this, the platform selected for payment could also be actively chosen to deepen social connections. Such a situation was recounted by P10 who made use of the social connectivity of WeChat to try to build a connection with the recipient of a payment. This participant had imported some eczema medicine for her daughter from South Korea, but the parcel had been impounded by customs who required a payment for it to be released back to her. Following a two-and-a-half-hour taxi ride she arrived at the tax office, but now with her phone out of power, she could not pay for the taxi, let alone the customs duty, as the driver did not have a phone charger. Getting desperate, she asked the taxi to wait for her while she tried to find a charging cable, allowing her to go back to the taxi to charge the phone and pay the driver, then return to the office to pay the tax. At the customs office she managed to borrow enough money to buy a cable from a vendor and returned to the taxi to connect her phone for around 20 minutes for a 5–10% battery charge—enough to pay the tax. However, she now hit a new snag causing her to panic, because on returning to the customs office, she found that the officials would only take payment in (physical) cash:

> 'I have no money, because there is no cash. I especially rushed. I immediately asked the people around me if they have cash. I can transfer the money to them and there is not enough cash. Because everyone pays taxes, they basically bring 500 yuan. 500 yuan is the cost of paying taxes, and there will be no extra money for me. Then what should I do? I can only [ask to] borrow money, borrow money, and borrowed many times without success. Then there was a kind-hearted aunt who said, "Oh, then I will help you get some money." I was crying at the time. You know, she just saw my special sadness, then said "I will help you", she took the money, then took almost 800, then gave it to me, then I transferred it to her on WeChat… I hope to become friends with her'. (P10)

As P10 later went on to describe, she planned to use the WeChat 'add friend' invitation necessary to make her repayment to build a social connection with this kindly stranger and show her appreciation for helping her through such a fraught moment. Here, the differentiated forms of social media

integration of Alipay and WeChat offered different and nuanced forms of access control over their personal information and connectivity when making digital payments.

6 Discussion and Implications for Design

As a result of the widespread adoption and use of Alipay and WeChat Pay, new and different kinds of social interactions around money appear to have become common and normalised. These have emerged both as a result of the apps' unique interactional affordances, but also from users working together to resolve problems in making or receiving payment across platforms. Our findings highlight the interdependent roles of both (i) interaction design and the user interface, and (ii) the constraints and opportunities of financial infrastructure, in shaping the nature of transactions and the social interactions that surround them. As with other forms of media that are entangled within social interactions, the social affordances offered by the apps and different social practices around these payment media contributed to how they were selected and used for specific purposes. The interactional affordances of these payment media are made explicit in the very names of the apps involved—We *chat* and Ali *pay*—and, as we show, the selection choices made by our participants profoundly shaped the organisation of the financial interactions that they engaged in. The importance of these interactions to our Chinese users, and the ways that they have built sophisticated practices around use has been driven by the massive pervasiveness of these systems in everyday life. As we saw in our data, it is increasingly difficult to live normally without access to digital money, something that was not always fully or effectively enabled by the technologies themselves, given limitations including power, network connectivity, interaction design and account transfer flexibility, and these challenges required considerable moneywork to make payment possible. We recognise the methodological limitations of extending our analysis beyond this middle-class, mostly middle-income, well educated, professional and urban user group in China. This is not a group that we saw struggling to finance their spending (such as those described in [51, 52, 65]), but rather one that needed to make payments with funds that they could not access easily or without a cost. Similarly, this user group was able to make sophisticated use of the richly interconnected digital and social media available to them in China. Nevertheless, what our participants were trying to achieve, namely, undertaking collaborative 'infrastructuring' work, to connect money fragmented across different systems, is a persistent problem that users across very different demographics, national boundaries and business infrastructures are likely to encounter.

One of the primary difficulties faced by users of payment platforms in China is that once deposited, their digital money enters a 'closed' private money system with constraints that delimit how, when and with whom transactions can be made. In particular, imposing charges on withdrawals has made money in these digital wallets 'stickier' so that it remains on the same platform [20]. While this is likely to offer business advantages for the incumbent platform operators, this makes for additional work from its users to create personal liquidity, even if they have sufficient overall savings to pay with. Although a fragmentation of digital money across several payment accounts (e.g., banks, building societies) and wallets (such as PayPal or shop payment apps) has been noted in the literature, these seem (so far) to have had less dramatic impacts on their users in the US and Europe (see, e.g., [28]), and our Chinese participants have therefore developed a different set of socio-digital practices in resolving the problems arising from this. Of course, these new practices and technologies in dealing with fragmentation did not emerge fully formed out of nowhere and have both shaped and been shaped through distinctive historical technical, commercial and cultural factors in China, including, for example, the deep social media integration of WeChat [63], gifting [68] and lending practices [39].

Interoperability across accounts and systems—a core function of money—is therefore critical if people are to make payments that will be widely accepted. Yet Alipay and WeChat Pay have both imposed interactional and transactional constraints through their platforms and app interfaces which meant that they were *not* interoperable. This has transformed the kinds of interactions that their users have with one another. To solve these problems of interoperability and overcome these specifically *technical* restrictions in the payments infrastructure, our participants pulled on their *social* networks (i.e. they do infrastructuring as a form of moneywork), in large part through the communications media that their payment platforms were integrated into. This integration of payments into social media applications also supported collaborative forms of financial sensemaking, for example allowing users to understand their social obligations (guanxi) in assessing who owes what to whom via their payments embedded in online 'chats'. The integration of payments into social media has enabled transfers across financial platforms that otherwise lack flexibility. These practices even allow digital money to be rematerialised into physical cash, similar to M-Pesa's retail agents [46], but simply using co-present third parties.

The need for people to enact workarounds in deploying their social relationships to reconnect these largely disconnected systems and avoid fees highlights shortcomings in how these payment systems support a critical part of contemporary life for their users. In large part, the cause of this in China has been the privatisation of fiat money through the payments system, which has allowed these organisations to try to 'win' customer business through creating siloed platforms that limit the circulation of money and financial services to within themselves. Yet, if money is to be a public infrastructural resource and serve society rather than the commercial interests of private businesses, then this must also be true for its means of payment as a part of this critical public infrastructure. This points to the need for regulatory frameworks to ensure *digital* interoperability so that users can treat their money as a unified and fungible form of payment, and not digitally 'earmarked' (cf. 80) so that it can only be spent on one platform. Internationally, this kind of financial control by government is recognised as an important control mechanism to shape financial infrastructures, for example, in applying regulatory and political pressure on banks to enable free and rapid inter-account transfers via the Faster Payment Systems. In this, we orient towards Plantin and Punathambekar's [62] insights into platforms-as-infrastructure, in emphasising the political and economic forces that shape their design and use in addition to the social and material practices more commonly addressed in HCI and CSCW. It is not the place of this article to write policy guidance, but there are clear indications in the data suggesting that regulatory consideration be given to support cross-platform financial transfers. These could, for example, remove fees for inter-platform transfers, mandate interoperability between wallets on different platforms, allow any banking service to connect with any payment app, or enforce a common clearing and settlement infrastructure. The regulator-led design of India's Unified Payments Interface (UPI, npci.org.in) in creating an interoperable payments infrastructure in which different platforms hosted similarly siloed wallets could provide a template for this. However, the UPI experience in India also shows that regulatory over-reach can have adverse consequences (e.g., setting deposit limits too low), pushing otherwise honest users into the informal economy, or, as we have also seen, falling back on their social networks to manage payments and access informal credit networks [57]. Although China presents a very different institutional, technical, social, cultural and political (amongst others) context to India, the underlying policy goal would be similar to this, in securing the singularity of money and prevent its fragmented use as a platform-specific token whose usability and utility is overshadowed by these platforms' corporate strategy.

The Chinese government has recognised that the payments system in China needs reform, in particular because of the dominance of Alipay and WeChat Pay as private-sector digital payment platforms. One of the most visible recent developments in this space since our own data collection

has been the introduction of the e-CNY (also known as the digital yuan/renminbi or DCEP), China's version of a **central bank digital currency (CBDC)** in 2019 by the People's Bank of China. It is one of the world's largest CBDC systems currently in operation, with a reported 261 million unique users by the end of 2021 (the last reported figures [16]). Although many reasons have been given for developing the e-CNY, interoperability between platforms [59] and concerns about the operation of private units of account [29] are cited as important drivers. Despite still being considered a 'pilot' study, the e-CNY has been widely integrated as a means of payment into online shopping sites and supported with significant incentives for users in the form of discounts and coupons. Crucially, for the purposes of this article, major ecommerce platforms are required to integrate e-CNY as a means of payment, and there are no fees for making e-CNY transfers. The effect of this is that users *should* be able to make or take payments using Alipay or WeChat via an e-CNY wallet, i.e. a unified source of money, solving many of the problems that our participants reported. However, in practice, e-CNY has had limited success, with reasons ranging from privacy intrusions and zero savings interest [11], financial ecosystem 'stickiness' and usability issues [14] and onboarding frictions [2]. A noticeable feature of e-CNY that has received less interest is its complete lack of integration and embeddedness into users' social media that exists with WeChat Pay and Alipay, and this may also be a factor in its lack of use. If this is the case, it reminds us that regulatory and policy decisions need to take account of their users' existing practices of use. The limited success of the introduction of the e-CNY contrasts with the explosive growth and enthusiastic adoption of WeChat Pay and Alipay. Both of these addressed real users' needs, WeChat Pay because it allowed digital payments between friends and Alipay because it enabled trustworthy ecommerce payments. As a 'third' app inserted into a functioning (even if not ideal) payments ecosystem, the e-CNY does not seem to fill an important gap in user needs. Certainly, our findings show that while disconnection between WeChat Pay and Alipay presented a technical barrier to inter-platform transfers, people were able to create workarounds to these restrictions using their social networks. It might just be that *when set against* the inconvenience and friction of creating workarounds to bridge payments, the value to users of these platforms and their embeddedness into wider aspects of everyday life is large enough to sustain their continued use, even when offered a more interoperable alternative solution such as the e-CNY—after all, we have seen that people made these systems work, even as they criticised them or faced challenges in doing so.

Drawing from our data and analysis, we move on to address concrete *design* solutions in rethinking how disconnected systems might be drawn back together and identify future opportunities for digital money and payment systems below. Our aim here is to draw inspiration from a relatively mature ecosystem (China) to show how interactions with digital money can motivate universal opportunities for design innovation that extend to payments infrastructures and devices across the rest of the world. Because financial transactions may be embedded in social interactions that are culturally unique to China, or shaped by its particular network infrastructures, device use, legislative and regulatory contexts, these digital payment practices may be less generalisable to different contexts. Nevertheless, rather than situating these as solely relevant to the Chinese market, the design implications developed below build from aspects of the empirical findings in this study to generate an abstracted set of insights that extend to a wide range of international settings.

Social Pooling for Financial Interoperability. There is a clear case to be made for designing solutions to enable better financial lubrication across multiple platforms. Moving money directly between Alipay and WeChat Pay and between user accounts can result in fees and in time-consuming and complex bank transfers that our users went to considerable lengths to avoid. As we have seen, participants often used their family and friends to avoid having to make cross-platform financial transfers, with significant collaborative work (cf. [23]) used to smooth over transactional problems, often enabled through social networks and media. However, relying on access to other

people's money also presented our participants with difficulties. While our participants' made use of their social relationships for free and relatively quick access to funds, limitations of this approach included situations in which they may have contacts on the 'wrong' payment platform (e.g., Alipay or WeChat friends), contacts with money in the 'wrong' account to help, contacts who did not reply in time, or needing to call on some friends uncomfortably often. Moreover, while they might know something of their friends and families' financial status, this knowledge could be uneven, or out of date. Nevertheless, these socio-financial transfers could also strengthen social bonds and offer openings for starting new conversations. Opportunities for interaction design may lie here in enriched socio-financial networks to support pooled requests for funding, allowing friends to collaboratively 'chip in' to enable cross-platform transfers and their repayment, or for giving an indication of the 'primary' or preferred funding pools for their social media connections. Likewise, there is potential in mapping out shared financial obligations, for example, with payment graphs that make these relationships visible, or by gamifying the process, for example, with running totals of who is the most financially supportive of their friends. As seen in China, there is considerable scope for building social networks around people's financial activity, and while this can be seen in a small number of services outside of China (e.g., venmo.com, Meta Pay), this has been limited in both functionality and its depth of social media integration. While our participants have called on family and friends to create interoperability across financial platforms because they both trust and know about each other, we can see that they are using their social networks trying to solve a primarily technical problem: digital services that offer trustworthy anonymous intermediation to manage cross-platform funding pools between *unknown* users—such as escrow arrangements—could also be deployed for this purpose. A key issue here for interaction designers, using the example of escrow, would lie in making these kinds of complex financial mechanisms simple to use and understand. Of course, such intermediaries would likely charge fees, and this would also lose the enriched social relationships that our participants reported experiencing as they helped each other out.

Many of the reasons for calling on social network contacts in China in our data arose out of difficulties in moving money between 'walled garden' systems. To date, there has been less need for this in more developed economies as digital payments are commonly directly serviced via bank accounts, with credit cards widely used to add flexibility. Our participants' experience in China shows that this direction of travel is *not* an inevitable outcome, especially where user populations are unbanked, and future users may need to leverage their social networks to bridge money between payment media (e.g., different currencies or stablecoins) and across disconnected financial platforms (e.g., across international banks, fintechs or blockchains).

Managing Socio-Financial Visibility. While social networks were used by participants to bridge their fragmented digital payment services, the communication affordances of the apps used in Alipay and WeChat Pay were used instrumentally by our participants to drive particular social outcomes. Alipay can offer a more anonymous service, while WeChat Pay connects its users into each other's social networks, and our participants made payment selection choices depending on the social outcomes that they wanted to achieve. As payment apps and social media become more connected (cf. [73]), and, as seen in Venmo or Meta's Libra, connectivity between the financial and the social seems to be an international industry aspiration, which is likely to add tensions and opportunities for other users outside of China. Allowing users to flexibly manage their identity exposure and social network connectivity when making payments seems a necessary design imperative. Where payment platforms fail to provide a suitable opportunity for managing social access, this social connectivity may expose users' payment histories to unwelcome attention, or conversely, where payments may expose users' social relationships to scrutiny (such as those seen in Venmo), such media are unlikely to be selected for payment or may leave users facing unwelcome intrusive consequences. However, as shown in the example with P10 selecting WeChat as a payment method

to connect the payee into her social network, payments can be valuable in building relationships, just as positive social media experiences are also described in Venmo interactions.

Social Entry into Financial Platforms. Low entry costs that do not require the effort or financial risk of bank account connection and elaborate user authentication seem to aid adoption and build critical mass. As illustrated by P1, WeChat Pay requires just a user's phone and citizen ID card numbers to set up an account, with a red envelope gift of funding to be able to make payments. Adding credit through gift cards or 'top-ups' from other people to lower entry barriers offers possibilities here. Supporting such 'entry' payments into users' accounts through their social networks also offers opportunities for accelerating wallet uptake: exogenously generated payments require no action by the recipient, and no requirement to connect with banking services to fund an account. This may be at odds with 'know-your-customer' or anti-money laundering legislation, although this is effectively no different to payment vouchers or gift cards that are also unlinked to a user's bank account or identity. In this sense, designing payment systems so that they can be used without the user requiring access to the infrastructure of the banking system, and instead, leveraging their social connections though the payment app to access funding (effectively 'bootstrapping' into the financial infrastructure; see also [63]) offers a pragmatic route into creating opportunities for increased financial inclusion.

Social Mediation for Physical-Digital Interchange. While its use maybe diminishing, we have seen that physical cash still has a role to play in some payments. Physical money can also act as a mechanism for interoperability between systems, and because it is an analogue medium, it can be used to bridge digital platforms without requiring technical solutions. There are therefore occasions when turning digital money back into cash is useful, and in these situations, third parties can offer a means to achieve this. However, trust and security issues dominate in these actions from our data because as money becomes material, it also loses its connection with the benefits of identity information that come packaged with the digital platforms, and as we saw with P10, strangers can be unwilling to do this. Design opportunities lie in how to provide social mechanisms to enable smooth physical-digital interchange, for example, using social recommender systems to show previous records of people's financial reliability. The notion of allowing shops or even bystanders to act as micro-agents is also an interesting possibility, drawing on the business model of M-Pesa's retail agents who facilitate cash deposits and withdrawals for a reward [46], or offering local bystanders who are prepared to act as third party payment enablers small 'agent' commissions or other rewards such as community badges or discounts in return. Such rewards need not be fee-based but could build on a social or commercial benefit, in the same way that some shops offer a complementary 'cashback' service to customers when making card payments. Geospatial information might also be useful to find friends nearby, connecting users to a trusted contact in the vicinity who could help in this. Using 'friend of a friend' connections could also offer an indication of the likely trustworthiness of parties in such a local transfer where people have no direct personal contacts available.

Socially Embedded Records of Financial Interaction. Our findings indicate that formal records of payments are rarely used in payment apps. They also suggest that tracing person-to-person payments through social media records may be an effective approach to tracking users' financial obligations and supporting their socio-financial management of personal debts (e.g., P5). As noted in the literature, this may also mesh particularly tightly with our Chinese users' orientation to informal guanxi practices in networks of mutual financial dependence [39], but social obligations to repay debt within personal networks are internationally universal. Designing access to financial records that are bound in with social media contacts could give useful insights to users about their credits or debts with these contacts, for example, by explicitly listing in/out payment records by contact addresses, or allowing a user to jump to chat 'locations' where money transfers were made

or repaid, perhaps using manual user tagging or automated analysis of chat messages to classify these transactions. One other benefit of choosing to access financial records via communication media is that, as we have seen in our data, payments between people can occur *between* platforms or accounts, and a single financial record (like a bank statement) will only pick up payments *within* one platform, or even just showing one account (e.g., current or savings accounts) on a platform. So, for example, if a user agrees to pay the money back to a friend over another, non-integrated platform, any repayment could remain unrecorded, or an agreement to repay appearing unresolved. Accessing transactions within their social context, however, makes understanding such financial interactions more meaningful, and any money lent is likely to be more easily auditable or recoverable because of its social visibility.

7 Conclusion

In this article, we explore the moneywork practices of digital money users in China in bridging financial infrastructures. Our findings show how Chinese users navigate the fragmented digital payment landscape of Alipay and WeChat Pay and overcome interoperability limitations in making payments by leveraging their social networks, using friends and family as intermediaries to transfer funds. Our analysis draws out a critical consequence of the rise of cashlessness in China: the growing heterogeneity and complexity of financial platforms, apps and accounts. All of our participants used *both* WeChat Pay and Alipay, but the money held in these platforms was not flexibly exchangeable across them. As we have shown, this limited their opportunities for making straightforward transactions. It therefore makes sense to talk about digital *monies* in China, not digital money, and that this has arisen as a function of the design decisions made in the different payment media and financial infrastructures of each platform. Paradoxically, while the digitalisation of money and payments might seem like a solution to reducing transactional barriers, its fragmented implementation in China has introduced new operational limitations to its flexibility and usability. To overcome these limitations, our participants developed complex socio-financial arrangements and practices for saving and spending by bridging funds that were in large part, enabled and shaped by the interaction design of their digital media, highlighting how our participants' networked lives are essential in navigating the difficulties posed by platform disconnection. The social media integration into payment apps supports this but has led to differentiated friendship groups based on the platforms that their contacts use, resulting in what we describe as 'app-shaped relationships'. While the user interfaces to our participants' payment technologies configured the transactional component of their interactions, our data suggests that focusing on this alone is insufficient to understand payment and its problems. This narrow focus conceals some of the reasons underpinning users' interactional choices when they make digital payments, the moneywork that they perform in accessing funds for payment, and their difficulties in making payments. As we have shown, what makes money systems function is not just a result of their technological infrastructures, but the work that their human users do to enable interoperability across technologically-imposed constraints.

Data Access Statement

The full set of interview data is not publicly available due to their containing personal and financially sensitive information that could compromise the privacy, safety or security of research participants.

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