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THE RISE OF E-WALLET SUPER-APPS AND BUY-NOW-PAY-LATER

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ABSTRACT

The rise of super-app digital wallets provides not only a conduit to banks but also internal payment options, including Buy-Now-Pay-Later (BNPL). We examine, for the first time, transactions matched with merchant and consumer information, from a leading e-wallet super-app, and complement the analyses with a randomized experiment. We document that BNPL serves as a dominant form of "digital cash" and expands payment and credit access to underserved consumers without increasing indebtedness or delinquencies despite their spending more. The findings crucially depend on the cross-sale capacity and inherent disciplinary incentives of super-app ecosystems. Our findings underscore the synergy between credit and payments and provide novel insights for economies transitioning to cashless via super-app-driven platforms, where FinTech credit sees the greatest potential.

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1. Introduction

The past decade saw a phenomenal world-wide rise of e-wallets, a.k.a, digital wallets, that enable users to make payments on their computers or mobile devices using linked bank cards, in-wallet balance and savings accounts, or new payment products.[1] The combination of digitalization and the contactless payments engendered by the COVID-19 pandemic has further accelerated e-wallet adoption and the tendency of e-wallets converging to the super-app model. A conservative estimate projects the total number of e-wallet users to be over 5.2 billion globally in 2026, up from 3.4 billion in 2022.[2] Meanwhile, Buy-Now-Pay-Later (BNPL), a short-term FinTech credit allowing consumers to defer payments interest free into one or a few installments at the point of sale, has become increasingly popular among e-wallet users. Now a common offering from leading e-wallet providers around the globe, BNPL is projected to account for $680 billion in global transactions by 2025.[3]

On the one hand, as a conduit to banks, e-wallets could reduce physical carrying costs of cards and alleviate transaction frictions and costs. Their adoption thus potentially benefits traditional financial intermediaries and consumers. On the other hand, e-wallets also offer their own payment options, which may circumvent banks, cutting banks off from valuable information related to FinTech lending and cashless payments (Ghosh, Vallee, and Zeng, 2022).[4] While economists agree that the shift from cash and bank cards toward e-wallets exerts a profound influence on the economy (Agarwal et al., 2020b, 2022), little is known about how various payment options interact and compete within e-wallet super-apps and whether BNPL as a combination of FinTech payment and credit substitutes or expands bank credit (Tang, 2019; Jagtiani

[1]Examples include PayPal, Apple Pay, the relaunched Google Pay, and super-apps such as WeChat Pay, Alipay, and Kakao Pay. A super-app offers a wide range of services all in one integrated app.
See https://www.pwc.com/gx/en/industries/financial-services/publications/financial-services-in-2025/payments-in-2025.html#macro3, retrieved on Nov 21, 2022.

[2] Juniper Research. See https://www.juniperresearch.com/press/digital-wallet-users-exceed-5bn-globally-2026.

[3] "Buy Now Pay Later Digital Spend, Led by Klarna, PayPal, and Afterpay, to Double by 2025: Reaching $680 Billion," Kaleido Intelligence, September 2020. Alipay's Huabei, PayPal Credit, and PayPal Pay Later are examples of this fast-growing new form of credit which is typically embedded in e-wallets; Apple introduced Apple Pay Later in March 2023.

[4] For example, PayPal provides several internal payment options in addition to external bank-linked accounts or cards: PayPal Balance, PayPal Savings, PayPal Credit, and PayPal Pay Later.

and Lemieux, 2019; Di Maggio and Yao, 2021), leads to excessive consumer spending and indebtedness (Ponce, Seira, and Zamarripa, 2017; Agarwal et al., 2020b), and affects the social welfare (Parlour, Rajan, and Zhu, 2022) – all core issues in the FinTech and household finance literature. Equally mysterious are the drivers behind the meteoric rise of super-app digital wallets and BNPL, as well as their role in the transition of economies from cash-heavy to cashless.

We bridge the knowledge gap by opening the black box of e-wallet super-apps that contain multiple payment options, and empirically investigating these issues using the most comprehensive and representative data to date from a world-leading e-wallet provider. We also obtain directly matched, transaction-level data on BNPL and credit cards, instead of inferring BNPL activities from bank transactions as is previously done. The sample covers over a million e-wallet transactions randomly drawn from all transactions in June 2020. We complement the data by randomly sampling from a two-month randomized experiment conducted by the same e-wallet provider in June 2017, and extending the random sample to December 2021 to study the impact of introducing BNPL credit to consumers.

Specifically, we (i) describe the various payment choices in super-app e-wallet transactions and their usage popularity, especially how BNPL dominates and crowds out other payment options, serving as a new digital cash for small transactions including non-durable purchases, (ii) analyze the expansion of e-wallet credit through BNPL for female consumers and regions underserved by banks, emphasizing the adoption in two-sided payment networks as the catalyst, and (iii) document that, different from the findings in previous studies, BNPL increases consumer spending, but does not lead to greater default or indebtedness. The empirical regularities can be jointly explained by the cross-sale capacity and the disciplining forces in the e-wallet ecosystem, a super-app model that e-payment and BNPL providers around the globe are converging to.

In addition to providing the first transaction-level analysis of e-wallet super-apps, we also join contemporaneous studies (e.g., Di Maggio, Williams, and Katz, 2022;

Guttman-Kenney, Firth, and Gathergood, 2023; deHaan et al., 2024) to add to the first canon of knowledge about BNPL and the economic implications of its emergence. Our study distinguishes itself by drawing evidence from an economy transitioning from being cash-heavy to cashless and tying together the payment and credit functions in e-wallets. Furthermore, we directly observe BNPL transactions with rich consumer and merchant information, circumventing any noisy inference from bank transactions alone.

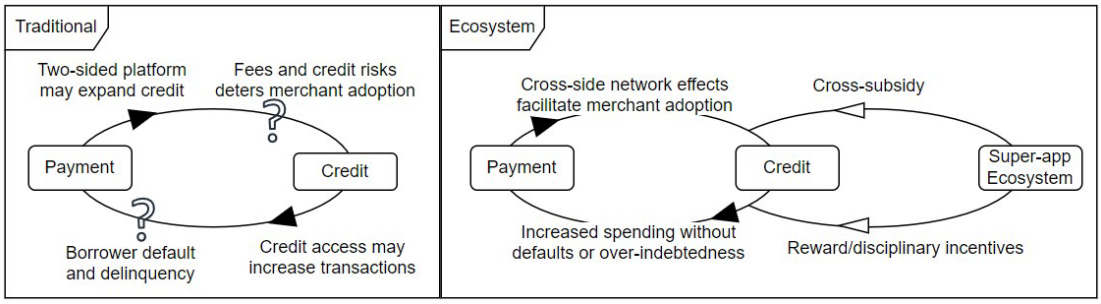

Figure 1. The economics of BNPL in the e-wallet super-app ecosystem

Importantly, our study highlights the role of super-app ecosystem. Bank credit cards and pure-play BNPL apps combine payment and credit functions (Figure 1 left panel). But the payment function of credit cards cannot automatically expand consumer credit because credit card companies or pure-play BNPL providers have to make profits by collecting fees from merchants and passing credit risks to them, which impede merchant adoption and, in turn, household credit expansion. In contrast, the existence of various services in an ecosystem enables super-apps (Figure 1 right panel) to cross-subsidize merchants while charging minimal fees for user acquisition. Similarly, the credit function attracts more users to increase spending and usage of a particular payment option only if the borrowers manage to stay away from delinquency and default. Because super-app ecosystems incentivize proper borrowing behavior (through, e.g., the conditional access to more services), they make BNPL the dominant "new cash" without competing heads-on with credit cards as documented in earlier studies concerning developed countries. Overall, our study provides insights about not only the Chinese market but also the global convergence of e-wallets towards the super-app model and of BNPL towards the observed cash-like usage.

We start by descriptively investigating the dual credit and payment nature of BNPL in the e-wallet super-app. We first document a substantial credit expansion effect of BNPL at the extensive margin. Specifically, 84.14% and 78.38% of on-site and online consumers without credit cards, respectively, can now access e-wallet credit through BNPL. Moreover, 43.54% of on-site merchants who previously did not accept credit cards now accept e-wallet credit through BNPL. Additionally, 44.37% of on-site and 90.21% of online transactions that could not be completed using credit cards can now be completed using e-wallet credit through BNPL. The combination of consumer and merchant demand for BNPL, and the supply by the e-wallet provider, has led to the exponential growth of BNPL usage. We then present stylized facts regarding the distribution of payment options and the popularity of BNPL within the e-wallet super-app. Internal payment options—particularly BNPL—have become consumers' predominant way to pay, accounting for more than half of all transactions, whereas the most popular external option—linked debit cards—accounts for less than one-third. The wide acceptance of BNPL as a new type of credit to both consumers and merchants, as well as the popularity of BNPL as a new payment option, reinforce each other.

We then delve deeper into the payment and credit aspects of BNPL respectively. Regarding the payment nature of BNPL, we estimate a payment choice model to investigate the influence of BNPL access on other payment choices after accounting for a set of typical factors such as consumer demographics, payment preferences, merchants' acceptance, and transaction value. We find that consumer access to e-wallet credit through BNPL crowds out the usage of other payment options in both on-site and online transactions. In line with the crowding-out effect, we also find that small transactions, which form a substantial share of e-wallet payments, are overwhelmingly settled with e-wallet credit through BNPL. Furthermore, the impact of BNPL access on consumer credit usage also appears to be more pronounced in less-developed areas, such as rural areas and northern regions, as well as among women.

After exploring the payment aspect of BNPL, we study the credit nature of BNPL in detail and the impact of BNPL on consumer spending and debt by exploiting a

randomized experiment conducted by the e-wallet provider in June 2017. With the wide use of BNPL, a potential concern is that the ease and convenience of this FinTech-based consumer credit may induce consumers, especially those lacking financial literacy, to overborrow and overspend (Berg, Fuster, and Puri, 2022; Bu et al., 2022). Our results demonstrate a significant consumption-boosting effect among users granted BNPL access in this experiment, mirroring trends observed in developed economies like the United States, with an increase equivalent to 4.78% of the average monthly consumption, as reported by the National Bureau of Statistics of China.

Next, we resort to our transaction data and analyze how consumers change their usage of BNPL when they have unpaid debt and incur interest expenses. We distinguish between two types of users according to their credit access: *single-access* users (e-wallet credit users with no linked credit card), and *dual-access* users (users with access to both e-wallet credit and credit cards). While single-access users appear to use e-wallet credit through BNPL more frequently, they use the credit cautiously, as the proportion of revolvers (those who incur interest charges on unpaid debt) is lower. They also reduce BNPL usage in transactions once they incur interest expenses from late payments (which are higher than the rate charged by credit cards).

While the traditional buffer-stock hypothesis (Carrol, 1997; Aydin, 2022) explains the consumption-boosting effect of BNPL well, it cannot explain two key findings in our study: the prevalent use of BNPL in small transactions and the absence of a direct link between increased consumption of BNPL and greater indebtedness. Utilizing the extended random sample, we instead propose a super-app ecosystem explanation on top of the buffer stock hypothesis to rationalize these observations. The e-wallet super-app constitutes an all-encompassing ecosystem where users can purchase wealth management products, hail taxis, book movie tickets, reserve hotels, pay utility bills, order food delivery, among others. We find that the overall benefits users receive from the ecosystem incentivize frequent yet responsible usage of BNPL, alleviating the

concerns of overuse or irresponsible usage that have been documented in other studies.[5]

While prior studies (e.g., Klee, 2008) conclude that physical cash is the main payment choice for settling high-frequency and small transactions in modern societies, we posit that BNPL is now the most popular payment choice in e-wallet transactions and hence serves as the new digital cash in transition to cashless societies.

Our data and the Chinese setting have several appealing features well-suited for the study. First, China is the largest e-wallet market in the world and currently has the largest number of BNPL users (Section 2.1 contains more details), with mature mobile payment networks.[6] Second, the e-wallet functionality and BNPL design in our study are reasonably representative, not only in China with its around one billion users but also on the world stage. For example, the BNPL embedded in the e-wallet we study offers a revolving credit line and allows installment payments, thus combining the features of PayPal Credit and PayPal Pay Later, and is similar to other major BNPL providers such as Affirm in terms of "Pay-in-4" (installments) products and credit lines. What give our findings external validity and implications are the representativeness in terms of functionality and the fact that many e-wallet providers converge to the Chinese model with small transactions, especially in nondurables, and with super-app ecosystems (CFPB, 2022 and Section 2.1). Finally, our dataset is likely the only one in the literature that allows direct observations of transactions in e-wallets and involving BNPL, covering both online and on-site transactions and encompassing both merchant and consumer information, thanks to that the e-wallet provider has its own e-commerce platforms and QR code registration system.

Our work is related to several strands of literature. We contribute to the literature on FinTech credit, especially the emergent discussions on BNPL. Earlier studies focus on credit for online merchants, small firms, and entrepreneurs (e.g., Huang et al., 2018;

[5] A recent study by Chen et al. (2024) corroborates our finding on the impact of BNPL usage on debt. They focus on consumer credit business offered by a leading e-commerce BigTech in China, and find that consumers receiving BigTech credit experience a significant increase in monthly spending.

[6] The mobile payment in China boomed early in 2011 and the adoption among Chinese adults reached 82% in 2017. The coverage and usage had since stabilized. See https://idf.pku.edu.cn/docs/20210421101507614920.pdf and http://www.pbc.gov.cn/goutongjiaoliu/113456/113469/3602384/index.html; accessed on August 6, 2022.

Hau et al., 2019; Hau et al., 2021, Gopal and Schnabl, 2022), whereas we study credit for consumers and households. Within this domain, marketplace lending has been shrinking while BNPL has been growing. Berg, Fuster, and Puri (2022) estimate that new lending in the U.S. marketplace lending market was $6 billion in 2020; the U.S. BNPL market, by contrast, was about $25 billion. Compared to the numerous studies on marketplace lending (e.g., Lin, Prabhala, and Viswanathan, 2013; Freedman and Jin, 2017; Hildebrand, Puri, and Rocholl, 2017; Jagtiani and Lemieux, 2019; Tang, 2019; Cong, Tang, Xie, and Miao, 2019), the research on BNPL is scarce.

Several contemporaneous articles study BNPL in developed economies where credit cards have significantly replaced cash. Guttman-Kenney, Firth, and Gathergood (2023) describe BNPL usage in the UK, where 19.5% of active credit card users had a card transaction with a BNPL firm in 2021. Di Maggio, Williams, and Katz (2022) find that BNPL access increases consumers' total spending and the proportion of retail spending in the United States, due to a "liquidity flypaper effect." deHaan et al. (2024) find that BNPL in the United States plausibly has a negative effect on users' spending habits and financial health. These studies rely on bank and credit card transactions to infer BNPL activities, thus capture only transactions linked to banks, with limited matched merchant or consumer information, and primarily through a small set of pure-play providers.[7] Focusing on the "pay in 30" (days) BNPL product for large transactions at an e-commerce company selling furniture in Germany, Berg et al. (2023) show that BNPL allows merchants to price-discriminate. We complement by examining now the most dominant form of BNPL in e-wallet ecosystems globally and transactions covering general product categories, with both large and small-value purchases.

FinTech firms typically start with payments and then expand into lending, insurance, investment products, etc. (Frost et al., 2019). However, the existing literature appears to focus predominately on lending, largely due to data limitations on payment transactions. Our study focuses on FinTech payments and provides the first empirical

[7] For example, PayPal is excluded from the data because it contains large non-BNPL business, despite also being a major BNPL player. The transactions from omitted BNPL providers are labeled as non-BNPL, leading to classification errors.

description on a timely and important issue: payment choices within e-wallet super-apps.[8] Although there have been digital payment surveys in advanced economies and numerous studies on (electronic) payment choices (e.g., Arango, Huynh, and Sabetti, 2015; Koulayev et al., 2016; Wang and Wloman., 2016; Crouzet, Gupta, and Mezzanotti, 2019; Agarwal et al., 2020b, Cong, Easley, and Prasad 2023), they have always categorized e-wallets, if at all, as an aggregate category. Looking into the black box of e-wallets is important for understanding current changes in payment systems and evaluating e-wallets' economic impacts. Together with Higgins (2024), our analysis of both consumer access to and merchant adoption of BNPL as a payment option also adds insights to empirical studies on technology adoption in two-sided markets.

We investigate the usage of BNPL and its impact on consumer spending and indebtedness directly using a comprehensive, matched, transaction-level dataset, in a country with drastically different financial development and business ecosystems, while featuring an equally important BNPL market and business model that many markets around the globe are converging to. We highlight the payment nature of BNPL in e-wallet ecosystems. Furthermore, our data are representative of the population of BNPL users from both sides of the payment markets because they are not limited to one merchant in a particular product category or merchants working with banks.

Finally, we complement earlier studies on mobile payment, consumer credit, and overspending (Aydin, 2022; Gross and Souleles, 2002; Ponce, Seira, and Zamarripa, 2017; Agarwal et al., 2020b). They document a spending-boosting effect of payment innovations, which causes concerns about overspending, consumer addiction, and debt traps in many developed economies (e.g., Manning, 2001; Williams, 2004). Recently, Wang (2023) theoretically and empirically analyzes competition among bank-card-based networks and finds that it leads to overuse of credit and reduced social welfare. Our findings differ in that BNPL, as a new consumer credit, boosts consumption without increasing household indebtedness---a phenomenon also documented in Israel

[8] Hong, Lu, and Pan (2020) document that repeated usage of digital payments through super-apps can help users build familiarity and trust, thereby increasing their participation and risk-taking in mutual fund investments offered by super-apps.

(Gelman and Roussanov, 2022). We show that heterogeneity in payment options leads to different merchant fees, retail prices, and consumer segments, with BNPL primarily serving consumers without credit card access. Moreover, we clarify for the first time that super-app ecosystems enhance the complementarity of the payment and credit functions of BNPL, because merchant fees do not necessarily get passed onto retail prices, and consumers do not necessarily overuse the newly available credit.

The rest of this paper is organized as follows. Section 2 describes the institutional background and the data. Section 3 presents descriptive evidence on stylized facts concerning credit and payment aspect of BNPL. Section 4 delves into the payment nature of BNPL, including BNPL's growing dominance and frequent usage in small transactions. Section 5 discusses the credit nature of BNPL, including its impacts on consumption and indebtedness. Section 6 proposes a super-app ecosystem model to coherently explain the findings in our study. Section 7 concludes.

2. Institutional Details and Data Description

2.1 Institutional Background

BNPL and the global convergence to the super-app model. Accompanying the worldwide adoption of e-wallets is the rise of BNPL. It should be noted that the BNPL concept is not new: it emerged in the United States as early as the 1920s and has an even longer history than credit cards (Olney, 1991). However, the era of digitalization has endowed BNPL with a substantial customer base and prompted business innovations through super-apps with proprietary ecosystems. While there is no single definition of BNPL, it is generally defined as short-term consumer credit that allows users to make purchases in several installments. With the pandemic limiting household income worldwide and bank lending, BNPL meets the elevated demand for non-contact payments and liquidity. As a result, established e-wallet providers such as Alipay and PayPal, as well as FinTech start-ups such as Affirm and Klarna, have all incorporated BNPL as a core product.

BNPL providers have two distinct strategies to acquire customers: in the merchant partner model, they cooperate with retailers to embed BNPL products on merchants' checkout pages; the app-driven model offers BNPL products either through e-wallets or "pure-play" BNPL apps and allows users to make purchases under a predetermined credit limit (Federal Reserve Bank of Kansas City, 2021; CFPB, 2022). Like credit cards, BNPL provides a line of credit to consumers for online or on-site purchases, but with lower fees and less stringent credit requirements for merchants and consumers.

In general, BNPL products are interest-free, but they may carry interest for late payments or loans with longer terms. For example, a typical BNPL product provides the option to pay in four installments made bi-weekly with no interest charge, starting with a down payment of 25 percent. In some cases of large, infrequent purchases with loan term lengths up to three years, a Point-of-Sale (POS) installment is also categorized as BNPL.[9] For POS installments, down payments are typically not required, but monthly payments include interest or fixed finance charges. Importantly, and different from traditional payment installments, BNPL or the associated e-wallet providers supply the BNPL credit, not the merchant or store.

The global BNPL market size was U.S. $103.6 billion in 2022 and is projected to reach U.S. $467.34 billion in 2026, and even U.S. $3.98 trillion by 2030.[10] Among the top 20 BNPL nations ranked by the proportion of BNPL transactions in e-commerce market in 2020, 12 nations are from the Europe, 7 nations are from the Asia-Pacific regions, and one nation is from North America.[11] In the United States, the five leading BNPL providers originated BNPL loans totaling U.S. $24.2 billion in 2021, with an annualized growth rate of over 200 percent since 2019 (CFPB, 2022). Australia, home to one of the earliest and most successful BNPL provider Afterpay, features more than

[9] A report by McKinsey mentioned POS installment as a type of BNPL lending. See https://www.mckinsey.com/industries/financial-services/our-insights/buy-now-pay-later-five-business-models-to-compete.

[10] Research and Markets report on global BNPL market. https://www.researchandmarkets.com/reports/5700456/buy-now-pay-later-global-market-report-2022?utm_source=BW&utm_medium=PressRelease&utm_code=tgbvg4&utm_campaign=1793416+-+Buy+Now+Pay+Later+Global+Market+Report+2022%3a+Increase+in+the+Adoption+of+Online+Payment+Methods+Drives+Growth&utm_exec=como322prd.

[11] https://www.paymentscardsandmobile.com/top-20-bnpl-nations-ranked-by-e-commerce-size-and-market-share/.

6.1 million BNPL users as of June 2019, representing up to 30% of the adult population; the BNPL transaction value increased from $3.1 billion to $5.6 billion in 2017-2019, with the growth rate up to 79 percent (ASIC, 2020). In Europe, BNPL accounted for 11.7% of e-commerce share in Denmark, 12.8% in Finland, 18.1% in Norway, 25.2% in Sweden, and 19.7% in Germany, as of the end of 2021. Asia also records strong BNPL growth. According to the report released by Mordor Intelligence, the transaction value of BNPL in India had reached about U.S. $7 billion in 2022, with 22% of Indian consumers using BNPL as a payment tool for their purchases.

Although BNPL was initially created to finance customers' big-ticket purchases at the point of sale, an increasing number of BNPL firms around the world have been shifting from the merchant partner acquisition model to the app-driven acquisition model over the past few years. Leading BNPL firms such as Sezzle, Affirm, Afterpay, Klarna, and Zip have launched their own apps or transitioned into super-apps. They issue virtual credit cards and offer credit lines to users upon app registration. The app-driven acquisition model gives customers flexibility in transactions: they can make a big-ticket purchase with installments, small purchases with no installment but pay the monthly aggregate bill in installments, or make payments like credit cards without installments. For example, the customers in the US are now using BNPL for daily expenses on coffee, gas refills, and groceries, which also manifests in our sample.[12]

A prominent feature in China is that BNPL is launched by leading e-wallet super-apps with internal e-commerce systems, such as Huabei in Taobao and Tmall and Baitiao in JD e-commerce platforms. This feature also manifests itself in a major BNPL provider in the United States, PayPal, which incorporates BNPL into its well-established e-wallet payment system. Notably, against the increasing interest rate environment worldwide, the marginal profit of BNPL providers is decreasing, making it more important to rely on a larger user base and cross-sale capacities to ensure sustainability. Consequently, an increasing number of major BNPL providers around

[12] CNN report, Red flag: Consumers are using Buy Now, Pay Later to cover everyday expenses. https://edition.cnn.com/2022/07/06/economy/buy-now-pay-later-bnpl-inflation-data/index.html.

the globe are creating their proprietary super-apps and offer BNPL within self-contained e-commerce ecosystem, converging to China's original BNPL practices (CFPB, 2022).

E-wallets popularity and the transition to a cashless society. Asia has led the world in super-app e-wallet economy. In 2021, e-wallets accounted for 69% of e-commerce spending and 44% of point-of-sale transactions in Asia-Pacific regions.[13] The underdeveloped payment infrastructure, a high proportion of unbanked population, and fast-growing e-commerce markets contribute to the emergence of e-wallet super-apps such as Alipay and WeChat Pay in China, Grab in Singapore, Gojek in Indonesia, Kakao in Republic of Korea, and Paytm, PhonePe, and Vodafone M-Pesa in India. These e-wallet providers started from scratch and attracted a significant consumer base underserved by banks via apps and QR codes. They provide a range of services, including payments, credit, wealth management, and everyday life services. The frequent use of the payment function helps customers build familiarity and trust with e-wallet super-apps, which facilitates the use of other services (Hong, Lu, and Pan, 2020). As *Financial Times* puts it, the "e-wallet economy" in Asia is a digital financial revolution that has boosted financial inclusion and empowered business by bringing billions of users into a quasi-banking ecosystem.[14]

Among Asian countries, China has the most developed e-wallet market, with e-wallets being the most popular payment method and accounting for 83% of e-commerce transactions in 2021. The corresponding number in India, Indonesia, and Philippines are 45.4%, 38.8%, and 30.5%, respectively.[15] Alipay and WeChat Pay are the two largest e-wallets in China, serving 1.3 billion and 0.9 billion users as of 2022 respectively.[16] The data for our study come from one of these leading e-wallet super-apps in China. The permissible credit amounts for BNPL offered through these digital

[13] Worldpay from FIS, the global payments report for financial institutions and merchants. Accessed from https://offers.worldpayglobal.com/rs/850-JOA-856/images/ENGPR2022.pdf.
[14] Financial Times, "Wallet Wisdom: The Transformative Power of Asia's "Wallet Economy." See https://www.ft.com/partnercontent/mastercard/wallet-wisdom-the-transformative-power-of-asias-wallet-economy.html
[15] Worldpay from FIS, the global payments report for financial institutions and merchants. Accessed from https://offers.worldpayglobal.com/rs/850-JOA-856/images/ENGPR2022.pdf.
[16] Data source: https://merchantmachine.co.uk/the-countries-most-reliant-on-cash-in-2022/.

wallets, like credit cards, are based on some form of credit reference systems, which builds on past activities within the ecosystem such as historical transactions.

Thanks to the rise of e-wallet super-apps, China has largely become cashless. For on-site transactions, most merchants do not or strongly prefer not to accept physical cash. Not only is carrying cash inconvenient (especially during the COVID-19 pandemic) for consumers, but giving changes in cash is also inconvenient for merchants. In fact, many unprepared visitors in China upon arrival complain about being unable to use physical cash and have to set up digital wallets.[17] Such situation only eased recently when the top e-wallets in China allow foreigners to link VISA or MasterCard cards to their e-wallet accounts.[18] As recently as 2006, cash use in China still accounted for 13% of GDP, much higher than that in the US (6.4%) and the UK (3.5%). However, the share of cash used in offline payment transactions at the point of sale (POS) in China has dropped to 10% in 2021, making China one of the most cashless countries.[19] Two Chinese commercial banks stopped providing services involving banknotes and coins in March and April of 2022, including over-the-counter deposits and withdrawals and cash services on ATM machines.[20] Moreover, according to the annual reports on the operation of the payment system by Chinese central bank, the number of ATMs had fallen below one million in 2021 and is continuing falling.

In North America and Europe, e-wallets initially follow different trajectories where bank cards acceptance is nearly universal, and cards still dominate the payment systems. In 2021, e-wallet transactions accounted for only 10% point-of-sale transactions in North America and 7.7% in Europe. Several prominent e-wallet providers in the United States, including PayPal, Apple Pay, and Google Pay, used to create a digital interface for physical cards and mainly relied on existing advanced card payment networks to

[17] For example, as the Wall Street Journal reported in 2019, "Foreign tourists in China looking to buy a bottle of water or a taxi ride with cash or credit card are finding themselves out of luck." https://www.wsj.com/articles/welcome-to-china-you-probably-cant-buy-anything-though-11573415753.
[18] https://www.mastercard.com/news/ap/en/newsroom/press-releases/en/2023/pay-like-a-local-alipay-and-mastercard-offer-international-travelers-another-convenient-way-to-make-cashless-payments-in-china/.
[19] Accessed from https://english.ckgsb.edu.cn/knowledges/will-china-first-cashless-society/ and https://www.statista.com/statistics/1277116/share-of-cash-at-pos-worldwide/.
[20] https://www.scmp.com/tech/tech-trends/article/3165809/chinas-fully-cashless-society-step-closer-after-two-private-banks.

process digital payments. However, as the COVID-19 pandemic has greatly increased the demand for e-wallets, these e-wallet providers are also trying to incorporate more functions such as wealth management and racing to create "super-apps" mimicking those in Asia. With the popularity of e-wallet super-apps in North America and Europe, these countries are expected to follow the trajectory of Asian countries relying less on physical cash in daily transactions.

2.2 Data Description

E-wallet data. Our first dataset contains over one million e-wallet transactions from a leading e-wallet super-app provider in China.[21] Supplementing this dataset are consumer- and merchant-level data from the two-sided market: buyers' demographic information and sellers' basic information including sales and industries. This e-wallet was initially launched on one of the world's largest e-commerce platforms as a payment tool to solve the problem of trust between buyers and sellers in online transactions, before growing into a multi-functional app with around one billion users. Its users are required to be at least 16 years old, and the proportion of users aged above 60 is less than 1.5%. The total number of domestic users as of June 2019 is about the same as (slightly bigger than) the size of the population aged 16-59 in China, based on the 2018 census.

The unit of observation is each checkout transaction, which represents one consumer's total purchase from one merchant at the point of sale. The data sample is comprised of 550,000 on-site transactions and 550,000 online transactions randomly drawn from all checkout transactions through this e-wallet provider in June 2020, whose distribution of payment options and purchase categories most closely mimics annual averages in 2019- 2021, and is free from the effects from national holidays.[22]

[21] Prior to our study, no similar data was explored in the literature. Following the implementation of China's 2021 Personal Information Protection Law, transaction-level data can no longer be used for academic research. According to the General Data Protection Regulation (GDPR) in Europe and laws like the California Consumer Privacy Act (CCPA) in the U.S., ensuring data minimization and pseudonymization in data usage makes it nearly impossible to obtain data as detailed as ours.

[22] The e-wallet allows peer-to-peer transfers on a limited scale, which is not included as payment transactions because they are much smaller in scale and the data is not accessible due to the Data Security Law and the Personal Information Protection Law introduced in June and August of 2021.

We observe information commonly found on most receipts from a purchase online or in a grocery store: the merchant identification number, consumer identification number, date and time of the transaction, transaction value, and payment instrument.

In a typical transaction, consumers face five payment options: e-wallet balance, e-wallet savings, e-wallet credit through BNPL, linked debit cards, and linked credit cards.[23] The e-wallet provider offers a positive interest rate on e-wallet savings and indeed reminds users about this option. Users are mandated to link their bank cards to the e-wallet to make daily payments feasible through the e-wallet. We exclude transactions with values lower than RMB ¥1 (approximately US$0.15), which are mostly from click farming and are a small fraction of all transactions, to avoid biasing our estimation. Furthermore, in the uncommon case of transactions combining multiple payment options, we record the payment option with the highest associated transaction value. Note that when merchants decide whether to accept an e-wallet, they automatically accept linked debit cards, e-wallet savings, and e-wallet balance. However, they have choices on whether to accept linked credit cards and/or BNPL.

The data provider internally matches consumers' and merchants' information to each transaction. Our data therefore contain information on the merchants, including (1) *average monthly sales*, the average value of monthly sales during the last twelve months; (2) *D_Merchant_CC*, a dummy variable that takes value of 1 if the merchant accepts payment by credit card; (3) *D_Merchant_BNPL*, a dummy variable that takes value of 1 if the merchant accepts payment through BNPL; and (4) *Industry*, the industry that the merchant belongs to.

Concerning consumers, our data cover (1) *D_Consumer_CC*, a dummy that takes value of 1 if the consumer has linked credit cards; (2) *D_Consumer_BNPL*, a dummy that takes value of 1 if the consumer has access to e-wallet credit through BNPL; (3) *Female*, a dummy variable that takes value of 1 for females and 0 for males; (4) *Age*,

[23] Coupons are associated only with e-commerce or on-site store promotion programs and often have to be combined with other payment options. Though in 2018 and 2019, some coupons were offered to first-time BNPL users, they are negligible in our 2020 data, and most coupons can be combined with any payment option.

the age of the consumer; (5) *e-wallet average monthly flow in the last year*, a measure that proxies for consumers' activeness in using the e-wallet and also (coarsely) for consumers' financial position in the sense of "cash flow"; and (6) *e-wallet wealth*, the total amount of savings and other wealth products of a user in the e-wallet. Similar to the variable *e-wallet average monthly flow in the last year*, the variable *e-wallet wealth* proxies for consumers' activeness in using the e-wallet and also (roughly) for consumers' financial position in the sense of "balance." We also create variables capturing consumers' payment preferences: how long since each payment option was adopted by a consumer (*Option_adoption_length*), and each consumer's most preferred option, which is set as the default payment option (*D_preferred_option*). They are useful in controlling for behavioral or cognitive biases, e.g., the default payment option gets used while a user would have preferred another option in its absence.

Table 1. Summary statistics of the main variables

Variables	N	Mean	Std	P25	P50	P75
A. Transaction and merchant levels						
Transaction value (log)	1,079,193	3.40	1.32	2.40	3.32	4.26
Average monthly sales (log, in 10,000 RMB)	1,076,689	12.37	3.97	9.22	11.88	14.85
D_Merchant_CC[d]	1,087,826	0.63	0.48	0	1	1
D_Merchant_BNPL[d]	1,100,000	0.75	0.43	1	1	1
B. Consumer level						
D_Consumer_BNPL[d]	1,095,838	0.85	0.36	1	1	1
D_Consumer_CC[d]	1,100,000	0.31	0.46	0	0	1
Female[d]	1,091,673	0.53	0.50	0	1	1
Age	1,071,705	32.74	9.58	25	31	38
E-wallet average monthly flow in last year (log)	1,086,206	9.71	2.98	8.70	10.42	11.61
E-wallet wealth (log)	1,090,573	4.47	3.58	0.43	4.63	7.30

Note: The data are winsorized at the 0.5% level. Superscript *d* indicates the dummy variables.

Table 1 presents summary statistics of the main characteristics of merchants and consumers, weighted by transaction frequencies as in Klee (2008). The sample exhibits significant variations in user demographics, with merchant age ranging from less than a year to over five years, and merchant sales varying substantially, covering a wide range of products and services. For consumers, although e-wallet flow and savings vary, their age is concentrated between 20 and 40, consistent with the overall age distribution of e-wallet users. The pattern on age is also consistent with the finding of Crouzet et al. (2024) that young adults show higher propensity to use mobile payments. Finally,

merchants' acceptance of and consumers' access to e-wallet credit through BNPL and credit cards vary substantially.

Data from a randomized experiment. Furthermore, we augment the transaction dataset by incorporating a second dataset derived from an earlier BNPL experiment conducted by the consumer credit department from the same e-wallet provider in June 2017 on millions of users who already met the credit eligibility criteria but had not yet been offered BNPL. Eligibility was determined mainly based on users' payment and consumption histories, which indicated how much consumer credit the users could and would repay. The requirement was much less stringent than that for credit cards, as evidenced by the less than 5% of our random sample of eligible users from the experiment having credit card access, and by the fact that more than one third of the Chinese population had utilized BNPL by 2020. Users residing in Beijing, Shanghai, Guangzhou, and Shenzhen were excluded because of the promotional BNPL activities in these large cities prior to the experiment.

On June 1, 2017, the company randomly assigned users to the treatment and control groups. The treated individuals were offered BNPL and were notified of their new credit limits immediately. The individuals in the control group had no access to BNPL and did not anticipate such access in the near future. The experiment ended after two months, in August 2017, when the control group was granted BNPL as well. This experiment could be interpreted as randomizing the timing of who gets BNPL access over the short run (Parker et al., 2013; Aydin, 2022). The e-wallet provider did not notify its users that they were part of an experiment, which eliminated the possibility of treatment group members changing their behavior in response to or anticipation of participation in BNPL experiment in any near term.

Our second dataset is a subsample of users in this experiment, including 700,000 user-month observations for 100,000 users between January and July 2017. [24] Specifically, the company randomly drew 50,000 users from the original treatment

[24] Due to the Data Security Law and the Personal Information Protection Law, we are not allowed to access the full sample. Exported variables are typically restricted to unitless ratios.

group and matched 50,000 users from the original control group to treated users based on their consumption and payment histories. Since we do not observe the separate trends for the level of consumption for treated and untreated users, we display the ratio of consumption of treated to untreated users to check for parallel pre-trends (see Figure 2). The ratio was between 0.99 and 1.00 before the experiment, indicating no significant difference in the levels and trends of monthly consumption between the two groups in each month prior to the intervention. We exploit this randomized trial mainly to study the effect of BNPL access on consumption and debt.

To further understand BNPL users' behavior, we extend this random sample to December 2021 with comprehensive ecosystem-based information on other services provided in the e-wallet super-app, including users' credit scores, credit limit of BNPL, credit limit in another lending service, the usage of deposit-free rental services, among others. For example, for BNPL users with good repayment histories, the e-wallet provides another lending service: users apply for it and receive funds in their e-wallet accounts or bank cards linked once approved. Moreover, eligible e-wallet users can enjoy the deposit-free rental services, that is, users can rent cars, bicycles, umbrellas, portable chargers, smartphones, and other products without the need for a deposit.

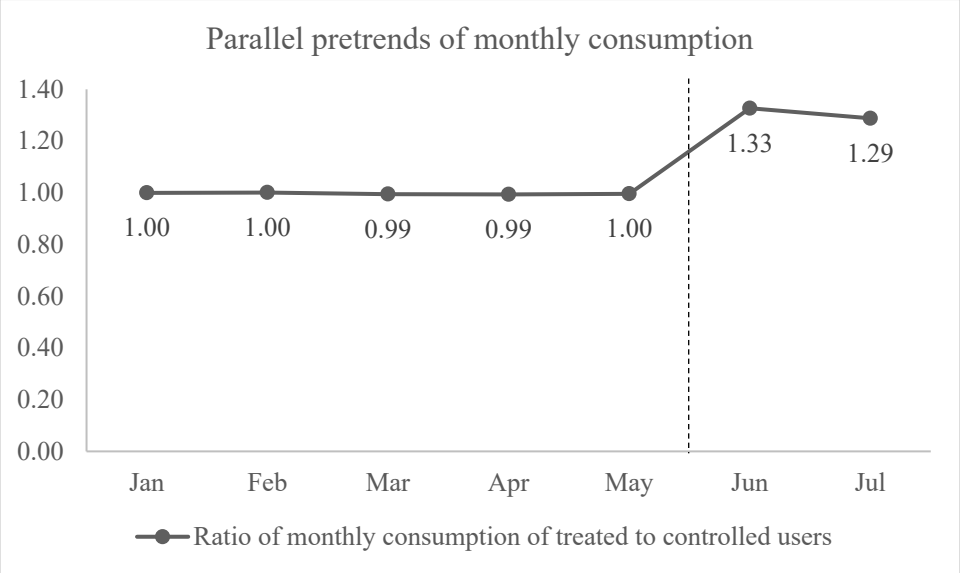

Figure 2. The pre-trends of consumption of treated and untreated users

3. Stylized Facts About BNPL in E-wallet Super-Apps

In this section, we document how BNPL is a dominant payment option in e-wallet transactions and how it has led to expansion of household credit. Notably, BNPL has outpaced credit cards as a form of short-term liquidity and credit.

3.1 Payment Dominance of BNPL

We start with the payment nature of BNPL by examining the competitive landscape of payment options within the e-wallet super-app. Our data enable us to offer the first empirical description and usage distribution of prominent payment options in e-wallets: linked debit cards, linked credit cards, e-wallet balance (digital cash stored in e-wallet accounts), e-wallet savings (wealth-management products provided by e-wallet providers that function as interest-bearing demand deposits), and e-wallet credit through the FinTech credit product, BNPL.

How users pay dictates how money and information flow through the plumbing of the e-wallet economy. Table 2a lists the two broad categories: Linked debit cards and credit cards constitute **external** options where the e-wallet functions as a conduit to banks and pass payment information to external ledgers; E-wallet balance, e-wallet savings, and BNPL are **internal** options where the e-wallet functions as an independent ecosystem and payment information stays within the wallet itself.

Table 2a. Payment options within the e-wallet

Types	Options	(1) Online transactions	(2) Total share	(3) On-site transactions	(4) Total share
External (bank-linked) options	Linked debit card	27.2%	36.0%	16.0%	17.9%
	Linked credit card	8.8%		1.9%	
Internal (e-wallet based) options	E-wallet balance	8.0%	62.7%	12.0%	81.6%
	E-wallet savings	10.9%		15.4%	
	BNPL	43.8%		54.2%	

Table 2b. Features of the five payment options

	Desirable features

Payment options	Free liquidity	Interest-bearing	Wide acceptance	Direct access to bank account funds	Credit building
BNPL	√		√		√
Linked credit card	√				√
E-wallet savings		√	√		
Linked debit card			√	√	
E-wallet balance			√		

Among external payment options, linked debit cards are the most frequently used, which is consistent with the low adoption of credit cards in China. Among internal payment options, the most popular is BNPL, which can be attributed to the opportunity costs associated with different internal payment options (e.g., Santomero and Seater, 1996; Klee, 2008). Specifically, because e-wallet savings offer positive interest rates, users prefer to exploit the free liquidity provided by BNPL for payments while leaving funds in e-wallet savings untouched to earn interest. (Table 2b displays the features of each payment option within the e-wallet.) Note that the e-wallet provider reminds users on the availability of the wealth-management products, hence e-wallet users are well aware of their options. In contrast, users seldom use e-wallet balances, as they provide neither interest earnings nor additional liquidity. Note that Berg et al. (2023) find that BNPL dominates the payment choices (51%) for a large furniture merchant in Germany, which is consistent with our finding.

As shown in Table 2a Columns (2) and (4), the proportion of e-wallet internal payments is significantly larger than that of external payments for both online and on-site transactions. Bank cards constitute only 36.0% and 17.9% of all online and on-site transactions, respectively. These results indicate that internal payment options dominate the e-wallet ecosystem, with e-wallet transactions largely bypassing banks and BNPL being the most frequently used option in the e-wallet. The current landscape is understandable considering that credit card penetration is low in China compared with other developed countries. Although debit cards are prevalent, overdraft is not

allowed.[25] Thus, for customers with no access to credit cards, BNPL serves as the sole payment tool that can provide free liquidity for their purchases, and in a more privacy-preserving manner than debit card transfers for which data must be transmitted to banks.

The relative distribution of internal versus external transactions holds important implications for traditional banking, as payment information is valuable and essential for other financial services such as credit scoring and origination (Agarwal et al., 2020a; Berg et al., 2022; Ghosh, Vallee, and Zeng, 2022; Parlour, Rajan, and Zhu, 2022). The rise of e-wallets and their dominant internal payment flows has led to banks being cut off from transaction information, motivating central banks worldwide, especially the People's Bank of China, to explore the introduction of their own digital currencies (known as central bank digital currencies, or CBDCs) to compete for payment flows (Auer, Cornelli, and Frost, 2020; Boar and Wehrli, 2021; Brown et al., 2022; Whited, Wu, and Xiao, 2022). Our findings provide empirical support for these oft-cited motivations for central bank electronic payment systems (EPSs) and CBDCs.

3.2 Credit Expansion of BNPL at the Extensive Margin

We now move to the credit nature of BNPL and present the stylized facts. One core question studied in the FinTech literature concerns whether FinTech credit is offered to inframarginal borrowers or unscorable borrowers with no prior credit access. Due to data limitations, previous studies cannot directly observe bank-credit access and FinTech-credit access for the same individual at the same time. They therefore had to indirectly infer the composition of FinTech borrowers through structural models (Tang, 2019) or characteristic matching (Jagtiani and Lemieux, 2019; Di Maggio and Yao, 2021). We overcome this empirical challenge because we can directly observe whether FinTech borrowers, i.e., BNPL users, have bank credit access.[26]

[25] According to a report on the operation of the payment system by China's central bank, as of 2020, the average number of debit cards per capita was 5.84, whereas it was only 0.56 for credit cards.

[26] One may argue that e-wallet users may choose not to link their credit cards to e-wallet accounts, which would result in a selection bias. We acknowledge this possibility but assuage the concern in several ways. First, e-wallet users are required to link at least one bank card when opening an account. Second, given the prevalence of e-wallets and QR payments in China, users are motivated to link their credit cards to improve their e-wallet credit scores, to enjoy credit card–related services provided by e-wallets, and to enable mobile front-end usage of their credit cards.

It is worth noting that the richness of the data enables us to add a new perspective on the expansion of FinTech credit: merchants' adoption. Previous studies on FinTech credit did not need to consider the merchant side because they mainly focused on marketplace lending, which is independent of merchant acceptance. Here, consumers' access to credit would be limited if few merchants accept BNPL as a payment option. The super-app ecosystem facilitates adoption on both sides of the payment market because e-wallet providers do not have to charge merchants high fees or pass them credit risks associated with BNPL payment.[27]

Table 3 shows the credit expansion from the consumer side, the merchant side, and the transaction level. First, from the consumer side, as shown in Panel A, among on-site consumers, 70.43% do not have a credit card linked to their e-wallets. For online consumers, the percentage is 68.31%. However, 84.14% of those with no credit card for on-site consumers and 78.38% for online consumers utilize BNPL as a form of e-wallet credit. This contrasts with some findings about the U.S. FinTech market, in which lenders primarily cater to borrowers who already have access to credit via traditional banks (Tang, 2019; Di Maggio and Yao, 2021). Furthermore, as shown in Panel B, 87.32% of on-site e-wallet users have e-wallet credit, while 82.28% of online e-wallet users have e-wallet credit. However, only 32.14% of on-site users and 35.02% of online users have linked credit cards at the same time. This finding indicates that the majority of BNPL users do not have linked credit cards. Compared to the inframarginal credit expansion documented in Tang (2019), the credit expansion at the extensive margin—that is, expanding credit access to those with no access to bank credit—is more pronounced in our sample. This result also echoes the finding of Chioda et al. (2024) that FinTech lenders can achieve credit expansion to borrowers with no credit history by exploiting alternative data from digital transactions.

It is therefore highly improbable that users choose not to link credit cards to their e-wallets. Third, in our sample, the fraction of e-wallet users with linked credit cards and the number of credit cards linked are similar to the fraction of credit card owners and average number of credit cards owned among Chinese adults overall—around 30% and 0.56, respectively—which means e-wallet users are representative of Chinese credit card ownership. Fourth, having an unlinked credit card would not bias against most of our findings.

[27] Higgins (2024) attempts to study the magnitude of these externalities and resulting spillovers of financial technology adoption within and across the two sides of the market using data from a large-scale conditional cash transfer program, Prospera, in Mexico.

Table 3. Expansion of e-wallet credit: Consumer side, merchant side, and transaction level

	On-site	Online
Consumer Side		
Panel A: Without credit cards	70.43%	68.31%
% of the above with e-wallet credit (BNPL)	84.14%	78.38%
Panel B: With e-wallet credit (BNPL)	87.32%	82.28%
% of the above with credit cards	32.14%	35.02%
Merchant Side		
Panel C: Do not accept credit cards	81.79%	1.08%
% of the above that accept e-wallet credit (BNPL)	43.54%	80.56%
Panel D: Accept e-wallet credit (BNPL)	50.81%	99.17%
% of the above that accept credit cards	29.90%	99.12%
Transaction Level		
Panel E: Cannot use credit cards	91.59%	68.45%
% of the above that can use e-wallet credit (BNPL)	44.37%	77.63%
Panel F: Accept e-wallet credit (BNPL)	50.81%	99.17%
% of the above that accept credit cards	29.90%	99.12%

From the merchant side, in Column 1 of Table 3, Panels C and D report credit expansion for on-site merchants. As shown in Panel C, among on-site merchants, 81.79% do not accept credit card payments. However, 43.54% of them accept BNPL, possibly because of its convenience and large user base. Next, as illustrated in Panel D, more than half (50.81%) of merchants accept BNPL payments, and only 29.90% of them also accept credit cards. The majority of merchants who accept BNPL in our data do not accept credit cards, and according to the e-wallet provider, they have never accepted credit cards previously, likely because for BNPL they need to neither supply the credit nor pay an exorbitant fee to the intermediaries. In addition, they can enjoy the larger customer base of BNPL. Therefore, the extensive marginal effect, not the intensive marginal effect, dominates the expansion of e-wallet credit for on-site merchants.[28] In

[28] One may be concerned that some merchants accepting credit cards would stop doing so once they adopt BNPL. According to the e-wallet provider, this occurrence is extremely rare, because many consumers, especially the ones with large transactions, still use credit cards. To be specific, less than 1% of the merchants who previously accepted credit cards stopped doing so after their adoption of BNPL in the entire history of the e-wallet provider. Therefore,

Column 2 of Table 3, Panels C and D demonstrate credit expansion for online merchants. Unlike on-site merchants, nearly all online merchants accept credit card payments, as shown in Panel C. Although the acceptance ratio of BNPL is high at 99.17%, as shown in Panel D, BNPL's credit expansion at the extensive margin for online merchants is tiny. The intensive marginal effect likely dominates the expansion of BNPL for online merchants.

We next discuss efficient credit expansion by combining the merchant side and the consumer side. A transaction can be completed using BNPL only if the consumer has access to it and the merchant accepts it as a payment method. Thus, credit expansion is efficient only when both the consumer's access to a payment method (using credit) and the merchant's acceptance of that payment method are aligned. To measure efficient credit expansion, we first determine whether a transaction can be completed with credit cards or BNPL based on both merchant acceptance and consumer access. We then classify the transactions into those that can be completed with credit cards only, those that can be completed with either BNPL or credit cards, and those that can be completed with BNPL only. When a transaction can be completed with BNPL only, we deem it an effective credit expansion.

Panel E and F in Table 3 show that efficient credit expansion remains significant along various dimensions. First, as illustrated in Panel E, 91.59% of on-site and 68.45% of online transactions cannot be completed with credit cards. However, 44.37% and 77.63% of them can be completed with BNPL. Hence, the extensive margin of efficient credit-access expansion is economically meaningful. Next, as revealed in Panel F, among the 47.00% of on-site transactions completed with BNPL, only 13.53% can be completed with credit cards. In contrast, among the 81.68% of online transactions completed with BNPL, only 34.95% can be completed with credit cards. The findings suggest that the extensive marginal effect, not the intensive marginal effect, dominates

the observed merchants who adopt BNPL but not credit cards represent an extensive margin for credit expansion through BNPL. Merchants who find credit cards unattractive would also opt for cash for on-site transactions to start with, rather than switching to BNPL. For online merchants, such a switch is virtually non-existent because 98.92% of them accept credit cards.

efficient credit expansion at the transaction level.

Furthermore, we follow Tang (2019) and make a simple comparison of user quality of dual-access and single-access users for on-site and online transactions. As documented in Appendix Table 1, dual-access users are older, wealthier, and located in more developed cities than single-access users. This suggests that e-wallet credit is primarily used by consumers who have limited access to bank credit or young consumers with low income.

In sum, considering the two-sided nature of the market, the expansion of e-wallet credit is economically significant at the extensive margin and BNPL is mostly provided to those with no access to bank credit: about 80% of consumers, 44% of on-site merchants, 44% of on-site transactions, and 90% of online transactions that cannot be completed by credit cards can now be completed with BNPL.[29]

4. BNPL as a Payment Option and Financial Inclusion

We now delve deeper into the payment nature of BNPL by exploring how BNPL access crowds out other payment options, as well as BNPL transactions in small transactions and less developed regions.

4.1 A Model Linking BNPL Access with Payment Choices

In examining the interaction between BNPL and other payment options, we specify, for on-site transactions, a logit model:

$$Payment\_Option\_Dummy_{\mathrm{jh},i,m,t} = \alpha_h + \beta_1 D\_Consumer\_BNPL_{j,i,t} + \beta_2 D\_Merchant\_BNPL_{\ j,m,t} + \gamma \mathrm{X} + \mathrm{I}ndustry_{j,m} + date_t + \varepsilon_j \ , \quad (1)$$

where j denotes transaction, and h denotes five alternative payment options:

$$h \in \{\mathrm{e}-\text{wallet balance}, \mathrm{e}-\text{wallet savings}, \mathrm{BNPL}, \text{linked debit cards}, \text{linked credit cards}\}.$$

[29] To take age structure into account, we have also drawn a subsample that has the same median age with Chinese total population and repeated the credit expansion analyses. The conclusion remains unchanged.

Here, the dependent variable is *Payment_option_dummy*, which takes value of 1 when transaction j is completed with payment option h, and 0 otherwise. And α_h is a payment-option-specific constant term. $D\_Consumer\_BNPL_{j,i,t}$ indicates whether the consumer i in transaction j has access to BNPL at date t, and $D\_Merchant\_BNPL_{j,m,t}$ indicates whether the merchant m in transaction j accepts BNPL at date t. X represents a vector of control variables: consumer access to credit cards (*D_Consumer_CC*); merchant acceptance of credit cards (*D_Merchant_CC*); whether the used payment option h is the default option of the consumer (*D_preferred_option*); how long the consumer has had access to payment option j (*Option_adoption_length*); the consumer's age, gender, the logarithm of e-wallet cash flows in the last year (*Ln_cashflow*), and the amount of wealth in the e-wallet (*Ln_wealth*); the logarithm of merchant's sales (*Ln_monthly_sales*); the logarithm of transaction value (*Ln_Transaction_value*). Industry fixed effects $Industry_{j,m}$ and daily time fixed effects $date_t$ are also included in the regression.

For online transactions, we adopt a similar econometric specification but omit the variables *D_Merchant_BNPL* and *D_Merchant_CC* because over 98% of online merchants accept both BNPL and credit cards:

$$Payment\_Option\_Dummy_{\mathrm{jh},i,m,t} = \alpha_h + \beta_1 D\_Consumer\_BNPL_{j,i,t} + \gamma \mathrm{X} + \mathrm{I}ndustry_{j,m} + date_t + \varepsilon_j. \quad (2)$$

We first investigate how consumer access to and merchant acceptance of BNPL influence payment choices. Table 4 presents the results for on-site transactions. Note that consumer access to BNPL is significantly and negatively associated with all other payment option usage here, indicating that the expansion of e-wallet credit through BNPL crowds out the usage of other payment options. Merchant acceptance of BNPL is positively associated with the usage of BNPL, credit cards, and e-wallet savings, but only the coefficient on BNPL usage is economically meaningful.

Table 4. Payment choices for on-site transactions

	Payment options				
	E-wallet credit (BNPL)	Credit cards	E-wallet balance	E-wallet savings	Debit cards
	(1)	(2)	(3)	(4)	(5)

D_Consumer_BNPL[d]	0.675***	-0.021***	-0.121***	-0.157***	-0.143***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D_Consumer_CC[d]	0.042***	0.063***	-0.040***	-0.040***	0.014***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D_Merchant_BNPL[d]	0.048***	0.001**	-0.002**	0.007***	-0.010***
	(0.000)	(0.039)	(0.025)	(0.000)	(0.000)
D_Merchant_CC[d]	-0.045***	0.049***	-0.015***	-0.011***	0.045***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D_preferred_option[d]	0.339***	0.021***	0.112***	0.227***	0.268***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Option_adoption_length	-0.000***	0.000	-0.000***	-0.000***	0.000***
	(0.000)	(0.390)	(0.000)	(0.000)	(0.000)
Age	0.002***	-0.001***	-0.001***	-0.005***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female[d]	-0.011***	0.003***	-0.003***	-0.007***	0.005***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Ln_transaction_value	-0.033***	0.001***	0.003***	0.003***	0.021***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ln_monthly_sales	-0.015***	-0.001***	-0.005***	-0.006***	0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ln_cashflow	-0.027***	-0.004***	0.020***	0.012***	-0.013***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ln_wealth	0.010***	0.000***	-0.024***	0.021***	-0.008***
	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)
Industry FE	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES
Observations	501,801	501,801	501,801	501,801	501,801
Pseudo-R^2	0.25	0.41	0.20	0.15	0.14

Notes: 1. Subscript *d* indicates dummy variables. 2. *** p < 0.01; ** p < 0.05; * p < 0.1. 3.We report the marginal effects for the logit model.

As for control variables, as expected, consumers' payment-option preference is positively correlated with the payment-option usage, while option adoption length has little explanatory power. Older consumers are less likely to use e-wallet savings, perhaps reflecting that financial experience accumulated over time helps users to recognize the higher opportunity cost of e-wallet savings compared to other options. Female consumers are less likely to use internal payment options and are more likely to use bank-linked external payment options. Debit cards are used more frequently in transactions with merchants that have higher average monthly sales. This is in accordance with economic intuition since debit cards are still the more popular payment instrument accepted by large sellers. The cash flow and wealth variables in the e-wallet show mixed results.

We find that the usage of BNPL is more likely for small transactions, while all other payment options are associated with higher-value transactions. Though we have only indirect measures of cash usage, the significant differences in coefficient estimation on transaction value for different payment options suggest how BNPL has become the new cash in the e-wallet ecosystem, managing small on-site transactions. Also note that the results are unlikely driven by the credit limits on BNPL because most e-wallet transactions did not exceed the BNPL credit limits (in the range of RMB ¥500-50,000). The annualized interest rate on delinquent payments for the BNPL credit is 13%-16%, which is slightly higher than the rates charged by most credit cards in China, ruling out the possibility that consumers embrace BNPL due to lower interest rates.

We repeat the analyses for online transactions in Appendix Table 2. Consumer access to BNPL similarly reduces the possibility of all other payment-option usage, indicating that e-wallet credit access as a payment option crowds out the other options. We still find no evidence of e-wallet credit being used for big-ticket purchases.

In sum, we provide evidence consistent with the notion that BNPL access displaces other payment options.[30] We also find that BNPL usage is not competing with credit cards for large value purchases, even though it resembles a virtual credit card. We also focus on the subsample of dual-access users who have access to both BNPL and credit cards to provide further evidence that BNPL serves primarily as a potential complement of credit cards, not a substitute (See Appendix Tables 3 and 4). The results show that dual-access users use e-wallet credit and credit cards in different payment scenarios,

[30] Though not included in the main text, we perform several robustness tests regarding the results in Tables 3 and 4. First, we apply the probit model and ordinary least squares method to estimate the baseline regression. Second, in Eqs. (1) and (2), we use a dummy variable indicating whether the used payment option is the most preferred (default) one (*D_preferred_option*) to proxy for consumer preference. We instead use the proportion of transactions using a payment option over the last three months as an alternative proxy. Third, we combine the online and on-site datasets to jointly estimate the regression model following Eq. (1). Our findings remain robust. Fourth, we re-run the regressions with city or province fixed effects. The logit model did not converge due to incidental parameter problems. We instead apply OLS to the model with city or province fixed effects, and our findings remain unchanged. For example, with city fixed effects, the coefficient estimates on *D_Consumer_BNPL* for on-site transactions are statistically significant at the 1% level, with the magnitudes of 0.279, -0.011, -0.192, -0.163, and -0.211 in the five columns respectively. The results are available upon request.

with e-wallet credit for daily, small transactions and credit cards for big-ticket purchases.

4.2 From Payments to Credit: Financial Inclusion Through BNPL

While both credit cards and BNPL are options to pay with credit, and both are helpful to build credit history, they could differ in actual usage scenarios due to discrepancies in merchant acceptance and consumer adoption. As BNPL is well accepted by both consumers and merchants, especially for those without credit cards, we propose the following financial inclusion hypothesis on credit payment usage:

H1(financial inclusion through credit expansion): Compared with credit card access, BNPL access is more significantly associated with credit usage by disadvantaged consumers, such as female consumers and those in less developed regions.

To empirically test the hypothesis, we will explore the determinants of consumer credit usage (credit cards and BNPL) as a whole, with a special focus on the heterogeneous impacts of BNPL access on female consumers and male consumers, as well as in well-developed and less-developed areas.[31] To achieve this, we introduce three *disadvantaged* dummy variables (*Female*, *Rural* and *North*) indicating whether a transaction is conducted by female consumer or occurs in rural areas or northern regions, along with their interactions with consumer access to BNPL (*D_Consumer_BNPL*). Additionally, for completeness, we incorporate the interaction terms between *Rural* (or *Female* or *North*) and consumer access to credit cards (*D_Consumer_CC*), merchant access to BNPL (*D_Merchant_BNPL*), and merchant access to credit cards (*D_Merchant_CC*). The model specification is as follows for on-site transactions:

$$CreditUsage_{j,i,m,t} = \beta_1 D\_Consumer\_BNPL_{j,i,t} + \beta_2 D\_Merchant\_BNPL_{j,m,t} + \beta_3 D\_Consumer\_CC_{j,i,t} +$$

[31] In Appendix Table 5, we report the fraction of on-site and online transactions using BNPL and credit cards in well-developed and less-developed areas. The proportion of transactions using credit cards in more developed regions (urban areas and southern regions) is significantly higher than that in less developed regions (rural areas and northern regions). In contrast, BNPL, as another consumer credit, does not exhibit a similar pattern. The proportion is even higher among on-site transactions in northern regions and among online transactions in rural areas. In this sense, the credit expansion of BNPL alleviates the inequality in access to bank consumer credit between well-developed and less-developed areas in China, consequently promoting financial inclusion.

$\beta_4 D\_Merchant\_CC_{j,m,t} + \beta_5 D\_Consumer\_BNPL_{j,i,t} * Disadvantaged_{j,i,t} + \beta_6 D\_Merchant\_BNPL_{j,m,t} *$

$Disadvantaged_{j,i,t} + +\beta_7 D\_Consumer\_CC_{j,i,t} * Disadvantaged_{j,i,t} + \beta_8 D\_Merchant\_CC_{j,m,t} *$

$Disadvantaged_{j,i,t} + \gamma X + Industry_{j,m} + date_t + \varepsilon_j$, (3)

For online transactions, we adopt a similar econometric specification but omit the variables *D_Merchant_BNPL* and *D_Merchant_CC* and the related interaction terms as more than 98% of online merchants accept both BNPL and credit cards.

Table 5. Financial Inclusion: BNPL VS. Credit Cards

	The dependent variable: =1 if a transaction is conducted by consumer credit (BNPL or credit cards)					
	Sample: On-site transactions Dummy: Disadvantaged=			Sample: Online transactions Dummy: Disadvantaged=		
	(1)	(2)	(3)	(4)	(5)	(6)
	Rural	North	Female	Rural	North	Female
D_Consumer_BNPL[d]	0.443***	0.437***	2.427***	0.205***	0.220***	0.931***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Disadvantaged[d]	-0.119***	-0.097***	-0.830***	-0.139***	-0.076***	-0.662***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D_Consumer_BNPL[d] * *Disadvantaged*[d]	0.113***	0.116***	0.535***	0.142***	0.075***	0.670***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D_Consumer_CC[d] * *Disadvantaged*[d]	-0.003	-0.000	0.378***	-0.064***	-0.006**	0.148***
	(0.248)	(0.870)	(0.000)	(0.000)	(0.024)	(0.000)
Control variables	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Day FE	YES	YES	YES	YES	YES	YES
Pseudo R^2	0.229	0.230	0.229	0.219	0.218	0.218
Observations	501,598	501,801	501,801	512,803	512,505	512,803

Notes: 1. Subscript *d* indicates dummy variables. 2. *** p < 0.01; ** p < 0.05; * p < 0.1. 3.We report the marginal effects for the logit model.

Table 5 presents the regression results, where the dependent variable indicates whether consumer credit (credit card or BNPL) is used in a transaction. First, the coefficients on *D_Consumer_BNPL* are positive and statistically significant at the 1% level, suggesting that consumer access to BNPL improves the use of consumer credit in transactions in males and more-developed regions (urban areas and southern regions). Meanwhile, the coefficients on *Disadvantaged* dummies (*North, Rural, Female*) are negative and statistically significant at the 1% level, suggesting that the use of consumer credit is less frequent for disadvantaged groups such as females and those in less-

developed regions (rural areas and northern regions). Second, the coefficients on the interaction terms between *D_Consumer_BNPL* and *Rural* (or *North* or Female) are positive and statistically significant, revealing that the impact of BNPL access on credit usage is even more pronounced for females and less-developed regions (rural areas and northern regions). In contrast, the coefficients on the interaction terms between credit card access (*D_Consumer_CC*) and *Rural* (or *North* or Female) are insignificant or smaller compared to the BNPL access interaction term, indicating that access to credit cards does not have a comparable financial inclusion effect as BNPL has.

The results make intuitive sense given the disparities in merchant acceptance of BNPL compared to credit cards. For inhabitants with less wealth or in less developed regions, possessing a credit card does not necessarily equate to the ability to use credit or build a credit history, because few merchants in these areas accept such payment. In contrast, access to BNPL can significantly enhance these consumers' chances to tap into readily available credit and start to build a credit history. The credit expansion through BNPL promotes financial inclusion, especially in females and less-developed regions. Finally, the financial inclusion effect and credit building function of BNPL for users in less-developed regions are consistent with frequent usage of BNPL on small transactions in e-wallets.

5. BNPL as Credit in E-wallet Super-App and Consumer Behavior

5.1 BNPL and Consumer Spending

BNPL has displaced other payment choices and expanded credit at the extensive margin. As a new form of consumer credit, how does BNPL impact consumer spending and indebtedness? Following Gross and Souleles (2002) and Aydin (2022) that exploit exogenous increases in credit supply, we similarly rely on the randomized experiment conducted by the e-wallet provider to examine this question.

BNPL has several unique features enriching our understanding of the impacts of credit increases on consumption and indebtedness beyond traditional credit lines

increases on credit cards. First, the BNPL in point targets young consumers with low income and no credit card, who are most likely to be financially constrained. Second, the BNPL service provides more options and flexibility for consumers and is particularly attractive for those who are uncomfortable carrying credit card balances but comfortable borrowing for specific purchases. These features of BNPL could have profound impacts on consumer spending. Our hypothesis is as follows:

H2 (BNPL and spending): Access to BNPL significantly increases consumers' spending.

To formally check the impact of introducing BNPL on consumer spending, we employ a difference-in-differences specification, thanks to that our dataset covers both the pre-treatment and post-treatment periods from January to July 2017. Specifically, we compare the outcomes of the treated users after gaining access to BNPL relative to the time before they had credit access and relative to users in the control group:

$$Consumption_{it} = \beta_0 + \beta_1 treat_i * post_t + \gamma \ln\_cashflow_{it} + \lambda_i + \delta_t + \varepsilon_{it} . \quad (4)$$

Here, $Consumption_{it}$ is the amount of spending through the e-wallet for consumer i in month t; $treat_i$ is a dummy variable that equals 1 for treated users and 0 for untreated users; $post_t$ is a dummy variable that equals 1 for user-month observations in June and July during the two-month experiment and 0 otherwise. The control variable $ln\_cashflow_{it}$ is the logarithm of e-wallet cash flows in the last year to proxy for users' financial position. We also include both user fixed effects (λ_i) and month fixed effects (δ_t) in the regression to control for the impacts of unobserved time-invariant user characteristics and macroeconomic factors.[32] ε_{it} is the error term.

The aggregate consumption effect in the full sample is reported in Table 6 Column (1); the heterogeneous effects of BNPL on single-access users without credit card access and dual-access users with both BNPL and credit card access are shown in Columns (2) and (3).

[32] Since user fixed effects are included in the regression, we do not report the coefficient estimates on users' age and gender. These two variables are fully absorbed by user fixed effects.

In all columns, the interaction term between the treatment and the time indicator, $treat_i$*$post_t$, is positive and statistically significant, implying that the introduction of BNPL increases consumer spending. In the full sample, compared with the average monthly consumption of untreated users, consumption of the treated group increases by RMB ¥86, corresponding to approximately 5.62% of total average monthly consumption (0.086/1.53) as reported by the National Bureau of Statistics of China.[33] For single-access users in Column (2), the average monthly consumption increases by RMB ¥85 after gaining access to BNPL; for dual-access users in Column (3), the average consumption increases by RMB ¥204.[34]

Table 6. The impact of BNPL on consumer spending

	Dependent variable: consumption (monthly, thousand RMB)		
	(1)	(2)	(3)
	Full sample	Single-access	Dual-access
Treat×Post	0.086***	0.085***	0.204***
	(0.002)	(0.002)	(0.047)
Ln_cashflow	0.014***	0.014***	0.044***
	(0.0003)	(0.0003)	(0.005)
User fixed effects	YES	YES	YES
Month fixed effects	YES	YES	YES
Observations	700,000	695,149	4,851
R^2	0.225	0.226	0.199

Notes: ***p < 0.01; **p < 0.05; *p < 0.1.

5.2 BNPL, Default, and Consumer Indebtedness

We then return to our transaction data to explore the dynamics of indebtedness and BNPL usage. Some may argue that BNPL boosts consumer spending, which then induces overspending and increases consumer indebtedness or default, especially for

[33] Average yearly consumption by Chinese people was RMB ¥18,322 in 2017. See http://www.stats.gov.cn/tjsj/zxfb/201801/t20180118_1574931.html; accessed on August 5, 2020.

[34] The higher effect for dual-access users may be attributed to their higher average wealth. This coefficient estimation for dual-access users should be interpreted with caution due to its limited sample size and much higher standard error. The 95% confidence interval of *Treat×Post* in Column (3) is (0.1124, 0.2952). In comparison, the 95% confidence interval of the coefficient estimate for *Treat×Post* in Column (1) is (0.0818, 0.0903). Though unreported, we also explored the effect of BNPL access on BNPL consumption. The coefficients on *Treat×Post* are 0.029 for single-access users and 0.054 for dual-access users. We also examine the cross-sectional heterogeneity of the consumption response of users by age and bank cards (see Figures A1 and A2). The consumption response is higher for younger customers and those with only one bank card, consumption also increases for older customers and those with multiple bank cards.

single-access users who are underserved by banks but have now received consumer credit for the first time.

To empirically test the claim, we first compare single-access and dual-access users in Table 7 concerning the BNPL usage as a means of payment and repay the balance each month (transactors) or the usage as a source of credit and incur interest charges for unpaid debt (revolvers). Note that the overall default rate is below 1% in our sample and below 2% among all BNPL users in the population.[35] But revolvers are common. About two-thirds of single-access consumers use BNPL as a means of payment; the fraction of revolvers is 32.33%, which is significantly lower than the fraction for dual-access users (40.78%). In addition, the ratio of unpaid BNPL credit to used credit balance is 28.13% for single-access revolvers, which is also slightly lower than that for dual-access revolvers (31.48%). Moreover, single-access users choose to pay with BNPL for 58.24% of their transactions, while dual-access users use BNPL for 56.97% of their transactions. Since the differences in Unpaid BNPL debt/used credit and BNPL/all transaction are economically negligible, the lower fraction of revolvers in single-access user group are not driven by their less-frequent BNPL usage.

Table 7. BNPL usage for different purposes between single-access users and dual-access users

	All e-wallet credit users (1)	Dual-access users (2)	Single-access users (3)	(2)−(3)
The fraction of revolvers %	35.16	40.78	32.33	8.45***
Unpaid BNPL debt/used credit %	29.32	31.48	28.13	3.35***
BNPL transactions/all transactions %	57.81	56.97	58.24	-1.27***

Notes: 1. The last column shows the difference between columns (2) and (3). 2. ***p < 0.01; **p < 0.05; *p < 0.1.

Single-access users appear to use BNPL more frequently and more cautiously, as demonstrated by a lower proportion of revolvers and a lower unpaid-debt ratio for revolvers.[36] This behavior is voluntary as the e-wallet provider benefits from receiving

[35] Data source: the 2020 prospectus from the data provider. The e-wallet provider also carefully manages default risk: in addition to the diversification of borrowers across demographic groups, the provider reduces a user's credit score within the e-commerce ecosystem if a user defaults, and utilizes proprietary data to screen for eligible and trusted borrowers.

[36] The overall debt level of dual-access users is inferred to be higher than that of single-access users because of the higher BNPL debt ratio. We also find that that BNPL access increases credit card consumption, and it is unlikely that dual-access users would engage in debt restructuring by turning credit card debt into BNPL debt.

interest payments and would not require BNPL users to reduce usage or impose penalty without default. To some extent, this alleviates our concern that single-access users who receive consumer credit for the first time may overuse BNPL due to the oft-cited lack of financial literacy and budgeting education.

We return to the transaction-level payment data and analyze how consumers change their usage of BNPL when they have unpaid debt and incur interest charges. It is important to consider the impact on the usage of BNPL as the payment method when an e-wallet user faces interest charges. If users choose to use more BNPL after incurring interest, they are likely to develop into deep revolvers bearing a heavier debt burden and a default can hurt their credit building efforts within the e-commerce system. In contrast, if e-wallet users reduce their BNPL usage once faced with interest expenses, then they are temporarily revolvers and likely to become transactors again in the future, alleviating the concern of excessive indebtedness. Considering the existence of an ecosystem in the super-app e-wallet to discipline users' behaviors, the hypothesis to be tested are as follows:

H3 (BNPL and debt): BNPL users are likely to reduce their usage when they incur interest expenses.

Here we examine the relationship between BNPL usage and interest expenses using the following model specification:

$$BNPL_{j,i,m,t} = \alpha + \beta_1 D\_Consumer\_BNPL_{j,i,t} + \beta_2 D\_Merchant\_BNPL_{j,m,t} + \beta_3 DebtProxy + \beta_4 DebtProxy * D\_Consumer\_BNPL_{j,i,t} + \gamma X + Industry_{j,m} + date_t + \varepsilon_j \ . \quad (5)$$

We have four proxies $DebtProxy$ to measure the extent to which a user incurs unpaid debt and interest charges in e-wallet credit: (1) a dummy variable indicating whether a user has unpaid debt (*D_Unpaid_BNPL*); (2) the logarithm of one plus the unpaid debt balance (*Ln_unpaid_BNPL_debt*); (3) the fraction of unpaid debt in used e-wallet credit (*Unpaid_BNPL_debt%*); (4) three dummy variables indicating whether the unpaid BNPL debt belongs to low-level, medium-level, or high-level groups

(*Unpaid_BNPL_debt_Low*/*Middle/High)*. We separately include these four proxies in Equations (1) and (2), which examine the determinants of the usage of BNPL as the payment instrument in on-site and online transactions. To differentiate the behavior of single-access users and that of dual-access users, we also include the interaction terms between the first three proxies and the dummy variable indicating whether a user has access to a credit card (*D_Consumer_CC*).

Table 8. The impact of incurring interest on the usage of BNPL as the payment instrument in on-site transactions

	The dependent variable: a dummy variable indicating whether BNPL is used in an on-site transaction			
	(1)	(2)	(3)	(4)
D_Consumer_CC^{d}	0.039***	0.043***	0.026***	0.033***
	(0.000)	(0.000)	(0.000)	(0.000)
D_Merchant_BNPL^{d}	0.028***	0.033***	0.030***	0.034***
	(0.000)	(0.000)	(0.000)	(0.000)
D_Merchant_CC^{d}	−0.071***	−0.070***	−0.060***	−0.074***
	(0.000)	(0.000)	(0.000)	(0.000)
Consumer_preference_BNPL^{d}	0.391***	0.383***	0.270***	0.382***
	(0.000)	(0.000)	(0.000)	(0.000)
D_Unpaid_BNPL^{d}	−0.060***			
	(0.000)			
D_Unpaid_BNPL^{d}×D_Consumer_CC^{d}	−0.010***			
	(0.000)			
Ln_unpaid_BNPL_debt		−0.008***		
		(0.000)		
Ln_unpaid_BNPL_debt×D_Consumer_CC^{d}		−0.002***		
		(0.000)		
Unpaid_BNPL_debt %			−0.184***	
			(0.000)	
Unpaid_BNPL_debt %× D_Consumer_CC^{d}			−0.006*	
			(0.077)	
Unpaid_BNPL_debt_Low^{d}				0.034***
				(0.000)
Unpaid_BNPL_debt_Middle^{d}				−0.068***
				(0.000)
Unpaid_BNPL_debt_High^{d}				−0.172***
				(0.000)
Control variables	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Day FE	YES	YES	YES	YES
Observations	448,270	442,493	393,482	448,270
Pseudo-R^2	0.13	0.13	0.11	0.14

Notes: 1. Unpaid_BNPL_debt %=unpaid debt / used e-wallet credit. 2. The superscript d indicates a dummy variable.

3. *** p < 0.01; ** p < 0.05; * p < 0.1. 4. We report the marginal effects for the logit model.

Table 8 presents the regression results for on-site transactions. The coefficients on the first three proxies are all negative and statistically significant, suggesting that single-access users reduce their usage of BNPL as the payment tool in both on-site and online transactions when they incur unpaid debt and interest charges. Relative to single-access users, dual-access users reduce their usage of BNPL as a payment tool in on-site transactions to a greater extent, while they reduce their usage of BNPL to a lesser extent in online transactions (see Appendix Table 6). According to the results in Columns (4) in Table 8, whilst BNPL users exhibit a slight increase in BNPL usage when faced with low-level unpaid debt, potentially to address their liquidity needs, their usage of BNPL significantly decreases as their debt levels enter the middle or high terciles. This could be intuitively attributed to the higher delinquent interest rate charged by BNPL providers compared to credit cards.[37] We repeat the analyses for online transactions in Appendix Table 6 and reach similar results.

Taken together, the results show that single-access users are careful in using BNPL even though they receive consumer credit for the first time. They have a lower fraction of revolvers and a lower ratio of unpaid debt to used e-wallet credit; they also voluntarily reduce their usage of BNPL as the payment tool in both on-site and online transactions after they incur unpaid debt and interest charges. Our findings are in line with those of Agarwal et al. (2021), who exploited a large-scale microcredit program in Rwanda. They found that a sizable share of first-time borrowers, who demonstrated lower default risks, successfully switched to bank credit later.

Our findings that BNPL boosts consumption without necessarily increasing indebtedness contrast sharply with the findings concerning developed countries documenting how BNPL leads to more defaults and delinquencies. There could be multiple drivers for these observations. First, because e-wallets contain information about borrowers' (including micro, small, and medium-sized enterprises) real-time,

[37] This is consistent with the common critique that BNPL is "inclusive but expensive" relative to credit cards. See https://m.21jingji.com/article/20201102/herald/62dfca7696f0148a9353a88dbd9eedf5.html.

high-frequency transactions, as well as complementary financial and behavioral data (e.g., gross merchandise volume, authenticity/illegal sales, customer ratings, credit card payments, online shopping payments, fund transfers, utility payments, etc.), BigTech firms providing e-wallets can learn clients' characteristics (Gambacorta, et al., 2023) and develop proprietary credit-reference systems to screen eligible consumers effectively while still remaining more inclusive than banks (Chen, Huang, Lin, and Sheng, 2022). Culture and tradition can play a role too. Tajaddini and Gholipour (2017) document that borrowers from countries with a culture of individualism default more on their mortgages. Among the 42 countries examined from 2010 to 2013, China has low individualism and the lowest mortgage default rate. Zhang (2022) uses data from a large peer-to-peer lending platform to document that borrowers from regions with stronger moral norms have lower loan default probabilities.

However, they are unlikely to be the main drivers. As demonstrated in Section 3, the credit expansion through BNPL is substantial at the extensive margin, where screening using existing data is limited or infeasible. Moreover, those more reliant on BNPL (i.e., single-access users) behave more cautiously compared to dual-access users, as evidenced in Table 8, despite sharing common cultural backgrounds. We propose and investigate a new economic channel, the super-app ecosystem model, in the next section: Given that the BNPL we study is integrated with an e-wallet ecosystem, it is natural to expect that this super-app model plays a vital role in disciplining BNPL users' behavior.

6. The Super-App Ecosystem Model

Previous theories on household credit cannot explain our findings jointly. For instance, the buffer-stock hypothesis can explain the consumption-boosting effect of BNPL well, but it fails to explain the prevalent use of BNPL in small transactions and the relation between BNPL use and consumer indebtedness. Importantly, the existence of a super-app ecosystem is one distinguished feature of the e-wallet we study. It was initially launched by China's leading e-commerce company and has gradually evolved from a mere payment tool to a super-app where users can purchase wealth management

products, hail taxis, book movie tickets, reserve hotels, pay utility bills, order food deliveries, among others. This e-wallet has permeated almost every aspect of people's life and most people cannot live without it.

To provide a coherent framework to rationalize all the empirical findings, we propose the super-app ecosystem model, which emphasizes the role of the e-wallet ecosystem in disciplining BNPL usage, rationalize users' frequent usage of BNPL, as well as users' consumption and indebtedness responses to the introduction of BNPL.

6.1 Reward/Disciplinary Incentives in the Super-app Ecosystem

Within this powerful ecosystem, users' digital footprints help the e-wallet in assessing their eligibility and trustworthiness. This, in turn, motivates users to leave more digital footprints and behave well in order to reap more benefits and avoid potential penalties within the ecosystem. For example, the e-wallet provider could temporarily suspend access to certain advanced services on the platform, and it can deduct balances from their digital wallets for repayment purposes (Chen, Huang, Lin, and Sheng, 2022; Gambacorta et al., 2023). This reduces borrower moral hazard because of the large network effects in the super-app and the high cost of switching between e-commerce platforms. Consumers also value the opportunity to improve their credit score within the super-app ecosystem, as it allows them to access a wider range of features and services. A parallel in the U.S. is PayPal Credit, where users with higher credit scores access more platform features, such as lower fees and special offers. This motivates individuals to improve creditworthiness, strengthening their commitment to responsible borrowing.

We propose the following hypothesis to explain the frequent yet responsible usage of BNPL in e-wallet super-app:

H4 (super-app ecosystem): The existence of ecosystem of the e-wallet super-app motivates users to use BNPL frequently yet responsibly.

Following Gross and Souleles (2002) and Aydin (2022) that rely on exogenous

increases in credit supply to identify the effect of credit usage, we similarly leverage the randomized experiment conducted by the e-wallet provider in 2017 to examine whether the frequent usage of BNPL serve as a ladder to access other services within the e-wallet ecosystem in the long run. To do it, we extend the sample of the randomized experiment to December 2021, with a special focus on four popular services offered by the e-wallet: internal credit scores, BNPL, another lending service for qualified BNPL users, and deposit-free rental services. We examine the impact of BNPL usage $BNPL\ usage_{i,tm}$, which is the total number of times user *i* uses BNPL in month *tm* on the access and usage of other services within the e-wallet ecosystem, utilizing an instrument with the interaction term between a dummy variable ($Treat_i$) indicating whether a user is in the treatment group for the randomized experiment in 2017 and the number of months since the inception of the experiment $InceptionMonth_{tm}$. The empirical specification is as follows:

$$BNPL\ usage_{i,tm} = \alpha + \beta_1 Treat_i * InceptionMonth_{tm} + \gamma X + Industry_{j,m} + date_t + \epsilon_j; \quad (6)$$

$$Eco\_function_{i,tm} = \alpha + \beta_1 \widehat{BNPL\ usage}_{i,tm} + \beta_2 \widehat{BNPL\ usage}_{i,tm} * High\_Debt_{i,tm} + \gamma X + Industry_{j,m} + date_t + \varepsilon_j. \quad (7)$$

The dependent variables include users' credit scores, credit limit of BNPL, credit limit in another lending service, and the usage of deposit-free rental services. The primary independent variable comprises both the *BNPL usage* and its interaction with the *High_Debt* indicator, which is assigned value one if a user's unpaid debt falls within the top 25% among all users, and zero otherwise. Due to variations in the initiation of the business and data privacy concerns by the e-wallet, the dependent variables have different time horizons in our sample: the data on deposit-free rental services starts from July 2020; the data on credit scores starts from January 2017; the credit limits of BNPL and another lending services are cross-sectional data in December 2021. Given this, we extend our initial random sample to December 2021 to examine the impact of BNPL usage on the utilization of these services. When the dependent variables are cross-sectional data, BNPL usage is instrumented by the indicator variable $Treat_i$.

Table 9. The impact of BNPL usage on users' utilization of other services in the e-wallet

	(1) Credit Scores	(2) Credit limit in another lending service (2021average)	(3) Credit limit in BNPL (2021average)	(4) Deposit-free rental services
BNPL usage	0.0279*** (0.000)	0.5569*** (0.000)	0.2277*** (0.000)	0.0041* (0.0505)
BNPL usage× High_Debt	-0.0257*** (0.000)	-0.5443*** (0.002)	-0.2165*** (0.000)	-0.0041* (0.0513)
User fixed effects	YES	NO	NO	YES
Month fixed effects	YES	NO	NO	YES
Observations	2,903,771	40,384	62,655	449,534

Notes: *P* values in parentheses. ***p < 0.01; **p < 0.05; *p < 0.1. The credit score data starts from Jan 2017, the rental services data starts from Jul 2020; the credit limit data is a cross-sectional level data of Dec 2021.

Table 9 reports the results of the two-stage least squares regression. More frequent BNPL usage is associated with higher credit scores, higher credit limits of BNPL and another lending service, and access to more services within the ecosystem. The access and usage of BNPL helps users enjoy more services within the e-wallet system, which motivates them to behave well in BNPL usage. However, the coefficients for the interaction term between BNPL usage and high debt are significantly negative for credit scores and credit limits of the two lending services, and negative yet less significant for deposit-free rental services. This suggests that frequent BNPL usage coupled with high debt may restrict users from fully utilizing the ecosystem, especially in credit-related services. Taken together, these findings help us understand why consumers use BNPL cautiously.

Furthermore, since an e-wallet super-app ecosystem fundamentally differs from a pure-play payment network based on bank cards, different payment options may lead to different merchant fees, retail prices, and consumer usage segments. As a result, in contrast to the findings documented in Wang (2023), which uses U.S. bank card data and focused on more homogenous payment networks, merchant fees do not increase or get passed onto retail prices, and consumers do not appear to overuse the newly available credit.

6.2 BNPL as the New Cash?

In addition to the disciplinary incentives, super-app ecosystem also helps explain the dominance of BNPL in e-wallet transactions, especially small transactions. The existence of various services in an ecosystem enables super-apps to cross-subsidize merchants while charging minimal fees for user acquisition, and the credit function attracts more users to increase spending and usage of BNPL. What's more, since super-app ecosystems incentivize proper borrowing behavior (through, e.g., the conditional access to more services), they make BNPL borrowers stay away from delinquency and default, and hence the frequent BNPL usage becomes sustainable. As such, BNPL becomes the dominant "new cash" without competing heads-on with credit cards as documented in earlier studies concerning developed countries.

The long-standing discussion of the "curse of cash" questions whether technological advances can reduce cash usage. While earlier studies document that cash is heavily used when available (Alvares and Argente, 2022) and electronic payment has limited effects on cash demand (Brown et al., 2022), these studies do not cover more advanced electronic payment systems or economies that have transitioned from a cash-heavy society to a cashless society such as China. It is well recognized that the popularity of e-wallets has driven this cash-heavy to cashless transition, but it is unclear which payment option has replaced physical cash for daily small transactions.

Our contribution is to document that BNPL is currently fulfilling this role. As shown in Figure 3, the proportion of bank card payments in the e-wallet has decreased from more than 90% at the beginning of 2017 to only over 30% in 2021. In contrast, the proportion of BNPL payments in the e-wallet has increased from nearly zero at the beginning of 2017 to around 50% in 2021. Because e-wallet payments have largely replaced cash transactions and BNPL dominates within the e-wallet, especially for small transactions and non-durables, we conclude that BNPL is currently serving as the new cash in this digital era, alongside with e-wallet accounts.

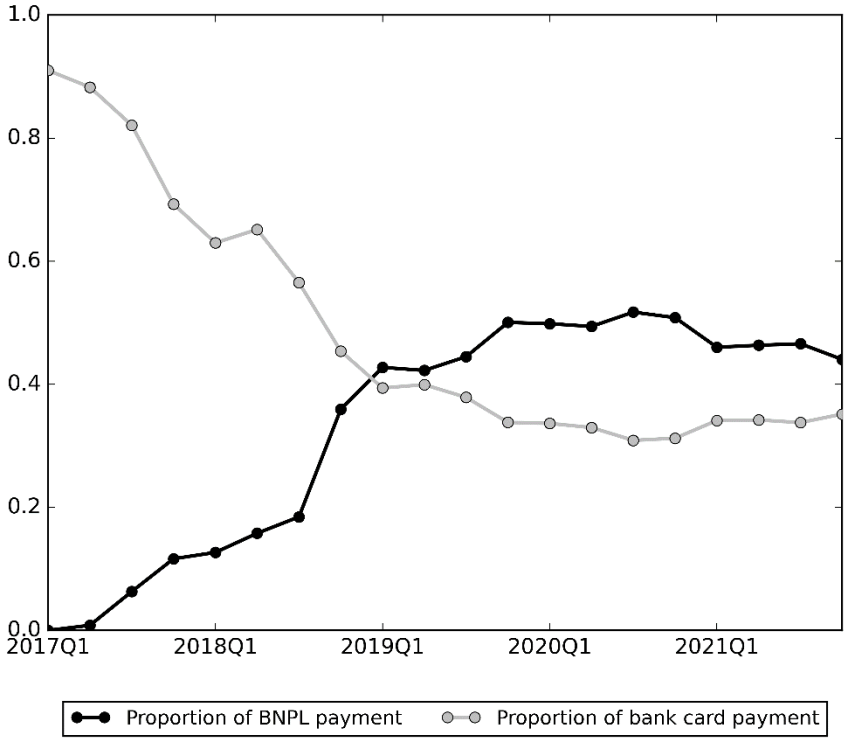

Figure 3. Proportion of e-wallet bank card payments vs BNPL payments

We further demonstrate that BNPL indeed performs the function of cash in settling small transactions, which is in contrast with the finding of Aydin (2022). Notably, Ho et al. (2022) find that the share of mobile payments has increased over time at the expense of cash payments, attributing this increase to price incentives. We propose additional driving forces with a more recent perspective: expanded consumer access to, and merchant acceptance of, e-wallet credit. Within the "super-app" system, which encompasses its various functions and large consumer and merchant base, four factors stand out to justify the use of BNPL in small transactions: the availability of saving options that encourage consumers to choose BNPL to utilize the free digital liquidity; the demographics of BNPL users, who are generally less wealthy than credit card holders and thus more inclined towards small transactions; the widespread acceptance of BNPL by merchants, enabling its use both online and in small brick-and-mortar stores; digital convenience, that is, the combination of installments and credit lines that allows users to use BNPL on nondurables and consolidate small transactions into one monthly bill, with or without installments.

Another important functionality of cash entails avoiding tax payments. Over the past decade, e-wallet usage has also largely served this purpose, as merchants could partially avoid taxes because e-wallets are not "business bank accounts" with direct tax information. That said, there have been lawsuit cases against merchants that reported unrealistically low sales, and regulators are tightening tax scrutiny to require e-wallet providers to report transactions with sufficiently high single-day-cumulative values. Unlike cash, BNPL and other e-wallet payment options are not as private, leave digital footprints, and cannot be used for various illicit activities. For these reasons, cash will likely continue to be used in situations where privacy and anonymity are required. Whether these situations are harmful to society is a separate question.

Overall, our study provides insights about the super-app ecosystem model, which not only provides disciplinary incentives for those using BNPL as a credit tool, but also promotes the frequent usage of BNPL as a payment option through cross-subsidies. The cross-subsidies and disciplinary incentives in the ecosystem reinforce each other, resulting in the observed cash-like usage of BNPL. The ecosystem mechanism provides insights about not only the Chinese market but also the global convergence of e-wallets towards the super-app model.

7. Conclusion

Digital wallets and Buy-Now-Pay-Later (BNPL) have experienced exponential growth around the globe, especially during the COVID-19 pandemic. Yet, their inner workings, the link between digital payments and FinTech consumer credit, and the effect of BNPL on consumer behavior are little understood, especially in economies transitioning from being cash-heavy to cashless, which have seen the largest market growth and potential.

We conduct the first investigation into the hitherto black box of e-wallets to better understand digital payment competition, FinTech credit provision to households, and their implications for consumer spending and debt management. Internal payment options in e-wallets dominate external options, with BNPL crowding out other payment

choices while complementing credit cards for small transactions. The e-wallet in our study has a pronounced credit-expansion effect for underserved consumers through BNPL adoption by both consumers and merchants, and in less developed regions and for individuals underserved by banks. Utilizing the large-scale, matched BNPL transaction data, as well as a randomized control experiment, we also document that BNPL significantly boosts consumption; yet, consumers—especially those who rely solely on BNPL for credit access—are careful with overspending and indebtedness.

Contrasting with studies on BNPL using bank data or surveys from developed countries where BNPL providers often started with pure-play merchant partner models, our paper highlights that introducing BNPL through super-apps creates a new "digital cash" that dominates (small-value) payments and promotes financial inclusion, which also lead to opposite outcomes in consumer indebtedness and loan defaults.[38] The findings cannot be explained by prior theories, but can be rationalized once we consider the disciplinary incentives and cross-sale capacities inherent in such digital ecosystems.

Admittedly, the payment landscape of China differs from that of Western developed economies such as the United States in the emergence of e-wallet super-apps and the lack of mature credit reference systems or widespread adoption of bank credit cards. That said, an increasing number of BNPL firms around the world have been transforming from the merchant partner acquisition model to the super-app-driven model, establishing their proprietary ecosystem.[39] Our insights into the role of e-wallets and BNPL in facilitating transactions, expanding consumer credit, and incentivizing

[38] Arguably, after 2020, regulatory changes in China's FinTech consumer credit services, such as tightened requirements for BNPL providers to report credit information to the central bank's credit reference system and reduction in credit limits for young adults, especially college students, further reinforce our findings regarding the consumer caution with BNPL usage and debt management. For more details, see https://www.wsj.com/articles/jack-mas-ant-group-slashes-credit-limits-for-some-younger-borrowers-in-china-11608738467?mod=article_inline and https://www.wsj.com/articles/ant-to-fully-share-consumer-credit-data-with-chinas-government-11632310975.

[39] On January 26, 2022, Affirm announced that it had turned its app into a super-app, integrating Affirm's shopping, payment, and financial services into a single destination. See, e.g., https://investors.affirm.com/news-releases/news-release-details/affirm-launches-superapp-and-browser-extension/. In a similar vein, Peleton collaborated with Affirm to offer customers the option to rent one of its internet-connected stationary bikes instead of outright purchase. See, e.g., https://news.crunchbase.com/business/bnpl-startups-challenges-affirm-peloton-pton. In October 2021, native checkout company Bonsai and BNPL provider Afterpay announced their partnership, allowing online shoppers to choose Afterpay's BNPL whenever they make their purchases. As noted by Saad Siddiqui, co-founder and CEO at Bonsai, they aim to build "a native commerce ecosystem that brings publishers like BuzzFeed, merchants and consumers together at the right moment, and with the right payment options available to them, to make online purchasing truly seamless."

responsible borrowing likely apply beyond the Chinese setting, especially given how BNPLs around the globe show convergence to the super-app model.[40]

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[40] For one, the rising popularity of e-wallet super-apps may significantly alleviate concerns about overspending and consumer indebtedness associated with credit cards and allow BNPL providers to survive the high-interest-rate environment in many countries.

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