



Can digitalized tools help stimulate the domestic economy? Evidence from the effects of digital coupons on merchant operation[☆]



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ABSTRACT

By analyzing high-frequency data of mobile platform transactions in a large Chinese city, this paper explores the effects of digital coupons on catering and retailing businesses. The results show that digital coupons could generate positive and sustainable effects on the turnover and total sales of local catering and retailing businesses. These positive effects are found for catering and retailing businesses of all sizes, especially large merchants. In addition, while digital coupons are effective in boosting the consumption of commodities such as food and cell phones, they do not crowd out spending on other categories.

1. Introduction

In 2020, when facing the outbreak of the COVID-19 pandemic and multiple domestic and foreign challenges, Chinese President Xi Jinping stressed fostering a new development paradigm featuring “dual circulation”, with domestic circulation as the mainstay and domestic and international circulation reinforcing each other. For domestic circulation, stimulating consumption potential, creating new consumption modes, expanding consumption channels and constructing a complete consumption system are the highest priorities. To revive the service sectors that were severely affected by the pandemic, including catering, retailing, tourism and entertaining industries, various policies have been introduced to stimulate domestic demand, among which releasing shopping coupons is one of the most important measures for local governments. Shopping coupons are helpful in boosting households’ confidence and willingness to consume, in advancing the recovery of the market, in helping firms resume operation and production and in stabilizing employment.

Unlike paper coupons and cash subsidies, digital shopping coupons are dispensed through third-party digital payment platforms, such as Alipay, WeChat and Meituan, so they have low transaction costs, high efficiency, and high-level transparency. In the context of the outbreak of the COVID-19 pandemic, how effective are digital shopping coupons in helping merchants survive hard times? Answering this question will help optimize the design of digital shopping coupons, provide experience to further promote this policy tool, and determine the possibility and feasibility of this policy as a normal fiscal policy tool.

Studies on this subject have examined the consumption response to fiscal stimulus policies or temporary changes in income. More than one study has explored the effects of stimulus programs on residents’ consumption behaviors, including the 1999 Japan shopping coupon program, the 2001 and 2008 US tax rebate programs, the 2009 Taiwan shopping coupon program and the 2011 Singapore

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growth dividend program (Hsieh et al., 2010; Johnson et al., 2006; Broda and Parker, 2014; Kan et al., 2017; Agarwal and Qian, 2014). These previous studies have found that the marginal propensity to consume (MPC) is between 0.1 and 0.8, and how the stimulus was dispensed could affect the consumption structure of those who received the subsidies. Haushofer and Shapiro (2016) studied Kenya's cash subsidy program and found that monthly distributed cash allowances boosted household spending for food, while families who obtained onetime cash transfers were more likely to buy durable goods. However, studies on China's stimulus programs are scarce. In this paper, we take the digital shopping coupon program in Shaoxing, a prefecture of China's Zhejiang province with a population of 5 million, as an example to explore the effects of such a stimulus policy on reviving the business sector after the pandemic. Our paper is closely related to Lin et al. (2020), Xing et al. (2020) and Liu et al. (2021). By analyzing daily observations from 197 cities, Lin et al. (2020) found that shopping coupons facilitated consumption and that supported industries in cities where shopping coupons were issued had 26.3% more transactions than their counterparts in other cities. Liu et al. (2021) studied the digital shopping coupon program in Hangzhou and found that this stimulus program could result in an MPC ranging from 3.4 to 5.8. Unlike the shopping coupons issued in Hangzhou, those released in Shaoxing were more targeted to particular sectors and thus are more suitable for studying the effects of shopping coupons on merchants in different industries. Although Xing et al. (2020) also studied the economic effects of the Shaoxing shopping coupon program, there are some key differences from this paper. Xing et al. (2020) focused on estimating the impacts of Shaoxing shopping coupons on residents' consumption and welfare, while in this paper, we focus on investigating the effects of shopping coupons on merchant sales and expanding the research dimensions of shopping coupon policies. From the perspective of policy goals, Xing et al. (2020) aimed to determine how to boost residents' consumption and expand domestic demand with the use of shopping coupons, while in this paper, by studying the economic effects of shopping coupon programs on merchants' operations, we aim to provide evidence of how governments can help merchants survive hard times.

Another strand of the literature studies the economic impact of COVID-19 and the economic effects of governments' policy responses to the pandemic. After the outbreak of COVID-19, policies such as city lockdowns and social distancing dampened household consumption, leading to rising unemployment and the closing of a large number of small and medium-sized enterprises (Carvalho et al., 2020; Coibion et al., 2020; Dunn et al., 2020). Based on an analysis of data from surveys, Fairlie (2020) found that 22% of American enterprises closed in April 2020 compared with the number in February 2020, and 15% of those remained closed in May 2020. In China, the service sector and micro, small and medium-sized enterprises are the most impacted by the pandemic and are also the main job creators (Zhang and Yang, 2020). Chen et al. (2020) investigated the daily transaction data of 214 cities from China Unionpay and found that the daily spending of consumers dropped 32% three months after the outbreak of COVID-19. In terms of industry sectors, catering and entertaining and tourism saw the largest drops, 64% and 59%, respectively. Zhu et al. (2020) conducted two surveys with micro, small and medium-sized enterprises, finding that 85% of them could not last three months with their current cash flow and that small enterprises were most impacted by the pandemic.

Governments around the world have taken measures to deal with the impacts of the pandemic. Chetty et al. (2020) evaluated the economic effects of multiple programs aiming to mitigate the influence of the pandemic by analyzing high-frequency real-time data. It is found that orderly economic openings in different states in the U.S. has little influence on local employment; stimulus payments to low-income families (CARES Act) greatly increase their spending but have only a moderate influence on employment in the short term; and loans to small businesses (Paycheck Protection Program) play a weak role in providing jobs for micro- and small enterprises. In this paper, our findings imply that digital shopping coupons encourage residents' consumption and boost the turnover and transactions of catering and retailing merchants, and the expenditure of government financial funds could effectively stimulate individual consumer expenditure, which will help offline merchants survive hard times and realize the goals of resuming production and stabilizing employment.

We believe this paper contributes to the following aspects. First, since China is well developed with a digital economy, digital shopping coupon programs have been widely implemented in many cities. However, there is still a lack of rigorous studies on the effects of such policies. This paper adopts high-frequency transaction data to precisely evaluate the effects of digital shopping coupons, which provides evidence and policy insights into the improvement and promotion of digital shopping coupons in China. Second, although Lin et al. (2020), Liu et al. (2021) and Xing et al. (2020) have conducted studies on the effects of Chinese digital shopping coupons on household consumption, there is still no research on the effects of these coupons on merchants, which is where the biggest contribution and uniqueness of this paper lies. This paper focuses on the influence of digital shopping coupons on merchants' operations, which is a beneficial supplement to fully understanding the effects and credibility of digital shopping coupons. Third, according to the heterogeneity analysis in this paper, we found that the effects of digital shopping coupons vary with industries and the type and scale of firms, and we uncovered how the designs of such digital shopping coupons could be improved, which provides a reference for optimizing the policy tool. Fourth, through the empirical research in this paper, we confirm the value of digital shopping coupons in fiscal policies. With the accurate identification, calculation and evaluation of the real effects of digital shopping coupons, the study could provide new insights into the application of digital technology and economic policy.

2. Digital coupons issuance in China

With the successive outbreaks of COVID-19 in China and other regions around the world, the global economy has suffered from the most severe impact since the Great Recession. The epidemic in most parts of China has been generally under control since March 2020, after which regular epidemic prevention and control is adopted, and post-epidemic economic recovery and rebuilding are prioritized. Although nationwide full-scale resumption of work was realized, the resumption rate of production was not as expected, especially in the most affected service sector, including catering business, retailing business, tourism and offline education. To ensure the stability of employment and the recovery of the economy, apart from tax rebates and liquidity injection, both the central and local governments

have repeatedly introduced policies to stimulate domestic demand and boost consumption. Among these policies, issuing shopping coupons is much preferred, as it is an innovative method in post-epidemic economy rebuilding in China.

2.1. Coupon programs in China

The Nanjing municipal government announced that it would issue 318 million yuan worth shopping coupons on Alipay on March 13, 2020, becoming one of the first cities to release shopping coupons in China since 2020. Since then, shopping coupons have become popular across the country. According to the Ministry of Commerce on May 8, 2020, a total of 19 billion-yuan shopping coupons were issued in 28 provinces and 170 cities with local governments and public funding (Lin et al., 2020). Regarding channels, most of the cities employed a third-party payment platform to provide shopping coupons, whereas others adopted a combination of the online and offline modes. In terms of types, there were mainly three kinds: general digital shopping coupons (as in Hangzhou), industry-specific digital shopping coupons (as in Shaoxing) and hybrid digital shopping coupons (as in Zhengzhou). The funding sources could be classified as governmental shopping coupons (as in Hangzhou and Shaoxing) and government-enterprise shopping coupons (as in Shanghai and Beijing). This paper uses the example of shopping coupons issued in Shaoxing, which were funded by the government mainly to target specific industries and dispensed through the Alipay platform, to evaluate how effective the program was in benefiting merchants.

2.2. The coupon program in Shaoxing

On March 2, 2020, Shaoxing lowered the emergency response to the COVID-19 epidemic from the top level to the second level and further lowered it to the third level on March 23. For the sake of promoting economic recovery and boosting offline consumption, the Shaoxing municipal government, together with Alipay, released 180 million yuan worth of coupons to the public in 6 waves. Among them, 27.5 million yuan (500 yuan per citizen) was given to the low-income groups, and 152.5 million yuan was provided in digital coupons, covering the catering, lodging, shopping, fitness, book and information (cell phone) industries. All these coupons had to be used within Shaoxing, and every one of them was valid for 7 days.¹

The redemption rate, the proportion of coupons used by the coupon holders within the validity period, is an important indicator to estimate the effect of coupons. As depicted in Fig. 1, the redemption rate of the Shaoxing Shopping coupon program increased in each wave. The redemption rate was only 38% for the first release, then it immediately rose to 60% during the second wave and eventually reached 70% in the sixth wave. For different industries, even though the redemption rates for all six industries show an upward trend, they are evidently different by industry. As shown in Fig. 2, after the first release of shopping coupons on April 3, the redemption rates of shopping and catering were the highest, 71% and 42%, respectively, followed by coupons for cell phones in the information industry, while those for books, lodging and fitness had low redemption rates. Until the last wave of shopping coupons on May 8, the redemption rates of coupons for shopping and catering were still the highest, rising to 90% and 81%, respectively, and those of coupons for cell phones jumped to 53%, while those of books, fitness and lodging were no more than 30% with slight growth. As a glance, digital shopping coupons in Shaoxing mainly helped service industries such as catering and retailing.

3. The empirical strategy and data

3.1. The empirical strategy

Bailing merchants, especially those offline small- and medium-sized service sectors, out of economic slump is an important goal of the Shaoxing digital coupon program. This paper takes catering and retailing as the targeted industries to explore the effects of digital shopping coupons on the business conditions of merchants in these two industries. Consumers who shop offline can be divided into two groups, those who attempted to claim coupons and those who never attempted to do so, while the former can be further divided into three groups: those who obtained and used coupons, those who acquired but did not use coupons and those who failed to obtain any coupons.² Consumers who attempt to claim coupons are comparable, as they share similar offline shopping intentions and digital payment habits. Therefore, it is reasonable to take consumers who attempted to claim coupons but failed as the control group for comparison to those who attempted to claim and successfully acquired coupons. Therefore, we constructed two estimation equations:

$$Y_{it} = \alpha + \beta_1 T_{it} + \beta_2 C_{it} + \theta_i + \omega_t + \varepsilon_{it} \tag{1}$$

$$Y_{it} = \alpha + \gamma_1 V_{it} + \gamma_2 T_{-}V_{it} + \gamma_3 C_{it} + \theta_i + \omega_t + \varepsilon_{it} \tag{2}$$

The dependent variable Y_{it} includes weekly turnover, net turnover (turnover minus the portion paid by the coupon) and weekly transactions (the number of transactions completed). The subscript i represents merchant identity, and t denotes the week. T_{it} denotes the proportion of coupon holders among all the customers shopping in merchant i during week t . C_{it} indicates the proportion of non-coupon holders who participated in the coupon program among all customers who shopped in merchant i in week t . Furthermore,

¹ For more details about the Shaoxing's coupon program, please refer to Xing et al. (2020).

² For each round of coupon program, the Alipay platform only provided a limited number of coupons based on a first-come, first-served basis. Those who wanted to participate in the coupon program need to log onto the Alipay portal, leaving the digital footprint of vouchers, whether they got the coupon or not.

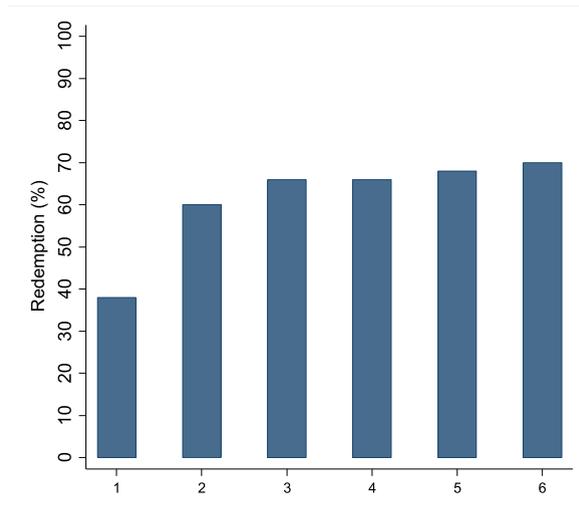


Fig. 1. Redemption rates of shopping coupons by different waves.

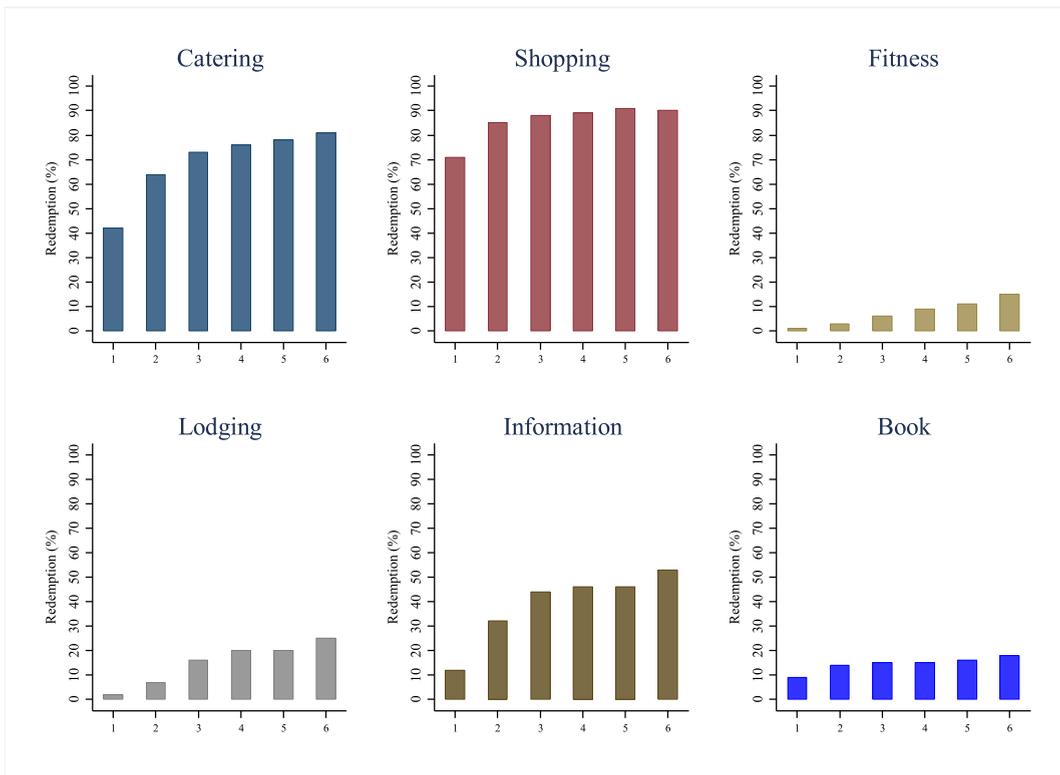


Fig. 2. Redemption rates of shopping coupons for different sectors.

the proportion of coupon holders T_{it} can be decomposed into V_{it} and $T - V_{it}$, with the former representing the proportion of coupon users (the coupon holders who chose to redeem the coupon) among all consumers shopping in the vendor during the week and the latter representing the proportion of coupon holders who did not use coupons among all the consumers shopping in merchant i during the week. For better understanding, we take weekly turnover as Y_{it} as an example. When the group of consumers who did not attempt to claim coupons is taken as the reference, then α , the constant term, represents the effect of an increase in the proportion of this group of consumers on a merchant's weekly turnover. β_1 and β_2 represent the increased weekly turnover from the increase in the number of consumers who successfully acquired coupons and those who attempted to claim coupons but did not win any coupons, respectively, relative to those who did not participate in the coupon rush. Therefore, $\beta_1 - \beta_2$ indicates the impacts of the shopping coupon policy on

merchants' revenue. In equation (2), γ_1 , γ_2 and γ_3 represent the increased weekly turnover from an increase in the number of coupon users, those who won coupons but did not use them, and those who participated but did not win any coupon, respectively, relative to those who did not attempt to claim coupons. Moreover, θ_i refers to merchant fixed effects that control for time-invariant factors of merchants, such as their location, establishment time, and size, while ω_t refers to week fixed effects, controlling for external factors changing over time within the 6 weeks that apply to all merchants, such as the local epidemic situations and social distancing measures.

3.2. Data

This paper follows the logic of “digital shopping coupons-consumers-merchants” to investigate the effects of issuing digital coupons on merchants. The data used here are from Alipay, one of the largest payment platforms in China.

Because of the epidemic, some merchants in our sample had no sales and were inactive during the implementation of the digital coupon program. For this paper, we selected merchants with at least one transaction per month during April and May 2020³ as the research sample to estimate the effects of coupons on merchants' performance. After a preliminary analysis of the sector pattern of the merchants registered with Alipay and actual redemption rates of coupons among different sectors, we chose catering and retailing as the two focal industries in our study. Specifically, we focused on these two sectors for the following three reasons: first, catering and retailing industries are closely related to households' everyday consumption and local employment, and they are also the sectors that are most severely affected by the epidemic; second, the merchants in these two sectors account for 95% of all merchants in the six sectors that are targeted by the coupon program, with merchants in catering 44% and in retailing 51%; third, food coupons and shopping coupons (mainly used in retailing) have the highest redemption rates, and cell phone sellers also belong to the retailing sector.

For this paper, we adopted deidentified merchant-level transaction data of the catering and retailing sectors from Alipay, including data from 196,109 retailers and 169,914 catering merchants. We aggregated the number of transactions of each merchant to the week level from April 3 to May 14, 2020, and obtained balanced panel data at the merchant level for six weeks. In addition to weekly turnover, weekly net turnover (turnover minus the portion paid by the coupon) and weekly number of transactions, we constructed four consumer-related indicators according to consumer information of each vendor. These four indicators are proportions of weekly coupon users to all consumers, coupon holders who did not redeem coupons to total consumers, consumers who participated but did not win coupons to total consumers, and consumers who did not attempt to claim coupons to total consumers. All data were organized by week. Table 1 presents the summary statistics of merchant-week-level related variables.

Merchants of catering and retailing were seriously hit by the epidemic. As shown in Fig. 3 (a), from January 17 to February 20, the number of consumers eating out was drastically reduced due to the social distancing restriction imposed by epidemic control (Xu et al., 2020). The number of Shaoxing's catering merchants who stayed active was obviously smaller than that before 2020. No more than 50 thousand were in operation every week, although the number increased afterward. From April 3 to May 14, the number of active merchants significantly increased to the same level as that one week before the outbreak of COVID-19 in Shaoxing (70 thousand) but was still lower than that of the beginning of 2020 (beyond 80 thousand). The number of retailers witnessed a similar trend during the same period.

Note: all merchants selected were in operation from January to September 2019. To avoid the influence of the epidemic on calculating one merchant's revenue size, this paper calculated the average weekly turnover from January to September 2019 for the selected merchant as a measure of merchant size to calculate the average size of merchants that operated each week from September 27, 2019, to May 21, 2020.

Thanks to digital coupons, small and micro catering and retailing merchants were increasingly active. Fig. 3 (b) presents the average weekly size of catering and retailing merchants from September 27, 2019, to May 21, 2020. From January 17 to April 2, 2020, the average weekly size of catering merchants was evidently more than that of the beginning of 2020 and that before 2020, which suggests that merchants that opened during this period were more likely to be large scale, while a large number of small merchants might have been closed or even exited the market. However, from April 3 to May 14, when the six waves of coupons were released, the average size of active merchants obviously decreased to a level similar to that of the beginning of and before 2020, while the number of active merchants increased (seen in Fig. 3(a)), which indicates that more small and micro merchants resumed business and production, which potentially benefited from the coupon policy, pulling down the average scale. Similar to the catering industry, digital coupons also facilitated an increasing number of small and micro retailers to resume business. The above are only visualized evidence of the impacts of shopping coupons, but to what extent do they help merchants? More rigorous quantitative evaluation is needed.

4. Empirical analysis of effects of digital coupons on merchants

By tracing the digital footprint of issuing, claiming and using shopping coupons, we can associate consumers with merchants to estimate the effects of digital coupons on merchants' business.

³ The merchant with at least one transaction per month during April and May 2020 does not mean that it could not get zero transaction in certain week during the period.

Table 1
Summary statistics of merchants in week (April 3–May 14, 2020).

Variables	Observations	Mean	SD	Min	Max
Retailing					
Revenue	1,176,654	3596.352	40684.690	0	1.28e+09
Revenue _{oop} ^a	1,176,654	3561.426	40544.650	0	1.28e+09
Transaction	1,176,654	19.164	242.961	0	129000
V	1,176,654	0.018	0.113	0	1
T_V	1,176,654	0.044	0.158	0	1
T	1,176,654	0.063	0.192	0	1
C	1,176,654	0.016	0.090	0	1
Catering					
Revenue	1,019,484	1946.988	50930.660	0	1.63e+09
Revenue _{oop}	1,019,484	1898.498	49251.860	0	1.63e+09
Transaction	1,019,484	18.798	1192.961	0	473997
V	1,019,484	0.017	0.109	0	1
T_V	1,019,484	0.044	0.155	0	1
T	1,019,484	0.060	0.193	0	1
C	1,019,484	0.015	0.089	0	1

^a Revenue_{oop} is the total revenue minus the portion paid by the coupon.

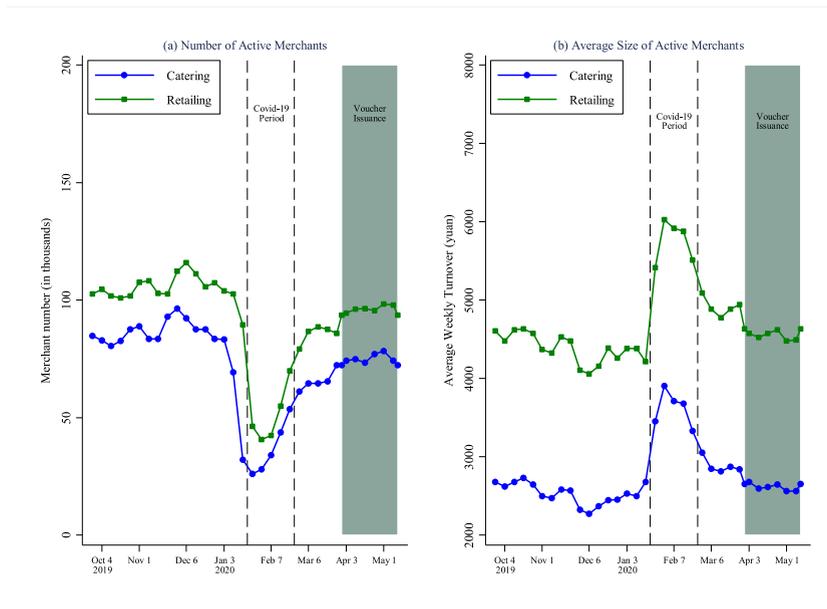


Fig. 3. The number of operating merchants and the average merchant size (September 27, 2019–May 21, 2020).

4.1. Basic results

4.1.1. Turnover

Turnover is the most direct indicator to measure a merchant's daily operation. Table 2 shows the impacts of digital shopping coupons on catering and retailing. Columns (1)–(3) in Panel A of Table 2 report the effects of digital coupons on catering merchants' turnover. Column (1) controls merchant and week fixed effects. The coefficient *T* is significantly positive at the 1% level, which indicates that consumers with coupons spend more than those without coupons and contribute more to catering merchants' turnover. As consumers who attempt to claim coupons are more willing to spend, those who win coupons and those who attempt but do not win any coupons are more comparable in terms of consumption levels (Xing et al., 2020). If the consumers who attempted but failed to claim coupons are considered the control group and the consumers who won coupons are taken as the treatment group, the difference between the coefficients of proportions of the treatment group and the control group is the newly added turnover to merchants from the usage of coupons. Column (2) is the estimated result based on equation (1), which shows that both coupon holders and consumers who attempted but failed to claim coupons spend more than those who did not attempt to claim coupons. Compared with consumers who did not attempt to claim coupons, if the proportion of those with coupons and those who attempted but failed to claim coupons increases by 1%, the turnover of catering merchants will increase by 18.14 yuan and 14.36 yuan, respectively. This suggests that the coupon policy boosts

Table 2
The impact of digital shopping coupons on merchants' turnover.

	(1)	(2)	(3)	(4)	(5)
	revenue	revenue	revenue	revenue_oop	revenue_oop
Panel A: catering merchants					
T	1777.606*** (74.427)	1813.695*** (74.534)		1609.834*** (71.255)	1645.833*** (71.386)
V			3225.699*** (295.899)		
T_V			1537.731*** (77.359)		
C		1436.336*** (103.760)	1432.869*** (103.787)		1432.731*** (103.626)
_cons	1839.901*** (4.484)	1816.316*** (4.843)	1804.989*** (5.762)	1801.518*** (4.293)	1777.986*** (4.677)
N	1,019,484	1,019,484	1,019,484	1,019,484	1,019,484
R ²	0.940	0.940	0.940	0.938	0.938
Panel B: retailers					
T	2354.874*** (77.080)	2397.946*** (77.137)		2172.620*** (74.684)	2215.636*** (74.741)
V			5850.700*** (240.383)		
T_V			1606.627*** (74.273)		
C		1675.168*** (105.534)	1665.168*** (105.528)		1673.039*** (105.401)
_cons	3447.573*** (4.870)	3417.239*** (5.242)	3389.298*** (5.960)	3424.162*** (4.718)	3393.867*** (5.100)
N	1,176,654	1,176,654	1,176,654	1,176,654	1,176,654
R ²	0.754	0.754	0.754	0.753	0.753
Firm FE	Y	Y	Y	Y	Y
Week FE	Y	Y	Y	Y	Y

Note: Standard errors are clustered at the merchant level and reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

merchants' turnover by stimulating consumption – if the proportion of consumers with coupons increases by 1%, the average weekly turnover of catering merchants will rise by 3.78 yuan (18.14–14.36).

Consumers with coupons could be further divided into two groups: those who redeemed coupons at the merchant and those who did not use coupons there. Column (3) in Panel A of Table 2 is the estimated result based on equation (2), showing that the increase in the proportions of all groups of consumers significantly (at the statistical level of 1%) advances the turnover of catering merchants, but with different magnitudes. Specifically, if the proportion of consumers who did not attempt to claim coupons increases by 1%, the turnover of catering merchants will rise by 18.05 yuan; if that of consumers who participated but did not win coupons and those who won but did not redeem coupons increase by 1%, the turnover of catering merchants will increase by 32.38 yuan and 33.43 yuan, respectively; and if the fraction of coupon users rises by 1%, the turnover of catering merchants will increase by 50.31 yuan. Columns (2) and (3) in Panel A of Table 2 illustrate that only when shopping coupons are redeemed can the turnover of catering merchants be notably increased.

Part of merchants' increased turnover is from the subsidized amount of the coupons, which is paid by the government. We can determine the net effect of the shopping coupon policy on merchants' turnover by excluding the subsidized value from the turnover. As shown in column (4) of Table 2-Panel A, removing the coupon-subsidized amount, coupon holders still spent more than those who did not even attempt to claim coupons. Column (5) in Table 2-Panel A shows that compared with consumers who did not attempt to claim coupons, a 1% increase in the proportion of those with coupons and those who participated but did not win coupons will bring 16.64 yuan and 14.33 yuan more to catering merchants' turnover, respectively. The difference between 16.64 yuan and 14.33 yuan, 2.13 yuan, is the increased net turnover of catering merchants stimulated by shopping coupons. This suggests that thanks to the shopping coupon policy, when the proportion of coupon holders increases by 1%, the catering merchants' turnover will increase by 3.78 yuan, 56.3% of which is from out-of-pocket spending from consumers (2.13 yuan), and 43.7% is from the subsidized amount from coupons (1.65 yuan).

Columns (1)–(3) in Table 2-Panel B show the effects of digital shopping coupons on retailers' turnover. Column (1) illustrates that compared with non-coupon holders, a 1% increase in the proportion of coupon holders will increase retailers' turnover by 23.55 yuan, which is definitely more than that to catering merchants. Column (2) shows that compared with consumers who did not attempt to claim coupons, a 1% increase in the proportion of coupon users and coupon holders who do not redeem coupons will bring 23.98 yuan and 16.75 yuan more to retailers' turnover, respectively. This means that if the proportion of coupon holders increases by 1% driven, retailers' turnover will increase by 7.23 yuan (23.98–16.75).

Column (3) in Table 2-Panel B demonstrates that the proportions of all groups of consumers significantly (at the 1% level) advance the turnover of retailers, but with different magnitudes. If the proportion of consumers who did not attempt to claim coupons increases by 1%, retailers receive 33.89 yuan more in their turnover. If the proportion of consumers who did not win coupons and that of coupon holders who did not redeem coupons increase by 1%, retailers' turnover will increase by 50.54 yuan and 49.96 yuan, respectively. If the proportion of coupon users increases by 1%, retailers' turnover will increase the most to 92.4 yuan. This further emphasizes the importance of the redemption of shopping coupons.

As seen in column (4) of Table 2-Panel B, coupon holders spent more than non-coupon holders in retailing. Noncoupon holders can be divided into two groups: consumers who did not attempt to claim coupons and those who participated but did not win coupons. Column (5) in Table 2-Panel B shows that compared with consumers who did not attempt to claim coupons, if the fraction of coupon holders and those who did not win coupons increase by 1%, retailers' net turnover will increase by 22.16 yuan and 16.73 yuan, respectively. The difference between them is 5.43 yuan, which is the retailers' newly added net turnover brought by the use of coupons. With the results in column (2) of Table 2-Panel B, if the proportion of coupon holders increases by 1%, retailers' turnover will be boosted by 7.23 yuan (23.98–16.75), 75.1% of which is paid by the out-of-pocket spending of consumers (5.43 yuan) and 24.9% is from the

subsidized amount of coupons (1.80 yuan).

4.1.2. Transactions

In addition to turnover, the number of transactions is another important indicator of merchants' operations. A larger number of transactions means that more consumers visit the merchant, which also suggests that the merchant is in better operation and more active in the market. Table 3 demonstrates the influence of digital coupons on catering and retailing merchants' transactions.

As shown in column (1) of Table 3, the coefficient of T is significant at the statistical level of 1%, which means that coupon holders make more transactions than non-coupon holders in catering. Consumers who did not win coupons are taken as the control group, while those who succeeded in claiming coupons are considered the treatment group. Column (2) is the estimated result based on equation (1), showing that if the proportion of coupon holders and non-coupon holders increases by 1%, there will be 0.237 and 0.203 more transactions in catering merchants, respectively. The difference between them is 0.034 transactions, which are newly added transactions brought by coupons. This means that shopping coupons stimulated coupon holders to make 16.7% (0.034/0.203) more transactions every week in catering merchants. Column (3) is the estimated result based on equation (2), illustrating that compared with consumers who did not attempt to claim coupons, if the fraction of those who participated but did not win coupons and coupon holders who do not redeem coupons rise by 1%, there will be 0.018 and 0.024 more transactions in catering merchants, respectively. If the proportion of coupon users increases by 1%, there will be 0.195 more transactions in catering merchants. This suggests that the increase in transactions driven by coupons lies in the fact that coupons greatly stimulate coupon users to make more transactions.

Columns (4)–(6) in Table 3 show the effects of digital coupons on the volume of transactions of retailers. As seen in column (4), coupon holders make more transactions than non-coupon holders in retailers. Column (5) illustrates that if the proportion of coupon holders and those who did not win coupons increase by 1%, 0.236 and 0.197 more transactions will be made in retailers, respectively, whose difference is 0.039 transactions. This means that coupons stimulated coupon holders to increase their transactions in offline retailers by 19.8% (0.039/0.197) every week. Based on column (5), column (6) further divides coupon holders, showing that in comparison with consumers who did not attempt to claim coupons, a 1% increase in the proportion of consumers who did not win coupons and those who succeeded in doing so but did not redeem coupons will lead to 0.009 and 0.017 more transactions in retailers, respectively. A 1% increase in the proportion of coupon users will result in 0.184 more transactions, much more than the other groups. This further demonstrates that attracting more coupon holders to redeem coupons in merchants will greatly help merchants go through hard times.

4.2. Robustness testing

In this paper, consumers who did not win coupons are taken as the control group, while those who succeeded in claiming coupons are taken as the treatment group. The effect of coupons is based on the difference between the two groups, without taking into account the possible spillover effect of coupons on the former group, so the actual effect of coupons could be underestimated. As Angelucci and De Giorgi (2009) found when they were exploring the effects of a cash transfer program in Mexico, since the program also affected the consumption of those who were ineligible for cash subsidies, examining only the effect on the treatment group would underestimate the impact of the program. Although consumers who did not win coupons did not enjoy discounts of coupons, they were still encouraged to shop offline, as the coupon policy released a positive sign for the recovery of offline shopping. However, we did not take this into account when evaluating the economic effects of digital coupons. In this sense, the real effects of coupons are larger than what we estimated.

In this paper, merchant and week fixed effects are controlled in the regressions, alleviating endogeneity to a large extent. The only omitted variable relates to the unobservable factors that change with both merchants and time, which mainly refers to promotions by merchants during the implementation period of the coupon program. In this paper, after controlling for merchant and week fixed effects, we compare the different effects of coupon holders (the treatment group) and non-coupon holders (the control group) on weekly turnover and transactions, respectively. If promotions by merchants are equal to the two groups, our results remain robust. However, when merchants offer different and unobserved promotions to coupon holders and non-coupon holders, for example, more discounts for

Table 3
The impact of digital shopping coupons on transactions.

	Catering merchants			Retailers		
	(1)	(2)	(3)	(4)	(5)	(6)
	transaction	transaction	transaction	transaction	transaction	transaction
T	5.174*** (0.381)	5.220*** (0.382)		4.759*** (0.205)	4.783*** (0.205)	
V			19.497*** (2.196)			18.356*** (0.886)
T_V			2.430*** (0.221)			1.673*** (0.113)
C		1.840*** (0.220)	1.805*** (0.220)		0.946* (0.522)	0.907* (0.522)
_cons	18.486*** (0.023)	18.456*** (0.024)	18.341*** (0.037)	18.863*** (0.013)	18.846*** (0.016)	18.736*** (0.020)
Firm FE	Y	Y	Y	Y	Y	Y
Week FE	Y	Y	Y	Y	Y	Y
N	1,019,484	1,019,484	1,019,484	1,176,654	1,176,654	1,176,654
R ²	0.996	0.996	0.996	0.682	0.682	0.682

Note: Standard errors are clustered at the merchant level and reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

coupon holders, our empirical results would be overestimated. However, in reality, most merchants are unlikely to offer such differentiated promotions. Therefore, the conclusions in this paper are less affected by factors such as promotions.

Catering and retailing are two basic service sectors, where there are a large number of small and micro merchants and individual merchants. For these merchants, Alipay is not necessarily their only platform to receive money, but Shaoxing digital coupons could be redeemed only through Alipay, which could induce coupon holders to turn to Alipay for payment. Although consumers tend to use the payment platform they are used to, we cannot rule out the possibility that some of them turn to Alipay only to redeem shopping coupons, which may overestimate the real stimulating effects of coupons. To exclude the influence of this confounding factor, we sorted catering and retailing merchants according to their turnover in 2019 and selected active merchants whose turnover accounted for 90% of the total to be included in the main analysis. Compared with the rest of the merchants, who are mostly micro merchants, these active merchants take Alipay as their main platform to receive money, and their customers' payment with Alipay is sustainable, which better reflects the real effects of coupons.

Table 4 illustrates the results of robustness testing on the effects of digital coupons on catering and retailing merchants' turnover and transactions. For catering merchants, the number of merchants selected here accounts for only 11% of that selected for the baseline results, which reflects that the size of catering merchants is in fat-tailed distribution. Columns (1) and (2) indicate that the coefficient of T is significantly different from 0 at the 5% statistical level and is larger than the coefficient of C in magnitude, which suggests that digital coupons boost the turnover and transactions of catering merchants. Similarly, the number of retailers selected here takes up only 13% of that selected for the baseline results, showing that the size of retailers is also remarkably in fat-tailed distribution. Columns (3) and (4) show that the coefficient of T is significantly larger than 0 at the 5% statistical level and is larger than the coefficient of C in magnitude, which means that digital coupons promote the turnover and transactions of retailers. The above results are based on data of active merchants at Alipay, which is consistent with the baseline results, indicating that payment channels do not actually interfere with the real effects of digital coupons.

4.3. Sustainable effects

The above results indicate that digital coupons stimulate residents' consumption and facilitate catering and retailing merchants' operations by increasing their turnover and transactions. Is this stimulating effect sustainable? We take 3 weeks as an observation period to explore whether the current-period coupon holders will continue to increase consumption to promote catering and retailing merchants' operations. Since Shaoxing issued six waves of shopping coupons, many consumers claimed coupons more than once. To evaluate the sustainability of the effects of digital coupons on merchants, it is necessary to control the sum of proportions of coupon holders and the sum of proportions of non-coupon holders in the next two weeks. Specifically, our equation is:

$$Y_{it}^{3w} = \alpha + \beta_1 T_{it} + \beta_2 C_{it} + \beta_3 T^{2w_ctrl}_{it} + \beta_4 C^{2w_ctrl}_{it} + \theta_i + \omega_t + \varepsilon_{it} \tag{3}$$

Y_{it}^{3w} is the merchant's total turnover (or transactions) in the current week and the next two weeks. $T^{2w_ctrl}_{it}$ is the sum of the proportions of coupon holders to the merchant in the next two weeks. $C^{2w_ctrl}_{it}$ is the sum of the proportions of non-coupon holders to the merchant in the next two weeks. The rest of the variables share the same meaning as equation (1).

Table 5 presents the regression results of the longer-term effects of shopping coupons on catering and retailing merchants' turnover and transactions. As shown in column (1) of Table 5-Panel A, compared with non-coupon holders, a 1% increase in the proportion of current-period coupon holders will bring 20.91 yuan more to catering merchants' turnover within the three-week period. Noncoupon holders are taken as the control group, and coupon holders are taken as the treatment group. Column (2) of Table 5-Panel A controls the sum of proportions of current-period non-coupon holders and non-coupon holders in the next two weeks. The difference between coefficients of T and C is the newly added turnover of catering merchants during the three-week period boosted by shopping coupons, which is 424, while that in column (2) of Table 2-Panel A is 377, and the former is only 112.5% of the latter. This suggests that digital coupons are effective in catering merchants' turnover in the short run, but the effect is not that sustainable.

The effects of digital coupons are effective in catering merchants' volume of transactions to some extent. The sum of the volume of

Table 4
Robustness checks on the effects of digital coupons on catering and retailing merchants' revenue and transactions.

	Catering merchants		retailers	
	(1)	(2)	(3)	(4)
	revenue	transaction	revenue	transaction
T	3433.567*** (947.791)	17.583** (8.813)	1288.214*** (684.794)	6.493** (3.066)
C	-11.790 (572.062)	2.667*** (7.879)	-655.742 (711.106)	-16.928 (13.266)
_cons	7419.958*** (99.322)	138.985*** (1.013)	12989.790*** (78.514)	117.400*** (0.535)
Firm FE	Y	Y	Y	Y
Week FE	Y	Y	Y	Y
N	112,416	112,416	158,238	158,238
R ²	0.958	0.996	0.827	0.680

Note: Standard errors are clustered at the merchant level and reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 5
The 3-week effects of digital shopping coupons on catering and retailing merchants' turnover and transactions.

	(1) revenue ^{3w}	(2) revenue ^{3w}	(3) transaction ^{3w}	(4) transaction ^{3w}
Panel A : catering merchants				
T	2090.577*** (108.312)	2159.935*** (110.040)	8.916*** (0.748)	9.094*** (0.756)
T ^{2w_ctrl}	1608.515*** (106.400)	1554.007*** (117.905)	5.569*** (0.747)	6.228*** (0.806)
C		1735.551*** (208.297)		3.393*** (0.327)
C ^{2w_ctrl}		270.228*** (91.714)		-0.921*** (0.298)
_cons	5497.025*** (20.022)	5447.088*** (21.777)	55.023*** (0.147)	54.952*** (0.146)
N	679,656	679,656	169,914	169,914
R ²	0.986	0.986	0.0005	0.0005
Panel B : retailers				
T	3205.727*** (153.806)	3263.586*** (156.011)	8.412*** (0.521)	8.454*** (0.537)
T ^{2w_ctrl}	2504.506*** (136.532)	2362.268*** (138.555)	6.075*** (0.393)	6.205*** (0.361)
C		1888.375*** (176.340)		0.817*** (1.715)
C ^{2w_ctrl}		388.686*** (109.837)		-0.174 (0.480)
_cons	10193.100*** (31.435)	10133.180*** (33.380)	55.741*** (0.095)	55.723*** (0.128)
N	679,656	679,656	784,436	784,436
R ²	0.986	0.986	0.898	0.898
Firm FE	Y	Y	Y	Y
Week FE	Y	Y	Y	Y

Note: Standard errors are clustered at the merchant level and reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

transactions of the current week and the next two weeks is taken as the dependent variable. As shown in column (3) of Table 5-Panel A, compared with non-coupon holders, a 1% increase in the fraction of current-period coupon holders will add 0.089 transactions to catering merchants within the three-week period. Column (4) in Table 5-Panel A controls the sum of the proportions of current-period non-coupon holders and non-coupon holders of the next two weeks. The difference between coefficients of T and C is 5.701, while that in column (2) of Table 3 is 3.380, and the former is 168.7% of the latter. Thus, digital coupons not only brought more consumers to the catering merchants, but this effect remained in the subsequent two weeks. This indicates that digital coupons boost consumers' confidence in offline catering consumption and strengthen their habits of offline shopping.

Columns (1) and (2) in Table 5-Panel B are the regression results of the sustainability of the effects of digital coupons on retailers' turnover. As seen in column (1) of Table 5-Panel B, compared with non-coupon holders, a 1% increase in the proportion of current-period coupon holders will add 32.06 yuan to retailers' turnover within the three-week period. Column (2) in Table 5-Panel B shows that a 1% increase in the proportion of coupon holders will bring 13.76 yuan to retailers' newly added turnover within the three-week period, while that in column (2) of Table 2-Panel B is 7.23 yuan, and the former is 190.3% of the latter. This means that digital shopping coupons are effective for retailers' turnover not only in the short run but also in the following two weeks.

After controlling the proportion of coupon holders in the next two weeks, column (3) of Table 5-Panel B shows that, compared with non-coupon holders, a 1% increase in the proportion of coupon holders will attract 0.084 more transactions to retailers' volume of transactions within the three-week period. As presented in column (4) of Table 5-Panel B, if the proportion of coupon holders increased by 1% due to digital coupons, retailers will have 0.076 more transactions, while the estimated effect in column (5) of Table 3 is 0.038 transactions, and the former is 200% of the latter. This illustrates that digital coupons are effective in attracting consumers to retailers not only in the current period but also in the next two weeks.

Table 6
The effects of digital coupons on different sized catering and retailing merchants' revenue and transactions.

	catering merchants			retailers		
	(1) small	(2) medium	(3) large	(4) small	(5) medium	(6) large
Panel A: revenue						
T	4.097*** (0.428)	4.675*** (0.188)	6.32*** (1.14)	4.211*** (0.272)	4.33*** (0.24)	4.575*** (0.489)
C	1.821*** (0.08)	1.737*** (0.096)	1.681** (0.712)	1.63*** (0.102)	1.626*** (0.094)	-0.934 (1.655)
Difference	2.276	2.938	4.639	2.581	2.704	4.575 ^a
Panel B: transaction						
T	4.097*** (0.428)	4.675*** (0.188)	6.32*** (1.14)	4.211*** (0.272)	4.33*** (0.24)	4.575*** (0.489)
C	1.821*** (0.08)	1.737*** (0.096)	1.681** (0.712)	1.63*** (0.102)	1.626*** (0.094)	-0.934 (1.655)
Difference	2.276	2.938	4.639	2.581	2.704	4.575 ^a

Note : All the regressions control for vendor fixed effects and week fixed effects. Standard errors are clustered at the merchant level and reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. ^a indicates the C coefficient is not significant, and Difference is defined as the difference between the T and the C coefficient.

Table 7

The effects of digital coupons on the revenue and transactions of merchants in different retail segments.

	(1)	(2)	(3)	(4)	(5)	(6)
	revenue	revenue	revenue	revenue	revenue	revenue
T	1465.4*** (286.5)	2117.5*** (182.7)	1435.8*** (99.1)	1561.9*** (224.9)	7626.3*** (333.8)	2074.6*** (168.7)
C	1888.6*** (372.9)	1007.0*** (270.3)	1508.8*** (157.5)	1638.3*** (395.0)	2181.0*** (451.4)	2183.0*** (217.8)
Difference	−423.2	1110.5	−73	−76.4	5445.3	−108.4
N	132,972	201,738	476,736	44,550	87,024	223,590
transaction		transaction	transaction	transaction	transaction	transaction
T	7.796*** (1.003)	12.915*** (1.175)	2.750*** (0.108)	2.454*** (0.310)	4.828*** (0.395)	2.047*** (0.130)
C	2.193*** (0.409)	−1.304 (0.749)	1.195*** (0.078)	1.436*** (0.489)	1.241*** (0.223)	1.200*** (0.071)
Difference	5.603	12.915 ^a	1.555	1.018	3.587	0.847
N	132,972	201,738	476,736	44,550	87,024	223,590

Note: All the regressions control for vendor fixed effects and week fixed effects. Standard errors are clustered at the merchant level and reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. ^a indicates the C coefficient is not significant, and Difference is defined as the difference between the T and the C coefficient. The dependent variables of columns (1) to (6) are comprehensive retailing; specialized retailing of food, beverage and tobacco products; specialized retailing of textile, clothing and daily necessities; specialized retailing of cultural and sports equipment; specialized retailing of household appliances and electronic products; and specialized retailing of hardware, furniture and indoor decoration materials.

4.4. Heterogeneity analysis

4.4.1. Merchant heterogeneity

Digital coupons, on the whole, improve catering and retailing merchants' turnover and volume of transactions, but whether it is also effective to all merchants needs further evaluation. This paper takes into account the heterogeneous effects of digital coupons on merchants of different sizes. Specifically, we equally sorted merchants into three groups—small, medium, and large—according to their total turnover in 2019.

We take consumers who did win any coupons as the control group and coupon holders as the treatment group, and the difference between the coefficients of the two groups is the effect of digital coupons. In this paper, we explore the effects of digital coupons on the turnover and transactions of merchants of different sizes. Table 6 shows that in terms of turnover, digital coupons significantly advance the turnover of all catering and retailing merchants, among which shopping coupons are similarly effective for small and medium-sized merchants but much more effective for large merchants. Regarding the volume of transactions, digital coupons notably boost the volume of transactions of all catering and retailing merchants, and the tool becomes more effective as the merchant size increases. Therefore, to make better use of digital coupons in helping small and micro merchants, a more precise arrangement of shopping coupons must be made.

4.4.2. Sector heterogeneity

As retailing is a comprehensive industry, the shopping coupons, book coupons and information coupons issued in Shaoxing are all related to this sector. To evaluate how effective these coupons are to merchants of a particular industry, we need to divide retailing into subsectors. According to the statistical yearbook of Zhejiang in 2020 and based on merchants' data from Alipay, we divide retailing into 7 subsectors, including comprehensive retailing; specialized retailing of food, beverage and tobacco products; specialized retailing of textile, clothing and daily necessities; specialized retailing of cultural and sports equipment; specialized retailing of household appliances and electronic products; and specialized retailing of hardware, furniture and indoor decoration materials. Hence, we study the effects of digital coupons on the turnover and transactions of the first six subsectors of retailing. The results are reported in Table 7.

Digital coupons are significantly effective in improving the turnover and transactions of specialized retailing of food, beverage and tobacco products and that of household appliances and electronic products, with the latter benefiting much more. For the former, food, beverage and tobacco products are daily necessities, so consumers are mostly interested in buying these products with coupons, leaving digital shopping coupons outstandingly effective to the turnover and transactions of this subsector. In regard to the latter, coupons for cell phones have the largest subsidy amount (spending 2,000 yuan, getting 200 yuan off), encouraging coupon holders to be most willing to redeem these coupons, which significantly increases the turnover and transactions of this sector (Table 7). It is worth noting that although digital coupons are not that effective for the other 4 subsectors of retailing, they still bring more consumers and transactions to those merchants. This indicates that digital coupons encourage customers to shop offline. While transactions of food and cell phones increase due to coupons, purchases of other retailing commodities are not crowded out but instead increase.

5. Conclusions and policy recommendation

The digital coupon program is an innovative policy exploration for post-epidemic economic construction based on China's development of the digital economy and mobile payment. However, there is still a lack of empirical research on the effectiveness of digital coupons, especially quantitative research on the effects of coupons in helping merchants. Therefore, this paper takes the digital coupons jointly issued by the Shaoxing government and dispensed on Alipay as an example to explore the effects of digital coupons on merchants' operations using big data of consumers and merchants. The following five conclusions are obtained.

First, digital coupons significantly promote catering (retailing) merchants' turnover; 56.3% (75.1%) of the newly added turnover is out-of-pocket spending by consumers. Second, digital coupons encourage consumers to shop offline, and coupon holders help catering and retailing merchants increase their transactions by 16.7% and 19.8%, respectively. Third, the effects of digital coupons on catering and retailing merchants are sustainable. Fourth, digital coupons alleviate the impact of the epidemic and boost the turnover and transactions of catering (retailing) merchants of all sizes, with large merchants benefiting the most. Fifth, in terms of the subsectors of retailing, although turnover of food and cell phones increases due to coupons, purchases of other retailing commodities do not decrease, which means that there is no crowding-out effect.

Three suggestions are proposed in this paper to optimize the design and implementation of digital coupons to further improve their role in facilitating consumption, helping merchants through hard times and stimulating the domestic economy. First, a "general + sector-specific" mode of coupons should be adopted to provide targeted support to specific sectors and make better use of governmental funds. Second, for "sector-specific" coupons, their expiration period should be appropriately extended, and they should be directed to specific groups to increase redemption rates. Third, reasonable thresholds and rules should be set to direct more coupons to be redeemed at small and micro merchants, for example, to lower the minimum purchase requirement for redeeming coupons, and cross-merchant redeemable coupons should be adopted to encourage more consumers to shop in small and micro merchants.

Declaration of competing interest

The authors (Yong Wang, Zhentao Yin, and Jianwei Xing) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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