Impacts of Digital Economy on Price Stickiness and Monetary Non-neutrality: Evidence from China

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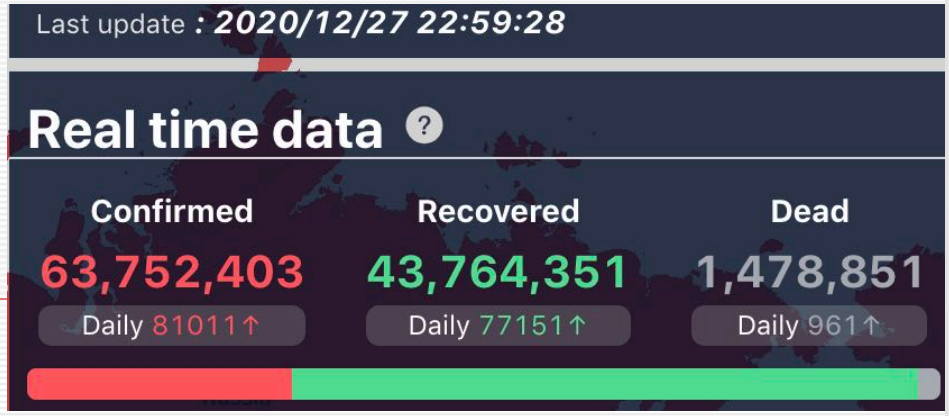
Outline

- Part 1: Introduction
- Part 2: Models
- Part 3: Comparison of Online and Offline Price Stickiness
- Part 4: Measurement of Monetary Non-neutrality
- Part 5: Conclusions and Implications

Part 1: Introduction

Motivation

- ✓ In recent years, the rapid development of the digital economy has profound impacts on society, especially during the Covid-19 period.
- ✓ At the meanwhile, short-term fluctuations in macroeconomics have become more frequent.



Motivation

- Online prices receive more and more attention.
  - ✓ BPP(Billion Price Project, http://www.thebillionpricesproject.com/)
  - ✓ Tsinghua University iCPI (Internet-based Consumer Price Index) program, http://www.bdecon.com/chartsEnglishIndex
- Online prices are different from prices in brick-and-mortar stores
  - ✓ low search costs
  - ✓ low costs of monitoring competitors' prices
  - ✓ low costs of nominal price adjustment

Motivation

- **Key Question 1:** Will the rapid development of digital economy affect the micro foundation of short-term macroeconomic analysis? What are the differences between online and offline price stickiness?
- **Key Question 2:** What are the impacts of digital economy on the monetary non-neutrality? What opportunities and challenges does the big data era provide for the analysis of monetary non-neutrality?

Literature Review

Basic price adjustment models

- ✓ time-dependent pricing model (TDP, Taylor, 1980; Calvo, 1983; Carvalho,2006; Alvarez et al., 2016)
- ✓ state-dependent pricing model (SDP, Barro, 1972; Dotsey et al., 1999; Golosov and Lucas, 2007; Nakamura and Steinsson,2010; Alvarez and Lippi,2014)

Theories about the cost of price adjustment

- ✓ search cost (Alchian,1969); menu cost(Sheshinski and Weiss, 1977)
- ✓ costs of updating information (Mankiw and Reis, 2002)
- ✓ observation costs for companies (Alvarez et al., 2011)

Empirical evidence of price stickiness

- ✓ Offline prices (Bils and Klenow, 2004; Klenow and Kryvtsov, 2008; Nakamura and Steinsson, 2008/2010)
- ✓ Online prices (Cavallo, 2016/2017/2018; Gorodnichenko et al., 2018)

Main Findings

- We measure and compare online and offline price stickiness with unique data in China, and employs the empirical evidence to calibrate the hybrid heterogeneous multi-sector price adjustment model.
- First, we find that the online and offline price change durations are one and half months, and six months, respectively. However, the online and offline absolute price change sizes are similar, namely about 15%. There also exists obvious heterogeneity in different divisions and asymmetry in price increases and decreases.
- Second, with current online markets accounting for about 20%, the effectiveness of monetary policy is estimated to be 42%- 53% of the pure offline market. If the online market share reaches 100% in the future, the monetary non-neutrality is only 7% -11% compared to that of pure offline market.

Marginal Contributions

- Firstly, this paper examines the differences between online and offline price adjustment behavior and its impact on monetary non-neutrality, which is an important problem in the digital economy era.
- Secondly, this paper adopts unique online and offline market micro-price data in China. The offline data comes from the Price Monitoring Center of the National Development and Reform Commission; the online data comes from the iCPI program of Tsinghua University.
- Finally, this paper shows that impacts of the digital economy on the transmission of monetary policy should not be ignored. In the digital economy era, central banks should pay more attention to high-frequency online inflation indicators, attach more importance to structural monetary policy.

Part 2: Models

☐ Hybrid Heterogeneous Multi-sector Price Adjustment Model

（“SDP+TDP”; Refer to Nakamura and Steinsson, 2010）

- **Hypothesis:**

✓ Dixit-Stiglitz, CES, differentiated goods and labor

✓ Sectors $s = 1,2,\dots,S$, firm $j \in [0,1]$, $\sum_{s=1}^{S} \omega_s = 1$

- **Household decision:**

$$\underset{\{C_t, L_{sj,t}\}}{Max}\ E_t\{\sum_{q=0}^{\infty} \beta^q \left(\frac{C_{t+q}^{1-\theta}-1}{1-\theta} - \sum_{s=1}^{S} \omega_s \int_0^1 \frac{L_{sj,t+q}^{1+\varphi}}{1+\varphi} dj \right)\}$$

$$\text{s.t. } P_t C_t + E_t\left[D_{t,t+1} B_{t+1}\right] \le \sum_{s=1}^{S} \omega_s \int_0^1 W_{sj,t} L_{sj,t} dj + B_t + \sum_{s=1}^{S} \omega_s \int_0^1 \Pi_{sj,t}\, dj$$

$$D_{t,t+1} = \beta \left(\frac{C_{t+1}}{C_t}\right)^{-\theta} \frac{P_t}{P_{t+1}} \qquad \frac{W_{sj,t}}{P_t} = L_{sj,t}^{\varphi} C_t^{\theta}$$

No-ponzy-game Scheme: $\lim_{T\to\infty} \beta^T a_{T+1} \ge 0$

Transversality Condition: $\lim_{T\to\infty} \beta^T u'(a_{T+1}) a_{T+1} = 0$

Hybrid Heterogeneous Multi-sector Price Adjustment Model（SDP+TDP）

- **Firm decision:**

$$\underset{\{P_{sj,t},N_{sj,t},H_{sj,t}\}}{Max} E_t\left[\sum_{q=0}^{\infty}\left(D_{t,t+q}\Pi_{sj,t+q}\right)\right]$$

$$\Pi_{sj,t} = P_{sj,t}Y_{sj,t} - W_{sj,t}N_{sj,t} - P_tH_{sj,t} - Z_sW_{sj,t}I_{sj,t}$$

$$s.t. \qquad Y_{sj,t} = A_{sj,t}{N_{sj,t}}^{1-\nu}{H_{sj,t}}^{\nu}$$

$$ln(A_{sj,t}) = \rho\, ln\left(A_{sj,t-1}\right) + \varepsilon_{sj,t}$$

$$\varepsilon_{sj,t} \sim N(0, \sigma^2_{s,\varepsilon})$$

Intermediate input $H_{sj,t}$: $H_{sj,t} = [\int_0^1 h_{sj,t}(k)^{\frac{\lambda-1}{\lambda}}dk]^{\frac{\lambda}{\lambda-1}}$

F.O.C: $h_{sj,t}(k) = H_{sj,t}\left(\frac{P_{sj,t}(k)}{P_t}\right)^{-\lambda}$

$$Y_{sj,t} = Y_t\left(\frac{P_{sj,t}}{P_t}\right)^{-\lambda}$$

Hybrid Heterogeneous Multi-sector Price Adjustment Model（SDP+TDP）

- **Two types of companies: (1) $Z_s = Z_{s,l}, \alpha_s$. (2) $Z_s = Z_{s,h}, 1-\alpha_s$**
- **Firm decision of low adjustment cost:**

$$\underset{\{P_{sjl,t}, N_{sjl,t}, H_{sjl,t}\}}{Max} E_t\left[\sum_{q=0}^{\infty}(D_{t,t+q}\Pi_{sjl,t+q})\right]$$

$$\Pi_{sjl,t} = P_{sjl,t}Y_{sjl,t} - W_{sj,t}N_{sjl,t} - P_t H_{sjl,t} - Z_{s,l}W_{sj,t}I_{sjl,t}$$

- **Firm decision of high adjustment cost :**

$$\underset{\{P_{sjh,t}, N_{sjh,t}, H_{sjh,t}\}}{Max} E_t\left[\sum_{q=0}^{\infty}(D_{t,t+q}\Pi_{sjh,t+q})\right]$$

$$\Pi_{sjh,t} = P_{sjh,t}Y_{sjh,t} - W_{sj,t}N_{sjh,t} - P_t H_{sjh,t} - Z_{s,h}W_{sj,t}I_{sjh,t}$$

- **The whole market :** $P_{s,t} = \left[(1-\alpha_s){P_{sjl,t}}^{1-\lambda} + \alpha_s {P_{sjh,t-1}}^{1-\lambda}\right]^{\frac{1}{1-\lambda}}$

Hybrid Heterogeneous Multi-sector Price Adjustment Model（SDP+TDP）

- **Other conditions**

✓ $Y_{sj,t} = C_{sj,t} + \sum_{s=1}^{S} \omega_s \int_0^1 h_{sj,t}(j)dj$, $Y_t = C_t + \sum_{s=1}^{S} \omega_s \int_0^1 H_{sj,t}dj$

✓ $L_{s,t} = N_{s,t} = (1-\alpha_s)N_{sjl,t} + \alpha_s N_{sjh,t}$

✓ $\mathrm{Ln}M_t = \mu + \ln M_{t-1} + \eta_t$ ， where $\eta_t \sim N(0, \sigma_\eta^2)$

- **Bellman Equation of low adjustment cost firms:**

$$V(A_{sjl,t}, \frac{P_{sjl,t-1}}{P_t}, \frac{M_t}{P_t}) = \max_{\{P_{sjl,t}, N_{sjl,t}, H_{sjl,t}\}} \{\Pi^r_{sjl,t} + E_t[D^r_{t,t+1} V(A_{sjl,t+1}, \frac{P_{sjl,t}}{P_{t+1}}, \frac{M_{t+1}}{P_{t+1}})]\}$$

$$\Pi^r_{sjl,t} = \frac{\Pi_{sjl,t}}{P_t} = \left(\frac{P_{sjl,t}}{P_t}\right) Y_{sjl,t} - \left(\frac{W_{sj,t}}{P_t}\right) N_{sjl,t} - H_{sjl,t} - Z_{s,l}(\frac{W_{sj,t}}{P_t}) I_{sjl,t}$$

$$D^r_{t,t+1} = \frac{D_{t,t+1}}{P_t}$$

Hybrid Heterogeneous Multi-sector Price Adjustment Model（SDP+TDP）

- **Bellman Equation of high adjustment cost firms:**

$$V(A_{sjh,t}, \frac{P_{sjh,t-1}}{P_t}, \frac{M_t}{P_t}) = \max_{\{P_{sjh,t}, N_{sjh,t}, H_{sjh,t}\}} \{\Pi^r_{sjh,t} + E_t[D^r_{t,t+1} V(A_{sjh,t+1}, \frac{P_{sjh,t}}{P_{t+1}}, \frac{M_{t+1}}{P_{t+1}})]\}$$

$$\Pi^r_{sjh,t} = \frac{\Pi_{sjh,t}}{P_t} = \left(\frac{P_{sjh,t}}{P_t}\right) Y_{sjh,t} - \left(\frac{W_{sj,t}}{P_t}\right) N_{sjh,t} - H_{sjh,t} - Z_{s,h}(\frac{W_{sj,t}}{P_t}) I_{sjh,t} \qquad (18)$$

$$D^r_{t,t+1} = \frac{D_{t,t+1}}{P_t}$$

- **Guess and Verify**

Part 3: Comparison of Online and Offline Price Stickiness

- Our online data contains prices from more than 100 websites covering the whole basket of Chinese CPI with over 19 million price records, including 8 divisions, 46 groups, and 262 classes. The sample period is from January, 2016 to February, 2019. (iCPI program in China; also refer to Jiang et al., 2020）.
- The offline data is from the price monitoring center of the National Development and Reform Commission in China, which includes 126 types of food, daily industrial consumer goods, and services with over 50 thousand price records. The sample period is from January, 2017 to March, 2020.

Comparison of overall online and offline price stickiness indicators

- The weighted average online and offline price change durations are one and half months, and six months, respectively, with obviously more frequent online price changes.
- The online and offline absolute price change sizes are very similar, namely about 15%.
- There exists obvious asymmetry in price increases and decreases for online and offline markets.

Table 1 Comparison of overall online and offline price stickiness indicators

Methods	Indicators	Offline Market	Online Market
Median	Change Frequency(%)	27.80	49.43
	Change Duration(months)	3	1.5
	Increase Frequency (%)	16.75	32.61
	Increase Duration(months)	5	2.5
	Decrease Frequency (%)	10.34	19.13
	Decrease Duration(months)	9	3.4
	Change size(%)	4.20	5.49
	Abs. Change Size(%)	18.97	19.49
	Increase Size(%)	19.40	20.94
	Decrease Size(%)	14.05	17.18
Mean	Change Frequency(%)	27.81	69.88
	Change Duration(months)	3	0.8
	Increase Frequency (%)	16.84	50.23
	Increase Duration(months)	5	1.4
	Decrease Frequency (%)	10.97	20.13
	Decrease Duration(months)	9	1.9
	Change size(%)	8.76	5.75
	Abs. Change Size(%)	20.81	20.07
	Increase Size(%)	22.36	22.96
	Decrease Size(%)	16.23	17.16
Weighted Average	Change Frequency(%)	13.92	47.18
	Change Duration(months)	6.7	1.6
	Increase Frequency (%)	8.85	28.89
	Increase Duration(months)	10.8	2.9
	Decrease Frequency (%)	5.07	21.13
	Decrease Duration(months)	19.2	3.5
	Change size(%)	7.39	3.15
	Abs. Change Size(%)	16.99	13.53
	Increase Size(%)	17.66	15.44
	Decrease Size(%)	13.11	11.21

Comparison of offline price stickiness among different divisions

- Offline food price adjustments are the most frequent, followed by manufactured consumer goods, and service price adjustments are the least frequent.
- Offline services have the largest price change size, followed by food, and manufactured consumer goods have the smallest price change size .
- There exists obvious heterogeneity in different divisions and asymmetry in price increases and decreases.

Table 3 Comparison of offline price stickiness among different divisions

Methods	Indicators	Offline-Overall	Offline-Food	Offline-Manufactured Consumer Goods	Offline-Service
Median	Change Frequency(%)	27.80	23.22	13.02	0.93
	Change Duration(months)	3	3.8	7.2	107.0
	Increase Frequency (%)	16.75	12.25	7.36	0.85
	Increase Duration(months)	5	7.7	13.1	117.0
	Decrease Frequency (%)	10.34	6.71	5.23	0.15
	Decrease Duration(months)	9	14.4	18.6	645.3
	Change size(%)	4.20	4.93	0.21	15.61
	Abs. Change Size(%)	18.97	13.50	6.42	22.74
	Increase Size(%)	19.40	16.19	5.03	26.23
	Decrease Size(%)	14.05	12.84	7.50	17.95
Mean	Change Frequency(%)	27.81	28.36	21.67	2.15
	Change Duration(months)	3	3.0	4.1	45.9
	Increase Frequency (%)	16.84	17.49	14.36	1.45
	Increase Duration(months)	5	5.2	6.5	68.3
	Decrease Frequency (%)	10.97	10.87	7.31	0.70
	Decrease Duration(months)	9	8.7	13.2	142.2
	Change size(%)	8.76	4.74	1.66	19.62
	Abs. Change Size(%)	20.81	15.28	8.05	30.59
	Increase Size(%)	22.36	17.04	8.15	30.86
	Decrease Size(%)	16.23	13.63	9.13	20.78
Weighted Average	Change Frequency(%)	13.92	38.75	24.89	5.01
	Change Duration(months)	6.7	2.0	3.5	19.5
	Increase Frequency (%)	8.85	24.28	17.27	3.36
	Increase Duration(months)	10.8	3.6	5.3	29.3
	Decrease Frequency (%)	5.07	14.46	7.62	1.65
	Decrease Duration(months)	19.2	6.4	12.6	59.9
	Change size(%)	7.39	5.74	0.60	11.09
	Abs. Change Size(%)	16.99	16.85	7.82	20.73
	Increase Size(%)	17.66	18.89	8.48	20.59
	Decrease Size(%)	13.11	14.64	9.10	13.79

Comparison of online price stickiness among different divisions

- For the online markets, there is obvious heterogeneity for price stickiness indicators among different divisions. However, price increase frequency is consistently higher than decrease frequency, and price increase size is also higher than decrease size.
- For both offline and online markets, the price stickiness indicators of different divisions have obvious heterogeneity and asymmetry.

Table 4 Comparison of online price stickiness among different divisions

Divisions	Division Weight (%)	Change Frequency (%)	Change Duration (Months)	Abs. Change Size (%)
		Weighted Average		
Food, Tobacco and Liquor	30.1	54.59	1.27	17.74
Clothing	7	55.55	1.23	26.22
Residence	21.9	6.00	16.17	7.01
Household Articles and Service	6.1	69.88	0.83	17.56
Transportation and Communication	13.7	30.64	2.73	5.42
Education, Culture and Recreation	11.2	67.08	0.9	11.87
Health Care	7.6	50.23	1.43	20.74
Other Articles and Services	2.4	56.54	1.2	4.25
		Mean		
Food, Tobacco and Liquor		59.71	1.10	20.15
Clothing		40.38	1.93	21.85
Residence		21.19	4.20	21
Household Articles and Service		62.01	1.03	21.67
Transportation and Communication		60.84	1.07	15.35
Education, Culture and Recreation		71.35	0.80	17.32
Health Care		53.66	1.30	23.02
Other Articles and Services		98.62	0.23	20.21
		Median		
Food, Tobacco and Liquor		62.01	1.03	19.1
Clothing		36.53	2.20	23.8
Residence		19.54	4.60	19.88
Household Articles and Service		59.71	1.10	22.53
Transportation and Communication		47.18	1.57	15.47
Education, Culture and Recreation		56.54	1.20	16.75
Health Care		51.05	1.40	22.77
Other Articles and Services		42.62	1.80	17.48

Part 4: Measurement of Monetary Non-neutrality

Benchmark Parameters

Table 5 **Benchmark Parameters**

Parameters	Value
Discount factor (monthly)	$\beta = 0.96^{1/12}$
Coefficient of relative risk aversion	$\theta = 1$
Inverse of Frisch elasticity of labor supply	$\varphi = 0$
Elasticity of demand	$\lambda = 6$
Steady-state labor supply	$L = 1/3$
Ratio of intermediate input	$\nu = 0.6$
Speed of mean reversion of idiosyncratic productivity	$\rho = 0.70$
Mean growth rate of nominal aggregate demand	$\mu = 0.0024$
Std. deviation of the growth rate of nominal aggregate demand	$\sigma_\eta = 0.0127$

Core Parameters Calibration

- We combine the empirical price stickiness indicators to calibrate the menu cost Z_s and productivity shock $\sigma_{S,\varepsilon}$.
- We find that, under the same conditions, the menu cost of offline market is significantly higher than that of the online market, but the productivity shocks of different markets have no specific relationship. This indicates that Internet greatly reduces the price adjustment cost.

Monetary Non-neutrality based on Online Markets

- Monetary Non-neutrality based on Online Markets
- ✓ TDP > SDP+TDP > SDP （1.5～3，1～2）
- ✓ With Intermediate Input>Without Intermediate Input （1.5～4）
- ✓ heterogeneous model> homogeneous model （7～17）

Table 8 **Monetary Non-neutrality based on Online Markets**

	SDP		TDP		SDP+TDP	
	Without Intermediate Input	With Intermediate Input	Without Intermediate Input	With Intermediate Input	Without Intermediate Input	With Intermediate Input
Without heterogeneous divisions						
Overall （Weighted Average）	0.1038	0.3152 (304%)	0.2329 [224%]	0.4972 (214%) [158%]	0.1378 [133%]	0.3692 (268%) [117%]
Overall （Arithmetic Mean）	0.1287	0.4272 (332%)	0.3051 [237%]	0.7060 (231%) [165%]	0.2135 [165%]	0.5230 (245%) [122%]
Overall （Median）	0.1619	0.4032 (249%)	0.2487 [154%]	0.6729 (271%) [167%]	0.1702 [105%]	0.4341 (255%) [108%]
With heterogeneous divisions						
Eight Divisions （Weighted Average）	1.1505 {1108%}	3.4541 (300%) {1096%}	2.7832 [242%] {1195%}	6.3256 (227%) [183%] {1272%}	2.3369 [203%] {1695%}	4.1124 (176%) [119%] {1114%}
Eight Divisions （Arithmetic Mean）	1.3715 {1066%}	3.2408 (236%) {759%}	2.8126 [205%] {922%}	5.0822 (181%) [157%] {719%}	2.4135 [176%] {1130%}	4.3324 (180%) [134%] {828%}
Eight Divisions （Median）	1.4173 {875%}	3.5762 (252%) {887%}	2.4336 [172%] {978%}	5.8145 (239%) [163%] {864%}	2.0593 [145%] {1210%}	3.7529 (182%) [104%] {865%}

Notes: (1) In table 8, the fluctuation variance of real GDP (not including intermediate products), $Var(C_t)$, is used to describe the degree of monetary non-neutrality. Since the value is small, we multiply by 10000, that is, the value in table 8 is $Var(C_t) * 10\text{^}4$; (2) The percentage in parentheses () indicates the ratio of monetary non-neutrality between "considering intermediate input" and "not considering intermediate input" under the same price adjustment model and heterogeneity, e.g. 0.3152/0.1038*100%=304%; (3) The percentage in brackets [] indicates the ratio of monetary non-neutrality of the TDP, SDP+TDP model to the SDP model under the same heterogeneity and intermediate input conditions, e.g. 0.2329/0.1038*100%=224%; (4) The percentage in curly brackets {} indicates the ratio of monetary non-neutrality of the "sectoral heterogeneity" to the "homogeneity" model under the same price adjustment model and intermediate inputs conditions, e.g. 1.1505/0.1038*100%=1108%.

Monetary Non-neutrality based on Offline Markets

- Under the same conditions, monetary non-neutrality based on offline market is significantly higher than that based on online market. (SDP+TDP，1.2017 /0.1378)

Table 11 Monetary Non-neutrality based on Offline Markets

	SDP		TDP		SDP+TDP	
	Without Intermediate Input	With Intermediate Input	Without Intermediate Input	With Intermediate Input	Without Intermediate Input	With Intermediate Input
Without heterogeneous divisions						
Overall（Weighted Average）	1.1536	4.5029 (390%)	1.6636 [144%]	6.2937 (378%) [140%]	1.2017 [104%]	5.2345 (436%) [116%]
Overall（Arithmetic Mean）	0.2955	1.5967 (540%)	0.4068 [138%]	2.3456 (577%) [147%]	0.3232 [109%]	1.9118 (592%) [120%]
Overall（Median）	0.3364	1.7220 (512%)	0.4758 [141%]	2.5471 (535%) [148%]	0.3609 [107%]	1.9617 (543%) [114%]
With heterogeneous divisions						
Three Divisions（Weighted Average）	3.8487 {334%}	7.7265 (201%) {172%}	5.4881 [143%] {330%}	10.4646 (191%) [135%] {166%}	4.1295 [107%] {344%}	8.5328 (207%) [110%] {163%}
Three Divisions（Arithmetic Mean）	2.0235 {685%}	4.9471 (245%) {310%}	3.3485 [165%] {823%}	7.3156 (218%) [148%] {312%}	2.8456 [141%] {880%}	5.2908 (186%) [107%] {277%}
Three Divisions（Median）	1.8607 {553%}	3.9276 (211%) {228%}	2.8511 [153%] {599%}	6.5637 (230%) [167%] {258%}	2.4229 [130%] {671%}	4.9628 (126%) [253%] {253%}

Notes: Refer to the notes of table 8.

Online-Offline Markets Combination and Monetary Non-neutrality

- We combine the weighted average price stickiness indicators of both online and offline markets to calibrate the model.

Table 13 Online-Offline Markets Combination and Monetary Non-neutrality

	SDP		TDP		SDP+TDP	
	Without Intermediate Input	With Intermediate Input	Without Intermediate Input	With Intermediate Input	Without Intermediate Input	With Intermediate Input
online markets-0%(pure offline markets)	1.1536	4.5029	1.6636	6.2937	1.2017	5.2345
online markets-20%	0.5653 (49%)	1.7561 (39%)	0.9686 (58%)	3.1601 (50%)	0.6374 (53%)	2.1760 (42%)
online markets-50%	0.4135 (36%)	1.2608 (28%)	0.8188 (49%)	2.6515 (42%)	0.5462 (45%)	2.0235 (39%)
online markets-80%	0.2192 (19%)	0.6754 (15%)	0.5669 (34%)	1.5803 (25%)	0.2968 (25%)	1.0956 (21%)
online markets-100% (pure online markets)	0.1038 (9%)	0.3152 (7%)	0.2329 (14%)	0.4972 (8%)	0.1378 (11%)	0.3692 (7%)

Notes: (1) In table 13, the fluctuation variance of real GDP (not including intermediate products), $Var(C_t)$, is used to describe the degree of monetary non-neutrality. Since the value is small, we multiply by 10000, that is, the value in table 13 is $Var(C_t) * 10\text{^}4$; (2) The value in parentheses is expressed as the percentage of the total output fluctuation relative to the fluctuation of pure offline markets with the same price adjustment model and the intermediate input conditions, e.g. 0.6374/1.2017*100%=53%.

Online-Offline Markets Combination and Monetary Non-neutrality

- According to the current situation, the online market accounts for about 20% in China, and the effectiveness of monetary policy is estimated to be 53% of the pure offline market without intermediate input, which is further reduced to 42% considering the intermediate input.
- As the digital economy develops, the online market share will increase, and if it reaches 100% in the future (under an extreme condition), the effectiveness of monetary policy is only 7% to 11% compared to that of pure offline market.

Part 5：Conclusions and Implications

☐ Main Conclusions

- The price stickiness indicators of online market and offline market in China are not only significantly different, but also have certain commonalities.

✓ On one hand, the online and offline price change durations are one and half months, and six months, respectively, indicating that online price changes are much more frequent due to low adjustment cost.

✓ The online and offline absolute price change sizes are very similar, namely about 15%. There exists obvious heterogeneity in different divisions and asymmetry in price increases and decreases.

Main Conclusions

- Recently, as the proportion of digital economy has been increasing in China, the degree of price stickiness has been significantly reduced (price change frequency has increased significantly), which to some extent has led to a weakening of the effectiveness of monetary policy.

✓ With current online markets accounting for about 20% in China, the effectiveness of monetary policy is estimated to be 53% of the pure offline market without intermediate input, which is further reduced to 42% considering the intermediate input.

✓ If the online market share reaches 100% in the future, the effectiveness of monetary policy is only 7% to 11% compared to that of pure offline market.

Implications

- First, in the digital economy era, companies are adjusting prices more frequently, and the effectiveness of traditional monetary policies has declined. Central banks need to pay attention to the influence of online markets on the monetary policy transmission, accelerate monetary policy transformation, and attach importance to high-frequency online inflation indicators.
- Second, central banks should pay attention to the development and application of structural monetary policy in the future, and be more cautious in the application of aggregate monetary policy. Besides, it should also try to stagger the monetary policy adjustment cycle and price adjustment cycle appropriately, and continue to innovate monetary policy tools.

Thank you!

Your questions are welcome!

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