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Trade liberalisation, imperfect pass-through and cost of living: evidence from Chinese cities

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ABSTRACT

This article investigates the consumption effect of trade liberalisation through changes in the cost of living in Chinese cities. We use fixed effects model and dynamic panel model based on household survey data from 2002 to 2009. We identify the imperfect pass-through mechanism of tariffs and non-tariff measures at city level. The main findings show that the aggregate cost of living in Chinese cities is an inverted-V trend. Tariffs reduction and the high incidence of non-tariff measures can decrease cost of living in Chinese cities, which improves the overall consumption welfare and narrows down the regional disparities. The consumption effects are heterogenous due to the diverse spatial effects, demand effects and competition effects across Chinese cities. Cities with a high expenditure share of manufactured goods have a larger effect on the reduction of cost of living. Tariffs have a larger marginal effect in small cities and cities with high level of privatisation. While the incidence of non-tariff measures has a larger marginal effect in small cities and cities with low level of privatisation.

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1. Introduction

Measuring welfare changes due to external shocks is a fundamental issue in economics, not least in the measurement of changes in the cost of living (Redding & Weinstein, 2020). When it comes to trade liberalisation, the price effects lay the foundations for welfare analysis, which are of paramount interest for consumers and policymakers. The real changes in the cost of living can better reflect the price effects caused by trade liberalisation at the consumption level.

After China's accession to the WTO in 2001, the average import tariffs have been drastically reduced from 15.9% in 2001 to 7.4% in 2019.[1] In addition, China also gradually reduced some non-technical measures, such as import quotas and licences (Imbruno, 2016). However, the technical measures, such as sanitary and phytosanitary measures (SPS) and technical barriers to trade (TBT), have been increasingly used

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and become the most influential non-tariff measures (NTMs) in China (Bao & Qiu, 2010; Niu et al., 2018; UNCTAD, 2018).[2] Trade liberalisation was one of the main reasons for China's rapid economic growth and poverty elimination (Zhu, 2012). China's economy maintained an average growth rate of around 8% per year and the poverty rate dropped from 97.5% in 1978 to 0.6% in 2019.[3] Meantime, the regional disparities, both income inequality and consumption inequality in China are continuously widening (Han et al., 2012; Knight et al., 2017; Zhao et al., 2017).

These stylised facts remind us that the aggregate welfare measured by average increases in China doesn't mean the gains are evenly distributed among all cities, especially considering the diverse economic characteristics of large domestic market. We need to re-examine and reveal the diverse welfare effects of trade liberalisation at micro level. To what extent the welfare changes affected by trade liberalisation at city level? Has trade liberalisation improved the welfare of all Chinese cities or increased regional disparities? How does the welfare effects vary across cities? There is no consensus on these issues. The welfare distribution of trade liberalisation across Chinese cities remains an important policy concern.

To answer these questions, this article aims to investigate the overall and heterogeneous consumption effects of trade liberalisation through changes in the cost of living in Chinese cities, which builds on the rising of anti-globalisation and China's high-quality regional synergy strategy. It is necessary and important to examine this issue because we need to better understand the diverse geographic welfare gains in China. Our study identifies imperfect pass-through mechanism of trade liberalisation at city level, to further understand the relationship between trade liberalisation and consumption inequality. China has been changing its high-speed development strategy to a high-quality regional synergy strategy in the new era. Accurately revealing the consumption effect of trade liberalisation at city level instead of the whole country perspective can provide valuable guidance to aid China in transforming the economic development strategy.

This article has several contributions to the existing literature. First, we extend the study by investigating consumption effect of trade liberalisation through changes in the cost of living at city level instead of income effect. This article provides a diverse geographic perspective, which was often overlooked. Second, in contrast to the existing literature that mainly focuses on tariffs, we identify imperfect pass-through mechanism of both tariffs and NTMs, to examine the overall and heterogeneous consumption effects of trade liberalisation. Thirdly, we provide extensive explanations on the heterogeneous effects of trade liberalisation in terms of cities to spatial effects, demand effects and competition effects. In general, our study complements the empirical literature on the price theory of trade liberalisation and provides evidence for China's development strategy.

This article is organised as follows. Section 2 presents the literature review. Section 3 details the methodology and data. Section 4 discusses the results. Section 5 provides the conclusion, implications and limitations.

2. Literature review

In recent years, emphasis of theoretical literature has shifted from the aggregate welfare gains to the welfare distribution and inequality caused by trade liberalisation,

examining the heterogeneous welfare gains at micro level (Carroll & Hur, 2020; Fajgelbaum & Khandelwal, 2016; Galle et al., 2017; Nigai, 2016). The reasons for such a shift are various, yet the asymmetrical welfare gains across countries, especially the unequal distribution among different groups in one specific country has been a catalyst for anti-globalisation (Autor et al., 2013; Pastor & Veronesi, 2021; Pavcnik, 2017; Pierce & Schott, 2016; Rodrik, 2018). Based on the accessibility of micro household survey data, the empirical literature examines the income effect, consumption effect and behavioural adjustment across household groups facing price changes in response to trade shocks, and further explores the heterogeneous welfare effects (Borusyak & Jaravel, 2018; Casabianca, 2016; Deaton, 1989; Han et al., 2016; Hottman & Monarch, 2020; Jaravel, 2019; Marchand, 2012; Nicita, 2009; Nicita et al., 2014; Porto, 2006, 2015; Wang & Qian, 2020). These results are quite different. The pro-poor or pro-rich effect of trade liberalisation is no consensus. Related research, however, has mainly focussed on the income effect of trade liberalisation across household groups or regions (Dix-Carneiro & Kovak, 2017; Goldberg & Pavcnik, 2007, 2016; Han et al., 2012). The consumption effect discussed at city level is often insufficient and understudied. Consumption is a more effective indicator to reflect the real inequality relative to income (Aguiar & Bils, 2015; Broda et al., 2009). We contribute to the literature by exploring the overall and heterogeneous consumption effects of trade liberalisation at city level.

Trade policy literature has been largely concentrated on tariffs for many years. However, with the drastic decrease in tariffs and steady increase of NTMs in the global trade, both policymakers and economists pay more attention on the role of NTMs (UNCTAD, 2013). Some literature examines the effects of NTMs on import values (Bao, 2014; Bratt, 2017; Hoekman & Nicita, 2011; Kinzius et al., 2019), which concludes that the effects of NTMs on import vary widely in different countries and different products due to the heterogeneity in trade structures and types of NTMs. In terms of the effects of NTMs on prices, Deardorff and Stern (1998) estimate the tariff-equivalent of NTMs using a good deal of fairly precise data at product-specific level, which is not usually available in many cities (Ferrantino, 2006). Bradford (2003) calculates the level of *ad valorem equivalent* (AVE) of trade protection for imported products without accounting for the incidence of NTMs. Kee et al. (2008, 2009) use NTMs incidence to indirectly estimate the AVEs of NTMs without price data. Dean et al. (2009) and Knebel (2010) directly estimate the price effects of NTMs using the retail price data in many countries, and incorporate the endogeneity of NTMs. The price effects of NTMs are correlated with country income. However, the cross-sectional data cannot estimate the time-variation of the price effects of NTMs. We contribute to the literature by using household survey panel data to directly estimate the consumption effects of NTMs and tariffs in Chinese cities.

For a large economy and developing country, the spatial variation in prices is an important reason for consumption inequality (Deaton & Dupriez, 2011; Mishra & Ray, 2014). The extent to which trade liberalisation affects the prices in diverse geographic areas depends on many factors (Marchand, 2017). The existing literature mainly focuses on the imperfect pass-through of tariffs onto domestic price changes, to examine various channels for different price effects of trade liberalisation. A strand

of literature studies the structure and the efficiency of product markets under imperfect competition (Atkin & Donaldson, 2015; Berner et al., 2017; Edmond et al., 2015; Feenstra, 1989). A portion of the price effects due to tariff reduction is absorbed by market power of dominant produces, foreign exporters and intermediaries or retailers. The other strand of literature finds the domestic factors also affect price transmission within the country. For example, factors could be the distance to the border (Nicita, 2009), transportation infrastructure (Donaldson, 2018), the isolated rural markets and well-connected urban markets (Marchand, 2012), or the domestic market structure (Han et al., 2016). We contribute to the literature by identifying the imperfect pass-through mechanism of tariffs and NTMs from the perspectives of city size and level of privatisation. The city size with different industries and income affects the prices of goods through the competition effects and demand effects (Ellison et al., 2010; Handbury, 2021; Handbury & Weinstein, 2015; Krugman, 1991). However, there is no consensus on which effect dominates the price changes. The level of privatisation impacts the price by changing competition and efficiency within the domestic industries (Bai et al., 2009; Brandt et al., 2012; Huang & Zhu, 2022; Park et al., 2006).

The related literature mainly uses the retail price or unit value to examine the price effects of trade liberalisation (Dean et al., 2009; Faber, 2014; Han et al., 2016; Marchand, 2012; Nicita, 2009). However, Cost of Living (COL) index that contains the level and structure of household consumption, can be a better indicator to reflect the real standard of living and consumer's taste which varies with time and income (Broda & Romalis, 2009; Lieu et al., 2013; Ogura, 2017). Importantly, COL index can capture the city-specific price index and measure the consumption inequality in different regions (Agarwal et al., 2017; Atkin et al., 2018; Handbury, 2021; Handbury & Weinstein, 2015). We contribute to the literature by calculating COL index in 133 prefecture-level and above cities in China and that of tradable goods and non-tradable services using its additive formula. We also investigate the consumption effects of trade liberalisation at city level.

3. Methodology

3.1. Conceptual framework

It is complicated to investigate the effects of trade liberalisation on domestic prices or cost of living. One reason is that different geographic regions may be segmented and not well-connected in large developing countries (Nicita, 2009). The local prices in segmented regions are less sensitive to trade policies than border prices of tradable goods. Consequently, domestic prices may react differently to trade shocks within the country.

Another reason is that NTMs cannot be easily measured, since NTMs contain different policies (UNCTAD, 2013). A wide variety of NTMs can have very diverse effects on the local prices. For the purpose of estimating the overall price effects, it is essential to directly and effectively measure the incidence of NTMs, which can work in a similar way as tariffs in empirical model.

Generally, trade policies can directly affect the prices of imported goods by imposing restrictions at the border, which influences trade costs of foreign exporters. Under perfect competition, trade policies are completely transmitted to domestic prices. If domestic or local market is imperfectly competitive, the response of local prices to one specific trade policy may be affected by factors such as transport costs, market structure, geographical areas (Marchand, 2017). Meantime, the trade structure of different regions or cities is also an important factor that influences the price transmission of trade policy (Lee & Swagel, 1997; Trefler, 1993). Therefore, the pass-through of trade policies would be imperfect. Besides, the prices of non-tradable services, such as housing, transport and communications, health and education, can be responsive to the price changes of tradable goods through changes in the demand elasticities (Casabianca, 2016; Han et al., 2016; Porto, 2006). Furthermore, trade policies may have heterogeneous effects on the prices of agricultural goods and manufactured goods due to difference in import penetration and demand elasticity. Therefore, we study the imperfect pass-through mechanism and the heterogeneous effects of trade liberalisation in our empirical strategy.

3.2. Quantification of trade liberalisation

Tariffs and NTMs as the proxies of trade liberalisation are used as two main independent variables in our empirical model. In this article, we adopt the frequency index (FI) to quantify the incidence of NTMs. FI measures the number of product subject to one or more NTMs as a percentage of the total number of products for one specific consumption item (Nicita & Gourdon, 2013). FI overcomes the heterogeneous property of NTMs, particularly the lack of available detailed information regarding NTMs implementation across products (UNCTAD, 2013). Most importantly, the FI can make the NTMs work in a similar way as tariffs.

$$\text{The frequency index is calculated} \quad FI_{it} = \frac{\sum D_{ht} M_{ht}}{\sum M_{ht}} \tag{1}$$

Where FI_{it} is the frequency index of consumption item i in year t, h is a HS6 product in consumption item i. If one NTM applied to HS6 product h in year t, the dummy variable D_{ht} takes the value of one or zero otherwise. M_{ht} is a dummy variable which is equal to one if there is any import of product h in year t . According to Eq. (1), the value of the FI of item i lies between zero and one. The higher the values of FI, the higher probability the corresponding NTMs is applied. It means that trade is less liberalised.

3.3. Measurement of COL index

COL index is the dependent variable in our empirical model. We use Törnqvist price index (TPI) and Laspeyres price index (LPI) to measure COL index at city-product level. TPI and LPI are the first-order approximations to COL index (Argente & Lee, 2021). TPI is defined as 'Superlative index number' because it is exactly equivalent to

the real COL index, which can avoid the substitution bias and be directly calculated by using price and expenditure data (Lieu et al., 2013). However, LPI will generate the substitution bias and overestimate the real COL index (Unayama, 2008). Therefore, in this article, we use LPI for the purpose of comparison and robustness check.

According to Diewert (1976), the formula of TPI as follows:

$$P^T\left(\boldsymbol{P^t}, \boldsymbol{P^0}, \boldsymbol{Q^t}, \boldsymbol{Q^0}\right) \equiv \prod\nolimits_{i\epsilon\boldsymbol{\Omega}} \left(\frac{p_{i,t}}{p_{i,0}}\right)^{(s_{i,t}+s_{i,0})/2} \tag{2}$$

Where $\boldsymbol{P^t}$, $\boldsymbol{P^0}$, $\boldsymbol{Q^t}$, $\boldsymbol{Q^0}$ represent, respectively, price and quantity vectors at period t and period 0, and $p_{i,t}$ and $p_{i,0}$ denote the price of consumption item i at period t and period 0; $\boldsymbol{\Omega}$ is the set of items consumed by households in a specific city; $s_{i,t}$ and $s_{i,0}$ denote the expenditure share for item i to total expenditures on all items at period t and period 0. $(s_{i,t} + s_{i,0})/2$ is the weight of geometric mean of price ratios.

Eq. (2) is used to calculate the aggregate COL index without solving the problem of non-additivity. In order to identify and analyze the exact contribution by each item i to the growth of COL index, we use the additive formula provided by Reinsdorf et al. (2002) to transform the Eq. (2) to Eq. (3) as follows:

$$P^T\left(\boldsymbol{P^t}, \boldsymbol{P^0}, \boldsymbol{Q^t}, \boldsymbol{Q^0}\right) \equiv \prod\nolimits_{i\epsilon\Omega} \left(\frac{p_{i,t}}{p_{i,0}}\right)^{(s_{i,t}+s_{i,0})/2} = \sum\nolimits_i \lambda_i \left(\frac{p_{i,t}}{p_{i,0}}\right) \tag{3}$$

where

$$\lambda_i = \frac{p_{i,0}\left((s_{i,t} + s_{i,0})/2\right)/m\left(p_{i,t}, P^T p_{i,0}\right)}{\sum_j p_{j,0}\left((s_{j,t} + s_{j,0})/2\right)/m\left(p_{j,t}, P^T p_{j,0}\right)} \tag{4}$$

and the logarithmic mean function $m(a, b)$ is defined for positive a and b as $(a - b)/(\log a - \log b)$ or as a if $a = b$. This additive formula is used in our empirical analysis.

The following LPI and its additive formula as follows:

$$P^L\left(\boldsymbol{P^t}, \boldsymbol{P^0}, \boldsymbol{Q^t}, \boldsymbol{Q^0}\right) = \frac{P^t Q^0}{P^0 Q^0} = \frac{\sum_i p_{i,t} q_{i,0}}{\sum_i p_{i,0} q_{i,0}} = \sum\nolimits_i s_{i,0} \left(\frac{p_{i,t}}{p_{i,0}}\right) \tag{5}$$

where

$$s_{i,0} = \frac{p_{i,0} q_{i,0}}{\sum_j p_{j,0} q_{j,0}} \tag{6}$$

3.4. Empirical strategy

Using the estimated NTMs and COL index in section 3.2 and 3.3, we construct three-dimensional panel data of 'city-year-product'. We further use the fixed effects

model and dynamic panel model to examine the overall consumption effects of trade liberalisation on COL index of Chinese cities at city-product level. The fixed effects model is the standard practice in related empirical literature (Dean et al., 2009; Han et al., 2016; Marchand, 2012; Nicita, 2009). The fixed effects model is set as follows:

$$\ln COL_{ict} = \alpha_0 + \alpha_1 \ln\left(1 + tariff_{it}\right) + \alpha_2 \ln\left(1 + NTM_{it}\right) + \alpha_3 \ln wp_{it} + \delta_{ct} + \gamma_{ic} + \eta_{kt} + \varepsilon_{ict} \quad (7)$$

Where COL_{ict} is COL index of tradable good i in city c in year t; NTM_{it} is the incidence of NTMs of good i in year t measured by the frequency index. $tariff_{it}$ is import tariff of good i in year t; wp_{it} is world price of good i in year t, which is control variable; δ_{ct} indicates city-year fixed effects that control for city-year level shocks common to all goods. γ_{ic} indicates product-city fixed effects that control for the unobserved heterogeneity that are specific to each city-good pairs, such as different preferences for certain goods in each city. η_{kt} denotes industry-year fixed effects to control for unobserved shocks at industry level. The industry indicator takes the value of one if the good is an agricultural product or zero if it is a manufactured product.[4] ε_{ict} is an *i.i.d* error term. The estimated coefficients are reported with robust standard errors, clustered at the city level.

Notably, the coefficient α_1 and α_2 represent pass-through rates of Tariffs and NTMs, indicating that the impact of Tariffs and NTMs on COL index of tradable goods. Based on the related literature, we expect α_1 to be positive and less than one. We also expect α_2 to be less than one, but the sign of α_2 may be uncertain, both positive and negative are possible. For control variables, we expect the coefficient α_3 to be positive. In addition, we perform 2SLS estimation of Eq. (7) using the first-order lags of tariffs and NTMs to overcome the endogeneity and robustness check. We also interact tariffs, NTMs with eastern region dummy to examine the diverse effects in different regions. Eastern region dummy is defined as one if the city is located in the eastern region; otherwise, it is zero.

We further use dynamic panel model to examine how COL index of non-tradable services responds to that of tradable goods for investigating the overall consumption effects of trade liberalisation. The dynamic panel model is constructed as follows:

$$\ln COL_{jct} = \beta_0 + \beta_1 \ln COL_{jc,t-1} + \sum_{i=1}^{T} \beta_{ij} \ln COL_{ict} + \gamma_t + \chi_c t + \varphi_{jct} \quad (8)$$

Where COL_{jct} is COL index of non-tradable service j in city c in year t; $COL_{jc,t-1}$ is the first-order lag of COL index of non-tradable service j. γ_t represents the year fixed effects and $\chi_c t$ is the city-specific trend. β_{ij} are key coefficients that indicate the elasticities of non-tradable service j to tradable good i. To control for any spurious correlations between COL index of non-tradable services and that of tradable goods, we estimate the model in first differences using the Arellano-Bond estimation method (Arellano & Bond, 1991).

3.5. Data

We use the Chinese Urban Household Survey (UHS) from National Bureau of Statistics of China (NBS) covering 2002–2009. The survey draws through stratified random sampling to ensure the representativeness of urban households in China. We are able to obtain the household survey data for 133 prefecture-level and above cities (13 provinces and 3 municipalities).[5] These cities in China represent different regions and provide a sound base for our empirical analysis. The year 2009 is the most updated data available from the survey.

The UHS provides detailed information about expenditures and quantities of the consumption items. We select a total of 31 goods and 7 services in cities for four categories: Food and Beverage, Clothing, Household Appliance and Services. Food and Beverages include grain, starch, edible oil, pork, beef, lamb, chicken, egg, fish, shrimp, vegetable, fruit, cake, milk, white wine, fruit wine, beer, cola and tea. Clothing includes clothes and shoes. Household Appliances include washing machine, refrigerator, air conditioner, television, motorcycle, sound, heater, telephone, camera and watch. Services include family service, health service, transport and communications service, entertainment service, education service, housing service and other service. The selected goods and services basically cover daily consumption activities and can better reflect the real COL of household.

According to section 3.3, to measure COL index of Chinese cities, the prices of goods and services and the relative expenditure shares need to be calculated. We use unit value to calculate the average price of the specific good listed above weighted by the expenditure share at the city level. Restricted by the availability of data in UHS, we use per capita service expenditure of household as the proxy of service price following Wang and Qian (2020), since a large household population generally indicates a high frequency of services consumption. Specifically, we calculate the average price of services weighted by the expenditure share at the city level. For the relative expenditure share of goods and services, we use the city-level average of the expenditure share of household, and then follow the additive formulas of TPI and LPI.

Tariffs data are obtained from the World Integrated Trade Solution (WITS) by 4-digit SITC categories. We match 4-digit SITC categories to 31 consumption goods, then calculate the weighted-average tariff rates weighted by import values. For world prices, we use CEPII-BACI database. First, we exclude China's import and export data, then we match the HS6 products to the 4-digit SITC categories and consumption items (see Appendix). If one consumption item is matched to multiple STIC categories or HS products, the weighted-average world prices will be used where the weights are import values. The data for the NTMs to calculate the frequency index comes from UNCTAD TRAINS database. First, we check whether each HS6 product is affected by one or more NTMs, then we match all HS6 products with BACI database to check if there is some import of the HS6 product.

For heterogeneity analysis across cities, we need to calculate the city size and the level of privatisation. First, we use the population to represent the city size. Population data comes from China City Statistical Yearbook. We average the population of all the cities in the yearbook, and classify the city with a population larger than the average as a large city, then classify the city with a smaller than the average

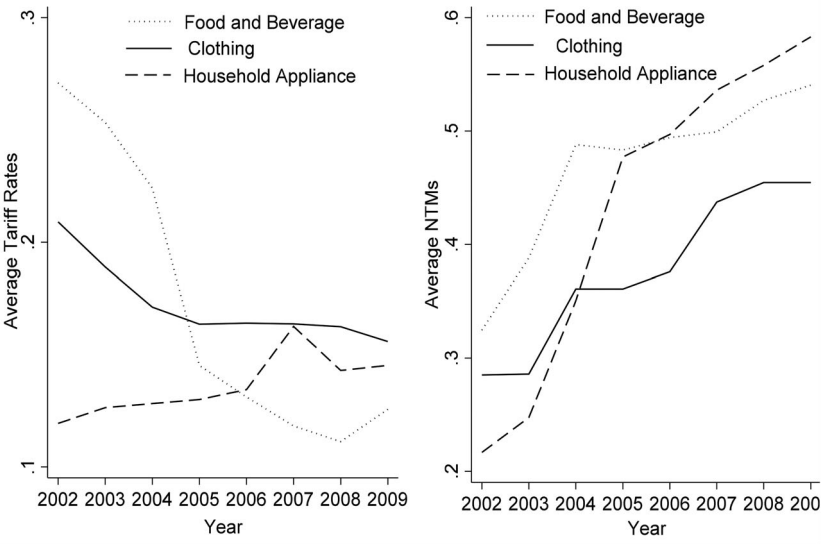

Figure 1. Average tariff rates and incidence of NTMs for major tradable categories.
Notes: Tariff rates at the 4-digit SITC level are extracted from WITS and aggregated to the three major tradable categories weighted by import values. The incidence of NTMs measured by the frequency index for three major categories are extracted from UNCTAD TRAINS and aggregated by tradable goods.
Source: Authors Calculation.

as a small city. Second, we use the proportion of workers in foreign and privately-owned firms to measure the level of privatisation, which is available in the UHS database. We average the proportion of workers in foreign and privately-owned firms in each city, and classify the city with a proportion higher than the average as high level of privatisation city, then classify the city with a proportion lower than the average as low level of privatisation city.

4. Results and discussions

4.1. The trends of tariffs and NTMs for major tradable categories

China has fully integrated into the international trade system since its WTO accession from 2001. Figure 1 presents the trends of average tariff rates and incidence of NTMs for three major tradable categories in China from 2002 to 2009, namely, Food and Beverage, Clothing as well as Household Appliance.

As Figure 1 showed, the average tariff rates of Food and Beverage and Clothing experienced profound reductions, respectively, 12.56% and 15.58% in 2009, showing trends of continuous decline. Average tariff rate of Household Appliance fluctuated slightly from the period of 2002 to 2009, but it was still at a relatively low level which is 14.52% in 2009. However, the incidence of NTMs for three major tradable categories showed an obviously increasing trend. The incidence of NTMs for Food and Beverage increased from 32.46% to 54.05%, indicating that the selected items of Food and Beverages were affected by NTMs for 54.05% in 2009. The incidence of Clothing and Household Appliance, respectively, 45.46% and 58.31% in 2009, also showed

Table 1. COL index of Chinese cities, 2002–2009 (2002 = 100).

	All cities		Eastern region		Central and Western regions	
Year	TPI	LPI	TPI	LPI	TPI	LPI
2002	100	100	100	100	100	100
2003	104.84	106.96	106.30	108.21	104.24	106.44
2004	118.53	121.13	119.80	121.77	118.00	120.86
2005	127.94	130.94	130.57	133.31	126.85	129.96
2006	135.30	138.37	137.60	140.25	134.34	137.60
2007	151.72	156.14	155.74	159.02	150.05	154.95
2008	176.60	182.90	182.76	188.61	174.05	180.53
2009	178.76	183.28	180.04	183.39	178.23	183.23
Total growth rate (%)						
2002–2009	78.76	83.28	80.04	83.39	78.23	83.23
Average growth rate (%)						
2002–2009	8.65	9.01	8.76	9.49	8.61	8.81

Note: According to the National Administrative Region Classification Standard of China, samples of Beijing, Shanghai, Jiangsu, Shandong and Guangdong in the UHS are classified as the eastern region, and the rest are classified as the central and western regions.
Source: Authors' Calculation.

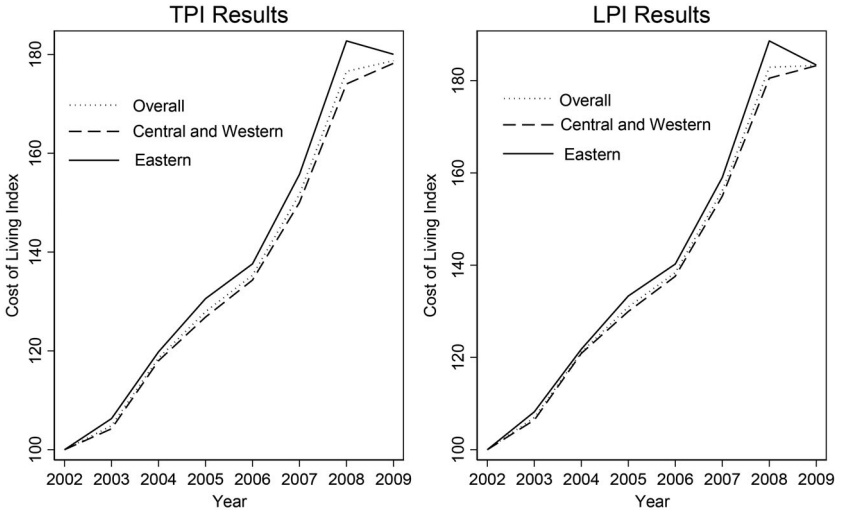

Figure 2. The trends for COL index.
Source: Authors' Calculation based on the Table 1.

significant increase. The NTMs have substituted tariffs as the most influential measures of trade protection in China.

4.2. COL index in Chinese cities and decomposition for major categories

We use TPI and LPI to measure COL index of 133 prefecture-level and above cities in China from 2002 to 2009. Table 1 and Figure 2 show the results and trends of the aggregate COL index for all cities, eastern region and central and western regions.

For all cities, the aggregate COL index measured by TPI has increased by 78.76% (equivalent to an annual compound growth rate of 8.65%), which is 4.52% lower than LPI (83.28%). The results demonstrate the theoretical expectation that LPI would overestimate the true COL index.

Table 2. COL index growth decomposed by major categories.

TPI						
	All cities		Eastern region		Central and Western regions	
Categories	Weight	Growth Rate	Weight	Growth Rate	Weight	Growth Rate
Food and Beverage	42.58	34.84	42.22	34.77	42.73	34.87
Clothing	16.38	13.6	14.98	14.34	16.96	13.3
Household Appliance	5.49	0.5	6.55	1.18	5.06	0.22
Services	35.55	29.81	36.25	29.75	35.26	29.84
Weight/Growth Rate	100	78.76	100	80.04	100	78.23
LPI						
	All cities		Eastern region		Central and Western regions	
Categories	Weight	Growth Rate	Weight	Growth Rate	Weight	Growth Rate
Food and Beverage	42.61	36.05	42.37	35.76	42.71	36.17
Clothing	15.93	13.55	14.78	14.25	16.41	13.26
Household Appliance	4.85	0.88	5.78	1.53	4.47	0.6
Services	36.6	32.8	37.07	31.85	36.41	33.2
Weight/Growth Rate	100	83.28	100	83.39	100	83.23

Notes: The above results are obtained by aggregating the product level data to each consumption categories from the UHS. Weights are the average relative expenditure share at the city-level.
Source: Authors' Calculation.

In terms of regions, the aggregate COL index for eastern region measured by TPI has increased by 80.04% (equivalent to an annual compound growth rate of 8.76%), while that of central and western regions have increased by 78.23% (equivalent to an annual compound growth rate of 8.61%), similar to LPI measurement. It indicates that COL index of eastern region is higher than that of the central and western regions for both the total and the average growth rate. In particular, due to the global financial crisis, the aggregate COL index for all the cities and regions increased rapidly in 2008, showing an inverted-V trend during the sample period.

Table 2 presents the decomposition of the aggregate COL index growth for four major categories based on the Eqs. (3) and (5). It evaluates the contribution of each category to the total growth of COL index.

Taking TPI as an example, 34.84% of the aggregate COL index growth for all cities can be attributed to Food and Beverage, and the relative expenditure share is 42.58%. Services is the second largest contributor to 29.81% of the aggregate COL index growth, and the relative expenditure share is 35.55%. While the contribution to the aggregate COL index by Clothing and Household Appliance, respectively, 13.60% and 0.50%, are relatively small. Viewed by regions, the results are basically similar to all cities, while the relative expenditure share of Food and Beverage in the central and western regions is higher than that in the eastern region, but the relative expenditure share of Services in central and western regions is lower than that in the eastern region, which confirms 'Engel's law'. Households in eastern region have high per capita disposable income and consumer more household appliances and services, and COL index of eastern region has risen more than that in the central and western regions. The results estimated by LPI is similar to the TPI results, while the LPI overestimates COL index of Food and Beverage and Services.

Table 3. Consumption effect for tradable goods.

	(1) TPI	(2) TPI	(3) TPI (2SLS)	(4) LPI	(5) LPI	(6) LPI (2SLS)
ln*tariff*	0.0644***	0.0752***	0.1479***	0.0706***	0.0825***	0.1728***
	(0.0084)	(0.0094)	(0.0153)	(0.0096)	(0.0106)	(0.0190)
ln*NTM*	−0.1772***	−0.1780***	−0.3079***	−0.1642***	−0.1689***	−0.2622***
	(0.0245)	(0.0298)	(0.0593)	(0.0252)	(0.0302)	(0.0591)
ln*wp*	0.1481***	0.1481***	0.0874***	0.1863***	0.1863***	0.1202***
	(0.0193)	(0.0193)	(0.0321)	(0.0213)	(0.0213)	(0.0371)
ln*tariff* **region*		−0.0364*	−0.0780**		−0.0403*	−0.0653*
		(0.0188)	(0.0309)		(0.0216)	(0.0363)
ln*NTM***region*		0.0251*	0.0399*		0.0191*	0.0152*
		(0.0148)	(0.0233)		(0.0152)	(0.0433)
City-year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
City-product fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	29,561	29,561	25,683	29,561	29,561	25,683
R-squared	0.666	0.666	0.922	0.606	0.606	0.922

Notes: Estimated coefficients are reported with robust standard errors, clustered at the city level in parentheses. ***, **, * indicates statistical significance at the 1%, 5% and 10% levels, respectively.
Source: Authors' Estimation.

4.3. The empirical results for the tradable goods

After analyzing the key variables in the previous section, we use fixed effects model to estimate the consumption effect of trade liberalisation on COL index of tradable goods at city-product level for both tariffs and NTMs.

Table 3 shows the estimation results of Eq. (7). We find that the coefficients of tariffs and world prices satisfy expectations very well in our benchmark and 2SLS estimation. Tariffs and world prices have significantly positive impact on COL index. It indicates that the reduction of tariffs and world prices will decrease COL index for tradable goods, and can improve the consumption welfare in Chinese cities. Specifically, the pass-through rates of tariffs are less than one. The results identify the imperfect pass-through mechanism of tariffs, which are in consistent with the existing evidence (Han et al., 2016; Marchand, 2012; Nicita, 2009; Wang & Qian, 2020).

We also identify the imperfect pass-through mechanism of NTMs. The coefficients of the incidence of NTMs are also less than one in our benchmark and 2SLS estimation. However, the sign of coefficients is significantly negative. It means the high incidence of NTMs can decrease COL index for tradable goods. There are two possible explanations. First, China implemented an export-oriented trade policy, with insufficient emphasis on imports, during the period of 2002–2009. For a large economy like China, the terms of trade may decrease the price because of the import protection (Chen et al., 2014; Dean et al., 2009; Soderbery, 2021). Second, as a developing country, the per capita disposable income for Chinese households is relatively lower than developed countries. Since NTMs have mainly related to the product quality, which may reduce the import of high-qualified products with high prices (UNCTAD, 2018), lowering the prices of domestic consumption products and decreasing COL index. The results also affirm empirical literature that the price effects of NTMs are country-specific (Cadot & Gourdon, 2016; Giordani et al., 2016; Knebel, 2010).

We believe that the spatial effect is one of the main reasons for imperfect pass-through mechanism. We discuss spatial effect in different regions through the

Table 4. The responses of COL index of non-tradable services.

	(1) Transport and Communications	(2) Education	(3) Health	(4) Family	(5) Housing	(6) Entertainment	(7) Other services
Food and Beverage	0.2974***	0.4130***	0.6281***	0.2680	0.3147	0.0813	0.3134
	(0.0780)	(0.1543)	(0.1682)	(0.2933)	(0.4253)	(0.1953)	(0.2677)
Clothing	0.2030***	0.2285***	0.0442	0.4258**	0.2429	0.6604***	0.1887
	(0.0364)	(0.0751)	(0.0760)	(0.1767)	(0.1929)	(0.0976)	(0.1556)
Household Appliance	0.0142	0.0712**	0.1038***	0.1127*	−0.0363	0.0506	−0.0272
	(0.0133)	(0.0299)	(0.0290)	(0.0642)	(0.0641)	(0.0417)	(0.0493)
L. dependent variable	0.3548***	0.2525***	0.1175**	0.2067***	0.2710***	0.0975**	0.3401***
	(0.0586)	(0.0434)	(0.0471)	(0.0436)	(0.0665)	(0.0413)	(0.0513)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	931	931	931	931	931	931	931
Wald χ^2 test	388.37	276.04	674.63	317.31	385.31	466.43	443.34

Notes: Estimated coefficients are reported with robust standard errors, clustered at the city level in parentheses. ***, **, * indicates statistical significance at the 1%, 5% and 10% levels, respectively.
Source: Authors' Estimation.

following interaction analysis. The interaction coefficients of tariffs and eastern region dummy are significantly negative and the interaction coefficients of NTMs and eastern region dummy are significantly positive at 10% level. It indicates that tariffs reduction and the high incidence of NTMs have a relatively greater marginal effect on the reduction of COL index in central and western regions on average, which can adjust the consumption inequality across regions. The possible reasons are as follows: China has implemented the Special Economic Zones (SEZ) in eastern region since the 1980s. On the one hand, the prices in eastern region have been relatively low due to more fierce import competition than that in central and western regions. Tariffs reduction has a greater marginal effect on COL index in central and western regions. On the other hand, the trade structure of eastern region is dominated by export-oriented industries, and more firms engage in the processing trade through the import of intermediate products. It is less likely to be imposed by NTMs due to foreign retaliation or a larger trade restriction on import values of manufactured products (Bao, 2014; Grübler et al., 2016; Lee & Swagel, 1997; Trefler, 1993). Different import and export sectors in different regions determine that the effects of NTMs are diverse. The high incidence of NTMs has a relatively greater marginal effect on COL index in central and western regions.

4.4. The responses of COL index of non-tradable services

We further estimate the elasticities of COL index of non-tradable services responds to that of tradable goods, to examine the overall consumption effects of trade liberalisation on COL index.

Table 4 presents the estimation of Eq. (8) for TPI measurement. The results show that the elasticities of non-tradable services are different in response to different tradable goods. For example, COL index of Food and Beverage is positively related to that of Transport and Communications, Education and Health services. COL index of Household Appliance is significantly positive with that of Education, Health and Family services, while it is negative, not significant with that of Housing and Other

Table 5. Heterogeneous effects on agricultural and manufactured goods.

	(1) TPI-Agri	(2) TPI-Manu	(3) LPI- Agri	(4) LPI- Manu
ln*tariff*	0.0246***	0.2556***	0.0041	0.3660***
	(0.0075)	(0.0310)	(0.0093)	(0.0348)
ln*NTM*	−0.0237*	−0.3132***	−0.0408***	−0.2509***
	(0.0123)	(0.0366)	(0.0110)	(0.0388)
ln*wp*	0.0268***	0.1335**	0.0345***	0.1474**
	(0.0085)	(0.0550)	(0.0094)	(0.0609)
Fixed effects	Yes	Yes	Yes	Yes
observations	19,152	10,409	19,152	10,409
R-squared	0.828	0.640	0.762	0.601

Notes: Estimated coefficients are reported with robust standard errors, clustered at the city level in parentheses. ***, **, * indicates statistical significance at the 1%, 5% and 10% levels, respectively.
Source: Authors' Estimation.

services. The possible reason is that the price of non-tradable services will endogenously adjust to the price of tradable goods so that the market is cleared in general equilibrium. However, these elasticities can show any sign because of the complex responses (Casabianca, 2016; Han et al., 2016; Porto, 2006). COL index of non-tradable services and tradable goods mostly change in the same direction. It indicates that trade liberalisation can also indirectly reduce COL index of non-tradable services in Chinese cities through the elasticities of tradable goods and non-tradable services.

4.5. Heterogeneity analysis

First, we explore heterogeneity across sectors to investigate how the expenditure shares of imported goods in Chinese cities, namely, demand effects, affect imperfect pass-through mechanism. Table 5 shows the estimation of Eq. (7) for each sector. We find that tariffs reduction and the high incidence of NTMs can reduce COL index for agricultural and manufactured goods. However, the pass-through rates of agricultural goods are lower than that of manufactured goods. It indicates that manufactured goods have a larger effect than agricultural goods. Similar results are found for TPI and LPI estimation. The possible reasons are as follows. On the one hand, the agricultural goods have a lower import penetration and demand elasticity than manufactured goods (Han et al., 2016; Simonovska, 2015). On the other hand, the imports of agricultural goods are usually used for final consumption. Compared to intermediate inputs of manufactured goods, the tariffs and NTMs have a greater impact on the intermediate inputs (Grübler et al., 2016). The results indicate that cities with a high expenditure share of manufactured goods have a larger effect on the reduction of COL index.

Second, we also believe that the competition effect is another reason for imperfect pass-through mechanism. We provide further empirical evidence to explore the competition effects across cities from the perspectives of city size and level of privatisation. Table 6 shows the estimation of Eq. (7) separately. We conclude that tariffs have a larger marginal effect on COL index in small cities and cities with high level of privatisation, while the incidence of NTMs have a larger marginal effect, significantly, on COL index in small cities and cities with lower level of privatisation.

Table 6. Heterogeneous effects across cities.

	(1) TPI-LC	(2) TPI-SC	(3) LPI-LC	(4) LPI-SC	(5) TPI-HP	(6) TPI-LP	(7) LPI-HP	(8) LPI-LP
Ln*tariff*	0.0445***	0.0701***	0.0469***	0.0786***	0.0523***	0.0414***	0.0526***	0.0475***
	(0.0119)	(0.0108)	(0.0153)	(0.0118)	(0.0161)	(0.0104)	(0.0200)	(0.0111)
ln*NTM*	−0.1749***	−0.1858***	−0.1517***	−0.1724***	−0.1318***	−0.1461***	−0.1141**	−0.1390***
	(0.0307)	(0.0426)	(0.0421)	(0.0312)	(0.0413)	(0.0319)	(0.0445)	(0.0309)
Ln*wp*	0.1763***	0.1377***	0.1788***	0.1863***	0.0805**	0.1443***	0.1059**	0.1879***
	(0.0392)	(0.0216)	(0.0417)	(0.0248)	(0.0375)	(0.0250)	(0.0406)	(0.0269)
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,097	21,383	7,987	21,434	13379	15617	13379	15617
R-squared	0.695	0.657	0.638	0.596	0.750	0.641	0.705	0.577

Notes: LC is large city, SC is small city, HP is high privatisation, LP is low privatisation. Estimated coefficients are reported with robust standard errors, clustered at the city level in parentheses. ***, **, * indicates statistical significance at the 1%, 5% and 10% levels, respectively.
Source: Authors' Estimation.

There are two possible explanations. First, in small cities, the competition effects caused by tariffs reduction decreases COL index more than that of large cities. That is because for a large number of intermediaries with great market power agglomerated in large cities, they may absorb the proportion of the tariff pass-through (Atkin & Donaldson, 2015). The small cities with low per capita disposable income actually demand more low-qualified products than the large cities (Handbury, 2021). The high incidence of NTMs can hinder the import of high-qualified products. Therefore, the high incidence of NTMs decrease COL index in small cities. Second, the high level of privatisation will improve the efficiency and competition within domestic industries (Bai et al., 2009; Brandt et al., 2012; Huang & Zhu, 2022). The high privatisation is usually associated with a high share of private sector, which will increase the price transmission (Han et al., 2016). Hence, tariffs reduction can decrease COL index in high privatisation cities more than that in low privatisation cities. Similar as the small cities, Cities with low privatisation demand more low-qualified products than cities with high privatisation. Therefore, the high incidence of NTMs decrease COL index for cities with low privatisation.

5. Conclusion, implications and limitations

We investigate the overall and heterogeneous consumption effects of trade liberalisation through changes in the cost of living in Chinese cities. We use the tariffs reduction and the incidence of NTMs to quantify trade liberalisation and identify the imperfect pass-through mechanism at city level. We conclude that tariffs reduction and the high incidence of NTMs can decrease cost of living in Chinese cities. It improves the overall consumption welfare and narrows down the regional disparities. The consumption effects are heterogeneous due to the diverse spatial effects, demand effects and competition effects across Chinese cities. Cities consume more manufactured goods can enjoy more reduction of cost of living. Small cities benefit more from tariffs reduction and the high incidence of NTMs than large cities. Cities with more private economy also enjoy more than tariffs reduction, however cities with less private economy actually enjoy more from the high incidence of NTMs.

Our study can provide some implications for China's trade policy and high-quality regional synergy strategy in the new era. China should make a more comprehensive opening-up strategy to continuously promote the process of trade liberalisation and improve the overall consumption welfare in cities. Specifically, China should further implement the market-oriented reforms to increase the level of privatisation in Chinese cities. In addition, China should also formulate different trade policies to support the development of small cities and implement a more equal payment transfer policy, to narrow down the actual welfare disparities across regions and also to better practice the high-quality regional synergy strategy.

Limitations of this study are as follows. First, the fixed effects model is the standard approach in related literature and can control for city-specific unobserved heterogeneity. However, the different pass-through rates across cities are also affected by many factors such as mark-ups of intermediaries and local producers' substitutes prices. We are not able to incorporate these variables since these data are not accessible for most cities during the sample period. For further research, we will supplement the study if data is updated. Second, as for NTMs, in practice, a large number of products have more than one NTM, which could be subject to SPS as well as TBT, or other measures. The frequency index does not take into account for that whether more than one type of NTMs is applied to the same product. In addition, the incidence of NTMs has a negative impact on the cost of living. It does not mean that more types of NTMs are better, because if these NTMs have totally binding constraints, there will be no import for related goods. The prices may be increase due to lack of competition with foreign exporters (Dean et al., 2009). For further research, we will distinguish the different effects for different types of NTMs.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes

1. Data from WITS database.
2. The non-tariff measures (NTMs) and non-tariff barriers (NTBs) are often used interchangeably in the literature.
3. Data from the National Bureau of Statistics of China (NBS).
4. Food and Beverages are classified as agricultural product, while Clothing and Household Appliances are classified as manufactured product.
5. The provinces contain Shanxi, Liaoning, Heilongjiang, Jiangsu, Anhui, Jiangxi, Shandong, Henan, Hubei, Guangdong, Sichuan, Yunnan and Gansu. The municipalities contain Beijing, Shanghai and Chongqing.

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Appendix

Table A1. Concordance UHS consumption items with 4-digit SITC categories and HS6 products.

items	4-digit SITC categories	HS6 products
grain	411;412;421;422;423;430;441;449; 451;452;453;459	100110;100190;100610-100640;100310;100390; 100510; 100590;100200;100400; 100700;100810-100890
starch	5921	110811-110820;110900
Edible Oil	4113;4211;4212;4213;4214;4215;4216; 4217;4218;4221;4222;4223	020900;150200-150600;150710;150790; 151221;151229;150810-150990;151000; 151211;151219;151521;151529;151411-151499; 151550;151511;151519;151110;151190; 151311;151319
Pork	13;122;161;175	010310;010391;010392;020311-020329; 021011-021019;160241-160249
Beef	11;111;112;176;179	010210;010290;020110-020130;020210-020230; 160250;160290
Lamb	12;121	010410;010420;020410-020450
Chicken	14	010511-010519;010592-010599
Egg	251;252;253	040700;040811-040899;350211;350219
Fish	341;342;344;345;351;352	030110-030270;030331-030380;030410-030490; 030551-030569
Shrimp	361;362	030611-030619;030621-030629
Vegetable	541;542;544;545;546;547;548; 561;564;566;567	070110-070990;070951;070952;071010-071090; 071120-071190;071410-071490;071220-071290; 121210-121299;121010-121020;110510-110630; 200110-200590
Fruit	571;572;573;574;575;576;579	080300;080510-080590;080420;020610;080620; 081310-081350;080820-080940
Cake	484;485	190520;190531;190532;191120
Milk	221;222	040110-040130;040210-040299
White wine	1124	220820-220890;210610;210690
Fruit wine	1121;1122	220410-220600
Beer	1123	220300
Cola	1110	220100-220290
Tea	741;743	090210-090240;090300;210120
Clothes	8411;8412;8413;8414;8415;8416;8431;8432; 8437;8438;8421;8422;8423;8424;8425; 8426;8427;8428;8441;8442;8447;8448	620111-620199;620311-620329;620311-620339; 620341-620349;620510-620590;620711-620729; 620791-620799;610110-610190;610311-610349; 610510-610590;610791-610799;610711-610729; 620211-620293;620411-620429;620431-620439; 620441-620449;620451-620459;620461-620469; 620610-620690;620891-620899;620811-620829; 610210-610290;610411-610459;610610-610690; 610891-610899;610811-610839
Shoes	8511;8512;8513;8514;8515;8517;8519	640110-640340;640212-640411;640191-640299; 640320-640510;640419-640520;640590-640699
Washing machine	7751	845011-845121
Refrigerator	7752	841810-841840
Air Conditioner	7758	851610-851690
Television	7611;7612	852812-820830
Motorcycle	7851	871110-871190
Sound	7638	852110;852190;852530;852540;851910-851929; 851940;851992-851999;852010-852090
Heater	7418	841911-841989;842119;842489;845610-845699; 846221-846599;847720-847989;851410-851580; 854311;854389;901041-901050
Telephone	7641	844351;847160;847180;851711-851780; 852510-852790;900911;900912
Camera	8811;8812;8813	900610-900699;900711-900792;900810-900890; 841989;841990;842119-842490;843139; 845610-845699;846221-846694;847720-847990; 851410-851590;854311-854390; 901010-901090;901190-901790
Watch	8853;8854;8855	910111-910199;910211-910299;910810-910890