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Population, Land, and the Development of the Commodity Economy: Evidence from Qing Dynasty China

Jiale Wan [1], Qian Dai [1] and Shuangyou Miao [1,2,*]

[1] School of Economics, Zhongnan University of Economics and Law, Wuhan 430073, China; jiale910314@163.com (J.W.); daiqianecon@163.com (Q.D.)
[2] School of Economics, Fudan University, Shanghai 200433, China
* Correspondence: shuangyou@fudan.edu.cn; Tel.: +86-13260598226

Abstract: Population growth exacerbates the pressure on land carrying capacity, affecting the sustainability of agricultural production, and also impacts non-agricultural industries. This paper utilizes grain price data from southern China during the Qing Dynasty (1776–1910) to examine the impact of population and land pressure on the development of the commodity economy under the "involution" of smallholder agriculture. This study finds that under conditions of stagnant technological advancement and limited natural resources, population growth during the Qing Dynasty created significant "Malthusian" population pressure. This pressure on land first resulted in the over-concentration of agricultural labor and saturation of the farming population. Surplus labor, unable to be absorbed by agriculture, shifted to non-agricultural sectors, engaging in the transportation and trade of grain. The pressure on land carrying capacity facilitated the cultivation and processing of cash crops, and product trade was supported by efficient waterway transportation. These activities generated commercial profits that alleviated survival pressures and promoted the prosperity of the commodity economy. However, this prosperity did not accompany significant productivity improvements; instead, it was a product of "involution" agriculture under high population density pressures.

Keywords: population pressure on land; involution; commodity economy; traditional society

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1. Introduction

Population growth places significant pressure on land, affecting not only the sustainability of agricultural production but also the ecological environment and socio-economic stability. As the population increases, the amount of arable land per capita decreases. To maintain their livelihoods, farmers are compelled to engage in more intensive farming practices on limited land, leading to the "involution" of agriculture. Due to limited land resources, a large portion of agricultural labor cannot be fully absorbed, resulting in an excess agricultural workforce. Consequently, some of the surplus labor is forced to transition to non-agricultural industries, engaging in other economic activities.

We focus on Qing dynasty China primarily for the following reasons: first, the Qing dynasty experienced unprecedented population growth. The rate and scale of population increase were unparalleled in previous dynasties, creating immense Malthusian population pressure due to limited arable land. The "Great Divergence" period of the Ming and Qing dynasties left a distinct mark of rapid population growth. The Qing dynasty was a time of dramatic population expansion, with a population explosion in the mid-Qing period. During the Daoguang era, the population exceeded 400 million for the first time, representing a demographic miracle. This massive population contributed to the prosperity of a predominantly smallholder society but also brought unprecedented pressure on land resources. Second, technological progress in Qing China was stagnant. Population pressure could not be alleviated by increasing agricultural productivity, and the surplus population gradually shifted from agricultural production to non-agricultural sectors such as commodity trade, promoting the prosperity of the market economy. Third, the Qing dynasty saw a highly prosperous commodity economy, characterized by an unprecedented degree of agricultural production commercialization. In the Jiangnan region, handicrafts evolved from the household sidelines to the main means of livelihood for farmers. There emerged specialized divisions of labor in handicrafts, and the cultivation of cash crops became more widespread, significantly increasing the degree of commercialization. Fourth, agricultural production in Qing China became more specialized, with clear regional divisions of labor. Natural endowment advantages led to the specialized cultivation of certain economic crops in specific areas, forming specialized divisions of labor and improving production efficiency. Finally, the Qing dynasty developed an extensive waterway transportation network, particularly in the southern regions. The diverse topography and dense river systems in these areas created a unique and complex natural water network. Utilizing these natural waterways, the southern regions developed an efficient waterway transportation network. Water transportation played a crucial role in connecting different regions and facilitating the exchange of people, goods, and culture.

Historically, population development exhibited cyclical fluctuations, with several periods of leap-like growth [1]. In the late Ming period, the actual population approached 200 million. In the early Qing dynasty, the population quickly recovered from wartime losses, increasing from approximately 150 million during the Kangxi reign to 430 million by the Daoguang reign [2]. During the "Great Divergence" era, the Qing dynasty experienced a different development trajectory from the West. The demand for labor in social production stimulated continuous population growth. Under the existing technological conditions, a large population was employed in intensive agricultural production to increase land output, resulting in some overall growth in the agricultural economy. However, with stagnant technological advancement, this explosive population growth did not lead to transformative changes in traditional agricultural society. Instead, it exhibited diminishing marginal returns in agricultural production, a phenomenon described as the "involution" of the smallholder economy [3].

The carrying capacity of arable land and traditional agricultural production could not sustain the surplus population. Land pressure forced an increasing number of people into non-agricultural sectors, engaging in handicrafts, commerce, and water and land transportation. This shift promoted the commercialization of agricultural products and market development, with the domestic commodity market remaining generally prosperous and trade continuing to flourish. This high level of prosperity, derived from the crisis in traditional agricultural production, was not a precursor to modernization. Instead, it was driven by survival needs under a high population density, resulting in what Huang termed "involution" due to diminishing labor returns [4].

Population growth, resource constraints, and economic development have long been intertwined issues. As early as the 18th century, Malthus posited that while population increases geometrically, the means of subsistence can only grow arithmetically, suggesting that the supply of resources may never be able to meet the needs of a growing population [5]. He argued that mechanisms such as war, famine, and moral restraint would reduce the population to levels that align with the available resources, thereby maintaining the per capita food supply at the minimum survival level and causing society to fall into a Malthusian trap. Malthus's theory sounded an alarm for long-term economic development and significantly influenced contemporary and later economic thought. The Club of Rome has tended to attribute modern issues like the energy crisis, resource depletion, and war to population pressure [6]. Following Malthus's path, pessimists also viewed population growth as opposed to economic development from a fixed technological perspective, explaining the conflict between population and resources through static internal logic [7]. When considering technological progress, the Malthusian growth model is disrupted, and the economy transitions into a phase of modern growth [8]. If we move beyond a static perspective, we can better appreciate the positive significance of population growth for economic development. To some extent, a large population stimulates technological change and improves economic efficiency [9]. Even in the absence of major technological innovations, different institutional arrangements can lead to varying economic performances. North emphasized that the key to long-term economic growth lies in institutional factors rather than technological ones, suggesting that population growth drives institutional innovation and change [10]. Acemoglu and Robinson, in explaining the differences in economic development levels and the rise and fall of civilizations between countries, attributed these differences to institutions [11].

However, in pre-industrial societies, technological stagnation was the norm, and institutional changes were relatively slow during stable periods. The impact of population pressure on the economy was complex and subtle. Generally, as population growth was constrained by the supply of subsistence, population pressure could lead to economic stagnation, causing society to fall into a Malthusian cycle. From another perspective, however, breaking away from traditional Malthusian thinking, population pressure could also drive the intensification of agricultural production and technological innovation, thereby promoting agricultural development [12]. The agricultural sector, bearing significant population pressure, faced major challenges regarding the sustainability of production systems and the efficient use of resource bases. Population pressure could thus transform into a driving force for the commercialization of agriculture [13]. By dynamically adjusting resource endowments, different agricultural technological changes could be induced, thereby fostering economic development. After the era of the "Great Divergence", traditional China lagged far behind the West, experiencing long-term technological stagnation and slow development. Unlike Western industrial and commercial civilizations, traditional China's smallholder economy was deeply entrenched. In this agrarian society, population pressure gave rise to numerous issues, becoming a constraint on socio-economic development and structural transformation. Traditional Chinese society fell into a Malthusian cycle, exhibiting a pattern of historical cyclicality and alternating periods of order and disorder [14,15].

In depicting the smallholder economy in rural North China, Huang introduced the concept of "involution" [16]. He argued that the immense population pressure during the Qing dynasty was not alleviated through industrialization but rather absorbed within the agrarian economy at the cost of labor productivity. Earlier, Geertz used the term "overintensification" to describe the phenomenon of diminishing marginal returns in crop cultivation due to excessive labor input [17]. Huang focused on the agricultural economies of rural North China and the Yangtze Delta, developing the "involution" theory. He posited that due to massive population growth, agriculture adopted an intensive farming model to absorb the large labor force. While this over-concentration of labor led to an increase in the total agricultural output, it came at the cost of continuously diminishing the marginal returns on labor and stagnant labor productivity—what he termed "growth without development" [3]. Chen and Liu supported this view, summarizing the "non-economic orientation" of the Qing dynasty's market mechanisms [18]. However, Huang's arguments about the "involution" of the traditional Chinese smallholder economy have faced criticism and prompted new perspectives. Yan, from the standpoint of monetary supply, measured the development of the commodity economy during the Qing dynasty and reached the opposite conclusion [19]. He argued that "involution" only occurred during economic downturns and that population pressure was not the cause of commodity economic development. Instead, the development of the commodity economy and the improvement of social division of labor increased the demand for labor, driving continuous population growth.

The concept of "involution" remains centered on traditional agriculture, with fluctuations in grain prices across regions reflecting the development of an agriculture-based commodity economy and indicating the degree of market integration. The unique historical context of the Qing dynasty serves as a natural quasi-experiment, providing a setting to observe the impact of population and land pressure on the commodity economy under agricultural "involution". This paper utilizes the monthly average prices of medium-grade rice from 160 prefectures across 12 southern provinces during the Qing dynasty to construct an indicator of commodity economic development based on the linear correlation coefficients of the grain prices. This approach identifies the impact of population and land pressure on the development of the commodity economy and clarifies the economic implications of "involution" for commercial development.

The contributions of this paper are as follows: this study enriches the existing literature on the relationship between population, land, and long-term economic growth. By delving into the issues of commodity trade and market integration during the Qing dynasty from the perspective of population growth, this study provides historical empirical evidence for understanding the dynamics between population, land, and economic development in contemporary society. Additionally, it deepens our empirical understanding of the effects of population growth, which will be beneficial for future research on the interplay between population, land, and economic growth.

2. Historical Background and Mechanism Analysis

2.1. Historical Background

2.1.1. Population and Land in the Qing Dynasty: Intensifying Population–Land Conflicts

During the Qing dynasty, China experienced an unprecedented population boom, unparalleled in previous dynasties. Before the Qing dynasty, China's population fluctuated with the rise and fall of dynasties, reaching a peak of over one hundred million. During the turbulent transition between the Ming and Qing dynasties, political instability led to significant population losses. In the early Qing period, a period of recuperation and rebuilding allowed the population to steadily recover, reaching approximately 100 million during the Kangxi era. The mid-Qing period marked a significant phase of population growth. By 1741, during the sixth year of Qianlong's reign, the registered population was about 140 million. This number continued to climb annually, reaching nearly 300 million by the end of Qianlong's reign and surpassing 400 million by the Daoguang period (1821–1850) [20]. Figure 1 visually presents the population trend changes during the Qing dynasty.

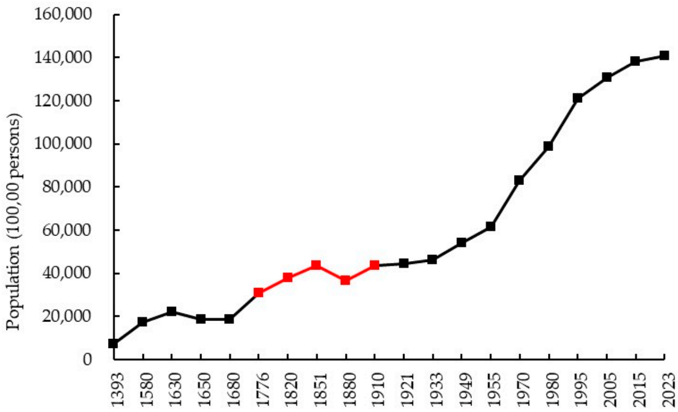

Figure 1. Changes in China's population (1393–2023). Notes: (1) Source: Cao's book "*Population History of China: Volume 5 (Qing Dynasty)*" [21]. (2) The Qing dynasty, which ruled China from 1644 to 1911, experienced its most rapid population growth during the "Kang–Qian Flourishing Age" from 1681 to 1796. (3) The population change in China during the research period (1776–1910) is shown as a red line.

The "population miracle" of the Qing dynasty was rooted in a period of peace and prosperity and was the result of a combination of political, economic, and social factors. In the early Qing period, political stability gradually increased, and the rulers of the Kangxi, Yongzheng, and Qianlong reigns encouraged land reclamation and improved water conservancy and supported the well-being of the people. This led to sustained economic prosperity and rapid population recovery and growth [22]. A key factor in this population growth was the reform of the tax and labor system. In the 51st year of Kangxi's reign (1712), the policy "population growth in times of prosperity, no increase in taxes" was implemented, and from the first year of Yongzheng's reign (1723), the "per capita land tax" was widely promoted, reducing restrictions on population growth and revealing a large hidden population. The deepening and widespread implementation of household registration systems and the expansion of the empire's territorial control also significantly contributed to population growth [23]. Furthermore, the crop structure was adjusted and optimized, with the promotion of high-yield crops such as corn and sweet potatoes, which greatly increased grain production and facilitated a significant rise in population [24].

Land is the most crucial resource for agricultural production. During the Qing dynasty, the ever-increasing population outpaced the supply of land, which could not support the survival needs of the rapidly growing population. Wars at the end of the Ming dynasty and the beginning of the Qing dynasty led to peasant migrations and abandoned fields. However, large-scale migration and land reclamation from the Shunzhi to Yongzheng periods partially restored the total arable land [25]. Despite this, from the Qianlong to the Jiaqing periods, the population grew rapidly while the increase in arable land was minimal [26], leading to the near-saturation of cultivated land. This imbalance between rapid population growth and slow land expansion inevitably exacerbated population–land conflicts. The mid- to late Qing dynasty saw the lowest historical per capita arable land, with significant fluctuations during the Kangxi and Qianlong periods [27], leading to a severe deterioration in the population–land ratio. Figure 2 compares the potential per capita arable land in the southern regions during the mid- to late Qing dynasty, showing a continuous decline in per capita arable land from the Qianlong to Guangxu periods. The intensifying population–land crisis aggravated social conflicts. The transmission of agricultural techniques, heavily reliant on human labor, struggled to sustain long-term economic growth [28]. Technological progress stagnated, labor productivity remained low, and grain supply could not meet demand. Even in years of good harvest, food shortages persisted, and rice prices did not significantly decrease. Grain price increases were noted across regions starting from the late Kangxi period. Moreover, the worsening population–land ratio meant the land could not absorb more labor. Coupled with the trends in land concentration, the prevalence of tenant farming relationships expanded within the economy [29]. Landless or land-poor agricultural laborers became tenants or agricultural workers, while others shifted away from farming to other occupations. The proportion of non-agricultural populations, such as artisans, merchants, salt workers, and itinerants, also showed an increasing trend [30,31].

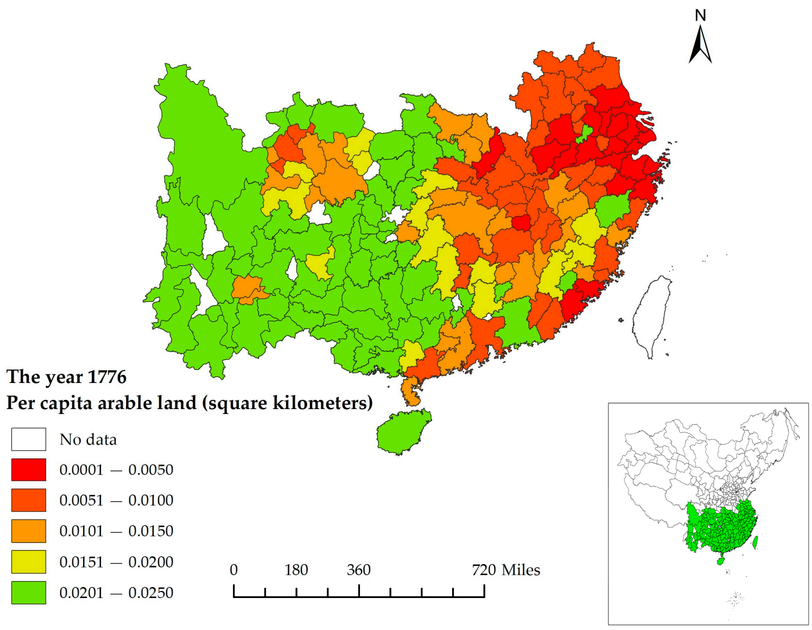

Figure 2. *Cont.*

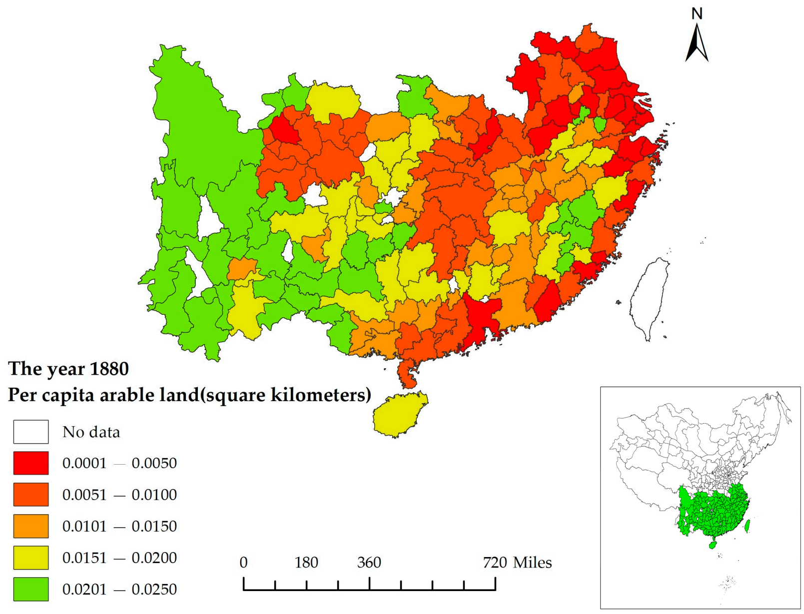

Figure 2. Comparison of potential per capita arable land in southern regions during the mid- to late Qing dynasty. Note: (1) Source: Cropland data are organized according to the GAEZ database; population data are from Cao's book "*Population History of China: Volume 5 (Qing Dynasty)*" [21]. (2) Per capita cropland unit: square kilometers. (3) The delineation of prefectural boundaries is generated based on the CHGIS vector map of Qing dynasty administrative divisions (1820).

2.1.2. The Prosperity of Commercial Trade in the Qing Dynasty

During the Qing dynasty, the commercial economy was exceptionally active, marked by the expansion of domestic markets, flourishing long-distance trade, and a well-developed merchant network. Large-scale merchants accumulated significant capital, and specialized industrial and commercial towns emerged in economically advanced regions. The development of regional specialization and labor division was remarkable, forming an economic structure centered around the Yangtze River Delta, with the eastern, central, and western regions serving as its hinterlands. Merchant groups, such as the Huizhou and Shanxi merchants, grew based on geographic ties, creating regional merchant organizations and establishing a nearly nationwide interregional commercial network [32]. Rural markets experienced significant growth, increasing in density and forming a three-tiered urban–rural market network system, comprising circulation hub cities, medium-sized commercial towns, and rural markets [33]. The unique political and social environment of the Qing dynasty nurtured the prosperity of the commercial economy. A comprehensive waterway network facilitated the flow of goods, with land routes centered on provincial official roads and water routes based on the Grand Canal, the Yangtze River system, and the Pearl River system, covering the entire nation and laying the foundation for interregional trade and market integration. The relaxation of land relations and the highly developed land rights market unleashed farmers' productive potential and enhanced merchants' economic strength [34]. Policies favoring and benefiting merchants created a conducive business environment, protecting merchant interests and accelerating the accumulation of commercial capital. The influx of hard currency, such as gold and silver from the Americas and Southeast Asia, stimulated the Chinese economy and promoted commercial development [19].

The commercial prosperity of the Qing dynasty is notably characterized by the unprecedented commercialization of agricultural production. During the Ming and Qing periods, particularly in the Jiangnan region, private handicrafts began to dominate, no longer serving merely as a supplementary household activity but becoming the primary means of livelihood for farming households. This period also saw the emergence of specialized divisions of labor within the handicraft industry [35]. The cultivation of cash crops became increasingly widespread, significantly enhancing the degree of commercialization.

For instance, in areas like Songjiang and Taicang in Jiangsu, cotton cultivation became predominant, leading to a situation where "only two or three out of ten farmers focused on rice cultivation, while seven or eight were engaged in cotton farming for profit" [36]. It is crucial to note that the essence of agricultural production commercialization lies in a shift in the production objectives. During the Qing dynasty, agricultural output far exceeded the needs for self-sufficiency, closely resembling production aimed at exchange and even serving to accommodate surplus labor. This form of production, which diverged from mere subsistence to profit-oriented activities, has been termed "the non-market orientation of peasant economic activities" [18].

Superficially, the prosperity of the commodity economy in the Qing dynasty appears to indicate a leap towards an industrial and commercial society. However, following the logic of Huang Zongzhi's "involution" theory, this prosperity can be viewed as a product of "involuted" agriculture. The development of the commodity economy during the Qing dynasty was fundamentally agricultural at its core, with non-agricultural industries being inseparable from agriculture. Handicrafts and cash crop production primarily served agricultural purposes. As the population increased, additional labor was absorbed into intensive farming practices. When the population grew further, those who could not be absorbed by agriculture were pushed into related commercial activities. In the mid-Qing period, rural markets were highly developed, and areas with higher population densities also had denser rural markets. The diversity of goods traded on the market was extensive, and examining the commodity economy through the lens of grain trade proves to be an effective approach. Farmers cultivated grain not only to meet their own needs but also to sell the surplus on the market for daily necessities and tax payments. Grain trading was widespread, with long-distance commercial activities aimed at trade becoming more common. The grain market in the Qing dynasty was highly developed, with grain crops constituting a significant portion of commodity transactions, approximately one-third of the total trade value [37]. Merchants involved in grain trade often dealt with other goods, and the transportation routes for grain often overlapped with those for other commodities. The grain market thus reflects the integration of other markets to a significant extent [38]. Moreover, grain trade is directly related to agricultural production, serving as an effective indicator of the impact of agricultural "involution". Figure 3 shows the grain price fluctuations in southern China during the Qing dynasty (1741–1910).

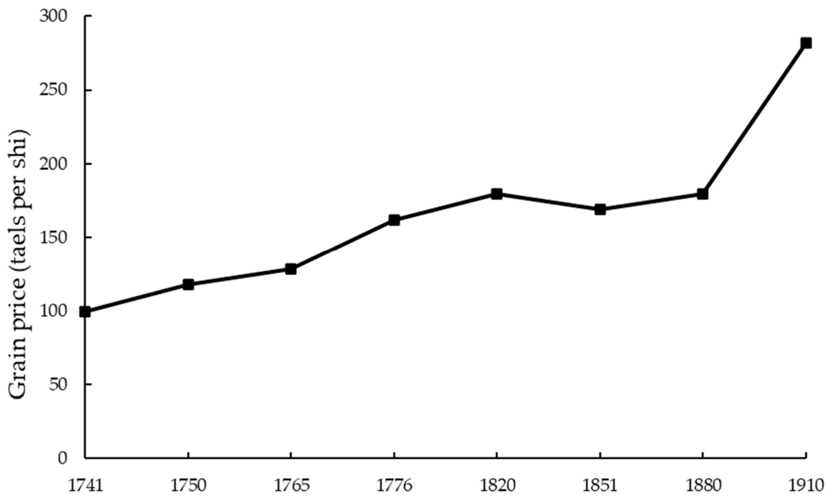

Figure 3. Grain price fluctuations in southern China during the Qing dynasty (1741–1910). Notes: (1) Source: Cao's book "*Population History of China: Volume 5 (Qing Dynasty)*" [21]. (2) The rice price data used in this study are sourced from Wang's "Qing Dynasty Food Price Database", which belongs to "Modern History Data Base (MHDB)".

2.2. Mechanism Analysis

The historical facts of population and commodity economy development in Qing dynasty China delineate the relationship between population size and socio-economic growth. The unprecedented population growth during this period exerted immense pressure, compelling an increasing number of people to seek livelihoods in non-agricultural sectors, engaging in commodity economy activities related to agriculture. This paper analyzes the mechanisms through which population pressure influences the development of the commodity economy from the perspectives of resource endowment effects and transportation network effects and proposes research hypotheses.

2.2.1. A Resource Endowment Effect

Different countries and regions have developed unique economic paths and industrial structures due to variations in their resource endowments. Areas with distinctive natural resources and geographical advantages often enjoy a resource advantage in economic activities. This advantage typically stems from the abundance, accessibility, or cost-effectiveness of specific resources, creating favorable conditions for local economic development and trade. The Qing dynasty in China offers a unique context in terms of population dynamics, resource endowments, policy frameworks, and socio-cultural factors. The significant population pressure, the specialized production patterns of agricultural products, effective government policies, and cultural influences provide an ideal environment for studying the relationship between population pressure and the commodity economy under the development of "involution". In Qing dynasty China, the initial stages of population growth relied heavily on intensive agricultural practices. Farmers increased labor inputs to boost per-unit area yields, supporting a larger population. As the population continued to grow, agricultural capacity became saturated, and the land's carrying capacity was exceeded. Sole reliance on agriculture could no longer sustain the increasing population. Facing population pressure, farmers sought additional income sources, shifting towards the cultivation and processing of cash crops like cotton, tea, and silk. Natural resource endowments such as climate, soil types, and water resources determined the suitability of regions for specific cash crops. These natural advantages facilitated specialization in certain cash crops, enhancing production efficiency through the specialized division of labor. Populations displaced from agriculture engaged in the cultivation and processing of these economic crops, not only increasing their income but also furthering the commercialization of agriculture.

Compared to traditional food crops, cash crops often possess higher market value. Farmers cultivate economic crops such as tea, fruit trees, and medicinal herbs and perform preliminary processing like drying, fermenting, and packaging. These processed products can then be directly sold on the market, yielding higher economic returns. Furthermore, by selling these crops and their derivatives, farmers can meet material needs beyond self-sufficiency and improve their quality of life. Farmers can also flexibly choose suitable crops based on market demand and personal conditions, achieving diversification in agricultural operations. In certain regions, the planting areas for economic crops are adjacent to handicraft zones. Crops like cotton, hemp, and silk provide abundant and inexpensive raw materials for textile and weaving industries, reducing production and transportation costs. Farmers process these economic crops in family workshops, such as tea production, sugar making, and fruit processing. This not only brings additional income to households but also stimulates the local market and commercial activities, significantly promoting the development of family handicrafts and commerce. Therefore, in regions where economic crops have clear advantages, smallholder families, facing population growth pressures, can expand their income sources through the cultivation and processing of economic crops. This not only effectively drives the development of family handicrafts and other non-agricultural industries but also strongly promotes agricultural commercialization and market economy growth. Based on this analysis, this paper proposes the following:

Hypothesis 1. *Population pressure on land in Qing dynasty China promoted the development of the commodity economy through a resource endowment effect.*

2.2.2. A Transportation Network Effect

China, a country endowed with numerous rivers and lakes, has historically relied on waterways as crucial routes for transportation and logistics. These waterways have played a vital role in the country's economic and social development, a role that was particularly pronounced during the Qing dynasty. Since the Qing dynasty, the population growth rate has been unprecedented. As the population increased and the demand for resources, goods, and services rose, the waterway transportation network developed and expanded to meet the growing needs for transportation and trade. This water transportation network was crucial in connecting specialized agricultural regions, facilitating the efficient movement of goods, and promoting regional economic integration. The government's strong support for infrastructure, along with socio-economic factors such as the structure of rural communities and urban–rural development, also drove the formation of a more advanced waterway transportation network in Qing dynasty China. Historically, many civilizations have emerged along rivers and coastlines, demonstrating the crucial role of waterways in connecting different regions and facilitating the exchange of people, goods, and culture. With population increases, both government and private sectors have invested in enhancing waterway infrastructures. The Grand Canal, for example, has been a vital economic and cultural link between northern and southern China, promoting regional trade and mobility. During the Ming and Qing periods, China's southern regions, influenced by a monsoonal climate and varied topography, developed extensive river networks like those of the Yangtze and Pearl Rivers. These networks supported a robust waterway system, accommodating large merchant vessels and smaller boats for local transport, crucial for regional economic growth.

In traditional Chinese society, agriculture and handicrafts were pivotal economic sectors, with waterways providing essential transport routes for market access. This network enabled farmers and artisans to reach distant markets, enhancing commercialization and income, thus fostering the development of agricultural and craft techniques. Particularly during the Qing dynasty, waterways were essential for distributing goods like silk, tea, grain, and cotton from production zones to consumer areas, making southern China one of the most economically vibrant regions. This efficient logistics and transport system was vital for supporting economic activities such as handicraft production and agricultural output, directly reducing transportation costs and boosting economic efficiency. Hence, population growth not only stimulated the expansion of these sectors but also enhanced the waterway network, thereby facilitating the flourishing of industrial and commercial enterprises. This analysis leads to the following proposal set forth in this paper:

Hypothesis 2. *Population pressure on land in Qing dynasty China promoted the development of the commodity economy through the effect of transportation networks.*

3. Materials and Methods

3.1. The Sample and Data Source

This paper uses rice price data from southern China during the Qing Dynasty (1776–1919) to identify the impact of population pressure on the development of the commodity economy under the conditions of "involution". The selection of the southern region is for several reasons: first, since the Song dynasty, the economic center of China had shifted to the south. By the Qing dynasty, the southern region had become the economic heart of the nation, with a dense population and bustling trade, making it ideal for observing the development of the commodity economy under the trend of "involution". Second, during the Ming and Qing periods, China had a complex grain transportation system (the Grand Canal), making the north a long-term grain-importing region. Thus, grain prices in northern China were influenced by southern transported grain prices. This situation was not common in the south, where grain prices more accurately reflected local supply and demand [39]. Traditionally, the prosperity of the commodity economy is assessed by focusing on the frequency of "exchanges" and the volume of goods involved in these exchanges. "Exchange", or "trade", can be seen as an activity connecting two locations. Therefore, this paper selects data from 160 prefectural-level administrative units in 12 southern provinces of Qing dynasty China over five widely spaced years from the Qianlong to Guangxu reigns. In pairing any two prefectures, each pair represents a potential trade route. This constructed sample provides a comprehensive depiction of the overall state of the grain market in southern China during the Qing dynasty.

The southern provinces included in this study are Jiangsu, Anhui, Zhejiang, Jiangxi, Hubei, Hunan, Sichuan, Yunnan, Guizhou, Fujian, Guangdong, and Guangxi. The prefectural-level administrative units comprise both prefectures and sub-prefectures but do not include smaller department-level administrative units, which are collectively referred to as "prefectures" in this paper. The years of study are 1776, 1820, 1851, 1880, and 1910. Considering that the national grain market had matured by the mid-Qing dynasty and long-distance grain transportation between upstream and downstream regions, as well as across river basins, was not uncommon in historical records, this study includes all paired combinations in the sample. No combinations of prefectures were excluded based on geographical distance.

The population data are sourced from Cao's book "*Population History of China: Volume 5 (Qing Dynasty)*" [21]. In this paper, arable land is defined as potential areas within a specific geographic range deemed suitable for cultivating food crops based on a comprehensive assessment of natural conditions, including climate, terrain, soil, and hydrology. These data are derived from the Global Agro-Ecological Zones (GAEZ) database established by the Food and Agriculture Organization of the United Nations (FAO). The database provides a global grid map with a composite index for the cultivation of 53 types of crops, assigning each grid an integer value from 1 to 8 according to an agricultural suitability index (ranging from Very High to Not Suitable). When processing with GIS software (Version 10.8), one can integrate the Qing dynasty administrative division vector map from the China Historical Geographic Information System (CHGIS) to calculate the area of grids within each prefecture's boundaries that fall within the suitable range for food crops, thereby obtaining data on the potential arable land area. The primary grain crops selected for this study include rice, wheat, corn, sweet potatoes, and soybeans. The cultivation index ranges from levels 1 to 5 ("Very High" to "Moderate"), which is considered suitable for growing these grain crops.

The rice price data used in this study are sourced from Wang's "Qing Dynasty Food Price Database", belonging to "Modern History Data Base (MHDB)". The analysis focuses on the monthly average prices of medium-quality rice. To account for the significant seasonal fluctuations in grain prices, the rice prices examined in this study are specifically from January of each year. If the January rice price data are missing, the closest available data from February or March are used as a substitute. If data for both February and March are also missing, the time series for that year is omitted. Due to incomplete data, the number of years for which price time series can be constructed varies among prefectures, resulting in the creation of an unbalanced panel dataset.

The straight-line geographical distance between paired prefectures (ln*dis*) is generated based on the Qing dynasty administrative division vector map from GHGIS. Data on natural disasters (*disaster*), including floods, droughts, epidemics, and famines, as well as the largest scale of warfare (*war*) between paired prefectures, are sourced from "*A Table of Natural and Man-Made Disasters in Chinese History*" [40]. The number of prefectures near major land routes (*road*) is taken from "*History of Ancient Chinese Road Transport*" [41]. The number of prefectures adjacent to rivers (*river*) and on land borders (*border*) and that are coastal (*coastal*), directly governed (*zhili*), and provincial capitals (*capital*) is determined based on the Qing Dynasty administrative division vector map from CHGIS and the "*Historical Atlas of China: Qing Dynasty Volume*" [42].

3.2. Methods

This study uses per capita arable land as a proxy indicator, considering both population and arable land factors to reflect the joint effects of population growth and agricultural development. When arable land resources are limited, a higher population results in less per capita arable land, indicating greater population pressure. The specific regression equation is as follows:

$$P_{ijt} = \alpha + \beta \ln perland_{ijt} + \lambda X_{ijt} + \mu_t + \varepsilon_{ijt} \quad (1)$$

In this study, *i* and *j* denote paired prefectures, and *t* represents the year of the observation. P_{ijt} is the linear correlation coefficient of grain prices between prefectures *i* and *j* in year *t*. $\ln perland_{ijt}$ represents the per capita arable land area of prefectures *i* and *j* in year *t*. μ_t accounts for time fixed effects. X_{ijt} includes control variables such as the geographical distance between the paired prefectures ($\ln dis_{ij}$), the frequency of natural disasters ($disaster_{ijt}$), the maximum scale of outbreaks of warfare (war_{ij}), the number of prefectures near major land routes ($road_{ij}$), the number of prefectures adjacent to rivers ($river_{ij}$), the number of prefectures on land borders ($border_{ij}$), the number of coastal prefectures ($coastal_{ij}$), the number of directly governed prefectures ($zhili_{ij}$), and the number of provincial capitals ($capital_{ij}$).

3.3. Variable Selection

3.3.1. The Independent Variable

This study employs per capita arable land (ln*perland*) as a proxy variable to measure population pressure. When examining population growth during the Qing dynasty and assessing population pressure, it is crucial to consider the role of agricultural land and its capacity to absorb the population. Given the historical obscurity, it is challenging to determine the exact proportion of the agricultural population at that time. Therefore, this study uses per capita arable land as a proxy indicator, considering the combined effects of population growth and agricultural development. The sample consists of paired "prefectures", and the per capita arable land is calculated as the arithmetic mean of the per capita arable land areas of the paired prefectures.

3.3.2. The Dependent Variable

This study uses Pearson's product–moment correlation coefficient of paired prefecture grain prices (*P*) as a proxy variable for the level of commodity economy development. Calculating this variable requires obtaining a time series of grain prices for each prefecture, with consistent years and exact matching of the annual data (hereinafter referred to as the grain price time series). Considering that current grain price correlations may be influenced by historical prices, this study takes the endpoint of each subject year and retrospectively includes the same number of years to establish the time series interval. This study initially planned to use time series lengths of 20 years, 15 years, 10 years, and 5 years. However, due to insufficient price data for constructing correlation coefficients in the 5-year scenario, the *p*-values could not reliably reflect the correlation of grain prices between paired prefectures. Therefore, the empirical analysis only retains the first three sample categories. From the Kangxi era onward, the Qing government implemented a reporting system to monitor and adjust regional grain prices, resulting in a systematic and comprehensive dataset of grain prices. Numerous studies on the integration of the Qing dynasty's commodity markets have utilized these grain price data [39]. As previously established, the development of the grain market is a good representation of the commodity economy's development. Trade in other commodities which are more profitable than grain should be even more active. Thus, this variable effectively proxies for the development of the commodity economy. The selected indicator *P* ranges from $[-1, 1]$, with values closer to 1 intuitively indicating a higher degree of synchronous movement in grain prices between the paired prefectures.

Practically, this implies a greater volume of grain flow carrying price information between the prefectures, higher transaction frequencies, and more active grain trade.

3.3.3. Control Variables

This study incorporates a comprehensive set of control variables: (1) Geographical distance between paired prefectures (ln*dis*). Geographical distance directly affects transportation costs, transit times, and market accessibility and can also cause price fluctuations that impact commodity trade. This analysis controls for the impact of these distances. (2) Natural disasters (*disaster*). Natural disasters like floods, earthquakes, and droughts can directly damage agricultural and industrial production facilities, disrupt supply chains, decrease production efficiency, and alter transportation, leading to shifts in market demand and significantly affecting commodity trade. This study controls for the effects of such disasters. (3) Major warfare (*war*). Warfare, through the destruction of infrastructure, the disruption of market order, and a reduction in productivity, heavily impacts the development of commodity trade. This research includes controls for war-related factors. (4) Geographical location factors, such as the number of prefectures near major land routes (*road*), the number of prefectures adjacent to rivers (*river*), the number of prefectures on land borders (*border*), and the number of prefectures in coastal locations (*coastal*). These geographical elements significantly influence the efficiency of goods production, transportation costs, and market accessibility, thus affecting the scale and flow of trade activities. The impact of these geographical factors is controlled for in this study. (5) Political characteristics, such as the number of directly governed states (*zhili*) and the number of provincial capitals (*capital*). Because administrative centers like provincial capitals and directly governed states significantly influence commodity trade through their economic, transportation, informational, policy, and infrastructural advantages, this paper further controls for these political factors. Table 1 provides descriptive statistics for the relevant variables.

Table 1. Descriptive statistics of variables.

Variable	N	Mean	Std	Min	Max
P	43,865	0.1912	0.4789	−1	1
ln*perland*	43,865	4.8253	0.6328	3.5229	6.5205
ln*dis*	43,865	6.5357	0.6613	1.7057	7.7271
disastar	43,865	2.5426	2.7678	0	24
war	43,865	0.3610	0.9749	0	4
road	43,865	1.5264	0.5995	0	2
river	43,865	1.4874	0.6155	0	2
border	43,865	0.0680	0.2569	0	2
coastal	43,865	0.3602	0.5417	0	2
zhili	43,865	0.4635	0.5946	0	2
capital	43,865	0.1566	0.3785	0	2

4. Results

4.1. The Baseline Results

This paper first examines the impact of population pressure on land on the development of the commodity economy. The linear correlation coefficient of grain prices represents the degree of the price convergence between paired prefectures, while per capita arable land reflects the population pressure in each paired prefecture. Population growth leads to an increase in the number of people engaged in non-agricultural industries, thereby objectively promoting the development of the commodity economy. We expect that greater population pressure on land will result in higher grain price correlation coefficients, with a negative regression coefficient for the independent variable. This means that with less per capita arable land available locally, the population is more likely to be driven into non-agricultural sectors related to the commodity economy. Consequently, grain prices across regions tend to become more uniform, and the degree of commodity economy development increases.

Table 2 reports the baseline regression results for the 10-year sample, reflecting the impact of population pressure on land on the synchronization of grain prices. In Column (1), the coefficient for the explanatory variable, per capita arable land, is negative and significant at the 1% level. This indicates that less per capita arable land equates to a higher grain price correlation coefficient, suggesting that greater population pressure on land leads to more synchronized grain prices across regions and a higher degree of commodity economy development. In Columns (2) through (6), we progressively include control variables. The results show that the coefficient for per capita arable land remains significantly negative at the 1% level across all specifications, affirming the robustness of our conclusion. This means that less per capita arable land, indicating greater population pressure, pushes excess labor into the transportation and trade of agricultural products when the land cannot absorb the growing labor force. Consequently, the grain price correlation coefficient increases, demonstrating that population pressure significantly promotes the development of the commodity economy.

Table 2. Baseline regression results.

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ln*perland*	−0.1155 ***	−0.0907 ***	−0.0695 ***	−0.0667 ***	−0.0920 ***	−0.0922 ***
	(0.0037)	(0.0035)	(0.0037)	(0.0038)	(0.0041)	(0.0041)
ln*dis*		−0.2009 ***	−0.2017 ***	−0.2028 ***	−0.1969 ***	−0.1973 ***
		(0.0032)	(0.0032)	(0.0033)	(0.0033)	(0.0033)
disaster			0.0150 ***	0.0149 ***	0.0143 ***	0.0143 ***
			(0.0008)	(0.0008)	(0.0008)	(0.0008)
war			−0.0001	−0.0009	−0.0030	−0.0025
			(0.0022)	(0.0023)	(0.0023)	(0.0023)
road				0.0016	0.0067 *	0.0087 **
				(0.0038)	(0.0039)	(0.0040)
river				0.0125 ***	0.0239 ***	0.0267 ***
				(0.0036)	(0.0037)	(0.0038)
border					0.0791 ***	0.0823 ***
					(0.0095)	(0.0096)
coastal					−0.0626 ***	−0.0622 ***
					(0.0045)	(0.0045)
zhili						0.0092 **
						(0.0039)
capital						−0.0086
						(0.0058)
Year fixed effects	yes	yes	yes	yes	yes	yes
Observations	43,865	43,865	43,865	43,865	43,865	43,865
R^2	0.022	0.098	0.104	0.105	0.110	0.111

Notes: 1. Robust standard errors are in parentheses. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. 2. The regression results for the constant term and time fixed effects are not reported here. 3. The regression results reported here are for the 10-year sample length.

4.2. The Nonlinear Relationship Test

Although the baseline results reflect the impact of population pressure on the commodity economy, they do not reveal the implications of "involutionary" commercialization. Population growth naturally leads to population pressure on land; however, this increased population is initially absorbed by local agricultural land, leading to increased labor input in crop cultivation to achieve higher yields. As the population continues to grow, the excess population that cannot be absorbed by agriculture shifts to non-agricultural sectors, engaging in activities such as the production and processing of economic crops and the trade and transport of agricultural products, thereby promoting the development of the commodity economy. Considering the potential nonlinear relationship between population pressure and commodity economy development, we include the squared term of per capita arable land in the regression model for identification. The results are shown in Table 3.

Table 3. Commodity economy under "involutionary" development.

	(1) Full Sample	(2) Full Sample	(3) Full Sample	(4) Sample to the Left of the Turning Point	(5) Sample to the Right of the Turning Point
ln*perland*	−0.7972 ***	−0.5298 ***		−0.0962 ***	−0.0485
	(0.0413)	(0.0402)		(0.0042)	(0.1274)
ln*perland* ^{2}	0.0702 ***	0.0446 ***			
	(0.0043)	(0.0041)			
ln*perlandlow*			−0.1115 ***		
			(0.0046)		
ln*perlandhigh*			−0.0458		
			(0.0636)		
high			0.0797 ***		
			(0.0220)		
Control variables	no	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes
Observations	43,865	43,865	43,865	43,352	513
R^2	0.028	0.113	0.113	0.111	0.236

Notes: 1. Robust standard errors are in parentheses. Significance levels are indicated as follows: *** $p < 0.01$; 2. The regression results for the constant term, control variables, and time fixed effects are not reported here; 3. The regression results reported here are for the 10-year sample length.

Column (1) of Table 3 shows that the coefficient for the squared term ln*perland*^{2} is significantly positive at the 1% level. This result remains robust even after adding the control variables in Column (2). We preliminarily conclude that there may be an inverted U-shaped relationship between population pressure and the development of the commodity economy. This indicates that as population grows, labor and other resources are initially directed towards agricultural cultivation, which suppresses the development of the commodity economy. However, as population pressure intensifies and per capita arable land falls below a critical threshold, agriculture can no longer sustain the excess population. Consequently, people begin to shift towards non-agricultural sectors in search of livelihoods, increasing their involvement in activities such as agricultural product trade. This shift leads to a higher grain price correlation coefficient and more active development of the commodity economy.

We further validate the U-shaped relationship. As shown in Column (2) of Table 3, the calculated turning point is 5.973, which falls within the range of per capita arable land values. Additionally, following Simonsohn's research approach [43], we conduct a linear regression using this turning point as a breakpoint. The regression equation is as follows:

$$P_{ijt} = \alpha + \beta \ln perlandlow_{ijt} + \gamma \ln perlandhigh_{ijt} + \varphi \text{high} + \lambda X_{ijt} + \mu_t + \varepsilon_{ijt} \quad (2)$$

In this context, $\ln perlandlow_{ijt}$ represents the value of $\ln perland_{ijt}$ minus 5.973 when $\ln perland_{ijt}$ is less than 5.973 and 0 otherwise; $\ln perlandhigh_{ijt}$ represents the value of $\ln perland_{ijt}$ minus 5.973 when $\ln perland_{ijt}$ is greater than or equal to 5.973 and 0 otherwise; *high* is an indicator variable that equals 1 when $\ln perland_{ijt}$ is greater than or equal to 5.973 and is 0 otherwise.

If β and γ in Equation (2) have opposite signs and are significant, this indicates a U-shaped relationship between per capita arable land and the grain price correlation coefficient. The regression results are presented in Column (3) of Table 3. The results show that the coefficient of ln*perlandlow* is significantly negative at the 1% level, while the coefficient of ln*perlandhigh* is not statistically significant. In Columns (4) and (5) of Table 3, we further regress the samples on either side of the turning point. For the samples to the left of the turning point, the coefficient of per capita arable land is significantly negative, indicating that population pressure has a significant promoting effect on commodity economy development. For the samples to the right of the turning point, the coefficient of per capita arable land is not significant, possibly due to the small sample size, suggesting that population pressure does not significantly affect commodity economy development. These results are consistent with the findings in Column (3). This implies that when per capita arable land is above the turning point, "intensive farming" absorbs most of the labor, leaving limited labor for the commodity economy, and population pressure does not significantly impact commercial development. However, when per capita arable land is below the turning point, agricultural labor reaches saturation and agricultural productivity is very low, forcing more people into non-agricultural sectors. These individuals engage in the trade and transport of agricultural products, handicrafts, and commercial activities, thereby showing that population pressure has a significantly positive impact on commodity economy development. The development of the commodity economy during the Qing dynasty did not accompany significant productivity improvements and does not indicate a transition towards an industrial and commercial society. Instead, it represents a response of "involutionary" agriculture to population pressure.

4.3. The Robustness Test

4.3.1. Replacing the Grain Price Time Series Length Sample

Due to the differences in the price information and historical data constructed from different time series lengths, there may be potential sample selection bias. To address this, we perform regressions using samples with time series lengths of 15 years and 20 years, following the same regression equation as Equation (1).

Table 4 presents the regression results for samples with different time series lengths. For comparison purposes, Column (1) shows the baseline regression results for the 10-year sample, while Columns (2) and (3) display the regression results for the 15-year and 20-year samples, respectively. The results indicate that for grain price time series lengths of 10 years, 15 years, and 20 years, the regression coefficients for ln*perland* are all significantly negative at the 1% level. This demonstrates that the greater the population pressure, the higher the degree of commodity economy development. The regression results remain robust, indicating that the choice of grain price time series length does not affect our conclusions.

Table 4. Robustness test: samples with different time series lengths.

Time Series Length	**(1)** **10**	**(2)** **15**	**(3)** **20**
ln*perland*	−0.0922 *** (0.0041)	−0.0197 *** (0.0040)	−0.0531 *** (0.0042)
Control variables	yes	yes	yes
Year fixed effects	yes	yes	yes
Observations	43,865	43,899	43,812
R^2	0.111	0.090	0.091

Notes: 1. Robust standard errors are in parentheses. Significance levels are indicated as follows: *** $p < 0.01$; 2. The regression results for the constant term, control variables, and time fixed effects are not reported here.

4.3.2. Subsample Regressions by Time Period and Region

Pomeranz analyzed the population changes in the Yangtze River Delta during the 19th century within the framework of the "Five Great Trends" of the British Industrial Revolution and concluded that population pressure in the Qing dynasty was alleviated through industrialization, leading to the prosperity of the commodity economy [44]. This process was accompanied by a significant increase in labor productivity. Although this conclusion is quite controversial, it is undeniable that late Qing China's modern industrialization indeed triggered profound changes in the traditional commodity economy. A pivotal historical event in the early modern industrialization process was the Self-Strengthening Movement (1861–1894). To determine whether this significant historical event led to systematic differences in the regression results, we conduct subsample regressions for the periods before and after the Self-Strengthening Movement. Columns (1) and (2) of Table 5 report the results of these period-specific regressions. It is evident that in the period before the Self-Strengthening Movement, the regression coefficient for per capita arable land is significantly negative at the 1% level (Column 1). In the period after the Self-Strengthening Movement, the coefficient remains significantly negative (Column 2). This confirms the robustness of the core relationship we are examining: population pressure on land has a positive and significant impact on the development of the commodity economy.

Table 5. Robustness test: subsample regressions by time period and region.

	(1) Before the Self-Strengthening Movement	(2) After the Self-Strengthening Movement	(3) Same Agricultural Region	(4) Same Province	(5) Excluding Southwestern Border	(6) Excluding Administrative Center
ln*perland*	−0.1028 ***	−0.0815 ***	−0.1026 ***	−0.0585 ***	−0.1505 ***	−0.1096 ***
	(0.0051)	(0.0072)	(0.0068)	(0.0115)	(0.0061)	(0.0063)
Control variables	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Observations	26,333	17,532	13,444	4160	28,486	21,272
R^2	0.112	0.111	0.135	0.059	0.146	0.110

Notes: 1. Robust standard errors are in parentheses. Significance levels are indicated as follows: *** $p < 0.01$; 2. The regression results for the constant term, control variables, and time fixed effects are not reported here; 3. The regression results reported here are for the 10-year sample length.

Different geographical distances between paired prefectures result in varying transportation costs and institutional differences. Considering the impact of geographical distance on grain trade, this study conducts regressions on subsamples of paired prefectures with different geographical distances. Columns (1) to (5) of Table 6 report the regression results for the full sample, with paired prefectures with distances less than 1200 km, less than 1000 km, less than 800 km, and less than 500 km, respectively. The results show that regardless of the geographical distance between the paired prefectures, the effect of per capita arable land on the grain price correlation coefficient remains significantly negative at the 1% level. This confirms the robustness of our conclusion.

Table 6. Robustness test: subsamples with different geographical distances.

Distance	(1) Full Sample	(2) Less Than 1200 km	(3) Less Than 1000 km	(4) Less Than 800 km	(5) Less Than 500 km
ln*perland*	−0.0946 ***	−0.1223 ***	−0.1345 ***	−0.1459 ***	−0.1412 ***
	(0.0041)	(0.0049)	(0.0052)	(0.0059)	(0.0079)
Control variables	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes
Observations	43,865	34,828	29,248	22,230	11,335
R^2	0.111	0.129	0.129	0.135	0.129

Notes: 1. Robust standard errors are in parentheses. Significance levels are indicated as follows: *** $p < 0.01$; 2. The regression results for the constant term, control variables, and time fixed effects are not reported here; 3. The regression results reported here are for the 10-year sample length.

4.3.3. Replacing the Grain Price Sample

Additionally, this paper conducts robustness checks using different price levels for various grades of rice. Due to the missing data for lower-grade rice in Yunnan and Sichuan provinces, this paper does not use lower-grade rice as a replacement sample. Table 7 reports the regression results for the alternative rice price samples. Columns (1) and (2) show the regression results for the high-price and low-price samples of medium-grade rice. Columns (3) to (5) report the results for the average-price, high-price, and low-price samples of high-grade rice, respectively. The results indicate that the coefficient for per capita arable land is significantly negative at the 1% level across all samples. This confirms the robustness of our regression results, demonstrating that the choice of rice price type does not affect our conclusions.

Table 7. Robustness test: alternative rice price samples.

Rice Price Category	(1) High Price for Medium-Grade Rice	(2) Low Price for Medium-Grade Rice	(3) Average Price for High-Grade Rice	(4) High Price for High-Grade Rice	(5) Low Price for High-Grade Rice
ln*perland*	−0.0709 ***	−0.1102 ***	−0.0992 ***	−0.0836 ***	−0.0970 ***
	(0.0042)	(0.0043)	(0.0046)	(0.0046)	(0.0048)
Control variables	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes
Observations	43,436	43,721	38,091	38,091	38,090
R^2	0.089	0.112	0.112	0.089	0.103

Notes: 1. Robust standard errors are in parentheses. Significance levels are indicated as follows: *** $p < 0.01$; 2. The regression results for the constant term, control variables, and time fixed effects are not reported here; 3. The regression results reported here are for the 10-year sample length.

4.4. Addressing Endogeneity Issues

To validate our conclusions better, we must first address the potential endogeneity issue between population pressure and the commodity economy. This is also the focal point of the scholarly debate on "involution". Proponents of the "involution" theory argue that there was no significant improvement in productivity during the Qing dynasty and that Malthusian population pressure was the reason for the "passive" prosperity of the commodity economy. Opponents, however, contend that the commodity economy showed significant development since the Ming dynasty, and its prosperity was a consequence of spontaneous productivity growth. This prosperity, in turn, raised the resource constraints, becoming a cause of population growth during the Qing dynasty. Therefore, establishing causality is crucial to determining the validity of "involution". This paper identifies causality through instrumental variable regression. We select the "potential suitability rate for maize cultivation in paired prefectures" (ln*maize*) as the instrumental variable. A higher lnmaize value indicates that the paired prefectures are more suitable for maize cultivation. This indicator is obtained by calculating the arithmetic mean of the potential suitability rates for maize cultivation in paired prefectures. The data on the potential land area suitable for maize cultivation are sourced from the GAEZ database's grid maps. In this paper, the suitability rating range for maize cultivation is determined to be [1,4] ("Very High" to "Medium"). By calculating the grid areas within each prefecture that fall within this suitability range, we obtain the potential land area suitable for maize cultivation. This, combined with the total land area of the prefecture, allows us to determine the potential suitability rate for maize cultivation in each prefecture.

The selection of this instrumental variable is primarily based on the following considerations: maize, originally from the Americas, was introduced to China in the mid-Ming dynasty, and its cultivation was widely promoted across the country during the Qing dynasty. The suitability of an area for maize cultivation is mainly determined by natural conditions such as climate, topography, and soil fertility, thus making the chosen instrumental variable entirely exogenous. As a high-yield crop that is resistant to cold, drought, and poor soils, maize significantly contributed to rapid population growth during the Qing period and helped mitigate famine and refugee issues [45]. This implies that the more suitable an area is for maize cultivation, the more densely populated it is likely to be. Additionally, due to maize's strong environmental adaptability, it can be grown in plains, mountainous areas, and even saline–alkali land across the country, meaning that no region has a distinct factor endowment advantage. Furthermore, the grain market was still dominated by staples such as rice and wheat, and maize did not directly impact the trade of these traditional grains. Therefore, the selection of this instrumental variable is feasible and appropriate.

The 2SLS results using the instrumental variable are presented in Table 8. Column (1) reports the first-stage regression results. The relevant tests for the instrumental variable show that the Kleibergen–Paap rk LM statistic is significant at the 1% level, passing the under-identification test. Additionally, the Cragg–Donald Wald F statistic is greater than 10, rejecting the hypothesis of weak instruments and demonstrating the validity of the chosen instrumental variable. In the first stage, the regression coefficient for the instrumental variable lnmaize is significantly negative, indicating that a higher suitability rate for maize cultivation is associated with less per capita arable land. This implies that maize cultivation promotes population growth, increasing the population pressure in paired prefectures. Column (2) presents the second-stage regression results, where the coefficient for per capita arable land is significantly negative at the 1% level. This indicates that less per capita arable land equates to a higher grain price correlation coefficient, meaning that greater population pressure leads to higher levels of commodity economy development. This result remains robust even after addressing endogeneity issues. Table 8 demonstrates that the instrumental variable regression effectively eliminates estimation bias due to endogeneity and confirms the positive impact of population pressure on the development of the commodity economy.

Table 8. Instrumental variable 2SLS regression.

Dependent Variable	**(1)** **First Stage** **ln*perland***	**(2)** **Second Stage** ***P***
ln*maize*	−0.0398 ***	
	(0.0024)	
ln*perland*		−0.9769 ***
		(0.0820)
Kleibergen–Paap rk LM statistic	274.12	
	[0.0000]	
Cragg–Donald Wald F statistic	213.60	
Control variables	yes	yes
Year fixed effects	yes	yes
Observations	43,865	43,865

Notes: 1. Robust standard errors are in parentheses. Significance levels are indicated as follows: *** $p < 0.01$, with p-values in [ ]; 2. The regression results for the constant term, control variables, time fixed effects, and R-squared are not reported here; 3. The regression results reported here are for the 10-year sample length.

5. Discussion

Based on the previous analysis, we have established the directional impact of population pressure on land and the development of the commodity economy. However, the underlying mechanisms driving this relationship require further investigation. We continue to explore the mechanisms linking population pressure and commodity economy development.

5.1. The Resource Endowment Effect

Economic crops held an indispensable position in the Qing dynasty economy, with their value becoming increasingly prominent. High population density pressures led the agricultural economy to shift from the already intricate, complex, and labor-intensive rice cultivation to even more labor-intensive economic crop cultivation and processing [3]. The cultivation of economic crops and the establishment of processing and handicraft industries based on these crops can be viewed as the bridge leading from population growth to the "involutionary" commodity economy. To a certain extent, the production and processing of economic crops fully met market demand, with a significant portion of the commodity economy consisting of economic crops and their processed products. As grain trade entered the realm of commodity circulation, it promoted the commercialization of agricultural products and market development. With population growth, the marginal benefits of agricultural production decreased, prompting farmers to allocate more labor to the cultivation and processing of economic crops to obtain essential goods, achieve diversified operations, and gain commercial profits. In certain regions, the proximity of economic crop production areas to handicraft zones provided raw materials for the latter, significantly reducing transportation costs. Smallholder farmers, through the cultivation and processing of economic crops, engaged in production aimed at exchange, alleviating local population pressure and objectively promoting the development of non-agricultural industries such as household handicrafts and commerce.

In regions where the factor endowment advantage of economic crops is more pronounced, smallholder families are more likely to have promising prospects for achieving agricultural commercialization. Through the resource endowment effect, population pressure drives an increasing number of people to engage in the cultivation and processing of economic crops, leveraging their advantageous resources. This adaptability to local conditions, in turn, promotes the development of the commodity economy.

Based on the consideration of factor endowments, this paper uses the potential suitability rate for the main economic crops in paired prefectures (ln*crop*) as a proxy variable for the mechanism analysis. The economic crops examined in this paper include cotton, tea, sugarcane, tobacco, and flax. The methodology for determining the potential suitability rate for the main economic crops is similar to that used for maize (ln*maize*). In this paper, the suitability rating for economic crops is considered "Good" or higher (grid values 1–3). The potential suitability rate for economic crop cultivation in paired prefectures is selected as the maximum suitability rate among the five economic crops examined in this study. We introduce an interaction term between per capita arable land and the suitability rate for economic crop cultivation to identify the underlying mechanism. The regression results are presented in Table 9.

Table 9. Identification of mechanisms.

	(1)	**(2)**
ln*perland*	−0.0424 ***	−0.0857 ***
	(0.0045)	(0.0060)
ln*crop*	−0.1358 ***	
	(0.0044)	
ln*perland* × ln*crop*	−0.0102 **	
	(0.0051)	
waterway		0.0679 *
		(0.0348)
ln*perland* × *waterway*		−0.0144 **
		(0.0071)
Control variables	yes	yes
Year fixed effects	yes	yes
Observations	43,865	43,865
R^2	0.132	0.112

Notes: 1. Robust standard errors are in parentheses. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; 2. The regression results for the constant term, control variables, and time fixed effects are not reported here; 3. The regression results reported here are for the 10-year sample length.

Column (1) of Table 9 reports the regression results for the mechanism of the suitability rate for economic crop cultivation. The coefficient for the interaction term, which we are particularly interested in, is significantly negative. This indicates that the potential suitability rate for the main economic crops in paired prefectures amplifies the positive effect of population pressure on the development of the commodity economy. In other words, the higher the suitability rate for economic crop cultivation, the greater the degree of commodity economy development. Moreover, this marginal effect intensifies with increasing population pressure. This result can be intuitively understood as follows: in regions with an advantage in economic crop cultivation, under significant population pressure, labor that is pushed out of agricultural production shifts to the cultivation and processing of economic crops, engaging in production for exchange purposes. As grain trade enters the market, commodity trade becomes more active. Thus, the resource endowment advantage of economic crops indeed facilitates the process of agricultural commercialization for smallholder families, thereby strengthening the commercial ties between different regions. These regression results successfully validate Hypothesis 1, demonstrating that the resource endowment effect plays a crucial role in the mechanism by which population pressure influences the development of the commodity economy. In areas more suitable for economic crop cultivation, the effect of land population pressure on promoting the commodity economy is more pronounced.

5.2. The Transportation Network Effect

The southern region of China is rich in water resources, with a network of interwoven rivers forming a dense waterway transportation network, which was a crucial conduit for the circulation of goods during the Qing dynasty. Diverse agricultural products were transported across the country through this developed waterway system, strengthening trade exchanges of local products. The waterway transportation network connected various regional commodity markets, promoting market integration and the development of the commodity economy. The Grand Canal, the Yangtze River system, and the Pearl River system, in particular, provided convenient conditions for the circulation and trade of agricultural products. In the Qing dynasty, the interconnections among the river systems, lake systems, and coastal networks in the southern region formed a comprehensive waterway system that facilitated merchant travel and enhanced the flow of goods. Regions with well-developed waterway transportation often became major grain trade centers.

In this paper, we use whether paired prefectures are connected by a major waterway (*waterway*) as a mechanism variable. We introduce an interaction term between per capita arable land and the presence of a waterway transportation network to identify the role of waterway transportation in the development of the commodity economy. If the paired prefectures are connected by a waterway, the value is set to 1; otherwise, it is set to 0. The determination of whether paired prefectures are connected by a major waterway is based on the Qing dynasty administrative division vector map from CHGIS and the "*Historical Atlas of China: Qing Dynasty Volume*" [42].

Column (2) of Table 9 reports the regression results for the mechanism of the transportation network effect. The coefficient for the interaction term is significantly negative, indicating that the better the waterway transportation, the greater the positive effect of population pressure on the development of the commodity economy. This means that in regions with more developed waterway transportation, as population pressure increases, the excess population leverages the transportation advantages to engage in the trade of agricultural products, thereby increasing the frequency of commodity exchanges and further promoting the development of the commodity economy. This finding supports the validity of Hypothesis 2. Therefore, the more developed the waterway transportation network, the stronger the effect of population pressure on promoting the development of the commodity economy. The ability of regions to exchange goods is largely due to the smooth navigation of major rivers and waterways, facilitating market integration for commodities like grain. Consequently, commercial trade thrives in regions with developed waterway transportation networks, enabling more people to engage in the transportation and sale of grain and other agricultural products, accelerating the commercialization of agricultural products and fostering commercial prosperity.

6. Conclusions

The relationship between population and land has always been a focal point of academic research. Population, land, and the economy are closely interlinked, and the balance between population growth, limited land resources, and economic development is at the core of sustainable development. Population, as the main driver of economic activities, profoundly influences both the growth in economic output and the transformation of economic structures. Observing traditional Chinese society during the "Great Divergence" era, the vast population becomes a striking feature of Qing dynasty China. This unprecedented population growth reached its peak, exerting immense pressure on land resources. Additionally, traditional China maintained an economy dominated by the natural economy for a long time, but during the Ming and Qing periods, commercial production relations underwent profound changes, impacting and eroding traditional economic forms, with the commodification of agricultural products reaching unprecedented levels. The unique history of the Qing dynasty provides an excellent perspective for exploring the relationship between population pressure on land and economic development.

This study uses grain trade during the Qing dynasty as a starting point to examine the impact of land population pressure on the development of the commodity economy, focusing on the "involution" of smallholder economies. Utilizing data on grain prices, population, and arable land from the Qing period, we confirm the close relationship between population pressure and the commodity economy. By using the suitability rate of maize cultivation as an instrumental variable, we identify the causal relationship between the two and examine the mechanisms involving the cultivation and processing of cash crops and the water transportation network. Our research reveals that under conditions of stagnant technological progress and limited natural resources, the population growth during the Qing dynasty created substantial "Malthusian" population pressure. This pressure initially led to an over-concentration of labor in agriculture, resulting in land carrying capacity saturation. The surplus population, unable to be sustained by agriculture, was pushed into handicrafts, commerce, and other non-agricultural sectors, fostering the prosperity of the commodity economy. This prosperity did not come with significant productivity gains and was not a precursor to modernization but rather a continuation of the natural economy driven by population pressure, resulting in "involutionary" commodification.

The mechanisms indicate that population land pressure in Qing dynasty China significantly promoted the development of the commodity economy through resource endowment effects and transportation network effects. Under immense population pressure, the surplus population engaged in the cultivation and processing of cash crops for exchange purposes to alleviate survival pressures and relied on convenient water transportation networks for commodity trade, thus driving the growth of the commodity economy. Regions with more apparent advantages in cash crop resource endowment and more developed water transportation networks experienced stronger effects of population pressure on commodity economy development. This study enriches the literature on history and economics, quantifies the economic effects of population growth in historical periods, and enhances our understanding of the relationship between population, land, and economic issues. It also contributes to our knowledge of the development paths of population, land, and economy in China.

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