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Revisiting the "Guns versus Butter" Argument in China (1950–2014): New Evidence from the Continuous Wavelet Analysis

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Abstract: The long-lasting "guns versus butter" argument reflects the fact that China has been experiencing a difficult choice in terms of improving the defense and social welfare sectors, and thus achieving fiscal sustainability. The result, however, is controversial. The present paper therefore re-examines the relationship between defense and social welfare by employing continuous wavelet analysis during a long period of 1950–2014 in China. We focus in particular on their dynamic correlation and the lead-lag relationship across different frequency bands. Our results clearly show the inexistence of the crowding-out effect between defense expenditure and social welfare; moreover, the increase in defense (social welfare) expenditure could stimulate the expansion of social welfare (defense) spending. In addition, we find a positive relationship between defense and social welfare with defense leading during 1961–1968 in the short term, when China suffered from the economic breakdown and the social turbulence caused by the Great Famine, Sino-Soviet border conflict, etc. Notably, social welfare also led the progress in defense during 1984–1988 and 1995–1998 in the medium and long terms by the further deepening of the opening-up policy and enforcing the economic system reform.

Keywords: defense expenditure; social welfare spending; crowding-out effect; continuous wavelet analysis; time-frequency domain

1. Introduction

There has been a long lasting debate about whether the expansion of defense expenditure crowds out social welfare spending and hinders the development of social welfare, viz. the "guns versus butter" argument. Since defense and social welfare expenditures are major components of government fiscal expenditure, examining the potential existence of the crowding-out effect between defense expenditure and social welfare is important for China to achieve fiscal sustainability and promote defense and social welfare progress.

Figure 1 shows the changing trends of defense expenditure (as a ratio to GDP), social welfare expenditure (as a ratio to GDP) and government fiscal expenditure (as a ratio to GDP) over the period of 1950–2014. As indicated by Figure 1, in general, defense expenditure as a ratio to GDP showed a downward trend during this time period, decreasing from the highest 16.75% in 1951 to a low and stable level at approximately 1.30% in recent years. It is worth noting that defense expenditure as a ratio to GDP decreased dramatically after 1978 (the implementation of reform and opening-up policy) and reached a plateau at a relatively low level in the most recent decade. In contrast, the social welfare expenditure as a ratio to GDP presented a continuously rising tendency, which first exceeded defense

expenditure in 1981 and the gap between them gradually kept enlarging. Thirdly, government fiscal expenditure displayed a downward trend with fluctuations, while it reached the lowest at 11.67% in 1995 and appeared to increase afterwards.

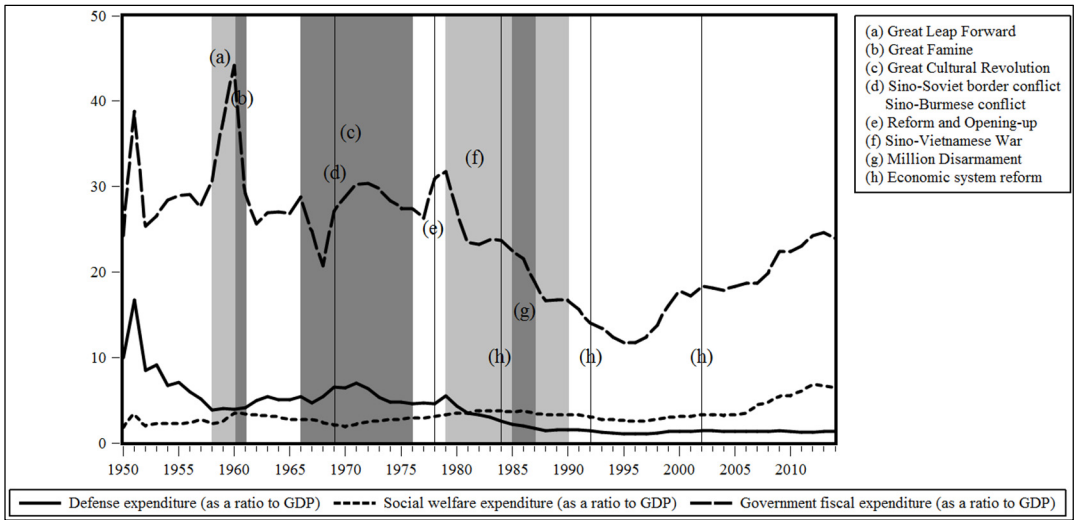

Figure 1. Changing trends of defense, social welfare and government fiscal expenditures. Source: National Bureau of Statistics of China, 2015 [1].

Significant changes can be observed in the three items during specific historical period. There was a sharp increase in social welfare expenditure during the Great Leap Forward and the Great Famine. At the same time, government fiscal expenditure first experienced a dramatic increase and a decline afterwards. This could be attributable to the pressure to provide relief supplies to the victims. In the 10 years of the Great Cultural Revolution, social welfare expenditure declined significantly because of the difficulties in the economy; meanwhile, a sharp increase could be found in defense expenditure in contrast. After the long-term social unrest and economic breakdown caused by events such as the Great Famine and the Great Cultural Revolution, China undertook the policy of reform and opening-up in 1978, which attached great importance to economic development and social welfare progress and decreased the investment in defense construction. Moreover, during the further deepening of the economic system reform, China balanced the defense growth and social welfare progress from the perspective of civil-military integration to achieve the coordinated development of defense and social welfare.

Our article focuses on the causal nexus between defense expenditures and social welfare spending in China and contributes to the existing research in three ways. Firstly, by investigating the crowding-out effect between defense expenditure and social welfare in China, a typical emerging economy, this study seeks to find out a reliable outcome, which can further be applied to other emerging economies. Secondly, we employ the long time series data during the period of 1950–2014 of China, which is capable of providing much more information and extending the time-varying analysis. Thirdly, the present paper uses the continuous wavelet analysis investigating the dynamic relationship between defense expenditure and social welfare spending. The continuous wavelet analysis has become a popular method in exploring the relationship between two variables, since it expands the time series to a time-frequency space in such a way that the correlation and the lead-lag relationship can be observed [2].

The remainder of this paper is structured as follows. Section 2 provides a brief summary of recent research including theoretical analysis and empirical evidence. Section 3 describes the empirical model. We use the continuous wavelet analysis to examine the existence of crowding-out effect between

defense expenditure and social welfare. Section 4 describes the data. Section 5 presents the empirical evidence. The final section concludes.

2. Literature Review

2.1. Theoretical Basis

Previous studies have provided a variety of theoretical bases for the relationship between defense expenditure and social welfare (see Table 1). On the one hand, from the Keynesian point of view, the expansion of defense expenditure can increase the aggregate demand, and accordingly stimulate the social welfare spending [3–6]. On the other hand, due to government budget constraints, the existence of the crowding-out effect suggests the expansion of defense expenditure can be at the expense of non-defense spending, such as education, health, culture and technology [6–12]. However, several studies contended that an increase in defense spending does not necessarily have any effect on social welfare spending [13–15].

Table 1. Theoretical studies on the relationship between defense and social welfare.

Theories	Authors	Details
Keynesian theory	Yildirim and Sezgin [5]; Kollias and Paleologou [3]; Lin, Ali and Lu [4]; Zhang, et al. [6]	Defense expenditure can stimulate social welfare spending by increasing the aggregate demand.
Crowding-out effect	Russett [12]; Dabelko and McCormick [8]; Peroff and Podolak-Warren [11]; Deger [9]; Apostolakis [7]; Ozsoy [10]; Zhang, et al. [6]	Defense expenditure can crowd out the social welfare spending.
No relationship	Russett [15]; Mintz [14]; Frederiksen and Looney [13]	Defense expenditure has no relationship with social welfare spending.

2.2. Empirical Analysis

There have been ample interesting empirical studies investigating the relationship between defense expenditure and social welfare, while the empirical support reflects a continuing lack of consensus. Table 2 reports the existing empirical findings on the crowding-out effect between defense expenditure and social welfare spending. The study on "guns versus butter" dates back to the pioneering work of Russett [12], which revealed that military spending is negatively correlated with the expenditures for health, education and other social welfare programs in the US, the UK, France and Canada. The negative relationship supported by the crowding-out theory has been confirmed in several studies since then [7–11,16]. Peroff [16] and Peroff and Podolak-Warren [11] found the existence of crowding-out effect in the US. Dabelko and McCormick [8], Deger [9] and Apostolakis [7] added to this view by providing the evidence in 77 countries, 50 less developed countries and 19 Latin American countries, respectively. There was also shown to be a crowding-out effect between defense and social welfare expenditures in Turkey [10]. In contrast, some studies suggested that the increase in defense expenditure could promote social welfare supported by the Keynesian theory [3,4,6,17,18]. Verner [18] confirmed that a rise in defense expenditure promoted education expenditure in 10 Latin American countries. Harris, Kelly and Pranowo [17] and Lin, Ali and Lu [4] showed the positive relationship between defense and social welfare expenditures in 3 Asian countries and 29 OECD (the Organisation for Economic Co-operation and Development) countries, respectively. A similar conclusion was also extended to Greece [3]. In addition, Zhang, et al. [6] confirmed the positive relationship by measuring the social welfare using inputs and outputs. However, a non-existent relationship has also been found in the literature [13–15,19–23]. For instance, Caputo [19] showed defense expenditure has no impact on social welfare in Australia, Sweden, the UK and the US. Russett [15] and Mintz [14] extended the

conclusion to the US. In addition, Hess and Mullan [23] further confirmed the relationship in 77 less developed countries.

Table 2. Empirical studies on the relationship between defense and social welfare.

Findings	Authors	Sample	Method
Positive	Verner [18]	10 Latin American countries, 1948–1979	Time-series regression analysis
	Harris, Kelly and Pranowo [17]	Korea, Malaysia and Sri Lanka, 1967–1982	Time-series data, a longitudinal regression analysis
	Kollias and Paleologou [3]	Greece, 1972–2004	Time-series analysis, VAR
	Lin, Ali and Lu [4]	29 OECD countries, 1988–2005	Panel data analysis, GMM
	Zhang, et al. [6]	BRICS and G7 countries, 1993–2007	Panel cointegration, impulse response function
Negative	Russett [12]	The US, the UK, France and Canada, 1939–1968	Time-series analysis, OLS (ordinary least squares)
	Peroff [16]	The US, 1929–1971	Time-series analysis, OLS
	Dabelko and McCormick [8]	77 countries, 1950–1972	Cross-sectional time-series, OLS
	Peroff and Podolak-Warren [11]	The US, 1929–1974	Time-series analysis, OLS
	Deger [9]	50 LDCs, 1967–1973	Cross-sectional time-series, 3SLS
	Apostolakis [7]	19 Latin American countries, 1953–1987	Time-series analysis
	Ozsoy [10]	Turkey, 1925–1998	Time-series analysis, OLS
No Relationship	Caputo [19]	Australia, Sweden, the UK and the US, 1950–1970	Standardized regressions and Pearson coefficients
	Russett [15]	The US, 1941–1971	Time-series analysis, OLS
	Domke, Eichenberg, and Kelleher [21]	The US, the UK, Germany and France, 1948–1980	Time-series analysis, OLS
	Eichenberg [22]	Germany, 1950–1979	Time-series analysis, OLS and GLS
	Hess and Mullan [23]	77 LDCs, 1982–1983	Cross-sectional time-series, 2SLS
	Mintz [14]	The US, 1947–1980	Time-series analysis, OLS
	Davis and Chan [20]	Taiwan, 1961–1985	Time-series analysis, 3SLS
	Frederiksen and Looney [13]	Pakistan, 1973–1986	Time-series analysis, short-run and long-run model

In summary, numerous studies have investigated the causal nexus between defense expenditure and social welfare; however, these empirical studies have obtained mixed results and the papers analyzing the case of China are relatively limited. For instance, Davis and Chan [20] used the data of Taiwan rather than mainland China. Therefore, this article investigates the relationship between defense and social welfare in China to enrich these empirical studies. In addition, following the above arguments, we derive this primary research to revisit the potential presence of crowding-out effect between defense expenditure and social welfare in China in the time-frequency domain by employing the continuous wavelet analysis.

3. Continuous Wavelet Analysis

The continuous wavelet analysis is employed to examine the dynamic relationship between defense expenditure and social welfare spending in this study. The continuous wavelet analysis has gained its popularity in the time-frequency analysis between two variables. First, it reveals how the relationship between two variables develops over time and varies across different frequency bands. Second, it provides a detailed picture about the lead-lag relationship between the two variables. Third,

it does not require the two time series to be stationary or cointegrated [2,24]. Based on the above advantages, the method of continuous wavelet analysis can provide more detailed empirical results about the interaction between defense expenditure and social welfare spending compared to other available empirical methods, which is capable of modeling the dynamic correlation and lead-lag relationship between defense and social welfare across different frequency bands during the period of 1950–2015 in China. Therefore, the main purpose of applying the continuous wavelet analysis, one of the most sophisticated time-frequency methods is to extend a thorough and elaborated analysis to examine the potential presence of the crowding–out effect and its changing trends in China. The continuous wavelet analysis used in this article has been developed by Aguiar-Conraria and Soares [2].

3.1. The Continuous Wavelet Transform

We conduct the continuous wavelet transform for a time series. Based on a mother wavelet ψ, a family $\psi_{\tau,s}$ of "wavelet daughters" is defined as:

$$\psi_{\tau,s}(t) := \frac{1}{\sqrt{|s|}}\psi\left(\frac{t-\tau}{s}\right),\ \tau, s \in \mathbb{R}, s \neq 0 \tag{1}$$

where τ is a translation parameter that controls the location of the wavelet, and s is a scaling factor that defines its width. In this study, we choose the most popular Morlet wavelet as the mother wavelet, which is given as:

$$\psi(t) = \pi^{-\frac{1}{4}} \exp(\mathrm{i}\omega_0 \mathrm{t}) \exp\left(-\frac{1}{2}t^2\right) \tag{2}$$

where $\int_{-\infty}^{\infty} |\psi(t)|^2 dt < \infty$, and $\int_{-\infty}^{\infty} \psi(t) dt = 0$.

Based on the choice of the mother wavelet, the continuous wavelet transform is defined as:

$$W_{x;\psi}(\tau, s) = \int_{-\infty}^{\infty} x(t) \frac{1}{\sqrt{|s|}} \psi^*\left(\frac{t-\tau}{s}\right) dt \tag{3}$$

where * denotes the complex conjugation of the Morlet wavelet. The continuous wavelet transform decomposes the original series into a function of τ and s, thus expands the time series into a time-frequency space. When the wavelet $\psi(t)$ is complex-valued, the wavelet transform $W_x(\tau, s)$ is also complex-valued and can be decomposed into its real part $\Re\{W_x(\tau, s)\}$ and its imaginary part $\Im\{W_x(\tau, s)\}$, or in its amplitude, $|W_x(\tau, s)|$, and its phase, $\phi_x(\tau, s) : W_x(\tau, s) = |W_x(\tau, s)| exp(i\phi_x(\tau, s))$.

3.2. The Power of Wavelet and Cross-Wavelet

Following the continuous wavelet transform, the wavelet power spectrum is conducted to measure the local variance for a time series at each frequency, which is given as:

$$WPS_x(\tau, s) = |W_x(\tau, s)|^2 \tag{4}$$

Furthermore, the cross-wavelet transform and the cross-wavelet power spectrum of the two series are extended to investigate the relationship between two variables. The cross-wavelet transform of the two time series, $x(t)$ and $y(t)$ is defined as:

$$W_{xy}(\tau, s) = W_x(\tau, s) W_y^*(\tau, s) \tag{5}$$

where $W_x(\tau, s)$ and $W_y^*(\tau, s)$ are the continuous wavelet transforms of time series $x(t)$ and $y(t)$, respectively. When $y = x$, the wavelet power spectrum $W_{xx}(\tau, s) = |W_x(\tau, s)|^2 = (WPS)_x(\tau, s)$. The cross-wavelet power is given as:

$$XWP_{xy}(\tau, s) = \left|W_{xy}(\tau, s)\right| \tag{6}$$

In general, the wavelet power spectrum of one time series presents the local variance, while the cross-wavelet power spectrum measures the local covariance of the two time series at each time and frequency.

3.3. The Wavelet Coherency and the Phase-Difference

Based on the wavelet power spectrum and the cross-wavelet power, the wavelet coherency is conducted to investigate the dynamic correlation in the time-frequency domain. The complex wavelet coherency ϱ_{xy} is given as:

$$\varrho_{xy} = \frac{S\left(W_{xy}\right)}{\left[S\left(|W_x|^2\right) S\left(|W_y|^2\right)\right]^{\frac{1}{2}}} \tag{7}$$

where S denotes a smoothing operator in both time and scale. The wavelet coherency is defined as the absolute value of the complex wavelet coherency:

$$R_{xy} = \frac{\left|S\left(W_{xy}\right)\right|}{\left[S\left(|W_x|^2\right) S\left(|W_y|^2\right)\right]^{\frac{1}{2}}}, \text{ with } 0 \leqslant R_{xy} \leqslant 1 \tag{8}$$

However, we are not able to differentiate the positive and negative correlation through the wavelet coherency since its value is always positive. Therefore, the phase-difference is applied to reveal the positive or negative correlation and lead-lag interaction between the two time series. The complex wavelet coherency ϱ_{xy} can be expressed in polar form, as $\varrho_{xy} = \left|\varrho_{xy}\right| exp\left(i\phi_{xy}\right)$. The angle ϕ_{xy} of the complex coherency is the phase-difference, which is given as:

$$\phi_{xy} = \tan^{-1}\left(\frac{\Im\left(S\left(W_{xy}\right)\right)}{\Re\left(S\left(W_{xy}\right)\right)}\right), \text{ with } \phi_{xy} \in [-\pi, \pi] \tag{9}$$

When $\phi_{xy} \in \left(0, \frac{\pi}{2}\right)$ and $\phi_{xy} \in \left(-\frac{\pi}{2}, 0\right)$, $x(t)$ and $y(t)$ move in phase (similarly to positive correlation), and the former case indicates $x(t)$ leads $y(t)$, while the latter case indicates $y(t)$ leads $x(t)$. When $\phi_{xy} \in \left(-\pi, -\frac{\pi}{2}\right)$ and $\phi_{xy} \in \left(\frac{\pi}{2}, \pi\right)$, $x(t)$ and $y(t)$ move anti-phase (similarly to negative correlation), and the former case suggests $x(t)$ leads $y(t)$, while the latter case suggests the opposite. Besides, $\phi_{xy} = 0$ reveals the positive relationship between $x(t)$ and $y(t)$, while $\phi_{xy} = \pi$ or $-\pi$ reveals the negative relationship between $x(t)$ and $y(t)$ at the specified time-frequency.

3.4. The Partial Wavelet Coherency and the Partial Phase-Difference

The dynamic relationship between two time series may be influenced by other variables, thus the partial wavelet coherency is employed to eliminate the effect of other variables. After controlling a third variable $z(t)$, the partial complex wavelet coherency is defined as:

$$\varrho_{xy,z} = \frac{\varrho_{xy} - \varrho_{xz}\varrho_{yz}^*}{\sqrt{\left(1 - R_{xz}^2\right)\left(1 - R_{yz}^2\right)}} \tag{10}$$

where ϱ_{ij} and R_{ij} $(i = x, y, z;\ j = x, y, z; i \neq j)$ is defined as Equations (7) and (8), respectively, and * denotes the complex conjugation. Based on the Equations (8) and (9), we can obtain the partial wavelet coherency ($R_{xy,z}$) and the partial-difference ($\phi_{xy,z}$). The interpretation of the partial phase-difference ($\phi_{xy,z}$) is consistent with the phase-difference (ϕ_{xy}).

In this study, we use the annual growth rate over the previous year for each variable to present the wavelet property in our dataset. Hence, $x(t)$ denotes the growth rate of the defense expenditure as a ratio to GDP. $y(t)$ denotes the growth rate of the social welfare spending as a ratio to GDP. $z(t)$ denotes the growth rate of government fiscal expenditure as a ratio to GDP, which is used as a control variable

in the continuous wavelet analysis. The continuous wavelet analysis performed in the present paper is processed by the MATLAB ASToolbox developed by Aguiar-Conraria and Soares [2].

4. Data Description

This article uses long time series data to explore the dynamic relationship between defense expenditure and social welfare spending. We use the expenditures of education, health, culture and technology to measure the level of social welfare spending. Since defense expenditure (*Defense*) and social welfare spending (*SW*) are a portion of government fiscal expenditure, the government fiscal expenditure as a ratio to GDP (*GFE*) is used as a control variable to eliminate the potential confounding effects. All the data are selected from National Bureau of Statistics of China, 2015 [1]. Because of data availability, we restrict our sample to the 1950–2014 period (Cazelles, et al. [25] suggested the continuous wavelet analysis requires approximately 30–40 data points. In this study, we use 65 observations, which is thus sufficient to extend the continuous wavelet analysis). The descriptions of the variables and the original data sources are listed in Table 3. The continuous wavelet analysis is applied to investigate the dynamic correlation and the lead-lag relationship across different frequency bands.

Table 3. Descriptions of variables.

Variable	Description	Time Period	Data Source
Defense	Government defense expenditure/GDP	1950–2014	National Bureau of Statistics of China, 2015 [1]
SW (social welfare)	Government expenditures of education, health, culture and technology/GDP	1950–2014	National Bureau of Statistics of China, 2015 [1]
GFE (government fiscal expenditure)	Government fiscal expenditure/GDP	1950-2014	National Bureau of Statistics of China, 2015 [1]

5. Empirical Analysis of Defense and Social Welfare

In this section, using the continuous wavelet analysis, we estimate the dynamic correlation and lead-lag relationship between defense and social welfare across different frequency bands during the period of 1951–2014.

5.1. Wavelet Power Spectrum Analysis

Figures 2–4 present the wavelet power spectrum of defense expenditure as a ratio to GDP, social welfare spending as a ratio to GDP and government fiscal expenditure as a ratio to GDP in terms of growth rate, respectively. The horizontal axis displays the time dimension, and the vertical axis presents the frequency dimension in time units (years). We separate the vertical axis into four frequency bands: 1–2 years, 2–4 years, 4–8 years, 8–16 years, corresponding to a short term, medium term, long term and very long-term relationship between defense expenditure and social welfare. The color represents the strength of power, ranging from blue (low power) to red (high power). The cone of influence (COI) is given by a thick black line, which defines the regions affected by the edge effects, we therefore mainly focus on the regions inside the COI.

Figure 2 shows the volatilities of the growth rate of the *Defense* are significant (at 5% significance level) in the 1st–4th frequency band over the period of 1952–1959 and in the 4th–16th frequency band over the period of 1962–1983. Since the political and economic situation was unstable after the establishment of the People's Republic of China over the period of 1952–1959, the defense expenditure experienced remarkable fluctuations. The high power in the 4th–16th frequency band over the period of 1962–1983 may due to the Great Cultural Revolution and the policy of reform and opening-up. The Great Cultural Revolution caused massive social and economic confusion, which generated a

powerful impact on the defense expenditure. In addition, China paid more attention to economic development and decreased the investment in defense construction based on the policy of reform and opening-up. Hence, the growth rate of defense expenditure presented significant volatility in the early years of the policy of reform and opening-up.

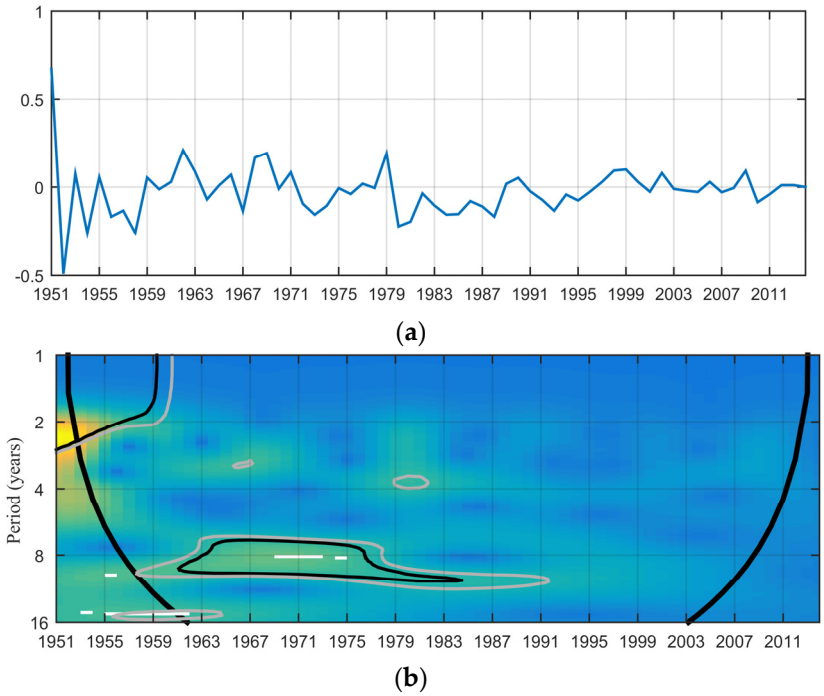

Figure 2. (**a**) Growth rate of *Defense*; (**b**) Wavelet power spectrum of the growth rate of *Defense*. Note: The black (gray) contour denotes the 5% (10%) significance level. The thick black contour represents the COI. Similarly hereinafter.

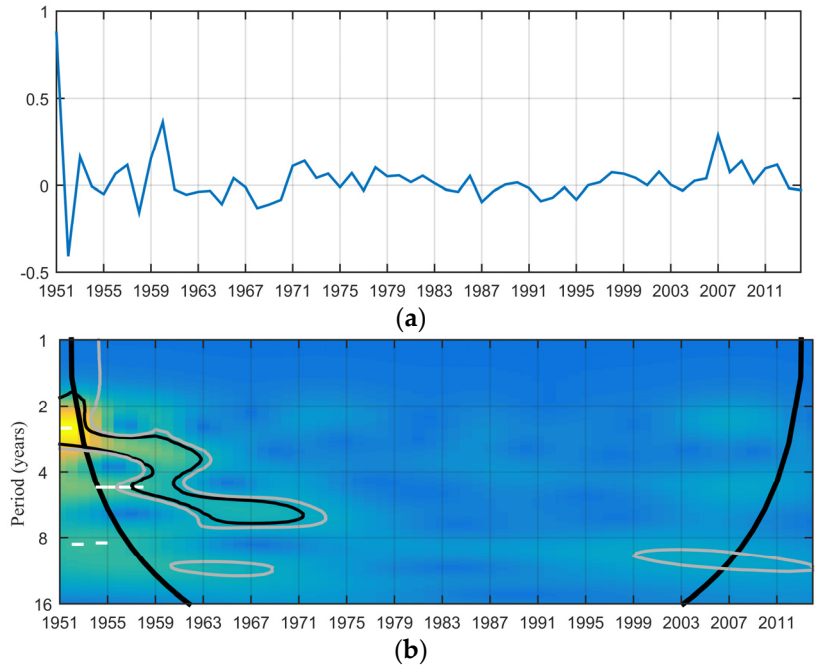

Figure 3. (**a**) Growth rate of social welfare (*SW*); (**b**) Wavelet power spectrum of the growth rate of *SW*.

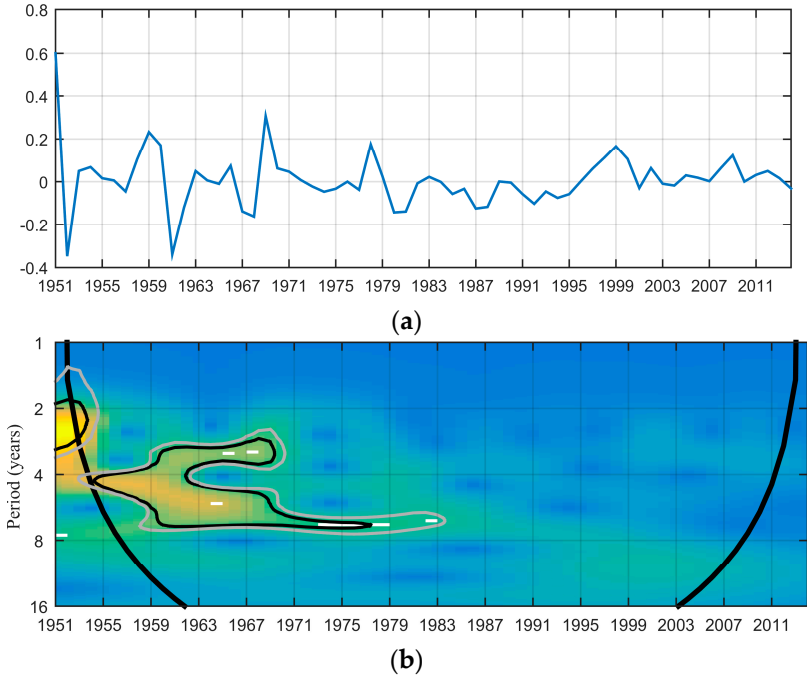

Figure 4. (**a**) Growth rate of government fiscal expenditure (*GFE*); (**b**) Wavelet power spectrum of the growth rate of *GFE*.

Figure 3 shows the power of the growth rate of *SW* is significant (at 5% significance level) in the 2–8 years band over the period of 1953–1971. China underwent enormous social and economic upheaval after the establishment of the People's Republic of China due to the Great Leap Forward, the Great Famine and the Great Cultural Revolution. The growth rate of social welfare spending therefore experienced fluctuations over this period in a medium term and a long term.

Figure 4 shows significant (at 5% significance level) volatilities of the growth rate of *GFE* in the 2nd–4th frequency band over the period of 1955–1969 and in the 4th–8th frequency band over the period of 1955–1978. Since social welfare spending is an important portion of government fiscal expenditure, the volatility of growth rate of government fiscal expenditure presents the similar pattern to the social welfare spending. The power was significantly high in a medium term and a long term during the period of the Great Leap Forward, the Great Famine and the Great Cultural Revolution, and tended to decrease after the reform and opening-up.

5.2. Partial Wavelet Coherency

Figure 5a,b present the wavelet coherency and partial wavelet coherency (conditional upon the growth rate of government fiscal expenditure as a ratio to GDP), respectively. We decompose the vertical axis into three frequency bands: 1–2 years, 2–4 years, 4–8 years, corresponding to a short term, medium term and long term correlationship and lead-lag relationship between defense expenditure and social welfare spending. In addition, Figure 5b shows changes in the partial wavelet coherency and phase differences with *GFE* as a control variable. In general, we use the partial wavelet coherency to examine the crowding-out effect and lead-lag relationship between the two variables.

Figure 5(b1) shows the high significant coherency in the 1st–2nd frequency band over the period of 1961–1968 (a period post-the Great Leap Forward and close to the Great Famine and the Great Cultural Revolution), 1986–1988 (a period close to the reform and opening-up and the economy system reform). Figure 5(b2) suggests the correlation and lead-lag relationship between the two variables in a short term. During the period of 1961–1968, $\phi_{xy,z} \in \left(0, \frac{\pi}{2}\right)$ indicates the positive relationship between *Defense* and *SW*, and *Defense* is leading *SW*. During this period, China attached great importance to defense and social welfare since it was in recovery from the economic breakdown and the unstable social

situation, then defense expenditure was positively related with social welfare, accordingly. In contrast, during the period of 1986–1988, $\phi_{xy,z} \in \left(\frac{\pi}{2}, \pi\right)$ indicates that *Defense* is negatively correlated with *SW*, and *SW* leads. China became more supportive of economic and social welfare progress and reduced the defense expenditure because of the reform and opening-up and the economic system reform, which resulted in the negative relationship between defense expenditure and social welfare spending in the short term.

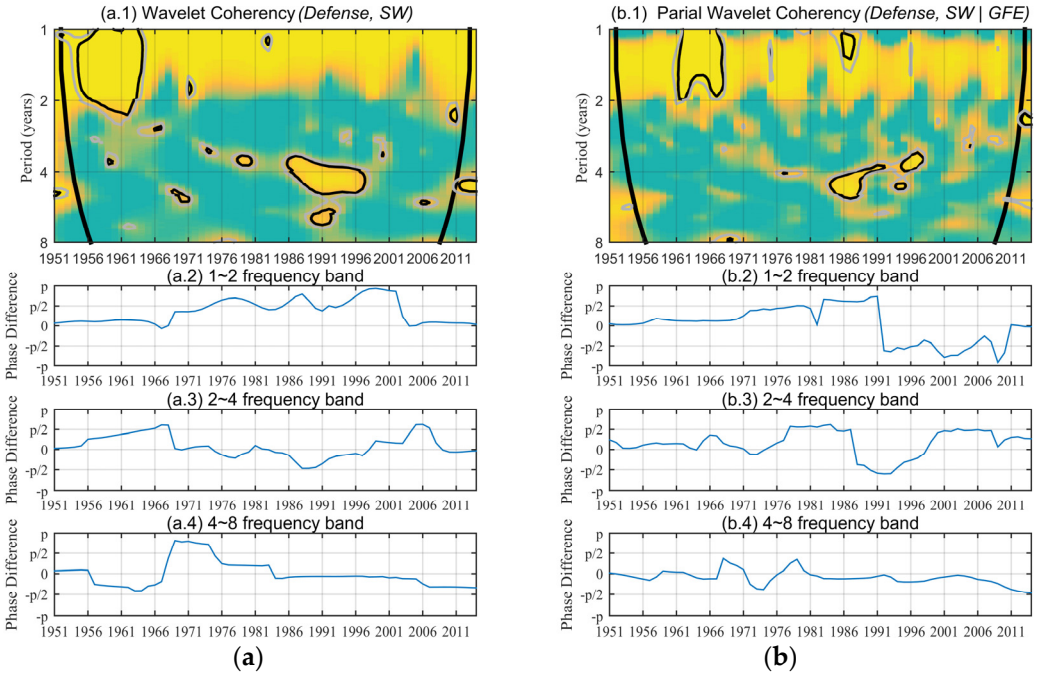

Figure 5. (**a**) Wavelet coherency between the growth rate of *Defense* and *SW*; (**b**) Partial wavelet coherency between the growth rate of *Defense* and *SW*.

Figure 5(b1) shows that the coherency of the two variables are significant during the period of 1989–1991 (a period post-the Sino-Vietnamese War), 1995–1998 and 2005 (two periods close to the economic system reform) in the 2nd–4th frequency band (medium term). As indicated by the Figure 5(b3), during the period of 1989–1991, $\phi_{xy,z} \in \left(-\pi, -\frac{\pi}{2}\right)$ means *Defense* and *SW* move anti-phase with one another, which suggests a negative relationship, and *Defense* leads. The Sino-Vietnamese War caused disorder in the social situation. China increased the defense expenditure to maintain the social stability and consequently crowded out the social welfare spending. In contrast, during the period of 1995–1998 and 2005, *Defense* is positively correlated with *SW*. In addition, the former case with $\phi_{xy,z} \in \left(-\frac{\pi}{2}, 0\right)$ reveals that *SW* is leading *Defense*, while the latter case with $\phi_{xy,z} \in \left(0, \frac{\pi}{2}\right)$ suggests the opposite. As the further deepening of the economic system reform took place, China tended to balance the defense growth and social welfare progress from the perspective of civil-military integration. The empirical results examined the inexistence of the crowding-out effect of defense expenditure and social welfare in the medium term.

We observe significant correlations between *Defense* and *SW* that correspond to the periods of 1969 (a period close to the Great Cultural Revolution, Sino-Soviet border conflict and the Sino-Burmese conflict), 1977 (post-the Great Cultural Revolution), 1984–1988 (the reform and opening-up), 1994–1995 (the economic system reform) in Figure 5(b1) for the time scale of 4–8 years. In 1969 and 1977, $\phi_{xy,z} \in \left(0, \frac{\pi}{2}\right)$ (i.e., in phase) reveals the positive relationship between defense expenditure and social welfare spending, and *Defense* is leading *SW*. Consistent with the high coherency in the 1st–2nd frequency band over the period of 1961–1968, *Defense* was positively correlated with *SW*, and *Defense* led in 1969 and 1977. During the period of 1984–1988 and 1994–1995, the correlations and lead-lag

relationships exhibit the same pattern. The partial wavelet coherency ($\phi_{xy,z}$) ranges from $-\frac{\pi}{2}$ to 0, which indicates the positive relationship between *Defense* and *SW*, with *SW* leading. Consistent with the high coherency in 1995–1998 in the 2nd–4th frequency band, as the further deepening of the economic system reform and economic growth, social welfare was positively correlated with defense expenditure. The crowding-out effects and the lead-lag relationships between *Defense* and *SW* during the sample period across all the frequency bands are listed in Table 4.

Table 4. Crowding-out effect and lead-lag relationship between *Defense* and *SW*.

Frequency Time	1–2 Years Band		2–4 Years Band		4–8 Years Band	
	Leading	**Correlation**	**Leading**	**Correlation**	**Leading**	**Correlation**
1951–1960						
1961–1968	*Defense*	positive				
1969					*Defense*	positive
1970–1976						
1977					*Defense*	positive
1978–1983						
1984–1985					*SW*	positive
1986–1988	*SW*	negative			*SW*	positive
1989–1991			*Defense*	negative		
1992–1993						
1994					*SW*	positive
1995			*SW*	positive	*SW*	positive
1996–1998			*SW*	positive		
1999–2004						
2005			*Defense*	positive		
2006–2014						

In summary, the partial wavelet coherency and phase differences provide a detailed picture about the dynamic relationship between defense expenditure and social welfare spending across three frequency bands during the 1951–2014 period. The results show the overall inexistence of the crowding-out effect, which indicates that the increase in defense (social welfare) expenditure is capable of promoting social welfare (defense) since China proceeds the mutual development of defense and social welfare. Furthermore, the lead-lag relationship between defense expenditure and social welfare spending varies after 1978, since China pays more attention to social welfare progress than defense construction based on the policy of reform and opening-up and the economic system reform, which causes social welfare to lead defense instead of the opposite.

6. Conclusions

Currently, the sustainability of China's fiscal budget has been challenged by the crowding-out effect between defense and social welfare sectors. This article therefore revisits the "guns and butter" argument by using the long time series data of China during the period of 1950–2014. The continuous wavelet analysis is employed to examine the dynamic crowding-out effect and lead-lag relationship across different frequency bands between defense expenditure and social welfare spending with government fiscal expenditure as a control variable.

Based on the empirical analyses, we draw three primary conclusions. Firstly, the volatilities of defense expenditure, social welfare and government fiscal expenditure have decreased since 1978 with the implementation of opening-up policy and the economic system reform. Secondly, there is no crowding-out effect between defense expenditure and social welfare, moreover, defense expenditure is positively correlated with social welfare in the time-frequency domain. Thirdly, the lead-lag relationship shows the significant variations from the perspective of frequency domain. Social welfare tended to lead defense since the opening-up policy and the economic system reform while the situation was the opposite before 1978.

Hence, it is suggested that China should, firstly, maintain the stability of the social and economic situation to achieve the steady progress of fiscal expenditure and revenue including defense and social welfare. Secondly, China should further balance the defense construction and social welfare development from the perspective of civil-military integration given the positive correlation of defense expenditure and social welfare spending. Thirdly, more attention should be paid to the leading role of social welfare in the lead-lag relationship between defense expenditure and social welfare. Social welfare progress will lead to simultaneous improvement in defense, which is beneficial to national security, economic growth and government fiscal sustainability.

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