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Class Power and China's Productivity Miracle: Applying the Labor Extraction Model to China's Industrial Sector, 1980-2007

Chiara Piovani[1]

Abstract

This paper aims to assess the relationship between industrial productivity and industrial wage share in China between 1980 and 2007, and to identify the determinants of the industrial wage share over the same period. The results suggest that the market reforms in China have led to a reduction of workers' bargaining power, which in turn explains both the rapid productivity increase and the steady decline in the wage share observed since the beginning of the reforms. The results also suggest that privatization, labor market informalization, and retreat of the state from social provisioning are key factors explaining the decline in the wage share. The current Chinese model of development, however, is unsustainable for economic, social, and environmental reasons, and a sustainable model of development is likely to require a more egalitarian income distribution.

JEL classification: J3; O4

Keywords

productivity, wage share, time-series

1. Introduction

Since the early 1980s, China has undertaken a process of market-oriented economic reform. According to the mainstream view, market reforms have contributed to rapid productivity growth by improving efficiency in resource allocation, providing better incentive mechanisms, and promoting innovation.

The mainstream interpretation of China's reforms ignores the pervasive market failures. In particular, the labor market suffers from serious market failures such as asymmetric information and moral hazard. This paper provides an interpretation of China's productivity growth that is alternative to the mainstream. Based on the labor extraction model, when there is an incomplete contract between employers and employees, power relations between different social classes could have an important impact on productivity.

[1]Assistant Professor, Department of Economics, University of Denver, Denver, CO, USA

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Corresponding Author:
Chiara Piovani, Assistant Professor, Department of Economics, University of Denver, 2000 E. Asbury Ave., Denver, CO 80208, USA.
Email: chiara.piovani@du.edu

Over the past three decades, privatization and labor market informalization have deteriorated the class power of the Chinese working class. Applying the labor extraction model, this paper finds that the decline of the workers' class power in the industrial sector (reflected by the decline of the workers' wage share) could explain the rapid rise in productivity in the Chinese industrial sector from 1980 to 2007.[1] This finding raises important questions regarding the sustainability of this engine of China's productivity growth. Section 2 reviews the mainstream literature, which argues that the introduction of market institutions have played a decisive role in China's rapid economic growth. This section also considers the limitations of the mainstream literature. Section 3 introduces the labor extraction model, which considers how power relations between capitalists and workers could affect productivity. Section 4 discusses the reasons why the labor extraction model may well explain China's rapid economic growth since the early 1980s. Section 5 conducts an empirical analysis that applies the labor extraction model to the context of the Chinese industrial sector over the period of 1980-2007. This section uses a time-series analysis based on cointegration and error correction model to evaluate the relationship between the wage share and productivity, where the wage share is used as an indicator of workers' bargaining power. Section 6 considers how privatization, labor market informalization, and government spending for social security have contributed to the observed decline in the wage share. The last section concludes the paper and raises questions concerning the long-run sustainability of China's growth model.

2. China's Market-oriented Reforms: The Mainstream Story

Since 1978, China has undertaken a process of progressive integration with the capitalist world economy by adopting economic reforms aiming at creating a "socialist market economy." Over the course of the reform period, China has accomplished very rapid economic growth. From 1978 to 2009, China's annual economic growth rate has averaged about 10 percent. As a result, China has overtaken Japan to become the world's second largest economy.

According to the mainstream view established in the literature on the Chinese economy, a competitive market economy based on private property rights is intrinsically superior to a centrally planned economy. According to the neoclassical Arrow-Debreu model, a competitive market economy in which profit-maximizing firms interact with utility-maximizing individuals – assuming markets exist for all goods at all times – is associated with maximum social welfare. Consistently, a centrally planned economy would inevitably fail because it cannot solve the information problem and incentive problem as efficiently as a competitive market economy.

Central planning requires a massive amount of information on individual preferences, techniques of productions, and resources available. In reality, it is beyond the capacity of the central planning agency to collect and process the required amount of information. By contrast, in a market economy, all the necessary information is efficiently conveyed by the price system. Moreover, with public ownership of the means of production, workers are poorly motivated and no one has any incentive to accumulate physical capital, human capital, or intellectual property rights. Without competition and in the absence of the threat of bankruptcy, there is no incentive for state-owned enterprises to pursue innovation and technological progress (Hayek 1991; Stiglitz 1996).

According to the mainstream literature, the Chinese economy in the Maoist era from the 1950s to the 1970s was a massive economic failure. The gradual introduction of market institutions and private property rights, which started in the 1980s, can fully explain China's rapid

[1]The notion of "class power" is not used in this context to indicate that workers' previously had some form of organization or bargaining rights during the Maoist era, which were taken away during the reform period. Clearly workers did not have any of these rights either before or after the reforms. What is meant here is that the Maoist ideology guaranteed workers a protected status as indicated by the "iron rice bowl," which prevented workers from being exploited to the degree that occurred after 1978. The erosion of workers' employment conditions (despite rising wages) and the increasing gap between the profit share and the wage share over the last thirty years indicate there has been a redistribution of class power away from labor to capital.

economic growth by removing the various distortions of central planning, dramatically improving the efficiency of resource allocation, and unleashing the creativity and initiatives of individual entrepreneurs.

Within the mainstream literature, there are different opinions regarding what the best strategy to introduce market-oriented reforms is. Some (the so-called "orthodox" neoclassical economists) argue that China could potentially achieve even better economic results by pursuing radical liberalization and privatization at a more rapid pace (Chow 2007; Gang 1994; Perkins 1988; Sachs and Woo 1997). In contrast, others (the more pragmatic neoclassical economists) argue that given the circumstances, the gradualist reform approach adopted by the Chinese government might have represented the best option in practice, which guaranteed the success of the reforms (Jefferson and Rawski 1994; McMillan and Naughton 1992; Nolan 1994; Naughton 1995, 2007; Rawski 1995; Qian 2003; Qian and Woo 2003).

Despite these differences in opinions, both groups of economists agree that the ultimate objective of the Chinese reform should be the building of a competitive market economy, and the success of the Chinese economy depends on to what extent the reform approaches this final objective.

The mainstream view is based on the belief that a competitive market economy is both achievable, and can efficiently solve the information and incentive problems. However, modern developments in microeconomic theory suggest that in the real world the market economy behaves in ways fundamentally different from how it is described by the neoclassical theoretical models. In reality, market failures are likely to be pervasive. For example, public goods and externalities could distort market prices of many goods and services. Uncertainty about the future and the lack of a complete set of future markets could lead to highly inefficient and unstable investment, leading to financial crises and depressions.

In particular, the labor market suffers from the problems of asymmetric information and moral hazard because employers may not be able to accurately assess, observe, or enforce an employee's potential or actual work effort and productivity before or after hire. How the market failures in the labor market are addressed has significant impact on workers' productivity and the overall economic performance.

3. The Labor Market and the Labor Extraction Model

The labor market provides an important example of market failure. In labor contracts, employers can specify the number of work hours, but there is not a mechanism to assure the actual level of labor productivity during these hours. Employers and employees are thus systematically involved in a bargaining process to set the actual work effort and the wage.

In response to the existence of market failures in the labor market, efficiency wage theories suggest that high real wages induce workers to be more productive. A reduction in the real wage would reduce the worker's effort and could reduce a firm's profit. Therefore, firms do not have the incentive to cut wages to the market-clearing level (Akerlof 1979; Akelorf and Yellen 1986; Stiglitz 2002).

In relation to the efficiency wage theories, Bowles, Gordon, and Weisskopf (1991) formulated a theoretical model – known as the "labor extraction model" – which focuses on power relations between classes as the critical factor explaining labor productivity (Bowles, Edwards, and Roosevelt 2005).[2] The labor extraction model shows that when workers have low bargaining

[2]The labor surplus economy model (LSEM) has been excluded as a possible theoretical framework, as the focus of the analysis in this article is productivity in the industrial sector. The LSEM helps explain the change in workers' bargaining power as a result of industrialization and waves of migration from rural areas to urban areas, but it cannot help identify the relationship between productivity in the industrial sector and class dynamics. For this reason, it has been excluded as a possible option to test the question investigated in the paper.

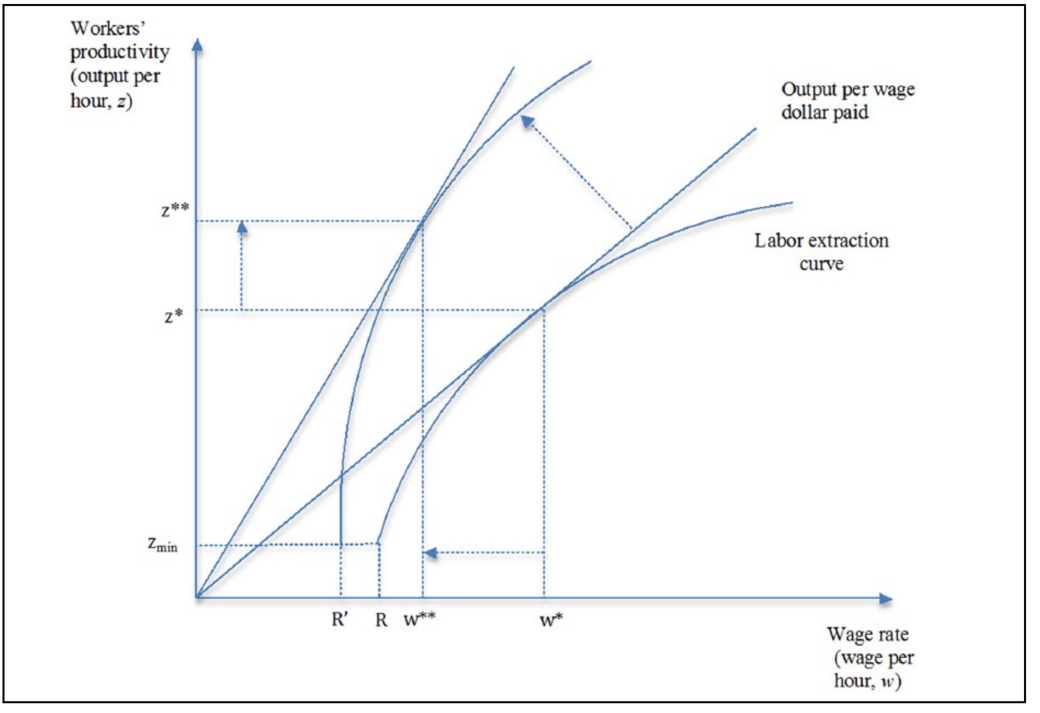

Figure 1. The Labor Extraction Model (Case 1).
Source: Adapted from Bowles, Edwards, and Roosevelt (2005).

power, it is possible for capitalists to pay low wages while at the same time "extracting" high labor productivity.[3]

In contrast to the neoclassical view that the economy is made of atomistic agents who are equally self-interested and equally powered, the labor extraction model demonstrates that class power matters in determining the equilibrium of a capitalist economy. The labor market is an important arena in which the equilibrium is the outcome of a "contested exchange," meaning that employers and employees have conflicting interests and unequal power. Given these conditions, the employers are in the position to exercise command and employees are constrained to comply (Bowles and Gintis 1988, 1993).

As shown in Figure 1, the "labor extraction curve" indicates the level of productivity (z) workers perform at each wage rate (w). The minimum wage rate workers are willing to accept to be

[3]Bowles, Gordon, and Weisskopf (1991) applied the labor extraction model to analyze the economic transformation of the U.S. economy in the postwar years. Using a time-series regression and data of the U.S economy from 1966 to 1979, they found that the dramatic slowdown of U.S. productivity growth after the 1960s could be explained by the decline of workers' effort level, which in turn could be explained by the increase in U.S. workers' bargaining power. They studied factors that could affect the U.S. workers' bargaining power, such as the rate of change of real spendable hourly earnings, the index of work safety, and the cost of job loss, and they found that by the 1970s all three factors tended to reduce productivity growth. The model used in this paper is consistent with the model used by Bowles, Gordon, and Weisskopf, but the specification is different due to differences in the availability of Chinese data. The different role of the state in the Chinese and in the U.S. economy certainly creates a fundamental difference in the model of capitalism in the two countries. The labor extraction model, however, looks at the economic relationship between productivity and wages in the industrial sector, which is the outcome of both class dynamics and state politics/policies. The labor extraction model does not imply that workers and capitalists are the only agents in the economy, and so it can find reasonable application beyond the context of the U.S. economy.

employed is known as the "fallback wage" or "reservation wage," as it reflects the level of income at which workers are indifferent between keeping their current job and being laid off. The reservation wage depends on the prospects of finding alternative jobs and on the likelihood of getting alternative jobs, which in turn depend on the size of the reserve army of labor (that is, the pool of the unemployed and underemployed workers). In correspondence with the reservation wage, workers perform their minimum work effort (z_{min}). As the wage rate rises, output per hour increases but at a decreasing marginal rate. As workers approach the limit of their work effort, a wage increase exerts little effect on labor productivity. The labor extraction curve thus has a slope that becomes progressively smaller as the wage rate rises.

On the employers' side, the conventional objective of maximizing profits requires minimizing unit labor cost. Firms want the ratio of productivity to wage rate (z/w) to be as large as possible. This means that, considering a ray starting from the origin, firms will prefer a straight line with the largest possible slope. As the slope increases, there will be greater productivity associated with each level of wage rate. A profit maximizing firm will choose to pay the wage w* because this is the wage where the labor extraction curve is tangent to the steepest possible ray.

Now suppose that following neoliberal institutional changes, the balance of power between employers and employees shifts to the employers' favor. With the reduction in job security and/or increase in the reserve army of labor, the reservation wage declines to R' and the labor extraction curve shifts to the left. The responsiveness of workers' productivity to a change in the wage rate may also be affected. Per any unitary change of the wage rate, workers may be induced to exercise more effort, leading to a higher level productivity per each wage rate. This means that, as a result of neoliberal reforms, the labor extraction curve shifts to the left and becomes steeper. In correspondence to the new labor extraction curve, the cost of job loss is higher at every wage rate, and employers are able to pay lower wages and to extract higher levels of productivity.

In the case represented in Figure 1, in equilibrium, the new labor extraction curve is tangent to a steeper ray so that in equilibrium employers are able to pay a lower wage rate (w**) while extracting higher labor productivity (z**). The new equilibrium outcome is thus characterized by higher productivity and a lower wage rate. This, in turn, implies a lower wage share, which reflects the loss of workers' bargaining power. In the new equilibrium, however, the wage rate does not necessarily have to decrease. As shown in the case represented in Figure 2, both productivity and the wage rate can increase. If productivity rises at a faster rate than the wage rate, this implies again a lower wage share and a loss of workers' bargaining power.[4]

The labor extraction model suggests that the level of productivity in a capitalist economy, or in any market economy based on private ownership of the means of production, depends on the relative power relations between the capitalist class and the working class. The labor extraction model, however, should not lead to the conclusion that greater class power for capitalists is better from a social and economic perspective. But it does mean that, given the dominance of capitalist or market institutions, other things being equal, greater capitalist power leads to higher productivity.[5] This outcome, though, may be undesirable and unsustainable for other economic, social, and ecological reasons.

Since the 1980s, China has pursued market-oriented reforms, privatization of state-owned enterprises, and informalization of the labor market, which are likely to have had a large negative

[4]In the labor extraction model, the cost of a job loss is considered to be the determinant factor affecting workers' bargaining power (Bowles and Gintis 1993). An increase in the cost of a job loss leads to a shift to the left of the labor extraction curve. In the new equilibrium, the level of productivity is higher and the wage ratio can either be higher, lower, or stagnant with respect to the original equilibrium.

[5]This statement holds for a given level of technology, which is assumed to remain constant in the labor extraction model. This means that, for a given level of technology, productivity can only increase through greater workers' effort.

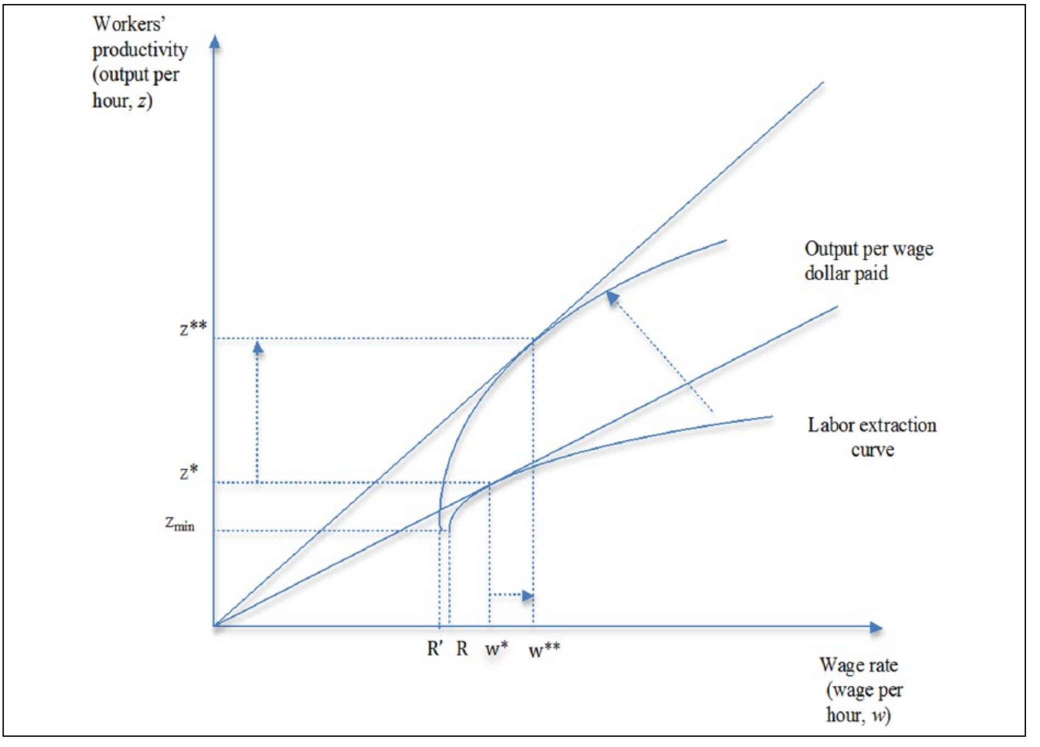

Figure 2. The Labor Extraction Model (Case 2).
Source: Adapted from Bowles, Edwards, and Roosevelt (2005).

impact on Chinese workers' class power. This raises interesting questions about whether the decline of the workers' class power could explain a significant portion of China's productivity growth in the market reform period.

4. The Labor Extraction Model: An Application to Post-reform China

The introduction of market-oriented reforms in China has led to a dramatic change in the traditional Chinese social structure, which has affected the composition of social classes and social relations. The literature on post-reform China shows a consensus on the following socio-economic effects of the reforms. First, state sector workers have experienced a severe deterioration of work conditions. The managerial reforms introduced in the urban industrial sector during the 1980s led to the erosion of the so-called "iron rice bowl," to which Chinese workers were entitled during the Mao era. The adoption of the "contract responsibility system" in 1987 in all state owned enterprises, while giving managers the decisional power over salaries and duration of employment, determined a historical break with the tradition of lifetime employment, subsidized housing, health care benefits, retirement pension, and children's education. The privatization process that started in the mid-1990s led to massive lay-offs in state owned enterprises. According to the Social Relief Division of the Ministry of Civil Affairs, nearly thirty million workers were laid off between 1998 and 2004 (China Labour Bulletin 2005). The number of state owned enterprises in the total industrial sector progressively declined over the past decade, and was reduced to less than 5 percent in 2008 (Green and Liu 2005). The restructuring of state owned enterprises coincided with other reforms that aimed to disconnect individual enterprises from the provisioning of social services, which were instead entrusted to the state, communities, or individual workers (Fan, Lunati and O'Connor 1998). The reforms implemented in the state industrial sector clearly changed the balance of power in capital's favor. The loss of class power experienced by workers in the state sector and the massive lay off of state sector workers during the 1990s are also likely to have weakened workers' class power in the nonstate sector.

Second, the process of economic reform in China has been accompanied by an increasing informalization of the labor market. The historical roots of this trend lie in the adoption of the "household responsibility system" in 1978, which represented a *de facto* privatization of the agricultural sector in China. This ownership change led to the accumulation of a massive labor force in the countryside, which was in "surplus" with respect to the needs of agricultural production and became available for the expansion of manufacturing and services in urban areas. According to official estimates, about 200 million people have left the countryside over the last three decades to search for jobs in urban areas. These conditions set the foundations for the rise of the proletariat in post-reform China. The availability of such a massive reserve army of labor fostered the expansion of irregular forms of employment, which were deprived of the job security and social protection that had traditionally characterized employment in China. In the industrial sector, the share of formal employment in total employment declined from 71 percent in 1978 to 36 percent in 2007. Informalization of employment intensified the effects of privatization in weakening workers' bargaining power. In turn, workers had to accept exploitative working conditions such as extremely long work hours, lack of safety, delayed payment, discrimination, and violation of human rights (Chan 2001; China Labor Bulletin 2007). Poor working conditions and low paid jobs in China continue to foster the international debate on the need for global labor standards (Elliott and Freeman 2003).

Finally, China's model of development has generated a sharp increase in inequality. Growing income and wealth inequality have been observed between coastal and inner provinces, between urban and rural areas, between men and women, and between classes and social groups (Khan and Riskin 2001; Lin 2007; Naughton 2007; UNDP 2005). The Gini coefficient approached 0.5 in 2006, making China one of the most unequal countries in the world (Bhaduri 2008). According to the Asian Development Bank (2007), the ratio of per capita income of the top 20 percent of the population to the bottom 20 percent is higher in China than in any other Asian country. There are no official statistics on China's total labor income. Estimates, however, indicate that China's labor income, which constituted about 50 percent of GDP in 1990, declined to 37 percent of GDP in 2005 (Piovani and Li 2011). China's model of development has thus led to a growing profit share, which in turn has fostered rapid capital accumulation and wealth concentration. China now has the second highest number of billionaires in the world, trailing only the United States (Kwong 2007).

All these factors (privatization, informalization, and increasingly uneven income distribution) provide evidence that the bargaining power of the Chinese working class has declined over the course of the reforms. Despite steadily rising wages in the industrial sector, between 1980 and 2007 the wage share in the industrial sector declined from 43 percent to 15 percent.

On the other hand, in the five-year plan announced in October 2006, the government announced its intention to pursue "harmonious growth," shifting away from the previous focus on achieving high economic growth *per se*. This new paradigm aims to tackle the different dimensions of inequality generated by the market reforms to accomplish "common prosperity" (Tan and Khor 2006). This new policy framework may have lessened the reduction in workers' bargaining power observed since the early 1980s. This paper is going to test the interplay between all the different forces that affected the dynamics of class relations over the reform period.

At this point, a fundamental question emerges. Could China's rapid economic growth be – to some extent – explained by the change in class relations and power redistribution away from labor to capital?

5. Workers' Bargaining Power and Productivity in the Chinese Industrial Sector: An Empirical Analysis

This section tests the labor extraction model in the context of the Chinese economy by using a time series analysis to investigate the relationship between changes in class relations and rapid economic growth in China since the beginning of the reform period. The analysis examines the impact of workers' bargaining power on industrial labor productivity in the period 1980-2007.

The impact of workers' bargaining power on productivity may be illustrated starting from the following theoretical expression for output:

$$Y = F\ (K,\ L,\ workers'\ bargaining\ power) \tag{1}$$

Equation (1) says that output (Y) is a function of capital (K), labor (L), and workers' bargaining power.

Assume the relationship between output and inputs follows the standard Cobb-Douglas production function. Equation (1) may thus be rewritten as follows:[6]

$$Y \ = \ AK^{\beta 1}L^{1-\beta 1} \ 0 \ < \beta_1 < \ (where\ \beta_1\ is\ the\ capital\ elasticity\ of\ output) \tag{2}$$

In the standard neoclassical interpretation, *A* represents total factor productivity. In the context of the labor extraction model, *A* may be interpreted as a variable that captures all influences on productivity except capital and labor, including workers' bargaining power.

According to the labor extraction model, workers' bargaining power is positively associated with the wage share of output, but negatively associated with labor productivity.[7] In addition, according to standard economic theory, productivity may also be influenced by changes in the price level. Inflation can create informational distortions affecting the producers' choice of inputs and investment decisions, in turn impacting productivity (Narayan and Smith 2009). Equation (3) says *A* is a function of the wage share (as an indicator of workers' bargaining power) and the inflation rate in the industrial sector:

$$A = A'\, W^{\beta 2}\ \Pi^{\beta 3} \tag{3}$$

A is assumed to be a function of W (wage share) and Π (Π is "e" to the power of π, and π is the inflation rate in the industrial sector). *A'* is simply the constant term that reflects all other factors that may have an impact on productivity. Substituting equation (3) into equation (2):

$$Y = (A'\, W^{\beta 2}\ \Pi^{\beta 3})\ K^{\beta 1}\ L^{1-\beta 1} \tag{4}$$

Dividing both sides by *L* and transforming all the variables into logarithms on both sides, the empirical model to be tested is derived:

$$y = \beta_0 + \beta_1 k + \beta_2 \omega + \beta_3 \pi + \varepsilon \tag{5}$$

[6]A Cobb-Douglas production function is assumed so that the theoretical equation can be transformed into an easily empirically testable form. It does not imply theoretical agreement with the neoclassical theory of factor productivity.

[7]As will be discussed in section 6, the decline of the wage share between 1980 and 2007 has been affected by a series of market-oriented reforms that resulted in a shift of class power away from labor towards capital. The wage share is thus used here as a proxy for workers' bargaining power.

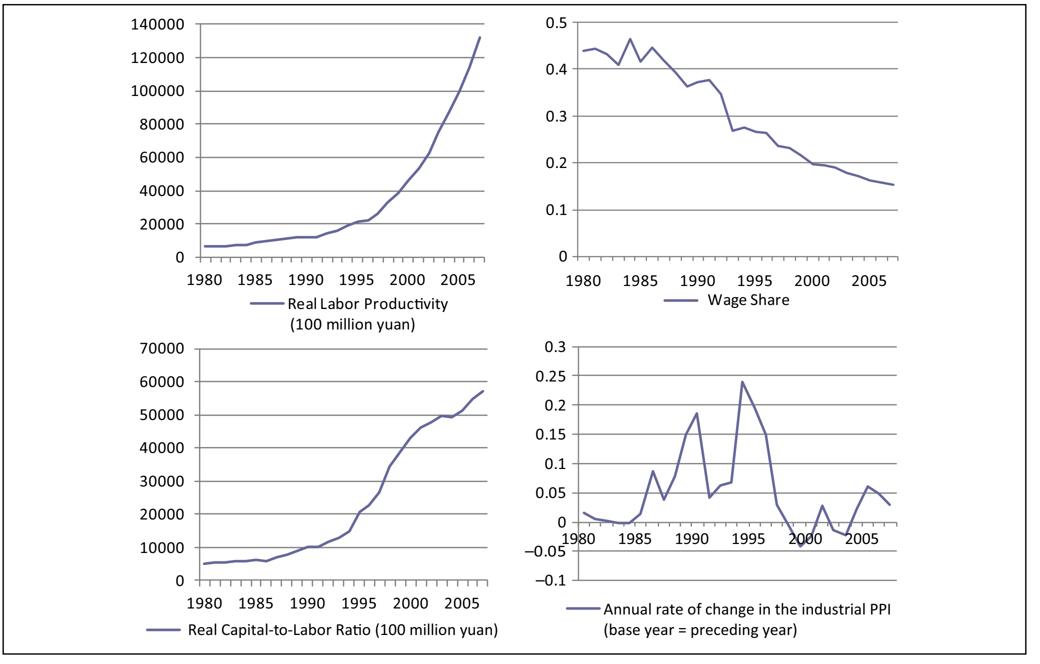

Figure 3. Real Labor Productivity, Wage Share, Real Capital-to-Labor Ratio, Annual Rate of Change in the Industrial PPI.
Source: *China Statistical Yearbook* and author's estimations, various years.

In equation (5), y = ln (Y/L), which measures labor productivity; k = ln (K/L), which measures the capital-labor ratio; ω = ln W, which measures the wage share; π is the inflation rate in the industrial sector; ε is the error term.

Labor productivity in the industrial sector is calculated as the ratio of real gross industrial output value to total industrial employment. The industrial sector is conventionally defined as the sum of manufacturing, mining, and provision of public utilities. The wage share is defined as the total wages in the industrial sector divided by the value added in the industrial sector. As Figure 3 shows, labor productivity has increased exponentially since the beginning of the reform period. In contrast, the wage share collapsed from 43 percent in 1980 to 15 percent in 2007. The decline has been particularly rapid since the intensification of the market reforms in the early 1990s.

The capital-labor ratio is calculated as the ratio of the real capital stock to the number of employees in the industrial sector. The inflation rate in the industrial sector is measured by the change in the industrial producer price index.

All variables are constructed using data from the *China Statistical Yearbook*. The construction procedure is explained in Appendix A and the methodology is explained in appendices B and C.

Figure 3 indicates that real labor productivity, wage share, real labor-to-capital, and the annual rate of change in the industrial PPI exhibit non-stationary behavior. It is however compulsory to run a formal stationarity test before proceeding to estimation. Table I summarizes the results of the augmented Dickey Fuller test. The test reveals that all variables considered in logarithms are non-stationary in levels and stationary in first difference, indicating that all variables contain one unit root. Given that all variables are integrated of order one, the Johansen cointegration test can be adopted to explore the long-run relationship between the variables.[8]

[8]The lag order selection criteria indicate that both VAR(1) and VAR(2) are plausible choices. In the present case, given the small sample, one lag is selected as the optimal option in the cointegration test.

Table I. The Productivity and Wage Share Nexus: Unit Root Test.

ADF Statistic (H0: Variable is non-stationary)				
	Intercept		Intercept and Trend	
Variables	Level	First Difference	Level	First Difference
y			–1.491642	–4.850599**
ω		–6.553692**	–3.026123	
k		–3.171330*	–2.935352	
π	–2.335476	–4.778164**		
Test Critical Values (MacKinnon, 1996)				
5% Level	–2.976263	–2.981038	–3.587527	–3.595026
10% Level	–2.62742	–2.629906	–3.22923	–3.233456

Note: * implies that the coefficient is significant at 0.05 level and **implies that the coefficient is significant at 0.10 level.

Table II indicates that both trace and maximum eigenvalue tests indicate one cointegrating equation at 5 percent level. Table III shows the cointegrating coefficients of the long-run equilibrium condition – the cointegration equation – in which the explanatory variables are normalized on y equal to one. The normalized cointegrating equation is estimated as follows:

$$y = -2.694706 - 1.996615*\omega + 0.484123*k + 1.158349*\pi \quad (6)$$

The results indicate that labor productivity has a direct relation with the capital-to-labor ratio (as expected) and also with the inflation variable. This latter result conflicts with the expected sign for inflation, but it is consistent with studies showing that there is mixed evidence on the effect of inflation on productivity (Freeman and Yerger 2000). The key result is that labor productivity has an inverse relation with the wage share. From a statistical point of view, the t-test shows that only the coefficient associated with ω is significant. The cointegrating equation shows that a 1 percent increase in the wage share is associated with a 2 percent drop in productivity. Between 1980 and 2007, productivity increased at an average annual rate of 11.8 percent. Over the same period, the wage share declined at an average annual rate of 3.8 percent. The coefficient associated with the wage share suggests that the decline of the wage share contributed to 7.6 percentage points of productivity growth. In other words, the decline of workers' bargaining power, by this measure, is associated with 64 percent of the productivity growth.

These results suggest that the labor extraction model is an appropriate theoretical framework to interpret the Chinese reform experience, which means that firms have been able to extract both low wages and high productivity over the course of the reforms as a consequence of workers losing bargaining power with the progressive dismantling of socialist institutions. The Chinese transformation from a socialist system to a capitalist economy (with Chinese characteristics) has thus been driven by the capacity of firms to prevent workers from absorbing a growing share of the rising surplus. The result has been a steady trade-off between real labor productivity and wage share of industrial value added. The market institutional environment has led to the emergence of a growing power gap between capitalists and workers, which set the foundations of the rapid pace of capital accumulation.

After having established the cointegrating relationship, an error correction model (involving the variables entering the cointegrating equation) can be estimated. With an error correction model both the short-run and the long-run dynamics of the model can be assessed. The estimation

Table II. The Productivity and Wage Share Nexus: The Johansen Cointegration Test.

	Eigenvalue Test:			
	Eigenvalue	Trace Statistic	Critical values 5%	Prob**
None*	0.687221	30.21870	27.58434	0.0224
At most 1	0.404979	13.49813	21.13162	0.4075
At most 2	0.294774	9.080150	14.26460	0.2795
At most 3	0.00532	0.138694	3.841466	0.7096
	Trace Test:			
	Eigenvalue	Max Eigen-Statistics	Critical values 5%	Prob**
None*	0.687221	52.93567	47.85613	0.0155
At most 1	0.404979	22.71698	29.79707	0.2602
At most 2	0.294774	9.218844	15.49471	0.3455
At most 3	0.00532	0.138694	3.841466	0.7096

*denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon-Haug-Michelis (1999) p-values.

Table III. The Productivity and Wage Share Nexus: Normalized Cointegrating Coefficients.

Variables	Coefficients	t-statistics
k	– 0.484123	1.31856
ω	1.996615*	2.33193
π	– 1.158349	1.46547

*denotes rejection of the H_0 hypothesis at the 0.05 level.

results with one lagged first difference terms are reported in Table IV. Since the analysis focuses on productivity, the results are not reported for all the variables included in the vector, but only for Δy. The model passes all the conventional tests for serial correlation, residual normality, heteroscedasticity, and functional form. The crucial parameter in the estimation output is the coefficient of the error-correction term, which measures the speed of adjustment of productivity to its equilibrium level. The error correction term (ECM), which shows the speed of adjustment to equilibrium in the period of study, is statistically significant and correctly signed. This indicates that productivity in China is associated with an automatic adjustment mechanism, as there is a tendency in the model to restore the long-term relationship following a temporary shock in the independent variables. A value of -0.11 for the coefficient of the error correction term suggests that productivity tends to converge towards its long-run equilibrium level with a moderately slow speed following a shock in inflation, capital-to-labor ratio, or wage share.

6. An Accounting of Workers' Bargaining Power: The Wage Share

The previous results clearly indicate that loss of workers' bargaining power is a critical factor behind rising labor productivity in China over the reform period. This second part of the empirical analysis aims to identify what specific economic changes have affected workers' bargaining power, in turn impinging on the industrial wage share.

As illustrated by the following equation, the wage share is explained using the bargaining power approach that underlies the labor extraction model. It is assumed that the wage share (W)

Table IV. Error Correction Model for Labor Productivity.

Error Correction:	D(y)
ECM (-1)	–0.111484
	[–3.40669]
D(y(-1))	0.314414
	[2.11599]
D(π(-1))	–0.487340
	[–3.72640]
D(ω(-1))	0.215728
	[1.73879]
D(k(–1))	–0.362504
	[–3.10525]
C	0.124237
	[6.12177]
R-squared	0.643774
Adj. R-squared	0.554718
Sum sq. resids	0.031527
S.E. equation	0.039703
F-statistic	7.228836
Log likelihood	50.40282
Akaike AIC	–3.415602
Schwarz SC	–3.125272
Mean dependent	0.116767
S.D. dependent	0.059499

[ ] shows 't' values of t-statistics.

depends on both the "reservation income" – which refers to the fall-back income on which workers can rely if they lose their current job – and the "reserve army of labor" – which refers to the size of the excess supply of labor:

$$W = W\ (reservation\ income,\ reserve\ army\ of\ labor) \tag{7}$$

In light of China's transition experience, the variables affecting the "reservation income" are associated with the different role the state has acquired with the dismantling of the socialist system, the urbanization process, and the effects of privatization. The change in the role of the State over the course of the reforms is proxied by the variable "Social Security" – the GDP share of social security expenditure – which is expected to positively affect workers' bargaining power by providing a fall-back income in case of market downturns.[9]

The effects of urbanization are captured in the analysis by a variable indicated as "Formal Wage," which is defined as the ratio of industrial formal average wage to net peasant per capita income (used as a proxy of the wage provided in the informal sector). Even though an important share of migrant workers is absorbed by the urban informal sector, it is assumed that the migration is driven by the expectation of finding employment in the formal sector in urban areas. The "Formal Wage" is expected to have a negative relationship with workers' bargaining power. As the ratio increases, workers' bargaining power is expected to decline as this indicates the value of

[9]China's social security system covers various forms of social insurance (pension, medical care, unemployment, disability, maternity, and childcare), but also social relief and welfare payments to disadvantaged citizens.

the informal income (which is the income on which workers may rely if they lose their job) decreases with the progress of the market reforms. Finally, the "State Wage," defined as the ratio of industrial formal wage in the state sector to industrial formal wage in the nonstate sector, is expected to positively influence workers' bargaining power as it exercises pressure on the wages offered by private enterprises.

Figure 3 shows the plot of the variables used in the wage share analysis. The variables are calculated using annual data provided by the *China Statistical Yearbook* from 1980 to 2007. "Social Security" steadily declined until 1995 as the reforms implied a retreat of the state from social provisioning. Starting from 1996, the trend reversed as new measures for social protections were introduced to offset the increase in inequality and the decline in poverty reduction generated by the market reforms. Some of the key actions included extension of the pension system in the cities, improvement of social assistance, better provision of housing benefits in the cities, and reform of the health care system.

The "Formal Wage" has steadily increased since 1997, as the reforms strengthened the role of *industrial employment* in people's livelihood. The trend of the "State Wage" did not change significantly until 1992; with the intensification of the market reforms, the wage ratio declined following a more rapid annual rise in the average wage of the nonstate sector with respect to the state sector. Since 2001, state wages have tended to increase more rapidly than nonstate wages leading to an inversion of the previous trend.

In the case of China, the variables affecting the "reserve army of labor," which refers to the level and composition of employment, are a consequence of the process of liberalization and privatization that occurred in the transition to a market economy. A good indicator summarizing the structural changes that affected the Chinese economy is the "State Share" – state share of total formal industrial employment – which measures the number of staff and workers employed in the state industrial sector relative to the total number of staff and workers employed in the industry. The higher the "State Share," the higher workers' bargaining power is expected to be, as the state sector offers greater job security and labor protection than the private sector. Figure 4 shows that the share of state formal employment in the formal industrial sector since 1998 has collapsed as a result of the intense privatization process adopted by the Chinese leadership since the early 1990s. The "State Share" declined from 70 percent in 1980 to 22 percent in 2007. In the analysis, the state share variable is considered lagged by one period, as the effect of a structural change such as the retreat of the state from being the main employment source in the economy is likely not to instantaneously affect the wage share, but it is likely to require some time to be effective.

The "reserve army" in the industrial sector is also likely to be affected by liberalization policies implemented in sectors of the economy different from industry. The variable "Formal Share" refers to the number of staff and workers employed in the nonindustrial sector, measured as a share of total nonindustrial employment. As formal employment is associated with greater job security, the "Formal Share" is expected to be positively associated with workers' bargaining power in the industrial sector.

The following notation is used to indicate the described variables: W = wage share; FW = Formal Wage; SW = State Wage; SEC = Social Security; STATE = State Share; FS = Formal Share. The empirical equation to be estimated is thus the following:

$$W_t = \gamma_0 + \gamma_1 FW_t + \gamma_2 SW_t + \gamma_3 SEC_t + \gamma_4 STATE_{t-1} + \gamma_5 FS_t + \varepsilon_t \tag{8}$$

The analysis of the determinants of the wage share follows the same procedure as the analysis of the productivity-wage share relation. The first requirement is to assess the stationarity of the series. Figure 4 seems to indicate that all series are nonstationary, but a formal test needs to be applied to assure all variables are characterized by the same order of integration. Table V reports the results of the augmented Dickey Fuller test, which cannot reject the hypothesis that all

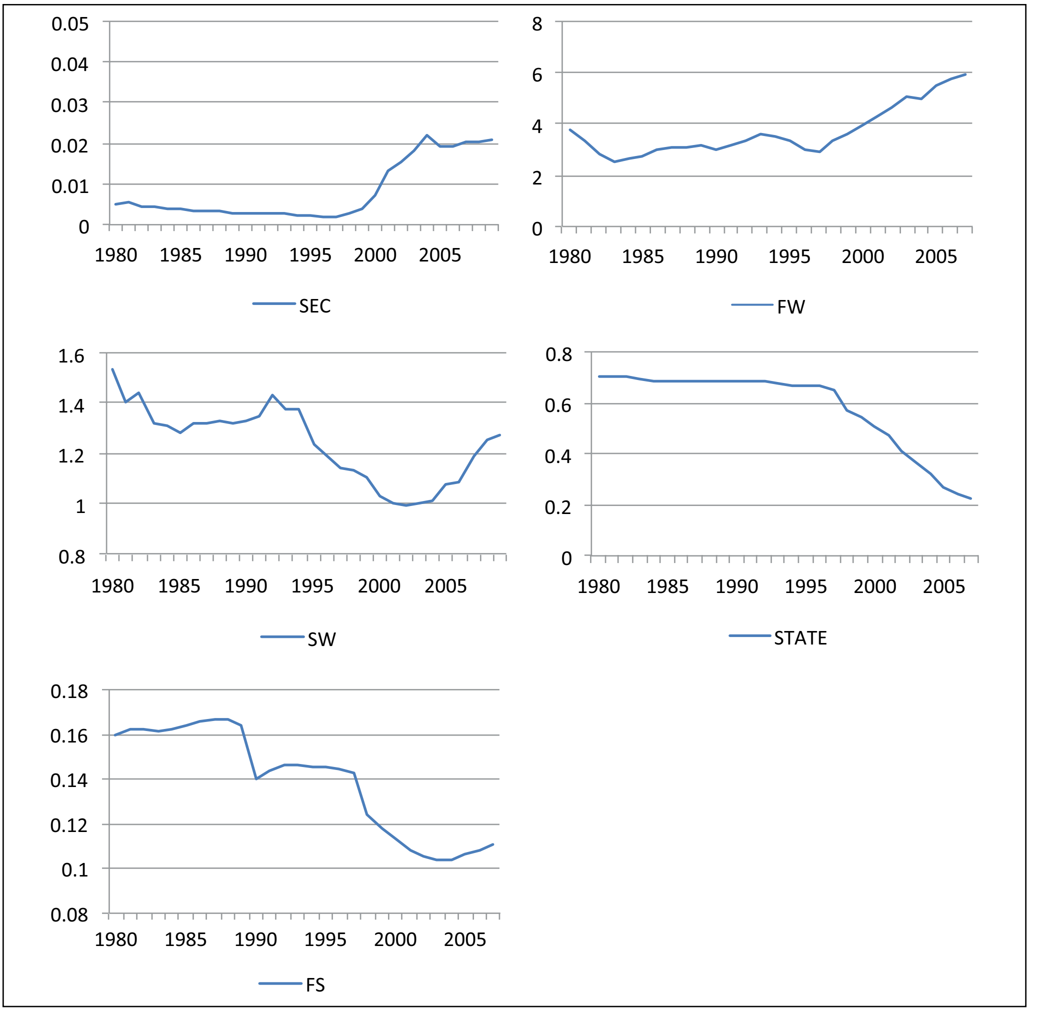

Figure 4. GDP Share of Social Security (SEC), Formal Wage (FW), State Wage (SW), State Share of Total Formal Industrial Employment (STATE), Non-Industrial Formal Employment Share of Total Non-Industrial Employment (FS).
Source: *China Statistical Yearbook* and author's calculations, various years.

variables contain one unit root. The Johansen cointegration procedure can thus be safely applied.[10] Considering as exogenous variables the lagged variables in the model, Table VI shows that the eigenvalue test and the trace test support the existence of four and five cointegrating relations among the variables at 5 percent significance level, respectively. Out of these statistically significant cointegrating relations, only one is not statistically significant but also economically meaningful for the case analyzed. Table VII reports the estimated cointegrated equation with W normalized to one. The cointegrating equation is as follows:

[10]All lag order selection criteria concur that one lag interval should be placed in the cointegration test.

Table V. The Wage Share Analysis: Unit Root Test.

ADF Statistic (H0: Variable is nonstationary)				
	Intercept		Intercept and Trend	
Variables	Level	First Difference	Level	First Difference
W		–7.282228**	–3.079768	
FW		–3.312803*	–1.863902	
SW		–4.064757*	–1.616629	
SEC		–3.010007*	–1.776716	
FS		–4.392872**	–2.290767	
STATE			0.763961	–3.751870*
Test Critical Values (MacKinnon 1996)				
5% Level	–2.976263	–2.981038	–3.587527	–3.595026
10% Level	–2.62742	–2.629906	–3.22923	–3.233456

Note: * implies that the coefficient is significant at 0.05 level and **implies that the coefficient is significant at 0.10 level.

Table VI. The Wage Analysis: The Johansen Cointegration Test.

Eigenvalue Test:				
	Eigenvalue	Max Eigen-Statistics	Critical values 5%	Prob**
None *	0.993061	119.2944	40.07757	0.0000
At most 1 *	0.891283	53.25608	33.87687	0.0001
At most 2 *	0.800902	38.73502	27.58434	0.0012
At most 3 *	0.595911	21.74686	21.13162	0.0409
At most 4	0.430187	13.49875	14.26460	0.0658
At most 5	0.089384	2.247207	3.841466	0.1339
Trace Test:				
	Eigenvalue	Trace Statistic	Critical values 5%	Prob**
None *	0.993061	248.7783	95.75366	0.0000
At most 1 *	0.891283	129.4839	69.81889	0.0000
At most 2 *	0.800902	76.22783	47.85613	0.0000
At most 3 *	0.595911	37.49281	29.79707	0.0054
At most 4 *	0.430187	15.74595	15.49471	0.0458
At most 5	0.089384	2.247207	3.841466	0.1339

*denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon-Haug-Michelis (1999) p-values.

$$W_t = 0.925813 - 0.094077{*}FW_t + 0.341369{*}SW_t + 23.46813{*}SEC_t + 0.282434{*}STATE_{t-1} + 5.712331{*}FS_t \tag{9}$$

The estimated coefficients present the expected sign; all variables are significant at 1 percent level. The results indicate that in the long run the wage share is critically affected by privatization, informalization, and social security expenditure of the state. State formal industrial employment as a share of total industrial employment lagged one period (STATE) has a positive effect

Table VII. The Wage Share Analysis: Normalized Cointegrating Coefficients.

Variables	Coefficients	t-statistics
$STATE_{t-1}$	–0.282434***	–6.05830
FW_t	0.094077***	13.4749
FS_t	–5.712331***	–35.5034]
SW_t	–0.341369***	–22.4085
SEC_t	–23.46813***	–53.4386

***denotes rejection of the H_0 hypothesis at the 0.01 level.

on the wage share and is significant at the 1 percent level. The ratio of state industrial formal wage to nonstate formal industrial wage (SW), the GDP share of social security (SEC), and the ratio of industrial formal average wage to informal wage (FW) have a positive effect on the wage share, which is statistically significant at the 1 percent level.

The above results suggest privatization, the informalization of the labor market, and the relative decline in the state sector wages all contributed to the decline of workers' bargaining power. But the negative effects were partially offset by the increase in government social security spending. The positive effect of social security spending, however, was not sufficient to offset the negative effects of market-oriented reforms.

As in the previous part of the analysis, based on the results of the cointegration test above, an error correction model with one lag first difference is estimated. Given that the emphasis of the analysis is on the wage share, Table VIII only reports the equation for ΔW. The model indicates that the long-run equilibrium is associated with a self-correcting short-run dynamics. The coefficient associated with the error correction term ECM1(–1) – -0.481355 – is both correctly signed and statistically significant. The magnitude of the coefficient indicates that the variables in the system have a tendency to revert back to their equilibrium relationship, even though the magnitude of the coefficient associated with the error correction term indicates that the adjustment occurs relatively slowly.

7. Conclusion

This paper represents the first significant attempt to empirically investigate the relationship between change in class relations and rapid economic growth in post-reform China. The first part of the empirical analysis of the study applies the labor extraction model to investigate the relationship between productivity and wage share in the Chinese industrial sector between 1980 and 2007. Cointegration and error correction analysis show that there is a robust negative relationship between productivity and wage share, which – as suggested by the labor extraction model – implies that firms have been able to extract both high productivity and declining wage share due to the deterioration of workers' bargaining power.

The second part of the empirical analysis of this paper aims to identify the critical factors that led to the shift of class power away from labor to capital. Cointegration and error correction analysis suggest that privatization, informalization of the labor market, and reduction in the social provisioning role of the state play a major role in explaining the dramatic decline of the wage share since the beginning of the reform period.

These results raise fundamental questions about whether China's productivity growth as based on declining workers' bargaining power can be sustained. First, despite the abundant surplus of labor in China's rural areas, the number of young migrant workers already appears to be in

Table VIII. Error Correction Model for the Wage Share.

Error Correction:	D(W)
ECM(–1)	–0.481355
	[–2.51619]
D(W(–1))	–0.236405
	[–0.78623]
D(STATENEW(–1))	–0.446309
	[–1.10029]
D(SW(–1))	–0.192737
	[–1.07650]
D(SEC(–1))	–7.967788
	[–1.52981]
D(FW(–1))	0.000356
	[0.01160]
D(FS(–1))	–2.262495
	[–1.98920]
C	–0.034830
	[–3.25738]
D(STATENEW(–2))	–0.503075
	[–1.33302]
D(SEC(–2))	–4.053267
	[–0.91678]
D(FS(–2))	–0.496659
	[–0.46043]
D(W(–2))	–0.253861
	[–0.93802]
D(W(–3))	–0.359428
	[–1.43745]
R-squared	0.555117
Adj. R-squared	0.069791
Sum sq. resids	0.006833
S.E. equation	0.024923
F-statistic	1.143802
Log likelihood	63.91452
Akaike AIC	–4.242876
Schwarz SC	–3.604764
Mean dependent	–0.010706
S.D. dependent	0.025841

[ ] shows 't' values of t-statistics.

shortage with respect to the demand of the export-oriented manufacturing industry (Chan 2010). Second, the low wages and harsh working conditions experienced by young Chinese workers are leading to an increasing number of strikes and protests, building fears that labor disputes may turn into a nationwide phenomenon (Barboza and Tabuchi 2010). Finally, the Chinese population is ageing very rapidly due to declining fertility rate and increasing life expectancy (ILO 2010). All these conditions – supply depletion of young rural workers, ageing population structure, and labor unrest – may lead to a bargaining power shift in workers' favor, in turn undermining the current engine of productivity growth.

The sustainability of China's productivity growth may also be undermined by the question of effective demand, which this article has ignored. In the last thirty years, production for foreign markets has compensated for the low level of internal consumption associated with falling labor income. The decline in the consumption share of GDP has largely paralleled the decline in the labor share of income. In this context, export-orientation has represented an essential driver of China's economic growth (Piovani and Li 2010). China's net export position depends primarily on the United States and secondarily on the European Union. The dependence on both markets presents potential upcoming problems. The United States is likely to be in prolonged stagnation and not able to sustain a rising trade deficit. The European Union is not likely to replace the United States as consumer of last resort on the world markets. If China does not shift the engine of economic growth to internal demand, and in particular to mass consumption, the problem of effective demand is likely to become determinant. This means that the Chinese government should introduce income redistribution measures or policies specifically oriented to support workers' bargaining power, which could counteract the ongoing decline of labor income.[11]

Besides economic imbalances, the sustainability of China's current model of development is also threatened by social and ecological imbalances. The change in class relations brought about by the economic reforms in China could eventually lead to potentially explosive social conflict, as workers appear increasingly unwilling to continue tolerating exploitative working conditions. The use of natural resources associated with China's current economic structure has already caused severe environmental degradation, and has greatly accelerated the international climate emergency (Piovani and Li 2010). Unless the government effectively intervenes to tackle the existing macroeconomic, social, and ecological imbalances, the current contradictions may unfold into a radical institutional transformation that prioritizes equity and sustainability over quantitative accumulation.

Appendix A

Data Sources and Construction

The *China Statistical Yearbook* (CSY 1980-2007) provides the necessary data to calculate real labor productivity, real capital-to-labor ratio, and the wage share for the *industrial enterprises with independent accounts (IEIA)*. In this study, all three variables are log-transformed.

(a) Real Labor Productivity (y)

Real labor productivity is calculated as the ratio of real gross output value of the IEIA to total industrial employment. Real gross output value is the gross output value deflated by the producer price index of industry. Before 1998, the official statistics do not provide direct employment data. The number of employees can however be calculated using the labor productivity data for the IEIA that the *China Statistical Yearbooks* provides.

(b) Real Capital-to-Labor Ratio (k)

[11]Since the Five Year Plan announced in 2006, the CCP has declared the need to move away from pursuing economic growth per se to target economic growth with equity. This declaration clearly suggests that the CCP is aware that China needs to boost internal consumption to maintain rapid economic growth. Despite this discourse, household consumption accounted for only 35 percent of GDP in 2011, which represents a decline by 9 percentage points since 2002 and remains far below the world's average consumption to GDP ratio. China is thus still far behind in the process of rebalancing its economy in a more sustainable way.

Real capital-to-labor ratio is calculated as the ratio of real stock of capital to number of employees in the IEIA. Real stock of capital (at replacement cost) in year t (K_t) is calculated as follows:

$$K_t = K_{t-1} + NI_t$$

where NI_t is real net investment at time *t*. Real stock of capital is constructed from the original value of fixed assets (book value of capital). The original value of fixed assets in 1980 is assumed to be equal to the net value of newly added fixed assets in 1980. Real net investment at time *t* is calculated as follows:

$$K_t = K_{t-1} + NI_t$$

where NI_t is the change in nominal fixed assets, and P_t is the producer price index in year *t*. This method of deflating the original value of fixed assets is the same adopted by Lo (1997).

The fixed investment price index is available in the *China Statistical Yearbook* since 1991. For the years from 1980 to 1990, the fixed investment price index is estimated as a weighted average of the producer price index of the machine building industry and the implicit GDP deflator of the construction industry, where the weights are assumed to be 0.4 and 0.6 respectively.

(c) Wage Share (LWS)

The wage share is calculated as the ratio of total wage in IEIA to total value added in IEIA. Total wage is given by the product of average industrial wage and employment in IEIA. For the years prior 1991, the *China Statistical Yearbook* only provides data for gross industrial output value. Value added is calculated assuming that the ratio of value added to gross output, which is approximately constant between 1992 and 2007, holds also for the period 1980-1991.

The other variables used in this study are calculated using data directly provided by the *China Statistical Yearbook*. The list and definition of the variables is the following:

- **(d) Inflation in the Industrial Sector (PP1_1)** = change in the producer price index (PPI) from the base year, lagged by one period. The base year in the *China Statistical Yearbook* is set to be equal to the preceding year.
- **(e) State Share of Total Formal Industrial Employment (SFE_1)** = number of staff and workers employed in the state industrial sector, measured as a share of the total number of staff and workers employed in the industrial sector.
- **(f) Wage Gap (WG)** = ratio of formal wage to informal wage. Informal wage is proxied by net peasant per capita income.
- **(g) Share of Non-Industrial Employment (NI)**: number of staff and workers employed in the non-industrial sector, measured as a share of total non-industrial employment.
- **(h) Wage Ratio (WR)** = ratio of industrial formal wage in the state sector to industrial formal wage in the non-state sector.
- **(i) GDP Share of Social Security Expenditure (SS)** = government expenditure of the state for social security measured as a share of GDP. Social security expenditure is defined by social insurance payments (pension, medical care, unemployment, disability, maternity, and childcare) in addition to social relief and welfare payments to disadvantaged citizens.

Appendix B

Time Series Analysis

When dealing with time series, it is essential to verify the presence of unit roots. Applying the conventional OLS procedure to nonstationary series is likely to lead to inaccurate results. Granger and Newbold (1974) demonstrated that, in the presence of nonstationarity, it is possible to obtain "spurious" regressions. A spurious regression occurs when the estimation results show very high R^2 and very high values of *t-ratios*, which may occur even when the model has no economic meaning. The OLS estimation procedure, in fact, tends to interpret the relation between two trended variables as positive (if the two variables move in the same direction) or negative (if the two variables move in opposite directions), but the coefficients may be significant even when there is no economic relation at all between the variables involved. When dealing with non-stationary variables, the OLS estimates may not be consistent, and therefore the conventional statistical tests are not valid (Asteriou and Hall 2007).

In order to address nonstationarity, the augmented Dickey-Fuller (ADF) test – which is the most widely used test to identify the presence of unit roots in time-series – is applied to determine the order of integration of the series (Dickey and Fuller 1979, 1981).[12] The augmented Dickey Fuller (ADF) test critically depends on two-specification problems: first, the inclusion of the time trend and/or the constant term in the estimating equation; second, the specification of the number of lags.[13] As conventional practice, the option "intercept and trend" has been selected when the variable "trend" showed to be significant in the auxiliary regression included in the augmented Dickey Fuller test, in which the variable in question is regressed on its lagged terms. The number of lags in ADF tests is chosen based on Akaike information criterion (AIC).

If the variables are found to be integrated of the same order, the Johansen's multivariate test for cointegration can be applied (Johansen 1988).[14] Cointegration is a statistical property that may characterize a vector of nonstationary variables. When series are nonstationary of the same order, but there is a linear combination of these series that is stationary, then the series are said to be "cointegrated" (Engle and Granger 1987). Cointegration is useful to identify equilibrium relationships among trending variables as it allows assessing whether variables present a long-run relationship in light of their common stochastic trend (Wooldridge 2008).

The Johansen procedure involves estimating a vector autoregression (VAR), which requires the selection of an appropriate lag order. The optimal lag is selected by comparing alternative statistics commonly used as criteria to identify the optimal lag order. The selected option of the Johansen cointegration test assumes an intercept, but not trend, in both the cointegrating equation and the VAR. The Johansen test applies maximum eigenvalue and trace tests to establish the number of cointegrating relations among the variables considered.

If a cointegrating relation is found, an error correction model involving the variables entering the cointegration equation can be estimated. This approach allows us to take into account both

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[12]A variable x is said to be integrated of order z, denoted by $x \sim I(z)$, if x has z unit roots or, equivalently, if the variable *x* taken in z-difference becomes stationary. The key insight of the approach introduced by Dickey and Fuller is that testing for nonstationarity corresponds to testing for the presence of a unit root (Asteriou and Hall 2007).

[13]The test requires choosing between three options depending on the behavior of the series: no intercept, only intercept, both intercept and trend. Macroeconomic series tend to fall in the last two categories. The ADF test thus allows distinguishing between difference stationary and trend-stationary time-series. In the first case, the variables contain unit roots; in the second case, the variables are stationary once a linear trend has been taken into account.

[14]Johansen demonstrated that cointegration may also be investigated among variables that are a combination of I(0) and I(1).

short-term and long-term dynamics in the model (Granger 1997). The variables in the regression equation are taken in differences in order to ensure stationary (avoiding this way the problem of the spurious regression). The regression equation also includes a vector error correction term (VECM), which corresponds to the cointegrating relationship between the variables provided by the Johansen test. The coefficients associated with the independent variables measure the short-run impact that a change in each independent variable has on the explanatory variable, whereas the coefficient associated with the error correction term measures the speed of adjustment from short-term disequilibrium to long-term equilibrium (Asteriou and Hall 2007; Enders 2010). Technical details on cointegration and error correction model are described in Appendix A.

Appendix C

Cointegration Test and Vector Error Correction Model

The existence of cointegration, or long-run relationship among the variables, has been assessed in this study by applying the Johansen methodology (Johansen 1988, 1996). The Johansen test is based on maximum likelihood estimation, which applies both maximum eigenvalue test and trace test to identify the number of cointegrating equations. Johansen's method can be explained with reference to the following vector autoregression (VAR) of order *k*:

$$y_t = A_0 + \sum_{i=1}^{k} A_i y_{t-1} + \varepsilon_t \tag{C.1}$$

where A_0 is a (nx 1) vector of deterministic variables such as trend and constant, y_t is a (n x 1) vector of nonstationary I(1) variables, k is the number of lags, A_i is a (n x n) matrix of coefficients, and ε_t is a (n x 1) vector of error terms. The above VAR could be rewritten as a vector error correction model (VECM):

$$\Delta y_t = A_0 + \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \Pi y_{t-k} + \varepsilon_t$$

where

$$\Gamma_i = -\sum_{j=i+1}^{k} A_j \text{ and } \Pi = \sum_{i=1}^{k} A_{i-I}$$

and I is a (n x n) identity matrix.

The number of cointegrating equations among the variables included in the vector y_t is represented by the rank of Π. Three possibilities may arise: 1) if Π has rank $r < n$, then there exist (n x r) matrices α and β each of them with rank r such that $\Pi = \alpha\beta'$ and $\beta y_t \sim I(0)$. In this case, r is called the cointegrating rank, β is the cointegrating matrix (i.e. the matrix of long-run coefficients), and the components of α are the adjustment parameters; 2) if the rank equals $n(r = n)$, all variables in y_t are stationary; 3) if the rank is 0 ($r = 0$), there exists no cointegrating relationship between variables.

Johansen's methodology focuses on estimating the matrix Π on the basis of an unrestricted VAR and to apply trace and maximum eigenvalue statistics to establish the number of non-zero eigenvalues of Π. $(\hat{\lambda}_1, \hat{\lambda}_2, \dots, \hat{\lambda}_{n-1})$ The trace statistics is the following:

$$LR_{trace}(r) = -T\sum_{i=r+1}^{n}\ln(1-\hat{\lambda}i) \tag{C.3}$$

The maximum eigenvalue statistic is:

$$LR_{max}(r, r+1) = -T\ \ln(1-\hat{\lambda}_{r+1}) = LR_{trace}(r) - LR_{trace}(r+1) \tag{C.4}$$

where $r = 0, 1, \ldots, n–1$ and T refers to the length of the time period.

The calculated values are compared with the critical values, determining in turn the number of cointegrating equations.

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References

ADB. Asian Development Bank. 2007. *Key indicators 2007*. Website: http://www.adb.org/Documents/Books/Key_Indicators/2007/default.asp

Akerlof, G.A. 1979. The case against conservative macroeconomics: An inaugural lecture. *Economica* 46: 219-37.

Akerlof, G.A., and J.L. Yellen. 1986. Introduction. In *Efficiency wage models of the labor market*, eds. G.A. Akerlof and J.L. Yellen. Cambridge: Cambridge University Press.

ASPO. Association for the Study of Peak Oil and Gas of Ireland. 2008. ASPO newsletters. Website: http://www.peakoil.ie

Asteriou, D., and S. G. Hall. 2007. *Applied econometrics: A modern approach using EViews and microfit revised*. New York: Palgrave Macmillan.

Barboza, D., and H. Tabuchi. 2010. Power grows for striking Chinese workers. *The New York Times*, June 8. Website: http://www.nytimes.com/2010/06/09/business/global/09labor.html.

Bhaduri, A. 2008. Predatory growth. *Economic and Political Weekly* 43(16): 10-13.

Bowles, S., R. Edwards, and F. Roosevelt. 2005a. Capitalism shakes the world. In *Understanding capitalism - Competition, command, and change*, eds. S. Bowles, R. Edwards, F. Roosevelt, 3-30. Oxford: Oxford University Press.

Bowles, S., R. Edwards, and F. Roosevelt. 2005b. Wages and work. In *Understanding capitalism - Competition, command, and change*, eds. S. Bowles, R. Edwards, F. Roosevelt, 283-311. Oxford: Oxford University Press.

Bowles, S., and H. Gintis. 1988. Contested exchange: Political economy and modern economic theory. *The American Economic Review* 78(2): 145-150.

Bowles, S., and H. Gintis. 1993. The revenge of homo economicus: Contested exchange and the revival of political economy. *The Journal of Economic Perspective* 7(1): 83-102.

Bowles, S., D. Gordon, and T. E. Weisskopf. 1991. *After the waste land: A democratic economics for the year 2000*. Armonk, NY: M.E. Sharpe.

Chan, A. 2001. *China's workers under assault: The exploitation of labor in a globalizing economy*. Armonk, NY: M.E. Sharpe.

China Labour Bulletin. 2005. Subsistence living for millions of former state workers. September 7. Website: http://www.clb.org.hk/en/node/17198

China Labour Bulletin. 2007. Speaking out: The workers' movement in China (2005-2006). Website: http://www.china-labour.org.hk/en/node/100013

Chow, G.C. 2007. *China's economic transformation*. Malden: Wiley-Blackwell.

Dickey, D.A., and W.A. Fuller. 1979. Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association* 74: 427-431.

Dickey, D.A., and W.A. Fuller. 1981. Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica* 49: 1,057-72.

Elliott, A., and R. Freeman. 2003. *Can labour standards improve under globalisation?* Washington DC: Institute for International Economics.

Enders, W. 2010. *Applied econometric time series*. Danvers: Wiley.

Fan, G., M. R. Lunati, and D. O'Connor. 1998. *Labor market aspects of state enterprise reform in China*. OECD Development Center Technical Papers No. 141.

Freeman, D., and D. B. Yerger. 2000. Does inflation lower productivity? Time series evidence on the impact of inflation on labor productivity in 12 OECD nations. *Atlantic Economic Journal* 28(3): 315-332.

Gang, F. 1994. Dual-track transition in China. *Economic Policy* 19 supplement December: 99-122.

Granger, C. W. J., and P. Newbold. 1974. Spurious regressions in econometrics. *Journal of Econometrics* 2: 111–120.

Granger, C. W. J. 1997. On modelling the long-run in applied economics. *The Economic Journal* 107 (1): 169-177.

Green, S., and G. S. Liu 2005. China's industrial reform strategy: Retreat and retain. In *Exit the dragon? Privatization and state control in China*, eds. S. Green and G. Liu, 15-41. London: Chatham House.

Hayek, F.A. 1991. *The fatal conceit*. Chicago: The University of Chicago Press.

Jefferson, G.H., and T.G. Rawski. 1994. Enterprise reform in Chinese industry. *Journal of Economic Perspectives* 8 (2): 47-70.

Johansen, S. 1988. Statistical analysis of cointegration vectors. *Journal of Economic Dynamic and Control* 12: 231-54.

Khan, A. R., and C. Riskin. 2001. *Inequality and poverty in China in the age of globalization*. Oxford and New York: Oxford University Press.

Kwong, P. 2007. China's billionaire bubble. *The New York Times*, November 16. Available at: http://www.nytimes.com/2007/11/16/opinion/16iht-edkwong.1.8365127.html.

Lin, T-H. 2007. Class structure, income inequality, and class consciousness in urban China: Evidence from the 2003 panel data. Paper presented at the annual meeting of the American Sociological Association, New York City, August 11.

McMillan, J., and B. Naughton. 1992. How to reform a planned economy: Lessons from China. *Oxford Review of Economic Policy* 8(1): 130-43.

Narayan, P., and R. Smith 2009. The effect of inflation and real wages on productivity: new evidence from a panel of G7 countries. *Applied Economics* 41: 1,285-1,291.

Naughton, B. 1995. *Growing out of the plan – Chinese economic reform 1978-1993*. New York: Cambridge University Press.

Naughton, B. 2007. *The Chinese economy – Transition and growth*. Cambridge; London: The MIT Press.

Perkins, D. H. 1988. Reforming China's economic system. *Journal of Economic Literature* XXVI (June 1988): 601-645.

Piovani, C., and M. Li. 2011. One hundred million jobs for the Chinese workers! Why China's current model of development is unsustainable and how a progressive economic program can help the Chinese workers, the Chinese economy, and China's environment. *Review of Radical Political Economics* 43(1): 77-94.

Qian, Y. 2003. How reform worked in China. In *In search of prosperity: Analytical narratives on economic growth*, ed. Dani Rodrik, 297-333. Princeton, NJ: Princeton University Press.

Qian, Y., and J. Wu. 2003. China's transition to a market economy: How far across the river? In *How far across the river?* ed. N.C. Hope, D.T. Yang, and M.Y. Li, 31-64. Stanford, CA: Stanford University Press.

Rawski, T.G. 1995. Implications of China's reform experience. *The China Quarterly* 144 (December): 1,150-1,173.

Sachs, J., and W. Thye Woo. 1994. Structural factors in economic reforms in China, Eastern Europe, and the former Soviet Union. *Economic Policy* 9(18): 101-45.

Stiglitz, J. 1996. *Whither socialism?* Cambridge, MA: MIT Press.

Tan, S.T., and H.E. Khor. 2006. China's changing economic structure and implications for regional patterns of trade, production, and integration. *China & World Economy* 14(6): 1-19.

UNDP. United Nations Development Programme. 2005. *China human development report 2005 – Development with equity*. Beijing: UNDP.

Wooldridge, J., 2008. *Introductory econometrics: A modern approach*. Mason: South-Western Cengage Learning.

Author Biography

Chiara Piovani received a PhD in Economics from the University of Utah in 2011 with a dissertation titled "Essays on China's Political Economy: Macroeconomic Imbalances, Social Conflict, and Climate Change." She is currently Assistant Professor in the Economics Department at the University of Denver. Her research focuses on the Chinese economy, feminist economics, and the global capitalist crisis.