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An Empirical Analysis of China's Dualistic Economic Development: 1965–2009*

Marco G. Ercolani
Department of Economics
Birmingham Business School
University of Birmingham
Edgbaston, B15 2TT
United Kingdom
M.G.Ercolani@bham.ac.uk

Zheng Wei
Nottingham University
Business School
University of Nottingham
Ningbo China
Ningbo, 315100, China
Zheng.Wei@nottingham.edu.cn

Abstract

We analyze China's rapid economic development in the context of the dualistic development theory. Over the period 1965–2009, we find that China's economic growth is mainly attributable to the development of the non-agricultural (industrial and service) sector, driven by rapid labor migration and capital accumulation. We find that the sectoral reallocation of labor plays a significant role in promoting China's economic growth. Further, we find that the marginal productivity of agricultural labor stopped stagnating in 1978, which indicates that China entered quickly into phase two of economic development with the initiation of market reforms. Moreover, by 2009, the marginal productivity of labor has likely exceeded the institutional wage, as defined by the initially low average labor productivity, indicating that China may be now in the process of entering phase three of economic development.

1. Introduction

China has a long history of dualistic economic development. Prior to the 1978 economic reforms led by Deng Xiaoping, China was a very poor and largely peasant agrarian economy. Eighty percent of the labor force was engaged in the rural agricultural sector. Agricultural labor productivity was extremely low due to the presence of surplus labor relative to other scarce resources. The

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economic reforms initiated in 1978 propelled the Chinese economy into a new phase of development. Rural liberalization led to development in the agricultural sector and to the establishment of township and village enterprises (TVEs). It also helped release surplus labor from agricultural production. The steady marketization of economic activities and the integration of China into the international economy generated a large demand for labor. As a result, there was a great increase in labor migration, albeit on a temporary basis due to the restriction on labor mobility by the household registration system (the Hukou system). In 1978, 4.38 million laborers migrated to the non-agricultural sector (Zhang and Song 2003); by 2009, the number of rural–urban migrants rose to over 145 million (Yao 2011). Labor in the non-agricultural sector increased from 29.5 percent of total employment in 1978 to 61.9 percent in 2009. Over the same period, the contribution of non-agricultural production to the value-added GDP increased from approximately 62 percent to 89 percent. Rapid development of the non-agricultural sector, fuelled by great inflows of rural labor, has driven the Chinese economy to grow at an average rate of 8 percent per annum for more than three decades since the 1978 economic reforms.

China's remarkable economic growth has been interpreted in various ways. Since the 1990s, two schools of thought, institutional experimentalism and institutional convergence, have emerged in the literature (Sachs and Woo 2000). Experimentalists attribute China's rapid economic growth to the discovery of new non-capitalist mechanisms (such as collectively owned TVEs) that were very efficient. In contrast, proponents of institutional convergence regard China's growth as the natural consequence of an initially poor peasant economy converging toward a developed market economy. Both schools, though disagreeing on the degree of institutional innovation, strongly emphasize the role of marketization and internationalization in spurring economic growth in China. It is generally accepted, however, that economic reforms are only able to lift an economy out of poverty if they are compatible with that economy's characteristics. China has been characterized as a dualistic economy with so-called "backward advantages," namely, the presence of surplus agricultural labor. The rapid development of China's economy is in fact largely attributable to its dualistic nature and the flows of surplus labor between the two sectors. Though China's economic reforms are undoubtedly important, they facilitated rather than caused the process of economic transition. Hence, it is more appropriate to interpret China's remarkable economic growth as a consequence of the development of a dualistic economy with surplus labor.

The most well-known theory of dualistic development was proposed by Lewis (1954) and formalized by Ranis and Fei (1961). The Lewis-Ranis-Fei theory of dualistic economic development describes the development of an over-populated and underdeveloped economy with vast amounts of surplus agricultural labor.[1] Economic growth in such an economy can be achieved by rapid development of the non-agricultural (industrial and service) sector, facilitated by capital accumulation and the drawing of surplus labor from the agricultural sector. Sectoral reallocation of surplus labor changes the productivity of labor and thereby drives the economy to transit from a labor-surplus stage to a labor-scarce stage of development. The Lewis-Ranis-Fei theory of dualistic economic development therefore provides a suitable theoretical framework for studying the growth path of labor-surplus developing economies such as China.

In this paper, we analyze the dualistic development of the Chinese economy using the Lewis-Ranis-Fei theory. In particular, we focus on addressing the pattern of China’s economic development by highlighting the role of sectoral reallocation of surplus labor. Moreover, we identify the three phases of China’s economic development and test if China has yet reached the Lewis turning point.[2] To answer these questions we first estimate Cobb–Douglas production functions for China’s agricultural and non-agricultural sectors using national-level data over the period 1965–2009. Our results show that China’s economic growth is driven by the rapid development of the non-agricultural sector, which results from the fast accumulation of non-agricultural capital as well as expansion of non-agricultural employment. We then evaluate the contribution of labor reallocation away from agriculture to non-agriculture by applying the Labor Reallocation Effects equation specified by the World Bank (1996). Our results suggest that labor reallocation has a positive impact on China’s economic growth, accounting for 1.37 percent of per annum GDP growth. This result coincides with the findings of Kuijs and Wang (2005), Woo (1998) and the World Bank (1996). It confirms the significant contribution of sectoral labor reallocation on the development of China’s dualistic economy. This finding also undermines other explanations of China’s growth miracle, such as the gradualist approach by Lin, Cai, and Lee (1994) or the experimentalist strategy proposed Naughton (1995), both of which make no reference to the important role of surplus labor in enabling the fast growth.

The phases of China’s economic development, and particularly the Lewis turning point, have been studied using various methods but no definitive conclusions have

1 Throughout the paper we refer to the two sectors as agricultural and non-agricultural. Various authors have used different terms interchangeably for these two sectors. Lewis (1954) originally named the two sectors as the subsistence and the capitalistic sectors and later in Lewis (1979) referred to them as the traditional and modern sectors. Jorgenson (1967, 291) elaborates further on the distinction between the two sectors and narrows this down to the stylized fact that the two sectors do not share the same production technology, particularly when it comes to capital accumulation.

2 The Lewis turning point refers to the point beyond which a developing country has depleted its surplus labor and its industry has to face rising wage rates (Yao 2011).

been reached. In this paper, we identify the phases of development and corresponding turning points by examining the evolution of labor productivities over time as indicated in the Lewis-Ranis-Fei model. We find that the Chinese economy has fully absorbed the redundant agricultural labor and entered phase two of development, as shown by the rising marginal productivity of labor since the 1978 economic reforms. We also find that labor's marginal productivity has continued to rise and by 2009 may even have exceeded the institutional wage as defined by the initial low average productivity of labor. This indicates that by 2009 China may near, or have actually reached, the Lewis turning point, which signals entry into phase three economic growth as defined in the Lewis-Ranis-Fei model.

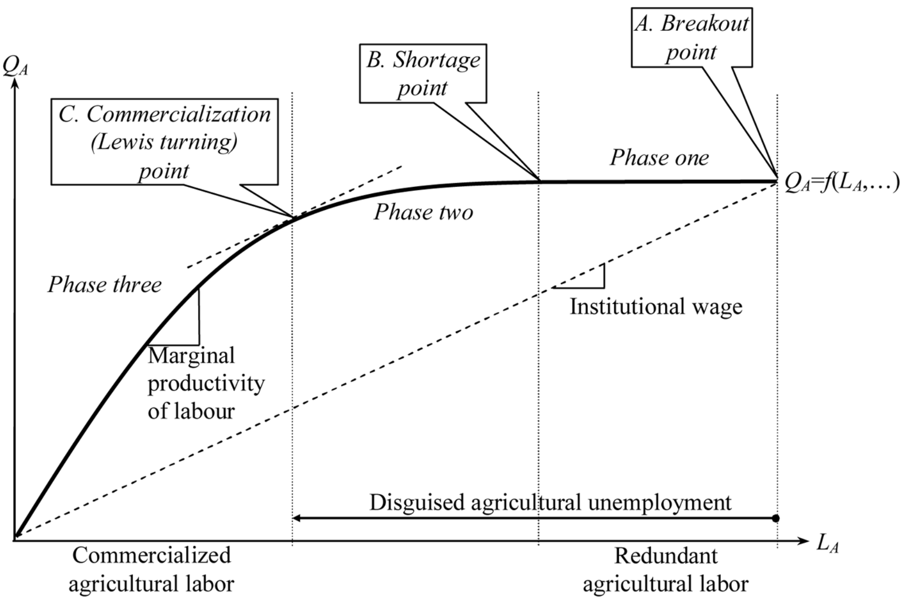
The paper proceeds as follows. Section 2 reviews the Lewis theory, the Ranis-Fei model, and the related literature. Section 3 discusses China's dual-sector economic development and rural–urban labor migration. Section 4 presents the model specifications for estimating the production functions, decomposing dual-sectoral economic growth rates and evaluating the effect of labor reallocation away from agriculture toward non-agriculture. Section 5 explains the data in relation to China's employment, capital stock, labor migration, and technological progress. Section 6 presents our estimation results. Section 7 provides detailed numerical analysis regarding China's sources of dual-sector economic growth, the role of labor reallocation, and phases of development and turning points that China has passed through. A final section concludes and provides tentative policy recommendations.

2. Literature survey

2.1 The Lewis-Ranis-Fei model

The Lewis (1954) theory of dualistic economic development provides the seminal contribution to theories of economic development particularly for labor-surplus and resource-poor developing countries. In the Lewis theory, the economy is assumed to comprise the agricultural and non-agricultural sectors. The agricultural sector is assumed to have vast amounts of surplus labor that results in an extremely low, close to zero, marginal productivity of labor. The agricultural wage rate is presumed to follow the sharing rule and be equal to average productivity, which is also known as the institutional wage. The non-agricultural sector has abundant capital and resources relative to labor. It pursues profit and employs labor at a wage rate higher than the agricultural institutional wage by approximately 30 percent (Lewis 1954, 150). The non-agricultural sector accumulates capital by drawing surplus labor out of the agricultural sector. When the surplus labor is exhausted, the Lewis turning point is reached and the economy completes the transition from a labor-surplus stage to a labor-scarce stage of development.

Figure 1. Lewis-Ranis-Fei phases of economic development in relation to agricultural labor input (L_A) and output (Q_A)



Source: *Ranis and Fei (1961, diagram 1.3).*

Later, Ranis and Fei (1961) formalized the Lewis theory by combining it with Rostow’s (1956) three “linear-stages-of-growth” theory. They subdivided Lewis’s first stage into two phases and make Lewis’s stage two correspond to their phase three. These three phases, illustrated in Figure 1, are defined by the marginal productivity of agricultural labor. The entry into each phase is formalized by three turning points:

- The *breakout point* leads to phase one growth with redundant agricultural labor.
- The *shortage point* leads to phase two growth with disguised agricultural unemployment.
- The *commercialization point,* or *Lewis turning point,* leads to phase three self-sustaining economic growth with the commercialization of the agricultural sector.

2.2 Relevant empirical studies on China’s growth

China’s remarkable economic performance has been closely studied and intensively debated, with the focus being the identification of the sources of China’s growth miracle. The debate over China's growth has been dominated by two schools of thought and has evolved over time. Initially the debate was over the speed of the reforms, namely, whether China's rapid growth was attributable to its gradual and incremental reforms or to its fast and comprehensive reforms. The accumulated evidence from Eastern Europe started to show that slow-reforming economies generally performed worse than fast-reforming economies. In addition, Vietnam provided another case-study for an economy where rapid reforms led to rates of economic growth similar to China's. As a result of this evidence, the debate moved on to one of interpreting the nature of China's economic reforms. Most economists who had favored the big-bang approach now view China's high growth as a consequence of the steady institutional convergence of China's socialist institutions towards capitalist ones. On the other hand, most economists who had favored the gradualist explanation now regard China's high growth rate a consequence of institutional innovation. They argue that the gradual nature of the Chinese reforms was due to economic experimentation, and the experiments succeeded in producing new noncapitalist institutions that are at least as efficient as capitalist ones. These gradual innovations include 15-year land leases instead of land privatization, collectively owned enterprises instead of private enterprises, and incentive-compatible profit-sharing contracts between state and state-owned enterprises (SOEs) instead of privatization.

The (initially gradualist) experimentalist school is led by Lin, Cai, and Lee (1994), Naughton (1995), and Nolan and Ash (1995). The convergence school is represented by Fan (1990, 1994), Bruno (1994), and Sachs and Woo (1994, 2000). In essence, the gradualist school claims that China's economic experimentation and innovation have helped China evolve toward a unique Chinese economic model. Conversely, the convergence school argues that China's growth is the consequence of rapid convergence from an initial labor-intensive peasant agrarian economy to an East Asian market economy. Both schools stress the common point that market reforms have spurred China's economic growth.

We note that China's economic reforms were first initiated in the backward rural agricultural sector, which featured surplus labor, and then extended to the urban industries. In our judgment, this reform sequence made the most of China's dualistic economy and thereby helped it to undertake its economic takeoff. In contrast, the economic transition that occurred in the already industrialized and urbanized Soviet economies led to economic downturns. Therefore, it was the dualistic economy that allowed economies like China, Vietnam, and Laos to grow, regardless of the speed of reform, during their transition from central planning. China's growth path is more relevant to the dualistic explanation, such as the Lewis-Ranis-Fei theory, than other debates.

The Lewis theory has been applied to several economies such as Japan, Korea, and Taiwan with various degrees of success (e.g., Ohkawa 1965; Ho 1972; Fei and Ranis 1973). In view of China's remarkable economic growth, the Lewis theory has recently been applied to its analysis, with particular focus on identifying the Lewis turning point, but no definitive consensus has been reached. For example, Cai (2007) argues that China had already reached the Lewis turning point. This was illustrated by increases in the wages of the rural migrant wages and the phenomenon of "rural labor-scarcity," which occurred in the Zhujiang triangle coastal area in 2003. This was also accelerated by the substantial decline in China's population growth during the demographic transition.

Cai's view is supported by scholars like Park, Cai, and Du (2010) and Wang (2008), while challenged by other such as Meng and Bai (2007), Knight (2007), Yao (2011), and Knight, Deng, and Li (2010). Knight Deng, and Li (2010) argue that evidence on the rising wages of migrants is subject to sample changes. Yao (2011) points out that recent agricultural wage increases are largely due to reductions in agricultural taxes in 2006, direct subsidies to grain production, and high price inflation for food. Various studies even indicate that China is a long way from the Lewis turning point. For instance, Knight et al. (2010) reports that in the 2002 and 2007 national household surveys, no significant rise was observed in migrants' wages and that a substantial pool of potential migrant workers, approximately 80 million, is still available in rural areas. Yao and Zhang (2010) confirm Knight's finding and argue that it may not be until 2018 that all of China's potential migrants are fully absorbed.

Disagreement between current studies is largely attributable to the diverse methods[3] used to identify China's Lewis turning point. Many studies (see Cai 2007; Knight 2007; Meng and Bai 2007) examine changes in rural household's net incomes and migrants' wages, whereas others (see Kwan 2009; Knight, Deng, and Li 2010; Minami and Ma 2010; Yao and Zhang 2010) estimate the amount of surplus labor in rural China. There are also studies (Cai and Wang 2008; Yao 2011) that estimate urban labor demand or the supply and demand functions for migrant workers. Studies based on estimates of labor supply and demand functions rely on rural wages, and therefore, they share the same problems as studies that focus directly on rural wages. These problems were first discussed by Minami (1968, 384):

> when there is a rising trend in the real wage, we cannot ascertain straightforwardly whether that increase comes from a change in the marginal productivity of labor or from an increase in the subsistence level itself.

3 Similar discussion is also provided by Knight, Deng, and Li (2010, 7–9).

Identifying the development turning point by measuring the amount of rural surplus labor seems close to the basic premise of the Lewis theory. Nevertheless, the theory of surplus labor refers to the situation where the marginal productivity of labor is lower than the institutional wage. Therefore, surplus labor need not be limited to rural labor, it could also exist in urban areas too, but this fact is difficult to verify in practice.

However, one technique that applies the Lewis-Ranis-Fei framework most directly to identifying the phases of economic development has, to date, not been applied to the Chinese case. This technique examines the change in the marginal productivity of agricultural labor over time and was first applied by Minami (1968) to study Japan's agricultural commercialization. It not only provides intuitive implications on the phases of economic development but also identifies the time when the Lewis turning point is achieved. In this paper, we apply this technique to identify whether China has reached the Lewis turning point.

3. The Chinese experience

3.1 China's dualistic economic development

China has had a long history of dualistic economic development. According to Putterman (1992), prior to the 1978 economic reforms, the rural agricultural sector was run using collective farms and wages were set by the government. The pursuit of profit was only allowed in the urban industrial sector. The 1978 economic reforms did not bring this dualistic structure to an end. Instead it allowed the urban sector to develop further by creating a dynamic service sector and a new class of TVEs. Thus, China's dualistic structure involves the agricultural sector in rural areas and the non-agricultural sector[4] in mainly urban areas.

As shown in Figure 2, the contribution of agricultural production to GDP falls from approximately 39 percent in the 1960s to 10 percent in 2009, whereas the contribution of non-agricultural production rises from 61 percent to 90 percent during the same period. Moreover, the non-agricultural sector grows at a faster pace than the agricultural sector. This indicates that economic growth in China is driven more by the non-agricultural sector than the agricultural sector.

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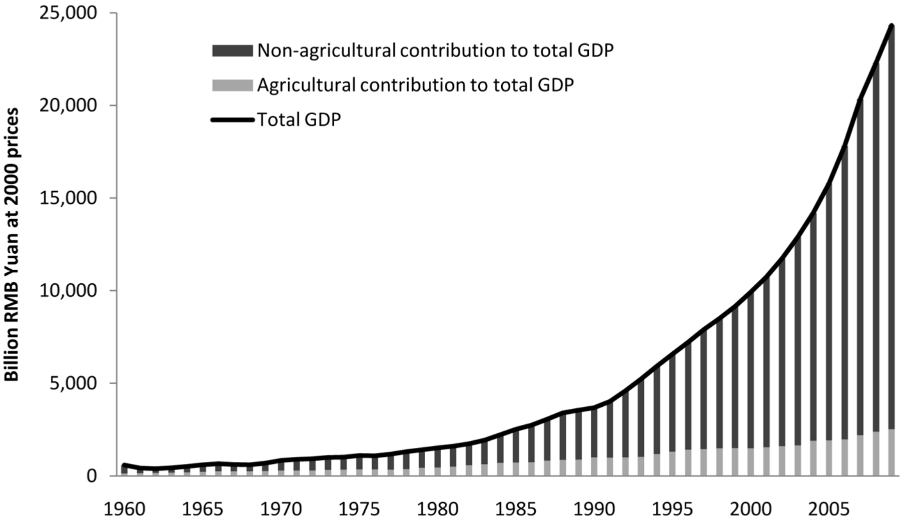
4 More precisely, the agricultural sector includes farming, animal husbandry, forestry, and fishery. The non-agricultural sector includes construction, industry (i.e., manufacturing, mining and quarrying, electricity, gas and water supply), transport, post and telecommunication services, wholesale and retail trade, and catering services. The output of TVEs is included in the non-agricultural sector, though they are in semi-urban locations.

Figure 2. Development of the Chinese dual-sector economy (1960–2009)



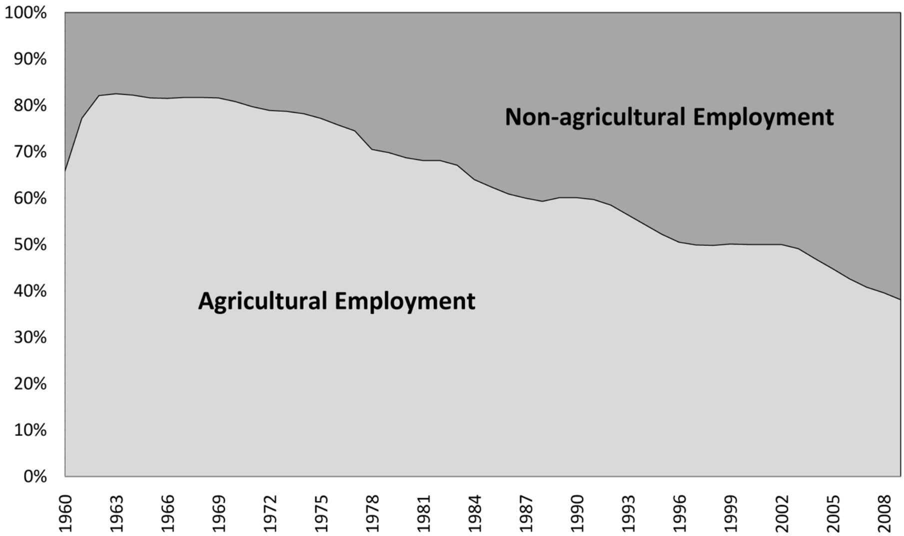
Source: *World Development Indictors (World Bank 2010).*

3.2 China's sectoral labor reallocation

China is a labor-surplus economy and most of this surplus is engaged in the agricultural sector. Before the 1978 economic reforms, labor mobility was controlled by the government through the "Hukou system." According to Zhao (2000), the average annual rural–urban migration rate was only 0.24 percent in 1949–85, much lower than the world average rate of 1.84 percent in 1950–90. Since the early 1980s, the restrictions on labor mobility have been relaxed to accommodate labor demand in the non-agricultural sector. However, the one-child policy introduced in the 1970s has been imposed more stringently, particularly in urban areas. This has slowed the growth of the urban-born labor force and aggravated the labor shortage in the non-agricultural sector (Knight 2007). Recently the restrictions on labor mobility have been relaxed and increasing numbers of rural laborers have migrated to towns and cities. As a result, relative employment in the agricultural sector (illustrated in Figure 3) dropped from 70 percent in 1978 to 38 percent in 2009. Correspondingly, employment in the non-agricultural sector rose rapidly and reached 62 percent of total employment. Note that even with the relaxation of restrictions on labor mobility, most of the migrants are only allowed into cities on a temporary basis.

There are no consistent and reliable data on China's rural–urban labor migration over time. Intermittent migration data are collected in population censuses at 8- to

Figure 3. Employment in the two sectors

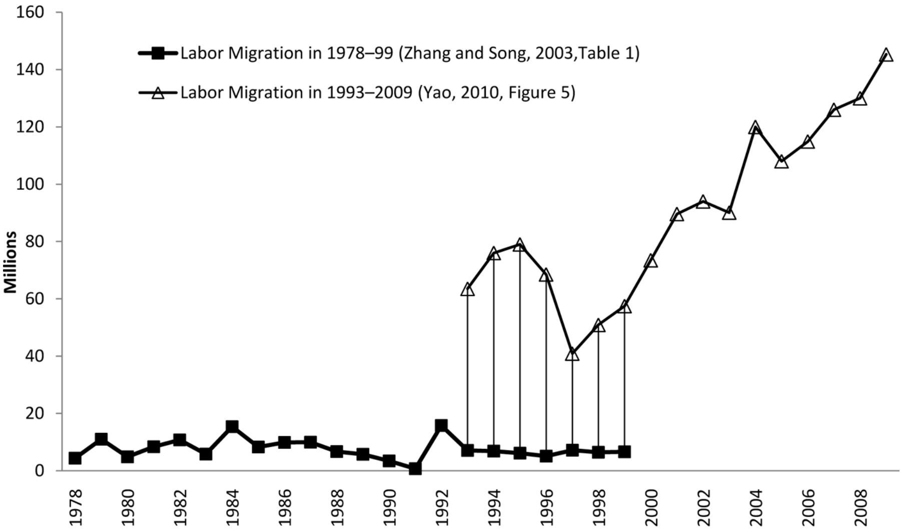


Source: *Data before1965 are from China Statistical Yearbook (NBS 2004), and data after 1965 are from the World Development Indicators (World Bank 2010).*

10-year intervals, or in surveys covering a few provinces. Many studies (e.g., Wu 1994; Zhang and Song 2003) apply the residual method suggested by the United Nations (1970) to derive a consistent time series for China's rural–urban labor migration. This method assumes that without international labor migration, the increase in urban population is attributable to the natural growth of the urban population and net rural-to-urban migration. Thus, net labor migration can be derived by subtracting the natural population growth from the aggregate population increase in urban areas. Zhang and Song[5] (2003, Table 1) apply this method and compute the series for rural–urban labor migration in 1978–99. This is illustrated in Figure 4. The abrupt drop in labor migration during 1989–91 may be due to events following the Tiananmen Square incident. Yao (2011, Figure 6) presents a time series for rural–urban migration in recent decades. As shown in Figure 4, the series reveals a large dis-

5 Zhang and Song (2003) compute the natural growth of urban population as the product of the total urban population and the natural urban population growth rate, which is proxied by the official "natural city growth rates." The data for the natural city growth rates in 1978–82 and 1988–99 are sourced from the *NBS Statistical Yearbook* (2000). For the missing data in 1982–88, they use a combination of correlations with city growth and projections from the available years. Similar patterns of the rural–urban labor migration are observed in the data generated by Wu (1994, Figure 4).

Figure 4. China's rural–urban labor migration (1978–2009)



Source: Data for the period 1978–92 are from Zhang and Song (2003, Table 1). Data for 1993–2009 are from Yao (2010, Figure 5).

crepancy, compared to that computed by Zhang and Song (2003), in the overlapping period 1993–99.

4. Model specification

In this section we introduce the production function specifications of the two sectors, the equations used in the growth decomposition to identify phases of development and the equations used to compute the contribution to growth of labor reallocation away from agriculture.

We assume a dualistic economic framework with the agricultural and non-agricultural sectors representing the traditional and modern sectors of the Lewis theory. Accordingly, agricultural output (Q_A) is a function of agricultural hectares (H_A), labor input (L_A), and agricultural capital (K_A). Output in the non-agricultural sector (Q_N) depends on employed labor (L_N) and capital stock (K_N). Both production functions feature Hicks neutral technological progress ($f_A(T)$, $f_N(T)$) where T denotes time; the exact functional form of these contain trends that reflect socio-economic events and possibly dummies for structural shifts. The resulting Cobb–Douglas production functions for the agricultural and non-agricultural sectors are

$$Q_A = f(L_A, K_A, H_A, T_A) = \alpha_0 e^{f_A(T)} L_A^{\alpha_L} H_A^{\alpha_H} K_A^{\alpha_K}, \tag{1}$$

$$Q_N = g(L_N, K_N, T_N) = \beta_0 e^{f_N(T)} L_N^{\beta_L} K_N^{\beta_K}. \tag{2}$$

By taking logarithms, we derive the log-linear forms in equations (3) and (4). The parameters with a hat "ˆ" are those to be estimated:

$$\ln Q_A = \ln\hat{\alpha}_0 + f_A(T) + \hat{\alpha}_L \ln L_A + \hat{\alpha}_H \ln H_A + \hat{\alpha}_K \ln K_A + e_A, \tag{3}$$

$$\ln Q_N = \ln\hat{\beta}_0 + f_B(T) + \hat{\beta}_L \ln L_N + \hat{\beta}_K \ln K_N + e_N. \tag{4}$$

We test for, but do not impose, constant returns to scale in each sector by the conditions ${}_L + {}_H + {}_K = 1$ and ${}_L + {}_K = 1$. We differentiate functions (3) and (4) with respect to time and obtain the following equations for decomposing sectoral economic growth rates:

$$g_{Q_A} = \frac{\partial f_A(T)}{\partial t} + \hat{\alpha}_L g_{L_A} + \hat{\alpha}_H g_{H_A} + \hat{\alpha}_K g_{K_A}, \tag{5}$$

$$g_{Q_N} = \frac{\partial f_N(T)}{\partial t} + \hat{\beta}_L g_{L_N} + \hat{\beta}_K g_{K_N}, \tag{6}$$

where the exponential growth rates for each factor X is calculated by either the instantaneous percentage growth rate in continuous time,

$$g_X = \frac{d \log X}{dt} \cdot 100 = \frac{(\log X_{2009} - \log X_{1965})}{(2009 - 1965)} \cdot 100,$$

or the true annual compounded percentage growth rate in discrete time,

$$AGR = (\exp g_x - 1)\,100.$$

In empirical studies, the annual compounded growth rate (AGR) is often used to represent the exponential growth rate. However, in theoretical models growth rates are usually expressed in continuous time by g_X. Unless the actual rate of growth is extremely high, the discrete-time measures of growth are very close to the continuous-time measures of growth. Finally, note that the time derivatives with respect to the Hicks-neutral technological changes ($f_A(T)$, $f_N(T)$) are captured by the appropriate time-trends and time-dummies in the estimated models.

We apply the labor reallocation effect (LRE) approach suggested by the World Bank (1996) to measure the contribution made to growth by the migration of laborers from the agricultural to the non-agricultural sector.[6] According to the World Bank, the agricultural labor reallocation effect is defined as:

$$LRE_{WB} = \frac{L}{Y}(MPL_N - MPL_A)g_{l_N} l_N , \qquad \text{where } l_N = \frac{L_N}{L} . \tag{7}$$

in which MPL_N and MPL_A refer to the marginal productivities of labor in the agricultural and non-agricultural sectors, respectively. They are calculated by

$$MPL_A = \frac{dQ_A}{dL_A} = \hat{\alpha}_L \frac{Q_A}{L_A} \hat{\alpha}_L APL_A , \tag{8}$$

$$MPL_N = \frac{dQ_N}{dL_N} = \hat{\beta}_L \frac{Q_N}{L_N} \hat{\beta}_L APL_N , \tag{9}$$

where $\hat{\alpha}_L$ and $\hat{\beta}_L$ are the estimated parameters in equations (3) and (4), and APL_A and APL_N refer to the respective average productivities of labor in the agricultural and non-agricultural sectors respectively. Equation (7) shows that a reallocation of labor away from agriculture will have a positive net effect on growth so long as the value of the marginal productivity of labor in the non-agricultural sector exceeds that in the agricultural sector. The size of this effect depends on how much more productive the non-agricultural sector is and on how large the share of non-agricultural labor (l_N) in the total labor force is (World Bank 1996, 67–68). In essence, the approach uses the difference in the labor productivities of the two sectors to quantify the contribution of sectoral labor reallocation to economic growth.

5. The data

Our data span the period 1965–2009 and are mainly from the World Bank's 2010 World Development Indicators. Data on China's total employment and percentages of sectoral employment are from *China Statistical Yearbooks* (2009) by China's National Bureau of Statistics (NBS) and the 2009 annual report by China's Ministry of Human Resources and Social Security (MOHRSS). Data on agricultural capital and on arable land and cropland are from the United Nation's Food and Agricultural Organization (FAO) online statistics database.[7] Output and capital stock values are in real RMB deflated to 2000 prices. Table 1 provides summary statistics and variable descriptions.

6 This approach has also been used to measure the effect of labor reallocation from the state to the non-state sector.

7 See www.faostat.fao.org.

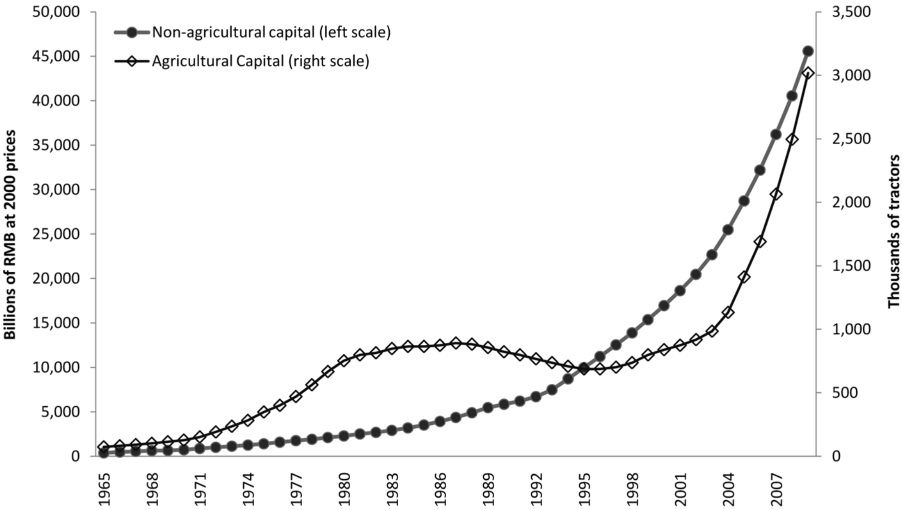
Table 1. Summary statistics

Variables	Mean	Min	Max	Description
Q_A	9.6×10^{11}	2.25×10^{11}	2.52×10^{12}	Agricultural output: in yuan at constant 2000 prices.
L_A	3.32×10^{8}	2.55×10^{8}	3.80×10^{8}	Agricultural labor: total workers.
K_A	756,452.4	73,021	3,010,658	Agricultural capital: total number of tractors.
H_A	1.18×10^{7}	1.00×10^{7}	1.34×10^{7}	Agricultural hectares of arable land and cropland.
$T_{1979–84}$	3.80	0	6	Agricultural technological trend: trend starts in 1979 and stops increasing in 1984, equals zero before 1979.
$T_{1985–92}$	3.82	0	8	Agricultural technological trend that starts in 1985 and ends in 1992. It equals zero before 1985 and equals 8 from 1992 on.
$T_{1993–on}$	3.40	0	17	Agricultural technological trend that starts in 1993 and equals zero before 1993.
Q_N	4.84×10^{12}	3.43×10^{11}	2.18×10^{13}	Non-agricultural output: in yuan at constant 2000 prices.
L_N	2.33×10^{8}	5.76×10^{7}	4.83×10^{8}	Non-agricultural labor: total workers.
K_N	9.72×10^{12}	3.79×10^{11}	4.56×10^{13}	Non-agricultural capital: calculated by the perpetual inventory method, 2000 prices.
$T_{1984–on}$	7.8	0	26	Non-agricultural technological trend that starts in 1984 and equals zero before 1984.
D_{1967}	0.02	0	1	Cultural Revolution dummy: equals one in 1967, zero otherwise.
D_{1968}	0.02	0	1	Cultural Revolution dummy: equals one in 1968, zero otherwise.

Source: *Authors' calculations.*

Agricultural and non-agricultural outputs are derived from the multiplication of the relative sectoral shares value-added in GDP by the real values of GDP. The data for China's total employment by the NBS show a spurious jump in 1990 due to acknowledged statistical adjustments. Such a jump is not revealed in the employment series by MOHRSS, but this is only available up to 2002. To generate a complete and consistent series for employment, we rescale the data from NBS for the period 1965–95 using the average ratio of the two employment series. Thus, sectoral employment series are derived by multiplying the total employment data by the sectoral employment shares. Agricultural capital is represented by the number of tractors, which is consistently available over the entire sample period from the FAO. Capital stock in the non-agricultural sector is obtained by applying the conventional Perpetual Inventory Method with an annual depreciation rate of 10 percent. The initial value of the capital stock is set at 378,847,553,230 yuan at 2000 constant prices based on the calculation by King and Levine (1994) that non-agricultural capital was equal to 63.9 percent of GDP in 1965. The two series of capital stock are illustrated in Figure 5.

Figure 5. Capital stock (1965–2009)



Source: *Agricultural capital represented by the number of tractors is from World Development Indicators (World Bank 2010). Non-agricultural capital is authors' calculation, based on the World Development Indicators (World Bank 2010) and Penn World Tables (Heston, Summers, and Aten 2002).*

We model technological progress in the agricultural sector by three segmented deterministic time trends. Following the work of Sachs and Woo (1994), the first trend covers 1979–84 to capture the decentralization of farming and the second trend covers 1985–92 to capture the introduction of the market system in the rural economy. The third trend, starting in 1993, captures the slight slowdown in agricultural technological progress. No technological trend is included before 1979, it being well established that agricultural technological progress had been negligible due to destabilizing socio-economic events (see Chow 1993).

Technological progress in the non-agricultural sector is modeled by a time trend for 1984 onward. This trend is justified by the fact that experimental reforms on SOEs began in August 1980 and this translated into widespread reforms by 1984. Political events surrounding the Cultural Revolution justify the inclusion of year dummies for 1967 and 1968. Other events may have justified the inclusion of year dummies for 1976 and 1990–91 but this would have removed almost all dynamics from the model and would necessitate a substantial number of dummies.

6. Estimates of the production functions

6.1 Stationarity tests

Before estimating the production functions, we test the stationarity of variables using Augmented Dickey-Fuller (ADF) (Dickey and Fuller 1979, 1981) and KPSS (Kwiatkowski et al. 1992) tests. The ADF tests are for the null hypothesis that the series are non-stationary, the KPSS tests are for the null hypothesis that the series are stationary. The results of these tests are reported in Table 2 and they suggest, at the 5 percent significance level, that all the variables are non-stationary and integrated of order one I(1). The one exception is the log of agricultural capital that is borderline integrated of order one I(1) or two I(2), $\ln K_A \sim \mathrm{I}(1/2)$, but it seems that this ambiguity may be due more to the long cycle in the data rather than it being I(2). Aware of the non-stationarity in the data we take steps to address it in the estimation of the models.

6.2 Result estimates of the production functions

We run regressions on the data described in the previous section to estimate the log-linear production functions in equations (3) and (4). We estimate these production functions[8] by Ordinary Least Squares (OLS), Generalized Least Squares (GLS), and Maximum Likelihood (ML) with robust t-tests based on White's (1984) heteroscedasticity-consistent standard errors. Regression results are reported in Tables 2 and 3.

The OLS production function estimates are reported in columns (1) in Tables 3 and 4, and they represent our initial base cases. The estimated elasticity parameters seem reasonable as do the technological trend parameters. F-tests suggest that neither sector exhibits constant returns to scale. The diagnostics on the residuals highlight two problems not uncommon to time-series regressions. The first is the large degree of residual serial correlation in the agricultural sector and the second is the heteroscedasticity in the non-agricultural production function. The heteroscedasticity has already been accounted for by using the White (1984) heteroscedasticity-consistent standard errors for the t-tests and F-tests. The autocorrelation is accounted for in the GLS and ML estimates that follow.

8 We estimated the production function in the agricultural sector by involving fertilizer consumption and irrigation but the results suffered from severe multi-collinearity problems. We therefore settled on the parsimonious parameterization reported in Table 3. Note also that although it has been suggested that the panel estimates could have been carried out using provincial-level data, the data for some variables, for example, agricultural machinery, are not available before 1978 across provinces. In that case, the sample period would not be long enough to test the Lewis theory, nor would it be long enough to identify the stages of economic development in China.

Table 2. Stationarity tests on variables

Vars	ADF on level	ADF on difference	ADF result	KPSS on level	lag	KPSS on difference	lag	KPSS result
ln Q_A	0.042	−5.803	I(1)	1.78	2	0.0645	2	I(1)
ln L_A	−1.888	−2.266	I(1)/I(2)	0.97	2	0.805	2	I(1) /I(2)
ln K_A	−0.779	−0.908	I(2)	1.37	2	0.409	2	I(1)
ln H_A	−1.070	−6.166	I(1)	1.38	2	0.274	2	I(1)
ln Q_N	1.083	−5.016	I(1)	1.78	2	0.237	2	I(1)
ln L_N	−1.847	−3.962	I(1)	1.75	2	0.489	2	I(1)/I(2)
ln K_N	0.341	−4.295	I(1)	1.78	2	0.229	2	I(1)

Source: *Authors' calculations.*

Note: *ADF(n): Augmented Dickey-Fuller test with n autoregressive lags. Reported value is t-statistic on lagged levels variable. Null hypothesis is that the variable contains a unit root (is non-stationary). Critical values are: −2.608 at the 10 percent significance level, −2.950 at the 5 percent significance level, and −3.628 at the 1 percent significance level.*

KPSS: Kwiatkowski et al. (1992) test. Null hypothesis is that the variable does not contain a unit root (is stationary). Optimal lag-length is chosen by the Newey–West (1994) automatic bandwidth selector applied by Hobijn, Philip, and Ooms (1998). Critical values are 0.347 at the 10 percent significance level, 0.463 at the 5 percent significance level, and 0.739 at the 1 percent significance level.

Table 3. Agricultural production function estimates

Dependent variable: lnQ_A	(1)	(2)	(3)
Estimation method	**OLS**	**GLS**	**ML**
Variables		**AR(1)**	**AR(1)**
lnL_A	0.369*	0.341	0.340
	(2.21)	(1.46)	(1.53)
lnK_A	0.178**	0.181**	0.181**
	(9.72)	(5.82)	(6.23)
lnH_A	−0.131	0.027	0.028
	(−0.65)	(0.10)	(0.10)
$T_{1979–84}$	0.088**	0.089**	0.089**
	(9.90)	(6.77)	(6.57)
$T_{1985–92}$	0.060**	0.053**	0.053**
	(6.53)	(4.63)	(4.37)
$T_{1993–on}$	0.038**	0.040**	0.040**
	(8.30)	(6.12)	(6.38)
Constant	19.475**	17.077*	17.076**
	(3.86)	(2.48)	(2.61)
AR(1)		0.626**	0.628**
		(5.37)	(4.05)
Observations	45	45	45
R^2	0.9952	0.9993	
Constant returns to scale test	F = 4.736	F = 1.515	χ^2 = 1.680
	[0.036]	[0.226]	[0.195]
Non-structural residual (e_t) diagnostics:			
Breusch-Godfrey autocorrelation LM χ^2 test	16.188	2.9342	2.041
	[0.000]	[0.087]	[0.153]
White heteroscedasticity χ^2 test	4.271	2.230	1.268
	[0.118]	[0.328]	[0.530]
Jarque-Bera normality χ^2 test	2.184	1.914	2.075
	[0.336]	[0.384]	[0.354]
Ramsey Reset F test	18.61	18.27	10.12
	[0.000]	[0.000]	[0.000]

Source: *Authors' calculations.*

Note: ** and ** denote significance at the 5 percent and the 1 percent level, respectively.*

Parentheses surround t statistics, square brackets represent densities in the tail of each distribution for rejection of the respective null hypotheses. OLS, GLS, and ML estimates of t statistics are based on the White (1984) robust covariance estimator.

The GLS and ML estimates reported in columns (2) and (3), respectively, of Tables 3 and 4 are for models that accommodate first order autoregression, AR(1), in the structural residuals. Equations (10) and (11) illustrate how AR(1) in the structural residuals is accommodated by adding a second equation to the production function:

$$\ln Q_t = \hat{\phi}_L \ln L_t + \hat{\phi}_K \ln K_t + \ldots + u_t, \tag{10}$$

$$u_t = \hat{\rho} u_{t-1} + e_t, \tag{11}$$

where u_t are the structural residuals and e_t are the non-structural residuals. These equations are valid for both the agricultural and non-agricultural production functions in equations (3) and (4). The GLS estimator is based on the Cochraine–Orcutt (1949) iterative procedure with the Prais–Winsten (1954) transformation to retain the first observation. The ML estimator is based on a unified log-likelihood equation that subsumes equations (10) and (11) into one. The parameter estimates in the GLS and ML estimates are similar to one another. This indicates that the estimates are robust to the estimation method. We expect that the GLS and ML parameter estimates are slightly better defined than the OLS ones because the error autocorrelation has been corrected for. The structural residuals have significant autoregressive parameters of magnitude 0.626 and 0.628 in agriculture, and 0.315 and 0.309 in non-agriculture. The diagnostics now pass the Breusch–Godfrey (Breusch 1978; Godfrey 1978) AR(1) test suggesting the non-structural residuals are, apart for the heteroscedasticity, white noise. There is evidence of non-normality in the residuals of the non-agricultural production function but this is due to large negative socio-economic shocks associated with 1968, 1976, and 1990.

Model estimates on non-stationary series may lead to spurious regressions. Therefore, we carry out Engle–Granger (1987) co-integration tests on the two estimated least squares production functions to verify that these are not spurious regressions. The Engle–Granger test results indicate that for both sectors the null hypothesis of non-stationarity on the residuals can be rejected at the 10 percent significance level. The computed tau statistics of the ADF tests on the residuals are –3.335 and –4.995 for the agricultural and non-agricultural sectors, respectively. They are lower than the Engle–Granger co-integration critical values at the 10 percent and 5 percent significance levels.[9] This implies that the series, despite being non-stationary, are co-integrated and the estimates on the non-stationary variables are reliable and superconsistent.

9 The estimated error correction parameters on the lagged error correction terms are –0.404 and –0.740 respectively, indicating a more rapid speed of adjustment in the non-agricultural production than agricultural production.

Table 4. Non-agricultural production function estimates

Dependent variable: lnQ_N	**(1)**	**(2)**	**(3)**
Estimation method:	**OLS**	**GLS**	**ML**
Variables:		**AR(1)**	**AR(1)**
lnL_N	0.732** (12.82)	0.734** (9.61)	0.734** (10.31)
lnK_N	0.208** (5.59)	0.212** (4.40)	0.212** (4.74)
T_{1984}	0.058** (25.41)	0.057** (20.13)	0.057** (20.67)
D_{1967}	−0.148** (−7.94)	−0.140** (−6.32)	−0.140** (−5.19)
D_{1968}	−0.268** (−15.06)	−0.238** (−5.47)	−0.238** (−4.37)
Constant	8.015** (19.80)	7.892** (15.59)	7.894** (14.60)
AR(1)		0.315* (2.18)	0.309 (1.26)
Observations	45	45	45
R^2	0.9993	0.9993	
Constant Returns to Scale test	F = 5.015 [0.031]	F = 2.332 [0.135]	χ^2 = 2.395 [0.122]
Non-structural residual (e_t) diagnostics:			
Breusch-Godfrey autocorrelation LM χ^2 test	3.049 [0.081]	1.222 [0.269]	0.921 [0.337]
White heteroscedasticity χ^2 test	4.942 [0.085]	5.644 [0.059]	5.079 [0.079]
Jarque-Bera normality χ^2 test	2.635 [0.268]	2.609 [0.271]	2.473 [0.276]
Ramsey Reset F test	1.91 [0.146]	1.91 [0.145]	1.94 [0.140]

Note: Same conventions as Table 3.

All the results are consistent with each other within each sector. All estimates seem reasonable with most diagnostic tests being passed. Given that all the structural parameter estimates are so similar, within each sector the growth decomposition analysis and other analyses could be carried out equally with any set of parameter estimates. Therefore, we opt to use the ML estimates for the analyses that follow, as these estimates represent the most parsimonious model estimates that satisfy all the diagnostic tests.

7. Empirical analysis on sectoral growth

7.1 Sources of China's dual-sector economic growth

Equations (5) and (6)[10] are used to decompose China's sectoral economic growth and display the results in Table 5. We find that the 4.84 percent exponential annual

10 In the literature, growth accounting is often applied to decompose economic growth.

growth rate of non-agricultural labor is much higher than the 0.34 percent rate of agricultural labor. Capital inputs in both sectors rise rapidly, 10.64 percent in the non-agricultural sector and 8.28 percent in the agricultural sector. Agricultural land, however, remains relatively constant, changing by an annual mean of just 0.30 percent during 1965–2009. Additionally, the 5.99 or 5.78 percent annual economic growth in the non-agricultural sector is over threefold that of the agricultural sector at 1.80 percent when measured by instantaneous growth rates, or 1.87 percent when measured by annually compounded growth rates. This implies that economic growth is mainly driven by the expansion of the non-agricultural sector, as suggested by the Lewis theory. Moreover, we find that growth in the agricultural sector is mainly driven by capital accumulation (83.06 percent), whereas growth in the non-agricultural sector is attributable to both labor accumulation (59.99 percent) and capital accumulation (39.02 percent). In both sectors, technological progress, despite being statistically significant in the estimation, only accounts for a relatively small share of economic growth. These results show that China's economic growth is due largely to factor accumulation. This finding is consistent with most studies in the literature (e.g., Woo 1998). Furthermore, we note that capital accumulates at a faster rate per annum than labor, whereas it accounts for a relatively smaller share of growth in the non-agricultural sector. This indicates that the expansion of labor employment plays a prominent role in promoting the development of the non-agricultural sector. In summary, consistent with the Lewis-Ranis-Fei theory, China's economic growth is driven by the rapid expansion of the non-agricultural sector, which is affected by capital accumulation and employment growth fuelled by sectoral labor reallocation.

7.2 The contribution of sectoral labor reallocation

We apply equation (7) to account for the sectoral labor reallocation effect (LRE_{WB}) suggested by the World Bank (1996). The merit of this approach is that it is independent of the number of migrant laborers and therefore one does not need to know the number of migrant workers to measure the contribution of sectoral labor reallocation to growth. As shown in Figure 6, the reallocation of labor away from agriculture has had a positive effect on China's economic growth for most of 1966–2009 except for a few years like 1967–68, 1989–90, and 1999–2000, associated with specific socio-economic disturbances. The computations suggest that sectoral labor realloca-

However, it is well established that growth accounting has many drawbacks. For example, it treats the contribution other than that by factor input as the total factor productivity. It therefore cannot distinguish the pure effect of technological progress on growth. In addition, the result is subject to the assigned input shares. In this paper, we carefully estimate the input elasticity and decompose economic growth by factor contributions. Chow and Li (2002) and Ho (1972) have used this approach to decompose economic growth in their studies.

Table 5. Dual-sector growth decomposition (1965–2009)

	Parameter estimates (1)	Instantaneous annual growth rate g_X* [or AGR**] % (2)	Product of parameter and growth [AGR product] (3)	Contribution to sectoral growth [AGR version] % (4)
Agricultural sector:				
Labor	0.340	0.34 [0.34]	0.115 [0.115]	6.39 [6.18]
Capital	0.181	8.28 [8.63]	1.498 [1.562]	83.06 [83.63]
Land	0.028	0.30 [0.30]	0.008 [0.008]	0.45 [0.44]
$T_{1979–84}$	0.089		0.089	4.94 [4.77]
$T_{1985–92}$	0.053		0.053	2.94 [2.84]
T_{1992_on}	0.040		0.040	2.22 [2.14]
Total			1.803 [1.867]	100 [100]
Non-agricultural sector:				
Labor	0.734	4.73 [4.84]	3.469 [3.552]	59.99 [59.30]
Capital	0.212	10.64 [11.23]	2.257 [2.381]	39.02 [39.75]
T_{1984_on}	0.057		0.057	0.99 [0.95]
Total			5.783 [5.991]	100 [100]

Source: *Authors' calculations.*

Note: *Column (1): Coefficients are from the ML estimates for both sectors and are taken from column (3) in Tables 3 and 4.*

*Column (2): *Instantaneous annual growth rates in column (2) are derived by* $g_X = [(lnX_{2009} - lnX_{1965})/(2009-1965)]\times 100$*, where X represents each of the inputs in turn: Labor, Capital, or Land.*

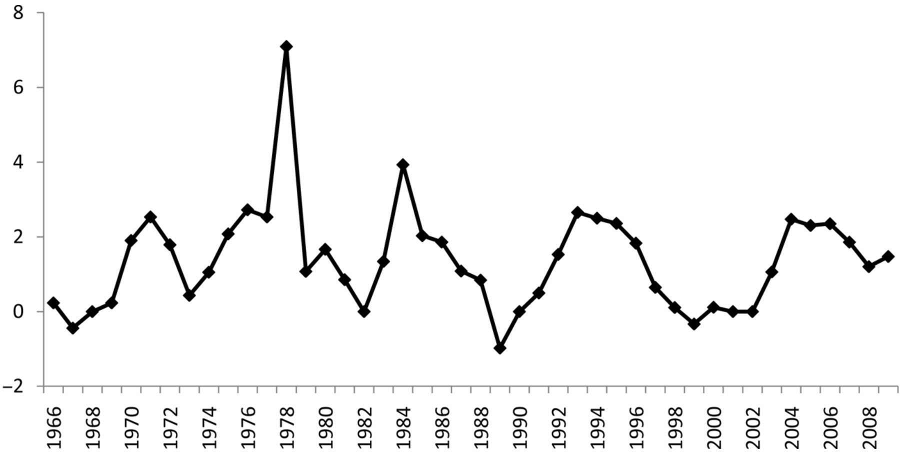
***AGR is the annually compounded growth rate given by* $AGR=(\exp g_X - 1)\times 100$*, values reported in square brackets.*

Column (3): Each value is simply the product of the value in columns (1) and (2) and represents the components in equations (5) and (6).

Column (4): The contribution to sectoral growth calculated as the corresponding value in column (3) divided by the respective total for column (3) in each sector.

tion contributes on average 1.37 percent to annual economic growth over the period 1966–2009. This amounts to approximately 81.34 billion yuan per annum to China's real GDP. Our finding is close to the 1.3 percent annual contribution to growth in 1985–93 reported by Woo (1998) and is consistent with other studies. For example, the World Bank (1996) found that the effect of labor reallocation away from agriculture accounted for 1 percent of China's rapid economic growth during 1985–94. Cai and Wang (1999) report a 1.62 percent average contribution in 1982–97.

Figure 6. The labor reallocation effect by the World Bank (1996) approach



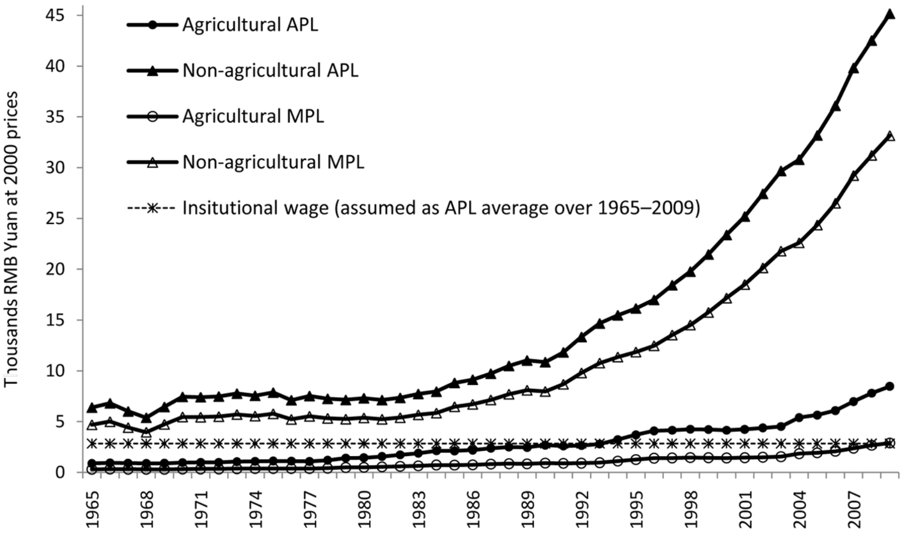
Source: *Authors' calculations.*

Additionally, in Figure 6, we find that the contribution of sectoral labor reallocation achieved its highest values, at 7.09 and 3.93 percent, in 1978–84. This is closely associated with the boom of the TVEs, which has effectively absorbed large amounts of rural surplus laborers (Knight 2007). However, since the mid-1990s, the contribution to the growth of labor reallocation has declined, indicating that labor absorption in the non-agricultural sector has slowed down. This finding is supported by Kuijs and Wang (2005), who also detect the slower pace of expansion in urban employment since 1993. The demise of TVEs as well as the stable share of industry employment in the 1990s contributes to the decline in labor reallocation effect. Furthermore, the low values of the reallocation effect in 1998–2002 may reflect the adverse impact of the 1997–98 Asian financial crisis on China's exports. To conclude, we find that the reallocation of labor away from agriculture has made a substantial contribution to China's economic growth. This finding agrees with the core of the Lewis-Ranis-Fei theory.

7.3 Phases in China's economic development and the turning points

As suggested by Minami (1968), we identify the phases in China's economic development, as well as the turning points, by comparing the agricultural marginal productivity of labor (MPL) to the agricultural institutional wage. Recall from Section 2.1 that in the Lewis-Ranis-Fei model the initial agricultural institutional wage is presumed to follow the sharing rule and be equal to the initially low average agri-

Figure 7. APLs and MPLs

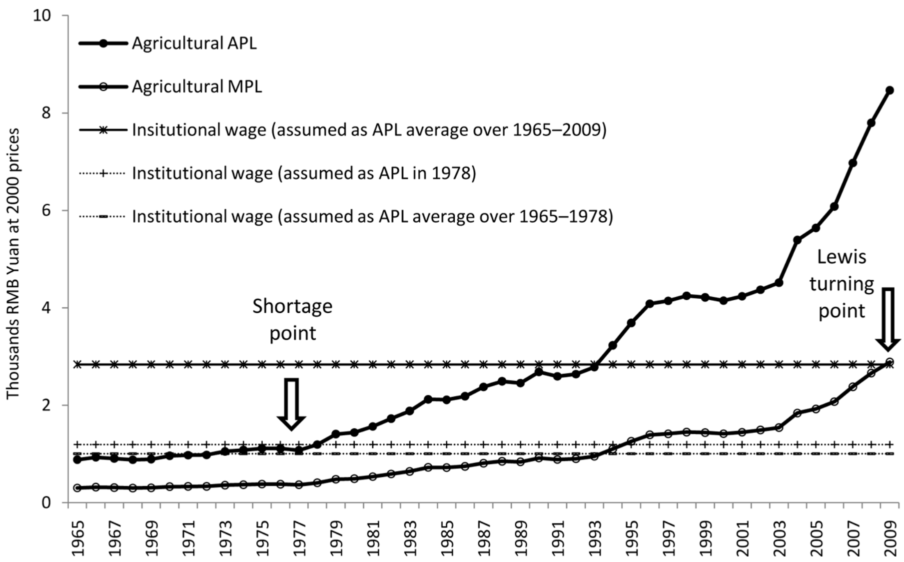


Source: *Authors' calculations based on the estimates in Table 3.*

cultural labor productivity. In the model, an economy is defined as entering phase two of economic development if the agricultural MPL starts to increase above its near-zero value but is still lower than the low agricultural institutional wage. The advantage of this method is that it does not require knowledge of sometimes unavailable measures such as rural wages and surplus labor. Admittedly, the application of this technique is sensitive to the specification of the agricultural institutional wage. We address this drawback by comparing the agricultural MPL to various proxies for the institutional wage. We represent three alternative institutional wages by using the agricultural APL averaged over three time periods: 1965–78, just 1978, and 1965–2009. These three proxies allow us to verify the sensitivity of the results to the choice of institutional wage. Among them, the mean value of the agricultural APL over the entire sample period of 1965–2009 is regarded as the best proxy in that it accommodates potential increases in the subsistence level itself, as suggested by Minami (1968).

We compute the MPL in the agricultural and non-agricultural sectors using the estimated elasticities of output to labor using the estimates for equations (8) and (9), respectively. The series for MPL, APL, and the institutional wage are illustrated in Figures 7 and 8. In Figure 7 it is obvious that in both sectors, both the marginal and

Figure 8. Agricultural APL and MPL



Source: *Authors' calculations based on the estimates in Table 3.*

average productivities of labor are stagnant before the 1978 economic reforms and then rise rapidly, particularly in the non-agricultural sector. The agricultural MPL is low before 1978 but begins to rise rapidly after the 1978 economic reforms. The rising agricultural MPL indicates that the redundant labor has been reallocated away from agriculture and the shortage point (see Figure 1) has been passed after 1978.

Figure 8 allows for the comparison of the agricultural MPL to various proxies for the agricultural institutional wage. It appears that by 2009, at the latest, the agricultural MPL surpassed the assumed institutional wage, as measured by various criteria, thus suggesting that China has reached the Lewis turning point of economic development. For instance, the MPL reaches the institutional wage assumed as the mean value of the 1965–78 agricultural APL in 1994; whereas it reaches the 1978 APL in 1995. When comparing this with our favored proxy for the institutional wage, namely, mean agricultural APL over the entire sample period 1965–2009, we find that the rising MPL crosses it in 2009.

Notwithstanding our results, we also note that China is a large and diverse economy. Thus, different Chinese regions may pass through the Lewis turning point in different years. Hence, entry into phase three economic growth may span several years rather than just one point in time. This way of looking at the Lewis turning point as occurring over a number of years is also adopted by Minami (1968), Garnaut and Song (2006), and Knight, Deng, and Li (2010). In short, we conclude that by 2009 China entered a transition period for the Lewis turning point and may take several years to fully complete it.

8. Conclusion and policy recommendations

Having tested the Lewis-Ranis-Fei theory for China's economy over 1965–2009, we found that China's economic growth is mainly attributable to the development of the non-agricultural sector. This is driven by rapid capital accumulation and employment growth. The reallocation of labor away from agriculture to non-agriculture has made a positive net contribution to China's rapid economic growth by around 1.37 percent per annum. By generating measures of the marginal productivity of labor, we found that the marginal productivity of agricultural labor started to increase noticeably after the 1978 economic reforms. This indicates that China entered phase two, as defined by the Lewis-Ranis-Fei theory, of economic development after 1978. The marginal productivity of agricultural labor has continued to rise thereafter and by 2009 it seems to have exceeded the agricultural institutional wage. Considering the huge diversity within an economy as large as China's we feel comfortable with the conclusion that China is now in a transition period of entry into phase three of economic growth.

Our evidence leads us to make two tentative policy recommendations. First and foremost, more resources should be dedicated to improving labor productivity particularly through rudimentary job training. As indicated by the dualism theory, the third phase of economic development relies on increasing labor productivity. Providing on-the-job training may improve the working skills of rural migrants and thereby raise their productivity.

Second, labor migration in China, though having made a significant contribution to economic growth, is largely temporary. This special characteristic of Chinese labor migration highlights the discrepancy between the rate of urbanization and the pace of industrialization. The Hukou registration system is the reason for this discrepancy; and, hence, it is important to remove the Hukou restrictions on migration. It is also important to provide more facilities and social services to accommodate rural migrants in urban areas. These policy changes would facilitate China's full transition into phase three of economic development.

References

Breusch, Trevor. 1978. Testing for Autocorrelation in Dynamic Linear Models. *Australian Economic Papers* 17:334–355.

Bruno, Michael. 1994. Our Assistance Includes Ideas as Well as Money. *Transition (World Bank)* 5(1):1–4.

Cai, Fang. 2007. The Lewisian Turning Point of China's Economic Development. In: *The Coming Lewisian Turning Point and Its Policy Implications, Reports on China's Population and Labor,* edited by Fang Cai and Yang Du, pp. 147–169. Beijing: Social Sciences Academic Press.

Cai, Fang, and Dewen Wang. 1999. The Sustainability of China's Economic Growth and Labor Contribution [Chinese]. *Journal of Economic Research* 10:62–68.

Cai, Fang, and Meiyun Wang. 2008. A Counterfactual of Unlimited Surplus Labor in Rural China. *China and the World Economy* 16(1):51–65.

Chow, Gregory. 1993. Capital Formation and Economic Growth in China. *Journal of Economics* 108(3):809–842.

Chow, Gregory, and Kui-Wai Li. 2002. China's Economic Growth: 1952–2010. *Economic Development and Cultural Change* 51(1):247–256.

Cochrane, Donald, and Guy Orcutt. 1949. Application of Least Squares Regression to Relationships Containing Autocorrelated Error Terms. *Journal of the American Statistical Association* 44(245):32–61.

Dickey, David, and Wayne Fuller. 1979. Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association* 74(366):427–431.

Dickey, David, and Wayne Fuller. 1981. Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica* 49(4):1057–1072.

Engle, Robert, and Clive Granger. 1987. Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica* 55(2):251–276.

Fan, Gang. 1990. *Macroeconomics Analysis of Public Ownership* [Chinese]. Shanghai: Shanghai United Press.

Fan, Gang. 1994. Incremental Changes and Dual Track Transition: Understanding the Case of China. *Economic Policy* 9(19 Supplement):99–122.

Fei, John, and Gustav Ranis. 1973. *A Model of Growth and Employment in the Open Dualistic Economy: The Cases of Korea and Taiwan.* New York: Asia Society.

Garnaut, Ross, and Ligang Song, editors. 2006. *The Turning Point in China's Economic Development.* Canberra: Asia Pacific Press.

Godfrey, Leslie. 1978. Testing Against General Autoregressive and Moving Average Error Models when the Regressor Includes Lagged Dependent Variables. *Econometrica* 46(6):1293–1302.

Heston, Alan, Robert Summers, and Bettina Aten. 2002. Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP). Available at http://pwt.econ.upenn.edu/.

Ho, Yhi-Min. 1972. Development with Surplus Population. The Case of Taiwan: A Critique of the Classical Two-Sector Model, à la Lewis. *Economic Development and Cultural Change* 20(2):210–234.

Hobijn, Bart, Philip Franses, and Marius Ooms. 1998. Generalizations of the KPSS-test for stationarity. Erasmus University Econometric Institute Report 9802/A. Rotterdam: Econometric Institute.

King, Robert, and Ross Levine. 1994. Capital Fundamentalism, Economic Development, and Economic Growth. Policy Research Working Paper No. 1285. Washington, DC: World Bank.

Knight, John. 2007. China, South Africa and the Lewis model. World Institute for Development Economic Research Research Paper No 2007/82. Helsinki: UNU-WIDER.

Knight, John, Quheng Deng, and Shi Li. 2010. The Puzzle of Migrant Labor Shortage and Rural Labor Surplus in China. Department of Economics Discussion Paper Series No. 494. Oxford: Oxford University.

Kuijs, Louis, and Tao Wang. 2005. China's Pattern of Growth: Moving to Sustainability and Reducing Inequality. World Bank Policy Research Working Paper No. 3767. Washington DC: World Bank.

Kwan, Fung. 2009. Agricultural Labour and the Incidence of Surplus Labour: Experience from China during Reform. *Journal of Chinese Economic and Business Studies* 7(3):79–94.

Kwiatkowski, Denis, Peter Phillips, Peter Schmidt, and Yongcheol Shin. 1992. Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root. *Journal of Econometrics* 54(1–3):159–178.

Lewis, W. Arthur. 1954. Economic Development with Unlimited Supplies of Labor. *The Manchester School* 22(2):139–191.

Lewis, W. Arthur. 1979. The Dual Economy Revisited. *The Manchester School* 47(3):211–229.

Lin, Justin, Fang Cai, and Zhou Li. 1994. China's Economic Reforms: Pointers for Other Economies in Transition. Policy Research Working Paper No. 1310. Washington, DC: World Bank.

Meng, Xin, and Nansheng Bai.2007. How Much Have the Wages of Unskilled Workers in China Increased? Data from Seven Factories in Guangdong. In: *China: Linking Markets for Growth,* edited by Ligang Song and Ross Garnaut, pp. 151–175. Canberra: Asian Pacific Press.

Minami, Ryoshin. 1968. The Turning Point in the Japanese Economy. *Quarterly Journal of Economics* 82 (3):380–402.

Minami, Ryoshin, and Xinxin Ma. 2010. The Lewis Turning Point of Chinese Economy: Comparison with Japanese Experience. *China Economic Journal* 3(2):163–179.

Ministry of Labor and Social Security of China. 2009. 2009 Human Resources and Social Security Statistical Report. Available at http://w1.mohrss.gov.cn/gb/zwxx/2010-05/21/content_382330.htm.

National Statistical Bureau of China. 2001, 2003, 2004, 2009. *The Chinese Statistical Yearbook.* Beijing: PRC.

Naughton, Barry. 1995. *Growing Out of the Plan: Chinese Economic Reform, 1978–1993.* Cambridge: Cambridge University Press.

Newey, Whitney, and Kenneth West. 1994. Automatic lag selection in covariance matrix estimation. *Review of Economic Studies* 61(4):631–653.

Nolan, Peter, and Robert Ash. 1995. China's Economy on the Eve of Reform. *The China Quarterly* 144(special issue):980–998.

Ohkawa, Kazushi. 1965. Agriculture and Turning Points in Economic Growth. *The Developing Economies* 3(4):471–486.

Park, Albert, Fang Cai, and Yang Du. 2010. Can China Meet Her Employment Challenges? In *Growing Pains: Tensions and Opportunities in China's Transformation,* edited by Jean Oi, Scott Rozelle, and Xuegang Zhou, pp. 27–55. Stanford, CA: Stanford Asia-Pacific Research Center.

Prais, Sigbert, and Christopher Winsten. 1954. Trend Estimators and Serial Correlation. Cowles Commission Discussion Paper No. 383. Available at http://cowles.econ.yale.edu/P/ccdp/st/s-0383.pdf.

Putterman, Louis. 1992. Dualism and Reform in China. *Economic Development and Cultural Change* 40(3):467–493.

Ranis, Gustav, and John Fei. 1961. A Theory of Economic Development. *American Economic Review* 51(4):533–565.

Rostow, Walt. 1956. The Take-off into Self-Sustaining Growth. *Economic Journal* 66(261):25–48.

Sachs, Jeffrey D., and Wing Thye Woo. 1994. Structural Factors in the Economic Reforms of China, East Europe and the Former Soviet Union. *Economic Policy* 18(1):102–145.

Sachs, Jeffrey D., and Wing Thye Woo. 2000. Understanding China's Economic Performance. *Journal of Policy Reform* 4(1):1–50.

United Nations. 1970. *Methods of Measuring Internal Migration.* New York: United Nations.

Wang, Dewen.W. 2008. Lewisian Turning Point: Chinese Experience [Chinese]. In *Reports on Chinese Population and Growth No. 9: Linking up Lewis and Kuznets Turning Points,* edited by Cai Fang, pp. 88–103. Beijing: Social Sciences Academic Press.

White, Halbert. 1984. A Heteroscedasticity Consistent Covariance Matrix Estimator and a Direct Test of Heteroscedasticity. *Econometrica* 48(4):817–838.

Woo, Wing Thye. 1998. Chinese Economic Growth: Sources and Prospects. In *The Chinese Economy,* edited by Michel Fouquin and Francoise Lemoine, pp. 17–48. London: Economica.

World Bank. 1996. *The Chinese Economy: Controlling Inflation, Deepening Reform.* Washington, DC: World Bank.

World Bank. 2010. *World Development Indicators.* Washington, DC: World Bank.

Wu, Xiaoying. 1994. Rural to Urban Migration in the People's Republic of China. *The China Quarterly* 139:669–698.

Yao, Yang. 2011. The Relationship between China's Export-led Growth and Its Double Transition of Demographic Change and Industrialization. *Asian Economic Papers* 10 (2):52–76.

Yao, Yang, and Ke Zhang. 2010. Has China Passed the Lewis Turning Point? A Structural Estimation Based on Provincial Data. *China Economic Journal* 3(2):155–162.

Zhang, Kevin, and Shunfeng Song. 2003. Rural-Urban Migration and Urbanization in China: Evidence from Time-Series and Cross-Section Analyses. *China Economic Review* 14(4):386–400.

Zhao, Yaohui. 2000. Rural to Urban Labor Migration in China: the Past and the Present. In *Rural Labor Flows in China,* edited by Loraine West and Yaohui Zhao, pp. 15–33. Berkeley, CA: Institute of East Asian Studies, University of California.