Lewis Growth Model and China's Industrialization

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Abstract

This paper examines China's industrialization in the light of the Lewis growth model. It begins with a perusal of Lewis' own writings and those of Fei and Ranis in order to clarify certain assumptions and predictions of the Lewis model. The paper then reviews previous applications of the Lewis model in studying industrialization in other countries, and notes the methodological problems that arise in this regard. In applying the Lewis model to study China's industrialization, the paper focuses on the dynamic relationship between wage and marginal product of labor in the traditional sector. For this purpose, the paper estimates a production function for China's agriculture sector using province level data and compares the estimated marginal product of labor with the corresponding wage of this sector. The results show that the marginal product has been increasing (from below) at a faster pace than the wage, as is predicted by the Lewis model. The results indicate that China as a whole is steadily moving toward the Lewis Turning Point.

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I. Introduction

This paper examines China's industrialization in the light of the Lewis growth model. Even casual observation suggests that the Chinese economy has many of the features that the Lewis model tries to capture. Yet, while the Lewis model has been applied to study industrialization of many other countries, surprisingly little, if any, effort has been made in this respect with regard to China. This paper is an attempt to fill this void.[1]

The paper begins with a brief perusal of Lewis' own writings and those of Fei and Ranis in order to clarify the assumptions and predictions of the Lewis model.[2] The review shows that, despite subsequent extensions, the main prediction of the model remains what is known as the Turning Point prediction, according to which the wage of unskilled labor in the 'modern' sector remains by and large unchanged for a considerable period of time before reaching the Turning Point and rising rapidly thereafter. This prediction also applies to the 'traditional' sector wage curve, which in fact is expected to reach a similar Turning Point earlier, even though remaining as a whole below the modern sector wage curve. Eventually the two curves get closer, signifying equalization of wages in the two sectors (subject to caveats) and disappearance of the duality of the economy.

In their empirical work inspired by the Lewis model, some researchers focused on testing directly the model's *assumptions*, such as duality, existence of surplus labor, etc. Scholars following this line of query often used micro data and adopted the methodology of comparative-statics.[3] However, as Lewis himself, and Fei and Ranis following him, frequently pointed out, the Lewis model is mainly about long run macro dynamics, even though, as Sen (1966, 1967a, 1967b) shows, the story does not contradict rational optimizing behavior at the micro level.[4] Many researchers have rightly focused on macro dynamic *predictions* of the Lewis model and, in

[1] Xu (1994) refers to the Lewis model, however does not really focus on testing Lewis model's assumptions or predictions in the context of China. Similarly, Putterman (1992) refers to dualism but does not engage in an application of the Lewis model to the case of China. At the time of revising this paper, the authors came to know about Cai (2007), a study conducted by the Chinese Academy of Social Sciences (CASS), which used the Lewis paradigm to describe and analyze China's labor situation. It is encouraging that the conclusions of this study broadly agree with the conclusions presented in this paper.

[2] Lewis' writings refer to Lewis (1954, 1955, 1972, 1979, 1980, and 1984). Works of Fei and Ranis refer to Fei and Ranis (1957, 1963, 1973, 1978, 1992, 1995, 2004), Ranis (1963, 1964, 1969), and Ranis and Fei (1961, 1963, 1975).

[3] For a review of this strand of literature, see for example Rosenzweig (1988).

[4] In particular, Sen (1967b) pointed to a distinction between 'marginal product of *labor*' and 'marginal product of a *laborer*' to help explain the micro foundations of the Lewis model.

particular, examined the wage data to see whether the Turning Point prediction held, and if yes, how long it took economies to reach the Turning Point, and what forces propelled the process.

Testing the Turning Point prediction is however not easy, as recognized by Lewis himself and other researchers. The challenges range from problems of finding the right empirical counterparts of the dual sectors of the theory to problems regarding the type of wage to examine. Despite the difficulties, many researchers have used the Lewis model and produced instructive results. For example, Williamson (1982) presents unskilled labor wage data for England during the first industrial revolution and shows that the wage curve remained essentially flat for about forty years before starting to rise. Fei and Ranis offer compilation and analysis of wage data for Taiwan and Korea showing that the marginal product in agriculture increased much faster than did wages.

Much research using the Lewis model was conducted on Japan, with a prominent role played in it by Minami (1964, 1966, 1967, 1968), who offered five criteria to identify the Lewis Turning Point. Denoting marginal product of labor and wage in the traditional sector by MP_L^T and w^T, respectively, Minami's Criterion-I simply notes that according to the Lewis model, $MP_L^T < w^T$ in the traditional sector until the Turning Point is reached. Based on a meticulous analysis focused on this criterion, Minami shows that Japan reached the Turning Point in the post World War II period, and not during the 1920s, as suggested earlier by Ranis (1957).

When it comes to China, the application of the Lewis model faces some additional difficulties arising from several of her specific institutional features, such as the (i) legacy of central planning, (ii) restrictions on rural-urban migration, (iii) frequent changes in the administrative jurisdiction of urban and rural counties, and (iv) establishment of modern industrial enterprises in rural areas in the form of Township and Village Enterprises (TVE). Earlier, based on a graphical analysis, Islam and Yokota (2006) showed that the wage curves in China indeed appeared to display the Turning Point feature and that, according to the results from the Fei-Ranis (1997) style decomposition, capital accumulation played the main role in propelling the economy toward that point.[5]

[5] Islam and Yokota (2006) examine national level wages in China and also province level manufacturing wages for Beijing, Shanghai, Guizhou, and Gansu. Fei and Ranis (1997) offer the following decomposition: $\eta_W = \eta_K + (J + B_L)/\varepsilon_{LL}$, where η_W is the growth rate of employment in the modern sector, η_K is the growth rate of capital accumulation, B_L is the labor-bias of technology, J is the innovation intensity (measured by total

The current paper takes the analysis to a deeper level by using Minami's Criteria-I, according to which the Turning Point is reached when the marginal product of labor in the traditional sector rises from below to become equal to the wage. In applying this criterion, the paper takes the 'agriculture' sector as the empirical counterpart of the 'traditional' sector of the Lewis model, and estimates the agricultural production function for different years, ranging from 1987 to 2005, using province level data. The estimated production function is used to obtain the marginal product of labor, which is then compared with wage.

The main results are as follows. First, the agricultural wage has increased over time, implying that the traditional sector wage curve has not remained entirely flat. This is however not surprising, because the Lewis model does not rule out some departures from the assumptions and the consequent increase in the wage before reaching the Turning Point. Second, the marginal product of labor in the traditional sector (MP_L^T) has been increasing at a faster rate than did the wage. This trend of increase accelerated from 1997, even though more recent years has witnessed some deceleration. Third, even though the MP_L^T curve is rising more steeply than wages, so that the gap between the two is narrowing, the average wage-curve as a whole still remains above the MP_L^T-curve. Together these results indicate that China is steadily progressing toward the Lewis Turning Point, though it has not crossed that point yet. The qualitative features of these results do not change with alternative ways of computing wage and with alternative ways of specifying and estimating the production function.

From a theoretical perspective, the findings lend support to the duality postulated by the Lewis model and the Turning Point prediction that ensues from it. By contrast, the neo-classical growth model, with its assumption of full employment, perfect mobility, and equalization of factor returns across sectors, does not seem to provide the right description of the Chinese economy. However, as Lewis himself noted, once the economy reaches the Turning Point and the duality disappears, the postulates of the neoclassical model may become applicable, though the issue of finding a satisfactory explanation of the technological progress, a task that the new growth models are struggling with, will still remain.[6]

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factor productivity growth), and ε_{LL} is the elasticity of marginal product of labor. See Fei and Ranis (1997) for a review and Islam and Yokota (2006) for an application to China and an extension of the decomposition to take into account the distinction between imported and domestic capital.

[6] For discussions of applicability of neoclassical and new growth theories for developing countries, see Islam (2004).

The discussion of this paper is organized as follows. Section 2 offers a brief recapitulation of the salient features of the Lewis model in order to clarify its assumptions and predictions. Section 3 considers the extensions of the Lewis model suggested in particular by Fei and Ranis. Section 4 reviews previous applications of the Lewis model in studying industrialization. Section 5 presents the empirical analysis and the results. Section 6 concludes.

II. Lewis Growth Model: A Brief Recapitulation

More than half a century ago, Arthur Lewis published his article, "Development with Unlimited Supply of Labor," which together with his subsequent writings gave rise to the famous 'Lewis Growth Model,' the hallmark of which is the assumption of a dual structure of the economy.[7] Various terminologies have been used to express this dualism, such as 'urban-rural,' 'capitalist-non capitalist,' 'modern-traditional,' 'capitalist-subsistence,' 'industrial-agricultural,' 'commercial-non commercial,' etc. Lewis himself started with the 'capitalist-non capitalist' characterization of this duality, but later recognized the possibility of other characterizations. In this paper, we will use the 'modern-traditional' terminology to express the Lewis dualism.

As Lewis (1972) explains, the difference between the two sectors is analytical, and not descriptive. The first analytical difference postulates that basically the same type of labor has higher productivity in the modern sector than in the traditional sector. Denoting the marginal product of labor in traditional and modern sectors by MP_L^T and MP_L^M, respectively, the Lewis proposition therefore suggests that $MP_L^M > MP_L^T$. This inequality signifies a departure from the neoclassical paradigm of perfect mobility and equalization of factor returns, and it implies that the economy may grow by transferring labor from the traditional to the modern sector.[8]

The second analytical difference between the two sectors concerns distribution. According to Lewis, distribution in the modern sector follows the 'marginal productivity rule' of distribution, so that $w^M = MP_L^M$, where w^M denotes the wage in the modern sector. However, it is assumed

[7] See Lewis (1954, 1955) for the original exposition of the model. For recent discussions of the Lewis model, see the December 2004 special issue of *Manchester School*, the journal in which the original Lewis (1954) paper appeared. The special issue is based on the papers of the symposium organized by the journal to celebrate 50 years of Lewis (1954). See in particular, Fields (2004), Kirkpatrick and Barrientos (2004), Ranis (2004), and Tignor (2004). See also Gersovitz, Diaz-Alejandro, Ranis, and Rosenzweig (ed.) (1982).

[8] Assuming that more is saved out of the modern sector's increased output, the shift provides further capital to the modern sector to absorb more labor from the traditional sector. This is basically what drives growth in the Lewis model.

that in the traditional sector, $w^T > MP_L^T$, where w^T denotes the wage in the traditional sector. This inequality is possible, because distribution in this sector is governed by a different rule, a rule that Ranis and Fei refer to as the 'kinship/community rule' of distribution. This difference in the rule of distribution signifies another departure from the neoclassical economy, according to which the same 'marginal product rule' of distribution applies to the entire economy.[9]

Lewis himself has not been very clear about the institutional and/or behavioral underpinnings of these analytical differences between the two sectors. A close analysis however shows that two conditions need to be satisfied for these analytical differences to emerge. The first is 'abundance' of labor (relative to other inputs, mainly land) in the traditional sector. The second is some restrictions that prevent a free flow of labor from the traditional to the modern sector, at least until the Lewis growth process starts.

Both these conditions in turn require some explanation. So far as the first is concerned, for many developing countries 'over-population' or 'surplus labor,' in a general sense, have been the legacy of the colonial rule during which mortality rate decreased without commensurate socio-economic transformation and the associated decline in the fertility rate. The result was a demographic disequilibrium, causing 'over population' or 'surplus labor' in the traditional sector, though the exact definition or measure of 'surplus' or 'abundance' is somewhat moot.

With respect to the second condition, it should be noted that restrictions on mobility may be either formal or informal, and they may be from the side of either the traditional or the modern sector. In the traditional sector itself, for example, various informal customs may discourage migration of labor to the modern sector, generally located in urban areas. In other cases, the restrictions may be formal. In China, for example, the *Hukou* (household registration) system formally restricts rural-urban migration.

A related issue here concerns uncertainty of finding a modern sector job upon migration, so that the expected wage, $E(w^M)$, may be significantly lower than the prevailing wage w^M, suggesting that the latter has to be greater than w^T in order to induce laborers to move from the traditional to the modern sector, even if there were no formal or informal restrictions on the movement.[10] Another relevant fact is higher cost of living and loss of familial, social, and

[9] Lewis himself did not dwell much on this second analytical difference. It was rather researchers working with the Lewis model who more sharply formulated this difference later.

[10] This is a point that many migration models, such as that of Harris and Todaro (1970), have emphasized.

environmental ‘benefits’ consequent upon moving to the modern sector, a loss that warrants some compensation in the form of higher wage rates. The modern sector itself may restrict the mobility through erection of various entry restrictions, either by trade unions or by the authorities of urban areas where the modern sector is generally located. Finally, there may be ‘efficiency wage’ considerations for modern sector managers themselves to prefer to have $w^M > w^T$. Taken together, the first analytical difference between the two sectors, namely that $MP_L^M > MP_L^T$, may not be too difficult to justify.

By comparison, justification of the second analytical difference, namely $MP_L^T < w^T$, is less straightforward. Nevertheless, it may be noted that, if the above two conditions are met, various institutional settings can support the ‘kinship/community rule’ of distribution. The most immediate case is provided by family farms which, when constrained to employ family labor only on their farms, engage in ‘output maximizing’ rather than ‘profit-maximizing’ behavior, and thus push application of labor to very low marginal productivity levels. The average product per labor of such farms, considered as ‘wage,’ will obviously be higher than the marginal product. To the extent that family farms comprise large parts of the economies of many densely populated developing countries, the above described ‘kinship rule of distribution’ may explain why $MP_L^T < w^T$ may be true for their traditional sectors.

It may be pointed out that the average product per labor in a family farm is not ‘wage’ in its strict sense.[11] However, many scholars have observed that the ‘kinship/community rule’ of distribution may extend beyond the family and hold at the community (village) level, and thus pertain to non-family, hired labor too. In some countries and during the pre-industrial era, villages indeed represented close-knit communities, members of which felt affinity among themselves. It is contended that, due to this affinity, even families hiring farm labor would pay institutional wage that was higher than the marginal product, so that the wage had a ‘sharing’ feature.[12] The Chinese Communes provide another example of institutions permitting ‘wages’ to

[11] This is true even without bringing up the issue of contribution of land, implements, and other family owned non-labor inputs that are employed in production.

[12] Measurement of marginal product in the agriculture sector is particularly problematic at the micro level. To the extent that the agricultural production process extends over a long period with labor requirement varying at different points in time, the marginal product of labor at a particular point of time cannot be determined without considering the labor application profile over the entire production period. Given the seasonality and quasi-fixed requirement of labor per unit of land cultivated, the marginal product may not be as low when the entire crop period is considered as it appears when just the short span during which the labor is actually engaged. Also recall the distinction between

have a ‘sharing’ feature and thus be higher than the marginal product, as these Communes also engaged in ‘output-maximizing’ (rather than profit-maximizing) behavior, and thus pushed marginal product to low levels, so that it would be case that $MP_L^T < w^T$.

It is not surprising that Ranis and Fei often use the expression ‘non-commercial organization’ as the distinctive feature of the Lewis model’s ‘traditional’ sector. Family farms, village communities, or the Chinese Communes all have in common the ‘non-commercial organization,’ which leads them to ‘output-maximizing behavior,’ and to follow the ‘kinship/community rule of distribution,’ allowing $MP_L^T < w^T$. By contrast, the modern sector is characterized by ‘commercial organization,’ leading it to ‘profit maximization behavior,’ and thus to follow the ‘marginal product rule of distribution,’ so that $w^M = MP_L^M$.

All together, we therefore have a dualistic economy characterized by the relationship: $MP_L^T < w^T < w^M = MP_L^M$.

The dualism of the economy however creates the possibility for the modern sector to expand through absorption of traditional sector’s labor without having to increase its wage offer. The relocation of labor from the traditional to the modern sector increases MP_L^T . However, as long as $MP_L^T < w^T < w^M$, such increases do not lead to increases in w^T , and therefore w^M does not have to respond. The modern sector can expand with w^M more or less unchanged, vindicating the possibility of ‘unlimited’ or ‘perfectly elastic’ supply of labor from the traditional sector. Only when the withdrawal of labor pushes up MP_L^T sufficiently high so that it gets closer to w^T , further withdrawal leads to increases in w^T , in turn creating pressure for w^M to rise. This is when the economy reaches the Turning Point, which is first experienced by w^T and then by w^M .

‘marginal product of *labor*’ and ‘marginal product of a *laborer*’ noted earlier. Despite these difficulties in conceptualization and estimation, it is generally argued that ‘abundance’ of labor and restriction on mobility lead to ‘output maximizing behavior’ even at the community level, so that the marginal product is pushed to a very low level, and distribution follows the ‘kinship/community rule’ allowing ‘wages’ to be higher than the marginal product of labor. In other words, wages represent some sort of sharing of the product at the community level, just as it does within family farms. Also, of note is the fact that wages in such situations generally correspond to a subsistence level, so that there may also be some efficiency argument for wages being higher than the marginal product. The average income is already so low that payment below a certain (subsistence) level may just fail to produce the labor that is necessary to carry out the production operations. The fact that a sense of ‘sharing’ does persist within villages and communities in developing countries has been revealed by many researchers investigating the issue of risk sharing. They found that villagers do share consumption risk through mutual lending and other traditional practices. See for example Townsend (1994), Coate and Ravallion (1993), and Fafchamps and Lund (2003). For another perspective on sharing, see Weitzman (1984).

With further progress of the process, the equality $MP_L^T = w^T = w^M = MP_L^M$ is reached, the duality of the economy disappears, and the economy starts to correspond to the neoclassical description. Figures 1 and 2 display the above processes in a graphical form.[13]

[Place Figure 1 and 2 about here]

III. Extensions of the Lewis Model

In their extension of the Lewis model, Ranis and Fei (1961) emphasize that the Lewis economy is characterized not only by an 'organizational dualism' but also by a 'product dualism.' The latter makes terms of trade between the two sectors an important determinant of the outcome, because wages of the modern sector are mostly spent on output of the traditional sector.[14] They draw attention to the fact that unless productivity in the traditional sector rises, expansion of the modern sector may worsen its terms of trade and choke the modern sector's expansion before reaching the Turning Point. The process of industrialization can thus get aborted.

Other researchers however have pointed out that the terms-of-trade apprehension may be unwarranted, because it applies only to a closed economy.[15] Oshima (1963, p. 449) for example notes that "it seems highly artificial to assume a closed system in a theory which makes the worsening of the terms of trade a cornerstone." Once external trade is assumed, this danger recedes, and Ranis and Fei (1963), in their reply to Oshima, basically concede to the point.[16]

There are several other issues that are of relevance for the goods market equilibrium, apart from the issue of whether the economy is open or closed. One of these concerns the consumption

[13] It needs to be noted that the wage curve in the classical economics is also flat and fixed at the subsistence level. This similarity and the associated departures from other neoclassical assumptions often led to the characterization of the Lewis model as belonging to the classical school. Lewis (1954) himself promoted the idea to some extent. However, it is important to note that the flatness of the wage curve in the Lewis model is not the same as the flatness in the classical economics. The latter, rooted in Malthusian population dynamics, continues in perpetuity (with temporary fluctuations around it) while the former disappears as industrialization progresses. Thus although there is some connection with overpopulation, the nature of the connection is very different in the Lewis model than in the classical model.

[14] For elaboration of the point by these authors see Fei and Ranis (1963, 1969), Ranis (1963), Ranis and Fei (1963).

[15] For related discussions see Choo (1971), Findlay (1980), Harris and Todaro (1970), Jorgenson (1961, 1967), Lesson (1979), and Nelson (1956)

[16] They note that "relaxation of our closed-economy assumption would represent an important next step in the evolution of our model; such relaxation would considerably soften the balanced growth constraint by relaxing a source of rigidity in the system (Ranis and Fei 1963, pp. 452-3)." Elsewhere they note that "the open economy can (indeed) be of considerable help in loosening the strait-jacket of resource constraints and inherited autarky, aiding the domestically-driven growth of the dualistic LDC (Fei and Ranis 1997, p. 283)."

behavior, in particular whether Engel's law holds and if yes in what manner. Another issue concerns productivity growth. Lewis allowed (labor) productivity in the modern sector to be higher than in the traditional sector. However, he did not consider any further change (growth) in productivity in any of the two sectors. Other researchers, including Fei and Ranis, have however considered the implications of various possibilities with regard to productivity growth in the two sectors. Matsuyama (1992, 2007), Eswaran and Kotwal (1993), and Laitner (2003) provide more detailed treatments of issues concerning openness of the economy, consumption behavior, and productivity growth, in the context of Lewis-type dualistic models.

In their extension of the Lewis model, Ranis and Fei (1961) suggest several other points in the wage curve. In doing so, they assume that the marginal product curve of the traditional sector is characterized by three phases. In the first phase, the marginal product is zero, so that the transfer of labor from the traditional sector to the modern sector does not lead to any reduction in the traditional sector's total output, and instead releases an amount of wage-goods (output of the traditional sector) that is equal to what is needed to employ the labor in the modern sector. This phase however comes to an end when the marginal product of labor in the traditional sector becomes positive, signifying the beginning of the second phase. Ranis and Fei call this point as the 'Shortage Point,' noting the fact that the traditional sector output now released will fall short of the amount of wage goods required by the laborer in the modern sector. However, to the extent that the marginal product is less than the wage (in the traditional sector), transfer of labor at this stage does not create pressure on the wage to rise.

This second phase ends with the advent of phase three when marginal product catches up with the wage, and any further transfer of labor now pushes up both the marginal product and the wage in the traditional sector to more or less the same degree. Ranis and Fei (1961) refer to this point as the 'Commercialization Point,' pointing to the fact that the advent of this point signifies the end of the non-commercial principle and the associated 'kinship rule of distribution' of the traditional sector.[17]

[17] "To facilitate our later analysis, let us refer to the boundary between phases 1 and 2 as the 'shortage point' signifying the beginning of shortages of agricultural goods as indicated by the fact that AAS (average agricultural surplus) falls below the minimum wage; let us also refer to the boundary between phases 2 and 3 as the 'commercialization point' signifying the beginning of equality between marginal productivity and the real wage in agriculture (Ranis and Fei 1961, p. 540)."

A general goal of Ranis and Fei (1961) is to bring more rigor to Lewis discussion,[18] and in doing so, they declare that the Lewis Turning Point coincides with the Shortage Point, and suggest that Lewis' 'unlimited' supply curve of labor is defined by the horizontal portion of the marginal product curve of labor in the traditional sector.[19] A closer observation however shows that the horizontal portion of the marginal product curve is not the same as the horizontal part of the Lewis wage curve, either in the traditional or in the modern sector. The wage curve remains horizontal in both phase one and two (i.e., as long as $MP_L^T < w^T < w^M$), while the marginal product curve (for traditional sector) is horizontal only in phase one. Actually, many researchers doubt marginal product being zero and want to drop phase one altogether.[20] Oshima (1963, p. 451, ff no. 4), for example, notes that once this is done "the flat portion of the total and marginal productivity curve in the model will be replaced by a gently rising slope," and then "*the first phase loses its distinctive character and becomes merged with the second* as far as industrial supply curve of labor is concerned." In such a scheme of things the Shortage Point of Fei and Ranis disappears.

According to Ranis and Fei (1961), Lewis refers to the following two things to happen for the Turning Point to occur: (a) the worsening of terms of trade for the industrial sector, and (b) the 'exhaustion of surplus labor' in the traditional sector. Given that the first of these do not apply to an open economy, it is only the second that warrants attention. However, 'exhaustion of labor surplus' happens only at the end of the second phase of the Fei-Ranis construct and not at the end of the first phase. The Lewis Turing Point therefore corresponds to their Commercialization Point, and not the Shortage Point. Fei and Ranis themselves elsewhere seem to correct their position by noting that "after the *turning point* the agriculture sector becomes completely

[18] According to Ranis and Fei (1961, p. 539), "Lewis himself explains the turning point *rather loosely* as occurring when one of the following events puts an end to the horizontal supply curve of labor: (a) the worsening of the terms of trade for the industrial sector, and (b) the exhaustion of the labor surplus in the agricultural sector."

[19] As Ranis and Fei (1961, p. 540) puts it, "The Lewis Turning Point … coincides with the shortage point and the upward movement of the industrial real wage is accentuated at the commercialization point." They think that "Lewis' 'unlimited' supply curve of labor is defined by the horizontal portion of the supply curve, i.e. *St* (the portion that pertains to phase 1). When this supply curve turns up, unlimitedness comes to an end (Ranis and Fei, 1961, p. 536)."

[20] Oshima (1963, p. 451) observes that "empirical studies are necessary to substantiate the concept of an institutional wage, i.e. a caloric-minimum wage substantially higher than MPP which the landlord is willing to pay in order to prevent wage levels from falling to caloric levels too low for efficient work. This assumes that the redundant workers have no other place to go and that cultivable land is fixed in the long run. And it contradicts the usual practice of sharp struggles between landlord and tenant in Asian countries. I think a stronger case can be made for assuming wages to be below MPP."

commercialized (Ranis and Fei 1961)," adding that "after the *turning point* the general level of real wages rises for the first time, as the disguised unemployed in the agricultural sector disappears and no longer plays the role of a 'reserve army.'"

Noting the efforts by Ranis and Fei and other researchers at extending his model and the controversies that arose, Lewis (1972) himself ventures to streamline the ideas.[21] He explains that there are three different versions of the model. In Model-I, the economy is closed, and there is no trade between the two sectors, implying that outputs of both sectors are fully convertible into each other (or are the same), and hence the issue of shortage (of wage good) and of the Fei-Ranis Shortage Point does not arise. In this model the Turning Point is reached when "the labor supply ceases to be infinitely elastic and the wage starts rising through pressure from the non-capitalist sector (Lewis 1972, p. 83)."[22]

Model-II continues with the closed economy scenario, but now assumes that the two sectors produce different goods and hence trade with each other. This is basically the Fei-Ranis model that emphasizes product dualism. We already saw that while the Shortage Point is a possibility in this model, it does not represent the Lewis Turning Point, which instead corresponds to the Commercialization Point. This model allows diverse outcomes with regard to the Turning Point depending on the relative productivity growth in the modern and traditional sectors.[23]

Model-III allows international trade (an open economy situation) so that a rapidly growing industrial sector faced by a too slow agricultural sector can import agricultural products and pay for the imports by exporting its own product. Model-III is therefore analytically equivalent to

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[21] See also Lewis (1979, 1980, 1984)

[22] Lewis also mentions of a *second* Turning Point, which is reached when "the marginal product is the same in the capitalist and non-capitalist sectors, so that we have reached the neo-classical one-sector economy (Lewis 1972, p. 83)." In a footnote, Lewis notes that "The second turning point is exactly the same as in Fei and Ranis (1964, p. 201-5). The definition of the first turning point is also the same, but the mechanism for reaching it is different, since Fei and Ranis are working with Model-II, in which the capitalist sector depends on the non-capitalist sector for agricultural products." (Lewis 1972, p. 83)

[23] Following Johnson's trade model, Lewis shows that the terms of trade between the two sectors will remain constant if the relative growth rates of industry and agriculture are the same as the relative income elasticities of demand for product of these two sectors. As Lewis (1972, p. 93) explains, "even if the terms of trade are rising, industrial expansion will not necessarily cease. Productivity is rising in the industrial sector, so if real wages (*w/c*) are constant, the profit margin will not fall unless the terms of trade rise faster than industrial productivity." According to Lewis, this will happen particularly if the productivity growth in the agricultural sector lags much behind that in the industry sector so that the price of agricultural products rises faster than those of the industrial sector. However, even if the terms of trade rise (deteriorates) for the industry, its expansion may not cease if the productivity growth in this sector outpaces the rate of deterioration in the terms of trade. (This is however a little confusing, because the rate of deterioration in the terms of trade itself depends on the rate of productivity growth, and hence two are not independent.) The concrete outcome will then depend on the relative rates of productivity increase in the two sectors and the resulting impact on the terms of trade and movement of the real wage.

Model-I, in the sense that products of the two sectors again become convertible, albeit indirectly, via international trade. The terms of trade now enter into the picture, and Lewis notes that in order to export more, the producers may have to lower the prices thus causing a dent in their profit margin.[24] He advises that "a country must plan its development in such a way as to be sure that its exports will keep pace with needed imports," and warns that "if it fails to do this, the rate of growth of output will be constrained by the rate of growth of export earnings (Lewis, 1972, p. 94)."

It needs to be noted that equating Lewis (1954, 1955) original papers with the closed economy Model-I, as is often done, is not accurate, because these original papers actually devoted considerable attention to cross-border *factor flows* (both labor and capital) and their impact (either directly or via terms of trade). For example, Lewis (1954) notes that progress towards the Turning Point may be checked by mass immigration and export of capital.[25] He also notes indirect consequences of export of capital. For example, he observes that export of capital, on the one hand, may cheapen the goods that workers import or raise the wage costs in competing countries, and thus facilitate the progress toward the Turning Point. On the other hand, capital export may raise the cost of imports or reduce costs in competing countries and thus make reaching the Turning Point difficult. Lewis notes the possibility of import of capital too. He notes that capital inflow will not generally raise wages as long as surplus labor exists, but would hasten the progress toward the Turning Point (Lewis 1954, p. 191).[26] In short, the economy of Lewis (1954) was open to factor flows and the terms of trade consequences of such flows.

In their subsequent work extending the Lewis model, synthesized in Fei and Ranis (1997), the authors propose four points, namely (i) Commercialization Point, (ii) Reversal Point, (iii) Export Substitution Point, and (iv) Switching Point. It may be observed that the list no longer includes the Shortage Point, vindicating the problems with this point mentioned earlier. Second, the Commercialization Point, as noted above, is basically the Lewis Turning Point, though Fei and

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[24] As Lewis (1972, p. 94) argues, "In order to export more it may have to lower its prices, thus squeezing its profits. Its real wages, in terms of agricultural products, are fixed by definition. If we take as given the propensity to import and the inflexibility of the agricultural sector, we can see that the possible rate of growth of such an economy is determined by its propensity to export." One can see here some influence of the "export pessimism" propounded by Raul Prebisch and others on Lewis thinking.

[25] "The country is still surrounded by other countries which have surplus labor. Accordingly, as soon as its wages begin to rise, mass immigration and the export of capital operate to check the rise." Lewis (1954, p. 190)

[26] "The importation of foreign capital does not raise real wages in countries which have surplus labor, unless the capital results in increased productivity in the commodities which they produce for their own consumption." (Lewis 1954, p. 191)

Ranis amplify on further properties of this point in the context of an open dualistic model.[27] Third, a close perusal shows that the other points identified by Fei and Ranis on the wage curve depend on particularistic assumptions and do not necessarily follow from the general construction of the Lewis model. These points also do not have particular *locus standi* or clear implications for the macro wage curves. For example, the 'Reversal Point' is reached when the traditional sector starts to witness absolute decline in its labor force. Next comes, according to Fei and Ranis, the 'Export Substitution Point,' and finally there is the 'Switching Point,' when the country becomes a net importer of agricultural goods.[28] The particularistic nature of these points is clear from the fact that not all industrializing economies are to follow the same import-substitution and export-promotion sequence and/or are destined to become net importers of agricultural goods.[29]

The above review shows that subsequent extensions by Ranis, Fei, and others do not change the Lewis model's basic prediction, which remains the Turning Point prediction.[30] However, these extensions introduce added possibilities and help to understand the likely causes that lead to these possibilities. The knowledge of these extensions should therefore prove useful in interpreting the results presented in this paper.

IV. Empirical Application of the Lewis Model

IV.1 Methodological problems in testing the prediction of the Lewis model

Many methodological problems arise in applying Lewis model to real experiences of industrialization. One of these concerns choice of appropriate empirical counterparts of the theoretical dual sectors of the Lewis economy. As noted earlier, there is considerable ambiguity

[27] Fei and Ranis (1997, p. 290) explain that commercialization "indicates the end of the surplus labor condition. From this point on, the real wage in agriculture equals the marginal product of labor, which signifies that labor is now a scarce factor and the wage increases rapidly." They further explain that the definition of this point remain unchanged for the open economy. As they put it, "this concept (of commercialization point) is also applicable to the open dualistic economy (p. 290)." See Islam and Yokota (2006, p. 108) for further details regarding Fei and Ranis notion of the Commercialization Point in an open economy.
[28] See Fei and Ranis (1997, pp. 292-97) and Islam and Yokota (2006, pp. 108-9) for further details regarding these additional turning points.
[29] Apart from trade flows, an open economy can or does witness other flows, namely of capital, technology, and even labor. As already noted, Lewis (1954) did consider factor flows, albeit in a rudimentary form, and at the very end of the article. Fei and Ranis (1997, pp. 306-319) provides a perceptive discussion of how these other flows can affect the development process of a dualistic economy.
[30] Fei and Ranis (1997, p. 283) too recognize this outcome, announcing that "domestic balanced growth remains the centerpiece of success in the open economy, even in relatively small country cases."

even with regard to the theoretical description of the dualism, with Lewis and other researchers using different terminologies to express it. No matter which of these different theoretical terminologies of dualism is preferred, there is never a perfect match between them and the empirical counterparts that may be chosen in the light of data availability and other feasibility considerations.

A second methodological problem concerns the type of labor to be studied. It is clear that the Turning Point prediction of the Lewis model concerns the wage of unskilled labor that can be easily transferred from the traditional to the modern sector. Therefore not all labor of the manufacturing sector, a part of which employ highly skilled labor, falls under the purview of the Lewis model. Yet, distinguishing unskilled labor separately within the modern sector is not always easy due to data and definitional problems.

A third problem concerns the type of wage to study given the particular type of labor that is selected for examination. As Lewis (1972, pp. 85-86) himself notes, "Real wage has many meanings." Expanding on the issue, he drew distinctions among "cost of living wage," defined as (w/c), where w is the nominal (money) wage and c is the cost of living; "factoral wage," defined as (w/a), where a is "the income of the non-capitalist worker;" "ratio of wages to prices," defined as (w/p), where p is the index of the "price received by capitalists;" product wage, defined as (wL/vQ), where L is the quantity of labor, Q is real output, and v is the value added price of output; and finally (wL/pQ) which is what product wages reduces to when no imported raw materials are used in production.

Given the multiple choices possible with regard to each of the three issues above, namely empirical counterparts of dual sectors, type of labor, and type of wage, it is clear what a bewildering variety of possible combinations a researcher has to confront in deciding about the empirical strategy for application of the Lewis model.

Another type of problem arises with regard to the marginal product. Unlike wage, which is observable, marginal product is unobservable and needs to be estimated assuming a production function and using econometric methods, an undertaking that is fraught with many conceptual and computational problems. Many scholars are averse to the very concept of production functions. Even if the concept is allowed, many issues remain with regard to its specification and estimation.

IV.2 Empirical evidence from other countries on Lewis wage curve

Despite the methodological difficulties, researchers have applied Lewis model to study industrialization experiences of different countries and produced instructive results. A quick review of this research will provide a useful background for considering the results obtained for China in this paper.

England: Lindert and Williamson (1983) and Williamson (1982) show that the real wage remained almost constant for nearly forty years (1780-1820) in England during the Industrial Revolution, with the wage in the modern sector being almost two times higher than in the traditional sector. The near constancy of the agricultural wage in the face of substantial increase in agricultural productivity after the Enclosure Movement presented additional supportive evidence of the Lewis process at work. The evidence led Lindert and Williamson to comment that "(Lewis was) right in viewing the rural sector as an industrial labor reserve such that the urban sector could draw on rural labor supplies during expansion' (Lindert and Williamson 1983 and also Fei and Ranis 1997, p. 156)." Commenting on England's experience, Fei and Ranis note that the classical economists were impressed by the stability of the real wage and saw in it the proof of the 'iron law of wages,' believing it to be ordained. However, they were soon proved wrong, because following on the heels of the classical writings, the Turing Point was reached, and the real wage started to increase sharply. By the time the Turning Point was reached, about forty-five percent of the labor force of the countryside was absorbed into England's industrial sector (Fei and Ranis 1997, p. 109)

Malaysia: The work by Huang (1971) on Malaysia shows that the marginal product of labor in agriculture increased at a significantly faster rate than the real wage in three separate regions of the country. The study also shows that the gap between the marginal product and wage decreased only when the country approached the Turning Point (Fei and Ranis 1997, p. 156).

Taiwan: A good part of the research by Fei and Ranis themselves was focused on Taiwan,[31] with results showing that while the Taiwanese agricultural real wage remained very stable for a long time (extending from 1958 to 1973), the marginal product increased steadily (since 1963). The research also showed that the Taiwanese industrial wage remained fairly stable for a long time, from 1957 until 1968, when it started to rise, and all the while remained above the

[31] See for example, Ranis (1973, 1978, 1992, and 1995) and Ranis and Fei (1975).

agricultural wage. (For details, see Fei and Ranis (1997, p. 157). Ranis (1995) also presents similar results.)[32]

Korea: Ranis (1995) provides a study of the Korean wage data showing the marginal product rising much faster than the real wage during 1960-1975. The study also shows Korean unskilled industrial wage to be higher than the agricultural wage during the period.[33]

IV.3 Empirical evidence on Turning Point in Japan

Japan occupies a special place in the literature on application of the Lewis model. The work started with Ranis (1957), showing on the basis of his findings regarding 'capital shallowing,' that Japan reached the Turning Point during the early twentieth century.[34] Disagreeing with Ranis, Minami offered a thorough application of the Lewis model to Japan's case, distinguishing the following five criteria for identifying the Turning Point:[35]

(I) Comparison between wages and marginal product of labor in the subsistence sector;

(II) Correlation between wages and marginal productivity of labor in the subsistence sector;

(III) Movements in real wages in the subsistence sector;

(IV) Changes in wage differential (between skilled and unskilled labor); and

(V) Elasticity of labor supply from the subsistence to the capitalist sector.

Minami shows that Criterion-I offers the most rigorous test of the Turing Point and dominates most of the other criteria, so that a Turning Point satisfying this criterion will also satisfy these other criteria. Minami's list of criteria also shows that in identifying the Turning Point he focuses on the traditional sector. There are several reasons for this choice. The first is the earlier noted fact that the Turning Point in the traditional sector wage curve has the logical and chronological

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[32] As Fei and Ranis (1997, p. 156) report, "Figures A3.6 and A3.7 present indices of the real wage and the marginal product of labor in the agricultural sectors of Taiwan and Japan during their well-known successful periods of transition. The indices, normalized to begin at the same point, unambiguously illustrate that in both nations the marginal product of labor in agriculture rose significantly faster than the real wage."

[33] See also Fields (1994).

[34] Fei and Ranis (1997, p. 158) presents Figure A3.7. Panel (a) showing 'Japanese agricultural real wage index' and 'Japanese agricultural marginal product-index.' It is seen that the latter always exceeds the former during the 1886-1928 period, with the gap narrowing towards the end of the period. Panel (b) of the Figure compares 'Japanese non-agricultural real wage' and 'Japanese agricultural real wage,' showing the former always to exceed the latter and the gap rising over the period (1886-1928).

[35] See Minami (1964, 1966, and 1968) for his early works on Japan. Minami (1973) compiles his research on Japan's Turning Point. Minami perceives the Turning Point prediction to be so central that he christens the Lewis model and its extensions as the 'Theory of the Turning Point.' See Minami (1973) for details.

precedence over the Turning Point in the modern sector wage curve. Second, the comparison of the marginal product and wage in the subsistence sector, as noted earlier, helps reveal the underlying process that finds reflection on the surface in the wage curves. The third advantage relates to practicality and data availability. As observed earlier, the Turning Point hypothesis applies to the wage of labor that is easily transferable from the traditional to the modern sector. From this point of view, Minami distinguishes within the modern sector three sub-sectors, namely (i) 'traditional,' (ii) 'semi-modern,' and (iii) 'modern,' and observes that it is the labor of 'traditional' and 'semi-modern' sub-sectors that is substitutable by labor of the 'agriculture' sector. By contrast, the labor of the 'modern' sub-sector, which requires a higher degree of skill, is not substitutable by agricultural labor. That is why Minami thought that "the theory of the turning point is not applicable to the 'modern sector' (Minami, 1973, pp. 69-70)."[36]

Following the classification above, the Turning Point hypothesis should be examined either in the context of the wage of the 'traditional' and 'semi-modern' sub-sectors of the 'modern' sector or in the context of the wage of the 'agriculture' sector. Unfortunately, separate wage data for the former two sub-sectors are often difficult to get, and this difficulty makes testing of the Turning Point hypothesis on the basis of the traditional sector's wage data a more appealing and feasible alternative.[37]

Having set out the criteria and explaining the reasons for focusing on the traditional sector, Minami (1973) presents a meticulous study of the Japanese agricultural wage data showing that Japan crossed the Turning Point some time during the 1950s and not during the 1920s, as claimed earlier by Ranis (1957).[38]

V. **Applying Lewis Model to China**

V.1 Particular problems with China

In applying Lewis model to China, one faces several additional problems caused by her specific institutional features. First, the theoretical 'modern-traditional' dichotomy, as already

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[36] There is a possibility of terminological confusion here. Minami uses the 'modern-subsistence' terminology to express the Lewis duality, and that is why it is not a problem for him to name a sub-sector of the modern sector as 'traditional.' This naming is however confusing from the point of view of the terminology, namely 'modern-traditional' that this paper uses to express the Lewis duality.

[37] It is not that skilled labor entirely escapes the purview of the Lewis model. Minami notices that one of the implications or predictions of the Lewis model is that the wage gap between unskilled and skilled labor will increase over time before decreasing. This is in fact his fourth criterion that can be used to find the turning point.

[38] See also the related contribution by Reubens (1964) and Yasuba (1976).

noted, is not the same as the empirical ‘urban-rural’ or ‘agriculture-industry’ dichotomy. This is more so in the case of China, because, on the one hand, her urban/modern sector has a large presence of informal enterprises using pre-industrial technologies. On the other hand, her rural economy is also heterogeneous, particularly due to the phenomenal growth of TVEs that use industrial technologies right inside what are administratively classified as rural areas. The problem is aggravated by the fact that formal boundaries of urban and rural areas in China undergo frequent changes due to administrative and political considerations, so that these boundaries often do not correspond to their expected economic content.

A second problem concerns movement of labor between traditional and modern sectors. The Lewis model assumes that the flow proceeds in an unrestricted fashion as industrialization progresses. This assumption does not hold true for China, because of its *Hukou* (household registration) system that restricts internal migration. Over time *Hukou* restrictions have been relaxed and/or modified, making internal migration easier. However, the system remains, and the situation is still not one of a free flow of labor from the traditional to the modern sector.

The *Hukou* system is actually a concrete manifestation of a more general institutional characteristic of China, namely the legacy of central planning. As noted earlier, Lewis conceived his model to explain *capitalist* growth of developing countries. That may be a reason why researchers have not been that enthusiastic about applying the Lewis model to China, even though it has been applied extensively to Japan, Taiwan, and other East Asian countries. Since wages (as are other prices) under central planning are determined by fiat/command/administrative methods, it might have been thought that Lewis model, which in a sense relies on the market rationale, was not the appropriate model to be used. However, industrialization in a dual economy faces the same economic fundamentals even when it is carried out under alternative, non-capitalist institutions. In fact, Lewis himself mentions that the experience of the (former) USSR (along with that of the UK) served for him as the empirical reference for his model.[39] Nevertheless, in considering industrialization under non-capitalist institutional frameworks, one has to keep in mind that the planners may not always go by the economic fundamentals, and instead try to impose choices inspired by political or ideological

[39] As Lewis (1972, p. 87) puts it, “When the first article was written, the historical wage data uppermost in my mind were those for the cost of living wage in Great Britain in the first half of the nineteenth century, and the USSR in the 1930s.” This may suggest that Lewis thought his model to be applicable for the analysis of industrialization in a dual economy under socialism (central planning) too.

considerations.[40] China's situation is further complicated by the fact that it is currently neither under central planning nor under entirely market conditions. It is in a transition from the former to the latter. This complex institutional context, on the one hand, makes the analysis more challenging, and on the other hand, offers more opportunities to see whether and how institutions influence the underlying economic process of industrialization and expansion of the modern sector through absorption of labor from the traditional sector.

V. 2 Empirical analysis and results

For the empirical analysis, we use Minami's Criterion-I to test the Lewis Turning Point hypothesis. The exercise requires comparison of the marginal product and wage of labor in the traditional sector, which for China we equate with the 'agriculture' sector rather than the 'rural' sector as a whole because of the already mentioned large presence of industrial enterprises in the form of TVEs in the Chinese countryside. As noted earlier, while wage is a directly observable variable, marginal product is not and requires econometric estimation based on an assumed production function. We therefore estimate an agriculture sector production function using province level data.

The standard arguments for an agricultural production function are land (R_i), labor (L_i), capital (K_i), materials (M_i), and total factor productivity (A_i), with *i* as the province subscript. To the extent that our interest is in the marginal product of labor and that data on material inputs and gross output are difficult to get, we use a production function with *value added* (instead of gross output) as the dependent variable, thus obviating the necessity of including M_i as an argument. So far as the total productivity term, A_i, is concerned, it may be assumed to have a province-specific (also systematic and time invariant) part, denoted by P_i, and a random part, denoted by υ_i, so that together, we would have: $A_i = P_i + \upsilon_i$.

Such a specification of A_i would require panel estimation to allow for province specific productivity effects P_i. However, the main purpose of the estimation in this paper is to trace out the marginal product of labor over time, so that estimation is required for each year separately,

[40] Bramall (2000) provides a good discussion of the influence of political considerations in deciding about economic matters in China during the Mao years.

thus ruling out panel estimation as an option.[41] We therefore strike a compromise and assume that systematic differences in productivity exist at the regional level, and once these differences are captured (through regional dummies), the remaining part of TFP differences can be treated as random.

There is considerable justification for this assumption. Differences in TFP in agriculture owe mainly to differences in resource endowment, climatic conditions, market opportunities, and institutions. It is well known that in these respects China differs more sharply across its regions, and less so across provinces within the same region. In view of the above, and following the general practice, we divide China into three broad regions, namely (i) Coastal, (ii) Middle, and (iii) Western, and create three dummies, DC_i, DM_i, and DW_i, respectively, to represent them. In actual estimation, we take the Middle region as the base case.

On the basis of the above, the specification that serves as the point of departure for the estimation exercise of this paper is given by Equation (1) below:

$$\ln Y_i = \beta_0 + \beta_L \ln L_i + \beta_R \ln R_i + \beta_K \ln K_i + \beta_C DC_i + \beta_W DW_i + \varepsilon_i \tag{1}$$

where Y_i is the value added, and ε_i captures not only υ_i, but other random errors.[42]

For data reasons, we limit the agriculture sector to its main part, namely the crop sub-sector.[43] The value-added data (in 100 million Yuan) are taken from *The China Rural Statistical Yearbook* of respective years and are converted into constant prices of 2000 using consumer price index (CPI) as the deflator. Other variables, including CPI, are obtained mainly from *The China Statistical Yearbook* of respective years. The labor variable, *L* (in 10,000 persons), is computed by multiplying the total number of employees in the agricultural sector by the share of crop sector in the total agriculture sector value added.[44] The land variable stands for total sown area measured in 1,000 hectares. Data on capital, not unexpectedly, is more problematic, as direct data on capital employed in the Chinese agriculture sector are not available. We use total power of agricultural machinery (in 10,000 kilo watts) as a measure of capital. The sample period runs

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[41] See Islam (1995) for arguments for panel estimation of production function in cross-country contexts.
[42] Since all the theoretically relevant variables are included in the specification, there should not be any significant omitted variable bias.
[43] In other words, fishery, forestry, and husbandry are excluded.
[44] This method of obtaining *L* is similar to what Lin (1992) used.

from 1988 to 2005 and the number of provinces is 29. The summary statistics of the data and the name of provinces included in the sample are presented in the Appendix Table A1.

We begin by estimating Equation (1) for each year of the sample period using provincial data.[45] To minimize the influence of seasonal and/or business cycle fluctuations, we use three-year moving averages of the variables. Thus, to estimate the production function for the year of 1991, we use the average for 1990, 1991 and 1992.[46] Table 1 presents the OLS results from estimation of equation (1) with standard errors computed using White's heteroskedasticity-consistent formula. Before turning to individual coefficients, we may first look at the last column, which shows results for a test of the constant returns to scale (CRS) hypothesis implying that the sum of coefficients of three inputs is equal to one. The *F*-values reported in the column indicate that the CRS assumption cannot be rejected for most of the years in the sample period. Given the divisibility of inputs (a consequence of relative lack of mechanization), the evidence for constant returns to scale is not surprising.

[Insert Table 1 around here]

Turning to the individual variables, we find that the coefficient for land proves to be highly significant for almost all years of the sample. Of the regional dummies, the coefficient for the coastal region, DC_i, proves to be highly significant for all years, while the coefficient for the western region, DW_i, proves to be insignificant. These results indicate that it is only the coastal region that enjoys higher TFP relative to the 'Middle region,' whereas there is not much difference in this regard between 'Middle' and 'Western' regions.

The disappointing side of the OLS estimation of equation (1) is that neither labor nor capital proves to be significant. The probable reasons for this insignificance are however different for these two variables. So far as capital is concerned, the insignificance can be explained by the following factors. The first is, as noted above, the general lack of mechanization of the Chinese agriculture, so that the capital requirement is not that high, a fact that actually justifies taking agriculture sector as the 'traditional' sector. Second, the variable (namely the power of agricultural machinery) used to proxy for capital may not be very satisfactory, though other

[45] We use data for all the provinces, except for Tibet and the newly created province of Chongqing, for which necessary data were not available. Given the almost full coverage of provinces, the estimation presented in this paper should not have any selection bias

[46] For the sample period's last year, namely 2005, we use the average for 2004 and 2005.

possible measures, such as the number of large- and medium-sized tractors, do not perform any better. In general, the lack of significance of the capital coefficient agrees well with the general observation, made earlier by Lin (1992, Table 5, p.43), that capital equipments as yet play a relatively minor role in the Chinese agriculture.

Unlike for capital, the reason for insignificance of the labor coefficient seems to be statistical, arising from collinearity between land and labor. The correlation coefficient between these two variables in the sample data is found to be 0.949. In view of this very high degree of correlation, insignificance of labor may not be surprising.

In order to carry forward the estimation in face of the problems above, we take several steps. The first is to drop capital from the equation, as this will help to gain efficiency, if not anything else. So far as the multicollinearity problem is concerned, we adopt two alternative strategies. The first is to convert Equation (1), which is in aggregate terms, into per labor terms, so that instead of two separate variables, we now have one explanatory variable, namely per labor land. As a result of the above changes, the re-specified production function now takes the following form of Equation (2):

$$\ln\left(Y_i / L_i \right) = \beta_0 + \beta_R \ \ln\left(R_i / L_i \right) + \beta_C DC_i + \beta_W DW_i + \varepsilon_i \ . \qquad (2)$$

OLS is used again to estimate Equation (2), and Table 2 presents the results. Based on earlier support for the CRS assumption, the coefficient for labor, β_L, can be obtained as (1- β_R). Once again the coefficient, β_R, of "per labor land" variable proves significant, and this significance by and large carries over to β_L, the coefficient of labor.

The above strategy of obtaining coefficient of labor may however appear to be contrived. As a further check on the issue, we therefore adopt a second strategy, under which the production function remains specified in level terms, but is now estimated using both cross-sectional and time-series data. We already used three-year moving averages for estimation of the production function (both Equation (1) and (2)) to avoid influence of year to year fluctuations. What we do now instead is to pool data for those three years, and carry out a pooled estimation, so as to allow both the cross section and time series variation in the data to play put in the estimation process more directly and in a more comprehensive manner in order to counteract the multicollinearity.

Thus, to estimate the equation for 1990, we pool data for 1989, 1990, and 1991. We however allow year dummies to control for year-specific common effects. This second strategy therefore requires estimation of the following Equation (3):

$$\ln Y_{it} = \beta_0 + \beta_L \ln L_{it} + \beta_R \ln R_{it} + \beta_C DC_i + \beta_W DW_i + year\, effects + \varepsilon_{it}\,, \qquad (3)$$

where *i* and *t* stand for province and year, respectively, and time effects are binary variables to represent the year to which the data belongs.

The results from the pooled estimation are presented in Table 3. This estimation strategy provides separate estimates of coefficients of both land and labor, and we now see that, the coefficient of labor also proves significant for most of the years of the sample period. The coefficient of land, as previously, proves significant for all years. Also, the general nature of results with regard to the regional dummies remains unchanged. Once again, we find the coastal dummy, DC_i, to be significant, while the western dummy, DW_i, to be not.

One general contention against estimation of production functions concerns endogeneity. It is argued that in a given year the output values may exert feedback effect on input levels, so that contemporaneous input values will be endogenous. So far as agricultural (crop sector) is concerned, this contention is more likely to be true in situations of multiple cropping, i.e. when several crops are cultivated during the same year. In such situations, the output level of the crop of the previous season may influence the amount of land and labor devoted to the production of the next season’s crop of the same year, thus creating an endogeneity problem. To the extent that multiple cropping in China is not as prevalent as in some other countries, the suspected endogeneity problem may not be that serious. However, to check on the issue, we re-estimate both Equations (2) and (3) using lagged values of inputs as instruments. Lagged values are likely to be good instruments as they are expected to be highly correlated with current values of input, and yet current output values are not likely to have exerted influence on past input values. The results from such instrumental variable (IV) estimation of Equations (2) and (3) are presented in Table 4. What we see is that, despite differences in details, the IV estimation results prove to be similar to the OLS results, thus indicating that the problem of endogeneity may not be a very serious one.

Having dealt with the broader issues of estimation, we may now pay some attention to the estimated values of the coefficients of different variables. Based on the results presented in Tables 1-4, we can make the following observations:

First, the coefficient of land dominates the results, not only in terms of significance, but also magnitude of coefficient values, which in case of OLS results for Equation (3) vary from 0.66 to 0.92. The coefficient of labor, by comparison, ranges from 0.08 to 0.24. Given the log-log specification, the coefficients also represent the shares in value added of the respective inputs. The results therefore suggest that land is still the overwhelming claimant of value created in Chinese agriculture, with labor receiving a relatively minor share. However, to the extent that the Chinese agriculture is now predominantly household "owned" and operated, the value added imputed to land actually accrues to the farm household members, who are also generally the suppliers of labor. The results therefore show that a large part of the income of agricultural households is of non-labor source.

Second, looking over time, we see that up until 1997, the share of land displayed an increasing trend. Since then land's share has witnessed some decrease, though there seems to be a rebound in this regard in the very recent years. The share of labor, as is expected, displays mirror opposite dynamics, decreasing up to 1997 and then increasing, even though there is a downward trend in the very recent years.

Third, the impact of regional differences in productivity seems to be increasing over time. Looking at the OLS results for Equation (3), we see that the value of the coastal dummy coefficient has steadily increased from 0.43 to 0.69 over the sample period. These results also show significant coefficient for western region dummy, DW_i, for some of the years. However, in each case the coefficient is negative, showing that the western region lags behind in agricultural productivity, compared to not only the coastal region but also the middle region. Rising regional inequality in China is a well known fact. What these results point out is that a part of that regional inequality may be arising from rising differences in agricultural productivity across regions.

Having dealt with issues concerning estimation and having established the general nature of the results, we may now use them to compute the marginal product of labor. Given the Cobb-Douglas specification, the marginal product of labor at time *t* (MP_L^t) can be obtained using the relationship: $MP_L^t = \beta_L \; AP_L^t$, where AP_L^t is the average product at time *t*, given in this case by

$\left(Y/L\right)$. Table 5 presents the values of AP_L^t and the estimated values of MP_L^t obtained from different specifications of the production function and difference methods of estimation. We see that the average value added (AP_L^t) has witnessed a steady increase from 2061.8 Yuan in 1989 to 7987.6 Yuan in 2005 (despite some fluctuations in the late 1990s).

The estimated values of the marginal product vary, as expected, depending on the chosen specification and estimator. For example $MP_L 1$, the marginal product obtained from OLS estimation of Equation (1), increased, from 478.3 Yuan in 1989 to 1453.7 Yuan in 2005, with some checkered dynamics in between. $MP_L 2$, the marginal product of labor computed on the basis of OLS estimation of Equation (2), increases from 257.7 Yuan in 1989 to 1294.0 Yuan in 2005. $MP_L 3$, the marginal product of labor obtained from pooled estimation of Equation (3) increases from 503.1 in 1989 to 1278.0 in 2005. These various sets of estimates appear to differ mainly by constant differentials, rather than by the extent of increase over time. Thus in all these three cases the marginal product seem to increase by about 800 Yuan over the entire period. Also, the intra-period dynamics are similar. The rate of increase in the marginal product tends to be sluggish up to 1995 and then quickens afterwards. $MP_L 4$ and $MP_L 5$, marginal product of labor computed on the basis of IV estimation of Equations (2) and (3), respectively, also agree, by and large, with the above trends and features.

Having obtained the estimated values of the marginal product, we may now turn to the comparison with wage. To facilitate this comparison, Table 5 presents the data on real wages too. Before commenting on the comparison, a few words regarding the wage data may be in order. Data on real wage in the agriculture sector is actually hard to obtain. We therefore use average net income per labor in the farming sector as a proxy for real agricultural wage, and calculate it using the following formula:

$$\text{Real Wage} = \left(F * \overline{N}\right) / \left(\overline{L} * p\right),$$

where, F is the net per capita income in the agriculture sector, $\overline{N}$ is the average number of persons in a family, $\overline{L}$ is the average number of laborers in a family, and p is the deflator, taken to be equal to the consumer price index. All these variables are national averages and data on them for different years of the sample period are obtained from respective issues of *The China Rural Statistical Yearbook.*

We calculate the real wages in two ways. The first, denoted by $w1$, is the *simple* average of provincial wage rates. The second, denoted by $w2$, is the *weighted* average of provincial wage rates, with the provincial labor force size as the weight. In other words, we have $w1 = \frac{1}{n}\sum_{i=1}^{n}\overline{w}_i$, and $w2 = \frac{\sum_{i=1}^{n}\overline{w}_i \cdot L_i}{\sum_{i=1}^{n}L_i}$, where n is the number of provinces, which equals 29 in our case, $\overline{w}_i$ is the average wage rate for province i, and L_i is the number of laborers in province i. The computation is done for each year of the sample period.

Looking at the results, we see that the wages have increased over time, from 851.1 Yuan in 1989 to 1560.4 Yuan in 2005, as measured by $w1$, and from 778.6 Yuan to 1392.4 Yuan, as measured by $w2$, over the same period. The fact that $w2$ values proved to be lower than $w1$ points to the fact that more people live in low wage provinces than the converse, and thus provides another manifestation of regional inequality in China.

What the wage figures show is that the traditional sector wage curve in China was not completely horizontal. This should however not be surprising, because the Lewis model does not rule out some increase in wage even before the Turning Point is reached.[47] The traditional sector neither remains nor is it expected to remain as placid in practice as is often assumed in Lewis theory. In reality, it may witness some capital accumulation and technological upgrading, leading to a rise in productivity (outward shift of the production function). In fact, as Ranis and Fei emphasize, some improvements in the productivity of the traditional sector is necessary for the progress toward the Turning Point not to get aborted. Improvements in productivity may lead to increases in wage.

Thus we see that both marginal product and wage have increased. What is now necessary is to examine the relative pace of increase, in particular, whether marginal product is increasing at a faster rate than wage. From this point of view of this comparison, we notice that the average annual rate of increase of $w1$ and $w2$ over the sample period is 3.51 and 3.42 percent,

[47] As Lewis (1972, p. 93) explains, "Real wages cannot be constant if agricultural productivity is rising significantly, since this would be moving the factoral terms of trade against industry. So what will happen to profits in any particular case will depend on a race between agricultural productivity, industrial productivity, real wages (which may rise on their own for exogenous reasons), and the commodity terms of trade. If one makes precise assumptions about these magnitudes one can get precise answers, as Fei and Ranis have done."

respectively. By comparison, the marginal product of labor, as measured by, MP_L1, MP_L2, and MP_L3 has increased over the same period at the average annual rate of 6.54, 9.49, and 5.48 percent, respectively. Similarly, MP_L4 and MP_L5 have increased by an average annual rate of 8.71, and 5.15 percent, respectively, over 1990-2005 period. Thus even the lowest measures of rate of increase of marginal product, as obtained from MP_L1 to MP_L3, are much higher than the wage growth rate.

There is also a marked contrast between wages and marginal product of labor from the view point of intra-period dynamics. We can see that wages increased at a brisk pace until 1996, after which these stagnated. As can be seen from the lower panel of Table 5, the average annual growth rate of *w*1 and *w*2 for 1989-1996 sub-period is 7.70 and 7.69, respectively. The rates slowed down to -0.20 and -0.34, respectively, during the 1996-2005 sub-period. We find a mirror-opposite picture with regard to marginal product of labor. The average annual growth rate of marginal product of labor, as measured by MP_L1, MP_L2, and MP_L3 for 1989-1996 sub-period prove to be -2.39, 4.00, and -3.27, respectively. Similarly, the average annual growth rate of MP_L4 and MP_L5 for 1990-1996 sub-period prove to be 3.28 and -2.73, respectively (Table 5, lower panel). For the 1996-2005 sub-period, the analogous growth rates of MP_L1, MP_L2, MP_L3, MP_L4, and MP_L5 are 13.02, 12.94, 11.94, 11.63, and 10.14, respectively. Thus the second sub-period's rates prove to be about 3.23 to 6.46 times greater that those of the first sub-period.

Overall, as noted above, marginal product is found to have increased at a much faster pace (at least 1.5 times faster) than wages.

The results presented in the Tables and described above are presented in the form of a graph, as depicted in Figure 3. It plots the two wages and all five measures of marginal product of labor on the same axes. The graph helps us to see the following aspects of the results more clearly. First, for the entire sample period, Chinese agricultural wages have increased, though much of this increase was achieved during the first sub-period, followed by stagnation in the second sub-period. Second, marginal product of labor, for the sample period as a whole, has increased at a much faster rate than did wages. In contrast to wages, marginal product has increased at a more rapid pace during the second sub-period and did not increase much during the first sub-period. Third, as a result of the overall faster pace of increase, marginal product curve is catching up with the wage curve, though as a whole the former still remains below the latter. These qualitative results remain robust with respect to the choice of wage rate and measure of marginal product of labor.

From a broader point of view, the analysis of this paper vindicates the usefulness of the Lewis model for analyzing China's industrialization process. We do see a departure of the wage rate from marginal product in China's traditional (agricultural) sector. We also see that over time, as more labor gets transferred from agriculture to industry, the marginal product increases at a much faster rate than the wages do. We see that over time the gap between wage and marginal product is narrowing, so that it may be concluded that China is steadily moving toward the Lewis Turning Point.

These findings correspond well with the general perception among scholars and Chinese policy makers about China's labor situation. This perception has two sides. On the one hand, scholars point to the fact that China still faces an enormous challenge of finding more productive employment for a huge pool of underutilized rural labor.[48] On the other hand, many observers point to a tightening of the labor market in particular areas, particularly in southern coastal cities and the consequent rise in the wage rate in those areas. The reason behind these apparently contradictory phenomena lies to a great extent in China's huge size and the administrative restrictions (such as *Hukou* etc.) on internal migration that still exist. In view of these two factors, it is quite possible to experience labor shortage and wage rise in coastal urban economies while vast amounts of under-utilized labor still existed in China's hinterland.

The question that may be of interest here is why in Chinese agriculture the wage rate proves to be greater than the marginal product. In pondering about this question, it may be noted that in post reform China, with the dissolution of Communes, agriculture has come to be dominated by family farming. Facing abundant labor, it is quite rational on the part of these farms to engage in 'output maximizing' rather than 'profit maximizing behavior,' and thus to push the marginal product to low levels. Second, despite their dissolution, the tradition of Communes and the

[48] Gang (2005, p. 17), the prominent Chinese economist, formulated China's long term challenge recently in the following way: "The real long term challenge is to create enough jobs for the rural people. Recently, I did some calculations with reference to agriculture and agricultural employment, in Japan, the US, and Australia. Using their experience as guidance, China eventually may only need, approximately 40-60 million farmers to farm the relatively small area of cultivable land in China – which means that in the long run, over the next 40-50 years, a total of 300-400 million people should be relocated from agriculture to the non-farming sector. But the present situation is that in each year, at the current level of technological progress, we shall only create 10-12 million new jobs. This means that over the long term, even with rapid GDP growth, there will still be a huge under-employment situation in rural areas and even more people will flock to the cities looking for jobs."

recent socialist past can have a lingering effect allowing the ‘kinship rule of distribution’ to have a greater influence in the agriculture of China than in the agriculture of many other ‘labor surplus’ developing countries.

Whatever the reason for wages to be higher than marginal product in the Chinese agriculture, the findings of this paper indicate that the marginal product is catching up with wage, so that with continuation of this trend, caused by further transfer of labor from the traditional (agricultural) sector to the modern (industrial) sector, the two will equalize. China will cross the Lewis Turning Point, and the “surplus labor” stage of its development will come to an end.

VI. Conclusions

Casual observations suggest that China, more than many other developing countries, displays the characteristics that the Lewis model tries to capture. Yet, very few attempts have been made to study China’s industrialization from the viewpoint of the Lewis model. Earlier, using a graphical analysis, Islam and Yokota (2006) found that the China’s wage curves appeared to conform to the Lewis model’s Turning Point prediction. This paper takes the analysis to a deeper level by applying Minami’s Criterion-I to test for the presence of the Turning Point in China’s wage curves. To implement the test, the paper estimates an aggregate production function for the Chinese agricultural sector, which is taken as the empirical counter part of the ‘traditional sector’ of the Lewis model, and computes the marginal product of labor for each year of the 1989-2005 sample period. The estimated values of the marginal product are then compared with the wage of corresponding years. The results show that the marginal product has increased (from below) faster than wage, as envisaged by the Lewis model, so that the gap between the two has narrowed over time. The findings therefore indicate that China is gradually moving toward the Lewis Turning Point though has not crossed that point yet. Such a conclusion agrees with the general perception of China observers. At a broader level, the analysis indicates that the Lewis model, with its assumption of dualism, conforms better to the reality of labor-abundant developing countries, such as China, than the neoclassical model that assumes perfect mobility and equality of factor returns across sectors.

Many weaknesses however remain in this study. First of all, there are generic problems with application of the Lewis model, such as difficulty in finding empirical sectors that correspond to the duality of the theory, ambiguity regarding the type of wage to examine, and conceptual and econometric problems with estimation of marginal product. In case of China, these generic problems are aggravated by specific problems arising from her special institutional characteristics, such as legacy of central planning, persistence of *Hukou* (household registration) system restricting mobility of labor, arbitrary and frequently changing definition of urban and rural areas, and weak statistical system.

In implementing Minami's Criterion-I, this paper faced particular problems regarding data on capital and wage of the agricultural sector. Direct data on agricultural capital stock are absent, so that one has to resort to proxies, none of which is entirely satisfactory. There is also no direct data on agricultural wage. This is in part due to the institutional setting of China's agriculture, which has switched from collective farming under Communes to household farming. Use of hired labor is therefore limited, and open labor markets with transparent wage setting are rare. The absence of explicit wage rates makes it necessary to use substitutes, such as the average income per labor, though such a substitution has its own theoretical and practical implications. Future studies can try to overcome these limitations arising from data problems.

Future studies may also focus on regional variation with regard to the Lewis growth process. China is a huge country, both in terms of population and size, so that behind the dynamics revealed by the aggregate, national data, there may be a lot of regional specifics. Some of these specifics have been alluded to in this paper, but they require fuller examination. Also remain to be more fully examined are issues concerning the impact of the administrative restrictions on internal mobility and other institutional specifics of China.

Despite these limitations, the exercise presented in this paper shows that Lewis model does provide a useful paradigm to understand China's industrialization process, and it may be hoped that researchers will make more use of it in future for both China and other labor abundant developing countries.

Table 1 Results from OLS estimation of Equation (1)

Equation (1): $\ln Y_i = \beta_0 + \beta_L \ln L_i + \beta_R \ln R_i + \beta_K \ln K_i + \beta_C DC_i + \beta_W DW_i + \varepsilon_i$

Year	ln L	ln R	ln K	DC	DW	Adj. R-sq	*F*-test	Obs.
1989	0.232	0.598	0.092	0.379	-0.135	0.92	1.13	29
	(0.145)	(0.241)**	(0.175)	(0.165)**	(0.147)		(0.300)	
1990	0.201	0.658	0.086	0.397	-0.100	0.92	0.54	29
	(0.148)	(0.240)**	(0.173)	(0.164)**	(0.148)		(0.468)	
1991	0.133	0.804	0.033	0.431	-0.083	0.91	0.14	29
	(0.154)	(0.244)***	(0.174)	(0.167)**	(0.153)		(0.709)	
1992	0.141	0.854	-0.033	0.520	-0.078	0.92	0.24	29
	(0.146)	(0.229)***	(0.167)	(0.163)***	(0.149)		(0.632)	
1993	0.134	0.887	-0.069	0.514	-0.131	0.92	0.43	29
	(0.141)	(0.214)***	(0.156)	(0.159)***	(0.144)		(0.521)	
1994	0.136	0.874	-0.049	0.522	-0.155	0.93	0.30	29
	(0.140)	(0.206)***	(0.148)	(0.157)***	(0.143)		(0.589)	
1995	0.085	0.939	-0.051	0.515	-0.148	0.93	0.16	29
	(0.139)	(0.196)***	(0.134)	(0.146)***	(0.136)		(0.689)	
1996	0.098	0.940	-0.049	0.515	-0.139	0.94	0.04	29
	(0.136)	(0.186)***	(0.122)	(0.138)***	(0.132)		(0.850)	
1997	0.096	0.969	-0.082	0.530	-0.123	0.95	0.08	29
	(0.135)	(0.180)***	(0.112)	(0.129)***	(0.126)		(0.783)	
1998	0.134	0.967	-0.118	0.571	-0.129	0.94	0.08	29
	(0.141)	(0.184)***	(0.113)	(0.131)***	(0.128)		(0.774)	
1999	0.149	0.982	-0.152	0.644	-0.129	0.94	0.13	29
	(0.144)	(0.188)***	(0.113)	(0.133)***	(0.128)		(0.722)	
2000	0.198	0.946	-0.168	0.680	-0.153	0.94	0.17	29
	(0.144)	(0.186)***	(0.114)	(0.136)***	(0.130)		(0.680)	
2001	0.232	0.893	-0.162	0.688	-0.181	0.94	0.42	29
	(0.142)	(0.183)***	(0.112)	(0.138)***	(0.131)		(0.525)	
2002	0.210	0.889	-0.144	0.689	-0.169	0.94	0.66	29
	(0.140)	(0.178)***	(0.111)	(0.137)***	(0.130)		(0.423)	
2003	0.197	0.906	-0.142	0.696	-0.162	0.94	0.52	29
	(0.137)	(0.175)***	(0.109)	(0.135)***	(0.129)		(0.478)	
2004	0.180	0.966	-0.200	0.682	-0.148	0.93	0.91	29
	(0.145)	(0.188)***	(0.121)	(0.146)***	(0.140)		(0.349)	
2005	0.182	0.971	-0.166	0.739	-0.127	0.95	0.07	29
	(0.131)	(0.171)***	(0.111)	(0.134)***	(0.129)		(0.800)	

Notes: Results for the constant term (β_0) are not reported to save space. Symbols *,**, and *** indicate that the estimated coefficient is significant at 10, 5, and 1 percent significance level, respectively. The numbers in parentheses (except those in the column for *F*-test) are White's heteroskedasticity-consistent standard error estimates. The *F*-values in the last but one column are from the test of the null hypothesis $H_0 : \beta_1 + \beta_1 + \beta_3 = 1$, implying constant returns to scale (CRS). Values in the parentheses in this column are corresponding *p*-values. Estimation is based on three-year moving averages of the variables.

Table 2 Results from OLS estimation of Equation (2)

Equation (2): $\ln\left(Y_i/L_i\right) = \beta_0 + \beta_R \ln\left(R_i/L_i\right) + \beta_C DC + \beta_W DW + \varepsilon_i$

Year	ln R/L	(ln L)	DC	DW	Adj. R-sq	Obs.
1989	0.875	0.125	0.517	-0.071	0.74	29
	(0.130)***		(0.127)***	(0.131)		
1990	0.883	0.117	0.507	-0.054	0.75	29
	(0.127)***		(0.126)***	(0.129)		
1991	0.909	0.091	0.480	-0.057	0.76	29
	(0.128)***		(0.127)***	(0.131)		
1992	0.893	0.107	0.533	-0.045	0.78	29
	(0.121)***		(0.124)***	(0.127)		
1993	0.905	0.095	0.510	-0.088	0.79	29
	(0.119)***		(0.121)***	(0.125)		
1994	0.899	0.101	0.525	-0.120	0.80	29
	(0.118)***		(0.118)***	(0.123)		
1995	0.939	0.061	0.504	-0.123	0.83	29
	(0.117)***		(0.113)***	(0.117)		
1996	0.912	0.088	0.493	-0.126	0.83	29
	(0.116)***		(0.108)***	(0.113)		
1997	0.919	0.081	0.494	-0.103	0.83	29
	(0.116)***		(0.103)***	(0.109)		
1998	0.886	0.114	0.519	-0.105	0.81	29
	(0.124)***		(0.106)***	(0.112)		
1999	0.878	0.122	0.578	-0.100	0.80	29
	(0.129)***		(0.109)***	(0.115)		
2000	0.837	0.163	0.610	-0.120	0.79	29
	(0.132)***		(0.113)***	(0.118)		
2001	0.814	0.186	0.636	-0.138	0.80	29
	(0.131)***		(0.115)***	(0.120)		
2002	0.841	0.159	0.663	-0.119	0.80	29
	(0.131)***		(0.114)***	(0.119)		
2003	0.845	0.155	0.670	-0.116	0.81	29
	(0.128)***		(0.113)***	(0.118)		
2004	0.872	0.128	0.656	-0.079	0.76	29
	(0.142)***		(0.126)***	(0.132)		
2005	0.838	0.162	0.682	-0.096	0.80	29
	(0.127)***		(0.114)***	(0.120)		

Notes: Results for the constant term (β_0) are not reported to save space. Symbols *,**, and *** indicate that the estimated coefficient is significant at 10, 5, and 1 percent significance level, respectively. Numbers in parentheses are White's heteroskedasticity-consistent standard error estimates. Estimated values of β_L , the coefficient for (ln*L*) are calculated from $1-\beta_R$. Estimation is based on three-year moving averages of the variables.

Table 3 Results from pooled estimation of Equation (3)

Equation (3): $\ln Y_{it} = \beta_0 + \beta_L \ln L_{it} + \beta_R \ln R_{it} + \beta_C DC_i + \beta_W DW_i + year\ \ effects + \varepsilon_{it}$

Year	ln L	ln R	DC	DW	Adj. R-sq	Obs.
1989	0.244	0.655	0.432	-0.154	0.92	87
	(0.082)***	(0.104)***	(0.079)***	(0.080)*		
1990	0.216	0.705	0.445	-0.119	0.92	87
	(0.083)**	(0.107)***	(0.080)***	(0.081)		
1991	0.134	0.829	0.449	-0.087	0.92	87
	(0.085)	(0.109)***	(0.080)***	(0.082)		
1992	0.147	0.820	0.505	-0.070	0.92	87
	(0.081)*	(0.105)***	(0.080)***	(0.081)		
1993	0.136	0.830	0.481	-0.117	0.93	87
	(0.078)*	(0.101)***	(0.077)***	(0.078)		
1994	0.135	0.835	0.498	-0.145	0.93	87
	(0.076)*	(0.098)***	(0.076)***	(0.077)*		
1995	0.089	0.891	0.487	-0.142	0.94	87
	(0.076)	(0.096)***	(0.072)***	(0.074)*		
1996	0.096	0.902	0.491	-0.130	0.94	87
	(0.074)	(0.092)***	(0.069)***	(0.071)*		
1997	0.083	0.917	0.493	-0.103	0.95	87
	(0.073)	(0.091)***	(0.066)***	(0.069)		
1998	0.118	0.884	0.521	-0.103	0.94	87
	(0.078)	(0.095)***	(0.069)***	(0.071)		
1999	0.135	0.864	0.579	-0.102	0.94	87
	(0.082)	(0.099)***	(0.072)***	(0.073)		
2000	0.179	0.817	0.607	-0.126	0.94	87
	(0.081)**	(0.097)***	(0.074)***	(0.074)*		
2001	0.205	0.780	0.621	-0.151	0.94	87
	(0.079)**	(0.095)***	(0.074)***	(0.073)**		
2002	0.193	0.780	0.632	-0.146	0.94	87
	(0.078)**	(0.092)***	(0.074)***	(0.073)**		
2003	0.179	0.799	0.646	-0.136	0.94	87
	(0.076)**	(0.089)***	(0.073)***	(0.072)*		
2004	0.156	0.838	0.685	-0.089	0.94	87
	(0.075)**	(0.087)***	(0.074)***	(0.073)		
2005	0.160	0.845	0.687	-0.090	0.95	58
	(0.091)*	(0.105)***	(0.091)***	(0.088)		

Notes: Results for the constant term (β_0) are not reported to save space. Symbols *,**, and *** indicate that the estimated coefficient is significant at 10, 5, and 1 percent significance level. The numbers in parentheses are White's heteroskedasticity-consistent standard error estimates. Estimation is carried out on the basis of three years' (with one year before and after of the year in question) pooled data, so that, with 29 provinces, the number of observations is 87 for every year, except for 2005, for which data for 2004 and 2005 data are used.

Table 4 Results from Instrumental Variable (IV) estimation of Equations (2) and (3)

Equation (2): $\ln\left(Y_i/L_i\right) = \beta_0 + \beta_R \ln\left(R_i/L_i\right) + \beta_C DC + \beta_W DW + \varepsilon_i$,

Equation (3): $\ln Y_{it} = \beta_0 + \beta_L \ln L_{it} + \beta_R \ln R_{it} + \beta_C DC_i + \beta_W DW_i + year\ \ effects + \varepsilon_{it}$

	IV Estimation of Eqaution (2)					IV Estimation of Equation (3)					
	ln R/L	(ln L)	Adj. R-sq	Obs.	*F* -test (R/L)	ln L	ln R	Adj. R-sq	Obs.	*F* -test (L)	*F* -test (R)
1990	0.867	0.133	0.75	29	7349.5***	0.219	0.701	0.92	87	21821.7***	1.40E+05***
	(0.128)***					(0.084)**	(0.108)***				
1991	0.899	0.101	0.76	29	6472.9***	0.139	0.822	0.92	87	16889.1***	1.30E+05***
	(0.128)***					(0.085)	(0.110)***				
1992	0.892	0.108	0.78	29	2980.1***	0.138	0.833	0.92	87	10604.4***	73343.6***
	(0.122)***					(0.082)*	(0.107)***				
1993	0.908	0.092	0.79	29	6552.1***	0.127	0.843	0.93	87	6993.6***	76794.1***
	(0.119)***					(0.080)	(0.103)***				
1994	0.900	0.100	0.80	29	7417.3***	0.128	0.845	0.93	87	7388.5***	63447.0***
	(0.118)***					(0.078)	(0.100)***				
1995	0.914	0.086	0.83	29	2317.9***	0.109	0.869	0.94	87	5465.8***	1.00E+05***
	(0.118)***					(0.077)	(0.097)***				
1996	0.901	0.099	0.83	29	4246.9***	0.107	0.890	0.94	87	2955.2***	23829.2***
	(0.116)***					(0.075)	(0.094)***				
1997	0.910	0.090	0.83	29	3060.2***	0.089	0.911	0.95	87	2754.6***	24675.5***
	(0.116)***					(0.075)	(0.092)***				
1998	0.879	0.121	0.81	29	2181.8***	0.114	0.890	0.94	87	4692.0***	24850.6***
	(0.125)***					(0.080)	(0.097)***				
1999	0.872	0.128	0.80	29	3704.3***	0.124	0.879	0.94	87	5591.5***	18399.6***
	(0.130)***					(0.084)	(0.101)***				
2000	0.839	0.161	0.79	29	3417.4***	0.166	0.834	0.94	87	15775.4***	28612.7***
	(0.132)***					(0.082)**	(0.099)***				
2001	0.829	0.171	0.80	29	3645.0***	0.182	0.809	0.94	87	22667.2***	23660.1***
	(0.132)***					(0.080)**	(0.096)***				
2002	0.858	0.142	0.80	29	2812.0***	0.166	0.812	0.94	87	14747.1***	26854.9***
	(0.131)***					(0.079)**	(0.093)***				
2003	0.856	0.144	0.81	29	3669.6***	0.159	0.824	0.94	87	15983.6***	35568.6***
	(0.129)***					(0.077)**	(0.090)***				
2004	0.889	0.111	0.76	29	3178.7***	0.134	0.862	0.94	87	15877.1***	51233.7***
	(0.142)***					(0.076)*	(0.088)***				
2005	0.840	0.160	0.80	29	13850.3***	0.149	0.857	0.95	58	14703.6***	36102.9***
	(0.127)***					(0.091)	(0.105)***				

Notes: Lagged values of the corresponding variables are used as instruments. Symbols *,**, and *** indicate that the estimated coefficient is significant at 10, 5, and 1 percent significance level, respectively. The numbers in parentheses are White's heteroskedasticity-consistent standard error estimates. Estimated values of β_L, the coefficient for (*ln*L), are calculated from $1-\beta_R$. *F*-test (R/L), *F*-test (L), and *F*-test (R) represent *F*-values for first stage OLS estimation of the equations: $\ln\left(R_{it}/L_{it}\right) = \alpha_0 + \alpha_R \ln\left(R_{i,t-1}/L_{i,t-1}\right) + \varepsilon_{it}$,

$\ln L_{it} = \alpha_0 + \alpha_L \ln L_{i,t-1} + \alpha_R \ln R_{i,t-1} + \varepsilon_{it}$, and $\ln R_{it} = \alpha_0 + \alpha_L \ln L_{i,t-1} + \alpha_R \ln R_{i,t-1} + \varepsilon_{it}$, respectively. Results for the constant term (β_0), regional dummies, and the time effects are not reported to save space.

Table 5 Marginal product of labor and real wage

Year	Average Product of Labor	Marginal Product of Labor					Real Wage	
	APL	*MPL1*	*MPL2*	*MPL3*	*MPL4*	*MPL5*	*w1*	*w2*
1989	2061.8	478.3	257.7	503.1	-	-	859.1	778.6
1990	2385.4	479.5	279.1	515.2	317.3	522.4	1036.3	920.8
1991	2385.4	317.3	217.1	319.6	240.9	331.6	1134.1	1003.9
1992	2559.4	360.9	273.9	376.2	276.4	353.2	1131.3	987.3
1993	2788.2	373.6	264.9	379.2	256.5	354.1	1254.6	1114.3
1994	3544.7	482.1	358.0	478.5	354.5	453.7	1322.0	1181.5
1995	4227.3	359.3	257.9	376.2	363.6	460.8	1494.9	1351.6
1996	4033.0	395.2	354.9	387.2	399.3	431.5	1591.1	1440.7
1997	4790.9	459.9	388.1	397.6	431.2	426.4	1500.2	1399.2
1998	4656.7	624.0	530.9	549.5	563.5	530.9	1499.5	1389.9
1999	4585.1	683.2	559.4	619.0	586.9	568.6	1430.9	1331.1
2000	4638.3	918.4	756.0	830.3	746.8	770.0	1346.1	1240.7
2001	4947.3	1147.8	920.2	1014.2	846.0	900.4	1391.1	1275.8
2002	5289.3	1110.7	841.0	1020.8	751.1	878.0	1393.2	1265.9
2003	5990.7	1180.2	928.6	1072.3	862.7	952.5	1374.0	1236.3
2004	7320.0	1317.6	937.0	1141.9	812.5	980.9	1535.0	1384.4
2005	7987.6	1453.7	1294.0	1278.0	1278.0	1190.1	1560.4	1392.4
			Average Annual Growth Rates (%)					
1989-1996	8.39%	-2.39%	4.00%	-3.27%	3.28%	-2.73%	7.70%	7.69%
1996-2005	6.83%	13.02%	12.94%	11.94%	11.63%	10.14%	-0.20%	-0.34%
1989-2005	7.97%	6.54%	9.49%	5.48%	8.71%	5.15%	3.51%	3.42%

Notes:

$MP_L 1$ is obtained from OLS estimation of Equation (1) as shown in Table 1.

$MP_L 2$ is obtained from OLS estimation of Equation (2) as shown in Table 2.

$MP_L 3$ is obtained from pooled estimation of Equation (3) as shown in Table 3.

$MP_L 4$ is obtained from Instrumental Variable (IV) estimation of Equation (2) as shown in Table 4.

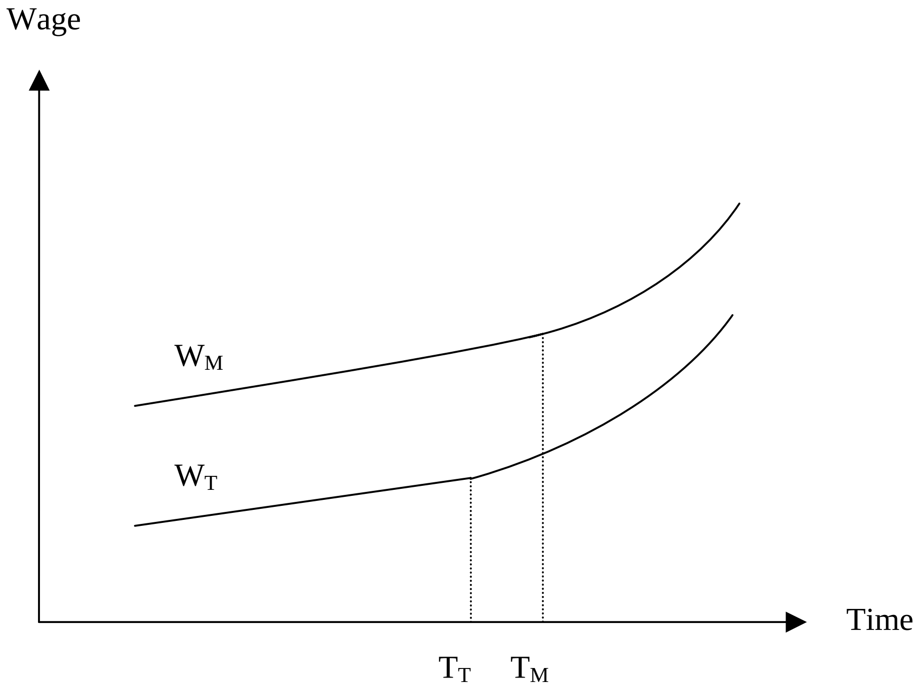
$MP_L 5$ is obtained from Instrumental Variable (IV) estimation of Equation (3) as shown in Table 4.

Average annual growth rates for $MP_L 4$ and $MP_L 5$ are calculated for the periods of 1990-1996, and 1990-2005.

The wage variables, namely *w*1 and *w*2, are simple and weighted averages of provincial wages, computed using the following formula:

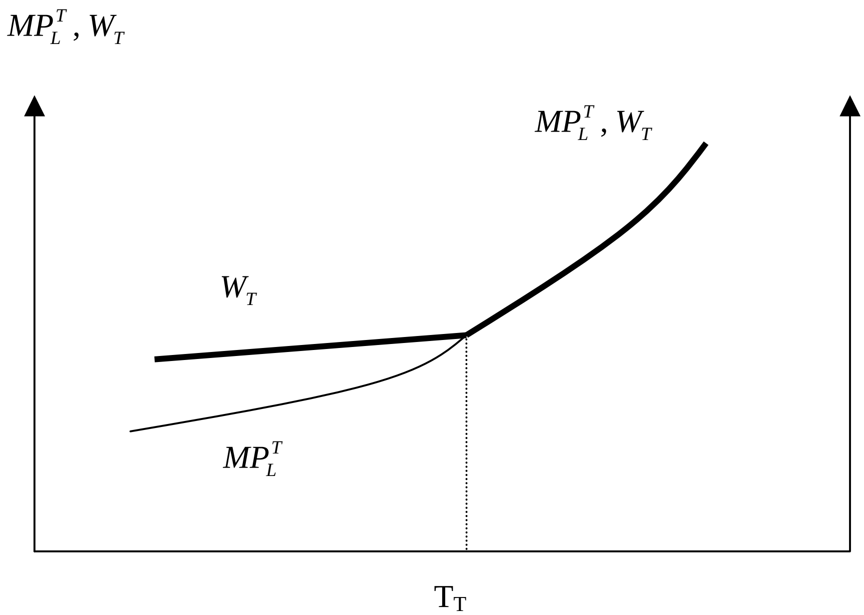
$w1 = \frac{1}{n}\sum_{i=1}^{n}\overline{w}_i$, and $w2 = \frac{\sum_{i=1}^{n}\overline{w}_i \cdot L_i}{\sum_{i=1}^{n} L_i}$, where $\overline{w}_i$ is the average wage for province i, and L_i is the size of its labor force.

Figure 1: Turning point hypothesis of the Lewis model



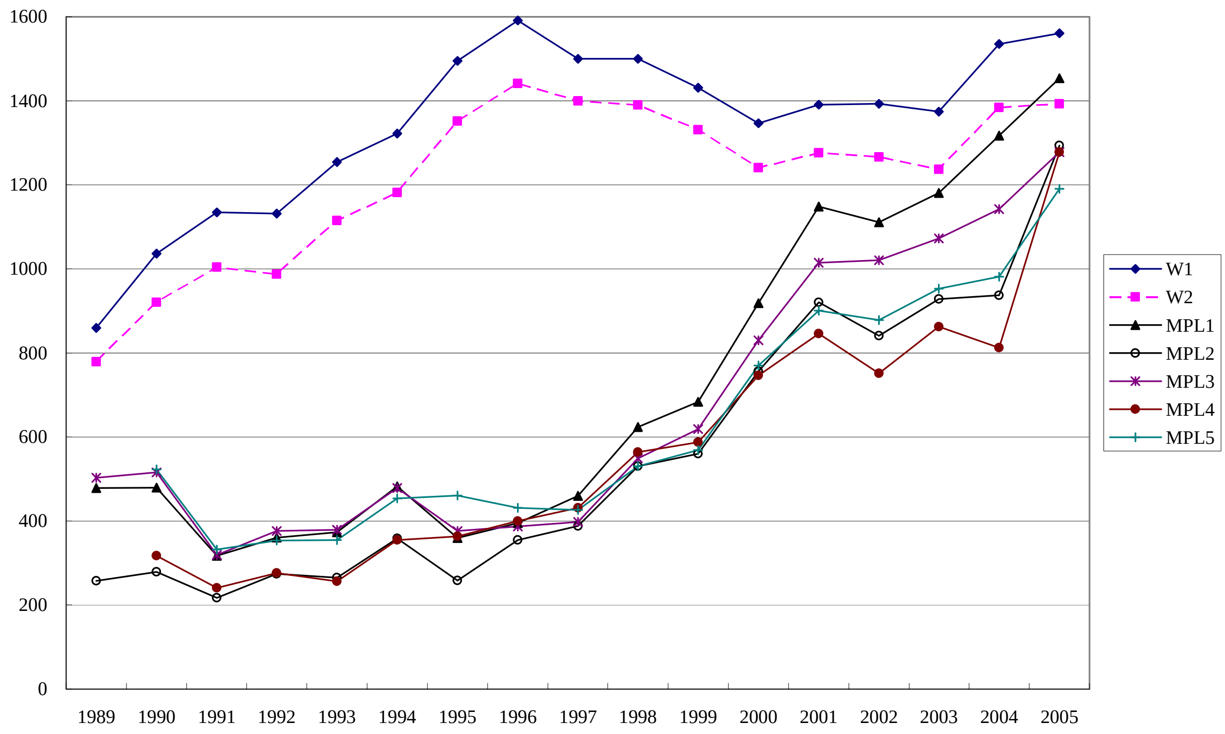
Notes: Figure 1 presents the Turning Point hypothesis of the Lewis model. In it w_T and w_M represent the wage curves of the traditional and modern sector, respectively. The figure shows that (i) both the wage curves are characterized by the presence of a Turning Point, (ii) the Turning Point for w_T (denoted by T_T) may precede that for w_M, and denoted by T_M, and (iii) eventually the two curves come closer as the duality of the economy disappears.

Figure 2: Marginal product and wage in the traditional sector.



Notes: Figure 2 illustrates the underlying process that causes the Turning Point. Initially the marginal product of labor in the traditional sector (MP_L^T) is very low, due to output-maximizing behavior. The wage in the sector (w_T) is higher than MP_L^T due to the 'kinship/community rule' of distribution. As the economy industrializes and more labor from traditional sector finds employment in the modern sector, and due to other productivity improvements, MP_L^T rises, but does not affect w_T until the Turning Point (T_T) is reached, from which point onwards w_T rises in tandem with w_T .

Figure 3: Marginal product and wage of labor
(Yuan at 2000 constant price)



Notes:

$MP_L 1$ is obtained from OLS estimation of Equation (1) as shown in Table 1.

$MP_L 2$ is obtained from OLS estimation of Equation (2) as shown in Table 2.

$MP_L 3$ is obtained from pooled estimation of Equation (3) as shown in Table 3.

$MP_L 4$ is obtained from Instrumental Variable (IV) estimation of Equation (2) as shown in Table 4.

$MP_L 5$ is obtained from Instrumental Variable (IV) estimation of Equation (3) as shown in Table 4.

The wage variables, namely *w*1 and *w*2, are simple and weighted averages of provincial wages, computed using the following formula:

$w1 = \frac{1}{n}\sum_{i=1}^{n} \overline{w}_i$, and $w2 = \frac{\sum_{i=1}^{n} \overline{w}_i \cdot L_i}{\sum_{i=1}^{n} L_i}$, where $\overline{w}_i$ is the average wage for province i, and L_i is the size of its labor force.

Table A1 Summary statistics of variables

	Province	Obs	ln Value-added		ln Labor		ln Land		ln Capital		Region
			Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.	
1	Beijing	18	3.8548	0.1124	3.4932	0.2512	6.1747	0.2471	6.0076	0.0966	1
2	Yianjin	18	3.6756	0.2159	3.8186	0.1922	6.3148	0.0529	6.2642	0.1440	1
3	Hebei	18	5.9457	0.5124	6.9063	0.1576	9.0844	0.0173	8.4857	0.4405	1
4	Shanxi	18	4.6669	0.3272	6.0435	0.0722	8.2728	0.0307	7.2723	0.2704	2
5	Inner Mongolia	18	5.0481	0.4557	5.6685	0.1404	8.5863	0.1102	6.9765	0.3292	3
6	Liaoning	18	5.4328	0.3788	5.7362	0.0883	8.2086	0.0255	7.0825	0.2063	1
7	Jilin	18	5.2927	0.4242	5.7824	0.1530	8.3622	0.0821	6.6949	0.3245	2
8	Heilongjiang	18	5.5621	0.4217	5.9560	0.1892	9.1129	0.0661	7.2510	0.2134	2
9	Shanghai	18	3.6048	0.2110	3.4285	0.1097	6.2795	0.1489	5.1154	0.3220	1
10	Jiangsu	18	6.2655	0.3347	6.7319	0.1815	8.9842	0.0286	7.8106	0.1704	1
11	Zhejiang	18	5.7077	0.3467	6.2914	0.2077	8.2159	0.1580	7.3928	0.2249	1
12	Anhui	18	5.8691	0.3224	7.0308	0.1313	9.0546	0.0434	7.6751	0.4209	2
13	Fujian	18	5.3219	0.4742	5.8035	0.0935	7.9166	0.0547	6.6438	0.1912	1
14	Jiangxi	18	5.3258	0.3618	6.2812	0.1218	8.6362	0.0540	6.7250	0.3155	2
15	Shandong	18	6.4155	0.3595	7.2133	0.0991	9.3004	0.0159	8.5116	0.4066	1
16	Henan	18	6.2860	0.4403	7.5649	0.0994	9.4401	0.0554	8.2730	0.4823	2
17	Hubei	18	5.9007	0.2879	6.6191	0.1598	8.9077	0.0288	7.1840	0.1857	2
18	Hunan	18	5.9355	0.3874	6.9922	0.1169	8.9705	0.0191	7.4739	0.3329	2
19	Guangdong	18	6.1357	0.3396	6.6559	0.1200	8.5693	0.0536	7.3634	0.1451	1
20	Guangxi	18	5.5292	0.4658	6.6978	0.0780	8.6664	0.0994	7.0577	0.3252	3
21	Hainan	18	4.0877	0.5188	4.2886	0.1041	6.7541	0.0657	5.1848	0.2221	1
22	Sichuan	18	6.3116	0.2430	7.4775	0.3348	9.3030	0.1441	7.3420	0.1774	3
23	Guizhou	18	4.9976	0.3233	6.7182	0.1495	8.3472	0.1155	6.1267	0.4205	3
24	Yunnan	18	5.3699	0.3666	6.8787	0.1146	8.5462	0.1154	6.9239	0.3517	3
25	Shaanxi	18	5.1338	0.3093	6.5260	0.1019	8.4280	0.0641	6.7992	0.2465	3
26	Gansu	18	4.6883	0.4292	6.1814	0.0956	8.2117	0.0204	6.7285	0.3207	3
27	Qinghai	18	2.7174	0.2969	4.0926	0.1428	6.2796	0.0676	5.2844	0.3568	3
28	Ningxia	18	3.2764	0.3631	4.5027	0.1116	6.8903	0.0950	5.6783	0.3975	3
29	Xianjiang	18	5.1839	0.4128	5.3760	0.1135	8.0760	0.0771	6.5742	0.2625	3
	1990	29	4.7327	0.9674	6.0002	1.2120	8.2012	0.9745	6.6060	0.8238	
	1995	29	5.2746	0.9885	5.9925	1.2090	8.2100	0.9817	6.7997	0.8597	
	2000	29	5.3202	1.0174	5.9653	1.1767	8.2235	1.0057	7.0763	0.9537	
	2005	29	5.6268	1.0519	5.7727	1.1851	8.1833	1.0751	7.3169	1.0233	

Notes: Value-added is in 100 million Yuan, labor is in 10,000 persons, capital is measured by the number of large- and medium-sized tractors in units, and land is in 1,000 hectare in original units. Region indicates that 1 means coastal region, 2 means middle region, and 3 means western region. Chongqing and Tibet are dropped from the sample because of the limitation of data availability.

Data source: Number of labor force (labor), total sown area (land), total power of agricultural machinery (capital), and consumer price index (CPI) are from *The China Statistical Yearbook*, respective years. Value-added, the net per capita income in the agriculture sector (F), the average number of persons in a family ($\overline{N}$), and the average number of laborers in a family ($\overline{L}$) are from *The China Rural Statistical Yearbook*, respective years.

References

Bramall, C., 2000, *Sources of Chinese Economic Growth 1978-1996.* Oxford University Press, Oxford.

Cai, F. ed. 2007, The Coming Lewisian Turning Point and Its Pollicy Implications. Reports on China's Population and Labor, No.8. Social Science Academic Press, Beijing.

Choo, H. J., 1971, On the empirical relevance of the Ranis-Fei model of economic development: comment. *American Economic Review*, **61**, pp. 695-703.

Coate, S. and M. Ravallion, 1993, Reciprocity without commitment: characterization and performance of informal insurance arrangements. *Journal of Development Economics*, **40**, pp. 1-24.

Department of Rural Survey, National Bureau of Statistics of China (various years), *The China Rural Statistical Yearbook.*

Eswaran, M. and A. Kotwal, 1993, A theory of real wage growth in LDCs. *Journal of Development Economics*, **42**, pp. 243-69.

Fafchamps, M. and S. Lund, 2003, Risk-sharing networks in rural philippines. *Journal of Development Economics*, **71**, pp. 261-87.

Fei, J. C. H. and G. Ranis, 1963, Innovation, capital accumulation, and economic development. *American Economic Review*, **53**, pp. 282-313.

Fei, J. C. H. and G. Ranis, 1964, *The Development of the Labour Surplus Economy*, Irwin, Homewood, IL.

Fei, J. C. H. and G. Ranis, 1969, Economic development in historical perspective. *American Economic Review*, **59** pp. 386-400.

Fei, J. C. H. and G. Ranis, 1997, *Growth and Development from and Evolutionary Perspective*. Basil Blackwell, Oxford.

Fields, G. S., 1994, Changing labor market conditions and economic development in Hong Kong, the Republic of Korea, Singapore, and Taiwan, China. *World Bank Economic Review*, **8**, pp. 395-414.

Fields, G. S., 2004, Dualism in the labor market: a perspective on the lewis model after half a century. *The Manchester School*, **72**, pp. 724-35.

Findlay, R., 1980, On Arthur Lewis' contribution to economics. *Scandinavian Journal of Economics*, **82,** pp. 62-76.

Gang, F. 2005, Coming collapse or continued economic growth? In: *Challenges for China's Development: An Enterprise Perspective* (eds Brown, D. H. and MacBean, A.), Routledge, London.

Gersovitz, M., C. Diaz-Alejandro, G. Ranis, and M. Rosenzweig (editors). 1982, *The Theory and Experiences of Economic Development: Essays in Honor of Sir W. Arthur Lewis*. Allen and Unwin, London.

Harris, J. and Todaro, M., 1970, Migration, unemployment, and development: a two-sector analysis. *American Economic Review*, **40**, pp. 126-42.

Huang, Y., 1971, Tenancy patterns, productivity, and rentals in Malaysia. *Economic Development and Cultural Change*, **23**, pp. 703-18.

Islam, N., 1995, Growth empirics: A panel data approach. *Quarterly Journal of Economics*, **110**, pp. 1127-70.

Islam, N., 2004, New growth theories: What is in there for developing countries? *Journal of Developing Areas*, **38** (1), pp. 171-213.

Islam, N. and K. Yokota, 2006, An initial look at China's industrialization in light of the Lewis growth model. *East Asian Economic Perspectives*, **17**, pp. 103-32.
Jorgenson, D. W., 1961, The development of a dual economy. *Economic Journal*, **71**, pp. 309-34.
Jorgenson, D. W., 1967, Surplus agricultural labor and the development of a dual economy. *Oxford Economic Papers*, New Series, **19**, pp. 288-312.
Kirkpatrick, C. and A. Barrientos, 2004, The Lewis model after 50 years. *The Manchester School*, **72**, pp. 679-90.
Laitner, J., 2003, Structural change and economic growth. *Review of Economic Studies*, **67**, pp. 545-61.
Lesson, P., 1979, The Lewis model and development theory. *The Manchester School*, **57**, pp. 196-210.
Lewis, A. W., 1954, Economic development with unlimited supplies of labor. *The Manchester School*, **22**, pp. 139-91.
Lewis, A. W., 1955, *The Theory of Economic Growth*, Richard D. Irwin, Homewood, IL.
Lewis, A. W., 1972, Reflections on unlimited supplies of labor. In: *International Economics and Development-Essays in Honor of Raul Prebisch*(ed diMarco. L. E.), Academic Press, New York, pp. 75-96.
Lewis, A. W., 1979, The dual economy revisited. *The Manchester School*, **47**, pp. 211-29.
Lewis, A. W., 1980, Autobiographical note. *Social and Economic Studies*, **29**, pp. 1-4.
Lewis, A. W., 1984, Development economics in the 1950s. In: *Pioneers in Development* (eds Meier, G. and Seers, D.), Oxford University Press, Oxford, pp. 121-37.
Lin, J. Y., 1992, Rural reforms and agricultural growth in China. *American Economic Review*, **82**, pp. 34-51.
Lindert, P. H. and J. Williamson, 1983, English workers' living standards during the industrial revolution: a new look. *The Economic History Review*, Second Series, **36**, pp. 1-25.
Matsuyama, K., 1992, Agricultural productivity, comparative advantage, and economic growth. *Journal of Economic Theory*, **58**, pp. 317-34.
Matsuyama, K., forthcoming, Structural change. draft for New Palgrave Dictionary of Economics, http://faculty.wcas.northwestern.edu/~kmatsu/Structural%20Change.pdf
Minami, R., 1964, Economic growth and labor supply. *Oxford Economic Papers*, New Series, **16**, pp. 194-200.
Minami, R., 1966, A model of economic development from classical to neoclassical stages. *Weltwirtschaftliches Archiv*, **97**, pp. 345-54.
Minami, R., 1967, Population migration away from agriculture in Japan. *Economic Development and Cultural Change*, **15**, pp. 183-201.
Minami, R., 1968, The turning point in the Japanese economy. *Quarterly Journal of Economics*, **82**, pp. 380-402.
Minami, R., 1973, *The Turning Point in Economic Development: Japan's Experience*, Economic Research Series No. 14, The Institute of Economic Research, Hitotsubashi University, Kinokuniya Bookstore, Tokyo.
National Bureau of Statistics of China (various years), *The China Statistical Yearbook*, Beijing.
Nelson, R. R., 1956, A theory of the low-level equilibrium trap in underdeveloped economies. *American Economic Review*, **46**, pp. 894-908.
Oshima, H. T., 1963, The Fei-Ranis model of economic development: comment. *American Economic Review*, **53**, pp. 448-52.

Putterman, L., 1992, Dualism and reform in China. *Economic Development and Cultural Change*, **40**, pp. 467-94.
Ranis, G., 1957, Factor proportions in Japanese economic development. *American Economic Review*, **47**, pp. 594-607.
Ranis, G., 1963, Allocation criteria and population growth. *American Economic Review*, **53** pp. 619-33.
Ranis, G., 1973, Industrial sector labor absorption. *Economic Development and Cultural Change*, **21**, pp. 387-408.
Ranis, G., 1978, Equity with growth in Taiwan: how special is the special case? *World Development*, **6,** pp. 397-409.
Ranis, G., 1992, *Taiwan: From Developing to Mature Economy*. Westview Press, Boulder, CO.
Ranis, G., 1995, Another look at the East Asian miracle. *World Bank Economic Review*, **9**, pp. 509-34.
Ranis, G., 2004, Arthur Lewis's contribution to development thinking and policy. *The Manchester School*, **72**, pp. 712-23.
Ranis, G. and J. C. H. Fei, 1961, A theory of economic development. *American Economic Review*, **51**, pp. 533-65.
Ranis, G. and J. C. H. Fei, 1963, The Ranis-Fei model of economic development: a reply. *American Economic Review,* **53** pp. 452-54.
Ranis, G. and J.C.H. Fei, 1975, A model of growth and employment in the open dualistic economy, the cases of Korea and Taiwan. *Journal of Development Studies*, **12**, pp.32-63.
Rosenzweig, M., 1988, Labor markets in low income countries. In: *Handbook of Development Economics*, **1** (eds Chenery, H. and Srinivason, T. N.),, Amsterdam, North-Holland.
Reubens, E. P., 1964, Capital-labor ratios in theory and in history: comment. *American Economic Review*, **54**, pp. 1052-62.
Sen, A. K., 1966, Peasants and dualism with and without surplus labor. *Journal of Political Economy*, **74**, pp. 425-50.
Sen, A. K., 1967a, Surplus labor in India: a critique of Schultz's statistical test. *Economic Journal*, **77**, pp. 154-61.
Sen, A. K., 1967b, Review of J.C.H. Fei and G. Ranis, 'Development of the Labor Surplus Economy: Theory and Policy. *Economic Journal*, **77**, pp. 346-49.
Tignor, R., 2004, Unlimited supplies of labor. *The Manchester School*, **72**, pp. 691-711.
Townsend, R. M., 1994, Risk and insurance in village India. *Econometrica*, **62**, pp. 539-91.
Weitzman, M., 1984, *The Share Economy, Conquering Stagflation,* Harvard University Press, Cambridge, MA.
Williamson, J., 1982, The structure of pay in Britain, 1710-1911. *Research in Economic History*, **7**, pp. 1-54.
Xu, Y., 1994, Trade liberalization in China: a CGE model with Lewis rural surplus labor. *China Economic Review*, **5**, pp. 205-19.
Yasuba, Y., 1976, The evolution of dualistic wage structure. I: *Japanese Industrialization and Its Social Consequences* (ed Hugh Patrick), University of California Press, Berkeley.